

GiNaC

1.8.7

Generated by Doxygen 1.13.2

1 Namespace Index	1
1.1 Namespace List	1
2 Hierarchical Index	3
2.1 Class Hierarchy	3
3 Class Index	7
3.1 Class List	7
4 File Index	15
4.1 File List	15
5 Namespace Documentation	19
5.1 GiNaC Namespace Reference	19
5.1.1 Typedef Documentation	58
5.1.1.1 archive_node_id	58
5.1.1.2 archive_atom	58
5.1.1.3 synthesize_func	58
5.1.1.4 unarchive_map_t	58
5.1.1.5 exvector	58
5.1.1.6 exset	59
5.1.1.7 exmap	59
5.1.1.8 evalffunctype	59
5.1.1.9 FUNCP_1P	59
5.1.1.10 FUNCP_2P	59
5.1.1.11 FUNCP_CUBA	59
5.1.1.12 epvector	59
5.1.1.13 epp	59
5.1.1.14 exprseq	60
5.1.1.15 paramset	60
5.1.1.16 eval_funcp	60
5.1.1.17 evalf_funcp	60
5.1.1.18 conjugate_funcp	60
5.1.1.19 real_part_funcp	60
5.1.1.20 imag_part_funcp	60
5.1.1.21 expand_funcp	60
5.1.1.22 derivative_funcp	60
5.1.1.23 expl_derivative_funcp	60
5.1.1.24 power_funcp	61
5.1.1.25 series_funcp	61
5.1.1.26 print_funcp	61
5.1.1.27 info_funcp	61
5.1.1.28 eval_funcp_1	61
5.1.1.29 evalf_funcp_1	61

5.1.1.30 conjugate_funcp_1	61
5.1.1.31 real_part_funcp_1	61
5.1.1.32 imag_part_funcp_1	61
5.1.1.33 expand_funcp_1	61
5.1.1.34 derivative_funcp_1	62
5.1.1.35 expl_derivative_funcp_1	62
5.1.1.36 power_funcp_1	62
5.1.1.37 series_funcp_1	62
5.1.1.38 print_funcp_1	62
5.1.1.39 info_funcp_1	62
5.1.1.40 eval_funcp_2	62
5.1.1.41 evalf_funcp_2	62
5.1.1.42 conjugate_funcp_2	62
5.1.1.43 real_part_funcp_2	62
5.1.1.44 imag_part_funcp_2	63
5.1.1.45 expand_funcp_2	63
5.1.1.46 derivative_funcp_2	63
5.1.1.47 expl_derivative_funcp_2	63
5.1.1.48 power_funcp_2	63
5.1.1.49 series_funcp_2	63
5.1.1.50 print_funcp_2	63
5.1.1.51 info_funcp_2	63
5.1.1.52 eval_funcp_3	63
5.1.1.53 evalf_funcp_3	63
5.1.1.54 conjugate_funcp_3	64
5.1.1.55 real_part_funcp_3	64
5.1.1.56 imag_part_funcp_3	64
5.1.1.57 expand_funcp_3	64
5.1.1.58 derivative_funcp_3	64
5.1.1.59 expl_derivative_funcp_3	64
5.1.1.60 power_funcp_3	64
5.1.1.61 series_funcp_3	64
5.1.1.62 print_funcp_3	64
5.1.1.63 info_funcp_3	64
5.1.1.64 eval_funcp_4	65
5.1.1.65 evalf_funcp_4	65
5.1.1.66 conjugate_funcp_4	65
5.1.1.67 real_part_funcp_4	65
5.1.1.68 imag_part_funcp_4	65
5.1.1.69 expand_funcp_4	65
5.1.1.70 derivative_funcp_4	65
5.1.1.71 expl_derivative_funcp_4	65

5.1.1.72 power_funcp_4	65
5.1.1.73 series_funcp_4	65
5.1.1.74 print_funcp_4	66
5.1.1.75 info_funcp_4	66
5.1.1.76 eval_funcp_5	66
5.1.1.77 evalf_funcp_5	66
5.1.1.78 conjugate_funcp_5	66
5.1.1.79 real_part_funcp_5	66
5.1.1.80 imag_part_funcp_5	66
5.1.1.81 expand_funcp_5	66
5.1.1.82 derivative_funcp_5	66
5.1.1.83 expl_derivative_funcp_5	67
5.1.1.84 power_funcp_5	67
5.1.1.85 series_funcp_5	67
5.1.1.86 print_funcp_5	67
5.1.1.87 info_funcp_5	67
5.1.1.88 eval_funcp_6	67
5.1.1.89 evalf_funcp_6	67
5.1.1.90 conjugate_funcp_6	67
5.1.1.91 real_part_funcp_6	67
5.1.1.92 imag_part_funcp_6	68
5.1.1.93 expand_funcp_6	68
5.1.1.94 derivative_funcp_6	68
5.1.1.95 expl_derivative_funcp_6	68
5.1.1.96 power_funcp_6	68
5.1.1.97 series_funcp_6	68
5.1.1.98 print_funcp_6	68
5.1.1.99 info_funcp_6	68
5.1.1.100 eval_funcp_7	68
5.1.1.101 evalf_funcp_7	69
5.1.1.102 conjugate_funcp_7	69
5.1.1.103 real_part_funcp_7	69
5.1.1.104 imag_part_funcp_7	69
5.1.1.105 expand_funcp_7	69
5.1.1.106 derivative_funcp_7	69
5.1.1.107 expl_derivative_funcp_7	69
5.1.1.108 power_funcp_7	69
5.1.1.109 series_funcp_7	69
5.1.1.110 print_funcp_7	70
5.1.1.111 info_funcp_7	70
5.1.1.112 eval_funcp_8	70
5.1.1.113 evalf_funcp_8	70

5.1.1.114 conjugate_funcp_8	70
5.1.1.115 real_part_funcp_8	70
5.1.1.116 imag_part_funcp_8	70
5.1.1.117 expand_funcp_8	70
5.1.1.118 derivative_funcp_8	70
5.1.1.119 expl_derivative_funcp_8	71
5.1.1.120 power_funcp_8	71
5.1.1.121 series_funcp_8	71
5.1.1.122 print_funcp_8	71
5.1.1.123 info_funcp_8	71
5.1.1.124 eval_funcp_9	71
5.1.1.125 evalf_funcp_9	71
5.1.1.126 conjugate_funcp_9	71
5.1.1.127 real_part_funcp_9	71
5.1.1.128 imag_part_funcp_9	72
5.1.1.129 expand_funcp_9	72
5.1.1.130 derivative_funcp_9	72
5.1.1.131 expl_derivative_funcp_9	72
5.1.1.132 power_funcp_9	72
5.1.1.133 series_funcp_9	72
5.1.1.134 print_funcp_9	72
5.1.1.135 info_funcp_9	72
5.1.1.136 eval_funcp_10	72
5.1.1.137 evalf_funcp_10	73
5.1.1.138 conjugate_funcp_10	73
5.1.1.139 real_part_funcp_10	73
5.1.1.140 imag_part_funcp_10	73
5.1.1.141 expand_funcp_10	73
5.1.1.142 derivative_funcp_10	73
5.1.1.143 expl_derivative_funcp_10	73
5.1.1.144 power_funcp_10	73
5.1.1.145 series_funcp_10	73
5.1.1.146 print_funcp_10	74
5.1.1.147 info_funcp_10	74
5.1.1.148 eval_funcp_11	74
5.1.1.149 evalf_funcp_11	74
5.1.1.150 conjugate_funcp_11	74
5.1.1.151 real_part_funcp_11	74
5.1.1.152 imag_part_funcp_11	74
5.1.1.153 expand_funcp_11	74
5.1.1.154 derivative_funcp_11	74
5.1.1.155 expl_derivative_funcp_11	75

5.1.1.156 power_funcp_11	75
5.1.1.157 series_funcp_11	75
5.1.1.158 print_funcp_11	75
5.1.1.159 info_funcp_11	75
5.1.1.160 eval_funcp_12	75
5.1.1.161 evalf_funcp_12	75
5.1.1.162 conjugate_funcp_12	75
5.1.1.163 real_part_funcp_12	76
5.1.1.164 imag_part_funcp_12	76
5.1.1.165 expand_funcp_12	76
5.1.1.166 derivative_funcp_12	76
5.1.1.167 expl_derivative_funcp_12	76
5.1.1.168 power_funcp_12	76
5.1.1.169 series_funcp_12	76
5.1.1.170 print_funcp_12	76
5.1.1.171 info_funcp_12	77
5.1.1.172 eval_funcp_13	77
5.1.1.173 evalf_funcp_13	77
5.1.1.174 conjugate_funcp_13	77
5.1.1.175 real_part_funcp_13	77
5.1.1.176 imag_part_funcp_13	77
5.1.1.177 expand_funcp_13	77
5.1.1.178 derivative_funcp_13	77
5.1.1.179 expl_derivative_funcp_13	78
5.1.1.180 power_funcp_13	78
5.1.1.181 series_funcp_13	78
5.1.1.182 print_funcp_13	78
5.1.1.183 info_funcp_13	78
5.1.1.184 eval_funcp_14	78
5.1.1.185 evalf_funcp_14	78
5.1.1.186 conjugate_funcp_14	78
5.1.1.187 real_part_funcp_14	79
5.1.1.188 imag_part_funcp_14	79
5.1.1.189 expand_funcp_14	79
5.1.1.190 derivative_funcp_14	79
5.1.1.191 expl_derivative_funcp_14	79
5.1.1.192 power_funcp_14	79
5.1.1.193 series_funcp_14	79
5.1.1.194 print_funcp_14	79
5.1.1.195 info_funcp_14	80
5.1.1.196 eval_funcp_exvector	80
5.1.1.197 evalf_funcp_exvector	80

5.1.1.198 conjugate_funcp_exvector	80
5.1.1.199 real_part_funcp_exvector	80
5.1.1.200 imag_part_funcp_exvector	80
5.1.1.201 expand_funcp_exvector	80
5.1.1.202 derivative_funcp_exvector	80
5.1.1.203 expl_derivative_funcp_exvector	80
5.1.1.204 power_funcp_exvector	80
5.1.1.205 series_funcp_exvector	81
5.1.1.206 print_funcp_exvector	81
5.1.1.207 info_funcp_exvector	81
5.1.1.208 exhashmap	81
5.1.1.209 spmap	81
5.1.1.210 lookup_map	81
5.1.1.211 lst	81
5.1.1.212 uintvector	81
5.1.1.213 unsignedvector	81
5.1.1.214 exvectorvector	81
5.1.1.215 sym_desc_vec	82
5.1.1.216 digits_changed_callback	82
5.1.1.217 print_context_class_info	82
5.1.1.218 registered_class_info	82
5.1.2 Enumeration Type Documentation	82
5.1.2.1 anonymous enum	82
5.1.3 Function Documentation	82
5.1.3.1 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [1/33]	82
5.1.3.2 GINAC_BIND_UNARCHIVER() [1/49]	83
5.1.3.3 GINAC_DECLARE_UNARCHIVER() [1/51]	83
5.1.3.4 write_unsigned()	83
5.1.3.5 read_unsigned()	83
5.1.3.6 operator<<() [1/16]	83
5.1.3.7 operator<<() [2/16]	83
5.1.3.8 operator>>() [1/3]	84
5.1.3.9 operator>>() [2/3]	84
5.1.3.10 find_factory_fcn()	84
5.1.3.11 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [2/33]	84
5.1.3.12 is_a() [1/3]	85
5.1.3.13 is_exactly_a() [1/2]	85
5.1.3.14 dynallocate() [1/2]	86
5.1.3.15 dynallocate() [2/2]	87
5.1.3.16 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [3/33]	87
5.1.3.17 print_func< print_dflt >() [1/3]	87
5.1.3.18 GINAC_BIND_UNARCHIVER() [2/49]	88

5.1.3.19 GINAC_BIND_UNARCHIVER() [3/49]	88
5.1.3.20 GINAC_BIND_UNARCHIVER() [4/49]	88
5.1.3.21 GINAC_BIND_UNARCHIVER() [5/49]	88
5.1.3.22 GINAC_BIND_UNARCHIVER() [6/49]	88
5.1.3.23 GINAC_BIND_UNARCHIVER() [7/49]	88
5.1.3.24 GINAC_BIND_UNARCHIVER() [8/49]	88
5.1.3.25 is_dirac_slash()	88
5.1.3.26 base_and_index()	89
5.1.3.27 dirac_ONE()	89
5.1.3.28 get_dim_uint()	89
5.1.3.29 clifford_unit()	89
5.1.3.30 dirac_gamma()	90
5.1.3.31 dirac_gamma5()	90
5.1.3.32 dirac_gammaL()	90
5.1.3.33 dirac_gammaR()	91
5.1.3.34 dirac_slash()	91
5.1.3.35 get_representation_label() [1/2]	92
5.1.3.36 trace_string()	92
5.1.3.37 dirac_trace() [1/3]	92
5.1.3.38 dirac_trace() [2/3]	92
5.1.3.39 dirac_trace() [3/3]	93
5.1.3.40 canonicalize_clifford()	93
5.1.3.41 clifford_star_bar()	93
5.1.3.42 clifford_prime()	94
5.1.3.43 remove_dirac_ONE()	94
5.1.3.44 clifford_max_label()	94
5.1.3.45 clifford_norm()	95
5.1.3.46 clifford_inverse()	95
5.1.3.47 lst_to_clifford() [1/2]	95
5.1.3.48 lst_to_clifford() [2/2]	95
5.1.3.49 get_clifford_comp()	96
5.1.3.50 clifford_to_lst()	96
5.1.3.51 clifford_moebius_map() [1/2]	97
5.1.3.52 clifford_moebius_map() [2/2]	97
5.1.3.53 GINAC_DECLARE_UNARCHIVER() [2/51]	98
5.1.3.54 GINAC_DECLARE_UNARCHIVER() [3/51]	98
5.1.3.55 GINAC_DECLARE_UNARCHIVER() [4/51]	98
5.1.3.56 GINAC_DECLARE_UNARCHIVER() [5/51]	98
5.1.3.57 GINAC_DECLARE_UNARCHIVER() [6/51]	98
5.1.3.58 GINAC_DECLARE_UNARCHIVER() [7/51]	98
5.1.3.59 GINAC_DECLARE_UNARCHIVER() [8/51]	98
5.1.3.60 is_clifford_tinfo()	98

5.1.3.61 clifford_bar()	99
5.1.3.62 clifford_star()	99
5.1.3.63 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [4/33]	99
5.1.3.64 print_func< print_dflt >() [2/3]	99
5.1.3.65 GINAC_BIND_UNARCHIVER() [9/49]	99
5.1.3.66 GINAC_BIND_UNARCHIVER() [10/49]	100
5.1.3.67 GINAC_BIND_UNARCHIVER() [11/49]	100
5.1.3.68 GINAC_BIND_UNARCHIVER() [12/49]	100
5.1.3.69 GINAC_BIND_UNARCHIVER() [13/49]	100
5.1.3.70 permute_free_index_to_front()	100
5.1.3.71 color_ONE()	100
5.1.3.72 color_T()	101
5.1.3.73 color_f()	101
5.1.3.74 color_d()	102
5.1.3.75 color_h()	102
5.1.3.76 is_color_tinfo()	102
5.1.3.77 get_representation_label() [2/2]	103
5.1.3.78 color_trace() [1/3]	103
5.1.3.79 color_trace() [2/3]	104
5.1.3.80 color_trace() [3/3]	104
5.1.3.81 GINAC_DECLARE_UNARCHIVER() [9/51]	104
5.1.3.82 GINAC_DECLARE_UNARCHIVER() [10/51]	105
5.1.3.83 GINAC_DECLARE_UNARCHIVER() [11/51]	105
5.1.3.84 GINAC_DECLARE_UNARCHIVER() [12/51]	105
5.1.3.85 GINAC_DECLARE_UNARCHIVER() [13/51]	105
5.1.3.86 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [5/33]	105
5.1.3.87 GINAC_BIND_UNARCHIVER() [14/49]	105
5.1.3.88 GINAC_DECLARE_UNARCHIVER() [14/51]	105
5.1.3.89 crc32()	106
5.1.3.90 are_ex_trivially_equal()	106
5.1.3.91 operator<<() [3/16]	106
5.1.3.92 operator<<() [4/16]	106
5.1.3.93 operator<<() [5/16]	107
5.1.3.94 nops() [1/2]	107
5.1.3.95 expand() [1/2]	107
5.1.3.96 conjugate()	107
5.1.3.97 real_part()	107
5.1.3.98 imag_part()	108
5.1.3.99 has()	108
5.1.3.100 find()	108
5.1.3.101 is_polynomial()	108
5.1.3.102 degree()	108

5.1.3.103 ldegree()	109
5.1.3.104 coeff()	109
5.1.3.105 numer() [1/2]	109
5.1.3.106 denom() [1/2]	109
5.1.3.107 numer_denom()	109
5.1.3.108 normal()	110
5.1.3.109 to_rational()	110
5.1.3.110 to_polynomial()	110
5.1.3.111 collect()	110
5.1.3.112 eval()	110
5.1.3.113 evalf() [1/2]	110
5.1.3.114 evalm()	111
5.1.3.115 eval_integ()	111
5.1.3.116 diff()	111
5.1.3.117 series()	111
5.1.3.118 match()	111
5.1.3.119 simplify_indexed() [1/3]	112
5.1.3.120 simplify_indexed() [2/3]	112
5.1.3.121 symmetrize() [1/4]	112
5.1.3.122 symmetrize() [2/4]	112
5.1.3.123 antisymmetrize() [1/4]	112
5.1.3.124 antisymmetrize() [2/4]	113
5.1.3.125 symmetrize_cyclic() [1/4]	113
5.1.3.126 symmetrize_cyclic() [2/4]	113
5.1.3.127 op()	113
5.1.3.128 lhs()	113
5.1.3.129 rhs()	114
5.1.3.130 is_zero() [1/2]	114
5.1.3.131 swap() [1/2]	114
5.1.3.132 subs() [1/3]	114
5.1.3.133 subs() [2/3]	114
5.1.3.134 subs() [3/3]	115
5.1.3.135 is_a() [2/3]	115
5.1.3.136 is_exactly_a() [2/2]	115
5.1.3.137 ex_to()	115
5.1.3.138 compile_ex() [1/3]	117
5.1.3.139 compile_ex() [2/3]	117
5.1.3.140 compile_ex() [3/3]	118
5.1.3.141 link_ex() [1/3]	118
5.1.3.142 link_ex() [2/3]	118
5.1.3.143 link_ex() [3/3]	119
5.1.3.144 unlink_ex()	119

5.1.3.145 swap() [2/2]	119
5.1.3.146 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [6/33]	119
5.1.3.147 conjugateepvector()	120
5.1.3.148 factor()	120
5.1.3.149 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [7/33]	120
5.1.3.150 GINAC_DECLARE_UNARCHIVER() [15/51]	121
5.1.3.151 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [8/33]	121
5.1.3.152 GINAC_BIND_UNARCHIVER() [15/49]	121
5.1.3.153 GINAC_DECLARE_UNARCHIVER() [16/51]	121
5.1.3.154 GINAC_BIND_UNARCHIVER() [16/49]	121
5.1.3.155 GINAC_DECLARE_UNARCHIVER() [17/51]	121
5.1.3.156 is_the_function()	121
5.1.3.157 make_hash_seed()	122
5.1.3.158 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [9/33]	122
5.1.3.159 print_func< print_context >()	122
5.1.3.160 GINAC_BIND_UNARCHIVER() [17/49]	122
5.1.3.161 GINAC_BIND_UNARCHIVER() [18/49]	122
5.1.3.162 GINAC_BIND_UNARCHIVER() [19/49]	122
5.1.3.163 is_dummy_pair() [1/2]	123
5.1.3.164 is_dummy_pair() [2/2]	123
5.1.3.165 find_free_and_dummy() [1/2]	123
5.1.3.166 minimal_dim()	124
5.1.3.167 GINAC_DECLARE_UNARCHIVER() [18/51]	124
5.1.3.168 GINAC_DECLARE_UNARCHIVER() [19/51]	124
5.1.3.169 GINAC_DECLARE_UNARCHIVER() [20/51]	124
5.1.3.170 find_free_and_dummy() [2/2]	124
5.1.3.171 find_dummy_indices()	124
5.1.3.172 count_dummy_indices()	125
5.1.3.173 count_free_indices()	125
5.1.3.174 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [10/33]	125
5.1.3.175 GINAC_BIND_UNARCHIVER() [20/49]	125
5.1.3.176 indices_consistent()	125
5.1.3.177 number_of_type()	126
5.1.3.178 rename_dummy_indices()	126
5.1.3.179 find_variant_indices()	126
5.1.3.180 reposition_dummy_indices()	126
5.1.3.181 product_to_exvector()	127
5.1.3.182 idx_symmetrization()	127
5.1.3.183 simplify_indexed() [3/3]	127
5.1.3.184 simplify_indexed_product()	128
5.1.3.185 hasindex()	128
5.1.3.186 get_all_dummy_indices_safely()	128

5.1.3.187 <code>get_all_dummy_indices()</code>	128
5.1.3.188 <code>rename_dummy_indices_uniquely()</code> [1/4]	129
5.1.3.189 <code>rename_dummy_indices_uniquely()</code> [2/4]	129
5.1.3.190 <code>rename_dummy_indices_uniquely()</code> [3/4]	129
5.1.3.191 <code>rename_dummy_indices_uniquely()</code> [4/4]	129
5.1.3.192 <code>expand_dummy_sum()</code>	129
5.1.3.193 <code>GINAC_DECLARE_UNARCHIVER()</code> [21/51]	130
5.1.3.194 <code>conjugate_evalf()</code>	130
5.1.3.195 <code>conjugate_eval()</code>	130
5.1.3.196 <code>conjugate_print_latex()</code>	130
5.1.3.197 <code>conjugate_conjugate()</code>	130
5.1.3.198 <code>conjugate_expl_derivative()</code>	131
5.1.3.199 <code>conjugate_real_part()</code>	131
5.1.3.200 <code>conjugate_imag_part()</code>	131
5.1.3.201 <code>func_arg_info()</code>	131
5.1.3.202 <code>conjugate_info()</code>	131
5.1.3.203 <code>REGISTER_FUNCTION()</code> [1/36]	132
5.1.3.204 <code>real_part_evalf()</code>	132
5.1.3.205 <code>real_part_eval()</code>	132
5.1.3.206 <code>real_part_print_latex()</code>	132
5.1.3.207 <code>real_part_conjugate()</code>	132
5.1.3.208 <code>real_part_real_part()</code>	133
5.1.3.209 <code>real_part_imag_part()</code>	133
5.1.3.210 <code>real_part_expl_derivative()</code>	133
5.1.3.211 <code>REGISTER_FUNCTION()</code> [2/36]	133
5.1.3.212 <code>imag_part_evalf()</code>	133
5.1.3.213 <code>imag_part_eval()</code>	134
5.1.3.214 <code>imag_part_print_latex()</code>	134
5.1.3.215 <code>imag_part_conjugate()</code>	134
5.1.3.216 <code>imag_part_real_part()</code>	134
5.1.3.217 <code>imag_part_imag_part()</code>	134
5.1.3.218 <code>imag_part_expl_derivative()</code>	134
5.1.3.219 <code>REGISTER_FUNCTION()</code> [3/36]	135
5.1.3.220 <code>abs_evalf()</code>	135
5.1.3.221 <code>abs_eval()</code>	135
5.1.3.222 <code>abs_expand()</code>	135
5.1.3.223 <code>abs_expl_derivative()</code>	135
5.1.3.224 <code>abs_print_latex()</code>	136
5.1.3.225 <code>abs_print_csrc_float()</code>	136
5.1.3.226 <code>abs_conjugate()</code>	136
5.1.3.227 <code>abs_real_part()</code>	136
5.1.3.228 <code>abs_imag_part()</code>	136

5.1.3.229 <code>abs_power()</code>	137
5.1.3.230 <code>abs_info()</code>	137
5.1.3.231 <code>REGISTER_FUNCTION()</code> [4/36]	137
5.1.3.232 <code>step_evalf()</code>	137
5.1.3.233 <code>step_eval()</code>	137
5.1.3.234 <code>step_series()</code>	138
5.1.3.235 <code>step_conjugate()</code>	138
5.1.3.236 <code>step_real_part()</code>	138
5.1.3.237 <code>step_imag_part()</code>	138
5.1.3.238 <code>REGISTER_FUNCTION()</code> [5/36]	138
5.1.3.239 <code>csgn_evalf()</code>	139
5.1.3.240 <code>csgn_eval()</code>	139
5.1.3.241 <code>csgn_series()</code>	139
5.1.3.242 <code>csgn_conjugate()</code>	139
5.1.3.243 <code>csgn_real_part()</code>	139
5.1.3.244 <code>csgn_imag_part()</code>	140
5.1.3.245 <code>csgn_power()</code>	140
5.1.3.246 <code>REGISTER_FUNCTION()</code> [6/36]	140
5.1.3.247 <code>eta_evalf()</code>	140
5.1.3.248 <code>eta_eval()</code>	140
5.1.3.249 <code>eta_series()</code>	141
5.1.3.250 <code>eta_conjugate()</code>	141
5.1.3.251 <code>eta_real_part()</code>	141
5.1.3.252 <code>eta_imag_part()</code>	141
5.1.3.253 <code>REGISTER_FUNCTION()</code> [7/36]	141
5.1.3.254 <code>Li2_evalf()</code>	142
5.1.3.255 <code>Li2_eval()</code>	142
5.1.3.256 <code>Li2_deriv()</code>	142
5.1.3.257 <code>Li2_series()</code> [1/2]	142
5.1.3.258 <code>Li2_conjugate()</code>	142
5.1.3.259 <code>REGISTER_FUNCTION()</code> [8/36]	143
5.1.3.260 <code>Li3_eval()</code>	143
5.1.3.261 <code>REGISTER_FUNCTION()</code> [9/36]	143
5.1.3.262 <code>zetaderiv_eval()</code>	143
5.1.3.263 <code>zetaderiv_deriv()</code>	143
5.1.3.264 <code>REGISTER_FUNCTION()</code> [10/36]	144
5.1.3.265 <code>factorial_evalf()</code>	144
5.1.3.266 <code>factorial_eval()</code>	144
5.1.3.267 <code>factorial_print_dflit_latex()</code>	144
5.1.3.268 <code>factorial_conjugate()</code>	144
5.1.3.269 <code>factorial_real_part()</code>	145
5.1.3.270 <code>factorial_imag_part()</code>	145

5.1.3.271 REGISTER_FUNCTION() [11/36]	145
5.1.3.272 binomial_evalf()	145
5.1.3.273 binomial_sym()	145
5.1.3.274 binomial_eval()	146
5.1.3.275 binomial_conjugate()	146
5.1.3.276 binomial_real_part()	146
5.1.3.277 binomial_imag_part()	146
5.1.3.278 REGISTER_FUNCTION() [12/36]	146
5.1.3.279 Order_eval()	147
5.1.3.280 Order_series()	147
5.1.3.281 Order_conjugate()	147
5.1.3.282 Order_real_part()	147
5.1.3.283 Order_imag_part()	147
5.1.3.284 Order_power()	147
5.1.3.285 Order_expl_derivative()	148
5.1.3.286 REGISTER_FUNCTION() [13/36]	148
5.1.3.287 Isolve()	148
5.1.3.288 fsolve()	148
5.1.3.289 zeta() [1/3]	149
5.1.3.290 zeta() [2/3]	149
5.1.3.291 is_the_function< zeta_SERIAL >()	149
5.1.3.292 G() [1/2]	149
5.1.3.293 G() [2/2]	150
5.1.3.294 is_the_function< G_SERIAL >()	150
5.1.3.295 psi() [1/4]	150
5.1.3.296 psi() [2/4]	150
5.1.3.297 is_the_function< psi_SERIAL >()	150
5.1.3.298 iterated_integral() [1/2]	151
5.1.3.299 iterated_integral() [2/2]	151
5.1.3.300 is_the_function< iterated_integral_SERIAL >()	151
5.1.3.301 is_order_function()	151
5.1.3.302 convert_H_to_Li()	151
5.1.3.303 EllipticK_evalf()	152
5.1.3.304 EllipticK_eval()	152
5.1.3.305 EllipticK_deriv()	152
5.1.3.306 EllipticK_series()	152
5.1.3.307 EllipticK_print_latex()	152
5.1.3.308 REGISTER_FUNCTION() [14/36]	153
5.1.3.309 EllipticE_evalf()	153
5.1.3.310 EllipticE_eval()	153
5.1.3.311 EllipticE_deriv()	153
5.1.3.312 EllipticE_series()	153

5.1.3.313 EllipticE_print_latex()	154
5.1.3.314 REGISTER_FUNCTION() [15/36]	154
5.1.3.315 iterated_integral_evalf_impl()	154
5.1.3.316 iterated_integral2_evalf()	154
5.1.3.317 iterated_integral3_evalf()	154
5.1.3.318 iterated_integral2_eval()	155
5.1.3.319 iterated_integral3_eval()	155
5.1.3.320 lgamma_evalf()	155
5.1.3.321 lgamma_eval()	155
5.1.3.322 lgamma_deriv()	156
5.1.3.323 lgamma_series()	156
5.1.3.324 lgamma_conjugate()	156
5.1.3.325 REGISTER_FUNCTION() [16/36]	156
5.1.3.326 tgamma_evalf()	156
5.1.3.327 tgamma_eval()	156
5.1.3.328 tgamma_deriv()	157
5.1.3.329 tgamma_series()	157
5.1.3.330 tgamma_conjugate()	157
5.1.3.331 REGISTER_FUNCTION() [17/36]	157
5.1.3.332 beta_evalf()	158
5.1.3.333 beta_eval()	158
5.1.3.334 beta_deriv()	158
5.1.3.335 beta_series()	158
5.1.3.336 REGISTER_FUNCTION() [18/36]	158
5.1.3.337 psi1_evalf()	159
5.1.3.338 psi1_eval()	159
5.1.3.339 psi1_deriv()	159
5.1.3.340 psi1_series()	159
5.1.3.341 psi2_evalf()	159
5.1.3.342 psi2_eval()	160
5.1.3.343 psi2_deriv()	160
5.1.3.344 psi2_series()	160
5.1.3.345 G2_evalf()	160
5.1.3.346 G2_eval()	160
5.1.3.347 G3_evalf()	161
5.1.3.348 G3_eval()	161
5.1.3.349 Li_evalf()	161
5.1.3.350 Li_eval()	161
5.1.3.351 Li_series()	162
5.1.3.352 Li_deriv()	162
5.1.3.353 Li_print_latex()	162
5.1.3.354 REGISTER_FUNCTION() [19/36]	162

5.1.3.355 S_evalf()	162
5.1.3.356 S_eval()	163
5.1.3.357 S_series()	163
5.1.3.358 S_deriv()	163
5.1.3.359 S_print_latex()	163
5.1.3.360 REGISTER_FUNCTION() [20/36]	164
5.1.3.361 H_evalf()	164
5.1.3.362 H_eval()	164
5.1.3.363 H_series()	164
5.1.3.364 H_deriv()	164
5.1.3.365 H_print_latex()	165
5.1.3.366 REGISTER_FUNCTION() [21/36]	165
5.1.3.367 zeta1_evalf()	165
5.1.3.368 zeta1_eval()	165
5.1.3.369 zeta1_deriv()	165
5.1.3.370 zeta1_print_latex()	166
5.1.3.371 zeta2_evalf()	166
5.1.3.372 zeta2_eval()	166
5.1.3.373 zeta2_deriv()	166
5.1.3.374 zeta2_print_latex()	166
5.1.3.375 exp_evalf()	166
5.1.3.376 exp_eval()	167
5.1.3.377 exp_expand()	167
5.1.3.378 exp_deriv()	167
5.1.3.379 exp_real_part()	167
5.1.3.380 exp_imag_part()	167
5.1.3.381 exp_conjugate()	168
5.1.3.382 exp_power()	168
5.1.3.383 exp_info()	168
5.1.3.384 REGISTER_FUNCTION() [22/36]	168
5.1.3.385 log_evalf()	168
5.1.3.386 log_eval()	169
5.1.3.387 log_deriv()	169
5.1.3.388 log_series()	169
5.1.3.389 log_real_part()	169
5.1.3.390 log_imag_part()	169
5.1.3.391 log_expand()	170
5.1.3.392 log_conjugate()	170
5.1.3.393 log_info()	170
5.1.3.394 REGISTER_FUNCTION() [23/36]	170
5.1.3.395 sin_evalf()	170
5.1.3.396 sin_eval()	171

5.1.3.397 sin_deriv()	171
5.1.3.398 sin_real_part()	171
5.1.3.399 sin_imag_part()	171
5.1.3.400 sin_conjugate()	171
5.1.3.401 trig_info()	172
5.1.3.402 REGISTER_FUNCTION() [24/36]	172
5.1.3.403 cos_evalf()	172
5.1.3.404 cos_eval()	172
5.1.3.405 cos_deriv()	172
5.1.3.406 cos_real_part()	173
5.1.3.407 cos_imag_part()	173
5.1.3.408 cos_conjugate()	173
5.1.3.409 REGISTER_FUNCTION() [25/36]	173
5.1.3.410 tan_evalf()	173
5.1.3.411 tan_eval()	174
5.1.3.412 tan_deriv()	174
5.1.3.413 tan_real_part()	174
5.1.3.414 tan_imag_part()	174
5.1.3.415 tan_series()	174
5.1.3.416 tan_conjugate()	175
5.1.3.417 REGISTER_FUNCTION() [26/36]	175
5.1.3.418 asin_evalf()	175
5.1.3.419 asin_eval()	175
5.1.3.420 asin_deriv()	175
5.1.3.421 asin_conjugate()	176
5.1.3.422 asin_info()	176
5.1.3.423 REGISTER_FUNCTION() [27/36]	176
5.1.3.424 acos_evalf()	176
5.1.3.425 acos_eval()	176
5.1.3.426 acos_deriv()	177
5.1.3.427 acos_conjugate()	177
5.1.3.428 REGISTER_FUNCTION() [28/36]	177
5.1.3.429 atan_evalf()	177
5.1.3.430 atan_eval()	177
5.1.3.431 atan_deriv()	178
5.1.3.432 atan_series()	178
5.1.3.433 atan_conjugate()	178
5.1.3.434 atan_info()	178
5.1.3.435 REGISTER_FUNCTION() [29/36]	178
5.1.3.436 atan2_evalf()	179
5.1.3.437 atan2_eval()	179
5.1.3.438 atan2_deriv()	179

5.1.3.439 atan2_info()	179
5.1.3.440 REGISTER_FUNCTION() [30/36]	179
5.1.3.441 sinh_evalf()	180
5.1.3.442 sinh_eval()	180
5.1.3.443 sinh_deriv()	180
5.1.3.444 sinh_real_part()	180
5.1.3.445 sinh_imag_part()	180
5.1.3.446 sinh_conjugate()	181
5.1.3.447 REGISTER_FUNCTION() [31/36]	181
5.1.3.448 cosh_evalf()	181
5.1.3.449 cosh_eval()	181
5.1.3.450 cosh_deriv()	181
5.1.3.451 cosh_real_part()	182
5.1.3.452 cosh_imag_part()	182
5.1.3.453 cosh_conjugate()	182
5.1.3.454 REGISTER_FUNCTION() [32/36]	182
5.1.3.455 tanh_evalf()	182
5.1.3.456 tanh_eval()	183
5.1.3.457 tanh_deriv()	183
5.1.3.458 tanh_series()	183
5.1.3.459 tanh_real_part()	183
5.1.3.460 tanh_imag_part()	183
5.1.3.461 tanh_conjugate()	184
5.1.3.462 REGISTER_FUNCTION() [33/36]	184
5.1.3.463 asinh_evalf()	184
5.1.3.464 asinh_eval()	184
5.1.3.465 asinh_deriv()	184
5.1.3.466 asinh_conjugate()	185
5.1.3.467 REGISTER_FUNCTION() [34/36]	185
5.1.3.468 acosh_evalf()	185
5.1.3.469 acosh_eval()	185
5.1.3.470 acosh_deriv()	185
5.1.3.471 acosh_conjugate()	186
5.1.3.472 REGISTER_FUNCTION() [35/36]	186
5.1.3.473 atanh_evalf()	186
5.1.3.474 atanh_eval()	186
5.1.3.475 atanh_deriv()	186
5.1.3.476 atanh_series()	187
5.1.3.477 atanh_conjugate()	187
5.1.3.478 REGISTER_FUNCTION() [36/36]	187
5.1.3.479 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [11/33]	187
5.1.3.480 subsvalue()	187

5.1.3.481 adaptivesimpson()	188
5.1.3.482 GINAC_BIND_UNARCHIVER() [21/49]	188
5.1.3.483 GINAC_DECLARE_UNARCHIVER() [22/51]	188
5.1.3.484 ifactor()	188
5.1.3.485 is_discriminant_of_quadratic_number_field()	189
5.1.3.486 kronecker_symbol()	189
5.1.3.487 primitive_dirichlet_character()	189
5.1.3.488 dirichlet_character()	190
5.1.3.489 generalised_Bernoulli_number()	190
5.1.3.490 Bernoulli_polynomial()	190
5.1.3.491 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [12/33]	190
5.1.3.492 GINAC_BIND_UNARCHIVER() [22/49]	191
5.1.3.493 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [13/33]	191
5.1.3.494 GINAC_BIND_UNARCHIVER() [23/49]	191
5.1.3.495 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [14/33]	191
5.1.3.496 GINAC_BIND_UNARCHIVER() [24/49]	191
5.1.3.497 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [15/33]	191
5.1.3.498 GINAC_BIND_UNARCHIVER() [25/49]	191
5.1.3.499 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [16/33]	192
5.1.3.500 GINAC_BIND_UNARCHIVER() [26/49]	192
5.1.3.501 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [17/33]	192
5.1.3.502 GINAC_BIND_UNARCHIVER() [27/49]	192
5.1.3.503 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [18/33]	192
5.1.3.504 GINAC_BIND_UNARCHIVER() [28/49]	192
5.1.3.505 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [19/33]	192
5.1.3.506 GINAC_BIND_UNARCHIVER() [29/49]	193
5.1.3.507 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [20/33]	193
5.1.3.508 GINAC_BIND_UNARCHIVER() [30/49]	193
5.1.3.509 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [21/33]	193
5.1.3.510 GINAC_BIND_UNARCHIVER() [31/49]	193
5.1.3.511 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [22/33]	193
5.1.3.512 GINAC_BIND_UNARCHIVER() [32/49]	193
5.1.3.513 GINAC_DECLARE_UNARCHIVER() [23/51]	194
5.1.3.514 GINAC_DECLARE_UNARCHIVER() [24/51]	194
5.1.3.515 GINAC_DECLARE_UNARCHIVER() [25/51]	194
5.1.3.516 GINAC_DECLARE_UNARCHIVER() [26/51]	194
5.1.3.517 GINAC_DECLARE_UNARCHIVER() [27/51]	194
5.1.3.518 GINAC_DECLARE_UNARCHIVER() [28/51]	194
5.1.3.519 GINAC_DECLARE_UNARCHIVER() [29/51]	194
5.1.3.520 GINAC_DECLARE_UNARCHIVER() [30/51]	194
5.1.3.521 GINAC_DECLARE_UNARCHIVER() [31/51]	194
5.1.3.522 GINAC_DECLARE_UNARCHIVER() [32/51]	195

5.1.3.523 GINAC_DECLARE_UNARCHIVER() [33/51]	195
5.1.3.524 GINAC_DECLARE_UNARCHIVER() [34/51]	195
5.1.3.525 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [23/33]	195
5.1.3.526 GINAC_BIND_UNARCHIVER() [33/49]	195
5.1.3.527 lst_to_matrix()	195
5.1.3.528 diag_matrix() [1/2]	196
5.1.3.529 diag_matrix() [2/2]	196
5.1.3.530 unit_matrix() [1/2]	196
5.1.3.531 symbolic_matrix() [1/2]	196
5.1.3.532 reduced_matrix()	197
5.1.3.533 sub_matrix()	197
5.1.3.534 GINAC_DECLARE_UNARCHIVER() [35/51]	197
5.1.3.535 nops() [2/2]	197
5.1.3.536 expand() [2/2]	197
5.1.3.537 evalf() [2/2]	198
5.1.3.538 rows()	198
5.1.3.539 cols()	198
5.1.3.540 transpose()	198
5.1.3.541 determinant()	198
5.1.3.542 trace()	198
5.1.3.543 charpoly()	199
5.1.3.544 inverse() [1/3]	199
5.1.3.545 inverse() [2/3]	199
5.1.3.546 rank() [1/2]	199
5.1.3.547 rank() [2/2]	199
5.1.3.548 unit_matrix() [2/2]	199
5.1.3.549 symbolic_matrix() [2/2]	200
5.1.3.550 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [24/33]	200
5.1.3.551 tryfactsubs()	200
5.1.3.552 algebraic_match_mul_with_mul()	200
5.1.3.553 GINAC_BIND_UNARCHIVER() [34/49]	201
5.1.3.554 GINAC_DECLARE_UNARCHIVER() [36/51]	201
5.1.3.555 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [25/33]	201
5.1.3.556 reeval_ncmul()	201
5.1.3.557 hold_ncmul()	201
5.1.3.558 GINAC_BIND_UNARCHIVER() [35/49]	201
5.1.3.559 GINAC_DECLARE_UNARCHIVER() [37/51]	201
5.1.3.560 get_first_symbol()	201
5.1.3.561 add_symbol()	202
5.1.3.562 collect_symbols()	202
5.1.3.563 get_symbol_stats()	202
5.1.3.564 lcmcoeff()	203

5.1.3.565 lcm_of_coefficients_denominators()	203
5.1.3.566 multiply_lcm()	203
5.1.3.567 quo()	203
5.1.3.568 rem()	204
5.1.3.569 decomp_rational()	204
5.1.3.570 prem()	205
5.1.3.571 sprem()	205
5.1.3.572 divide()	206
5.1.3.573 divide_in_z()	206
5.1.3.574 sr_gcd()	207
5.1.3.575 interpolate()	208
5.1.3.576 heur_gcd_z()	208
5.1.3.577 heur_gcd()	209
5.1.3.578 gcd_pf_pow()	209
5.1.3.579 gcd_pf_mul()	210
5.1.3.580 gcd() $[1/2]$	210
5.1.3.581 gcd_pf_pow_pow()	211
5.1.3.582 lcm() $[1/2]$	211
5.1.3.583 sqrfree_yun()	211
5.1.3.584 sqrfree()	212
5.1.3.585 sqrfree_parfrac()	212
5.1.3.586 replace_with_symbol() $[1/2]$	213
5.1.3.587 replace_with_symbol() $[2/2]$	214
5.1.3.588 frac_cancel()	214
5.1.3.589 find_common_factor()	214
5.1.3.590 collect_common_factors()	215
5.1.3.591 resultant()	215
5.1.3.592 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() $[26/33]$	215
5.1.3.593 make_real_float()	215
5.1.3.594 read_real_float()	216
5.1.3.595 GINAC_BIND_UNARCHIVER() $[36/49]$	216
5.1.3.596 write_real_float()	216
5.1.3.597 print_real_number()	216
5.1.3.598 print_integer_csrc()	217
5.1.3.599 print_real_csrc()	217
5.1.3.600 coerce()	217
5.1.3.601 coerce< int, cln::cl_I >()	217
5.1.3.602 coerce< unsigned int, cln::cl_I >()	218
5.1.3.603 print_real_cl_N()	218
5.1.3.604 exp()	218
5.1.3.605 log()	218
5.1.3.606 sin()	219

5.1.3.607 cos()	219
5.1.3.608 tan()	220
5.1.3.609 asin()	220
5.1.3.610 acos()	220
5.1.3.611 atan() ^[1/2]	220
5.1.3.612 atan() ^[2/2]	221
5.1.3.613 sinh()	221
5.1.3.614 cosh()	222
5.1.3.615 tanh()	222
5.1.3.616 asinh()	222
5.1.3.617 acosh()	223
5.1.3.618 atanh()	223
5.1.3.619 Li2_series() ^[2/2]	223
5.1.3.620 Li2_projection()	223
5.1.3.621 Li2_()	224
5.1.3.622 Li2()	224
5.1.3.623 zeta() ^[3/3]	224
5.1.3.624 guess_precision()	224
5.1.3.625 lgamma() ^[1/2]	225
5.1.3.626 lgamma() ^[2/2]	225
5.1.3.627 tgamma() ^[1/2]	225
5.1.3.628 tgamma() ^[2/2]	225
5.1.3.629 psi() ^[3/4]	225
5.1.3.630 psi() ^[4/4]	226
5.1.3.631 factorial()	226
5.1.3.632 doublefactorial()	226
5.1.3.633 binomial()	227
5.1.3.634 bernoulli()	227
5.1.3.635 fibonacci()	227
5.1.3.636 abs()	228
5.1.3.637 mod()	228
5.1.3.638 smod()	229
5.1.3.639 irem() ^[1/2]	229
5.1.3.640 irem() ^[2/2]	229
5.1.3.641 iquo() ^[1/2]	230
5.1.3.642 iquo() ^[2/2]	230
5.1.3.643 gcd() ^[2/2]	231
5.1.3.644 lcm() ^[2/2]	231
5.1.3.645 sqrt() ^[1/2]	231
5.1.3.646 isqrt()	232
5.1.3.647 PiEvalf()	232
5.1.3.648 EulerEvalf()	232

5.1.3.649 CatalanEvalf()	232
5.1.3.650 operator<<() [6/16]	232
5.1.3.651 GINAC_DECLARE_UNARCHIVER() [38/51]	232
5.1.3.652 pow() [1/3]	233
5.1.3.653 inverse() [3/3]	233
5.1.3.654 step()	233
5.1.3.655 csgn()	233
5.1.3.656 is_zero() [2/2]	234
5.1.3.657 is_positive()	234
5.1.3.658 is_negative()	234
5.1.3.659 is_integer()	234
5.1.3.660 is_pos_integer()	234
5.1.3.661 is_nonneg_integer()	234
5.1.3.662 is_even()	235
5.1.3.663 is_odd()	235
5.1.3.664 is_prime()	235
5.1.3.665 is_rational()	235
5.1.3.666 is_real()	235
5.1.3.667 is_cinteger()	235
5.1.3.668 is_crational()	236
5.1.3.669 to_int()	236
5.1.3.670 to_long()	236
5.1.3.671 to_double()	236
5.1.3.672 real()	236
5.1.3.673 imag()	236
5.1.3.674 numer() [2/2]	237
5.1.3.675 denom() [2/2]	237
5.1.3.676 exadd()	237
5.1.3.677 exmul()	237
5.1.3.678 exminus()	237
5.1.3.679 operator+() [1/4]	238
5.1.3.680 operator-() [1/4]	238
5.1.3.681 operator*() [1/2]	238
5.1.3.682 operator/() [1/2]	238
5.1.3.683 operator+() [2/4]	238
5.1.3.684 operator-() [2/4]	238
5.1.3.685 operator*() [2/2]	239
5.1.3.686 operator/() [2/2]	239
5.1.3.687 operator+=() [1/2]	239
5.1.3.688 operator-=() [1/2]	239
5.1.3.689 operator*=() [1/2]	239
5.1.3.690 operator/=() [1/2]	239

5.1.3.691 operator+=() [2/2]	240
5.1.3.692 operator-=() [2/2]	240
5.1.3.693 operator*=() [2/2]	240
5.1.3.694 operator/=() [2/2]	240
5.1.3.695 operator+() [3/4]	240
5.1.3.696 operator-() [3/4]	240
5.1.3.697 operator+() [4/4]	240
5.1.3.698 operator-() [4/4]	241
5.1.3.699 operator++() [1/4]	241
5.1.3.700 operator--() [1/4]	241
5.1.3.701 operator++() [2/4]	241
5.1.3.702 operator--() [2/4]	241
5.1.3.703 operator++() [3/4]	242
5.1.3.704 operator--() [3/4]	242
5.1.3.705 operator++() [4/4]	242
5.1.3.706 operator--() [4/4]	242
5.1.3.707 operator==()	242
5.1.3.708 operator!=()	243
5.1.3.709 operator<()	243
5.1.3.710 operator<=()	243
5.1.3.711 operator>()	243
5.1.3.712 operator>=()	243
5.1.3.713 my_ios_index()	243
5.1.3.714 my_ios_callback()	244
5.1.3.715 get_print_context()	244
5.1.3.716 set_print_context()	244
5.1.3.717 get_print_options()	244
5.1.3.718 set_print_options()	244
5.1.3.719 operator<<() [7/16]	245
5.1.3.720 operator>>() [3/3]	245
5.1.3.721 dflit()	245
5.1.3.722 latex()	245
5.1.3.723 python()	245
5.1.3.724 python_repr()	245
5.1.3.725 tree()	245
5.1.3.726 csrc()	246
5.1.3.727 csrc_float()	246
5.1.3.728 csrc_double()	246
5.1.3.729 csrc_cl_N()	246
5.1.3.730 index_dimensions()	246
5.1.3.731 no_index_dimensions()	246
5.1.3.732 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [27/33]	247

5.1.3.733 <code>print_sym_pow()</code>	247
5.1.3.734 <code>GINAC_BIND_UNARCHIVER()</code> [37/49]	247
5.1.3.735 <code>GINAC_DECLARE_UNARCHIVER()</code> [39/51]	247
5.1.3.736 <code>pow()</code> [2/3]	247
5.1.3.737 <code>pow()</code> [3/3]	248
5.1.3.738 <code>sqrt()</code> [2/2]	248
5.1.3.739 <code>is_a()</code> [3/3]	248
5.1.3.740 <code>GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()</code> [28/33]	248
5.1.3.741 <code>GINAC_BIND_UNARCHIVER()</code> [38/49]	248
5.1.3.742 <code>GINAC_DECLARE_UNARCHIVER()</code> [40/51]	248
5.1.3.743 <code>series_to_poly()</code>	248
5.1.3.744 <code>is_terminating()</code>	249
5.1.3.745 <code>make_return_type_t()</code>	249
5.1.3.746 <code>set_print_func()</code> [1/2]	249
5.1.3.747 <code>set_print_func()</code> [2/2]	249
5.1.3.748 <code>GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()</code> [29/33]	250
5.1.3.749 <code>GINAC_BIND_UNARCHIVER()</code> [39/49]	250
5.1.3.750 <code>print_operator()</code>	250
5.1.3.751 <code>GINAC_DECLARE_UNARCHIVER()</code> [41/51]	250
5.1.3.752 <code>GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()</code> [30/33]	250
5.1.3.753 <code>get_default_TeX_name()</code>	250
5.1.3.754 <code>GINAC_BIND_UNARCHIVER()</code> [40/49]	251
5.1.3.755 <code>GINAC_BIND_UNARCHIVER()</code> [41/49]	251
5.1.3.756 <code>GINAC_BIND_UNARCHIVER()</code> [42/49]	251
5.1.3.757 <code>GINAC_DECLARE_UNARCHIVER()</code> [42/51]	251
5.1.3.758 <code>GINAC_DECLARE_UNARCHIVER()</code> [43/51]	251
5.1.3.759 <code>GINAC_DECLARE_UNARCHIVER()</code> [44/51]	251
5.1.3.760 <code>GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()</code> [31/33]	251
5.1.3.761 <code>GINAC_BIND_UNARCHIVER()</code> [43/49]	251
5.1.3.762 <code>index0()</code>	252
5.1.3.763 <code>index1()</code>	252
5.1.3.764 <code>index2()</code>	252
5.1.3.765 <code>index3()</code>	252
5.1.3.766 <code>not_symmetric()</code>	252
5.1.3.767 <code>symmetric2()</code>	252
5.1.3.768 <code>symmetric3()</code>	253
5.1.3.769 <code>symmetric4()</code>	253
5.1.3.770 <code>antisymmetric2()</code>	253
5.1.3.771 <code>antisymmetric3()</code>	253
5.1.3.772 <code>antisymmetric4()</code>	253
5.1.3.773 <code>canonicalize()</code>	253
5.1.3.774 <code>symm()</code>	254

5.1.3.775 symmetrize() [3/4]	254
5.1.3.776 antisymmetrize() [3/4]	254
5.1.3.777 symmetrize_cyclic() [3/4]	255
5.1.3.778 GINAC_DECLARE_UNARCHIVER() [45/51]	255
5.1.3.779 sy_none() [1/4]	255
5.1.3.780 sy_none() [2/4]	255
5.1.3.781 sy_none() [3/4]	255
5.1.3.782 sy_none() [4/4]	255
5.1.3.783 sy_symm() [1/4]	256
5.1.3.784 sy_symm() [2/4]	256
5.1.3.785 sy_symm() [3/4]	256
5.1.3.786 sy_symm() [4/4]	256
5.1.3.787 sy_anti() [1/4]	256
5.1.3.788 sy_anti() [2/4]	256
5.1.3.789 sy_anti() [3/4]	257
5.1.3.790 sy_anti() [4/4]	257
5.1.3.791 sy_cycl() [1/4]	257
5.1.3.792 sy_cycl() [2/4]	257
5.1.3.793 sy_cycl() [3/4]	257
5.1.3.794 sy_cycl() [4/4]	257
5.1.3.795 symmetrize() [4/4]	258
5.1.3.796 antisymmetrize() [4/4]	258
5.1.3.797 symmetrize_cyclic() [4/4]	258
5.1.3.798 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [32/33]	258
5.1.3.799 print_func< print_dflt >() [3/3]	258
5.1.3.800 GINAC_BIND_UNARCHIVER() [44/49]	259
5.1.3.801 GINAC_BIND_UNARCHIVER() [45/49]	259
5.1.3.802 GINAC_BIND_UNARCHIVER() [46/49]	259
5.1.3.803 GINAC_BIND_UNARCHIVER() [47/49]	259
5.1.3.804 GINAC_BIND_UNARCHIVER() [48/49]	259
5.1.3.805 delta_tensor()	259
5.1.3.806 metric_tensor()	260
5.1.3.807 lorentz_g()	260
5.1.3.808 spinor_metric()	260
5.1.3.809 epsilon_tensor() [1/2]	261
5.1.3.810 epsilon_tensor() [2/2]	261
5.1.3.811 lorentz_eps()	262
5.1.3.812 GINAC_DECLARE_UNARCHIVER() [46/51]	262
5.1.3.813 GINAC_DECLARE_UNARCHIVER() [47/51]	262
5.1.3.814 GINAC_DECLARE_UNARCHIVER() [48/51]	262
5.1.3.815 GINAC_DECLARE_UNARCHIVER() [49/51]	262
5.1.3.816 GINAC_DECLARE_UNARCHIVER() [50/51]	263

5.1.3.817 log2()	263
5.1.3.818 multinomial_coefficient()	263
5.1.3.819 rotate_left()	263
5.1.3.820 compare_pointers()	263
5.1.3.821 golden_ratio_hash()	264
5.1.3.822 permutation_sign() [1/2]	264
5.1.3.823 permutation_sign() [2/2]	264
5.1.3.824 shaker_sort()	264
5.1.3.825 cyclic_permutation()	265
5.1.3.826 format_index_value() [1/2]	265
5.1.3.827 format_index_value() [2/2]	265
5.1.3.828 operator<<() [8/16]	265
5.1.3.829 operator<<() [9/16]	266
5.1.3.830 operator<<() [10/16]	266
5.1.3.831 operator<<() [11/16]	266
5.1.3.832 operator<<() [12/16]	266
5.1.3.833 operator<<() [13/16]	267
5.1.3.834 operator<<() [14/16]	267
5.1.3.835 operator<<() [15/16]	267
5.1.3.836 operator<<() [16/16]	267
5.1.3.837 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [33/33]	268
5.1.3.838 GINAC_BIND_UNARCHIVER() [49/49]	268
5.1.3.839 haswild()	268
5.1.3.840 GINAC_DECLARE_UNARCHIVER() [51/51]	268
5.1.3.841 wild()	268
5.1.4 Variable Documentation	268
5.1.4.1 unarch_table_instance	268
5.1.4.2 map_evalm	269
5.1.4.3 map_eval_integ	269
5.1.4.4 class_info< OPT >::first	269
5.1.4.5 class_info< OPT >::parents_identified	269
5.1.4.6 tensor	269
5.1.4.7 Pi	269
5.1.4.8 Euler	270
5.1.4.9 Catalan	270
5.1.4.10 crctab	270
5.1.4.11 library_initializer	270
5.1.4.12 _num0_bp	270
5.1.4.13 idx	270
5.1.4.14 force_include_tgamma	271
5.1.4.15 force_include_zeta1	271
5.1.4.16 GINAC_BIND_UNARCHIVER	271

5.1.4.17 l	271
5.1.4.18 Digits	271
5.1.4.19 next_print_context_id	272
5.1.4.20 structure< T, CP >::reg_info	272
5.1.4.21 version_major	272
5.1.4.22 version_minor	272
5.1.4.23 version_micro	272
5.1.4.24 _num_120_p	272
5.1.4.25 _ex_120	272
5.1.4.26 _num_60_p	272
5.1.4.27 _ex_60	273
5.1.4.28 _num_48_p	273
5.1.4.29 _ex_48	273
5.1.4.30 _num_30_p	273
5.1.4.31 _ex_30	273
5.1.4.32 _num_25_p	273
5.1.4.33 _ex_25	273
5.1.4.34 _num_24_p	273
5.1.4.35 _ex_24	274
5.1.4.36 _num_20_p	274
5.1.4.37 _ex_20	274
5.1.4.38 _num_18_p	274
5.1.4.39 _ex_18	274
5.1.4.40 _num_15_p	274
5.1.4.41 _ex_15	274
5.1.4.42 _num_12_p	274
5.1.4.43 _ex_12	275
5.1.4.44 _num_11_p	275
5.1.4.45 _ex_11	275
5.1.4.46 _num_10_p	275
5.1.4.47 _ex_10	275
5.1.4.48 _num_9_p	275
5.1.4.49 _ex_9	275
5.1.4.50 _num_8_p	275
5.1.4.51 _ex_8	276
5.1.4.52 _num_7_p	276
5.1.4.53 _ex_7	276
5.1.4.54 _num_6_p	276
5.1.4.55 _ex_6	276
5.1.4.56 _num_5_p	276
5.1.4.57 _ex_5	276
5.1.4.58 _num_4_p	276

5.1.4.59 _ex_4	277
5.1.4.60 _num_3_p	277
5.1.4.61 _ex_3	277
5.1.4.62 _num_2_p	277
5.1.4.63 _ex_2	277
5.1.4.64 _num_1_p	277
5.1.4.65 _ex_1	278
5.1.4.66 _num_1_2_p	278
5.1.4.67 _ex_1_2	278
5.1.4.68 _num_1_3_p	278
5.1.4.69 _ex_1_3	278
5.1.4.70 _num_1_4_p	278
5.1.4.71 _ex_1_4	279
5.1.4.72 _num0_p	279
5.1.4.73 _ex0	279
5.1.4.74 _num1_4_p	279
5.1.4.75 _ex1_4	280
5.1.4.76 _num1_3_p	280
5.1.4.77 _ex1_3	280
5.1.4.78 _num1_2_p	280
5.1.4.79 _ex1_2	280
5.1.4.80 _num1_p	280
5.1.4.81 _ex1	281
5.1.4.82 _num2_p	281
5.1.4.83 _ex2	281
5.1.4.84 _num3_p	282
5.1.4.85 _ex3	282
5.1.4.86 _num4_p	282
5.1.4.87 _ex4	282
5.1.4.88 _num5_p	282
5.1.4.89 _ex5	282
5.1.4.90 _num6_p	282
5.1.4.91 _ex6	283
5.1.4.92 _num7_p	283
5.1.4.93 _ex7	283
5.1.4.94 _num8_p	283
5.1.4.95 _ex8	283
5.1.4.96 _num9_p	283
5.1.4.97 _ex9	283
5.1.4.98 _num10_p	284
5.1.4.99 _ex10	284
5.1.4.100 _num11_p	284

5.1.4.101 _ex11	284
5.1.4.102 _num12_p	284
5.1.4.103 _ex12	284
5.1.4.104 _num15_p	284
5.1.4.105 _ex15	285
5.1.4.106 _num18_p	285
5.1.4.107 _ex18	285
5.1.4.108 _num20_p	285
5.1.4.109 _ex20	285
5.1.4.110 _num24_p	285
5.1.4.111 _ex24	285
5.1.4.112 _num25_p	285
5.1.4.113 _ex25	286
5.1.4.114 _num30_p	286
5.1.4.115 _ex30	286
5.1.4.116 _num48_p	286
5.1.4.117 _ex48	286
5.1.4.118 _num60_p	286
5.1.4.119 _ex60	286
5.1.4.120 _num120_p	286
5.1.4.121 _ex120	287
5.2 GiNaC::internal Namespace Reference	287
5.3 std Namespace Reference	287
5.3.1 Function Documentation	287
5.3.1.1 swap()	287
6 Class Documentation	289
6.1 GiNaC::internal::_iter_rep Struct Reference	289
6.1.1 Constructor & Destructor Documentation	290
6.1.1.1 _iter_rep()	290
6.1.2 Member Function Documentation	290
6.1.2.1 operator==()	290
6.1.2.2 operator!=(())	290
6.1.3 Member Data Documentation	290
6.1.3.1 e	290
6.1.3.2 i	291
6.1.3.3 i_end	291
6.2 GiNaC::_numeric_digits Class Reference	291
6.2.1 Detailed Description	292
6.2.2 Constructor & Destructor Documentation	292
6.2.2.1 _numeric_digits()	292
6.2.3 Member Function Documentation	292

6.2.3.1 operator=()	292
6.2.3.2 operator long()	292
6.2.3.3 print()	292
6.2.3.4 add_callback()	293
6.2.4 Member Data Documentation	293
6.2.4.1 digits	293
6.2.4.2 too_late	293
6.2.4.3 callbacklist	293
6.3 GiNaC::add Class Reference	294
6.3.1 Detailed Description	300
6.3.2 Constructor & Destructor Documentation	300
6.3.2.1 add() [1/6]	300
6.3.2.2 add() [2/6]	300
6.3.2.3 add() [3/6]	301
6.3.2.4 add() [4/6]	301
6.3.2.5 add() [5/6]	301
6.3.2.6 add() [6/6]	301
6.3.3 Member Function Documentation	301
6.3.3.1 precedence()	301
6.3.3.2 info()	302
6.3.3.3 is_polynomial()	302
6.3.3.4 degree()	302
6.3.3.5 ldegree()	302
6.3.3.6 coeff()	303
6.3.3.7 eval()	303
6.3.3.8 evalm()	303
6.3.3.9 series()	304
6.3.3.10 normal()	304
6.3.3.11 integer_content()	304
6.3.3.12 smod()	304
6.3.3.13 max_coefficient()	305
6.3.3.14 conjugate()	305
6.3.3.15 real_part()	305
6.3.3.16 imag_part()	306
6.3.3.17 get_free_indices()	306
6.3.3.18 eval_ncmul()	306
6.3.3.19 derivative()	306
6.3.3.20 return_type()	306
6.3.3.21 return_type_tinfo()	307
6.3.3.22 thisexpairseq() [1/2]	307
6.3.3.23 thisexpairseq() [2/2]	307
6.3.3.24 split_ex_to_pair()	307

6.3.3.25 combine_ex_with_coeff_to_pair()	308
6.3.3.26 combine_pair_with_coeff_to_pair()	308
6.3.3.27 recombine_pair_to_ex()	308
6.3.3.28 expand()	308
6.3.3.29 print_add()	309
6.3.3.30 do_print()	309
6.3.3.31 do_print_latex()	309
6.3.3.32 do_print_csrc()	309
6.3.3.33 do_print_python_repr()	309
6.3.4 Friends And Related Symbol Documentation	310
6.3.4.1 mul	310
6.3.4.2 power	310
6.4 GiNaC::archive Class Reference	310
6.4.1 Detailed Description	312
6.4.2 Member Typedef Documentation	312
6.4.2.1 inv_at_cit	312
6.4.3 Constructor & Destructor Documentation	312
6.4.3.1 archive() [1/3]	312
6.4.3.2 ~archive()	312
6.4.3.3 archive() [2/3]	312
6.4.3.4 archive() [3/3]	313
6.4.4 Member Function Documentation	313
6.4.4.1 archive_ex()	313
6.4.4.2 unarchive_ex() [1/3]	313
6.4.4.3 unarchive_ex() [2/3]	313
6.4.4.4 unarchive_ex() [3/3]	314
6.4.4.5 num_expressions()	314
6.4.4.6 get_top_node()	314
6.4.4.7 clear()	315
6.4.4.8 add_node()	315
6.4.4.9 get_node()	315
6.4.4.10 forget()	315
6.4.4.11 printraw()	315
6.4.4.12 atomize()	316
6.4.4.13 unatomize()	316
6.4.5 Friends And Related Symbol Documentation	316
6.4.5.1 operator<<	316
6.4.5.2 operator>>	316
6.4.6 Member Data Documentation	317
6.4.6.1 nodes	317
6.4.6.2 exprs	317
6.4.6.3 atoms	317

6.4.6.4 inverse_atoms	317
6.4.6.5 exprtable	317
6.5 GiNaC::archive_node Class Reference	318
6.5.1 Detailed Description	320
6.5.2 Member Typedef Documentation	320
6.5.2.1 propinfovector	320
6.5.2.2 archive_node_cit	320
6.5.3 Member Enumeration Documentation	320
6.5.3.1 property_type	320
6.5.4 Constructor & Destructor Documentation	321
6.5.4.1 archive_node() [1/2]	321
6.5.4.2 archive_node() [2/2]	321
6.5.5 Member Function Documentation	321
6.5.5.1 operator=()	321
6.5.5.2 add_bool()	321
6.5.5.3 add_unsigned()	322
6.5.5.4 add_string()	322
6.5.5.5 add_ex()	322
6.5.5.6 find_bool()	322
6.5.5.7 find_unsigned()	323
6.5.5.8 find_string()	323
6.5.5.9 find_first()	323
6.5.5.10 find_last()	323
6.5.5.11 find_property_range()	324
6.5.5.12 find_ex()	324
6.5.5.13 find_ex_by_loc()	324
6.5.5.14 find_ex_node()	325
6.5.5.15 get_properties()	325
6.5.5.16 unarchive()	325
6.5.5.17 has_same_ex_as()	325
6.5.5.18 has_ex()	325
6.5.5.19 get_ex()	326
6.5.5.20 forget()	326
6.5.5.21 printraw()	326
6.5.6 Friends And Related Symbol Documentation	326
6.5.6.1 operator<<	326
6.5.6.2 operator>>	326
6.5.7 Member Data Documentation	327
6.5.7.1 a	327
6.5.7.2 props	327
6.5.7.3 has_expression	327
6.5.7.4 e	327

6.6 GiNaC::archive_node::archive_node_cit_range Struct Reference	328
6.6.1 Member Data Documentation	328
6.6.1.1 begin	328
6.6.1.2 end	329
6.7 GiNaC::archive::archived_ex Struct Reference	329
6.7.1 Detailed Description	329
6.7.2 Constructor & Destructor Documentation	329
6.7.2.1 archived_ex() [1/2]	329
6.7.2.2 archived_ex() [2/2]	329
6.7.3 Member Data Documentation	330
6.7.3.1 name	330
6.7.3.2 root	330
6.8 GiNaC::basic Class Reference	330
6.8.1 Detailed Description	335
6.8.2 Constructor & Destructor Documentation	335
6.8.2.1 basic() [1/2]	335
6.8.2.2 ~basic()	335
6.8.2.3 basic() [2/2]	335
6.8.3 Member Function Documentation	336
6.8.3.1 operator=()	336
6.8.3.2 duplicate()	336
6.8.3.3 eval()	336
6.8.3.4 evalf()	336
6.8.3.5 evalm()	337
6.8.3.6 eval_integ()	337
6.8.3.7 eval_ncmul()	337
6.8.3.8 eval_indexed()	337
6.8.3.9 print()	337
6.8.3.10 dbgprint()	338
6.8.3.11 dbgprinttree()	338
6.8.3.12 precedence()	339
6.8.3.13 info()	339
6.8.3.14 nops()	339
6.8.3.15 op()	340
6.8.3.16 operator[]() [1/4]	340
6.8.3.17 operator[]() [2/4]	340
6.8.3.18 let_op()	340
6.8.3.19 operator[]() [3/4]	341
6.8.3.20 operator[]() [4/4]	341
6.8.3.21 has()	341
6.8.3.22 match()	341
6.8.3.23 match_same_type()	342

6.8.3.24 subs()	342
6.8.3.25 map()	342
6.8.3.26 accept()	343
6.8.3.27 is_polynomial()	343
6.8.3.28 degree()	343
6.8.3.29 ldegree()	343
6.8.3.30 coeff()	344
6.8.3.31 expand()	344
6.8.3.32 collect()	344
6.8.3.33 derivative()	345
6.8.3.34 series()	345
6.8.3.35 normal()	346
6.8.3.36 to_rational()	346
6.8.3.37 to_polynomial()	346
6.8.3.38 integer_content()	346
6.8.3.39 smod()	346
6.8.3.40 max_coefficient()	347
6.8.3.41 get_free_indices()	347
6.8.3.42 add_indexed()	347
6.8.3.43 scalar_mul_indexed()	348
6.8.3.44 contract_with()	348
6.8.3.45 return_type()	349
6.8.3.46 return_type_tinfo()	349
6.8.3.47 conjugate()	350
6.8.3.48 real_part()	350
6.8.3.49 imag_part()	350
6.8.3.50 compare_same_type()	350
6.8.3.51 is_equal_same_type()	351
6.8.3.52 calchash()	351
6.8.3.53 print_dispatch() [1/2]	351
6.8.3.54 print_dispatch() [2/2]	352
6.8.3.55 archive()	352
6.8.3.56 read_archive()	352
6.8.3.57 subs_one_level()	353
6.8.3.58 diff()	353
6.8.3.59 compare()	353
6.8.3.60 is_equal()	354
6.8.3.61 hold()	354
6.8.3.62 gethash()	355
6.8.3.63 setflag()	355
6.8.3.64 clearflag()	355
6.8.3.65 ensure_if_modifiable()	356

6.8.3.66 do_print()	356
6.8.3.67 do_print_tree()	356
6.8.3.68 do_print_python_repr()	356
6.8.4 Friends And Related Symbol Documentation	357
6.8.4.1 ex	357
6.8.5 Member Data Documentation	358
6.8.5.1 flags	358
6.8.5.2 hashvalue	358
6.9 GiNaC::basic_log_kernel Class Reference	359
6.9.1 Detailed Description	363
6.9.2 Member Function Documentation	364
6.9.2.1 series_coeff_impl()	364
6.9.2.2 do_print()	364
6.10 GiNaC::basic_multi_iterator< T > Class Template Reference	364
6.10.1 Detailed Description	366
6.10.2 Constructor & Destructor Documentation	366
6.10.2.1 basic_multi_iterator() [1/3]	366
6.10.2.2 basic_multi_iterator() [2/3]	367
6.10.2.3 basic_multi_iterator() [3/3]	367
6.10.2.4 ~basic_multi_iterator()	367
6.10.3 Member Function Documentation	367
6.10.3.1 size()	367
6.10.3.2 overflow()	368
6.10.3.3 get_vector()	368
6.10.3.4 operator[]() [1/2]	368
6.10.3.5 operator[]() [2/2]	368
6.10.3.6 operator()() [1/2]	368
6.10.3.7 operator()() [2/2]	369
6.10.3.8 init()	369
6.10.3.9 operator++()	369
6.10.4 Friends And Related Symbol Documentation	369
6.10.4.1 operator<<	369
6.10.5 Member Data Documentation	370
6.10.5.1 N	370
6.10.5.2 B	370
6.10.5.3 v	370
6.10.5.4 flag_overflow	371
6.11 GiNaC::basic_partition_generator Class Reference	371
6.11.1 Detailed Description	372
6.11.2 Constructor & Destructor Documentation	372
6.11.2.1 basic_partition_generator()	372
6.11.3 Member Data Documentation	373

6.11.3.1 mpgen	373
6.12 GiNaC::class_info< OPT > Class Template Reference	373
6.12.1 Constructor & Destructor Documentation	374
6.12.1.1 class_info()	374
6.12.2 Member Function Documentation	375
6.12.2.1 get_parent()	375
6.12.2.2 find()	375
6.12.2.3 dump_hierarchy()	375
6.12.2.4 dump_tree()	375
6.12.2.5 identify_parents()	375
6.12.3 Member Data Documentation	376
6.12.3.1 options	376
6.12.3.2 first	376
6.12.3.3 next	376
6.12.3.4 parent	376
6.12.3.5 parents_identified	376
6.13 GiNaC::clifford Class Reference	377
6.13.1 Detailed Description	385
6.13.2 Constructor & Destructor Documentation	385
6.13.2.1 clifford() [1/4]	385
6.13.2.2 clifford() [2/4]	385
6.13.2.3 clifford() [3/4]	386
6.13.2.4 clifford() [4/4]	386
6.13.3 Member Function Documentation	386
6.13.3.1 precedence()	386
6.13.3.2 archive()	386
6.13.3.3 read_archive()	387
6.13.3.4 eval_ncmul()	387
6.13.3.5 match_same_type()	387
6.13.3.6 thiscontainer() [1/2]	388
6.13.3.7 thiscontainer() [2/2]	388
6.13.3.8 return_type()	388
6.13.3.9 return_type_tinfo()	388
6.13.3.10 get_representation_label()	388
6.13.3.11 get_metric() [1/2]	389
6.13.3.12 get_metric() [2/2]	389
6.13.3.13 same_metric()	389
6.13.3.14 get_commutator_sign()	389
6.13.3.15 nops()	389
6.13.3.16 op()	390
6.13.3.17 let_op()	390
6.13.3.18 subs()	390

6.13.3.19 do_print_dflt()	390
6.13.3.20 do_print_latex()	391
6.13.3.21 do_print_tree()	391
6.13.4 Member Data Documentation	391
6.13.4.1 representation_label	391
6.13.4.2 metric	391
6.13.4.3 commutator_sign	391
6.14 GiNaC::cliffordunit Class Reference	392
6.14.1 Detailed Description	396
6.14.2 Member Function Documentation	397
6.14.2.1 contract_with()	397
6.14.2.2 do_print()	397
6.14.2.3 do_print_latex()	397
6.15 GiNaC::color Class Reference	397
6.15.1 Detailed Description	405
6.15.2 Constructor & Destructor Documentation	406
6.15.2.1 color() [1/4]	406
6.15.2.2 color() [2/4]	406
6.15.2.3 color() [3/4]	406
6.15.2.4 color() [4/4]	406
6.15.3 Member Function Documentation	407
6.15.3.1 archive()	407
6.15.3.2 read_archive()	407
6.15.3.3 eval_ncmul()	407
6.15.3.4 match_same_type()	408
6.15.3.5 thiscontainer() [1/2]	408
6.15.3.6 thiscontainer() [2/2]	408
6.15.3.7 return_type()	408
6.15.3.8 return_type_tinfo()	409
6.15.3.9 get_representation_label()	409
6.15.4 Member Data Documentation	409
6.15.4.1 representation_label	409
6.16 GiNaC::compare_all_equal< T > Class Template Reference	409
6.16.1 Detailed Description	410
6.16.2 Constructor & Destructor Documentation	410
6.16.2.1 ~compare_all_equal()	410
6.16.3 Member Function Documentation	410
6.16.3.1 struct_is_equal()	410
6.16.3.2 struct_compare()	410
6.17 GiNaC::compare_bitwise< T > Class Template Reference	410
6.17.1 Detailed Description	411
6.17.2 Constructor & Destructor Documentation	411

6.17.2.1 <code>~compare_bitwise()</code>	411
6.17.3 Member Function Documentation	411
6.17.3.1 <code>struct_is_equal()</code>	411
6.17.3.2 <code>struct_compare()</code>	411
6.18 <code>GiNaC::compare_std_less< T ></code> Class Template Reference	411
6.18.1 Detailed Description	412
6.18.2 Constructor & Destructor Documentation	412
6.18.2.1 <code>~compare_std_less()</code>	412
6.18.3 Member Function Documentation	412
6.18.3.1 <code>struct_is_equal()</code>	412
6.18.3.2 <code>struct_compare()</code>	412
6.19 <code>GiNaC::composition_generator</code> Class Reference	413
6.19.1 Detailed Description	414
6.19.2 Constructor & Destructor Documentation	414
6.19.2.1 <code>composition_generator()</code>	414
6.19.3 Member Function Documentation	414
6.19.3.1 <code>get()</code>	414
6.19.3.2 <code>next()</code>	414
6.19.4 Member Data Documentation	414
6.19.4.1 <code>cmgen</code>	414
6.19.4.2 <code>atend</code>	414
6.19.4.3 <code>trivial</code>	415
6.19.4.4 <code>composition</code>	415
6.19.4.5 <code>current_updated</code>	415
6.20 <code>GiNaC::const_iterator</code> Class Reference	415
6.20.1 Member Typedef Documentation	416
6.20.1.1 <code>iterator_category</code>	416
6.20.1.2 <code>value_type</code>	417
6.20.1.3 <code>difference_type</code>	417
6.20.1.4 <code>pointer</code>	417
6.20.1.5 <code>reference</code>	417
6.20.2 Constructor & Destructor Documentation	417
6.20.2.1 <code>const_iterator()</code> [1/2]	417
6.20.2.2 <code>const_iterator()</code> [2/2]	417
6.20.3 Member Function Documentation	417
6.20.3.1 <code>operator*()</code>	417
6.20.3.2 <code>operator->()</code>	417
6.20.3.3 <code>operator[]()</code>	418
6.20.3.4 <code>operator++()</code> [1/2]	418
6.20.3.5 <code>operator++()</code> [2/2]	418
6.20.3.6 <code>operator+=()</code>	418
6.20.3.7 <code>operator+()</code>	418

6.20.3.8 operator--() [1/2]	418
6.20.3.9 operator--() [2/2]	418
6.20.3.10 operator-=()	419
6.20.3.11 operator-()	419
6.20.3.12 operator==()	419
6.20.3.13 operator"!=(419
6.20.3.14 operator<()	419
6.20.3.15 operator>()	419
6.20.3.16 operator<=()	419
6.20.3.17 operator>=()	420
6.20.4 Friends And Related Symbol Documentation	420
6.20.4.1 ex	420
6.20.4.2 const_preorder_iterator	420
6.20.4.3 const_postorder_iterator	420
6.20.4.4 operator+	420
6.20.4.5 operator-	420
6.20.5 Member Data Documentation	421
6.20.5.1 e	421
6.20.5.2 i	421
6.21 GiNaC::const_postorder_iterator Class Reference	421
6.21.1 Member Typedef Documentation	422
6.21.1.1 iterator_category	422
6.21.1.2 value_type	422
6.21.1.3 difference_type	422
6.21.1.4 pointer	422
6.21.1.5 reference	422
6.21.2 Constructor & Destructor Documentation	422
6.21.2.1 const_postorder_iterator() [1/2]	422
6.21.2.2 const_postorder_iterator() [2/2]	422
6.21.3 Member Function Documentation	423
6.21.3.1 operator*()	423
6.21.3.2 operator->()	423
6.21.3.3 operator++() [1/2]	423
6.21.3.4 operator++() [2/2]	423
6.21.3.5 operator==()	423
6.21.3.6 operator"!=(423
6.21.3.7 descend()	423
6.21.3.8 increment()	424
6.21.4 Member Data Documentation	424
6.21.4.1 s	424
6.22 GiNaC::const_preorder_iterator Class Reference	424
6.22.1 Member Typedef Documentation	425

6.22.1.1 <code>iterator_category</code>	425
6.22.1.2 <code>value_type</code>	425
6.22.1.3 <code>difference_type</code>	425
6.22.1.4 <code>pointer</code>	425
6.22.1.5 <code>reference</code>	425
6.22.2 Constructor & Destructor Documentation	425
6.22.2.1 <code>const_preorder_iterator()</code> [1/2]	425
6.22.2.2 <code>const_preorder_iterator()</code> [2/2]	425
6.22.3 Member Function Documentation	426
6.22.3.1 <code>operator*()</code>	426
6.22.3.2 <code>operator->()</code>	426
6.22.3.3 <code>operator++()</code> [1/2]	426
6.22.3.4 <code>operator++()</code> [2/2]	426
6.22.3.5 <code>operator==()</code>	426
6.22.3.6 <code>operator!=()</code>	426
6.22.3.7 <code>increment()</code>	426
6.22.4 Member Data Documentation	427
6.22.4.1 <code>s</code>	427
6.23 <code>GiNaC::constant</code> Class Reference	427
6.23.1 Detailed Description	432
6.23.2 Constructor & Destructor Documentation	432
6.23.2.1 <code>constant()</code> [1/2]	432
6.23.2.2 <code>constant()</code> [2/2]	432
6.23.3 Member Function Documentation	433
6.23.3.1 <code>info()</code>	433
6.23.3.2 <code>evalf()</code>	433
6.23.3.3 <code>is_polynomial()</code>	433
6.23.3.4 <code>conjugate()</code>	433
6.23.3.5 <code>real_part()</code>	434
6.23.3.6 <code>imag_part()</code>	434
6.23.3.7 <code>archive()</code>	434
6.23.3.8 <code>read_archive()</code>	434
6.23.3.9 <code>derivative()</code>	435
6.23.3.10 <code>is_equal_same_type()</code>	435
6.23.3.11 <code>calchash()</code>	435
6.23.3.12 <code>do_print()</code>	435
6.23.3.13 <code>do_print_tree()</code>	436
6.23.3.14 <code>do_print_latex()</code>	436
6.23.3.15 <code>do_print_python_repr()</code>	436
6.23.4 Member Data Documentation	436
6.23.4.1 <code>name</code>	436
6.23.4.2 <code>TeX_name</code>	436

6.23.4.3 ef	437
6.23.4.4 number	437
6.23.4.5 serial	437
6.23.4.6 next_serial	437
6.23.4.7 domain	437
6.24 GiNaC::container< C > Class Template Reference	438
6.24.1 Detailed Description	443
6.24.2 Member Typedef Documentation	444
6.24.2.1 STLT	444
6.24.2.2 const_iterator	444
6.24.2.3 const_reverse_iterator	444
6.24.3 Constructor & Destructor Documentation	444
6.24.3.1 container() [1/4]	444
6.24.3.2 container() [2/4]	444
6.24.3.3 container() [3/4]	444
6.24.3.4 container() [4/4]	444
6.24.4 Member Function Documentation	445
6.24.4.1 get_default_flags()	445
6.24.4.2 get_open_delim()	445
6.24.4.3 get_close_delim()	445
6.24.4.4 info()	445
6.24.4.5 precedence()	445
6.24.4.6 nops()	446
6.24.4.7 op()	446
6.24.4.8 let_op()	446
6.24.4.9 subs()	447
6.24.4.10 read_archive()	447
6.24.4.11 archive()	447
6.24.4.12 conjugate()	448
6.24.4.13 real_part()	448
6.24.4.14 imag_part()	448
6.24.4.15 is_equal_same_type()	448
6.24.4.16 thiscontainer() [1/2]	449
6.24.4.17 thiscontainer() [2/2]	449
6.24.4.18 printseq()	449
6.24.4.19 sort_() [1/2]	449
6.24.4.20 sort_() [2/2]	450
6.24.4.21 unique_() [1/2]	450
6.24.4.22 prepend()	450
6.24.4.23 append()	450
6.24.4.24 remove_first()	450
6.24.4.25 remove_last()	451

6.24.4.26 remove_all()	451
6.24.4.27 sort()	451
6.24.4.28 unique()	451
6.24.4.29 begin()	451
6.24.4.30 end()	452
6.24.4.31 rbegin()	452
6.24.4.32 rend()	452
6.24.4.33 do_print()	452
6.24.4.34 do_print_tree()	452
6.24.4.35 do_print_python()	452
6.24.4.36 do_print_python_repr()	453
6.24.4.37 subchildren()	453
6.24.4.38 unique_() [2/2]	453
6.25 GiNaC::container_storage< C > Class Template Reference	453
6.25.1 Detailed Description	454
6.25.2 Member Typedef Documentation	454
6.25.2.1 STLT	454
6.25.3 Constructor & Destructor Documentation	454
6.25.3.1 container_storage() [1/4]	454
6.25.3.2 container_storage() [2/4]	455
6.25.3.3 container_storage() [3/4]	455
6.25.3.4 container_storage() [4/4]	455
6.25.3.5 ~container_storage()	455
6.25.4 Member Function Documentation	455
6.25.4.1 reserve() [1/4]	455
6.25.4.2 reserve() [2/4]	455
6.25.4.3 reserve() [3/4]	455
6.25.4.4 reserve() [4/4]	456
6.25.5 Member Data Documentation	456
6.25.5.1 seq	456
6.26 GiNaC::composition_generator::coolmulti Struct Reference	457
6.26.1 Constructor & Destructor Documentation	457
6.26.1.1 coolmulti()	457
6.26.1.2 ~coolmulti()	458
6.26.2 Member Function Documentation	458
6.26.2.1 next_permutation()	458
6.26.2.2 finished()	458
6.26.3 Member Data Documentation	458
6.26.3.1 head	458
6.26.3.2 i	458
6.26.3.3 after_i	458
6.27 GiNaC::derivative_map_function Struct Reference	459

6.27.1 Detailed Description	460
6.27.2 Constructor & Destructor Documentation	460
6.27.2.1 derivative_map_function()	460
6.27.3 Member Function Documentation	460
6.27.3.1 operator>()	460
6.27.4 Member Data Documentation	460
6.27.4.1 s	460
6.28 GiNaC::determinant_algo Class Reference	461
6.28.1 Detailed Description	461
6.28.2 Member Enumeration Documentation	461
6.28.2.1 anonymous enum	461
6.29 GiNaC::diracgamma Class Reference	462
6.29.1 Detailed Description	467
6.29.2 Member Function Documentation	467
6.29.2.1 contract_with()	467
6.29.2.2 do_print()	467
6.29.2.3 do_print_latex()	467
6.30 GiNaC::diracgamma5 Class Reference	468
6.30.1 Detailed Description	472
6.30.2 Member Function Documentation	472
6.30.2.1 conjugate()	472
6.30.2.2 do_print()	472
6.30.2.3 do_print_latex()	472
6.31 GiNaC::diracgammaL Class Reference	473
6.31.1 Detailed Description	477
6.31.2 Member Function Documentation	477
6.31.2.1 conjugate()	477
6.31.2.2 do_print()	477
6.31.2.3 do_print_latex()	477
6.32 GiNaC::diracgammaR Class Reference	478
6.32.1 Detailed Description	482
6.32.2 Member Function Documentation	482
6.32.2.1 conjugate()	482
6.32.2.2 do_print()	482
6.32.2.3 do_print_latex()	482
6.33 GiNaC::diracone Class Reference	483
6.33.1 Detailed Description	487
6.33.2 Member Function Documentation	487
6.33.2.1 do_print()	487
6.33.2.2 do_print_latex()	487
6.34 GiNaC::do_taylor Class Reference	488
6.34.1 Detailed Description	488

6.35 GiNaC::domain Class Reference	488
6.35.1 Detailed Description	488
6.35.2 Member Enumeration Documentation	488
6.35.2.1 anonymous enum	488
6.36 GiNaC::dunno Class Reference	489
6.36.1 Detailed Description	489
6.37 GiNaC::Ebar_kernel Class Reference	489
6.37.1 Detailed Description	494
6.37.2 Constructor & Destructor Documentation	495
6.37.2.1 Ebar_kernel()	495
6.37.3 Member Function Documentation	495
6.37.3.1 nops()	495
6.37.3.2 op()	495
6.37.3.3 let_op()	495
6.37.3.4 is_numeric()	496
6.37.3.5 get_numerical_value()	496
6.37.3.6 series_coeff_impl()	496
6.37.3.7 do_print()	496
6.37.4 Member Data Documentation	497
6.37.4.1 n	497
6.37.4.2 m	497
6.37.4.3 x	497
6.37.4.4 y	497
6.38 GiNaC::Eisenstein_h_kernel Class Reference	497
6.38.1 Detailed Description	503
6.38.2 Constructor & Destructor Documentation	504
6.38.2.1 Eisenstein_h_kernel()	504
6.38.3 Member Function Documentation	504
6.38.3.1 series()	504
6.38.3.2 nops()	504
6.38.3.3 op()	504
6.38.3.4 let_op()	505
6.38.3.5 is_numeric()	505
6.38.3.6 Laurent_series()	505
6.38.3.7 get_numerical_value()	505
6.38.3.8 uses_Laurent_series()	506
6.38.3.9 coefficient_a0()	506
6.38.3.10 coefficient_an()	506
6.38.3.11 q_expansion_modular_form()	506
6.38.3.12 do_print()	507
6.38.4 Member Data Documentation	507
6.38.4.1 k	507

6.38.4.2 N	507
6.38.4.3 r	507
6.38.4.4 s	507
6.38.4.5 C_norm	507
6.39 GiNaC::Eisenstein_kernel Class Reference	508
6.39.1 Detailed Description	514
6.39.2 Constructor & Destructor Documentation	514
6.39.2.1 Eisenstein_kernel()	514
6.39.3 Member Function Documentation	514
6.39.3.1 series()	514
6.39.3.2 nops()	515
6.39.3.3 op()	515
6.39.3.4 let_op()	515
6.39.3.5 is_numeric()	515
6.39.3.6 Laurent_series()	515
6.39.3.7 get_numerical_value()	516
6.39.3.8 uses_Laurent_series()	516
6.39.3.9 q_expansion_modular_form()	516
6.39.3.10 do_print()	516
6.39.4 Member Data Documentation	516
6.39.4.1 k	516
6.39.4.2 N	517
6.39.4.3 a	517
6.39.4.4 b	517
6.39.4.5 K	517
6.39.4.6 C_norm	517
6.40 GiNaC::composition_generator::coolmulti::element Struct Reference	517
6.40.1 Constructor & Destructor Documentation	518
6.40.1.1 element()	518
6.40.1.2 ~element()	518
6.40.2 Member Data Documentation	518
6.40.2.1 value	518
6.40.2.2 next	518
6.41 GiNaC::ELi_kernel Class Reference	519
6.41.1 Detailed Description	524
6.41.2 Constructor & Destructor Documentation	525
6.41.2.1 ELi_kernel()	525
6.41.3 Member Function Documentation	525
6.41.3.1 nops()	525
6.41.3.2 op()	525
6.41.3.3 let_op()	525
6.41.3.4 is_numeric()	526

6.41.3.5 <code>get_numerical_value()</code>	526
6.41.3.6 <code>series_coeff_impl()</code>	526
6.41.3.7 <code>do_print()</code>	526
6.41.4 Member Data Documentation	526
6.41.4.1 <code>n</code>	526
6.41.4.2 <code>m</code>	527
6.41.4.3 <code>x</code>	527
6.41.4.4 <code>y</code>	527
6.42 <code>std::equal_to< GiNaC::ex ></code> Struct Reference	527
6.42.1 Detailed Description	527
6.42.2 Member Function Documentation	527
6.42.2.1 <code>operator()()</code>	527
6.43 <code>GiNaC::error_and_integral</code> Struct Reference	528
6.43.1 Constructor & Destructor Documentation	528
6.43.1.1 <code>error_and_integral()</code>	528
6.43.2 Member Data Documentation	529
6.43.2.1 <code>error</code>	529
6.43.2.2 <code>integral</code>	529
6.44 <code>GiNaC::error_and_integral_is_less</code> Struct Reference	529
6.44.1 Member Function Documentation	529
6.44.1.1 <code>operator()()</code>	529
6.45 <code>GiNaC::eval_integ_map_function</code> Struct Reference	530
6.45.1 Detailed Description	531
6.45.2 Member Function Documentation	531
6.45.2.1 <code>operator()()</code>	531
6.46 <code>GiNaC::evalf_map_function</code> Struct Reference	531
6.46.1 Detailed Description	532
6.46.2 Member Function Documentation	532
6.46.2.1 <code>operator()()</code>	532
6.47 <code>GiNaC::evalm_map_function</code> Struct Reference	533
6.47.1 Detailed Description	534
6.47.2 Member Function Documentation	534
6.47.2.1 <code>operator()()</code>	534
6.48 <code>GiNaC::ex</code> Class Reference	534
6.48.1 Detailed Description	538
6.48.2 Constructor & Destructor Documentation	538
6.48.2.1 <code>ex()</code> [1/10]	538
6.48.2.2 <code>ex()</code> [2/10]	538
6.48.2.3 <code>ex()</code> [3/10]	539
6.48.2.4 <code>ex()</code> [4/10]	539
6.48.2.5 <code>ex()</code> [5/10]	539
6.48.2.6 <code>ex()</code> [6/10]	539

6.48.2.7 <code>ex()</code> [7/10]	539
6.48.2.8 <code>ex()</code> [8/10]	539
6.48.2.9 <code>ex()</code> [9/10]	539
6.48.2.10 <code>ex()</code> [10/10]	540
6.48.3 Member Function Documentation	540
6.48.3.1 <code>swap()</code>	540
6.48.3.2 <code>begin()</code>	540
6.48.3.3 <code>end()</code>	540
6.48.3.4 <code>preorder_begin()</code>	540
6.48.3.5 <code>preorder_end()</code>	541
6.48.3.6 <code>postorder_begin()</code>	541
6.48.3.7 <code>postorder_end()</code>	541
6.48.3.8 <code>eval()</code>	541
6.48.3.9 <code>evalf()</code>	541
6.48.3.10 <code>evalm()</code>	541
6.48.3.11 <code>eval_ncmul()</code>	541
6.48.3.12 <code>eval_integ()</code>	542
6.48.3.13 <code>print()</code>	542
6.48.3.14 <code>dbgprint()</code>	542
6.48.3.15 <code>dbgprinttree()</code>	542
6.48.3.16 <code>info()</code>	543
6.48.3.17 <code>nops()</code>	543
6.48.3.18 <code>op()</code>	544
6.48.3.19 <code>operator[]()</code> [1/4]	544
6.48.3.20 <code>operator[]()</code> [2/4]	544
6.48.3.21 <code>let_op()</code>	544
6.48.3.22 <code>operator[]()</code> [3/4]	545
6.48.3.23 <code>operator[]()</code> [4/4]	545
6.48.3.24 <code>lhs()</code>	545
6.48.3.25 <code>rhs()</code>	545
6.48.3.26 <code>conjugate()</code>	545
6.48.3.27 <code>real_part()</code>	546
6.48.3.28 <code>imag_part()</code>	546
6.48.3.29 <code>has()</code>	546
6.48.3.30 <code>find()</code>	546
6.48.3.31 <code>match()</code> [1/2]	546
6.48.3.32 <code>match()</code> [2/2]	547
6.48.3.33 <code>subs()</code> [1/3]	547
6.48.3.34 <code>subs()</code> [2/3]	547
6.48.3.35 <code>subs()</code> [3/3]	547
6.48.3.36 <code>map()</code> [1/2]	548
6.48.3.37 <code>map()</code> [2/2]	548

6.48.3.38	accept()	548
6.48.3.39	traverse_preorder()	548
6.48.3.40	traverse_postorder()	548
6.48.3.41	traverse()	549
6.48.3.42	is_polynomial()	549
6.48.3.43	degree()	549
6.48.3.44	ldegree()	549
6.48.3.45	coeff()	549
6.48.3.46	lcoeff()	550
6.48.3.47	tcoeff()	550
6.48.3.48	expand()	550
6.48.3.49	collect()	550
6.48.3.50	diff()	550
6.48.3.51	series()	551
6.48.3.52	normal()	552
6.48.3.53	to_rational()	552
6.48.3.54	to_polynomial()	552
6.48.3.55	numer()	553
6.48.3.56	denom()	553
6.48.3.57	numer_denom()	554
6.48.3.58	unit()	554
6.48.3.59	content()	554
6.48.3.60	integer_content()	555
6.48.3.61	primpart() $[1/2]$	555
6.48.3.62	primpart() $[2/2]$	556
6.48.3.63	unitcontprim()	556
6.48.3.64	smod()	557
6.48.3.65	max_coefficient()	557
6.48.3.66	get_free_indices()	557
6.48.3.67	simplify_indexed() $[1/2]$	557
6.48.3.68	simplify_indexed() $[2/2]$	558
6.48.3.69	compare()	558
6.48.3.70	is_equal()	559
6.48.3.71	is_zero()	559
6.48.3.72	is_zero_matrix()	559
6.48.3.73	symmetrize() $[1/2]$	560
6.48.3.74	symmetrize() $[2/2]$	560
6.48.3.75	antisymmetrize() $[1/2]$	560
6.48.3.76	antisymmetrize() $[2/2]$	560
6.48.3.77	symmetrize_cyclic() $[1/2]$	560
6.48.3.78	symmetrize_cyclic() $[2/2]$	561
6.48.3.79	return_type()	561

6.48.3.80 return_type_tinfo()	561
6.48.3.81 gethash()	561
6.48.3.82 construct_from_basic()	561
6.48.3.83 construct_from_int()	562
6.48.3.84 construct_from_uint()	562
6.48.3.85 construct_from_long()	562
6.48.3.86 construct_from_ulong()	562
6.48.3.87 construct_from_longlong()	563
6.48.3.88 construct_from_ulonglong()	563
6.48.3.89 construct_from_double()	563
6.48.3.90 construct_from_string_and_lst()	563
6.48.3.91 makewritable()	563
6.48.3.92 share()	564
6.48.4 Friends And Related Symbol Documentation	564
6.48.4.1 archive_node	564
6.48.4.2 are_ex_trivially_equal	564
6.48.4.3 ex_to	564
6.48.4.4 is_a	565
6.48.4.5 is_exactly_a	565
6.48.5 Member Data Documentation	566
6.48.5.1 bp	566
6.49 GiNaC::ex_base_is_less Struct Reference	566
6.49.1 Member Function Documentation	566
6.49.1.1 operator()	566
6.50 GiNaC::ex_is_equal Struct Reference	566
6.50.1 Member Function Documentation	567
6.50.1.1 operator()	567
6.51 GiNaC::ex_is_less Struct Reference	567
6.51.1 Member Function Documentation	567
6.51.1.1 operator()	567
6.52 GiNaC::ex_swap Struct Reference	567
6.52.1 Member Function Documentation	568
6.52.1.1 operator()	568
6.53 GiNaC::expair Class Reference	568
6.53.1 Detailed Description	569
6.53.2 Constructor & Destructor Documentation	569
6.53.2.1 expair() [1/2]	569
6.53.2.2 expair() [2/2]	569
6.53.3 Member Function Documentation	570
6.53.3.1 is_equal()	570
6.53.3.2 is_less()	570
6.53.3.3 compare()	570

6.53.3.4 print()	570
6.53.3.5 is_canonical_numeric()	570
6.53.3.6 swap()	571
6.53.3.7 conjugate()	571
6.53.4 Member Data Documentation	571
6.53.4.1 rest	571
6.53.4.2 coeff	571
6.54 GiNaC::expair_is_less Struct Reference	572
6.54.1 Detailed Description	572
6.54.2 Member Function Documentation	572
6.54.2.1 operator()	572
6.55 GiNaC::expair_rest_is_less Struct Reference	572
6.55.1 Detailed Description	572
6.55.2 Member Function Documentation	573
6.55.2.1 operator()	573
6.56 GiNaC::expair_swap Struct Reference	573
6.56.1 Member Function Documentation	573
6.56.1.1 operator()	573
6.57 GiNaC::expairseq Class Reference	574
6.57.1 Detailed Description	579
6.57.2 Constructor & Destructor Documentation	579
6.57.2.1 expairseq() [1/4]	579
6.57.2.2 expairseq() [2/4]	580
6.57.2.3 expairseq() [3/4]	580
6.57.2.4 expairseq() [4/4]	580
6.57.3 Member Function Documentation	580
6.57.3.1 precedence()	580
6.57.3.2 info()	580
6.57.3.3 nops()	581
6.57.3.4 op()	581
6.57.3.5 map()	581
6.57.3.6 eval()	581
6.57.3.7 to_rational()	582
6.57.3.8 to_polynomial()	582
6.57.3.9 match()	582
6.57.3.10 subs()	582
6.57.3.11 conjugate()	583
6.57.3.12 archive()	583
6.57.3.13 read_archive()	583
6.57.3.14 is_equal_same_type()	584
6.57.3.15 return_type()	584
6.57.3.16 calchash()	584

6.57.3.17	expand()	584
6.57.3.18	thisexpairseq() [1/2]	585
6.57.3.19	thisexpairseq() [2/2]	585
6.57.3.20	printseq()	585
6.57.3.21	printpair()	585
6.57.3.22	split_ex_to_pair()	586
6.57.3.23	combine_ex_with_coeff_to_pair()	586
6.57.3.24	combine_pair_with_coeff_to_pair()	586
6.57.3.25	recombine_pair_to_ex()	586
6.57.3.26	expair_needs_further_processing()	587
6.57.3.27	default_overall_coeff()	587
6.57.3.28	combine_overall_coeff() [1/2]	587
6.57.3.29	combine_overall_coeff() [2/2]	587
6.57.3.30	can_make_flat()	587
6.57.3.31	do_print()	588
6.57.3.32	do_print_tree()	588
6.57.3.33	construct_from_2_ex()	588
6.57.3.34	construct_from_2_expairseq()	588
6.57.3.35	construct_from_expairseq_ex()	588
6.57.3.36	construct_from_exvector()	589
6.57.3.37	construct_from_epvector() [1/2]	589
6.57.3.38	construct_from_epvector() [2/2]	589
6.57.3.39	make_flat() [1/2]	589
6.57.3.40	make_flat() [2/2]	589
6.57.3.41	canonicalize()	590
6.57.3.42	combine_same_terms_sorted_seq()	590
6.57.3.43	is_canonical()	590
6.57.3.44	expandchildren()	590
6.57.3.45	evalchildren()	591
6.57.3.46	subchildren()	591
6.57.4	Member Data Documentation	591
6.57.4.1	seq	591
6.57.4.2	overall_coeff	592
6.58	GiNaC::expand_map_function Struct Reference	592
6.58.1	Detailed Description	593
6.58.2	Constructor & Destructor Documentation	593
6.58.2.1	expand_map_function()	593
6.58.3	Member Function Documentation	594
6.58.3.1	operator()()	594
6.58.4	Member Data Documentation	594
6.58.4.1	options	594
6.59	GiNaC::expand_options Class Reference	594

6.59.1 Detailed Description	594
6.59.2 Member Enumeration Documentation	594
6.59.2.1 anonymous enum	594
6.60 GiNaC::factor_options Class Reference	595
6.60.1 Detailed Description	595
6.60.2 Member Enumeration Documentation	595
6.60.2.1 anonymous enum	595
6.61 GiNaC::fail Class Reference	596
6.61.1 Member Function Documentation	600
6.61.1.1 return_type()	600
6.61.1.2 do_print()	600
6.62 GiNaC::fderivative Class Reference	600
6.62.1 Detailed Description	609
6.62.2 Constructor & Destructor Documentation	609
6.62.2.1 fderivative() [1/3]	609
6.62.2.2 fderivative() [2/3]	609
6.62.2.3 fderivative() [3/3]	610
6.62.3 Member Function Documentation	610
6.62.3.1 print()	610
6.62.3.2 eval()	610
6.62.3.3 series()	611
6.62.3.4 thiscontainer() [1/2]	611
6.62.3.5 thiscontainer() [2/2]	611
6.62.3.6 archive()	611
6.62.3.7 read_archive()	612
6.62.3.8 derivative()	612
6.62.3.9 is_equal_same_type()	612
6.62.3.10 match_same_type()	613
6.62.3.11 derivatives()	613
6.62.3.12 do_print()	613
6.62.3.13 do_print_latex()	614
6.62.3.14 do_print_csrc()	614
6.62.3.15 do_print_tree()	614
6.62.4 Member Data Documentation	614
6.62.4.1 parameter_set	614
6.63 GiNaC::function Class Reference	615
6.63.1 Detailed Description	623
6.63.2 Constructor & Destructor Documentation	623
6.63.2.1 function() [1/18]	623
6.63.2.2 function() [2/18]	623
6.63.2.3 function() [3/18]	623
6.63.2.4 function() [4/18]	623

6.63.2.5 function() [5/18]	624
6.63.2.6 function() [6/18]	624
6.63.2.7 function() [7/18]	624
6.63.2.8 function() [8/18]	624
6.63.2.9 function() [9/18]	625
6.63.2.10 function() [10/18]	625
6.63.2.11 function() [11/18]	625
6.63.2.12 function() [12/18]	626
6.63.2.13 function() [13/18]	626
6.63.2.14 function() [14/18]	626
6.63.2.15 function() [15/18]	627
6.63.2.16 function() [16/18]	627
6.63.2.17 function() [17/18]	627
6.63.2.18 function() [18/18]	627
6.63.3 Member Function Documentation	627
6.63.3.1 print()	627
6.63.3.2 precedence()	628
6.63.3.3 expand()	628
6.63.3.4 eval()	628
6.63.3.5 evalf()	629
6.63.3.6 eval_ncmul()	629
6.63.3.7 calchash()	629
6.63.3.8 series()	629
6.63.3.9 thiscontainer() [1/2]	630
6.63.3.10 thiscontainer() [2/2]	630
6.63.3.11 conjugate()	630
6.63.3.12 real_part()	630
6.63.3.13 imag_part()	631
6.63.3.14 archive()	631
6.63.3.15 read_archive()	631
6.63.3.16 info()	631
6.63.3.17 derivative()	632
6.63.3.18 is_equal_same_type()	632
6.63.3.19 match_same_type()	632
6.63.3.20 return_type()	633
6.63.3.21 return_type_tinfo()	633
6.63.3.22 pderivative()	633
6.63.3.23 expl_derivative()	633
6.63.3.24 registered_functions()	633
6.63.3.25 lookup_remember_table()	634
6.63.3.26 store_remember_table()	634
6.63.3.27 power()	634

6.63.3.28 register_new()	634
6.63.3.29 find_function()	634
6.63.3.30 get_registered_functions()	635
6.63.3.31 get_serial()	635
6.63.3.32 get_name()	635
6.63.4 Friends And Related Symbol Documentation	635
6.63.4.1 remember_table_entry	635
6.63.5 Member Data Documentation	635
6.63.5.1 current_serial	635
6.63.5.2 serial	636
6.64 GiNaC::function_options Class Reference	636
6.64.1 Constructor & Destructor Documentation	642
6.64.1.1 function_options() [1/3]	642
6.64.1.2 function_options() [2/3]	643
6.64.1.3 function_options() [3/3]	643
6.64.1.4 ~function_options()	643
6.64.2 Member Function Documentation	643
6.64.2.1 initialize()	643
6.64.2.2 dummy()	644
6.64.2.3 set_name()	644
6.64.2.4 latex_name()	644
6.64.2.5 eval_func() [1/15]	644
6.64.2.6 eval_func() [2/15]	644
6.64.2.7 eval_func() [3/15]	644
6.64.2.8 eval_func() [4/15]	645
6.64.2.9 eval_func() [5/15]	645
6.64.2.10 eval_func() [6/15]	645
6.64.2.11 eval_func() [7/15]	645
6.64.2.12 eval_func() [8/15]	645
6.64.2.13 eval_func() [9/15]	645
6.64.2.14 eval_func() [10/15]	645
6.64.2.15 eval_func() [11/15]	646
6.64.2.16 eval_func() [12/15]	646
6.64.2.17 eval_func() [13/15]	646
6.64.2.18 eval_func() [14/15]	646
6.64.2.19 evalf_func() [1/15]	646
6.64.2.20 evalf_func() [2/15]	646
6.64.2.21 evalf_func() [3/15]	646
6.64.2.22 evalf_func() [4/15]	647
6.64.2.23 evalf_func() [5/15]	647
6.64.2.24 evalf_func() [6/15]	647
6.64.2.25 evalf_func() [7/15]	647

6.64.2.26 evalf_func()	[8/15]	647
6.64.2.27 evalf_func()	[9/15]	647
6.64.2.28 evalf_func()	[10/15]	647
6.64.2.29 evalf_func()	[11/15]	648
6.64.2.30 evalf_func()	[12/15]	648
6.64.2.31 evalf_func()	[13/15]	648
6.64.2.32 evalf_func()	[14/15]	648
6.64.2.33 conjugate_func()	[1/15]	648
6.64.2.34 conjugate_func()	[2/15]	648
6.64.2.35 conjugate_func()	[3/15]	648
6.64.2.36 conjugate_func()	[4/15]	649
6.64.2.37 conjugate_func()	[5/15]	649
6.64.2.38 conjugate_func()	[6/15]	649
6.64.2.39 conjugate_func()	[7/15]	649
6.64.2.40 conjugate_func()	[8/15]	649
6.64.2.41 conjugate_func()	[9/15]	649
6.64.2.42 conjugate_func()	[10/15]	649
6.64.2.43 conjugate_func()	[11/15]	650
6.64.2.44 conjugate_func()	[12/15]	650
6.64.2.45 conjugate_func()	[13/15]	650
6.64.2.46 conjugate_func()	[14/15]	650
6.64.2.47 real_part_func()	[1/15]	650
6.64.2.48 real_part_func()	[2/15]	650
6.64.2.49 real_part_func()	[3/15]	650
6.64.2.50 real_part_func()	[4/15]	651
6.64.2.51 real_part_func()	[5/15]	651
6.64.2.52 real_part_func()	[6/15]	651
6.64.2.53 real_part_func()	[7/15]	651
6.64.2.54 real_part_func()	[8/15]	651
6.64.2.55 real_part_func()	[9/15]	651
6.64.2.56 real_part_func()	[10/15]	651
6.64.2.57 real_part_func()	[11/15]	652
6.64.2.58 real_part_func()	[12/15]	652
6.64.2.59 real_part_func()	[13/15]	652
6.64.2.60 real_part_func()	[14/15]	652
6.64.2.61 imag_part_func()	[1/15]	652
6.64.2.62 imag_part_func()	[2/15]	652
6.64.2.63 imag_part_func()	[3/15]	652
6.64.2.64 imag_part_func()	[4/15]	653
6.64.2.65 imag_part_func()	[5/15]	653
6.64.2.66 imag_part_func()	[6/15]	653
6.64.2.67 imag_part_func()	[7/15]	653

6.64.2.68 imag_part_func() [8/15]	653
6.64.2.69 imag_part_func() [9/15]	653
6.64.2.70 imag_part_func() [10/15]	653
6.64.2.71 imag_part_func() [11/15]	654
6.64.2.72 imag_part_func() [12/15]	654
6.64.2.73 imag_part_func() [13/15]	654
6.64.2.74 imag_part_func() [14/15]	654
6.64.2.75 expand_func() [1/15]	654
6.64.2.76 expand_func() [2/15]	654
6.64.2.77 expand_func() [3/15]	654
6.64.2.78 expand_func() [4/15]	655
6.64.2.79 expand_func() [5/15]	655
6.64.2.80 expand_func() [6/15]	655
6.64.2.81 expand_func() [7/15]	655
6.64.2.82 expand_func() [8/15]	655
6.64.2.83 expand_func() [9/15]	655
6.64.2.84 expand_func() [10/15]	655
6.64.2.85 expand_func() [11/15]	656
6.64.2.86 expand_func() [12/15]	656
6.64.2.87 expand_func() [13/15]	656
6.64.2.88 expand_func() [14/15]	656
6.64.2.89 derivative_func() [1/15]	656
6.64.2.90 derivative_func() [2/15]	656
6.64.2.91 derivative_func() [3/15]	656
6.64.2.92 derivative_func() [4/15]	657
6.64.2.93 derivative_func() [5/15]	657
6.64.2.94 derivative_func() [6/15]	657
6.64.2.95 derivative_func() [7/15]	657
6.64.2.96 derivative_func() [8/15]	657
6.64.2.97 derivative_func() [9/15]	657
6.64.2.98 derivative_func() [10/15]	657
6.64.2.99 derivative_func() [11/15]	658
6.64.2.100 derivative_func() [12/15]	658
6.64.2.101 derivative_func() [13/15]	658
6.64.2.102 derivative_func() [14/15]	658
6.64.2.103 expl_derivative_func() [1/15]	658
6.64.2.104 expl_derivative_func() [2/15]	658
6.64.2.105 expl_derivative_func() [3/15]	658
6.64.2.106 expl_derivative_func() [4/15]	659
6.64.2.107 expl_derivative_func() [5/15]	659
6.64.2.108 expl_derivative_func() [6/15]	659
6.64.2.109 expl_derivative_func() [7/15]	659

6.64.2.110	expl_derivative_func()	[8/15]	659
6.64.2.111	expl_derivative_func()	[9/15]	659
6.64.2.112	expl_derivative_func()	[10/15]	659
6.64.2.113	expl_derivative_func()	[11/15]	660
6.64.2.114	expl_derivative_func()	[12/15]	660
6.64.2.115	expl_derivative_func()	[13/15]	660
6.64.2.116	expl_derivative_func()	[14/15]	660
6.64.2.117	power_func()	[1/15]	660
6.64.2.118	power_func()	[2/15]	660
6.64.2.119	power_func()	[3/15]	660
6.64.2.120	power_func()	[4/15]	661
6.64.2.121	power_func()	[5/15]	661
6.64.2.122	power_func()	[6/15]	661
6.64.2.123	power_func()	[7/15]	661
6.64.2.124	power_func()	[8/15]	661
6.64.2.125	power_func()	[9/15]	661
6.64.2.126	power_func()	[10/15]	661
6.64.2.127	power_func()	[11/15]	662
6.64.2.128	power_func()	[12/15]	662
6.64.2.129	power_func()	[13/15]	662
6.64.2.130	power_func()	[14/15]	662
6.64.2.131	series_func()	[1/15]	662
6.64.2.132	series_func()	[2/15]	662
6.64.2.133	series_func()	[3/15]	662
6.64.2.134	series_func()	[4/15]	663
6.64.2.135	series_func()	[5/15]	663
6.64.2.136	series_func()	[6/15]	663
6.64.2.137	series_func()	[7/15]	663
6.64.2.138	series_func()	[8/15]	663
6.64.2.139	series_func()	[9/15]	663
6.64.2.140	series_func()	[10/15]	663
6.64.2.141	series_func()	[11/15]	664
6.64.2.142	series_func()	[12/15]	664
6.64.2.143	series_func()	[13/15]	664
6.64.2.144	series_func()	[14/15]	664
6.64.2.145	info_func()	[1/15]	664
6.64.2.146	info_func()	[2/15]	664
6.64.2.147	info_func()	[3/15]	664
6.64.2.148	info_func()	[4/15]	665
6.64.2.149	info_func()	[5/15]	665
6.64.2.150	info_func()	[6/15]	665
6.64.2.151	info_func()	[7/15]	665

6.64.2.152 info_func() [8/15]	665
6.64.2.153 info_func() [9/15]	665
6.64.2.154 info_func() [10/15]	665
6.64.2.155 info_func() [11/15]	666
6.64.2.156 info_func() [12/15]	666
6.64.2.157 info_func() [13/15]	666
6.64.2.158 info_func() [14/15]	666
6.64.2.159 eval_func() [15/15]	666
6.64.2.160 evalf_func() [15/15]	666
6.64.2.161 conjugate_func() [15/15]	666
6.64.2.162 real_part_func() [15/15]	667
6.64.2.163 imag_part_func() [15/15]	667
6.64.2.164 expand_func() [15/15]	667
6.64.2.165 derivative_func() [15/15]	667
6.64.2.166 expl_derivative_func() [15/15]	667
6.64.2.167 power_func() [15/15]	667
6.64.2.168 series_func() [15/15]	667
6.64.2.169 info_func() [15/15]	668
6.64.2.170 print_func() [1/15]	668
6.64.2.171 print_func() [2/15]	668
6.64.2.172 print_func() [3/15]	668
6.64.2.173 print_func() [4/15]	668
6.64.2.174 print_func() [5/15]	668
6.64.2.175 print_func() [6/15]	669
6.64.2.176 print_func() [7/15]	669
6.64.2.177 print_func() [8/15]	669
6.64.2.178 print_func() [9/15]	669
6.64.2.179 print_func() [10/15]	669
6.64.2.180 print_func() [11/15]	669
6.64.2.181 print_func() [12/15]	670
6.64.2.182 print_func() [13/15]	670
6.64.2.183 print_func() [14/15]	670
6.64.2.184 print_func() [15/15]	670
6.64.2.185 set_return_type()	670
6.64.2.186 do_not_evalf_params()	670
6.64.2.187 remember()	671
6.64.2.188 overloaded()	671
6.64.2.189 set_symmetry()	671
6.64.2.190 get_name()	671
6.64.2.191 get_nparams()	671
6.64.2.192 has_derivative()	671
6.64.2.193 has_power()	671

6.64.2.194 test_and_set_nparams()	672
6.64.2.195 set_print_func()	672
6.64.3 Friends And Related Symbol Documentation	672
6.64.3.1 function	672
6.64.3.2 fderivative	673
6.64.4 Member Data Documentation	673
6.64.4.1 name	673
6.64.4.2 TeX_name	673
6.64.4.3 nparams	673
6.64.4.4 eval_f	673
6.64.4.5 evalf_f	673
6.64.4.6 conjugate_f	674
6.64.4.7 real_part_f	674
6.64.4.8 imag_part_f	674
6.64.4.9 expand_f	674
6.64.4.10 derivative_f	674
6.64.4.11 expl_derivative_f	674
6.64.4.12 power_f	675
6.64.4.13 series_f	675
6.64.4.14 print_dispatch_table	675
6.64.4.15 info_f	675
6.64.4.16 evalf_params_first	675
6.64.4.17 use_return_type	675
6.64.4.18 return_type	675
6.64.4.19 return_type_tinfo	676
6.64.4.20 use_remember	676
6.64.4.21 remember_size	676
6.64.4.22 remember_assoc_size	676
6.64.4.23 remember_strategy	676
6.64.4.24 eval_use_exvector_args	676
6.64.4.25 evalf_use_exvector_args	676
6.64.4.26 conjugate_use_exvector_args	676
6.64.4.27 real_part_use_exvector_args	677
6.64.4.28 imag_part_use_exvector_args	677
6.64.4.29 expand_use_exvector_args	677
6.64.4.30 derivative_use_exvector_args	677
6.64.4.31 expl_derivative_use_exvector_args	677
6.64.4.32 power_use_exvector_args	677
6.64.4.33 series_use_exvector_args	677
6.64.4.34 print_use_exvector_args	677
6.64.4.35 info_use_exvector_args	678
6.64.4.36 functions_with_same_name	678

6.64.4.37 symtree	678
6.65 GiNaC::G2_SERIAL Class Reference	678
6.65.1 Detailed Description	678
6.65.2 Member Data Documentation	678
6.65.2.1 serial	678
6.66 GiNaC::G3_SERIAL Class Reference	679
6.66.1 Detailed Description	679
6.66.2 Member Data Documentation	679
6.66.2.1 serial	679
6.67 GiNaC::gcd_options Struct Reference	679
6.67.1 Detailed Description	679
6.67.2 Member Enumeration Documentation	679
6.67.2.1 anonymous enum	679
6.68 GiNaC::gcdheu_failed Class Reference	680
6.68.1 Detailed Description	680
6.69 GiNaC::has_distance< T > Class Template Reference	680
6.69.1 Detailed Description	681
6.69.2 Member Typedef Documentation	681
6.69.2.1 yes_type	681
6.69.2.2 no_type	681
6.69.3 Member Enumeration Documentation	681
6.69.3.1 anonymous enum	681
6.69.4 Member Function Documentation	681
6.69.4.1 test() [1/2]	681
6.69.4.2 test() [2/2]	682
6.70 GiNaC::has_options Class Reference	682
6.70.1 Detailed Description	682
6.70.2 Member Enumeration Documentation	682
6.70.2.1 anonymous enum	682
6.71 std::hash< GiNaC::ex > Struct Reference	682
6.71.1 Detailed Description	683
6.71.2 Member Function Documentation	683
6.71.2.1 operator>()	683
6.72 GiNaC::idx Class Reference	683
6.72.1 Detailed Description	688
6.72.2 Constructor & Destructor Documentation	688
6.72.2.1 idx()	688
6.72.3 Member Function Documentation	688
6.72.3.1 info()	688
6.72.3.2 nops()	689
6.72.3.3 op()	689
6.72.3.4 map()	689

6.72.3.5 evalf()	689
6.72.3.6 subs()	689
6.72.3.7 archive()	690
6.72.3.8 read_archive()	690
6.72.3.9 derivative()	690
6.72.3.10 match_same_type()	691
6.72.3.11 calchash()	691
6.72.3.12 is_dummy_pair_same_type()	691
6.72.3.13 get_value()	692
6.72.3.14 is_numeric()	692
6.72.3.15 is_symbolic()	692
6.72.3.16 get_dim()	692
6.72.3.17 is_dim_numeric()	692
6.72.3.18 is_dim_symbolic()	693
6.72.3.19 replace_dim()	693
6.72.3.20 minimal_dim()	693
6.72.3.21 print_index()	693
6.72.3.22 do_print()	693
6.72.3.23 do_print_csrc()	694
6.72.3.24 do_print_latex()	694
6.72.3.25 do_print_tree()	694
6.72.4 Member Data Documentation	694
6.72.4.1 value	694
6.72.4.2 dim	694
6.73 GiNaC::idx_is_equal_ignore_dim Struct Reference	695
6.73.1 Member Function Documentation	695
6.73.1.1 operator>()	695
6.74 GiNaC::indexed Class Reference	695
6.74.1 Detailed Description	702
6.74.2 Constructor & Destructor Documentation	702
6.74.2.1 indexed() [1/13]	702
6.74.2.2 indexed() [2/13]	703
6.74.2.3 indexed() [3/13]	703
6.74.2.4 indexed() [4/13]	703
6.74.2.5 indexed() [5/13]	704
6.74.2.6 indexed() [6/13]	704
6.74.2.7 indexed() [7/13]	705
6.74.2.8 indexed() [8/13]	705
6.74.2.9 indexed() [9/13]	705
6.74.2.10 indexed() [10/13]	706
6.74.2.11 indexed() [11/13]	706
6.74.2.12 indexed() [12/13]	706

6.74.2.13 indexed() [13/13]	706
6.74.3 Member Function Documentation	707
6.74.3.1 precedence()	707
6.74.3.2 info()	707
6.74.3.3 eval()	707
6.74.3.4 real_part()	707
6.74.3.5 imag_part()	708
6.74.3.6 get_free_indices()	708
6.74.3.7 archive()	708
6.74.3.8 read_archive()	708
6.74.3.9 derivative()	709
6.74.3.10 thiscontainer() [1/2]	709
6.74.3.11 thiscontainer() [2/2]	709
6.74.3.12 return_type()	709
6.74.3.13 return_type_tinfo()	710
6.74.3.14 expand()	710
6.74.3.15 all_index_values_are()	710
6.74.3.16 get_indices()	710
6.74.3.17 get_dummy_indices() [1/2]	710
6.74.3.18 get_dummy_indices() [2/2]	711
6.74.3.19 has_dummy_index_for()	711
6.74.3.20 get_symmetry()	711
6.74.3.21 printindices()	711
6.74.3.22 print_indexed()	711
6.74.3.23 do_print()	712
6.74.3.24 do_print_latex()	712
6.74.3.25 do_print_tree()	712
6.74.3.26 validate()	712
6.74.4 Friends And Related Symbol Documentation	713
6.74.4.1 simplify_indexed	713
6.74.4.2 simplify_indexed_product	713
6.74.4.3 reposition_dummy_indices	713
6.74.5 Member Data Documentation	714
6.74.5.1 symtree	714
6.75 GiNaC::info_flags Class Reference	714
6.75.1 Detailed Description	714
6.75.2 Member Enumeration Documentation	714
6.75.2.1 anonymous enum	714
6.76 GiNaC::integral Class Reference	715
6.76.1 Detailed Description	721
6.76.2 Constructor & Destructor Documentation	721
6.76.2.1 integral()	721

6.76.3 Member Function Documentation	721
6.76.3.1 precedence()	721
6.76.3.2 eval()	721
6.76.3.3 evalf()	721
6.76.3.4 degree()	722
6.76.3.5 ldegree()	722
6.76.3.6 eval_ncmul()	722
6.76.3.7 nops()	722
6.76.3.8 op()	722
6.76.3.9 let_op()	723
6.76.3.10 expand()	723
6.76.3.11 get_free_indices()	723
6.76.3.12 return_type()	723
6.76.3.13 return_type_tinfo()	723
6.76.3.14 conjugate()	724
6.76.3.15 eval_integ()	724
6.76.3.16 archive()	724
6.76.3.17 read_archive()	724
6.76.3.18 derivative()	725
6.76.3.19 series()	725
6.76.3.20 do_print()	725
6.76.3.21 do_print_latex()	726
6.76.4 Member Data Documentation	726
6.76.4.1 max_integration_level	726
6.76.4.2 relative_integration_error	726
6.76.4.3 x	726
6.76.4.4 a	726
6.76.4.5 b	726
6.76.4.6 f	727
6.77 GiNaC::integration_kernel Class Reference	727
6.77.1 Detailed Description	732
6.77.2 Member Function Documentation	732
6.77.2.1 series()	732
6.77.2.2 has_trailing_zero()	732
6.77.2.3 is_numeric()	733
6.77.2.4 Laurent_series()	733
6.77.2.5 get_numerical_value()	733
6.77.2.6 uses_Laurent_series()	734
6.77.2.7 series_coeff_impl()	734
6.77.2.8 get_cache_size()	734
6.77.2.9 set_cache_step()	734
6.77.2.10 get_series_coeff()	735

6.77.2.11 series_coeff()	735
6.77.2.12 get_numerical_value_impl()	735
6.77.2.13 do_print()	735
6.77.3 Member Data Documentation	736
6.77.3.1 cache_step_size	736
6.77.3.2 series_vec	736
6.78 GiNaC::is_not_a_clifford Struct Reference	736
6.78.1 Detailed Description	736
6.78.2 Member Function Documentation	736
6.78.2.1 operator()	736
6.79 GiNaC::is_summation_idx Struct Reference	737
6.79.1 Member Function Documentation	737
6.79.1.1 operator()	737
6.80 GiNaC::iterated_integral2_SERIAL Class Reference	737
6.80.1 Detailed Description	737
6.80.2 Member Data Documentation	737
6.80.2.1 serial	737
6.81 GiNaC::iterated_integral3_SERIAL Class Reference	738
6.81.1 Detailed Description	738
6.81.2 Member Data Documentation	738
6.81.2.1 serial	738
6.82 GiNaC::Kronecker_dtau_kernel Class Reference	738
6.82.1 Detailed Description	744
6.82.2 Constructor & Destructor Documentation	745
6.82.2.1 Kronecker_dtau_kernel()	745
6.82.3 Member Function Documentation	745
6.82.3.1 nops()	745
6.82.3.2 op()	745
6.82.3.3 let_op()	745
6.82.3.4 is_numeric()	746
6.82.3.5 get_numerical_value()	746
6.82.3.6 series_coeff_impl()	746
6.82.3.7 do_print()	746
6.82.4 Member Data Documentation	747
6.82.4.1 n	747
6.82.4.2 z	747
6.82.4.3 K	747
6.82.4.4 C_norm	747
6.83 GiNaC::Kronecker_dz_kernel Class Reference	748
6.83.1 Detailed Description	753
6.83.2 Constructor & Destructor Documentation	754
6.83.2.1 Kronecker_dz_kernel()	754

6.83.3 Member Function Documentation	754
6.83.3.1 nops()	754
6.83.3.2 op()	754
6.83.3.3 let_op()	754
6.83.3.4 is_numeric()	755
6.83.3.5 get_numerical_value()	755
6.83.3.6 series_coeff_impl()	755
6.83.3.7 do_print()	755
6.83.4 Member Data Documentation	756
6.83.4.1 n	756
6.83.4.2 z_j	756
6.83.4.3 tau	756
6.83.4.4 K	756
6.83.4.5 C_norm	756
6.84 GiNaC::lanczos_coeffs Class Reference	756
6.84.1 Constructor & Destructor Documentation	757
6.84.1.1 lanczos_coeffs()	757
6.84.2 Member Function Documentation	757
6.84.2.1 sufficiently_accurate()	757
6.84.2.2 get_order()	757
6.84.2.3 calc_lanczos_A()	757
6.84.3 Member Data Documentation	758
6.84.3.1 coeffs	758
6.84.3.2 current_vector	758
6.85 std::less< GiNaC::ptr< T > > Struct Template Reference	758
6.85.1 Detailed Description	758
6.85.2 Member Function Documentation	758
6.85.2.1 operator()	758
6.86 GiNaC::library_init Class Reference	759
6.86.1 Detailed Description	759
6.86.2 Constructor & Destructor Documentation	759
6.86.2.1 library_init()	759
6.86.2.2 ~library_init()	760
6.86.3 Member Function Documentation	760
6.86.3.1 init_unarchivers()	760
6.86.4 Member Data Documentation	760
6.86.4.1 count	760
6.87 GiNaC::make_flat_inserter Class Reference	760
6.87.1 Detailed Description	761
6.87.2 Constructor & Destructor Documentation	761
6.87.2.1 make_flat_inserter() [1/2]	761
6.87.2.2 make_flat_inserter() [2/2]	761

6.87.3 Member Function Documentation	761
6.87.3.1 handle_factor()	761
6.87.3.2 combine_indices()	762
6.87.4 Member Data Documentation	762
6.87.4.1 do_renaming	762
6.87.4.2 used_indices	762
6.88 GiNaC::map_function Struct Reference	762
6.88.1 Detailed Description	764
6.88.2 Member Typedef Documentation	764
6.88.2.1 argument_type	764
6.88.2.2 result_type	764
6.88.3 Constructor & Destructor Documentation	764
6.88.3.1 ~map_function()	764
6.88.4 Member Function Documentation	764
6.88.4.1 operator()()	764
6.89 GiNaC::matrix Class Reference	765
6.89.1 Detailed Description	770
6.89.2 Constructor & Destructor Documentation	770
6.89.2.1 matrix() [1/5]	770
6.89.2.2 matrix() [2/5]	771
6.89.2.3 matrix() [3/5]	771
6.89.2.4 matrix() [4/5]	771
6.89.2.5 matrix() [5/5]	771
6.89.3 Member Function Documentation	772
6.89.3.1 nops()	772
6.89.3.2 op()	772
6.89.3.3 let_op()	772
6.89.3.4 evalm()	772
6.89.3.5 subs()	773
6.89.3.6 eval_indexed()	773
6.89.3.7 add_indexed()	773
6.89.3.8 scalar_mul_indexed()	773
6.89.3.9 contract_with()	774
6.89.3.10 conjugate()	774
6.89.3.11 real_part()	774
6.89.3.12 imag_part()	774
6.89.3.13 archive()	774
6.89.3.14 read_archive()	775
6.89.3.15 match_same_type()	775
6.89.3.16 return_type()	775
6.89.3.17 rows()	775
6.89.3.18 cols()	776

6.89.3.19 add()	776
6.89.3.20 sub()	776
6.89.3.21 mul() [1/2]	776
6.89.3.22 mul() [2/2]	777
6.89.3.23 mul_scalar()	777
6.89.3.24 pow()	777
6.89.3.25 operator>() [1/2]	777
6.89.3.26 operator>() [2/2]	778
6.89.3.27 set()	778
6.89.3.28 transpose()	778
6.89.3.29 determinant()	779
6.89.3.30 trace()	779
6.89.3.31 charpoly()	780
6.89.3.32 inverse() [1/2]	780
6.89.3.33 inverse() [2/2]	780
6.89.3.34 solve()	781
6.89.3.35 rank() [1/2]	782
6.89.3.36 rank() [2/2]	782
6.89.3.37 is_zero_matrix()	782
6.89.3.38 determinant_minor()	782
6.89.3.39 echelon_form()	783
6.89.3.40 gauss_elimination()	783
6.89.3.41 division_free_elimination()	783
6.89.3.42 fraction_free_elimination()	784
6.89.3.43 markowitz_elimination()	784
6.89.3.44 pivot()	784
6.89.3.45 print_elements()	785
6.89.3.46 do_print()	785
6.89.3.47 do_print_latex()	785
6.89.3.48 do_print_python_repr()	785
6.89.4 Member Data Documentation	786
6.89.4.1 row	786
6.89.4.2 col	786
6.89.4.3 m	786
6.90 GiNaC::minkmetric Class Reference	787
6.90.1 Detailed Description	792
6.90.2 Constructor & Destructor Documentation	792
6.90.2.1 minkmetric()	792
6.90.3 Member Function Documentation	792
6.90.3.1 info()	792
6.90.3.2 eval_indexed()	793
6.90.3.3 archive()	793

6.90.3.4 read_archive()	793
6.90.3.5 return_type()	793
6.90.3.6 do_print()	793
6.90.3.7 do_print_latex()	794
6.90.4 Member Data Documentation	794
6.90.4.1 pos_sig	794
6.91 GiNaC::modular_form_kernel Class Reference	794
6.91.1 Detailed Description	799
6.91.2 Constructor & Destructor Documentation	799
6.91.2.1 modular_form_kernel()	799
6.91.3 Member Function Documentation	800
6.91.3.1 series()	800
6.91.3.2 nops()	800
6.91.3.3 op()	800
6.91.3.4 let_op()	800
6.91.3.5 is_numeric()	801
6.91.3.6 Laurent_series()	801
6.91.3.7 get_numerical_value()	801
6.91.3.8 uses_Laurent_series()	801
6.91.3.9 q_expansion_modular_form()	802
6.91.3.10 do_print()	802
6.91.4 Member Data Documentation	802
6.91.4.1 k	802
6.91.4.2 P	802
6.91.4.3 C_norm	802
6.92 GiNaC::basic_partition_generator::mpartition2 Struct Reference	803
6.92.1 Constructor & Destructor Documentation	803
6.92.1.1 mpartition2()	803
6.92.2 Member Function Documentation	803
6.92.2.1 next_partition()	803
6.92.3 Member Data Documentation	803
6.92.3.1 x	803
6.92.3.2 n	803
6.92.3.3 m	804
6.93 GiNaC::mul Class Reference	804
6.93.1 Detailed Description	810
6.93.2 Constructor & Destructor Documentation	810
6.93.2.1 mul() [1/7]	810
6.93.2.2 mul() [2/7]	810
6.93.2.3 mul() [3/7]	810
6.93.2.4 mul() [4/7]	811
6.93.2.5 mul() [5/7]	811

6.93.2.6 mul() [6/7]	811
6.93.2.7 mul() [7/7]	811
6.93.3 Member Function Documentation	811
6.93.3.1 precedence()	811
6.93.3.2 info()	812
6.93.3.3 is_polynomial()	812
6.93.3.4 degree()	812
6.93.3.5 ldegree()	812
6.93.3.6 coeff()	813
6.93.3.7 has()	813
6.93.3.8 eval()	813
6.93.3.9 evalf()	814
6.93.3.10 real_part()	814
6.93.3.11 imag_part()	814
6.93.3.12 evalm()	814
6.93.3.13 series()	814
6.93.3.14 normal()	815
6.93.3.15 integer_content()	815
6.93.3.16 smod()	815
6.93.3.17 max_coefficient()	816
6.93.3.18 get_free_indices()	816
6.93.3.19 conjugate()	816
6.93.3.20 derivative()	816
6.93.3.21 eval_ncmul()	817
6.93.3.22 return_type()	817
6.93.3.23 return_type_tinfo()	817
6.93.3.24 thisexpairseq() [1/2]	817
6.93.3.25 thisexpairseq() [2/2]	817
6.93.3.26 split_ex_to_pair()	818
6.93.3.27 combine_ex_with_coeff_to_pair()	818
6.93.3.28 combine_pair_with_coeff_to_pair()	818
6.93.3.29 recombine_pair_to_ex()	818
6.93.3.30 expair_needs_further_processing()	819
6.93.3.31 default_overall_coeff()	819
6.93.3.32 combine_overall_coeff() [1/2]	819
6.93.3.33 combine_overall_coeff() [2/2]	819
6.93.3.34 can_make_flat()	819
6.93.3.35 expand()	820
6.93.3.36 algebraic_subs_mul()	820
6.93.3.37 find_real_imag()	820
6.93.3.38 print_overall_coeff()	820
6.93.3.39 do_print()	821

6.93.3.40 do_print_latex()	821
6.93.3.41 do_print_csrc()	821
6.93.3.42 do_print_python_repr()	821
6.93.3.43 can_be_further_expanded()	821
6.93.3.44 expandchildren()	822
6.93.4 Friends And Related Symbol Documentation	822
6.93.4.1 add	822
6.93.4.2 ncmul	822
6.93.4.3 power	822
6.94 GiNaC::multi_iterator_counter< T > Class Template Reference	823
6.94.1 Detailed Description	824
6.94.2 Constructor & Destructor Documentation	825
6.94.2.1 multi_iterator_counter() [1/3]	825
6.94.2.2 multi_iterator_counter() [2/3]	825
6.94.2.3 multi_iterator_counter() [3/3]	825
6.94.3 Member Function Documentation	825
6.94.3.1 init()	825
6.94.3.2 operator++()	826
6.94.4 Friends And Related Symbol Documentation	826
6.94.4.1 operator<<	826
6.95 GiNaC::multi_iterator_counter_indv< T > Class Template Reference	826
6.95.1 Detailed Description	828
6.95.2 Constructor & Destructor Documentation	828
6.95.2.1 multi_iterator_counter_indv() [1/3]	828
6.95.2.2 multi_iterator_counter_indv() [2/3]	828
6.95.2.3 multi_iterator_counter_indv() [3/3]	829
6.95.3 Member Function Documentation	829
6.95.3.1 init()	829
6.95.3.2 operator++()	829
6.95.4 Friends And Related Symbol Documentation	830
6.95.4.1 operator<<	830
6.95.5 Member Data Documentation	830
6.95.5.1 Nv	830
6.96 GiNaC::multi_iterator_ordered< T > Class Template Reference	830
6.96.1 Detailed Description	832
6.96.2 Constructor & Destructor Documentation	832
6.96.2.1 multi_iterator_ordered() [1/3]	832
6.96.2.2 multi_iterator_ordered() [2/3]	832
6.96.2.3 multi_iterator_ordered() [3/3]	833
6.96.3 Member Function Documentation	833
6.96.3.1 init()	833
6.96.3.2 operator++()	833

6.96.4 Friends And Related Symbol Documentation	834
6.96.4.1 operator<<	834
6.97 GiNaC::multi_iterator_ordered_eq< T > Class Template Reference	834
6.97.1 Detailed Description	836
6.97.2 Constructor & Destructor Documentation	836
6.97.2.1 multi_iterator_ordered_eq() [1/3]	836
6.97.2.2 multi_iterator_ordered_eq() [2/3]	836
6.97.2.3 multi_iterator_ordered_eq() [3/3]	836
6.97.3 Member Function Documentation	837
6.97.3.1 init()	837
6.97.3.2 operator++()	837
6.97.4 Friends And Related Symbol Documentation	837
6.97.4.1 operator<<	837
6.98 GiNaC::multi_iterator_ordered_eq_indv< T > Class Template Reference	838
6.98.1 Detailed Description	839
6.98.2 Constructor & Destructor Documentation	840
6.98.2.1 multi_iterator_ordered_eq_indv() [1/3]	840
6.98.2.2 multi_iterator_ordered_eq_indv() [2/3]	840
6.98.2.3 multi_iterator_ordered_eq_indv() [3/3]	840
6.98.3 Member Function Documentation	840
6.98.3.1 init()	840
6.98.3.2 operator++()	841
6.98.4 Friends And Related Symbol Documentation	841
6.98.4.1 operator<<	841
6.98.5 Member Data Documentation	841
6.98.5.1 Nv	841
6.99 GiNaC::multi_iterator_permutation< T > Class Template Reference	842
6.99.1 Detailed Description	843
6.99.2 Constructor & Destructor Documentation	844
6.99.2.1 multi_iterator_permutation() [1/3]	844
6.99.2.2 multi_iterator_permutation() [2/3]	844
6.99.2.3 multi_iterator_permutation() [3/3]	844
6.99.3 Member Function Documentation	844
6.99.3.1 init()	844
6.99.3.2 operator++()	845
6.99.3.3 get_sign()	845
6.99.4 Friends And Related Symbol Documentation	845
6.99.4.1 operator<<	845
6.100 GiNaC::multi_iterator_shuffle< T > Class Template Reference	846
6.100.1 Detailed Description	847
6.100.2 Constructor & Destructor Documentation	848
6.100.2.1 multi_iterator_shuffle() [1/2]	848

6.100.2.2 multi_iterator_shuffle() [2/2]	848
6.100.3 Member Function Documentation	848
6.100.3.1 init()	848
6.100.3.2 operator++()	848
6.100.4 Friends And Related Symbol Documentation	849
6.100.4.1 operator<<	849
6.100.5 Member Data Documentation	849
6.100.5.1 N_internal	849
6.100.5.2 v_internal	849
6.100.5.3 v_orig	849
6.101 GiNaC::multi_iterator_shuffle_prime< T > Class Template Reference	850
6.101.1 Detailed Description	852
6.101.2 Constructor & Destructor Documentation	852
6.101.2.1 multi_iterator_shuffle_prime() [1/2]	852
6.101.2.2 multi_iterator_shuffle_prime() [2/2]	852
6.101.3 Member Function Documentation	853
6.101.3.1 init()	853
6.101.4 Friends And Related Symbol Documentation	853
6.101.4.1 operator<<	853
6.102 GiNaC::multiple_polylog_kernel Class Reference	853
6.102.1 Detailed Description	859
6.102.2 Constructor & Destructor Documentation	859
6.102.2.1 multiple_polylog_kernel()	859
6.102.3 Member Function Documentation	860
6.102.3.1 nops()	860
6.102.3.2 op()	860
6.102.3.3 let_op()	860
6.102.3.4 is_numeric()	860
6.102.3.5 series_coeff_impl()	860
6.102.3.6 do_print()	861
6.102.4 Member Data Documentation	861
6.102.4.1 z	861
6.103 GiNaC::ncmul Class Reference	861
6.103.1 Detailed Description	868
6.103.2 Constructor & Destructor Documentation	868
6.103.2.1 ncmul() [1/7]	868
6.103.2.2 ncmul() [2/7]	868
6.103.2.3 ncmul() [3/7]	869
6.103.2.4 ncmul() [4/7]	869
6.103.2.5 ncmul() [5/7]	869
6.103.2.6 ncmul() [6/7]	869
6.103.2.7 ncmul() [7/7]	869

6.103.3 Member Function Documentation	869
6.103.3.1 precedence()	869
6.103.3.2 info()	870
6.103.3.3 degree()	870
6.103.3.4 ldegree()	870
6.103.3.5 expand()	870
6.103.3.6 coeff()	871
6.103.3.7 eval()	871
6.103.3.8 evalm()	871
6.103.3.9 get_free_indices()	872
6.103.3.10 thiscontainer() [1/2]	872
6.103.3.11 thiscontainer() [2/2]	872
6.103.3.12 conjugate()	872
6.103.3.13 real_part()	872
6.103.3.14 imag_part()	873
6.103.3.15 derivative()	873
6.103.3.16 return_type()	873
6.103.3.17 return_type_tinfo()	873
6.103.3.18 do_print()	874
6.103.3.19 do_print_csrc()	874
6.103.3.20 count_factors()	874
6.103.3.21 append_factors()	874
6.103.3.22 expandchildren()	874
6.103.3.23 get_factors()	875
6.103.4 Friends And Related Symbol Documentation	875
6.103.4.1 power	875
6.103.4.2 reeval_ncmul	875
6.103.4.3 hold_ncmul	875
6.104 GiNaC::normal_map_function Struct Reference	876
6.104.1 Detailed Description	877
6.104.2 Member Function Documentation	877
6.104.2.1 operator()	877
6.105 GiNaC::numeric Class Reference	877
6.105.1 Detailed Description	883
6.105.2 Constructor & Destructor Documentation	883
6.105.2.1 numeric() [1/10]	883
6.105.2.2 numeric() [2/10]	884
6.105.2.3 numeric() [3/10]	884
6.105.2.4 numeric() [4/10]	884
6.105.2.5 numeric() [5/10]	884
6.105.2.6 numeric() [6/10]	884
6.105.2.7 numeric() [7/10]	884

6.105.2.8 numeric() [8/10]	885
6.105.2.9 numeric() [9/10]	885
6.105.2.10 numeric() [10/10]	885
6.105.3 Member Function Documentation	885
6.105.3.1 precedence()	885
6.105.3.2 info()	886
6.105.3.3 is_polynomial()	886
6.105.3.4 degree()	886
6.105.3.5 ldegree()	886
6.105.3.6 coeff()	887
6.105.3.7 has()	887
6.105.3.8 eval()	887
6.105.3.9 evalf()	887
6.105.3.10 subs()	888
6.105.3.11 normal()	888
6.105.3.12 to_rational()	888
6.105.3.13 to_polynomial()	889
6.105.3.14 integer_content()	889
6.105.3.15 smod()	889
6.105.3.16 max_coefficient()	890
6.105.3.17 conjugate()	890
6.105.3.18 real_part()	890
6.105.3.19 imag_part()	890
6.105.3.20 archive()	890
6.105.3.21 read_archive()	891
6.105.3.22 derivative()	891
6.105.3.23 is_equal_same_type()	891
6.105.3.24 calchash()	891
6.105.3.25 add()	892
6.105.3.26 sub()	892
6.105.3.27 mul()	892
6.105.3.28 div()	892
6.105.3.29 power()	893
6.105.3.30 add_dyn()	893
6.105.3.31 sub_dyn()	893
6.105.3.32 mul_dyn()	894
6.105.3.33 div_dyn()	894
6.105.3.34 power_dyn()	894
6.105.3.35 operator=() [1/6]	894
6.105.3.36 operator=() [2/6]	895
6.105.3.37 operator=() [3/6]	895
6.105.3.38 operator=() [4/6]	895

6.105.3.39 operator=() [5/6]	895
6.105.3.40 operator=() [6/6]	895
6.105.3.41 inverse()	895
6.105.3.42 step()	896
6.105.3.43 csgn()	896
6.105.3.44 compare()	896
6.105.3.45 is_equal()	897
6.105.3.46 is_zero()	897
6.105.3.47 is_positive()	897
6.105.3.48 is_negative()	897
6.105.3.49 is_integer()	898
6.105.3.50 is_pos_integer()	898
6.105.3.51 is_nonneg_integer()	898
6.105.3.52 is_even()	898
6.105.3.53 is_odd()	898
6.105.3.54 is_prime()	899
6.105.3.55 is_rational()	899
6.105.3.56 is_real()	899
6.105.3.57 is_cinteger()	899
6.105.3.58 is_crational()	900
6.105.3.59 operator==(())	900
6.105.3.60 operator!=(())	900
6.105.3.61 operator<()	900
6.105.3.62 operator<=()	900
6.105.3.63 operator>()	900
6.105.3.64 operator>=()	901
6.105.3.65 to_int()	901
6.105.3.66 to_long()	901
6.105.3.67 to_double()	902
6.105.3.68 to_cl_N()	902
6.105.3.69 real()	902
6.105.3.70 imag()	902
6.105.3.71 numer()	903
6.105.3.72 denom()	903
6.105.3.73 int_length()	903
6.105.3.74 print_numeric()	903
6.105.3.75 do_print()	904
6.105.3.76 do_print_latex()	904
6.105.3.77 do_print_csrc()	904
6.105.3.78 do_print_csrc_cl_N()	904
6.105.3.79 do_print_tree()	904
6.105.3.80 do_print_python_repr()	905

6.105.4 Member Data Documentation	905
6.105.4.1 value	905
6.106 GiNaC::op0_is_equal Struct Reference	905
6.106.1 Member Function Documentation	905
6.106.1.1 operator>()	905
6.107 GiNaC::partition_generator Class Reference	906
6.107.1 Detailed Description	907
6.107.2 Constructor & Destructor Documentation	907
6.107.2.1 partition_generator()	907
6.107.3 Member Function Documentation	907
6.107.3.1 get()	907
6.107.3.2 next()	907
6.107.4 Member Data Documentation	908
6.107.4.1 partition	908
6.107.4.2 current_updated	908
6.108 GiNaC::partition_with_zero_parts_generator Class Reference	908
6.108.1 Detailed Description	909
6.108.2 Constructor & Destructor Documentation	910
6.108.2.1 partition_with_zero_parts_generator()	910
6.108.3 Member Function Documentation	910
6.108.3.1 get()	910
6.108.3.2 next()	910
6.108.4 Member Data Documentation	910
6.108.4.1 m	910
6.108.4.2 partition	910
6.108.4.3 current_updated	911
6.109 GiNaC::pointer_to_map_function Class Reference	911
6.109.1 Constructor & Destructor Documentation	913
6.109.1.1 pointer_to_map_function()	913
6.109.2 Member Function Documentation	913
6.109.2.1 operator>()	913
6.109.3 Member Data Documentation	913
6.109.3.1 ptr	913
6.110 GiNaC::pointer_to_map_function_1arg< T1 > Class Template Reference	913
6.110.1 Constructor & Destructor Documentation	915
6.110.1.1 pointer_to_map_function_1arg()	915
6.110.2 Member Function Documentation	915
6.110.2.1 operator>()	915
6.110.3 Member Data Documentation	915
6.110.3.1 ptr	915
6.110.3.2 arg1	915
6.111 GiNaC::pointer_to_map_function_2args< T1, T2 > Class Template Reference	916

6.111.1 Constructor & Destructor Documentation	917
6.111.1.1 pointer_to_map_function_2args()	917
6.111.2 Member Function Documentation	917
6.111.2.1 operator()()	917
6.111.3 Member Data Documentation	918
6.111.3.1 ptr	918
6.111.3.2 arg1	918
6.111.3.3 arg2	918
6.112 GiNaC::pointer_to_map_function_3args< T1, T2, T3 > Class Template Reference	918
6.112.1 Constructor & Destructor Documentation	920
6.112.1.1 pointer_to_map_function_3args()	920
6.112.2 Member Function Documentation	920
6.112.2.1 operator()()	920
6.112.3 Member Data Documentation	920
6.112.3.1 ptr	920
6.112.3.2 arg1	920
6.112.3.3 arg2	920
6.112.3.4 arg3	921
6.113 GiNaC::pointer_to_member_to_map_function< C > Class Template Reference	921
6.113.1 Constructor & Destructor Documentation	923
6.113.1.1 pointer_to_member_to_map_function()	923
6.113.2 Member Function Documentation	923
6.113.2.1 operator()()	923
6.113.3 Member Data Documentation	923
6.113.3.1 ptr	923
6.113.3.2 c	923
6.114 GiNaC::pointer_to_member_to_map_function_1arg< C, T1 > Class Template Reference	924
6.114.1 Constructor & Destructor Documentation	925
6.114.1.1 pointer_to_member_to_map_function_1arg()	925
6.114.2 Member Function Documentation	925
6.114.2.1 operator()()	925
6.114.3 Member Data Documentation	926
6.114.3.1 ptr	926
6.114.3.2 c	926
6.114.3.3 arg1	926
6.115 GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 > Class Template Reference	926
6.115.1 Constructor & Destructor Documentation	928
6.115.1.1 pointer_to_member_to_map_function_2args()	928
6.115.2 Member Function Documentation	928
6.115.2.1 operator()()	928
6.115.3 Member Data Documentation	928
6.115.3.1 ptr	928

6.115.3.2 c	928
6.115.3.3 arg1	928
6.115.3.4 arg2	929
6.116 GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 > Class Template Reference	929
6.116.1 Constructor & Destructor Documentation	931
6.116.1.1 pointer_to_member_to_map_function_3args()	931
6.116.2 Member Function Documentation	931
6.116.2.1 operator()()	931
6.116.3 Member Data Documentation	931
6.116.3.1 ptr	931
6.116.3.2 c	931
6.116.3.3 arg1	932
6.116.3.4 arg2	932
6.116.3.5 arg3	932
6.117 GiNaC::pole_error Class Reference	932
6.117.1 Detailed Description	933
6.117.2 Constructor & Destructor Documentation	933
6.117.2.1 pole_error()	933
6.117.3 Member Function Documentation	933
6.117.3.1 degree()	933
6.117.4 Member Data Documentation	934
6.117.4.1 deg	934
6.118 GiNaC::possymbol Class Reference	934
6.118.1 Detailed Description	939
6.118.2 Constructor & Destructor Documentation	939
6.118.2.1 possymbol() [1/3]	939
6.118.2.2 possymbol() [2/3]	939
6.118.2.3 possymbol() [3/3]	939
6.118.3 Member Function Documentation	940
6.118.3.1 get_domain()	940
6.118.3.2 duplicate()	940
6.119 GiNaC::power Class Reference	940
6.119.1 Detailed Description	945
6.119.2 Constructor & Destructor Documentation	945
6.119.2.1 power() [1/2]	945
6.119.2.2 power() [2/2]	945
6.119.3 Member Function Documentation	945
6.119.3.1 precedence()	945
6.119.3.2 info()	946
6.119.3.3 nops()	946
6.119.3.4 op()	946
6.119.3.5 map()	946

6.119.3.6 is_polynomial()	947
6.119.3.7 degree()	947
6.119.3.8 ldegree()	947
6.119.3.9 coeff()	947
6.119.3.10 eval()	948
6.119.3.11 evalf()	948
6.119.3.12 evalm()	949
6.119.3.13 series()	949
6.119.3.14 subs()	949
6.119.3.15 has()	950
6.119.3.16 normal()	950
6.119.3.17 to_rational()	950
6.119.3.18 to_polynomial()	951
6.119.3.19 conjugate()	951
6.119.3.20 real_part()	951
6.119.3.21 imag_part()	951
6.119.3.22 archive()	951
6.119.3.23 read_archive()	952
6.119.3.24 derivative()	952
6.119.3.25 eval_ncmul()	952
6.119.3.26 return_type()	952
6.119.3.27 return_type_tinfo()	953
6.119.3.28 expand()	953
6.119.3.29 print_power()	953
6.119.3.30 do_print_dfft()	953
6.119.3.31 do_print_latex()	954
6.119.3.32 do_print_csrc()	954
6.119.3.33 do_print_python()	954
6.119.3.34 do_print_python_repr()	954
6.119.3.35 do_print_csrc_cl_N()	954
6.119.3.36 expand_add()	955
6.119.3.37 expand_add_2()	955
6.119.3.38 expand_mul()	955
6.119.4 Friends And Related Symbol Documentation	956
6.119.4.1 mul	956
6.119.5 Member Data Documentation	956
6.119.5.1 basis	956
6.119.5.2 exponent	956
6.120 GiNaC::print_context Class Reference	957
6.120.1 Detailed Description	957
6.120.2 Constructor & Destructor Documentation	957
6.120.2.1 print_context()	957

6.120.2.2 ~print_context()	958
6.120.3 Member Data Documentation	958
6.120.3.1 s	958
6.120.3.2 options	958
6.121 GiNaC::print_context_options Class Reference	959
6.121.1 Detailed Description	959
6.121.2 Constructor & Destructor Documentation	959
6.121.2.1 print_context_options()	959
6.121.3 Member Function Documentation	959
6.121.3.1 get_name()	959
6.121.3.2 get_parent_name()	960
6.121.3.3 get_id()	960
6.121.4 Member Data Documentation	960
6.121.4.1 name	960
6.121.4.2 parent_name	960
6.121.4.3 id	960
6.122 GiNaC::print_csrc Class Reference	961
6.122.1 Detailed Description	962
6.122.2 Constructor & Destructor Documentation	962
6.122.2.1 print_csrc()	962
6.123 GiNaC::print_csrc_cl_N Class Reference	962
6.123.1 Detailed Description	963
6.123.2 Constructor & Destructor Documentation	964
6.123.2.1 print_csrc_cl_N()	964
6.124 GiNaC::print_csrc_double Class Reference	964
6.124.1 Detailed Description	965
6.124.2 Constructor & Destructor Documentation	966
6.124.2.1 print_csrc_double()	966
6.125 GiNaC::print_csrc_float Class Reference	966
6.125.1 Detailed Description	967
6.125.2 Constructor & Destructor Documentation	968
6.125.2.1 print_csrc_float()	968
6.126 GiNaC::print_dflt Class Reference	968
6.126.1 Detailed Description	969
6.126.2 Constructor & Destructor Documentation	969
6.126.2.1 print_dflt()	969
6.127 GiNaC::print_functor Class Reference	969
6.127.1 Detailed Description	970
6.127.2 Constructor & Destructor Documentation	970
6.127.2.1 print_functor() [1/5]	970
6.127.2.2 print_functor() [2/5]	970
6.127.2.3 print_functor() [3/5]	970

6.127.2.4 <code>print_functor()</code> [4/5]	971
6.127.2.5 <code>print_functor()</code> [5/5]	971
6.127.3 Member Function Documentation	971
6.127.3.1 <code>operator=()</code>	971
6.127.3.2 <code>operator>()</code>	971
6.127.3.3 <code>is_valid()</code>	971
6.127.4 Member Data Documentation	971
6.127.4.1 <code>impl</code>	971
6.128 <code>GiNaC::print_functor_impl</code> Class Reference	972
6.128.1 Detailed Description	972
6.128.2 Constructor & Destructor Documentation	972
6.128.2.1 <code>~print_functor_impl()</code>	972
6.128.3 Member Function Documentation	972
6.128.3.1 <code>duplicate()</code>	972
6.128.3.2 <code>operator>()</code>	973
6.129 <code>GiNaC::print_latex</code> Class Reference	973
6.129.1 Detailed Description	974
6.129.2 Constructor & Destructor Documentation	974
6.129.2.1 <code>print_latex()</code>	974
6.130 <code>GiNaC::print_memfun_handler< T, C ></code> Class Template Reference	975
6.130.1 Detailed Description	976
6.130.2 Member Typedef Documentation	976
6.130.2.1 <code>F</code>	976
6.130.3 Constructor & Destructor Documentation	976
6.130.3.1 <code>print_memfun_handler()</code>	976
6.130.4 Member Function Documentation	976
6.130.4.1 <code>duplicate()</code>	976
6.130.4.2 <code>operator>()</code>	977
6.130.5 Member Data Documentation	977
6.130.5.1 <code>f</code>	977
6.131 <code>GiNaC::print_options</code> Class Reference	977
6.131.1 Detailed Description	977
6.131.2 Member Enumeration Documentation	977
6.131.2.1 anonymous enum	977
6.132 <code>GiNaC::print_ptrfun_handler< T, C ></code> Class Template Reference	978
6.132.1 Detailed Description	979
6.132.2 Member Typedef Documentation	979
6.132.2.1 <code>F</code>	979
6.132.3 Constructor & Destructor Documentation	979
6.132.3.1 <code>print_ptrfun_handler()</code>	979
6.132.4 Member Function Documentation	979
6.132.4.1 <code>duplicate()</code>	979

6.132.4.2 operator()()	980
6.132.5 Member Data Documentation	980
6.132.5.1 f	980
6.133 GiNaC::print_python Class Reference	980
6.133.1 Detailed Description	981
6.133.2 Constructor & Destructor Documentation	981
6.133.2.1 print_python()	981
6.134 GiNaC::print_python_repr Class Reference	982
6.134.1 Detailed Description	983
6.134.2 Constructor & Destructor Documentation	983
6.134.2.1 print_python_repr()	983
6.135 GiNaC::print_tree Class Reference	983
6.135.1 Detailed Description	984
6.135.2 Constructor & Destructor Documentation	984
6.135.2.1 print_tree() [1/2]	984
6.135.2.2 print_tree() [2/2]	984
6.135.3 Member Data Documentation	985
6.135.3.1 delta_indent	985
6.136 GiNaC::archive_node::property Struct Reference	985
6.136.1 Detailed Description	985
6.136.2 Constructor & Destructor Documentation	985
6.136.2.1 property() [1/2]	985
6.136.2.2 property() [2/2]	986
6.136.3 Member Data Documentation	986
6.136.3.1 type	986
6.136.3.2 name	986
6.136.3.3 value	986
6.137 GiNaC::archive_node::property_info Struct Reference	986
6.137.1 Detailed Description	987
6.137.2 Constructor & Destructor Documentation	987
6.137.2.1 property_info() [1/2]	987
6.137.2.2 property_info() [2/2]	987
6.137.3 Member Data Documentation	987
6.137.3.1 type	987
6.137.3.2 name	988
6.137.3.3 count	988
6.138 GiNaC::pseries Class Reference	988
6.138.1 Detailed Description	993
6.138.2 Constructor & Destructor Documentation	993
6.138.2.1 pseries() [1/2]	993
6.138.2.2 pseries() [2/2]	994
6.138.3 Member Function Documentation	994

6.138.3.1 precedence()	994
6.138.3.2 nops()	994
6.138.3.3 op()	995
6.138.3.4 degree()	995
6.138.3.5 ldegree()	995
6.138.3.6 coeff()	995
6.138.3.7 collect()	996
6.138.3.8 eval()	996
6.138.3.9 evalf()	996
6.138.3.10 series()	996
6.138.3.11 subs()	997
6.138.3.12 normal()	997
6.138.3.13 expand()	997
6.138.3.14 conjugate()	998
6.138.3.15 real_part()	998
6.138.3.16 imag_part()	998
6.138.3.17 eval_integ()	998
6.138.3.18 evalm()	998
6.138.3.19 archive()	999
6.138.3.20 read_archive()	999
6.138.3.21 derivative()	999
6.138.3.22 get_var()	999
6.138.3.23 get_point()	999
6.138.3.24 convert_to_poly()	999
6.138.3.25 is_compatible_to()	1000
6.138.3.26 is_zero()	1000
6.138.3.27 is_terminating()	1000
6.138.3.28 coeffop()	1000
6.138.3.29 exponop()	1000
6.138.3.30 add_series()	1000
6.138.3.31 mul_const()	1001
6.138.3.32 mul_series()	1001
6.138.3.33 power_const()	1001
6.138.3.34 shift_exponents()	1002
6.138.3.35 print_series()	1002
6.138.3.36 do_print()	1002
6.138.3.37 do_print_latex()	1002
6.138.3.38 do_print_tree()	1003
6.138.3.39 do_print_python()	1003
6.138.3.40 do_print_python_repr()	1003
6.138.4 Member Data Documentation	1003
6.138.4.1 seq	1003

6.138.4.2 var	1003
6.138.4.3 point	1004
6.139 GiNaC::psi1_SERIAL Class Reference	1004
6.139.1 Detailed Description	1004
6.139.2 Member Data Documentation	1004
6.139.2.1 serial	1004
6.140 GiNaC::psi2_SERIAL Class Reference	1005
6.140.1 Detailed Description	1005
6.140.2 Member Data Documentation	1005
6.140.2.1 serial	1005
6.141 GiNaC::ptr< T > Class Template Reference	1005
6.141.1 Detailed Description	1006
6.141.2 Constructor & Destructor Documentation	1007
6.141.2.1 ptr() [1/3]	1007
6.141.2.2 ptr() [2/3]	1007
6.141.2.3 ptr() [3/3]	1007
6.141.2.4 ~ptr()	1007
6.141.3 Member Function Documentation	1007
6.141.3.1 operator=()	1007
6.141.3.2 operator*()	1008
6.141.3.3 operator->()	1008
6.141.3.4 makewritable()	1008
6.141.3.5 swap()	1008
6.141.3.6 operator==()	1008
6.141.3.7 operator"!=()	1008
6.141.4 Friends And Related Symbol Documentation	1009
6.141.4.1 std::less< ptr< T > >	1009
6.141.4.2 get_pointer	1009
6.141.4.3 operator== [1/2]	1009
6.141.4.4 operator"!= [1/2]	1009
6.141.4.5 operator== [2/2]	1009
6.141.4.6 operator"!= [2/2]	1010
6.141.4.7 operator<<	1010
6.141.5 Member Data Documentation	1010
6.141.5.1 p	1010
6.142 GiNaC::realsymbol Class Reference	1010
6.142.1 Detailed Description	1015
6.142.2 Constructor & Destructor Documentation	1015
6.142.2.1 realsymbol() [1/3]	1015
6.142.2.2 realsymbol() [2/3]	1016
6.142.2.3 realsymbol() [3/3]	1016
6.142.3 Member Function Documentation	1016

6.142.3.1 get_domain()	1016
6.142.3.2 conjugate()	1016
6.142.3.3 real_part()	1016
6.142.3.4 imag_part()	1016
6.142.3.5 duplicate()	1017
6.143 GiNaC::refcounted Class Reference	1017
6.143.1 Detailed Description	1019
6.143.2 Constructor & Destructor Documentation	1019
6.143.2.1 refcounted()	1019
6.143.3 Member Function Documentation	1019
6.143.3.1 add_reference()	1019
6.143.3.2 remove_reference()	1019
6.143.3.3 get_refcount()	1019
6.143.3.4 set_refcount()	1019
6.143.4 Member Data Documentation	1020
6.143.4.1 refcount	1020
6.144 GiNaC::registered_class_options Class Reference	1020
6.144.1 Detailed Description	1020
6.144.2 Constructor & Destructor Documentation	1021
6.144.2.1 registered_class_options()	1021
6.144.3 Member Function Documentation	1021
6.144.3.1 get_name()	1021
6.144.3.2 get_parent_name()	1021
6.144.3.3 get_id()	1021
6.144.3.4 get_print_dispatch_table()	1021
6.144.3.5 print_func() [1/3]	1021
6.144.3.6 print_func() [2/3]	1022
6.144.3.7 print_func() [3/3]	1022
6.144.3.8 set_print_func()	1022
6.144.4 Member Data Documentation	1022
6.144.4.1 name	1022
6.144.4.2 parent_name	1022
6.144.4.3 tinfo_key	1022
6.144.4.4 print_dispatch_table	1023
6.145 GiNaC::relational Class Reference	1023
6.145.1 Detailed Description	1028
6.145.2 Member Typedef Documentation	1028
6.145.2.1 safe_bool	1028
6.145.3 Member Enumeration Documentation	1028
6.145.3.1 operators	1028
6.145.4 Constructor & Destructor Documentation	1029
6.145.4.1 relational()	1029

6.145.5 Member Function Documentation	1029
6.145.5.1 precedence()	1029
6.145.5.2 info()	1029
6.145.5.3 nops()	1029
6.145.5.4 op()	1030
6.145.5.5 map()	1030
6.145.5.6 subs()	1030
6.145.5.7 archive()	1030
6.145.5.8 read_archive()	1031
6.145.5.9 canonical()	1031
6.145.5.10 eval_ncmul()	1031
6.145.5.11 match_same_type()	1031
6.145.5.12 return_type()	1032
6.145.5.13 return_type_tinfo()	1032
6.145.5.14 calchash()	1032
6.145.5.15 do_print()	1032
6.145.5.16 do_print_python_repr()	1032
6.145.5.17 lhs()	1033
6.145.5.18 rhs()	1033
6.145.5.19 make_safe_bool()	1033
6.145.5.20 operator safe_bool()	1033
6.145.5.21 operator"!"()	1033
6.145.6 Member Data Documentation	1034
6.145.6.1 lh	1034
6.145.6.2 rh	1034
6.145.6.3 o	1034
6.146 GiNaC::remember_strategies Class Reference	1034
6.146.1 Detailed Description	1034
6.146.2 Member Enumeration Documentation	1034
6.146.2.1 anonymous enum	1034
6.147 GiNaC::remember_table Class Reference	1035
6.147.1 Detailed Description	1036
6.147.2 Constructor & Destructor Documentation	1036
6.147.2.1 remember_table() [1/2]	1036
6.147.2.2 remember_table() [2/2]	1037
6.147.3 Member Function Documentation	1037
6.147.3.1 lookup_entry()	1037
6.147.3.2 add_entry()	1037
6.147.3.3 clear_all_entries()	1037
6.147.3.4 show_statistics()	1037
6.147.3.5 remember_tables()	1037
6.147.3.6 init_table()	1038

6.147.4 Member Data Documentation	1038
6.147.4.1 table_size	1038
6.147.4.2 max_assoc_size	1038
6.147.4.3 remember_strategy	1038
6.148 GiNaC::remember_table_entry Class Reference	1039
6.148.1 Detailed Description	1040
6.148.2 Constructor & Destructor Documentation	1040
6.148.2.1 remember_table_entry()	1040
6.148.3 Member Function Documentation	1040
6.148.3.1 is_equal()	1040
6.148.3.2 get_result()	1040
6.148.3.3 get_last_access()	1040
6.148.3.4 get_successful_hits()	1041
6.148.4 Member Data Documentation	1041
6.148.4.1 hashvalue	1041
6.148.4.2 seq	1041
6.148.4.3 result	1041
6.148.4.4 last_access	1041
6.148.4.5 successful_hits	1041
6.148.4.6 access_counter	1041
6.149 GiNaC::remember_table_list Class Reference	1042
6.149.1 Detailed Description	1043
6.149.2 Constructor & Destructor Documentation	1043
6.149.2.1 remember_table_list()	1043
6.149.3 Member Function Documentation	1043
6.149.3.1 add_entry()	1043
6.149.3.2 lookup_entry()	1043
6.149.4 Member Data Documentation	1043
6.149.4.1 max_assoc_size	1043
6.149.4.2 remember_strategy	1043
6.150 GiNaC::return_type_t Struct Reference	1044
6.150.1 Detailed Description	1044
6.150.2 Member Function Documentation	1044
6.150.2.1 operator<()	1044
6.150.2.2 operator==(())	1044
6.150.2.3 operator"!=(())	1045
6.150.3 Member Data Documentation	1045
6.150.3.1 tinfo	1045
6.150.3.2 rl	1045
6.151 GiNaC::return_types Class Reference	1045
6.151.1 Member Enumeration Documentation	1045
6.151.1.1 anonymous enum	1045

6.152 GiNaC::relational::safe_bool_helper Struct Reference	1046
6.152.1 Member Function Documentation	1046
6.152.1.1 nonnull()	1046
6.153 GiNaC::scalar_products Class Reference	1046
6.153.1 Detailed Description	1047
6.153.2 Member Function Documentation	1047
6.153.2.1 add() [1/2]	1047
6.153.2.2 add() [2/2]	1047
6.153.2.3 add_vectors()	1047
6.153.2.4 clear()	1048
6.153.2.5 is_defined()	1048
6.153.2.6 evaluate()	1048
6.153.2.7 debugprint()	1048
6.153.3 Member Data Documentation	1048
6.153.3.1 spm	1048
6.154 GiNaC::series_options Class Reference	1049
6.154.1 Detailed Description	1049
6.154.2 Member Enumeration Documentation	1049
6.154.2.1 anonymous enum	1049
6.155 GiNaC::solve_algo Class Reference	1049
6.155.1 Detailed Description	1049
6.155.2 Member Enumeration Documentation	1049
6.155.2.1 anonymous enum	1049
6.156 GiNaC::spinidx Class Reference	1050
6.156.1 Detailed Description	1057
6.156.2 Constructor & Destructor Documentation	1057
6.156.2.1 spinidx()	1057
6.156.3 Member Function Documentation	1058
6.156.3.1 is_dummy_pair_same_type()	1058
6.156.3.2 conjugate()	1058
6.156.3.3 archive()	1058
6.156.3.4 read_archive()	1058
6.156.3.5 match_same_type()	1059
6.156.3.6 is_dotted()	1059
6.156.3.7 is_undotted()	1059
6.156.3.8 toggle_dot()	1059
6.156.3.9 toggle_variance_dot()	1060
6.156.3.10 do_print()	1060
6.156.3.11 do_print_latex()	1060
6.156.3.12 do_print_tree()	1060
6.156.4 Member Data Documentation	1060
6.156.4.1 dotted	1060

6.157 GiNaC::spinmetric Class Reference	1061
6.157.1 Detailed Description	1066
6.157.2 Member Function Documentation	1066
6.157.2.1 info()	1066
6.157.2.2 eval_indexed()	1066
6.157.2.3 contract_with()	1067
6.157.2.4 do_print()	1067
6.157.2.5 do_print_latex()	1067
6.158 GiNaC::spmapkey Class Reference	1067
6.158.1 Constructor & Destructor Documentation	1068
6.158.1.1 spmapkey() [1/2]	1068
6.158.1.2 spmapkey() [2/2]	1069
6.158.2 Member Function Documentation	1069
6.158.2.1 operator==(())	1069
6.158.2.2 operator<()	1069
6.158.2.3 debugprint()	1069
6.158.3 Member Data Documentation	1069
6.158.3.1 v1	1069
6.158.3.2 v2	1069
6.158.3.3 dim	1070
6.159 GiNaC::status_flags Class Reference	1070
6.159.1 Detailed Description	1070
6.159.2 Member Enumeration Documentation	1070
6.159.2.1 anonymous enum	1070
6.160 GiNaC::structure< T, ComparisonPolicy > Class Template Reference	1071
6.160.1 Detailed Description	1075
6.160.2 Constructor & Destructor Documentation	1075
6.160.2.1 structure()	1075
6.160.3 Member Function Documentation	1076
6.160.3.1 get_class_name()	1076
6.160.3.2 eval()	1076
6.160.3.3 evalm()	1076
6.160.3.4 eval_ncmul()	1076
6.160.3.5 eval_indexed()	1076
6.160.3.6 print()	1077
6.160.3.7 precedence()	1077
6.160.3.8 info()	1077
6.160.3.9 nops()	1077
6.160.3.10 op()	1078
6.160.3.11 operator[]() [1/4]	1078
6.160.3.12 operator[]() [2/4]	1078
6.160.3.13 let_op()	1078

6.160.3.14 operator[]() [3/4]	1078
6.160.3.15 operator[]() [4/4]	1079
6.160.3.16 has()	1079
6.160.3.17 match()	1079
6.160.3.18 match_same_type()	1079
6.160.3.19 subs()	1080
6.160.3.20 map()	1080
6.160.3.21 degree()	1080
6.160.3.22 ldegree()	1080
6.160.3.23 coeff()	1081
6.160.3.24 expand()	1081
6.160.3.25 collect()	1081
6.160.3.26 derivative()	1082
6.160.3.27 series()	1082
6.160.3.28 normal()	1082
6.160.3.29 to_rational()	1083
6.160.3.30 to_polynomial()	1083
6.160.3.31 integer_content()	1083
6.160.3.32 smod()	1083
6.160.3.33 max_coefficient()	1084
6.160.3.34 get_free_indices()	1084
6.160.3.35 add_indexed()	1084
6.160.3.36 scalar_mul_indexed()	1084
6.160.3.37 contract_with()	1085
6.160.3.38 return_type()	1086
6.160.3.39 return_type_tinfo()	1086
6.160.3.40 is_equal_same_type()	1086
6.160.3.41 calchash()	1086
6.160.3.42 operator->()	1087
6.160.3.43 get_struct() [1/2]	1087
6.160.3.44 get_struct() [2/2]	1087
6.160.4 Member Data Documentation	1087
6.160.4.1 obj	1087
6.161 GiNaC::su3d Class Reference	1088
6.161.1 Detailed Description	1092
6.161.2 Member Function Documentation	1092
6.161.2.1 eval_indexed()	1092
6.161.2.2 contract_with()	1092
6.161.2.3 return_type()	1093
6.161.2.4 do_print()	1093
6.161.2.5 do_print_latex()	1093
6.162 GiNaC::su3f Class Reference	1093

6.162.1 Detailed Description	1097
6.162.2 Member Function Documentation	1098
6.162.2.1 eval_indexed()	1098
6.162.2.2 contract_with()	1098
6.162.2.3 return_type()	1098
6.162.2.4 do_print()	1098
6.162.2.5 do_print_latex()	1098
6.163 GiNaC::su3one Class Reference	1099
6.163.1 Detailed Description	1103
6.163.2 Member Function Documentation	1103
6.163.2.1 do_print()	1103
6.163.2.2 do_print_latex()	1103
6.164 GiNaC::su3t Class Reference	1104
6.164.1 Detailed Description	1108
6.164.2 Member Function Documentation	1108
6.164.2.1 contract_with()	1108
6.164.2.2 do_print()	1108
6.164.2.3 do_print_latex()	1109
6.165 GiNaC::subs_options Class Reference	1109
6.165.1 Detailed Description	1109
6.165.2 Member Enumeration Documentation	1109
6.165.2.1 anonymous enum	1109
6.166 GiNaC::sy_is_less Class Reference	1110
6.166.1 Constructor & Destructor Documentation	1110
6.166.1.1 sy_is_less()	1110
6.166.2 Member Function Documentation	1110
6.166.2.1 operator()()	1110
6.166.3 Member Data Documentation	1110
6.166.3.1 v	1110
6.167 GiNaC::sy_swap Class Reference	1110
6.167.1 Constructor & Destructor Documentation	1111
6.167.1.1 sy_swap()	1111
6.167.2 Member Function Documentation	1111
6.167.2.1 operator()()	1111
6.167.3 Member Data Documentation	1111
6.167.3.1 v	1111
6.167.3.2 swapped	1111
6.168 GiNaC::sym_desc Struct Reference	1112
6.168.1 Detailed Description	1113
6.168.2 Constructor & Destructor Documentation	1113
6.168.2.1 sym_desc()	1113
6.168.3 Member Function Documentation	1113

6.168.3.1 operator<()	1113
6.168.4 Member Data Documentation	1114
6.168.4.1 sym	1114
6.168.4.2 deg_a	1114
6.168.4.3 deg_b	1114
6.168.4.4 ldeg_a	1114
6.168.4.5 ldeg_b	1114
6.168.4.6 max_deg	1114
6.168.4.7 max_lcnops	1115
6.169 GiNaC::symbol Class Reference	1115
6.169.1 Detailed Description	1119
6.169.2 Constructor & Destructor Documentation	1120
6.169.2.1 symbol() [1/2]	1120
6.169.2.2 symbol() [2/2]	1120
6.169.3 Member Function Documentation	1120
6.169.3.1 info()	1120
6.169.3.2 eval()	1120
6.169.3.3 evalf()	1121
6.169.3.4 series()	1121
6.169.3.5 subs()	1121
6.169.3.6 normal()	1121
6.169.3.7 to_rational()	1122
6.169.3.8 to_polynomial()	1122
6.169.3.9 conjugate()	1122
6.169.3.10 real_part()	1122
6.169.3.11 imag_part()	1122
6.169.3.12 is_polynomial()	1123
6.169.3.13 archive()	1123
6.169.3.14 read_archive()	1123
6.169.3.15 derivative()	1123
6.169.3.16 is_equal_same_type()	1124
6.169.3.17 calchash()	1124
6.169.3.18 get_domain()	1124
6.169.3.19 set_name()	1124
6.169.3.20 set_TeX_name()	1125
6.169.3.21 get_name()	1125
6.169.3.22 get_TeX_name()	1125
6.169.3.23 do_print()	1125
6.169.3.24 do_print_latex()	1125
6.169.3.25 do_print_tree()	1125
6.169.3.26 do_print_python_repr()	1126
6.169.4 Member Data Documentation	1126

6.169.4.1 serial	1126
6.169.4.2 name	1126
6.169.4.3 TeX_name	1126
6.169.4.4 next_serial	1126
6.170 GiNaC::symbolset Class Reference	1127
6.170.1 Constructor & Destructor Documentation	1127
6.170.1.1 symbolset()	1127
6.170.2 Member Function Documentation	1127
6.170.2.1 insert_symbols()	1127
6.170.2.2 has()	1127
6.170.3 Member Data Documentation	1128
6.170.3.1 s	1128
6.171 GiNaC::symmetry Class Reference	1128
6.171.1 Detailed Description	1133
6.171.2 Member Enumeration Documentation	1133
6.171.2.1 symmetry_type	1133
6.171.3 Constructor & Destructor Documentation	1133
6.171.3.1 symmetry() [1/2]	1133
6.171.3.2 symmetry() [2/2]	1133
6.171.4 Member Function Documentation	1134
6.171.4.1 archive()	1134
6.171.4.2 read_archive()	1134
6.171.4.3 calchash()	1134
6.171.4.4 get_type()	1135
6.171.4.5 set_type()	1135
6.171.4.6 add()	1135
6.171.4.7 validate()	1135
6.171.4.8 has_symmetry()	1135
6.171.4.9 has_nonsymmetric()	1136
6.171.4.10 has_cyclic()	1136
6.171.4.11 do_print()	1136
6.171.4.12 do_print_tree()	1136
6.171.5 Friends And Related Symbol Documentation	1136
6.171.5.1 sy_is_less	1136
6.171.5.2 sy_swap	1137
6.171.5.3 canonicalize	1137
6.171.6 Member Data Documentation	1137
6.171.6.1 type	1137
6.171.6.2 indices	1137
6.171.6.3 children	1138
6.172 GiNaC::symminfo Class Reference	1138
6.172.1 Detailed Description	1139

6.172.2 Constructor & Destructor Documentation	1139
6.172.2.1 symminfo() [1/2]	1139
6.172.2.2 symminfo() [2/2]	1139
6.172.3 Member Data Documentation	1139
6.172.3.1 symmterm	1139
6.172.3.2 coeff	1140
6.172.3.3 orig	1140
6.172.3.4 num	1140
6.173 GiNaC::symminfo_is_less_by_orig Class Reference	1140
6.173.1 Member Function Documentation	1140
6.173.1.1 operator()()	1140
6.174 GiNaC::symminfo_is_less_by_symmterm Class Reference	1141
6.174.1 Member Function Documentation	1141
6.174.1.1 operator()()	1141
6.175 GiNaC::tensdelta Class Reference	1141
6.175.1 Detailed Description	1145
6.175.2 Member Function Documentation	1146
6.175.2.1 info()	1146
6.175.2.2 eval_indexed()	1146
6.175.2.3 contract_with()	1146
6.175.2.4 return_type()	1146
6.175.2.5 do_print()	1147
6.175.2.6 do_print_latex()	1147
6.176 GiNaC::tensepsilon Class Reference	1147
6.176.1 Detailed Description	1152
6.176.2 Constructor & Destructor Documentation	1152
6.176.2.1 tensepsilon()	1152
6.176.3 Member Function Documentation	1152
6.176.3.1 info()	1152
6.176.3.2 eval_indexed()	1152
6.176.3.3 contract_with()	1153
6.176.3.4 archive()	1153
6.176.3.5 read_archive()	1153
6.176.3.6 return_type()	1153
6.176.3.7 do_print()	1154
6.176.3.8 do_print_latex()	1154
6.176.4 Member Data Documentation	1154
6.176.4.1 minkowski	1154
6.176.4.2 pos_sig	1154
6.177 GiNaC::tensmetric Class Reference	1155
6.177.1 Detailed Description	1159
6.177.2 Member Function Documentation	1160

6.177.2.1 info()	1160
6.177.2.2 eval_indexed()	1160
6.177.2.3 contract_with()	1160
6.177.2.4 return_type()	1160
6.177.2.5 do_print()	1161
6.178 GiNaC::tensor Class Reference	1161
6.178.1 Detailed Description	1165
6.178.2 Member Function Documentation	1165
6.178.2.1 return_type()	1165
6.178.2.2 replace_contr_index()	1166
6.179 GiNaC::terminfo Class Reference	1166
6.179.1 Detailed Description	1167
6.179.2 Constructor & Destructor Documentation	1167
6.179.2.1 terminfo()	1167
6.179.3 Member Data Documentation	1167
6.179.3.1 orig	1167
6.179.3.2 symm	1167
6.180 GiNaC::terminfo_is_less Class Reference	1168
6.180.1 Member Function Documentation	1168
6.180.1.1 operator()	1168
6.181 GiNaC::class_info< OPT >::tree_node Struct Reference	1168
6.181.1 Constructor & Destructor Documentation	1169
6.181.1.1 tree_node()	1169
6.181.2 Member Function Documentation	1169
6.181.2.1 add_child()	1169
6.181.3 Member Data Documentation	1169
6.181.3.1 children	1169
6.181.3.2 info	1169
6.182 GiNaC::unarchive_table_t Class Reference	1169
6.182.1 Constructor & Destructor Documentation	1170
6.182.1.1 unarchive_table_t()	1170
6.182.1.2 ~unarchive_table_t()	1170
6.182.2 Member Function Documentation	1170
6.182.2.1 find()	1170
6.182.2.2 insert()	1170
6.182.3 Member Data Documentation	1171
6.182.3.1 usecount	1171
6.182.3.2 unarch_map	1171
6.183 GiNaC::user_defined_kernel Class Reference	1171
6.183.1 Detailed Description	1176
6.183.2 Constructor & Destructor Documentation	1177
6.183.2.1 user_defined_kernel()	1177

6.183.3 Member Function Documentation	1177
6.183.3.1 nops()	1177
6.183.3.2 op()	1177
6.183.3.3 let_op()	1177
6.183.3.4 is_numeric()	1177
6.183.3.5 Laurent_series()	1178
6.183.3.6 uses_Laurent_series()	1178
6.183.3.7 do_print()	1178
6.183.4 Member Data Documentation	1178
6.183.4.1 f	1178
6.183.4.2 x	1178
6.184 GiNaC::varidx Class Reference	1179
6.184.1 Detailed Description	1184
6.184.2 Constructor & Destructor Documentation	1184
6.184.2.1 varidx()	1184
6.184.3 Member Function Documentation	1185
6.184.3.1 is_dummy_pair_same_type()	1185
6.184.3.2 archive()	1185
6.184.3.3 read_archive()	1185
6.184.3.4 match_same_type()	1186
6.184.3.5 is_covariant()	1186
6.184.3.6 is_contravariant()	1186
6.184.3.7 toggle_variance()	1186
6.184.3.8 do_print()	1187
6.184.3.9 do_print_tree()	1187
6.184.4 Member Data Documentation	1187
6.184.4.1 covariant	1187
6.185 GiNaC::visitor Class Reference	1187
6.185.1 Detailed Description	1188
6.185.2 Constructor & Destructor Documentation	1188
6.185.2.1 ~visitor()	1188
6.186 GiNaC::wildcard Class Reference	1188
6.186.1 Detailed Description	1192
6.186.2 Constructor & Destructor Documentation	1192
6.186.2.1 wildcard()	1192
6.186.3 Member Function Documentation	1193
6.186.3.1 match()	1193
6.186.3.2 archive()	1193
6.186.3.3 read_archive()	1193
6.186.3.4 calchash()	1193
6.186.3.5 get_label()	1194
6.186.3.6 do_print()	1194

6.186.3.7 do_print_tree()	1194
6.186.3.8 do_print_python_repr()	1194
6.186.4 Member Data Documentation	1194
6.186.4.1 label	1194
6.187 GiNaC::zeta1_SERIAL Class Reference	1195
6.187.1 Detailed Description	1195
6.187.2 Member Data Documentation	1195
6.187.2.1 serial	1195
6.188 GiNaC::zeta2_SERIAL Class Reference	1195
6.188.1 Detailed Description	1196
6.188.2 Member Data Documentation	1196
6.188.2.1 serial	1196
7 File Documentation	1197
7.1 add.cpp File Reference	1197
7.1.1 Detailed Description	1197
7.2 add.h File Reference	1198
7.2.1 Detailed Description	1198
7.3 archive.cpp File Reference	1198
7.3.1 Detailed Description	1199
7.4 archive.h File Reference	1199
7.4.1 Detailed Description	1200
7.4.2 Macro Definition Documentation	1200
7.4.2.1 GINAC_DECLARE_UNARCHIVER	1200
7.4.2.2 GINAC_BIND_UNARCHIVER	1201
7.5 assertion.h File Reference	1201
7.5.1 Detailed Description	1202
7.5.2 Macro Definition Documentation	1202
7.5.2.1 GINAC_ASSERT	1202
7.6 basic.cpp File Reference	1203
7.6.1 Detailed Description	1204
7.7 basic.h File Reference	1204
7.7.1 Detailed Description	1205
7.8 class_info.h File Reference	1205
7.8.1 Detailed Description	1206
7.9 clifford.cpp File Reference	1206
7.9.1 Detailed Description	1208
7.10 clifford.h File Reference	1208
7.10.1 Detailed Description	1210
7.11 color.cpp File Reference	1210
7.11.1 Detailed Description	1211
7.11.2 Macro Definition Documentation	1211

7.11.2.1 TEST_PERMUTATION	1211
7.11.2.2 CMPINDICES	1212
7.12 color.h File Reference	1212
7.12.1 Detailed Description	1213
7.13 compiler.h File Reference	1213
7.13.1 Detailed Description	1213
7.13.2 Macro Definition Documentation	1214
7.13.2.1 unlikely	1214
7.13.2.2 likely	1214
7.13.2.3 attribute_deprecated	1214
7.14 constant.cpp File Reference	1214
7.14.1 Detailed Description	1215
7.15 constant.h File Reference	1215
7.15.1 Detailed Description	1216
7.16 container.h File Reference	1216
7.16.1 Detailed Description	1216
7.17 crc32.h File Reference	1216
7.17.1 Detailed Description	1217
7.18 ex.cpp File Reference	1217
7.18.1 Detailed Description	1217
7.19 ex.h File Reference	1217
7.19.1 Detailed Description	1219
7.20 excompiler.cpp File Reference	1220
7.20.1 Detailed Description	1220
7.21 excompiler.h File Reference	1220
7.21.1 Detailed Description	1221
7.22 expair.cpp File Reference	1221
7.22.1 Detailed Description	1222
7.23 expair.h File Reference	1222
7.23.1 Detailed Description	1222
7.24 expairseq.cpp File Reference	1223
7.24.1 Detailed Description	1223
7.25 expairseq.h File Reference	1223
7.25.1 Detailed Description	1224
7.26 exprseq.cpp File Reference	1224
7.26.1 Detailed Description	1224
7.27 exprseq.h File Reference	1225
7.27.1 Detailed Description	1225
7.28 factor.cpp File Reference	1225
7.28.1 Detailed Description	1226
7.28.2 Macro Definition Documentation	1226
7.28.2.1 DCOUT	1226

7.28.2.2 DCOUTVAR	1226
7.28.2.3 DCOUT2	1226
7.28.2.4 USE_SAME_DEGREE_FACTOR	1227
7.29 factor.h File Reference	1227
7.29.1 Detailed Description	1227
7.30 fail.cpp File Reference	1227
7.30.1 Detailed Description	1227
7.31 fail.h File Reference	1228
7.31.1 Detailed Description	1228
7.32 fderivative.cpp File Reference	1228
7.32.1 Detailed Description	1229
7.33 fderivative.h File Reference	1229
7.33.1 Detailed Description	1229
7.34 flags.h File Reference	1229
7.34.1 Detailed Description	1230
7.35 function.cpp File Reference	1230
7.35.1 Detailed Description	1231
7.36 function.h File Reference	1231
7.36.1 Detailed Description	1238
7.36.2 Macro Definition Documentation	1238
7.36.2.1 DECLARE_FUNCTION_1P	1238
7.36.2.2 DECLARE_FUNCTION_2P	1238
7.36.2.3 DECLARE_FUNCTION_3P	1238
7.36.2.4 DECLARE_FUNCTION_4P	1239
7.36.2.5 DECLARE_FUNCTION_5P	1239
7.36.2.6 DECLARE_FUNCTION_6P	1239
7.36.2.7 DECLARE_FUNCTION_7P	1239
7.36.2.8 DECLARE_FUNCTION_8P	1240
7.36.2.9 DECLARE_FUNCTION_9P	1240
7.36.2.10 DECLARE_FUNCTION_10P	1240
7.36.2.11 DECLARE_FUNCTION_11P	1240
7.36.2.12 DECLARE_FUNCTION_12P	1241
7.36.2.13 DECLARE_FUNCTION_13P	1241
7.36.2.14 DECLARE_FUNCTION_14P	1241
7.36.2.15 REGISTER_FUNCTION	1241
7.36.2.16 is_ex_the_function	1242
7.37 ginac.h File Reference	1242
7.37.1 Detailed Description	1243
7.38 hash_map.h File Reference	1243
7.38.1 Detailed Description	1243
7.39 hash_seed.h File Reference	1243
7.39.1 Detailed Description	1244

7.40 idx.cpp File Reference	1244
7.40.1 Detailed Description	1245
7.41 idx.h File Reference	1245
7.41.1 Detailed Description	1246
7.42 indexed.cpp File Reference	1246
7.42.1 Detailed Description	1247
7.43 indexed.h File Reference	1248
7.43.1 Detailed Description	1248
7.44 inifcns.cpp File Reference	1249
7.44.1 Detailed Description	1252
7.45 inifcns.h File Reference	1252
7.45.1 Detailed Description	1253
7.46 inifcns_elliptic.cpp File Reference	1253
7.46.1 Detailed Description	1254
7.47 inifcns_gamma.cpp File Reference	1255
7.47.1 Detailed Description	1256
7.48 inifcns_nstdsums.cpp File Reference	1256
7.48.1 Detailed Description	1257
7.49 inifcns_trans.cpp File Reference	1258
7.49.1 Detailed Description	1261
7.50 integral.cpp File Reference	1261
7.50.1 Detailed Description	1262
7.51 integral.h File Reference	1262
7.51.1 Detailed Description	1262
7.52 integration_kernel.cpp File Reference	1262
7.52.1 Detailed Description	1264
7.53 integration_kernel.h File Reference	1264
7.53.1 Detailed Description	1265
7.54 lst.cpp File Reference	1265
7.54.1 Detailed Description	1266
7.55 lst.h File Reference	1266
7.55.1 Detailed Description	1266
7.56 matrix.cpp File Reference	1266
7.56.1 Detailed Description	1267
7.57 matrix.h File Reference	1267
7.57.1 Detailed Description	1268
7.58 mul.cpp File Reference	1269
7.58.1 Detailed Description	1269
7.59 mul.h File Reference	1269
7.59.1 Detailed Description	1270
7.60 ncmul.cpp File Reference	1270
7.60.1 Detailed Description	1271

7.61 ncmul.h File Reference	1271
7.61.1 Detailed Description	1271
7.62 normal.cpp File Reference	1272
7.62.1 Detailed Description	1274
7.62.2 Macro Definition Documentation	1274
7.62.2.1 FAST_COMPARE	1274
7.62.2.2 USE_REMEMBER	1274
7.62.2.3 USE_TRIAL_DIVISION	1274
7.62.2.4 STATISTICS	1274
7.63 normal.h File Reference	1274
7.63.1 Detailed Description	1275
7.64 numeric.cpp File Reference	1276
7.64.1 Detailed Description	1279
7.65 numeric.h File Reference	1279
7.65.1 Detailed Description	1282
7.66 operators.cpp File Reference	1282
7.66.1 Detailed Description	1284
7.67 operators.h File Reference	1284
7.67.1 Detailed Description	1285
7.68 power.cpp File Reference	1285
7.68.1 Detailed Description	1286
7.69 power.h File Reference	1286
7.69.1 Detailed Description	1287
7.70 print.cpp File Reference	1287
7.70.1 Detailed Description	1287
7.71 print.h File Reference	1287
7.71.1 Detailed Description	1289
7.71.2 Macro Definition Documentation	1289
7.71.2.1 GINAC_DECLARE_PRINT_CONTEXT_COMMON	1289
7.71.2.2 GINAC_DECLARE_PRINT_CONTEXT_BASE	1289
7.71.2.3 GINAC_DECLARE_PRINT_CONTEXT	1290
7.71.2.4 GINAC_IMPLEMENT_PRINT_CONTEXT	1290
7.72 pseries.cpp File Reference	1290
7.72.1 Detailed Description	1291
7.73 pseries.h File Reference	1291
7.73.1 Detailed Description	1291
7.74 ptr.h File Reference	1292
7.74.1 Detailed Description	1292
7.75 registrar.cpp File Reference	1292
7.75.1 Detailed Description	1292
7.76 registrar.h File Reference	1293
7.76.1 Detailed Description	1294

7.76.2 Macro Definition Documentation	1294
7.76.2.1 GINAC_DECLARE_REGISTERED_CLASS_COMMON	1294
7.76.2.2 GINAC_DECLARE_REGISTERED_CLASS_NO_CTORS	1294
7.76.2.3 GINAC_DECLARE_REGISTERED_CLASS	1294
7.76.2.4 GINAC_IMPLEMENT_REGISTERED_CLASS	1295
7.76.2.5 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT	1295
7.76.2.6 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT_T	1295
7.77 relational.cpp File Reference	1296
7.77.1 Detailed Description	1296
7.78 relational.h File Reference	1296
7.78.1 Detailed Description	1297
7.79 remember.cpp File Reference	1297
7.79.1 Detailed Description	1297
7.80 remember.h File Reference	1297
7.80.1 Detailed Description	1298
7.81 structure.h File Reference	1298
7.81.1 Detailed Description	1298
7.82 symbol.cpp File Reference	1299
7.82.1 Detailed Description	1299
7.83 symbol.h File Reference	1299
7.83.1 Detailed Description	1300
7.84 symmetry.cpp File Reference	1300
7.84.1 Detailed Description	1301
7.85 symmetry.h File Reference	1301
7.85.1 Detailed Description	1302
7.86 tensor.cpp File Reference	1303
7.86.1 Detailed Description	1304
7.87 tensor.h File Reference	1304
7.87.1 Detailed Description	1305
7.88 utils.cpp File Reference	1305
7.88.1 Detailed Description	1307
7.89 utils.h File Reference	1307
7.89.1 Detailed Description	1308
7.89.2 Macro Definition Documentation	1309
7.89.2.1 DEFAULT_CTOR	1309
7.89.2.2 DEFAULT_COMPARE	1309
7.89.2.3 DEFAULT_PRINT	1309
7.89.2.4 DEFAULT_PRINT_LATEX	1309
7.90 utils_multi_iterator.h File Reference	1309
7.90.1 Detailed Description	1311
7.91 version.h File Reference	1311
7.91.1 Detailed Description	1311

7.91.2 Macro Definition Documentation	1312
7.91.2.1 GINACLIB_MAJOR_VERSION	1312
7.91.2.2 GINACLIB_MINOR_VERSION	1312
7.91.2.3 GINACLIB_MICRO_VERSION	1312
7.91.2.4 GINAC_LT_CURRENT	1312
7.91.2.5 GINAC_LT_REVISION	1312
7.91.2.6 GINAC_LT_AGE	1312
7.91.2.7 GINACLIB_ARCHIVE_VERSION	1312
7.91.2.8 GINACLIB_ARCHIVE_AGE	1312
7.91.2.9 GINACLIB_STR_HELPER	1312
7.91.2.10 GINACLIB_STR	1313
7.91.2.11 GINACLIB_VERSION	1313
7.92 wildcard.cpp File Reference	1313
7.92.1 Detailed Description	1313
7.93 wildcard.h File Reference	1314
7.93.1 Detailed Description	1314

Chapter 1

Namespace Index

1.1 Namespace List

Here is a list of all namespaces with brief descriptions:

GiNaC	19
GiNaC::internal	287
std	287

Chapter 2

Hierarchical Index

2.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

GiNaC::internal::_iter_rep	289
GiNaC::_numeric_digits	291
GiNaC::archive	310
GiNaC::archive_node	318
GiNaC::archive_node::archive_node_cit_range	328
GiNaC::archive::archived_ex	329
GiNaC::basic_multi_iterator< T >	364
GiNaC::multi_iterator_counter< T >	823
GiNaC::multi_iterator_counter_indv< T >	826
GiNaC::multi_iterator_ordered< T >	830
GiNaC::multi_iterator_ordered_eq< T >	834
GiNaC::multi_iterator_ordered_eq_indv< T >	838
GiNaC::multi_iterator_permutation< T >	842
GiNaC::multi_iterator_shuffle< T >	846
GiNaC::multi_iterator_shuffle_prime< T >	850
GiNaC::basic_partition_generator	371
GiNaC::partition_generator	906
GiNaC::partition_with_zero_parts_generator	908
GiNaC::class_info< OPT >	373
GiNaC::compare_all_equal< T >	409
GiNaC::compare_bitwise< T >	410
GiNaC::compare_std_less< T >	411
ComparisonPolicy	
GiNaC::structure< T, ComparisonPolicy >	1071
GiNaC::composition_generator	413
GiNaC::const_iterator	415
GiNaC::const_postorder_iterator	421
GiNaC::const_preorder_iterator	424
GiNaC::container_storage< C >	453
GiNaC::container< std::vector >	438
GiNaC::function	615
GiNaC::fderivative	600
GiNaC::indexed	695
GiNaC::clifford	377

GiNaC::color	397
GiNaC::ncmul	861
GiNaC::container< std::list >	438
GiNaC::container< C >	438
GiNaC::composition_generator::coolmulti	457
GiNaC::determinant_algo	461
GiNaC::do_taylor	488
GiNaC::domain	488
std::domain_error	
GiNaC::pole_error	932
GiNaC::dunno	489
GiNaC::composition_generator::coolmulti::element	517
std::equal_to< GiNaC::ex >	527
GiNaC::error_and_integral	528
GiNaC::error_and_integral_is_less	529
GiNaC::ex	534
GiNaC::ex_base_is_less	566
GiNaC::ex_is_equal	566
GiNaC::ex_is_less	567
GiNaC::ex_swap	567
GiNaC::expair	568
GiNaC::expair_is_less	572
GiNaC::expair_rest_is_less	572
GiNaC::expair_swap	573
GiNaC::expand_options	594
GiNaC::factor_options	595
GiNaC::function_options	636
GiNaC::G2_SERIAL	678
GiNaC::G3_SERIAL	679
GiNaC::gcd_options	679
GiNaC::gcdheu_failed	680
GiNaC::has_distance< T >	680
GiNaC::has_options	682
std::hash< GiNaC::ex >	682
GiNaC::idx_is_equal_ignore_dim	695
GiNaC::info_flags	714
GiNaC::is_not_a_clifford	736
GiNaC::is_summation_idx	737
GiNaC::iterated_integral2_SERIAL	737
GiNaC::iterated_integral3_SERIAL	738
GiNaC::lanczos_coeffs	756
std::less< GiNaC::ptr< T > >	758
GiNaC::library_init	759
std::list	
GiNaC::remember_table_list	1042
GiNaC::make_flat_inserter	760
GiNaC::map_function	762
GiNaC::derivative_map_function	459
GiNaC::eval_integ_map_function	530
GiNaC::evalf_map_function	531
GiNaC::evalm_map_function	533
GiNaC::expand_map_function	592
GiNaC::normal_map_function	876
GiNaC::pointer_to_map_function	911
GiNaC::pointer_to_map_function_1arg< T1 >	913
GiNaC::pointer_to_map_function_2args< T1, T2 >	916
GiNaC::pointer_to_map_function_3args< T1, T2, T3 >	918
GiNaC::pointer_to_member_to_map_function< C >	921

GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >	924
GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >	926
GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >	929
GiNaC::basic_partition_generator::mpartition2	803
GiNaC::op0_is_equal	905
GiNaC::print_context	957
GiNaC::print_csrc	961
GiNaC::print_csrc_cl_N	962
GiNaC::print_csrc_double	964
GiNaC::print_csrc_float	966
GiNaC::print_dflt	968
GiNaC::print_latex	973
GiNaC::print_python	980
GiNaC::print_python_repr	982
GiNaC::print_tree	983
GiNaC::print_context_options	959
GiNaC::print_functor	969
GiNaC::print_functor_impl	972
GiNaC::print_memfun_handler< T, C >	975
GiNaC::print_ptrfun_handler< T, C >	978
GiNaC::print_options	977
GiNaC::archive_node::property	985
GiNaC::archive_node::property_info	986
GiNaC::psi1_SERIAL	1004
GiNaC::psi2_SERIAL	1005
GiNaC::ptr< T >	1005
GiNaC::refcounted	1017
GiNaC::basic	330
GiNaC::container< std::vector >	438
GiNaC::container< std::list >	438
GiNaC::constant	427
GiNaC::container< C >	438
GiNaC::expairseq	574
GiNaC::add	294
GiNaC::mul	804
GiNaC::fail	596
GiNaC::idx	683
GiNaC::varidx	1179
GiNaC::spinidx	1050
GiNaC::integral	715
GiNaC::integration_kernel	727
GiNaC::ELi_kernel	519
GiNaC::Ebar_kernel	489
GiNaC::Eisenstein_h_kernel	497
GiNaC::Eisenstein_kernel	508
GiNaC::Kronecker_dtau_kernel	738
GiNaC::Kronecker_dz_kernel	748
GiNaC::basic_log_kernel	359
GiNaC::modular_form_kernel	794
GiNaC::multiple_polylog_kernel	853
GiNaC::user_defined_kernel	1171
GiNaC::matrix	765
GiNaC::numeric	877
GiNaC::power	940
GiNaC::pseries	988
GiNaC::relational	1023
GiNaC::structure< T, ComparisonPolicy >	1071

GiNaC::symbol	1115
GiNaC::realsymbol	1010
GiNaC::possymbol	934
GiNaC::symmetry	1128
GiNaC::tensor	1161
GiNaC::cliffordunit	392
GiNaC::diracgamma	462
GiNaC::diracgamma5	468
GiNaC::diracgammaL	473
GiNaC::diracgammaR	478
GiNaC::diracone	483
GiNaC::su3d	1088
GiNaC::su3f	1093
GiNaC::su3one	1099
GiNaC::su3t	1104
GiNaC::tensdelta	1141
GiNaC::tensepsilon	1147
GiNaC::tensmetric	1155
GiNaC::minkmetric	787
GiNaC::spinmetric	1061
GiNaC::wildcard	1188
GiNaC::registered_class_options	1020
GiNaC::remember_strategies	1034
GiNaC::remember_table_entry	1039
GiNaC::return_type_t	1044
GiNaC::return_types	1045
GiNaC::relational::safe_bool_helper	1046
GiNaC::scalar_products	1046
GiNaC::series_options	1049
GiNaC::solve_algo	1049
GiNaC::spmapkey	1067
GiNaC::status_flags	1070
GiNaC::subs_options	1109
GiNaC::sy_is_less	1110
GiNaC::sy_swap	1110
GiNaC::sym_desc	1112
GiNaC::symbolset	1127
GiNaC::symminfo	1138
GiNaC::symminfo_is_less_by_orig	1140
GiNaC::symminfo_is_less_by_symmterm	1141
GiNaC::terminfo	1166
GiNaC::terminfo_is_less	1168
GiNaC::class_info< OPT >::tree_node	1168
GiNaC::unarchive_table_t	1169
std::vector	
GiNaC::remember_table	1035
GiNaC::visitor	1187
GiNaC::zeta1_SERIAL	1195
GiNaC::zeta2_SERIAL	1195

Chapter 3

Class Index

3.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

GiNaC::internal::_iter_rep	289
GiNaC::_numeric_digits	
This class is used to instantiate a global singleton object Digits which behaves just like Maple's	
Digits	291
GiNaC::add	
Sum of expressions	294
GiNaC::archive	
This class holds archived versions of GiNaC expressions (class ex)	310
GiNaC::archive_node	
This class stores all properties needed to record/retrieve the state of one object of class basic	
(or a derived class)	318
GiNaC::archive_node::archive_node_cit_range	328
GiNaC::archive::archived_ex	
Archived expression descriptor	329
GiNaC::basic	
This class is the ABC (abstract base class) of GiNaC 's class hierarchy	330
GiNaC::basic_log_kernel	
The basic integration kernel with a logarithmic singularity at the origin	359
GiNaC::basic_multi_iterator< T >	
Basic_multi_iterator is a base class	364
GiNaC::basic_partition_generator	
Base class for generating all bounded combinatorial partitions of an integer n with exactly m	
parts in non-decreasing order	371
GiNaC::class_info< OPT >	373
GiNaC::clifford	
This class holds an object representing an element of the Clifford algebra (the Dirac gamma	
matrices)	377
GiNaC::cliffordunit	
This class represents the Clifford algebra generators (units)	392
GiNaC::color	
This class holds a generator T_a or the unity element of the Lie algebra of SU(3), as used for	
calculations in quantum chromodynamics	397
GiNaC::compare_all_equal< T >	
Comparison policy: all structures of one type are equal	409
GiNaC::compare_bitwise< T >	
Comparison policy: use bit-wise comparison to compare structures	410

GiNaC::compare_std_less< T >	
Comparison policy: use <code>std::equal_to</code> / <code>std::less</code> (defaults to operators <code>==</code> and <code><</code>) to compare structures	411
GiNaC::composition_generator	
Generate all compositions of a partition of an integer n , starting with the compositions which has non-decreasing order	413
GiNaC::const_iterator	415
GiNaC::const_postorder_iterator	421
GiNaC::const_preorder_iterator	424
GiNaC::constant	
This class holds constants, symbols with specific numerical value	427
GiNaC::container< C >	
Wrapper template for making GiNaC classes out of STL containers	438
GiNaC::container_storage< C >	
Helper template for encapsulating the <code>reserve()</code> mechanics of STL containers	453
GiNaC::composition_generator::coolmulti	457
GiNaC::derivative_map_function	
Function object to be applied by <code>basic::derivative()</code>	459
GiNaC::determinant_algo	
Switch to control algorithm for determinant computation	461
GiNaC::diracgamma	
This class represents the Dirac gamma Lorentz vector	462
GiNaC::diracgamma5	
This class represents the Dirac gamma5 object which anticommutes with all other gammas	468
GiNaC::diracgammaL	
This class represents the Dirac gammaL object which behaves like $1/2 (1-\text{gamma}5)$	473
GiNaC::diracgammaR	
This class represents the Dirac gammaL object which behaves like $1/2 (1+\text{gamma}5)$	478
GiNaC::diracone	
This class represents the Clifford algebra unity element	483
GiNaC::do_taylor	
Exception class thrown by classes which provide their own series expansion to signal that ordinary Taylor expansion is safe	488
GiNaC::domain	
Domain of an object	488
GiNaC::dunno	
Exception class thrown by functions to signal unimplemented functionality so the expression may just be <code>.hold()</code>	489
GiNaC::Ebar_kernel	
The Ebar-kernel	489
GiNaC::Eisenstein_h_kernel	
The kernel corresponding to the Eisenstein series $h_{k,N,r,s}(\tau)$	497
GiNaC::Eisenstein_kernel	
The kernel corresponding to the Eisenstein series $E_{k,N,a,b,K}(\tau)$	508
GiNaC::composition_generator::coolmulti::element	517
GiNaC::ELi_kernel	
The ELi-kernel	519
std::equal_to< GiNaC::ex >	
Specialization of <code>std::equal_to()</code> for <code>ex</code> objects	527
GiNaC::error_and_integral	528
GiNaC::error_and_integral_is_less	529
GiNaC::eval_integ_map_function	
Function object to be applied by <code>basic::eval_integ()</code>	530
GiNaC::evalf_map_function	
Function object to be applied by <code>basic::evalf()</code>	531
GiNaC::evalm_map_function	
Function object to be applied by <code>basic::evalm()</code>	533

GiNaC::ex	
Lightweight wrapper for GiNaC 's symbolic objects	534
GiNaC::ex_base_is_less	566
GiNaC::ex_is_equal	566
GiNaC::ex_is_less	567
GiNaC::ex_swap	567
GiNaC::expair	
A pair of expressions	568
GiNaC::expair_is_less	
Function object for insertion into third argument of STL's sort() etc	572
GiNaC::expair_rest_is_less	
Function object not caring about the numerical coefficients for insertion into third argument of STL's sort()	572
GiNaC::expair_swap	573
GiNaC::expairseq	
A sequence of class expair	574
GiNaC::expand_map_function	
Function object to be applied by basic::expand()	592
GiNaC::expand_options	
Flags to control the behavior of expand()	594
GiNaC::factor_options	
Flags to control the polynomial factorization	595
GiNaC::fail	596
GiNaC::fderivative	
This class represents the (abstract) derivative of a symbolic function	600
GiNaC::function	
The class function is used to implement builtin functions like sin, cos... and user defined functions	615
GiNaC::function_options	636
GiNaC::G2_SERIAL	
Generalized multiple polylogarithm	678
GiNaC::G3_SERIAL	
Generalized multiple polylogarithm with explicit imaginary parts	679
GiNaC::gcd_options	
Flags to control the behavior of gcd() and friends	679
GiNaC::gcdheu_failed	
Exception thrown by heur_gcd() to signal failure	680
GiNaC::has_distance< T >	
SFINAE test for distance	680
GiNaC::has_options	
Flags to control the behavior of has()	682
std::hash< GiNaC::ex >	
Specialization of std::hash() for ex objects	682
GiNaC::idx	
This class holds one index of an indexed object	683
GiNaC::idx_is_equal_ignore_dim	695
GiNaC::indexed	
This class holds an indexed expression	695
GiNaC::info_flags	
Possible attributes an object can have	714
GiNaC::integral	
Symbolic integral	715
GiNaC::integration_kernel	
The base class for integration kernels for iterated integrals	727
GiNaC::is_not_a_clifford	
Predicate for finding non-clifford objects	736
GiNaC::is_summation_idx	737
GiNaC::iterated_integral2_SERIAL	
Complete elliptic integral of the first kind	737

GiNaC::iterated_integral3_SERIAL	
Iterated integral with explicit truncation	738
GiNaC::Kronecker_dtau_kernel	
The kernel corresponding to integrating the Kronecker coefficient function $g^{(n)}(z_j, K\tau)$ in τ (or equivalently in \bar{q})	738
GiNaC::Kronecker_dz_kernel	
The kernel corresponding to integrating the Kronecker coefficient function $g^{(n-1)}(z - z_j, K\tau)$ in z	748
GiNaC::lanczos_coeffs	756
std::less< GiNaC::ptr< T > >	
Specialization of <code>std::less</code> for <code>ptr<T></code> to enable ordering of <code>ptr<T></code> objects (e.g.	758
GiNaC::library_init	
Helper class to initialize the library	759
GiNaC::make_flat_inserter	
Class to handle the renaming of dummy indices	760
GiNaC::map_function	
Function object for <code>map()</code>	762
GiNaC::matrix	
Symbolic matrices	765
GiNaC::minkmetric	
This class represents a Minkowski metric tensor	787
GiNaC::modular_form_kernel	
A kernel corresponding to a polynomial in Eisenstein series	794
GiNaC::basic_partition_generator::mpartition2	803
GiNaC::mul	
Product of expressions	804
GiNaC::multi_iterator_counter< T >	
The class <code>multi_iterator_counter</code> defines a <code>multi_iterator</code> (i_1, i_2, \dots, i_k) , such that	823
GiNaC::multi_iterator_counter_indv< T >	
The class <code>multi_iterator_counter_indv</code> defines a <code>multi_iterator</code> (i_1, i_2, \dots, i_k) , such that	826
GiNaC::multi_iterator_ordered< T >	
The class <code>multi_iterator_ordered</code> defines a <code>multi_iterator</code> (i_1, i_2, \dots, i_k) , such that	830
GiNaC::multi_iterator_ordered_eq< T >	
The class <code>multi_iterator_ordered_eq</code> defines a <code>multi_iterator</code> (i_1, i_2, \dots, i_k) , such that	834
GiNaC::multi_iterator_ordered_eq_indv< T >	
The class <code>multi_iterator_ordered_eq_indv</code> defines a <code>multi_iterator</code> (i_1, i_2, \dots, i_k) , such that	838
GiNaC::multi_iterator_permutation< T >	
The class <code>multi_iterator_permutation</code> defines a <code>multi_iterator</code> (i_1, i_2, \dots, i_k) , for which	842
GiNaC::multi_iterator_shuffle< T >	
The class <code>multi_iterator_shuffle</code> defines a <code>multi_iterator</code> , which runs over all shuffles of a and b	846
GiNaC::multi_iterator_shuffle_prime< T >	
The class <code>multi_iterator_shuffle_prime</code> defines a <code>multi_iterator</code> , which runs over all shuffles of a and b, excluding the first one (a,b)	850
GiNaC::multiple_polylog_kernel	
The integration kernel for multiple polylogarithms	853
GiNaC::ncmul	
Non-commutative product of expressions	861
GiNaC::normal_map_function	
Function object to be applied by <code>basic::normal()</code>	876
GiNaC::numeric	
This class is a wrapper around CLN-numbers within the <code>GiNaC</code> class hierarchy	877
GiNaC::op0_is_equal	905
GiNaC::partition_generator	
Generate all bounded combinatorial partitions of an integer n with exactly m parts (not including zero parts) in non-decreasing order	906
GiNaC::partition_with_zero_parts_generator	
Generate all bounded combinatorial partitions of an integer n with exactly m parts (including zero parts) in non-decreasing order	908

GiNaC::pointer_to_map_function	911
GiNaC::pointer_to_map_function_1arg< T1 >	913
GiNaC::pointer_to_map_function_2args< T1, T2 >	916
GiNaC::pointer_to_map_function_3args< T1, T2, T3 >	918
GiNaC::pointer_to_member_to_map_function< C >	921
GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >	924
GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >	926
GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >	929
GiNaC::pole_error	
Exception class thrown when a singularity is encountered	932
GiNaC::possymbol	
Specialization of symbol to real positive domain	934
GiNaC::power	
This class holds a two-component object, a basis and and exponent representing exponentiation	940
GiNaC::print_context	
Base class for print_contexts	957
GiNaC::print_context_options	
This class stores information about a registered print_context class	959
GiNaC::print_csrc	
Base context for C source output	961
GiNaC::print_csrc_cl_N	
Context for C source output using CLN numbers	962
GiNaC::print_csrc_double	
Context for C source output using double precision	964
GiNaC::print_csrc_float	
Context for C source output using float precision	966
GiNaC::print_dflt	
Context for default (ginsh-parsable) output	968
GiNaC::print_functor	
This class represents a print method for a certain algebraic class and print_context type	969
GiNaC::print_functor_impl	
Base class for print_functor handlers	972
GiNaC::print_latex	
Context for latex-parsable output	973
GiNaC::print_memfun_handler< T, C >	
Print_functor handler for member functions of class T, context type C	975
GiNaC::print_options	
Flags to control the behavior of a print_context	977
GiNaC::print_ptrfun_handler< T, C >	
Print_functor handler for pointer-to-functions of class T, context type C	978
GiNaC::print_python	
Context for python pretty-print output	980
GiNaC::print_python_repr	
Context for python-parsable output	982
GiNaC::print_tree	
Context for tree-like output for debugging	983
GiNaC::archive_node::property	
Archived property (data type, name and associated data)	985
GiNaC::archive_node::property_info	
Information about a stored property	986
GiNaC::pseries	
This class holds a extended truncated power series (positive and negative integer powers)	988
GiNaC::psi1_SERIAL	
Polylogarithm and multiple polylogarithm	1004
GiNaC::psi2_SERIAL	
Derivatives of Psi-function (aka polygamma-functions)	1005
GiNaC::ptr< T >	
Class of (intrusively) reference-counted pointers that support copy-on-write semantics	1005

GiNaC::realsymbol	
Specialization of symbol to real domain	1010
GiNaC::refcounted	
Base class for reference-counted objects	1017
GiNaC::registered_class_options	
This class stores information about a registered GiNaC class	1020
GiNaC::relational	
This class holds a relation consisting of two expressions and a logical relation between them	1023
GiNaC::remember_strategies	
Strategies how to clean up the function remember cache	1034
GiNaC::remember_table	
The remember table is organized like an n-fold associative cache in a microprocessor	1035
GiNaC::remember_table_entry	
A single entry in the remember table of a function	1039
GiNaC::remember_table_list	
A list of entries in the remember table having some least significant bits of the hashvalue in common	1042
GiNaC::return_type_t	
To distinguish between different kinds of non-commutative objects	1044
GiNaC::return_types	1045
GiNaC::relational::safe_bool_helper	1046
GiNaC::scalar_products	
Helper class for storing information about known scalar products which are to be automatically replaced by simplify_indexed()	1046
GiNaC::series_options	
Flags to control series expansion	1049
GiNaC::solve_algo	
Switch to control algorithm for linear system solving	1049
GiNaC::spinidx	
This class holds a spinor index that can be dotted or undotted and that also has a variance	1050
GiNaC::spinmetric	
This class represents an antisymmetric spinor metric tensor which can be used to raise/lower indices of 2-component Weyl spinors	1061
GiNaC::spmapkey	1067
GiNaC::status_flags	
Flags to store information about the state of an object	1070
GiNaC::structure< T, ComparisonPolicy >	
Wrapper template for making GiNaC classes out of C++ structures	1071
GiNaC::su3d	
This class represents the tensor of symmetric su(3) structure constants	1088
GiNaC::su3f	
This class represents the tensor of antisymmetric su(3) structure constants	1093
GiNaC::su3one	
This class represents the su(3) unity element	1099
GiNaC::su3t	
This class represents an su(3) generator	1104
GiNaC::subs_options	
Flags to control the behavior of subs()	1109
GiNaC::sy_is_less	1110
GiNaC::sy_swap	1110
GiNaC::sym_desc	
This structure holds information about the highest and lowest degrees in which a symbol appears in two multivariate polynomials "a" and "b"	1112
GiNaC::symbol	
Basic CAS symbol	1115
GiNaC::symbolset	1127
GiNaC::symmetry	
This class describes the symmetry of a group of indices	1128

GiNaC::symminfo	
This structure stores the individual symmetrized terms obtained during the simplification of sums	1138
GiNaC::symminfo_is_less_by_orig	1140
GiNaC::symminfo_is_less_by_symmterm	1141
GiNaC::tensdelta	
This class represents the delta tensor	1141
GiNaC::tensepsilon	
This class represents the totally antisymmetric epsilon tensor	1147
GiNaC::tensmetric	
This class represents a general metric tensor which can be used to raise/lower indices	1155
GiNaC::tensor	
This class holds one of GiNaC 's predefined special tensors such as the delta and the metric tensors	1161
GiNaC::terminfo	
This structure stores the original and symmetrized versions of terms obtained during the simplification of sums	1166
GiNaC::terminfo_is_less	1168
GiNaC::class_info< OPT >::tree_node	1168
GiNaC::unarchive_table_t	1169
GiNaC::user_defined_kernel	
A user-defined integration kernel	1171
GiNaC::varidx	
This class holds an index with a variance (co- or contravariant)	1179
GiNaC::visitor	
Degenerate base class for visitors	1187
GiNaC::wildcard	
This class acts as a wildcard for subs() , match() , has() and find()	1188
GiNaC::zeta1_SERIAL	
Complex conjugate	1195
GiNaC::zeta2_SERIAL	
Alternating Euler sum or colored MZV	1195

Chapter 4

File Index

4.1 File List

Here is a list of all files with brief descriptions:

add.cpp	Implementation of GiNaC 's sums of expressions	1197
add.h	Interface to GiNaC 's sums of expressions	1198
archive.cpp	Archiving of GiNaC expressions	1198
archive.h	Archiving of GiNaC expressions	1199
assertion.h	Assertion macro definition	1201
basic.cpp	Implementation of GiNaC 's ABC	1203
basic.h	Interface to GiNaC 's ABC	1204
class_info.h	Helper templates to provide per-class information for class hierarchies	1205
clifford.cpp	Implementation of GiNaC 's clifford algebra (Dirac gamma) objects	1206
clifford.h	Interface to GiNaC 's clifford algebra (Dirac gamma) objects	1208
color.cpp	Implementation of GiNaC 's color (SU(3) Lie algebra) objects	1210
color.h	Interface to GiNaC 's color (SU(3) Lie algebra) objects	1212
compiler.h	Definition of optimizing macros	1213
constant.cpp	Implementation of GiNaC 's constant types and some special constants	1214
constant.h	Interface to GiNaC 's constant types and some special constants	1215
container.h	Wrapper template for making GiNaC classes out of STL containers	1216
crc32.h	CRC32 hash function	1216
ex.cpp	Implementation of GiNaC 's light-weight expression handles	1217

ex.h	Interface to GiNaC 's light-weight expression handles	1217
excompiler.cpp	Functions to facilitate the conversion of a ex to a function pointer suited for fast numerical integration	1220
excompiler.h	Functions to facilitate the conversion of a ex to a function pointer suited for fast numerical integration	1220
expair.cpp	Implementation of expression pairs (building blocks of expairseq)	1221
expair.h	Definition of expression pairs (building blocks of expairseq)	1222
expairseq.cpp	Implementation of sequences of expression pairs	1223
expairseq.h	Interface to sequences of expression pairs	1223
exprseq.cpp	Implementation of GiNaC 's exprseq	1224
exprseq.h	Definition of GiNaC 's exprseq	1225
factor.cpp	Polynomial factorization (implementation)	1225
factor.h	Polynomial factorization	1227
fail.cpp	Implementation of class signaling failure of operation	1227
fail.h	Interface to class signaling failure of operation	1228
fderivative.cpp	Implementation of abstract derivatives of functions	1228
fderivative.h	Interface to abstract derivatives of functions	1229
flags.h	Collection of all flags used through the GiNaC framework	1229
function.cpp	Implementation of class of symbolic functions	1230
function.h	Interface to class of symbolic functions	1231
ginac.h	This include file includes all other public GiNaC headers	1242
hash_map.h	Replacement for <code>map<></code> using hash tables	1243
hash_seed.h	Type-specific hash seed	1243
idx.cpp	Implementation of GiNaC 's indices	1244
idx.h	Interface to GiNaC 's indices	1245
indexed.cpp	Implementation of GiNaC 's indexed expressions	1246
indexed.h	Interface to GiNaC 's indexed expressions	1248
inifcns.cpp	Implementation of GiNaC 's initially known functions	1249
inifcns.h	Interface to GiNaC 's initially known functions	1252
inifcns_elliptic.cpp	Implementation of some special functions related to elliptic curves	1253

inifcns_gamma.cpp	Implementation of Gamma-function, Beta-function, Polygamma-functions, and some related stuff	1255
inifcns_nstdsums.cpp	Implementation of some special functions that have a representation as nested sums	1256
inifcns_trans.cpp	Implementation of transcendental (and trigonometric and hyperbolic) functions	1258
integral.cpp	Implementation of GiNaC 's symbolic integral	1261
integral.h	Interface to GiNaC 's symbolic integral	1262
integration_kernel.cpp	Implementation of GiNaC 's integration kernels for iterated integrals	1262
integration_kernel.h	Interface to GiNaC 's integration kernels for iterated integrals	1264
lst.cpp	Implementation of GiNaC 's <code>lst</code>	1265
lst.h	Definition of GiNaC 's <code>lst</code>	1266
matrix.cpp	Implementation of symbolic matrices	1266
matrix.h	Interface to symbolic matrices	1267
mul.cpp	Implementation of GiNaC 's products of expressions	1269
mul.h	Interface to GiNaC 's products of expressions	1269
ncmul.cpp	Implementation of GiNaC 's non-commutative products of expressions	1270
ncmul.h	Interface to GiNaC 's non-commutative products of expressions	1271
normal.cpp	This file implements several functions that work on univariate and multivariate polynomials and rational functions	1272
normal.h	This file defines several functions that work on univariate and multivariate polynomials and rational functions	1274
numeric.cpp	This file contains the interface to the underlying bignum package	1276
numeric.h	Makes the interface to the underlying bignum package available	1279
operators.cpp	Implementation of GiNaC 's overloaded operators	1282
operators.h	Interface to GiNaC 's overloaded operators	1284
power.cpp	Implementation of GiNaC 's symbolic exponentiation ($\text{basis}^{\text{exponent}}$)	1285
power.h	Interface to GiNaC 's symbolic exponentiation ($\text{basis}^{\text{exponent}}$)	1286
print.cpp	Implementation of helper classes for expression output	1287
print.h	Definition of helper classes for expression output	1287
pseries.cpp	Implementation of class for extended truncated power series and methods for series expansion	1290
pseries.h	Interface to class for extended truncated power series	1291
ptr.h	Reference-counted pointer template	1292

registrar.cpp	
GiNaC's class registrar (for class basic and all classes derived from it)	1292
registrar.h	
GiNaC's class registrar (for class basic and all classes derived from it)	1293
relational.cpp	
Implementation of relations between expressions	1296
relational.h	
Interface to relations between expressions	1296
remember.cpp	
Implementation of helper classes for using the remember option in GiNaC functions	1297
remember.h	
Interface to helper classes for using the remember option in GiNaC functions	1297
structure.h	
Wrapper template for making GiNaC classes out of C++ structures	1298
symbol.cpp	
Implementation of GiNaC's symbolic objects	1299
symbol.h	
Interface to GiNaC's symbolic objects	1299
symmetry.cpp	
Implementation of GiNaC's symmetry definitions	1300
symmetry.h	
Interface to GiNaC's symmetry definitions	1301
tensor.cpp	
Implementation of GiNaC's special tensors	1303
tensor.h	
Interface to GiNaC's special tensors	1304
utils.cpp	
Implementation of several small and furry utilities needed within GiNaC but not of any interest to the user of the library	1305
utils.h	
Interface to several small and furry utilities needed within GiNaC but not of any interest to the user of the library	1307
utils_multi_iterator.h	
Utilities for summing over multiple indices	1309
version.h	
GiNaC library version information	1311
wildcard.cpp	
Implementation of GiNaC's wildcard objects	1313
wildcard.h	
Interface to GiNaC's wildcard objects	1314

Chapter 5

Namespace Documentation

5.1 GiNaC Namespace Reference

Namespaces

- namespace [internal](#)

Classes

- class [_numeric_digits](#)
This class is used to instantiate a global singleton object Digits which behaves just like Maple's Digits.
- class [add](#)
Sum of expressions.
- class [archive](#)
This class holds archived versions of [GiNaC](#) expressions (class [ex](#)).
- class [archive_node](#)
This class stores all properties needed to record/retrieve the state of one object of class [basic](#) (or a derived class).
- class [basic](#)
This class is the ABC (abstract base class) of [GiNaC](#)'s class hierarchy.
- class [basic_log_kernel](#)
The basic integration kernel with a logarithmic singularity at the origin.
- class [basic_multi_iterator](#)
[basic_multi_iterator](#) is a base class.
- class [basic_partition_generator](#)
Base class for generating all bounded combinatorial partitions of an integer n with exactly m parts in non-decreasing order.
- class [class_info](#)
- class [clifford](#)
This class holds an object representing an element of the Clifford algebra (the Dirac gamma matrices).
- class [cliffordunit](#)
This class represents the Clifford algebra generators (units).
- class [color](#)
This class holds a generator T_a or the unity element of the Lie algebra of $SU(3)$, as used for calculations in quantum chromodynamics.
- class [compare_all_equal](#)
Comparison policy: all structures of one type are equal.

- class [compare_bitwise](#)
Comparison policy: use bit-wise comparison to compare structures.
- class [compare_std_less](#)
Comparison policy: use `std::equal_to/std::less` (defaults to operators `==` and `<`) to compare structures.
- class [composition_generator](#)
Generate all compositions of a partition of an integer n , starting with the compositions which has non-decreasing order.
- class [const_iterator](#)
- class [const_postorder_iterator](#)
- class [const_preorder_iterator](#)
- class [constant](#)
This class holds constants, symbols with specific numerical value.
- class [container](#)
Wrapper template for making [GiNaC](#) classes out of STL containers.
- class [container_storage](#)
Helper template for encapsulating the [reserve\(\)](#) mechanics of STL containers.
- struct [derivative_map_function](#)
Function object to be applied by `basic::derivative()`.
- class [determinant_algo](#)
Switch to control algorithm for determinant computation.
- class [diracgamma](#)
This class represents the Dirac gamma Lorentz vector.
- class [diracgamma5](#)
This class represents the Dirac gamma5 object which anticommutes with all other gammas.
- class [diracgammaL](#)
This class represents the Dirac gammaL object which behaves like $1/2 (1-\text{gamma}5)$.
- class [diracgammaR](#)
This class represents the Dirac gammaL object which behaves like $1/2 (1+\text{gamma}5)$.
- class [diracone](#)
This class represents the Clifford algebra unity element.
- class [do_taylor](#)
Exception class thrown by classes which provide their own series expansion to signal that ordinary Taylor expansion is safe.
- class [domain](#)
Domain of an object.
- class [dunno](#)
Exception class thrown by functions to signal unimplemented functionality so the expression may just be `.hold()`
- class [Ebar_kernel](#)
The Ebar-kernel.
- class [Eisenstein_h_kernel](#)
The kernel corresponding to the Eisenstein series $h_{k,N,r,s}(\tau)$.
- class [Eisenstein_kernel](#)
The kernel corresponding to the Eisenstein series $E_{k,N,a,b,K}(\tau)$.
- class [ELi_kernel](#)
The ELi-kernel.
- struct [error_and_integral](#)
- struct [error_and_integral_is_less](#)
- struct [eval_integ_map_function](#)
Function object to be applied by `basic::eval_integ()`.
- struct [evalf_map_function](#)
Function object to be applied by `basic::evalf()`.

- struct [evalm_map_function](#)
Function object to be applied by [basic::evalm\(\)](#).
- class [ex](#)
Lightweight wrapper for [GiNaC](#)'s symbolic objects.
- struct [ex_base_is_less](#)
- struct [ex_is_equal](#)
- struct [ex_is_less](#)
- struct [ex_swap](#)
- class [expair](#)
A pair of expressions.
- struct [expair_is_less](#)
Function object for insertion into third argument of STL's [sort\(\)](#) etc.
- struct [expair_rest_is_less](#)
Function object not caring about the numerical coefficients for insertion into third argument of STL's [sort\(\)](#).
- struct [expair_swap](#)
- class [expairseq](#)
A sequence of class [expair](#).
- struct [expand_map_function](#)
Function object to be applied by [basic::expand\(\)](#).
- class [expand_options](#)
Flags to control the behavior of [expand\(\)](#).
- class [factor_options](#)
Flags to control the polynomial factorization.
- class [fail](#)
- class [fderivative](#)
This class represents the (abstract) derivative of a symbolic function.
- class [function](#)
The class [function](#) is used to implement builtin functions like [sin](#), [cos](#)... and user defined functions.
- class [function_options](#)
- class [G2_SERIAL](#)
Generalized multiple polylogarithm.
- class [G3_SERIAL](#)
Generalized multiple polylogarithm with explicit imaginary parts.
- struct [gcd_options](#)
Flags to control the behavior of [gcd\(\)](#) and friends.
- class [gcdheu_failed](#)
Exception thrown by [heur_gcd\(\)](#) to signal failure.
- class [has_distance](#)
SFINAE test for distance.
- class [has_options](#)
Flags to control the behavior of [has\(\)](#).
- class [idx](#)
This class holds one index of an indexed object.
- struct [idx_is_equal_ignore_dim](#)
- class [indexed](#)
This class holds an indexed expression.
- class [info_flags](#)
Possible attributes an object can have.
- class [integral](#)
Symbolic integral.
- class [integration_kernel](#)

- The base class for integration kernels for iterated integrals.

 - struct [is_not_a_clifford](#)

Predicate for finding non-clifford objects.
 - struct [is_summation_idx](#)
 - class [iterated_integral2_SERIAL](#)

Complete elliptic integral of the first kind.
 - class [iterated_integral3_SERIAL](#)

Iterated integral with explicit truncation.
 - class [Kronecker_dtau_kernel](#)

The kernel corresponding to integrating the Kronecker coefficient function $g^{(n)}(z_j, K\tau)$ in τ (or equivalently in \bar{q}).
 - class [Kronecker_dz_kernel](#)

The kernel corresponding to integrating the Kronecker coefficient function $g^{(n-1)}(z - z_j, K\tau)$ in z .
 - class [lanczos_coeffs](#)
 - class [library_init](#)

Helper class to initialize the library.
 - class [make_flat_inserter](#)

Class to handle the renaming of dummy indices.
 - struct [map_function](#)

Function object for `map()`.
 - class [matrix](#)

Symbolic matrices.
 - class [minkmetric](#)

This class represents a Minkowski metric tensor.
 - class [modular_form_kernel](#)

A kernel corresponding to a polynomial in Eisenstein series.
 - class [mul](#)

Product of expressions.
 - class [multi_iterator_counter](#)

The class [multi_iterator_counter](#) defines a `multi_iterator` (i_1, i_2, \dots, i_k) , such that.
 - class [multi_iterator_counter_indv](#)

The class [multi_iterator_counter_indv](#) defines a `multi_iterator` (i_1, i_2, \dots, i_k) , such that.
 - class [multi_iterator_ordered](#)

The class [multi_iterator_ordered](#) defines a `multi_iterator` (i_1, i_2, \dots, i_k) , such that.
 - class [multi_iterator_ordered_eq](#)

The class [multi_iterator_ordered_eq](#) defines a `multi_iterator` (i_1, i_2, \dots, i_k) , such that.
 - class [multi_iterator_ordered_eq_indv](#)

The class [multi_iterator_ordered_eq_indv](#) defines a `multi_iterator` (i_1, i_2, \dots, i_k) , such that.
 - class [multi_iterator_permutation](#)

The class [multi_iterator_permutation](#) defines a `multi_iterator` (i_1, i_2, \dots, i_k) , for which.
 - class [multi_iterator_shuffle](#)

The class [multi_iterator_shuffle](#) defines a `multi_iterator`, which runs over all shuffles of a and b .
 - class [multi_iterator_shuffle_prime](#)

The class [multi_iterator_shuffle_prime](#) defines a `multi_iterator`, which runs over all shuffles of a and b , excluding the first one (a,b) .
 - class [multiple_polylog_kernel](#)

The integration kernel for multiple polylogarithms.
 - class [ncmul](#)

Non-commutative product of expressions.
 - struct [normal_map_function](#)

Function object to be applied by `basic::normal()`.
 - class [numeric](#)

This class is a wrapper around CLN-numbers within the [GiNaC](#) class hierarchy.

- struct [op0_is_equal](#)
- class [partition_generator](#)

Generate all bounded combinatorial partitions of an integer n with exactly m parts (not including zero parts) in non-decreasing order.
- class [partition_with_zero_parts_generator](#)

Generate all bounded combinatorial partitions of an integer n with exactly m parts (including zero parts) in non-decreasing order.
- class [pointer_to_map_function](#)
- class [pointer_to_map_function_1arg](#)
- class [pointer_to_map_function_2args](#)
- class [pointer_to_map_function_3args](#)
- class [pointer_to_member_to_map_function](#)
- class [pointer_to_member_to_map_function_1arg](#)
- class [pointer_to_member_to_map_function_2args](#)
- class [pointer_to_member_to_map_function_3args](#)
- class [pole_error](#)

Exception class thrown when a singularity is encountered.
- class [possymbol](#)

Specialization of symbol to real positive domain.
- class [power](#)

This class holds a two-component object, a basis and an exponent representing exponentiation.
- class [print_context](#)

Base class for print contexts.
- class [print_context_options](#)

This class stores information about a registered [print_context](#) class.
- class [print_csrc](#)

Base context for C source output.
- class [print_csrc_cl_N](#)

Context for C source output using CLN numbers.
- class [print_csrc_double](#)

Context for C source output using double precision.
- class [print_csrc_float](#)

Context for C source output using float precision.
- class [print_dflt](#)

Context for default (ginsh-parsable) output.
- class [print_functor](#)

This class represents a print method for a certain algebraic class and [print_context](#) type.
- class [print_functor_impl](#)

Base class for [print_functor](#) handlers.
- class [print_latex](#)

Context for latex-parsable output.
- class [print_memfun_handler](#)

[print_functor](#) handler for member functions of class T , context type C
- class [print_options](#)

Flags to control the behavior of a [print_context](#).
- class [print_ptrfun_handler](#)

[print_functor](#) handler for pointer-to-functions of class T , context type C
- class [print_python](#)

Context for python pretty-print output.
- class [print_python_repr](#)

Context for python-parsable output.

- class [print_tree](#)
Context for tree-like output for debugging.
- class [pseries](#)
This class holds a extended truncated power series (positive and negative integer powers).
- class [psi1_SERIAL](#)
Polylogarithm and multiple polylogarithm.
- class [psi2_SERIAL](#)
Derivatives of Psi-function (aka polygamma-functions).
- class [ptr](#)
Class of (intrusively) reference-counted pointers that support copy-on-write semantics.
- class [realsymbol](#)
Specialization of symbol to real domain.
- class [refcounted](#)
Base class for reference-counted objects.
- class [registered_class_options](#)
This class stores information about a registered [GiNaC](#) class.
- class [relational](#)
This class holds a relation consisting of two expressions and a logical relation between them.
- class [remember_strategies](#)
Strategies how to clean up the function remember cache.
- class [remember_table](#)
The remember table is organized like an n-fold associative cache in a microprocessor.
- class [remember_table_entry](#)
A single entry in the remember table of a function.
- class [remember_table_list](#)
A list of entries in the remember table having some least significant bits of the hashvalue in common.
- struct [return_type_t](#)
To distinguish between different kinds of non-commutative objects.
- class [return_types](#)
- class [scalar_products](#)
Helper class for storing information about known scalar products which are to be automatically replaced by [simplify_indexed\(\)](#).
- class [series_options](#)
Flags to control series expansion.
- class [solve_algo](#)
Switch to control algorithm for linear system solving.
- class [spinidx](#)
This class holds a spinor index that can be dotted or undotted and that also has a variance.
- class [spinmetric](#)
This class represents an antisymmetric spinor metric tensor which can be used to raise/lower indices of 2-component Weyl spinors.
- class [smapkey](#)
- class [status_flags](#)
Flags to store information about the state of an object.
- class [structure](#)
Wrapper template for making [GiNaC](#) classes out of C++ structures.
- class [su3d](#)
This class represents the tensor of symmetric $su(3)$ structure constants.
- class [su3f](#)
This class represents the tensor of antisymmetric $su(3)$ structure constants.
- class [su3one](#)

This class represents the $su(3)$ unity element.

- class **su3t**

This class represents an $su(3)$ generator.

- class subs options

Flags to control the behavior of `subs()`.

- class `sy_is_less`
- class `sy_swap`
- struct `sym_desc`

This structure holds information about the highest and lowest degrees in which a symbol appears in two multivariate polynomials "a" and "b":

- class **symbol**

Basic CAS symbol.

- class `symbolset`
- class `symmetry`

This class describes the symmetry of a group of indices.

- class `symminfo`

This structure stores the individual symmetrized terms obtained during the simplification of sums.

- class `symminfo_is_less_by_orig`
- class `symminfo_is_less_by_symmterm`
- class `tensdelta`

This class represents the delta tensor.

- class `tensepsilon`

This class represents the totally antisymmetric epsilon tensor.

- class `tensmetric`

This class represents a general metric tensor which can be used to raise/lower indices.

- class **tensor**

This class holds one of GiNaC's predefined special tensors such as the delta and the metric tensors.

- class `terminfo`

This structure stores the original and symmetrized versions of terms obtained during the simplification of sums.

- class `terminfo_is_less`
- class `unarchive_table_t`
- class `user defined kernel`

A user-defined integration kernel.

- class `varidx`

This class holds an index with a variance (co- or contravariant).

- class **visitor**

Degenerate base class for visitors.

- class wildcard

This class acts as a wildcard for `subs()`, `match()`, `has()` and `find()`.

- class **zeta1** SERIAL

Complex conjugate.

- class `zeta2` SERIAL

Alternating Euler sum or colored MZV.

Typedefs

- typedef unsigned archive node id

Numerical ID value to refer to an [archive node](#).

- typedef unsigned archive atom

Numerical ID value to refer to a string.

- typedef **basic** *(* **synthesize** func) ()

- typedef std::map< std::string, [synthesize_func](#) > [unarchive_map_t](#)
- typedef std::vector< [ex](#) > [exvector](#)
- typedef std::set< [ex](#), [ex_is_less](#) > [exset](#)
- typedef std::map< [ex](#), [ex](#), [ex_is_less](#) > [exmap](#)
- typedef [ex](#)(* [evalffunc](#)) ()
- typedef double(* [FUNCP_1P](#)) (double)
Function pointer with one function parameter.
- typedef double(* [FUNCP_2P](#)) (double, double)
Function pointer with two function parameters.
- typedef void(* [FUNCP_CUBA](#)) (const int *, const double[], const int *, double[])
Function pointer for use with the CUBA library (<http://www.feynarts.de/cuba>).
- typedef std::vector< [expair](#) > [epvector](#)
expair-vector
- typedef [epvector](#)::iterator [epp](#)
expair-vector pointer
- typedef [container](#)< std::vector > [exprseq](#)
- typedef std::multiset< unsigned > [paramset](#)
- typedef [ex](#)(* [eval_func](#)) ()
- typedef [ex](#)(* [evalf_func](#)) ()
- typedef [ex](#)(* [conjugate_func](#)) ()
- typedef [ex](#)(* [real_part_func](#)) ()
- typedef [ex](#)(* [imag_part_func](#)) ()
- typedef [ex](#)(* [expand_func](#)) ()
- typedef [ex](#)(* [derivative_func](#)) ()
- typedef [ex](#)(* [expl_derivative_func](#)) ()
- typedef [ex](#)(* [power_func](#)) ()
- typedef [ex](#)(* [series_func](#)) ()
- typedef void(* [print_func](#)) ()
- typedef bool(* [info_func](#)) ()
- typedef [ex](#)(* [eval_func_1](#)) (const [ex](#) &)
- typedef [ex](#)(* [evalf_func_1](#)) (const [ex](#) &)
- typedef [ex](#)(* [conjugate_func_1](#)) (const [ex](#) &)
- typedef [ex](#)(* [real_part_func_1](#)) (const [ex](#) &)
- typedef [ex](#)(* [imag_part_func_1](#)) (const [ex](#) &)
- typedef [ex](#)(* [expand_func_1](#)) (const [ex](#) &, unsigned)
- typedef [ex](#)(* [derivative_func_1](#)) (const [ex](#) &, unsigned)
- typedef [ex](#)(* [expl_derivative_func_1](#)) (const [ex](#) &, const [symbol](#) &)
- typedef [ex](#)(* [power_func_1](#)) (const [ex](#) &, const [ex](#) &)
- typedef [ex](#)(* [series_func_1](#)) (const [ex](#) &, const [relational](#) &, int, unsigned)
- typedef void(* [print_func_1](#)) (const [ex](#) &, const [print_context](#) &)
- typedef bool(* [info_func_1](#)) (const [ex](#) &, unsigned)
- typedef [ex](#)(* [eval_func_2](#)) (const [ex](#) &, const [ex](#) &)
- typedef [ex](#)(* [evalf_func_2](#)) (const [ex](#) &, const [ex](#) &)
- typedef [ex](#)(* [conjugate_func_2](#)) (const [ex](#) &, const [ex](#) &)
- typedef [ex](#)(* [real_part_func_2](#)) (const [ex](#) &, const [ex](#) &)
- typedef [ex](#)(* [imag_part_func_2](#)) (const [ex](#) &, const [ex](#) &)
- typedef [ex](#)(* [expand_func_2](#)) (const [ex](#) &, const [ex](#) &, unsigned)
- typedef [ex](#)(* [derivative_func_2](#)) (const [ex](#) &, const [ex](#) &, unsigned)
- typedef [ex](#)(* [expl_derivative_func_2](#)) (const [ex](#) &, const [ex](#) &, const [symbol](#) &)
- typedef [ex](#)(* [power_func_2](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &)
- typedef [ex](#)(* [series_func_2](#)) (const [ex](#) &, const [ex](#) &, const [relational](#) &, int, unsigned)
- typedef void(* [print_func_2](#)) (const [ex](#) &, const [ex](#) &, const [print_context](#) &)
- typedef bool(* [info_func_2](#)) (const [ex](#) &, const [ex](#) &, unsigned)
- typedef [ex](#)(* [eval_func_3](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &)

- [illegible]

- [illegible]

- ```

• typedef ex>(* eval_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
• typedef ex>(* evalf_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
• typedef ex>(* conjugate_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
• typedef ex>(* real_part_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
• typedef ex>(* imag_part_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
• typedef ex>(* expand_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
• typedef ex>(* derivative_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
• typedef ex>(* expl_derivative_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const symbol &)
• typedef ex>(* power_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
• typedef ex>(* series_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const relational &, int, unsigned)
• typedef void(* print_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const print_context &)
• typedef bool(* info_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
• typedef ex(* eval_funcp_exvector) (const exvector &)
• typedef ex(* evalf_funcp_exvector) (const exvector &)
• typedef ex(* conjugate_funcp_exvector) (const exvector &)
• typedef ex(* real_part_funcp_exvector) (const exvector &)
• typedef ex(* imag_part_funcp_exvector) (const exvector &)
• typedef ex(* expand_funcp_exvector) (const exvector &, unsigned)
• typedef ex(* derivative_funcp_exvector) (const exvector &, unsigned)
• typedef ex(* expl_derivative_funcp_exvector) (const exvector &, const symbol &)
• typedef ex(* power_funcp_exvector) (const exvector &, const ex &)
• typedef ex(* series_funcp_exvector) (const exvector &, const relational &, int, unsigned)
• typedef void(* print_funcp_exvector) (const exvector &, const print_context &)
• typedef bool(* info_funcp_exvector) (const exvector &, unsigned)
• template<typename T, class Hash = std::hash<ex>, class KeyEqual = std::equal_to<ex>, class Allocator = std::allocator<std::pair<const ex, T>>>
using exhashmap = std::unordered_map<ex, T, Hash, KeyEqual, Allocator>
• typedef std::map< spmapkey, ex > spmap
• typedef map< error_and_integral, ex, error_and_integral_is_less > lookup_map
• typedef container< std::list > lst
• typedef std::vector< std::size_t > uintvector
• typedef std::vector< unsigned > unsignedvector
• typedef std::vector< exvector > exvectorvector
• typedef std::vector< sym_desc > sym_desc_vec
• typedef void(* digits_changed_callback) (long)

Function pointer to implement callbacks in the case 'Digits' gets changed.
• typedef class_info< print_context_options > print_context_class_info
• typedef class_info< registered_class_options > registered_class_info

```

## Enumerations

- enum { `callback_registered` = 1 }

## Functions

- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`add`, `expairseq`, `print_func`< `print_context` >(&`add::do_print`), `print_func`< `print_latex` >(&`add::do_print_latex`), `print_func`< `print_csrc` >(&`add::do_print_csrc`), `print_func`< `print_tree` >(&`add::do_print_tree`), `print_func`< `print_python_repr` >(&`add::do_print_python_repr`))  
`add`
- `GINAC_BIND_UNARCHIVER` (`add`)
- `GINAC_DECLARE_UNARCHIVER` (`add`)
- static void `write_unsigned` (`std::ostream` &`os`, unsigned `val`)  
*Write unsigned integer quantity to stream.*
- static unsigned `read_unsigned` (`std::istream` &`is`)  
*Read unsigned integer quantity from stream.*
- `std::ostream` & `operator<<` (`std::ostream` &`os`, const `archive_node` &`n`)  
*Write `archive_node` to binary data stream.*
- `std::ostream` & `operator<<` (`std::ostream` &`os`, const `archive` &`ar`)  
*Write archive to binary data stream.*
- `std::istream` & `operator>>` (`std::istream` &`is`, `archive_node` &`n`)  
*Read `archive_node` from binary data stream.*
- `std::istream` & `operator>>` (`std::istream` &`is`, `archive` &`ar`)  
*Read archive from binary data stream.*
- static `synthesize_func find_factory_fcn` (const `std::string` &`name`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`basic`, void, `print_func`< `print_context` >(&`basic::do_print`), `print_func`< `print_tree` >(&`basic::do_print_tree`), `print_func`< `print_python_repr` >(&`basic::do_print_python_repr`))  
`basic`  
*basic copy constructor: implicitly assumes that the other class is of the exact same type (as it's used by `duplicate()`), so it can copy the `info_key` and the `hash` value.*
- template<class `T`>  
bool `is_a` (const `basic` &`obj`)  
*Check if `obj` is a `T`, including base classes.*
- template<class `T`>  
bool `is_exactly_a` (const `basic` &`obj`)  
*Check if `obj` is a `T`, not including base classes.*
- template<class `B`, typename... `Args`>  
`B` & `dynallocate` (`Args` &&... `args`)  
*Constructs a new (class basic or derived) `B` object on the heap.*
- template<class `B`>  
`B` & `dynallocate` (`std::initializer_list`< `ex` > `il`)  
*Constructs a new (class basic or derived) `B` object on the heap.*
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`clifford`, `indexed`, `print_func`< `print_dflt` >(&`clifford::do_print_dflt`), `print_func`< `print_latex` >(&`clifford::do_print_latex`), `print_func`< `print_tree` >(&`clifford::do_print_tree`))  
`GINAC_IMPLEMENT_REGISTERED_CLASS_OPT`(`diracone`
- `print_func`< `print_dflt` > (&`diracone::do_print`), `print_func`< `print_latex` >(&`diracone`
- `GINAC_BIND_UNARCHIVER` (`clifford`)
- `GINAC_BIND_UNARCHIVER` (`cliffordunit`)
- `GINAC_BIND_UNARCHIVER` (`diracone`)
- `GINAC_BIND_UNARCHIVER` (`diracgamma`)
- `GINAC_BIND_UNARCHIVER` (`diracgamma5`)
- `GINAC_BIND_UNARCHIVER` (`diracgammaL`)
- `GINAC_BIND_UNARCHIVER` (`diracgammaR`)

- static bool `is_dirac_slash` (const `ex` &seq0)
- static void `base_and_index` (const `ex` &c, `ex` &b, `ex` &i)  
*This function decomposes  $\gamma \sim \mu \rightarrow (1, \mu)$  and  $a \rightarrow (a.ix, ix)$*
- `ex_dirac_ONE` (unsigned char rl=0)  
*Create a Clifford unity object.*
- static unsigned `get_dim_uint` (const `ex` &e)
- `ex_clifford_unit` (const `ex` &mu, const `ex` &metr, unsigned char rl=0)  
*Create a Clifford unit object.*
- `ex_dirac_gamma` (const `ex` &mu, unsigned char rl=0)  
*Create a Dirac gamma object.*
- `ex_dirac_gamma5` (unsigned char rl=0)  
*Create a Dirac gamma5 object.*
- `ex_dirac_gammaL` (unsigned char rl=0)  
*Create a Dirac gammaL object.*
- `ex_dirac_gammaR` (unsigned char rl=0)  
*Create a Dirac gammaR object.*
- `ex_dirac_slash` (const `ex` &e, const `ex` &dim, unsigned char rl=0)  
*Create a term of the form  $e_\mu * \gamma \sim \mu$  with a unique index  $\mu$ .*
- static unsigned char `get_representation_label` (const `return_type_t` &ti)  
*Extract representation label from tinfo key (as returned by `return_type_tinfo()`).*
- static `ex_trace_string` (exvector::const\_iterator ix, size\_t num)  
*Take trace of a string of an even number of Dirac gammas given a vector of indices.*
- `ex_dirac_trace` (const `ex` &e, const std::set< unsigned char > &rls, const `ex` &trONE=4)  
*Calculate dirac traces over the specified set of representation labels.*
- `ex_dirac_trace` (const `ex` &e, const `lst` &rls, const `ex` &trONE=4)  
*Calculate dirac traces over the specified list of representation labels.*
- `ex_dirac_trace` (const `ex` &e, unsigned char rl=0, const `ex` &trONE=4)  
*Calculate the trace of an expression containing gamma objects with a specified representation label.*
- `ex_canonicalize_clifford` (const `ex` &e)  
*Bring all products of clifford objects in an expression into a canonical order.*
- `ex_clifford_star_bar` (const `ex` &e, bool do\_bar, unsigned options)  
*An auxillary function performing `clifford_star()` and `clifford_bar()`.*
- `ex_clifford_prime` (const `ex` &e)  
*Automorphism of the Clifford algebra, simply changes signs of all clifford units.*
- `ex_remove_dirac_ONE` (const `ex` &e, unsigned char rl=0, unsigned options=0)  
*Replaces `dirac_ONE`'s (with a `representation_label` no less than `rl`) in `e` with 1.*
- int `clifford_max_label` (const `ex` &e, bool ignore\_ONE=false)  
*Returns the maximal representation label of a clifford object if `e` contains at least one, otherwise returns -1.*
- `ex_clifford_norm` (const `ex` &e)  
*Calculation of the norm in the Clifford algebra.*
- `ex_clifford_inverse` (const `ex` &e)  
*Calculation of the inverse in the Clifford algebra.*
- `ex_lst_to_clifford` (const `ex` &v, const `ex` &mu, const `ex` &metr, unsigned char rl=0)  
*List or vector conversion into the Clifford vector.*
- `ex_lst_to_clifford` (const `ex` &v, const `ex` &e)  
*List or vector conversion into the Clifford vector.*
- static `ex_get_clifford_comp` (const `ex` &e, const `ex` &c, bool root=true)  
*Auxiliary structure to define a function for stripping one Clifford unit from vectors.*
- `lst_clifford_to_lst` (const `ex` &e, const `ex` &c, bool algebraic=true)  
*An inverse function to `lst_to_clifford()`.*

- `ex clifford_moebius_map` (const `ex` &a, const `ex` &b, const `ex` &c, const `ex` &d, const `ex` &v, const `ex` &G, unsigned char rl=0)  
*Calculations of Moebius transformations (conformal map) defined by a 2x2 Clifford matrix (a b|c d) in linear spaces with arbitrary signature.*
- `ex clifford_moebius_map` (const `ex` &M, const `ex` &v, const `ex` &G, unsigned char rl=0)  
*The second form of Moebius transformations defined by a 2x2 Clifford matrix M This function takes the transformation matrix M as a single entity.*
- `GINAC_DECLARE_UNARCHIVER` (clifford)
- `GINAC_DECLARE_UNARCHIVER` (diracone)
- `GINAC_DECLARE_UNARCHIVER` (cliffordunit)
- `GINAC_DECLARE_UNARCHIVER` (diracgamma)
- `GINAC_DECLARE_UNARCHIVER` (diracgamma5)
- `GINAC_DECLARE_UNARCHIVER` (diracgammaL)
- `GINAC_DECLARE_UNARCHIVER` (diracgammaR)
- `bool is_clifford_tinfo` (const `return_type_t` &ti)  
*Check whether a given `return_type_t` object (as returned by `return_type_tinfo()`) is that of a clifford object (with an arbitrary representation label).*
- `ex clifford_bar` (const `ex` &e)  
*Main anti-automorphism of the Clifford algebra: makes reversion and changes signs of all clifford units.*
- `ex clifford_star` (const `ex` &e)  
*Reversion of the Clifford algebra, reverse the order of all clifford units in ncmul.*
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (su3one, tensor, print\_func< `print_dflt` >(&su3one::do\_print). print\_func< `print_latex` >(&su3one::do\_print\_latex)) `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT`(su3t
- `print_func< print_dflt >` (&su3t::do\_print). `print_func< print_latex >`(&su3t
- `GINAC_BIND_UNARCHIVER` (color)
- `GINAC_BIND_UNARCHIVER` (su3one)
- `GINAC_BIND_UNARCHIVER` (su3t)
- `GINAC_BIND_UNARCHIVER` (su3f)
- `GINAC_BIND_UNARCHIVER` (su3d)
- `static ex permute_free_index_to_front` (const `exvector` &iv3, const `exvector` &iv2, int &sig)  
*Given a vector iv3 of three indices and a vector iv2 of two indices that is a subset of iv3, return the (free) index that is in iv3 but not in iv2 and the sign introduced by permuting that index to the front.*
- `ex color_ONE` (unsigned char rl=0)  
*Create the su(3) unity element.*
- `ex color_T` (const `ex` &a, unsigned char rl=0)  
*Create an su(3) generator.*
- `ex color_f` (const `ex` &a, const `ex` &b, const `ex` &c)  
*Create an su(3) antisymmetric structure constant.*
- `ex color_d` (const `ex` &a, const `ex` &b, const `ex` &c)  
*Create an su(3) symmetric structure constant.*
- `ex color_h` (const `ex` &a, const `ex` &b, const `ex` &c)  
*This returns the linear combination d.a.b.c+l\*f.a.b.c.*
- `static bool is_color_tinfo` (const `return_type_t` &ti)  
*Check whether a given tinfo key (as returned by `return_type_tinfo()`) is that of a color object (with an arbitrary representation label).*
- `static unsigned char get_representation_label` (const `return_type_t` &ti)  
*Extract representation label from tinfo key (as returned by `return_type_tinfo()`).*
- `ex color_trace` (const `ex` &e, const `std::set< unsigned char >` &rls)  
*Calculate color traces over the specified set of representation labels.*
- `ex color_trace` (const `ex` &e, const `lst` &rls)  
*Calculate color traces over the specified list of representation labels.*
- `ex color_trace` (const `ex` &e, unsigned char rl=0)

*Calculate the trace of an expression containing color objects with a specified representation label.*

- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([color](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([su3one](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([su3t](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([su3f](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([su3d](#))
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([constant](#), [basic](#), [print\\_func](#)< [print\\_context](#) >(&[constant::do\\_print](#)), [print\\_func](#)< [print\\_latex](#) >(&[constant::do\\_print\\_latex](#)), [print\\_func](#)< [print\\_tree](#) >(&[constant::do\\_print\\_tree](#)), [print\\_func](#)< [print\\_python\\_repr](#) >(&[constant::do\\_print\\_python\\_repr](#))) [const ant](#)
- [GINAC\\_BIND\\_UNARCHIVER](#) ([constant](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([constant](#))
- [static unsigned crc32](#) ([const char \\*c](#), [const unsigned len](#), [const unsigned crcinit](#))
- [bool are\\_ex\\_trivially\\_equal](#) ([const ex &e1](#), [const ex &e2](#))

*Compare two objects of class quickly without doing a deep tree traversal.*

- [std::ostream & operator<<](#) ([std::ostream &os](#), [const exvector &e](#))
- [std::ostream & operator<<](#) ([std::ostream &os](#), [const exset &e](#))
- [std::ostream & operator<<](#) ([std::ostream &os](#), [const exmap &e](#))
- [size\\_t nops](#) ([const ex &thisex](#))
- [ex expand](#) ([const ex &thisex](#), [unsigned options=0](#))
- [ex conjugate](#) ([const ex &thisex](#))
- [ex real\\_part](#) ([const ex &thisex](#))
- [ex imag\\_part](#) ([const ex &thisex](#))
- [bool has](#) ([const ex &thisex](#), [const ex &pattern](#), [unsigned options=0](#))
- [bool find](#) ([const ex &thisex](#), [const ex &pattern](#), [exset &found](#))
- [bool is\\_polynomial](#) ([const ex &thisex](#), [const ex &vars](#))
- [int degree](#) ([const ex &thisex](#), [const ex &s](#))
- [int ldegree](#) ([const ex &thisex](#), [const ex &s](#))
- [ex coeff](#) ([const ex &thisex](#), [const ex &s](#), [int n=1](#))
- [ex numer](#) ([const ex &thisex](#))
- [ex denom](#) ([const ex &thisex](#))
- [ex numer\\_denom](#) ([const ex &thisex](#))
- [ex normal](#) ([const ex &thisex](#))
- [ex to\\_rational](#) ([const ex &thisex](#), [exmap &repl](#))
- [ex to\\_polynomial](#) ([const ex &thisex](#), [exmap &repl](#))
- [ex collect](#) ([const ex &thisex](#), [const ex &s](#), [bool distributed=false](#))
- [ex eval](#) ([const ex &thisex](#))
- [ex evalf](#) ([const ex &thisex](#))
- [ex evalm](#) ([const ex &thisex](#))
- [ex eval\\_integ](#) ([const ex &thisex](#))
- [ex diff](#) ([const ex &thisex](#), [const symbol &s](#), [unsigned nth=1](#))
- [ex series](#) ([const ex &thisex](#), [const ex &r](#), [int order](#), [unsigned options=0](#))
- [bool match](#) ([const ex &thisex](#), [const ex &pattern](#), [exmap &repl\\_lst](#))
- [ex simplify\\_indexed](#) ([const ex &thisex](#), [unsigned options=0](#))
- [ex simplify\\_indexed](#) ([const ex &thisex](#), [const scalar\\_products &sp](#), [unsigned options=0](#))
- [ex symmetrize](#) ([const ex &thisex](#))
- [ex symmetrize](#) ([const ex &thisex](#), [const lst &l](#))
- [ex antisymmetrize](#) ([const ex &thisex](#))
- [ex antisymmetrize](#) ([const ex &thisex](#), [const lst &l](#))
- [ex symmetrize\\_cyclic](#) ([const ex &thisex](#))
- [ex symmetrize\\_cyclic](#) ([const ex &thisex](#), [const lst &l](#))
- [ex op](#) ([const ex &thisex](#), [size\\_t i](#))
- [ex lhs](#) ([const ex &thisex](#))
- [ex rhs](#) ([const ex &thisex](#))
- [bool is\\_zero](#) ([const ex &thisex](#))

- `void swap (ex &e1, ex &e2)`
- `ex subs (const ex &thisex, const exmap &m, unsigned options=0)`
- `ex subs (const ex &thisex, const lst &ls, const lst &lr, unsigned options=0)`
- `ex subs (const ex &thisex, const ex &e, unsigned options=0)`
- `template<class T>`  
`bool is_a (const ex &obj)`  
*Check if ex is a handle to a T, including base classes.*
- `template<class T>`  
`bool is_exactly_a (const ex &obj)`  
*Check if ex is a handle to a T, not including base classes.*
- `template<class T>`  
`const T &ex_to (const ex &e)`  
*Return a reference to the basic-derived class T object embedded in an expression.*
- `void compile_ex (const ex &expr, const symbol &sym, FUNC_P_1P &fp, const std::string filename="")`  
*Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.*
- `void compile_ex (const ex &expr, const symbol &sym1, const symbol &sym2, FUNC_P_2P &fp, const std::string filename="")`  
*Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.*
- `void compile_ex (const lst &exprs, const lst &syms, FUNC_CUBA &fp, const std::string filename="")`  
*Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.*
- `void link_ex (const std::string filename, FUNC_P_1P &fp)`  
*Opens an existing so-file and returns a function pointer of type FUNC\_P\_1P to the contained function.*
- `void link_ex (const std::string filename, FUNC_P_2P &fp)`  
*Opens an existing so-file and returns a function pointer of type FUNC\_P\_2P to the contained function.*
- `void link_ex (const std::string filename, FUNC_CUBA &fp)`  
*Opens an existing so-file and returns a function pointer of type FUNC\_CUBA to the contained function.*
- `void unlink_ex (const std::string filename)`  
*Closes all linked .so files that have the supplied filename.*
- `void swap (expair &e1, expair &e2)`
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (expairseq, basic, print_func< print_context >(&expairseq::do_print), print_func< print_tree >(&expairseq::do_print_tree)) class epp_is_less`
- `epvector * conjugateepvector (const epvector &)`  
*Complex conjugate every element of an epvector.*
- `ex factor (const ex &poly, unsigned options)`  
*Interface function to the outside world.*
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (fail, basic, print_func< print_context >(&fail::do_print), print_func< print_tree >(&fail::do_print_tree)) GINAC_BIND_UNARCHIVER(fail)`
- `GINAC_DECLARE_UNARCHIVER (fail)`
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (fderivative, function, print_func< print_context >(&fderivative::do_print), print_func< print_latex >(&fderivative::do_print_latex), print_func< print_csrc >(&fderivative::do_print_csrc), print_func< print_tree >(&fderivative::do_print_tree)) fderivative`
- `GINAC_BIND_UNARCHIVER (fderivative)`
- `GINAC_DECLARE_UNARCHIVER (fderivative)`
- `GINAC_BIND_UNARCHIVER (function)`
- `GINAC_DECLARE_UNARCHIVER (function)`
- `template<typename T>`  
`bool is_the_function (const ex &x)`
- `static unsigned make_hash_seed (const std::type_info &tinfo)`  
*We need a hash function which gives different values for objects of different types.*
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (idx, basic, print_func< print_context >(&idx::do_print), print_func< print_latex >(&idx::do_print_latex), print_func< print_csrc >(&idx::do_print_csrc), print_func< print_tree >(&idx::do_print_tree)) GINAC_IMPLEMENT_REGISTERED_CLASS_OPT(varidx`
- `print_func< print_context > (&varidx::do_print), print_func< print_latex >(&varidx`

- [GINAC\\_BIND\\_UNARCHIVER](#) ([idx](#))
- [GINAC\\_BIND\\_UNARCHIVER](#) ([varidx](#))
- [GINAC\\_BIND\\_UNARCHIVER](#) ([spinidx](#))
- [bool is\\_dummy\\_pair](#) (const [idx](#) &i1, const [idx](#) &i2)  
*Check whether two indices form a dummy pair.*
- [bool is\\_dummy\\_pair](#) (const [ex](#) &e1, const [ex](#) &e2)  
*Check whether two expressions form a dummy index pair.*
- [void find\\_free\\_and\\_dummy](#) ([exvector::const\\_iterator](#) it, [exvector::const\\_iterator](#) itend, [exvector](#) &out\_free, [exvector](#) &out\_dummy)  
*Given a vector of indices, split them into two vectors, one containing the free indices, the other containing the dummy indices (numeric indices are neither free nor dummy ones).*
- [ex minimal\\_dim](#) (const [ex](#) &dim1, const [ex](#) &dim2)  
*Return the minimum of two index dimensions.*
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([idx](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([varidx](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([spinidx](#))
- [void find\\_free\\_and\\_dummy](#) (const [exvector](#) &v, [exvector](#) &out\_free, [exvector](#) &out\_dummy)  
*Given a vector of indices, split them into two vectors, one containing the free indices, the other containing the dummy indices (numeric indices are neither free nor dummy ones).*
- [void find\\_dummy\\_indices](#) (const [exvector](#) &v, [exvector](#) &out\_dummy)  
*Given a vector of indices, find the dummy indices.*
- [size\\_t count\\_dummy\\_indices](#) (const [exvector](#) &v)  
*Count the number of dummy index pairs in an index vector.*
- [size\\_t count\\_free\\_indices](#) (const [exvector](#) &v)  
*Count the number of dummy index pairs in an index vector.*
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([indexed](#), [exprseq](#), [print\\_func](#)< [print\\_context](#) >(&[indexed::do\\_print](#)), [print\\_func](#)< [print\\_latex](#) >(&[indexed::do\\_print\\_latex](#)), [print\\_func](#)< [print\\_tree](#) >(&[indexed::do\\_print\\_tree](#)))  
[indexed](#)
- [GINAC\\_BIND\\_UNARCHIVER](#) ([indexed](#))
- [static bool indices\\_consistent](#) (const [exvector](#) &v1, const [exvector](#) &v2)  
*Check whether two sorted index vectors are consistent (i.e.*
- [template<class T>](#)  
[size\\_t number\\_of\\_type](#) (const [exvector](#) &v)
- [template<class T>](#)  
[static ex rename\\_dummy\\_indices](#) (const [ex](#) &e, [exvector](#) &global\_dummy\_indices, [exvector](#) &local\_dummy\_↵  
\_indices)  
*Rename dummy indices in an expression.*
- [static void find\\_variant\\_indices](#) (const [exvector](#) &v, [exvector](#) &variant\_indices)  
*Given a set of indices, extract those of class varidx.*
- [bool reposition\\_dummy\\_indices](#) ([ex](#) &e, [exvector](#) &variant\_dummy\_indices, [exvector](#) &moved\_indices)  
*Raise/lower dummy indices in a single indexed objects to canonicalize their variance.*
- [static void product\\_to\\_exvector](#) (const [ex](#) &e, [exvector](#) &v, bool &non\_commutative)
- [template<class T>](#)  
[ex idx\\_symmetrization](#) (const [ex](#) &r, const [exvector](#) &local\_dummy\_indices)
- [ex simplify\\_indexed](#) (const [ex](#) &e, [exvector](#) &free\_indices, [exvector](#) &dummy\_indices, const [scalar\\_products](#) &sp)  
*Simplify indexed expression, return list of free indices.*
- [ex simplify\\_indexed\\_product](#) (const [ex](#) &e, [exvector](#) &free\_indices, [exvector](#) &dummy\_indices, const [scalar\\_products](#) &sp)  
*Simplify product of indexed expressions (commutative, noncommutative and simple squares), return list of free indices.*
- [bool hasindex](#) (const [ex](#) &x, const [ex](#) &sym)
- [exvector get\\_all\\_dummy\\_indices\\_safely](#) (const [ex](#) &e)



*More reliable version of the form.*

- [exvector get\\_all\\_dummy\\_indices](#) (const [ex](#) &e)  
*Returns all dummy indices from the exvector.*
- [lst rename\\_dummy\\_indices\\_uniquely](#) (const [exvector](#) &va, const [exvector](#) &vb)  
*Similar to above, where va and vb are the same and the return value is a list of two lists for substitution in b.*
- [ex rename\\_dummy\\_indices\\_uniquely](#) (const [exvector](#) &va, const [exvector](#) &vb, const [ex](#) &b)  
*Same as above, where va and vb contain the indices of a and b and are sorted.*
- [ex rename\\_dummy\\_indices\\_uniquely](#) (const [ex](#) &a, const [ex](#) &b)  
*Returns b with all dummy indices, which are common with a, renamed.*
- [ex rename\\_dummy\\_indices\\_uniquely](#) ([exvector](#) &va, const [ex](#) &b, bool modify\_va=false)  
*Returns b with all dummy indices, which are listed in va, renamed if modify\_va is set to TRUE all dummy indices of b will be appended to va.*
- [ex expand\\_dummy\\_sum](#) (const [ex](#) &e, bool subs\_idx=false)  
*This function returns the given expression with expanded sums for all dummy index summations, where the dimensionality of the dummy index is a nonnegative integer.*
- [GINAC\\_DECLARE\\_UNARCHIVER](#) (indexed)
- static [ex conjugate\\_evalf](#) (const [ex](#) &arg)
- static [ex conjugate\\_eval](#) (const [ex](#) &arg)
- static void [conjugate\\_print\\_latex](#) (const [ex](#) &arg, const [print\\_context](#) &c)
- static [ex conjugate\\_conjugate](#) (const [ex](#) &arg)
- static [ex conjugate\\_expl\\_derivative](#) (const [ex](#) &arg, const [symbol](#) &s)
- static [ex conjugate\\_real\\_part](#) (const [ex](#) &arg)
- static [ex conjugate\\_imag\\_part](#) (const [ex](#) &arg)
- static bool [func\\_arg\\_info](#) (const [ex](#) &arg, unsigned inf)
- static bool [conjugate\\_info](#) (const [ex](#) &arg, unsigned inf)
- [REGISTER\\_FUNCTION](#) (conjugate\_function, eval\_func([conjugate\\_eval](#)). evalf\_func([conjugate\\_evalf](#)).  
expl\_derivative\_func([conjugate\\_expl\\_derivative](#)). info\_func([conjugate\\_info](#)). print\_func< [print\\_latex](#)  
>([conjugate\\_print\\_latex](#)). conjugate\_func([conjugate\\_conjugate](#)). real\_part\_func([conjugate\\_real\\_part](#)).  
imag\_part\_func([conjugate\\_imag\\_part](#)). set\_name("conjugate","conjugate"))
- static [ex real\\_part\\_evalf](#) (const [ex](#) &arg)
- static [ex real\\_part\\_eval](#) (const [ex](#) &arg)
- static void [real\\_part\\_print\\_latex](#) (const [ex](#) &arg, const [print\\_context](#) &c)
- static [ex real\\_part\\_conjugate](#) (const [ex](#) &arg)
- static [ex real\\_part\\_real\\_part](#) (const [ex](#) &arg)
- static [ex real\\_part\\_imag\\_part](#) (const [ex](#) &arg)
- static [ex real\\_part\\_expl\\_derivative](#) (const [ex](#) &arg, const [symbol](#) &s)
- [REGISTER\\_FUNCTION](#) (real\_part\_function, eval\_func([real\\_part\\_eval](#)). evalf\_func([real\\_part\\_evalf](#)). expl←  
\_expl\_derivative\_func([real\\_part\\_expl\\_derivative](#)). print\_func< [print\\_latex](#) >([real\\_part\\_print\\_latex](#)). conjugate←  
\_func([real\\_part\\_conjugate](#)). real\_part\_func([real\\_part\\_real\\_part](#)). imag\_part\_func([real\\_part\\_imag\\_part](#)).  
set\_name("real\_part","real\_part"))
- static [ex imag\\_part\\_evalf](#) (const [ex](#) &arg)
- static [ex imag\\_part\\_eval](#) (const [ex](#) &arg)
- static void [imag\\_part\\_print\\_latex](#) (const [ex](#) &arg, const [print\\_context](#) &c)
- static [ex imag\\_part\\_conjugate](#) (const [ex](#) &arg)
- static [ex imag\\_part\\_real\\_part](#) (const [ex](#) &arg)
- static [ex imag\\_part\\_imag\\_part](#) (const [ex](#) &arg)
- static [ex imag\\_part\\_expl\\_derivative](#) (const [ex](#) &arg, const [symbol](#) &s)
- [REGISTER\\_FUNCTION](#) (imag\_part\_function, eval\_func([imag\\_part\\_eval](#)). evalf\_func([imag\\_part\\_evalf](#)).  
expl\_derivative\_func([imag\\_part\\_expl\\_derivative](#)). print\_func< [print\\_latex](#) >([imag\\_part\\_print\\_latex](#)).  
conjugate\_func([imag\\_part\\_conjugate](#)). real\_part\_func([imag\\_part\\_real\\_part](#)). imag\_part\_func([imag\\_part\\_imag\\_part](#)).  
set\_name("imag\_part","imag\_part"))
- static [ex abs\\_evalf](#) (const [ex](#) &arg)
- static [ex abs\\_eval](#) (const [ex](#) &arg)
- static [ex abs\\_expand](#) (const [ex](#) &arg, unsigned options)



- static `ex abs_expl_derivative` (const `ex` &arg, const `symbol` &s)
- static void `abs_print_latex` (const `ex` &arg, const `print_context` &c)
- static void `abs_print_csrc_float` (const `ex` &arg, const `print_context` &c)
- static `ex abs_conjugate` (const `ex` &arg)
- static `ex abs_real_part` (const `ex` &arg)
- static `ex abs_imag_part` (const `ex` &arg)
- static `ex abs_power` (const `ex` &arg, const `ex` &exp)
- bool `abs_info` (const `ex` &arg, unsigned inf)
- `REGISTER_FUNCTION` (`abs`, `eval_func(abs_eval)`. `evalf_func(abs_evalf)`. `expand_func(abs_expand)`. `expl_derivative_func(abs_expl_derivative)`. `info_func(abs_info)`. `print_func< print_latex >(abs_print_latex)`. `print_func< print_csrc_float >(abs_print_csrc_float)`. `print_func< print_csrc_double >(abs_print_csrc_double)`. `conjugate_func(abs_conjugate)`. `real_part_func(abs_real_part)`. `imag_part_func(abs_imag_part)`. `power_func(abs_power)`)
- static `ex step_evalf` (const `ex` &arg)
- static `ex step_eval` (const `ex` &arg)
- static `ex step_series` (const `ex` &arg, const `relational` &rel, int order, unsigned options)
- static `ex step_conjugate` (const `ex` &arg)
- static `ex step_real_part` (const `ex` &arg)
- static `ex step_imag_part` (const `ex` &arg)
- `REGISTER_FUNCTION` (`step`, `eval_func(step_eval)`. `evalf_func(step_evalf)`. `series_func(step_series)`. `conjugate_func(step_conjugate)`. `real_part_func(step_real_part)`. `imag_part_func(step_imag_part)`)
- static `ex csgn_evalf` (const `ex` &arg)
- static `ex csgn_eval` (const `ex` &arg)
- static `ex csgn_series` (const `ex` &arg, const `relational` &rel, int order, unsigned options)
- static `ex csgn_conjugate` (const `ex` &arg)
- static `ex csgn_real_part` (const `ex` &arg)
- static `ex csgn_imag_part` (const `ex` &arg)
- static `ex csgn_power` (const `ex` &arg, const `ex` &exp)
- `REGISTER_FUNCTION` (`csgn`, `eval_func(csgn_eval)`. `evalf_func(csgn_evalf)`. `series_func(csgn_series)`. `conjugate_func(csgn_conjugate)`. `real_part_func(csgn_real_part)`. `imag_part_func(csgn_imag_part)`. `power_func(csgn_power)`)
- static `ex eta_evalf` (const `ex` &x, const `ex` &y)
- static `ex eta_eval` (const `ex` &x, const `ex` &y)
- static `ex eta_series` (const `ex` &x, const `ex` &y, const `relational` &rel, int order, unsigned options)
- static `ex eta_conjugate` (const `ex` &x, const `ex` &y)
- static `ex eta_real_part` (const `ex` &x, const `ex` &y)
- static `ex eta_imag_part` (const `ex` &x, const `ex` &y)
- `REGISTER_FUNCTION` (`eta`, `eval_func(eta_eval)`. `evalf_func(eta_evalf)`. `series_func(eta_series)`. `latex_name("\\eta")`. `set_symmetry(sy_symm(0, 1))`. `conjugate_func(eta_conjugate)`. `real_part_func(eta_real_part)`. `imag_part_func(eta_imag_part)`)
- static `ex Li2_evalf` (const `ex` &x)
- static `ex Li2_eval` (const `ex` &x)
- static `ex Li2_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex Li2_series` (const `ex` &x, const `relational` &rel, int order, unsigned options)
- static `ex Li2_conjugate` (const `ex` &x)
- `REGISTER_FUNCTION` (`Li2`, `eval_func(Li2_eval)`. `evalf_func(Li2_evalf)`. `derivative_func(Li2_deriv)`. `series_func(Li2_series)`. `conjugate_func(Li2_conjugate)`. `latex_name("\\mathrm{Li}_2")`)
- static `ex Li3_eval` (const `ex` &x)
- `REGISTER_FUNCTION` (`Li3`, `eval_func(Li3_eval)`. `latex_name("\\mathrm{Li}_3")`)
- static `ex zetaderiv_eval` (const `ex` &n, const `ex` &x)
- static `ex zetaderiv_deriv` (const `ex` &n, const `ex` &x, unsigned deriv\_param)
- `REGISTER_FUNCTION` (`zetaderiv`, `eval_func(zetaderiv_eval)`. `derivative_func(zetaderiv_deriv)`. `latex_name("\\zeta^{\\prime}")`)
- static `ex factorial_evalf` (const `ex` &x)
- static `ex factorial_eval` (const `ex` &x)

- static void `factorial_print_dflt_latex` (const `ex` &x, const `print_context` &c)
- static `ex` `factorial_conjugate` (const `ex` &x)
- static `ex` `factorial_real_part` (const `ex` &x)
- static `ex` `factorial_imag_part` (const `ex` &x)
- `REGISTER_FUNCTION` (`factorial`, `eval_func`(`factorial_eval`). `evalf_func`(`factorial_evalf`). `print_func`<`print_dflt` >(`factorial_print_dflt_latex`). `print_func`<`print_latex` >(`factorial_print_dflt_latex`). `conjugate_↔`  
`func`(`factorial_conjugate`). `real_part_func`(`factorial_real_part`). `imag_part_func`(`factorial_imag_part`))
- static `ex` `binomial_evalf` (const `ex` &x, const `ex` &y)
- static `ex` `binomial_sym` (const `ex` &x, const `numeric` &y)
- static `ex` `binomial_eval` (const `ex` &x, const `ex` &y)
- static `ex` `binomial_conjugate` (const `ex` &x, const `ex` &y)
- static `ex` `binomial_real_part` (const `ex` &x, const `ex` &y)
- static `ex` `binomial_imag_part` (const `ex` &x, const `ex` &y)
- `REGISTER_FUNCTION` (`binomial`, `eval_func`(`binomial_eval`). `evalf_func`(`binomial_evalf`). `conjugate_↔`  
`func`(`binomial_conjugate`). `real_part_func`(`binomial_real_part`). `imag_part_func`(`binomial_imag_part`))
- static `ex` `Order_eval` (const `ex` &x)
- static `ex` `Order_series` (const `ex` &x, const `relational` &r, int order, unsigned options)
- static `ex` `Order_conjugate` (const `ex` &x)
- static `ex` `Order_real_part` (const `ex` &x)
- static `ex` `Order_imag_part` (const `ex` &x)
- static `ex` `Order_power` (const `ex` &x, const `ex` &e)
- static `ex` `Order_expl_derivative` (const `ex` &arg, const `symbol` &s)
- `REGISTER_FUNCTION` (`Order`, `eval_func`(`Order_eval`). `series_func`(`Order_series`). `latex_name`("\\mathcal{O}").  
`expl_derivative_func`(`Order_expl_derivative`). `conjugate_func`(`Order_conjugate`). `real_part_func`(`Order_real_part`).  
`imag_part_func`(`Order_imag_part`). `power_func`(`Order_power`))
- `ex` `Isolve` (const `ex` &eqns, const `ex` &symbols, unsigned options=`solve_algo::automatic`)  
*Factorial function.*
- const `numeric` `fsolve` (const `ex` &f, const `symbol` &x, const `numeric` &x1, const `numeric` &x2)  
*Find a real root of real-valued function f(x) numerically within a given interval.*
- template<typename T1>  
`function` `zeta` (const T1 &p1)
- template<typename T1, typename T2>  
`function` `zeta` (const T1 &p1, const T2 &p2)
- template<> bool `is_the_function`<`zeta_SERIAL` > (const `ex` &x)
- template<typename T1, typename T2>  
`function` `G` (const T1 &x, const T2 &y)
- template<typename T1, typename T2, typename T3>  
`function` `G` (const T1 &x, const T2 &s, const T3 &y)
- template<> bool `is_the_function`<`G_SERIAL` > (const `ex` &x)
- template<typename T1>  
`function` `psi` (const T1 &p1)
- template<typename T1, typename T2>  
`function` `psi` (const T1 &p1, const T2 &p2)
- template<> bool `is_the_function`<`psi_SERIAL` > (const `ex` &x)
- template<typename T1, typename T2>  
`function` `iterated_integral` (const T1 &kernel\_lst, const T2 &lambda)
- template<typename T1, typename T2, typename T3>  
`function` `iterated_integral` (const T1 &kernel\_lst, const T2 &lambda, const T3 &N\_trunc)
- template<> bool `is_the_function`<`iterated_integral_SERIAL` > (const `ex` &x)
- bool `is_order_function` (const `ex` &e)  
*Check whether a function is the Order (O(n)) function.*
- `ex` `convert_H_to_Li` (const `ex` &parameterlst, const `ex` &arg)  
*Converts a given list containing parameters for H in Remiddi/Vermaseren notation into the corresponding GiNaC functions.*
- static `ex` `EllipticK_evalf` (const `ex` &k)

- static `ex EllipticK_eval` (const `ex` &k)
- static `ex EllipticK_deriv` (const `ex` &k, unsigned deriv\_param)
- static `ex EllipticK_series` (const `ex` &k, const `relational` &rel, int order, unsigned options)
- static void `EllipticK_print_latex` (const `ex` &k, const `print_context` &c)
- `REGISTER_FUNCTION` (EllipticK, evalf\_func(`EllipticK_evalf`). eval\_func(`EllipticK_eval`). derivative\_↵  
func(`EllipticK_deriv`). series\_func(`EllipticK_series`). print\_func< `print_latex` >(`EllipticK_print_latex`). do\_↵  
not\_evalf\_params())
- static `ex EllipticE_evalf` (const `ex` &k)
- static `ex EllipticE_eval` (const `ex` &k)
- static `ex EllipticE_deriv` (const `ex` &k, unsigned deriv\_param)
- static `ex EllipticE_series` (const `ex` &k, const `relational` &rel, int order, unsigned options)
- static void `EllipticE_print_latex` (const `ex` &k, const `print_context` &c)
- `REGISTER_FUNCTION` (EllipticE, evalf\_func(`EllipticE_evalf`). eval\_func(`EllipticE_eval`). derivative\_↵  
func(`EllipticE_deriv`). series\_func(`EllipticE_series`). print\_func< `print_latex` >(`EllipticE_print_latex`). do\_↵  
not\_evalf\_params())
- static `ex iterated_integral_evalf_impl` (const `ex` &kernel\_lst, const `ex` &lambda, const `ex` &N\_trunc)
- static `ex iterated_integral2_evalf` (const `ex` &kernel\_lst, const `ex` &lambda)
- static `ex iterated_integral3_evalf` (const `ex` &kernel\_lst, const `ex` &lambda, const `ex` &N\_trunc)
- static `ex iterated_integral2_eval` (const `ex` &kernel\_lst, const `ex` &lambda)
- static `ex iterated_integral3_eval` (const `ex` &kernel\_lst, const `ex` &lambda, const `ex` &N\_trunc)
- static `ex lgamma_evalf` (const `ex` &x)
- static `ex lgamma_eval` (const `ex` &x)

*Evaluation of  $\lgamma(x)$ , the natural logarithm of the Gamma function.*

- static `ex lgamma_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex lgamma_series` (const `ex` &arg, const `relational` &rel, int order, unsigned options)
- static `ex lgamma_conjugate` (const `ex` &x)
- `REGISTER_FUNCTION` (lgamma, eval\_func(`lgamma_eval`). evalf\_func(`lgamma_evalf`). derivative\_↵  
func(`lgamma_deriv`). series\_func(`lgamma_series`). conjugate\_func(`lgamma_conjugate`). latex\_name("\\log  
\\Gamma"))
- static `ex tgamma_evalf` (const `ex` &x)
- static `ex tgamma_eval` (const `ex` &x)

*Evaluation of  $tgamma(x)$ , the true Gamma function.*

- static `ex tgamma_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex tgamma_series` (const `ex` &arg, const `relational` &rel, int order, unsigned options)
- static `ex tgamma_conjugate` (const `ex` &x)
- `REGISTER_FUNCTION` (tgamma, eval\_func(`tgamma_eval`). evalf\_func(`tgamma_evalf`). derivative\_↵  
\_func(`tgamma_deriv`). series\_func(`tgamma_series`). conjugate\_func(`tgamma_conjugate`). latex\_↵  
name("\\Gamma"))
- static `ex beta_evalf` (const `ex` &x, const `ex` &y)
- static `ex beta_eval` (const `ex` &x, const `ex` &y)
- static `ex beta_deriv` (const `ex` &x, const `ex` &y, unsigned deriv\_param)
- static `ex beta_series` (const `ex` &arg1, const `ex` &arg2, const `relational` &rel, int order, unsigned options)
- `REGISTER_FUNCTION` (beta, eval\_func(`beta_eval`). evalf\_func(`beta_evalf`). derivative\_func(`beta_deriv`).  
series\_func(`beta_series`). latex\_name("\\mathrm{B}"). set\_symmetry(`sy_symm`(0, 1)))
- static `ex psi1_evalf` (const `ex` &x)
- static `ex psi1_eval` (const `ex` &x)

*Evaluation of digamma-function  $\psi(x)$ .*

- static `ex psi1_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex psi1_series` (const `ex` &arg, const `relational` &rel, int order, unsigned options)
- static `ex psi2_evalf` (const `ex` &n, const `ex` &x)
- static `ex psi2_eval` (const `ex` &n, const `ex` &x)

*Evaluation of polygamma-function  $\psi(n,x)$ .*

- static `ex psi2_deriv` (const `ex` &n, const `ex` &x, unsigned deriv\_param)
- static `ex psi2_series` (const `ex` &n, const `ex` &arg, const `relational` &rel, int order, unsigned options)

- static `ex G2_evalf` (const `ex` &x\_, const `ex` &y)
- static `ex G2_eval` (const `ex` &x\_, const `ex` &y)
- static `ex G3_evalf` (const `ex` &x\_, const `ex` &s\_, const `ex` &y)
- static `ex G3_eval` (const `ex` &x\_, const `ex` &s\_, const `ex` &y)
- static `ex Li_evalf` (const `ex` &m\_, const `ex` &x\_)
- static `ex Li_eval` (const `ex` &m\_, const `ex` &x\_)
- static `ex Li_series` (const `ex` &m, const `ex` &x, const `relational` &rel, int order, unsigned options)
- static `ex Li_deriv` (const `ex` &m\_, const `ex` &x\_, unsigned deriv\_param)
- static void `Li_print_latex` (const `ex` &m\_, const `ex` &x\_, const `print_context` &c)
- `REGISTER_FUNCTION` (Li, evalf\_func(`Li_evalf`). eval\_func(`Li_eval`). series\_func(`Li_series`). derivative\_↔  
func(`Li_deriv`). print\_func< `print_latex` >(`Li_print_latex`). do\_not\_evalf\_params())
- static `ex S_evalf` (const `ex` &n, const `ex` &p, const `ex` &x)
- static `ex S_eval` (const `ex` &n, const `ex` &p, const `ex` &x)
- static `ex S_series` (const `ex` &n, const `ex` &p, const `ex` &x, const `relational` &rel, int order, unsigned options)
- static `ex S_deriv` (const `ex` &n, const `ex` &p, const `ex` &x, unsigned deriv\_param)
- static void `S_print_latex` (const `ex` &n, const `ex` &p, const `ex` &x, const `print_context` &c)
- `REGISTER_FUNCTION` (S, evalf\_func(`S_evalf`). eval\_func(`S_eval`). series\_func(`S_series`). derivative\_↔  
func(`S_deriv`). print\_func< `print_latex` >(`S_print_latex`). do\_not\_evalf\_params())
- static `ex H_evalf` (const `ex` &x1, const `ex` &x2)
- static `ex H_eval` (const `ex` &m\_, const `ex` &x)
- static `ex H_series` (const `ex` &m, const `ex` &x, const `relational` &rel, int order, unsigned options)
- static `ex H_deriv` (const `ex` &m\_, const `ex` &x, unsigned deriv\_param)
- static void `H_print_latex` (const `ex` &m\_, const `ex` &x, const `print_context` &c)
- `REGISTER_FUNCTION` (H, evalf\_func(`H_evalf`). eval\_func(`H_eval`). series\_func(`H_series`). derivative\_↔  
func(`H_deriv`). print\_func< `print_latex` >(`H_print_latex`). do\_not\_evalf\_params())
- static `ex zeta1_evalf` (const `ex` &x)
- static `ex zeta1_eval` (const `ex` &m)
- static `ex zeta1_deriv` (const `ex` &m, unsigned deriv\_param)
- static void `zeta1_print_latex` (const `ex` &m\_, const `print_context` &c)
- static `ex zeta2_evalf` (const `ex` &x, const `ex` &s)
- static `ex zeta2_eval` (const `ex` &m, const `ex` &s\_)
- static `ex zeta2_deriv` (const `ex` &m, const `ex` &s, unsigned deriv\_param)
- static void `zeta2_print_latex` (const `ex` &m\_, const `ex` &s\_, const `print_context` &c)
- static `ex exp_evalf` (const `ex` &x)
- static `ex exp_eval` (const `ex` &x)
- static `ex exp_expand` (const `ex` &arg, unsigned options)
- static `ex exp_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex exp_real_part` (const `ex` &x)
- static `ex exp_imag_part` (const `ex` &x)
- static `ex exp_conjugate` (const `ex` &x)
- static `ex exp_power` (const `ex` &x, const `ex` &a)
- static bool `exp_info` (const `ex` &x, unsigned inf)
- `REGISTER_FUNCTION` (exp, eval\_func(`exp_eval`). evalf\_func(`exp_evalf`). info\_func(`exp_info`). expand\_↔  
func(`exp_expand`). derivative\_func(`exp_deriv`). real\_part\_func(`exp_real_part`). imag\_part\_func(`exp_imag_part`).  
conjugate\_func(`exp_conjugate`). power\_func(`exp_power`). latex\_name("\\exp"))
- static `ex log_evalf` (const `ex` &x)
- static `ex log_eval` (const `ex` &x)
- static `ex log_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex log_series` (const `ex` &arg, const `relational` &rel, int order, unsigned options)
- static `ex log_real_part` (const `ex` &x)
- static `ex log_imag_part` (const `ex` &x)
- static `ex log_expand` (const `ex` &arg, unsigned options)
- static `ex log_conjugate` (const `ex` &x)
- static bool `log_info` (const `ex` &x, unsigned inf)

- [REGISTER\\_FUNCTION](#) ([log](#), [eval\\_func\(log\\_eval\)](#). [evalf\\_func\(log\\_evalf\)](#). [info\\_func\(log\\_info\)](#). [expand\\_func\(log\\_expand\)](#). [derivative\\_func\(log\\_deriv\)](#). [series\\_func\(log\\_series\)](#). [real\\_part\\_func\(log\\_real\\_part\)](#). [imag\\_part\\_func\(log\\_imag\\_part\)](#). [conjugate\\_func\(log\\_conjugate\)](#). [latex\\_name\("\\ln"\)](#))
- static [ex sin\\_evalf](#) (const [ex](#) &x)
- static [ex sin\\_eval](#) (const [ex](#) &x)
- static [ex sin\\_deriv](#) (const [ex](#) &x, unsigned [deriv\\_param](#))
- static [ex sin\\_real\\_part](#) (const [ex](#) &x)
- static [ex sin\\_imag\\_part](#) (const [ex](#) &x)
- static [ex sin\\_conjugate](#) (const [ex](#) &x)
- static bool [trig\\_info](#) (const [ex](#) &x, unsigned [inf](#))
- [REGISTER\\_FUNCTION](#) ([sin](#), [eval\\_func\(sin\\_eval\)](#). [evalf\\_func\(sin\\_evalf\)](#). [info\\_func\(trig\\_info\)](#). [derivative\\_func\(sin\\_deriv\)](#). [real\\_part\\_func\(sin\\_real\\_part\)](#). [imag\\_part\\_func\(sin\\_imag\\_part\)](#). [conjugate\\_func\(sin\\_conjugate\)](#). [latex\\_name\("\\sin"\)](#))
- static [ex cos\\_evalf](#) (const [ex](#) &x)
- static [ex cos\\_eval](#) (const [ex](#) &x)
- static [ex cos\\_deriv](#) (const [ex](#) &x, unsigned [deriv\\_param](#))
- static [ex cos\\_real\\_part](#) (const [ex](#) &x)
- static [ex cos\\_imag\\_part](#) (const [ex](#) &x)
- static [ex cos\\_conjugate](#) (const [ex](#) &x)
- [REGISTER\\_FUNCTION](#) ([cos](#), [eval\\_func\(cos\\_eval\)](#). [info\\_func\(trig\\_info\)](#). [evalf\\_func\(cos\\_evalf\)](#). [derivative\\_func\(cos\\_deriv\)](#). [real\\_part\\_func\(cos\\_real\\_part\)](#). [imag\\_part\\_func\(cos\\_imag\\_part\)](#). [conjugate\\_func\(cos\\_conjugate\)](#). [latex\\_name\("\\cos"\)](#))
- static [ex tan\\_evalf](#) (const [ex](#) &x)
- static [ex tan\\_eval](#) (const [ex](#) &x)
- static [ex tan\\_deriv](#) (const [ex](#) &x, unsigned [deriv\\_param](#))
- static [ex tan\\_real\\_part](#) (const [ex](#) &x)
- static [ex tan\\_imag\\_part](#) (const [ex](#) &x)
- static [ex tan\\_series](#) (const [ex](#) &x, const [relational](#) &rel, int [order](#), unsigned [options](#))
- static [ex tan\\_conjugate](#) (const [ex](#) &x)
- [REGISTER\\_FUNCTION](#) ([tan](#), [eval\\_func\(tan\\_eval\)](#). [evalf\\_func\(tan\\_evalf\)](#). [info\\_func\(trig\\_info\)](#). [derivative\\_func\(tan\\_deriv\)](#). [series\\_func\(tan\\_series\)](#). [real\\_part\\_func\(tan\\_real\\_part\)](#). [imag\\_part\\_func\(tan\\_imag\\_part\)](#). [conjugate\\_func\(tan\\_conjugate\)](#). [latex\\_name\("\\tan"\)](#))
- static [ex asin\\_evalf](#) (const [ex](#) &x)
- static [ex asin\\_eval](#) (const [ex](#) &x)
- static [ex asin\\_deriv](#) (const [ex](#) &x, unsigned [deriv\\_param](#))
- static [ex asin\\_conjugate](#) (const [ex](#) &x)
- static bool [asin\\_info](#) (const [ex](#) &x, unsigned [inf](#))
- [REGISTER\\_FUNCTION](#) ([asin](#), [eval\\_func\(asin\\_eval\)](#). [evalf\\_func\(asin\\_evalf\)](#). [info\\_func\(asin\\_info\)](#). [derivative\\_func\(asin\\_deriv\)](#). [conjugate\\_func\(asin\\_conjugate\)](#). [latex\\_name\("\\arcsin"\)](#))
- static [ex acos\\_evalf](#) (const [ex](#) &x)
- static [ex acos\\_eval](#) (const [ex](#) &x)
- static [ex acos\\_deriv](#) (const [ex](#) &x, unsigned [deriv\\_param](#))
- static [ex acos\\_conjugate](#) (const [ex](#) &x)
- [REGISTER\\_FUNCTION](#) ([acos](#), [eval\\_func\(acos\\_eval\)](#). [evalf\\_func\(acos\\_evalf\)](#). [info\\_func\(asin\\_info\)](#). [derivative\\_func\(acos\\_deriv\)](#). [conjugate\\_func\(acos\\_conjugate\)](#). [latex\\_name\("\\arccos"\)](#))
- static [ex atan\\_evalf](#) (const [ex](#) &x)
- static [ex atan\\_eval](#) (const [ex](#) &x)
- static [ex atan\\_deriv](#) (const [ex](#) &x, unsigned [deriv\\_param](#))
- static [ex atan\\_series](#) (const [ex](#) &arg, const [relational](#) &rel, int [order](#), unsigned [options](#))
- static [ex atan\\_conjugate](#) (const [ex](#) &x)
- static bool [atan\\_info](#) (const [ex](#) &x, unsigned [inf](#))
- [REGISTER\\_FUNCTION](#) ([atan](#), [eval\\_func\(atan\\_eval\)](#). [evalf\\_func\(atan\\_evalf\)](#). [info\\_func\(atan\\_info\)](#). [derivative\\_func\(atan\\_deriv\)](#). [series\\_func\(atan\\_series\)](#). [conjugate\\_func\(atan\\_conjugate\)](#). [latex\\_name\("\\arctan"\)](#))
- static [ex atan2\\_evalf](#) (const [ex](#) &y, const [ex](#) &x)

- static `ex atan2_eval` (const `ex` &y, const `ex` &x)
- static `ex atan2_deriv` (const `ex` &y, const `ex` &x, unsigned deriv\_param)
- static bool `atan2_info` (const `ex` &y, const `ex` &x, unsigned inf)
- `REGISTER_FUNCTION` (`atan2`, `eval_func(atan2_eval)`. `evalf_func(atan2_evalf)`. `info_func(atan2_info)`. `evalf_func(atan2_evalf)`. `derivative_func(atan2_deriv)`)
- static `ex sinh_evalf` (const `ex` &x)
- static `ex sinh_eval` (const `ex` &x)
- static `ex sinh_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex sinh_real_part` (const `ex` &x)
- static `ex sinh_imag_part` (const `ex` &x)
- static `ex sinh_conjugate` (const `ex` &x)
- `REGISTER_FUNCTION` (`sinh`, `eval_func(sinh_eval)`. `evalf_func(sinh_evalf)`. `info_func(atan_info)`. `derivative_func(sinh_deriv)`. `real_part_func(sinh_real_part)`. `imag_part_func(sinh_imag_part)`. `conjugate_←func(sinh_conjugate)`. `latex_name("\\sinh")`)
- static `ex cosh_evalf` (const `ex` &x)
- static `ex cosh_eval` (const `ex` &x)
- static `ex cosh_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex cosh_real_part` (const `ex` &x)
- static `ex cosh_imag_part` (const `ex` &x)
- static `ex cosh_conjugate` (const `ex` &x)
- `REGISTER_FUNCTION` (`cosh`, `eval_func(cosh_eval)`. `evalf_func(cosh_evalf)`. `info_func(exp_info)`. `derivative_func(cosh_deriv)`. `real_part_func(cosh_real_part)`. `imag_part_func(cosh_imag_part)`. `conjugate_←func(cosh_conjugate)`. `latex_name("\\cosh")`)
- static `ex tanh_evalf` (const `ex` &x)
- static `ex tanh_eval` (const `ex` &x)
- static `ex tanh_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex tanh_series` (const `ex` &x, const `relational` &rel, int order, unsigned options)
- static `ex tanh_real_part` (const `ex` &x)
- static `ex tanh_imag_part` (const `ex` &x)
- static `ex tanh_conjugate` (const `ex` &x)
- `REGISTER_FUNCTION` (`tanh`, `eval_func(tanh_eval)`. `evalf_func(tanh_evalf)`. `info_func(atan_info)`. `derivative_func(tanh_deriv)`. `series_func(tanh_series)`. `real_part_func(tanh_real_part)`. `imag_part_←func(tanh_imag_part)`. `conjugate_func(tanh_conjugate)`. `latex_name("\\tanh")`)
- static `ex asinh_evalf` (const `ex` &x)
- static `ex asinh_eval` (const `ex` &x)
- static `ex asinh_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex asinh_conjugate` (const `ex` &x)
- `REGISTER_FUNCTION` (`asinh`, `eval_func(asinh_eval)`. `evalf_func(asinh_evalf)`. `info_func(atan_info)`. `derivative_func(asinh_deriv)`. `conjugate_func(asinh_conjugate)`)
- static `ex acosh_evalf` (const `ex` &x)
- static `ex acosh_eval` (const `ex` &x)
- static `ex acosh_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex acosh_conjugate` (const `ex` &x)
- `REGISTER_FUNCTION` (`acosh`, `eval_func(acosh_eval)`. `evalf_func(acosh_evalf)`. `info_func(asin_info)`. `derivative_func(acosh_deriv)`. `conjugate_func(acosh_conjugate)`)
- static `ex atanh_evalf` (const `ex` &x)
- static `ex atanh_eval` (const `ex` &x)
- static `ex atanh_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex atanh_series` (const `ex` &arg, const `relational` &rel, int order, unsigned options)
- static `ex atanh_conjugate` (const `ex` &x)
- `REGISTER_FUNCTION` (`atanh`, `eval_func(atanh_eval)`. `evalf_func(atanh_evalf)`. `info_func(asin_info)`. `derivative_func(atanh_deriv)`. `series_func(atanh_series)`. `conjugate_func(atanh_conjugate)`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`integral`, `basic`, `print_func< print_dflt >(&integral::do_print)`. `print_func< print_python >(&integral::do_print)`. `print_func< print_latex >(&integral::do_print_latex)`) `integral`
- `ex subvalue` (const `ex` &var, const `ex` &value, const `ex` &fun)



- [ex adaptivesimpson](#) (const [ex](#) &x, const [ex](#) &a\_in, const [ex](#) &b\_in, const [ex](#) &f, const [ex](#) &error)  
*Numeric integration routine based upon the "Adaptive Quadrature" one in "Numerical Analysis" by Burden and Faires.*
- [GINAC\\_BIND\\_UNARCHIVER](#) (integral)
- [GINAC\\_DECLARE\\_UNARCHIVER](#) (integral)
- [ex ifactor](#) (const [numeric](#) &n)  
*Returns the decomposition of the positive integer n into prime numbers in the form  $lst(p_1, \dots, pr), lst(a_1, \dots, ar)$  such that  $n = p_1^{a_1} \dots p_r^{a_r}$ .*
- [bool is\\_discriminant\\_of\\_quadratic\\_number\\_field](#) (const [numeric](#) &n)  
*Returns true if the integer n is either one or the discriminant of a quadratic number field.*
- [numeric kronecker\\_symbol](#) (const [numeric](#) &a, const [numeric](#) &n)  
*Returns the Kronecker symbol a: integer n: integer.*
- [numeric primitive\\_dirichlet\\_character](#) (const [numeric](#) &n, const [numeric](#) &a)  
*Defines a primitive Dirichlet character through the Kronecker symbol.*
- [numeric dirichlet\\_character](#) (const [numeric](#) &n, const [numeric](#) &a, const [numeric](#) &N)  
*Defines a Dirichlet character through the Kronecker symbol.*
- [numeric generalised\\_Bernoulli\\_number](#) (const [numeric](#) &k, const [numeric](#) &b)  
*The generalised Bernoulli number.*
- [ex Bernoulli\\_polynomial](#) (const [numeric](#) &k, const [ex](#) &x)  
*The Bernoulli polynomials.*
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (integration\_kernel, basic, print\_func< [print\\_context](#) >(&integration\_kernel::do\_print)) integration\_kernel
- [GINAC\\_BIND\\_UNARCHIVER](#) (integration\_kernel)
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (basic\_log\_kernel, integration\_kernel, print\_func< [print\\_context](#) >(&basic\_log\_kernel::do\_print)) basic\_log\_kernel
- [GINAC\\_BIND\\_UNARCHIVER](#) (basic\_log\_kernel)
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (multiple\_polylog\_kernel, integration\_kernel, print\_func< [print\\_context](#) >(&multiple\_polylog\_kernel::do\_print)) multiple\_polylog\_kernel
- [GINAC\\_BIND\\_UNARCHIVER](#) (multiple\_polylog\_kernel)
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (ELi\_kernel, integration\_kernel, print\_func< [print\\_context](#) >(&ELi\_kernel::do\_print)) ELi\_kernel
- [GINAC\\_BIND\\_UNARCHIVER](#) (ELi\_kernel)
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (Ebar\_kernel, integration\_kernel, print\_func< [print\\_context](#) >(&Ebar\_kernel::do\_print)) Ebar\_kernel
- [GINAC\\_BIND\\_UNARCHIVER](#) (Ebar\_kernel)
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (Kronecker\_dtau\_kernel, integration\_kernel, print\_func< [print\\_context](#) >(&Kronecker\_dtau\_kernel::do\_print)) Kronecker\_dtau\_kernel
- [GINAC\\_BIND\\_UNARCHIVER](#) (Kronecker\_dtau\_kernel)
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (Kronecker\_dz\_kernel, integration\_kernel, print\_func< [print\\_context](#) >(&Kronecker\_dz\_kernel::do\_print)) Kronecker\_dz\_kernel
- [GINAC\\_BIND\\_UNARCHIVER](#) (Kronecker\_dz\_kernel)
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (Eisenstein\_kernel, integration\_kernel, print\_func< [print\\_context](#) >(&Eisenstein\_kernel::do\_print)) Eisenstein\_kernel
- [GINAC\\_BIND\\_UNARCHIVER](#) (Eisenstein\_kernel)
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (Eisenstein\_h\_kernel, integration\_kernel, print\_func< [print\\_context](#) >(&Eisenstein\_h\_kernel::do\_print)) Eisenstein\_h\_kernel
- [GINAC\\_BIND\\_UNARCHIVER](#) (Eisenstein\_h\_kernel)
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (modular\_form\_kernel, integration\_kernel, print\_func< [print\\_context](#) >(&modular\_form\_kernel::do\_print)) modular\_form\_kernel
- [GINAC\\_BIND\\_UNARCHIVER](#) (modular\_form\_kernel)
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (user\_defined\_kernel, integration\_kernel, print\_func< [print\\_context](#) >(&user\_defined\_kernel::do\_print)) user\_defined\_kernel
- [GINAC\\_BIND\\_UNARCHIVER](#) (user\_defined\_kernel)
- [GINAC\\_DECLARE\\_UNARCHIVER](#) (integration\_kernel)
- [GINAC\\_DECLARE\\_UNARCHIVER](#) (basic\_log\_kernel)

- `GINAC_DECLARE_UNARCHIVER` (`multiple_polylog_kernel`)
- `GINAC_DECLARE_UNARCHIVER` (`ELi_kernel`)
- `GINAC_DECLARE_UNARCHIVER` (`Ebar_kernel`)
- `GINAC_DECLARE_UNARCHIVER` (`Kronecker_dtau_kernel`)
- `GINAC_DECLARE_UNARCHIVER` (`Kronecker_dz_kernel`)
- `GINAC_DECLARE_UNARCHIVER` (`Eisenstein_kernel`)
- `GINAC_DECLARE_UNARCHIVER` (`Eisenstein_h_kernel`)
- `GINAC_DECLARE_UNARCHIVER` (`modular_form_kernel`)
- `GINAC_DECLARE_UNARCHIVER` (`user_defined_kernel`)
- `GINAC_DECLARE_UNARCHIVER` (`lst`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`matrix`, `basic`, `print_func` < `print_context` > (&`matrix::do_print`). `print_func` < `print_latex` > (&`matrix::do_print_latex`). `print_func` < `print_tree` > (&`matrix::do_print_tree`). `print_func` < `print_python_repr` > (&`matrix::do_print_python_repr`)) `matrix`  
*Default ctor.*
- `GINAC_BIND_UNARCHIVER` (`matrix`)
- `ex lst_to_matrix` (`const lst &l`)  
*Convert list of lists to matrix.*
- `ex diag_matrix` (`const lst &l`)  
*Convert list of diagonal elements to matrix.*
- `ex diag_matrix` (`std::initializer_list< ex > l`)
- `ex unit_matrix` (`unsigned r`, `unsigned c`)  
*Create an r times c unit matrix.*
- `ex symbolic_matrix` (`unsigned r`, `unsigned c`, `const std::string &base_name`, `const std::string &tex_base_name`)  
*Create an r times c matrix of newly generated symbols consisting of the given base name plus the numeric row/column position of each element.*
- `ex reduced_matrix` (`const matrix &m`, `unsigned r`, `unsigned c`)  
*Return the reduced matrix that is formed by deleting the rth row and cth column of matrix m.*
- `ex sub_matrix` (`const matrix &m`, `unsigned r`, `unsigned nr`, `unsigned c`, `unsigned nc`)  
*Return the nr times nc submatrix starting at position r, c of matrix m.*
- `GINAC_DECLARE_UNARCHIVER` (`matrix`)
- `size_t nops` (`const matrix &m`)
- `ex expand` (`const matrix &m`, `unsigned options=0`)
- `ex evalf` (`const matrix &m`)
- `unsigned rows` (`const matrix &m`)
- `unsigned cols` (`const matrix &m`)
- `matrix transpose` (`const matrix &m`)
- `ex determinant` (`const matrix &m`, `unsigned options=determinant_algo::automatic`)
- `ex trace` (`const matrix &m`)
- `ex charpoly` (`const matrix &m`, `const ex &lambda`)
- `matrix inverse` (`const matrix &m`)
- `matrix inverse` (`const matrix &m`, `unsigned algo`)
- `unsigned rank` (`const matrix &m`)
- `unsigned rank` (`const matrix &m`, `unsigned solve_algo`)
- `ex unit_matrix` (`unsigned x`)  
*Create a x times x unit matrix.*
- `ex symbolic_matrix` (`unsigned r`, `unsigned c`, `const std::string &base_name`)  
*Create an r times c matrix of newly generated symbols consisting of the given base name plus the numeric row/column position of each element.*
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`mul`, `expairseq`, `print_func` < `print_context` > (&`mul::do_print`). `print_func` < `print_latex` > (&`mul::do_print_latex`). `print_func` < `print_csrc` > (&`mul::do_print_csrc`). `print_func` < `print_tree` > (&`mul::do_print_tree`). `print_func` < `print_python_repr` > (&`mul::do_print_python_repr`)) `mul`
- `bool tryfactsubs` (`const ex &origfactor`, `const ex &patternfactor`, `int &nummatches`, `exmap &repls`)



- bool [algebraic\\_match\\_mul\\_with\\_mul](#) (const [mul](#) &e, const [ex](#) &pat, [exmap](#) &repls, int [factor](#), int &num-matches, const std::vector< bool > &subsed, std::vector< bool > &matched)
 

*Checks whether e matches to the pattern pat and the (possibly to be updated) list of replacements repls.*
- [GINAC\\_BIND\\_UNARCHIVER](#) ([mul](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([mul](#))
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([ncmul](#), [exprseq](#), print\_func< [print\\_context](#) >(&[ncmul::do\\_print](#)), print\_func< [print\\_tree](#) >(&[ncmul::do\\_print\\_tree](#)), print\_func< [print\\_csrc](#) >(&[ncmul::do\\_print\\_csrc](#)), print\_func< [print\\_python\\_repr](#) >(&[ncmul::do\\_print\\_csrc](#))) [ncmul](#)
- [ex reeval\\_ncmul](#) (const [exvector](#) &v)
- [ex hold\\_ncmul](#) (const [exvector](#) &v)
- [GINAC\\_BIND\\_UNARCHIVER](#) ([ncmul](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([ncmul](#))
- static bool [get\\_first\\_symbol](#) (const [ex](#) &e, [ex](#) &x)
 

*Return pointer to first symbol found in expression.*
- static void [add\\_symbol](#) (const [ex](#) &s, [sym\\_desc\\_vec](#) &v)
- static void [collect\\_symbols](#) (const [ex](#) &e, [sym\\_desc\\_vec](#) &v)
- static void [get\\_symbol\\_stats](#) (const [ex](#) &a, const [ex](#) &b, [sym\\_desc\\_vec](#) &v)
 

*Collect statistical information about symbols in polynomials.*
- static [numeric lcmcoeff](#) (const [ex](#) &e, const [numeric](#) &l)
- static [numeric lcm\\_of\\_coefficients\\_denominators](#) (const [ex](#) &e)
 

*Compute LCM of denominators of coefficients of a polynomial.*
- static [ex multiply\\_lcm](#) (const [ex](#) &e, const [numeric](#) &lcm)
 

*Bring polynomial from  $Q[X]$  to  $Z[X]$  by multiplying in the previously determined LCM of the coefficient's denominators.*
- [ex quo](#) (const [ex](#) &a, const [ex](#) &b, const [ex](#) &x, bool check\_args)
 

*Quotient  $q(x)$  of polynomials  $a(x)$  and  $b(x)$  in  $Q[x]$ .*
- [ex rem](#) (const [ex](#) &a, const [ex](#) &b, const [ex](#) &x, bool check\_args)
 

*Remainder  $r(x)$  of polynomials  $a(x)$  and  $b(x)$  in  $Q[x]$ .*
- [ex decomp\\_rational](#) (const [ex](#) &a, const [ex](#) &x)
 

*Decompose rational function  $a(x)=N(x)/D(x)$  into  $P(x)+n(x)/D(x)$  with  $\text{degree}(n, x) < \text{degree}(D, x)$ .*
- [ex prem](#) (const [ex](#) &a, const [ex](#) &b, const [ex](#) &x, bool check\_args)
 

*Pseudo-remainder of polynomials  $a(x)$  and  $b(x)$  in  $Q[x]$ .*
- [ex sprem](#) (const [ex](#) &a, const [ex](#) &b, const [ex](#) &x, bool check\_args)
 

*Sparse pseudo-remainder of polynomials  $a(x)$  and  $b(x)$  in  $Q[x]$ .*
- bool [divide](#) (const [ex](#) &a, const [ex](#) &b, [ex](#) &q, bool check\_args)
 

*Exact polynomial division of  $a(X)$  by  $b(X)$  in  $Q[X]$ .*
- static bool [divide\\_in\\_z](#) (const [ex](#) &a, const [ex](#) &b, [ex](#) &q, [sym\\_desc\\_vec::const\\_iterator](#) var)
 

*Exact polynomial division of  $a(X)$  by  $b(X)$  in  $Z[X]$ .*
- static [ex sr\\_gcd](#) (const [ex](#) &a, const [ex](#) &b, [sym\\_desc\\_vec::const\\_iterator](#) var)
 

*Compute GCD of multivariate polynomials using the subresultant PRS algorithm.*
- static [ex interpolate](#) (const [ex](#) &gamma, const [numeric](#) &xi, const [ex](#) &x, int degree\_hint=1)
 

*xi-adic polynomial interpolation*
- static bool [heur\\_gcd\\_z](#) ([ex](#) &res, const [ex](#) &a, const [ex](#) &b, [ex](#) \*ca, [ex](#) \*cb, [sym\\_desc\\_vec::const\\_iterator](#) var)
 

*Compute GCD of multivariate polynomials using the heuristic GCD algorithm.*
- static bool [heur\\_gcd](#) ([ex](#) &res, const [ex](#) &a, const [ex](#) &b, [ex](#) \*ca, [ex](#) \*cb, [sym\\_desc\\_vec::const\\_iterator](#) var)
 

*Compute GCD of multivariate polynomials using the heuristic GCD algorithm.*
- static [ex gcd\\_pf\\_pow](#) (const [ex](#) &a, const [ex](#) &b, [ex](#) \*ca, [ex](#) \*cb)
- static [ex gcd\\_pf\\_mul](#) (const [ex](#) &a, const [ex](#) &b, [ex](#) \*ca, [ex](#) \*cb)
- [ex gcd](#) (const [ex](#) &a, const [ex](#) &b, [ex](#) \*ca, [ex](#) \*cb, bool check\_args, unsigned options)
 

*Compute GCD (Greatest Common Divisor) of multivariate polynomials  $a(X)$  and  $b(X)$  in  $Z[X]$ .*
- static [ex gcd\\_pf\\_pow\\_pow](#) (const [ex](#) &a, const [ex](#) &b, [ex](#) \*ca, [ex](#) \*cb)
- [ex lcm](#) (const [ex](#) &a, const [ex](#) &b, bool check\_args)
 

*Compute LCM (Least Common Multiple) of multivariate polynomials in  $Z[X]$ .*

- static `epvector sqrfree_yun` (const `ex` &a, const `symbol` &x)  
*Compute square-free factorization of multivariate polynomial  $a(x)$  using Yun's algorithm.*
- `ex sqrfree` (const `ex` &a, const `lst` &l)  
*Compute a square-free factorization of a multivariate polynomial in  $Q[X]$ .*
- `ex sqrfree_parfrac` (const `ex` &a, const `symbol` &x)  
*Compute square-free partial fraction decomposition of rational function  $a(x)$ .*
- static `ex replace_with_symbol` (const `ex` &e, `exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier)  
*Create a symbol for replacing the expression "e" (or return a previously assigned symbol).*
- static `ex replace_with_symbol` (const `ex` &e, `exmap` &repl)  
*Create a symbol for replacing the expression "e" (or return a previously assigned symbol).*
- static `ex frac_cancel` (const `ex` &n, const `ex` &d)  
*Fraction cancellation.*
- static `ex find_common_factor` (const `ex` &e, `ex` &factor, `exmap` &repl)  
*Remove the common factor in the terms of a sum 'e' by calculating the GCD, and multiply it into the expression 'factor' (which needs to be initialized to 1, unless you're accumulating factors).*
- `ex collect_common_factors` (const `ex` &e)  
*Collect common factors in sums.*
- `ex resultant` (const `ex` &e1, const `ex` &e2, const `ex` &s)  
*Resultant of two expressions  $e_1, e_2$  with respect to symbol  $s$ .*
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`numeric`, `basic`, `print_func`< `print_context` >(&`numeric::do_print`), `print_func`< `print_latex` >(&`numeric::do_print_latex`), `print_func`< `print_csrc` >(&`numeric::do_print_csrc`), `print_func`< `print_csrc_cl_N` >(&`numeric::do_print_csrc_cl_N`), `print_func`< `print_tree` >(&`numeric::do_print_tree`), `print_func`< `print_python_repr` >(&`numeric::do_print_python_repr`)) `numeric`  
*default ctor.*
- static const `cln::cl_F make_real_float` (const `cln::cl_idcoded_float` &dec)  
*Construct a floating point number from sign, mantissa, and exponent.*
- static const `cln::cl_F read_real_float` (`std::istream` &s)  
*Read serialized floating point number.*
- `GINAC_BIND_UNARCHIVER` (`numeric`)
- static void `write_real_float` (`std::ostream` &s, const `cln::cl_R` &n)
- static void `print_real_number` (const `print_context` &c, const `cln::cl_R` &x)  
*Helper function to print a real number in a nicer way than is CLN's default.*
- static void `print_integer_csrc` (const `print_context` &c, const `cln::cl_I` &x)  
*Helper function to print integer number in C++ source format.*
- static void `print_real_csrc` (const `print_context` &c, const `cln::cl_R` &x)  
*Helper function to print real number in C++ source format.*
- template<typename T1, typename T2>  
static bool `coerce` (T1 &dst, const T2 &arg)
- template<> bool `coerce`< `int`, `cln::cl_I` > (`int` &dst, const `cln::cl_I` &arg)  
*Check if CLN integer can be converted into int.*
- template<> bool `coerce`< `unsigned int`, `cln::cl_I` > (`unsigned int` &dst, const `cln::cl_I` &arg)
- static void `print_real_cl_N` (const `print_context` &c, const `cln::cl_R` &x)  
*Helper function to print real number in C++ source format using `cl_N` types.*
- const `numeric exp` (const `numeric` &x)  
*Exponential function.*
- const `numeric log` (const `numeric` &x)  
*Natural logarithm.*
- const `numeric sin` (const `numeric` &x)  
*Numeric sine (trigonometric function).*
- const `numeric cos` (const `numeric` &x)  
*Numeric cosine (trigonometric function).*
- const `numeric tan` (const `numeric` &x)



- *Absolute value.*
- const [numeric mod](#) (const [numeric](#) &a, const [numeric](#) &b)
- *Modulus (in positive representation).*
- const [numeric smod](#) (const [numeric](#) &a\_, const [numeric](#) &b\_)
- *Modulus (in symmetric representation).*
- const [numeric irem](#) (const [numeric](#) &a, const [numeric](#) &b)
- *Numeric integer remainder.*
- const [numeric irem](#) (const [numeric](#) &a, const [numeric](#) &b, [numeric](#) &q)
- *Numeric integer remainder.*
- const [numeric iquo](#) (const [numeric](#) &a, const [numeric](#) &b)
- *Numeric integer quotient.*
- const [numeric iquo](#) (const [numeric](#) &a, const [numeric](#) &b, [numeric](#) &r)
- *Numeric integer quotient.*
- const [numeric gcd](#) (const [numeric](#) &a, const [numeric](#) &b)
- *Greatest Common Divisor.*
- const [numeric lcm](#) (const [numeric](#) &a, const [numeric](#) &b)
- *Least Common Multiple.*
- const [numeric sqrt](#) (const [numeric](#) &x)
- *Numeric square root.*
- const [numeric isqrt](#) (const [numeric](#) &x)
- *Integer numeric square root.*
- [ex PiEvalf](#) ()
- *Floating point evaluation of Archimedes' constant Pi.*
- [ex EulerEvalf](#) ()
- *Floating point evaluation of Euler's constant gamma.*
- [ex CatalanEvalf](#) ()
- *Floating point evaluation of Catalan's constant.*
- std::ostream & [operator<<](#) (std::ostream &os, const [\\_numeric\\_digits](#) &e)
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([numeric](#))
- const [numeric pow](#) (const [numeric](#) &x, const [numeric](#) &y)
- const [numeric inverse](#) (const [numeric](#) &x)
- [numeric step](#) (const [numeric](#) &x)
- int [csgn](#) (const [numeric](#) &x)
- bool [is\\_zero](#) (const [numeric](#) &x)
- bool [is\\_positive](#) (const [numeric](#) &x)
- bool [is\\_negative](#) (const [numeric](#) &x)
- bool [is\\_integer](#) (const [numeric](#) &x)
- bool [is\\_pos\\_integer](#) (const [numeric](#) &x)
- bool [is\\_nonneg\\_integer](#) (const [numeric](#) &x)
- bool [is\\_even](#) (const [numeric](#) &x)
- bool [is\\_odd](#) (const [numeric](#) &x)
- bool [is\\_prime](#) (const [numeric](#) &x)
- bool [is\\_rational](#) (const [numeric](#) &x)
- bool [is\\_real](#) (const [numeric](#) &x)
- bool [is\\_cinteger](#) (const [numeric](#) &x)
- bool [is\\_crational](#) (const [numeric](#) &x)
- int [to\\_int](#) (const [numeric](#) &x)
- long [to\\_long](#) (const [numeric](#) &x)
- double [to\\_double](#) (const [numeric](#) &x)
- const [numeric real](#) (const [numeric](#) &x)
- const [numeric imag](#) (const [numeric](#) &x)
- const [numeric numer](#) (const [numeric](#) &x)

- const [numeric denom](#) (const [numeric](#) &x)
- static const [ex exadd](#) (const [ex](#) &lh, const [ex](#) &rh)
  - Used internally by [operator+\(\)](#) to add two [ex](#) objects.*
- static const [ex exmul](#) (const [ex](#) &lh, const [ex](#) &rh)
  - Used internally by [operator\\*\(\)](#) to multiply two [ex](#) objects.*
- static const [ex exminus](#) (const [ex](#) &lh)
  - Used internally by [operator-\(\)](#) and friends to change the sign of an argument.*
- const [ex operator+](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [ex operator-](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [ex operator\\*](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [ex operator/](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [numeric operator+](#) (const [numeric](#) &lh, const [numeric](#) &rh)
- const [numeric operator-](#) (const [numeric](#) &lh, const [numeric](#) &rh)
- const [numeric operator\\*](#) (const [numeric](#) &lh, const [numeric](#) &rh)
- const [numeric operator/](#) (const [numeric](#) &lh, const [numeric](#) &rh)
- [ex & operator+=](#) ([ex](#) &lh, const [ex](#) &rh)
- [ex & operator-=](#) ([ex](#) &lh, const [ex](#) &rh)
- [ex & operator\\*=](#) ([ex](#) &lh, const [ex](#) &rh)
- [ex & operator/=](#) ([ex](#) &lh, const [ex](#) &rh)
- [numeric & operator+=](#) ([numeric](#) &lh, const [numeric](#) &rh)
- [numeric & operator-=](#) ([numeric](#) &lh, const [numeric](#) &rh)
- [numeric & operator\\*=](#) ([numeric](#) &lh, const [numeric](#) &rh)
- [numeric & operator/=](#) ([numeric](#) &lh, const [numeric](#) &rh)
- const [ex operator+](#) (const [ex](#) &lh)
- const [ex operator-](#) (const [ex](#) &lh)
- const [numeric operator+](#) (const [numeric](#) &lh)
- const [numeric operator-](#) (const [numeric](#) &lh)
- [ex & operator++](#) ([ex](#) &rh)
  - Expression prefix increment.*
- [ex & operator--](#) ([ex](#) &rh)
  - Expression prefix decrement.*
- const [ex operator++](#) ([ex](#) &lh, int)
  - Expression postfix increment.*
- const [ex operator--](#) ([ex](#) &lh, int)
  - Expression postfix decrement.*
- [numeric & operator++](#) ([numeric](#) &rh)
  - Numeric prefix increment.*
- [numeric & operator--](#) ([numeric](#) &rh)
  - Numeric prefix decrement.*
- const [numeric operator++](#) ([numeric](#) &lh, int)
  - Numeric postfix increment.*
- const [numeric operator--](#) ([numeric](#) &lh, int)
  - Numeric postfix decrement.*
- const [relational operator==](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [relational operator!=](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [relational operator<](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [relational operator<=](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [relational operator>](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [relational operator>=](#) (const [ex](#) &lh, const [ex](#) &rh)
- static int [my\\_ios\\_index](#) ()
- static void [my\\_ios\\_callback](#) (std::ios\_base::event ev, std::ios\_base &s, int i)
- static [print\\_context](#) \* [get\\_print\\_context](#) (std::ios\_base &s)
- static void [set\\_print\\_context](#) (std::ios\_base &s, const [print\\_context](#) &c)

- static unsigned [get\\_print\\_options](#) (std::ios\_base &s)
- static void [set\\_print\\_options](#) (std::ostream &s, unsigned options)
- std::ostream & [operator<<](#) (std::ostream &os, const [ex](#) &e)
- std::istream & [operator>>](#) (std::istream &is, [ex](#) &e)
- std::ostream & [dflt](#) (std::ostream &os)
- std::ostream & [latex](#) (std::ostream &os)
- std::ostream & [python](#) (std::ostream &os)
- std::ostream & [python\\_repr](#) (std::ostream &os)
- std::ostream & [tree](#) (std::ostream &os)
- std::ostream & [csrc](#) (std::ostream &os)
- std::ostream & [csrc\\_float](#) (std::ostream &os)
- std::ostream & [csrc\\_double](#) (std::ostream &os)
- std::ostream & [csrc\\_cl\\_N](#) (std::ostream &os)
- std::ostream & [index\\_dimensions](#) (std::ostream &os)
- std::ostream & [no\\_index\\_dimensions](#) (std::ostream &os)
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (power, basic, print\_func< [print\\_dflt](#) >(&power::do\_print\_dflt). print\_func< [print\\_latex](#) >(&power::do\_print\_latex). print\_func< [print\\_csrc](#) >(&power::do\_print\_csrc). print\_func< [print\\_python](#) >(&power::do\_print\_python). print\_func< [print\\_python\\_repr](#) >(&power::do\_print\_python\_repr). print\_func< [print\\_csrc\\_cl\\_N](#) >(&power::do\_print\_csrc\_cl\_N)) power
- static void [print\\_sym\\_pow](#) (const [print\\_context](#) &c, const [symbol](#) &x, int exp)
- [GINAC\\_BIND\\_UNARCHIVER](#) (power)
- [GINAC\\_DECLARE\\_UNARCHIVER](#) (power)
- [ex pow](#) (const [ex](#) &b, const [ex](#) &e)  
*Symbolic exponentiation.*
- template<typename T1, typename T2>  
[ex pow](#) (const T1 &b, const T2 &e)
- [ex sqrt](#) (const [ex](#) &a)  
*Square root expression.*
- template<class T>  
bool [is\\_a](#) (const [print\\_context](#) &obj)  
*Check if obj is a T, including base classes.*
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (pseries, basic, print\_func< [print\\_context](#) >(&pseries::do\_print). print\_func< [print\\_latex](#) >(&pseries::do\_print\_latex). print\_func< [print\\_tree](#) >(&pseries::do\_print\_tree). print\_func< [print\\_python](#) >(&pseries::do\_print\_python). print\_func< [print\\_python\\_repr](#) >(&pseries::do\_print\_python\_repr)) pseries
- [GINAC\\_BIND\\_UNARCHIVER](#) (pseries)
- [GINAC\\_DECLARE\\_UNARCHIVER](#) (pseries)
- [ex series\\_to\\_poly](#) (const [ex](#) &e)  
*Convert the pseries object embedded in an expression to an ordinary polynomial in the expansion variable.*
- bool [is\\_terminating](#) (const [pseries](#) &s)
- template<typename T>  
[return\\_type\\_t](#) [make\\_return\\_type\\_t](#) (const unsigned rl=0)
- template<class Alg, class Ctx, class T, class C>  
void [set\\_print\\_func](#) (void f(const T &, const C &c, unsigned))  
*Add or replace a print method.*
- template<class Alg, class Ctx, class T, class C>  
void [set\\_print\\_func](#) (void (T::\*f)(const C &, unsigned))  
*Add or replace a print method.*
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (relational, basic, print\_func< [print\\_context](#) >(&relational::do\_print). print\_func< [print\\_tree](#) >(&relational::do\_print\_tree). print\_func< [print\\_python\\_repr](#) >(&relational::do\_print\_python\_repr)) relational
- [GINAC\\_BIND\\_UNARCHIVER](#) (relational)
- static void [print\\_operator](#) (const [print\\_context](#) &c, [relational::operators](#) o)
- [GINAC\\_DECLARE\\_UNARCHIVER](#) (relational)

- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([symbol](#), [basic](#), [print\\_func](#)< [print\\_context](#) >(&[symbol::do\\_print](#)), [print\\_func](#)< [print\\_latex](#) >(&[symbol::do\\_print\\_latex](#)), [print\\_func](#)< [print\\_tree](#) >(&[symbol::do\\_print\\_tree](#)), [print\\_func](#)< [print\\_python\\_repr](#) >(&[symbol::do\\_print\\_python\\_repr](#))) [symbol](#)
- static const std::string & [get\\_default\\_TeX\\_name](#) (const std::string &name)  
*Return default TeX name for symbol.*
- [GINAC\\_BIND\\_UNARCHIVER](#) ([symbol](#))
- [GINAC\\_BIND\\_UNARCHIVER](#) ([realsymbol](#))
- [GINAC\\_BIND\\_UNARCHIVER](#) ([possymbol](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([symbol](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([realsymbol](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([possymbol](#))
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([symmetry](#), [basic](#), [print\\_func](#)< [print\\_context](#) >(&[symmetry::do\\_print](#)), [print\\_func](#)< [print\\_tree](#) >(&[symmetry::do\\_print\\_tree](#))) [symmetry](#)
- [GINAC\\_BIND\\_UNARCHIVER](#) ([symmetry](#))
- static const [symmetry](#) & [index0](#) ()
- static const [symmetry](#) & [index1](#) ()
- static const [symmetry](#) & [index2](#) ()
- static const [symmetry](#) & [index3](#) ()
- const [symmetry](#) & [not\\_symmetric](#) ()
- const [symmetry](#) & [symmetric2](#) ()
- const [symmetry](#) & [symmetric3](#) ()
- const [symmetry](#) & [symmetric4](#) ()
- const [symmetry](#) & [antisymmetric2](#) ()
- const [symmetry](#) & [antisymmetric3](#) ()
- const [symmetry](#) & [antisymmetric4](#) ()
- int [canonicalize](#) (exvector::iterator v, const [symmetry](#) &[symm](#))  
*Canonicalize the order of elements of an expression vector, according to the symmetry properties defined in a symmetry tree.*
- static [ex symm](#) (const [ex](#) &e, exvector::const\_iterator [first](#), exvector::const\_iterator last, bool asymmetric)
- [ex symmetrize](#) (const [ex](#) &e, exvector::const\_iterator [first](#), exvector::const\_iterator last)  
*Symmetrize expression over a set of objects (symbols, indices).*
- [ex antisymmetrize](#) (const [ex](#) &e, exvector::const\_iterator [first](#), exvector::const\_iterator last)  
*Antisymmetrize expression over a set of objects (symbols, indices).*
- [ex symmetrize\\_cyclic](#) (const [ex](#) &e, exvector::const\_iterator [first](#), exvector::const\_iterator last)  
*Symmetrize expression by cyclic permutation over a set of objects (symbols, indices).*
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([symmetry](#))
- [symmetry sy\\_none](#) ()
- [symmetry sy\\_none](#) (const [symmetry](#) &c1, const [symmetry](#) &c2)
- [symmetry sy\\_none](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3)
- [symmetry sy\\_none](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3, const [symmetry](#) &c4)
- [symmetry sy\\_symm](#) ()
- [symmetry sy\\_symm](#) (const [symmetry](#) &c1, const [symmetry](#) &c2)
- [symmetry sy\\_symm](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3)
- [symmetry sy\\_symm](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3, const [symmetry](#) &c4)
- [symmetry sy\\_anti](#) ()
- [symmetry sy\\_anti](#) (const [symmetry](#) &c1, const [symmetry](#) &c2)
- [symmetry sy\\_anti](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3)
- [symmetry sy\\_anti](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3, const [symmetry](#) &c4)
- [symmetry sy\\_cycl](#) ()
- [symmetry sy\\_cycl](#) (const [symmetry](#) &c1, const [symmetry](#) &c2)
- [symmetry sy\\_cycl](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3)
- [symmetry sy\\_cycl](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3, const [symmetry](#) &c4)
- [ex symmetrize](#) (const [ex](#) &e, const [exvector](#) &v)  
*Symmetrize expression over a set of objects (symbols, indices).*



- [ex antisymmetrize](#) (const [ex](#) &e, const [exvector](#) &v)  
*Antisymmetrize expression over a set of objects (symbols, indices).*
- [ex symmetrize\\_cyclic](#) (const [ex](#) &e, const [exvector](#) &v)  
*Symmetrize expression by cyclic permutation over a set of objects (symbols, indices).*
- [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([tensdelta](#), [tensor](#), print\_func< [print\\_dflt](#) >(&[tensdelta::do\\_print](#)), print\_func< [print\\_latex](#) >(&[tensdelta::do\\_print\\_latex](#))) [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#)([tensmetric](#)
- [print\\_func](#)< [print\\_dflt](#) > (&[tensmetric::do\\_print](#)). [print\\_func](#)< [print\\_latex](#) >(&[tensmetric](#)
- [GINAC\\_BIND\\_UNARCHIVER](#) ([minkmetric](#))
- [GINAC\\_BIND\\_UNARCHIVER](#) ([tensepsilon](#))
- [GINAC\\_BIND\\_UNARCHIVER](#) ([tensdelta](#))
- [GINAC\\_BIND\\_UNARCHIVER](#) ([tensmetric](#))
- [GINAC\\_BIND\\_UNARCHIVER](#) ([spinmetric](#))
- [ex delta\\_tensor](#) (const [ex](#) &i1, const [ex](#) &i2)  
*Create a delta tensor with specified indices.*
- [ex metric\\_tensor](#) (const [ex](#) &i1, const [ex](#) &i2)  
*Create a symmetric metric tensor with specified indices.*
- [ex lorentz\\_g](#) (const [ex](#) &i1, const [ex](#) &i2, bool pos\_sig=false)  
*Create a Minkowski metric tensor with specified indices.*
- [ex spinor\\_metric](#) (const [ex](#) &i1, const [ex](#) &i2)  
*Create a spinor metric tensor with specified indices.*
- [ex epsilon\\_tensor](#) (const [ex](#) &i1, const [ex](#) &i2)  
*Create an epsilon tensor in a Euclidean space with two indices.*
- [ex epsilon\\_tensor](#) (const [ex](#) &i1, const [ex](#) &i2, const [ex](#) &i3)  
*Create an epsilon tensor in a Euclidean space with three indices.*
- [ex lorentz\\_eps](#) (const [ex](#) &i1, const [ex](#) &i2, const [ex](#) &i3, const [ex](#) &i4, bool pos\_sig=false)  
*Create an epsilon tensor in a Minkowski space with four indices.*
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([tensdelta](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([tensmetric](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([minkmetric](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([spinmetric](#))
- [GINAC\\_DECLARE\\_UNARCHIVER](#) ([tensepsilon](#))
- unsigned [log2](#) (unsigned n)  
*Integer binary logarithm.*
- const [numeric multinomial\\_coefficient](#) (const std::vector< unsigned > &p)  
*Compute the multinomial coefficient n!*
- unsigned [rotate\\_left](#) (unsigned n)  
*Rotate bits of unsigned value by one bit to the left.*
- template<class T>  
int [compare\\_pointers](#) (const T \*a, const T \*b)  
*Compare two pointers (just to establish some sort of canonical order).*
- unsigned [golden\\_ratio\\_hash](#) (uintptr\_t n)  
*Truncated multiplication with golden ratio, for computing hash values.*
- template<class It>  
int [permutation\\_sign](#) (It first, It last)
- template<class It, class Cmp, class Swap>  
int [permutation\\_sign](#) (It first, It last, Cmp comp, Swap swapit)
- template<class It, class Cmp, class Swap>  
void [shaker\\_sort](#) (It first, It last, Cmp comp, Swap swapit)
- template<class It, class Swap>  
void [cyclic\\_permutation](#) (It first, It last, It new\_first, Swap swapit)



- `template<typename T>`  
`std::enable_if< has\_distance< T >::value, typename std::iterator_traits< T >::difference_type >::type`  
`format\_index\_value (const T &a, const T &b)`  
*For printing a multi-index: If the templates are used, where T is an iterator, printing the address where the iterator points to is not meaningful.*
- `template<typename T>`  
`std::enable_if<!has\_distance< T >::value, T >::type format\_index\_value (const T &a, const T &b)`  
*For all other cases we simply print the value.*
- `template<class T>`  
`std::ostream & operator<< (std::ostream &os, const basic\_multi\_iterator< T > &v)`  
*Output operator.*
- `template<class T>`  
`std::ostream & operator<< (std::ostream &os, const multi\_iterator\_ordered< T > &v)`  
*Output operator.*
- `template<class T>`  
`std::ostream & operator<< (std::ostream &os, const multi\_iterator\_ordered\_eq< T > &v)`  
*Output operator.*
- `template<class T>`  
`std::ostream & operator<< (std::ostream &os, const multi\_iterator\_ordered\_eq\_indv< T > &v)`  
*Output operator.*
- `template<class T>`  
`std::ostream & operator<< (std::ostream &os, const multi\_iterator\_counter< T > &v)`  
*Output operator.*
- `template<class T>`  
`std::ostream & operator<< (std::ostream &os, const multi\_iterator\_counter\_indv< T > &v)`  
*Output operator.*
- `template<class T>`  
`std::ostream & operator<< (std::ostream &os, const multi\_iterator\_permutation< T > &v)`  
*Output operator.*
- `template<class T>`  
`std::ostream & operator<< (std::ostream &os, const multi\_iterator\_shuffle< T > &v)`  
*Output operator.*
- `template<class T>`  
`std::ostream & operator<< (std::ostream &os, const multi\_iterator\_shuffle\_prime< T > &v)`  
*Output operator.*
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (wildcard, basic, print_func< print\_context >(&wildcard::do_print).`  
`print_func< print\_tree >(&wildcard::do_print_tree). print_func< print\_python\_repr >(&wildcard::do_print_python_repr))`  
`wildcard`
- `GINAC_BIND_UNARCHIVER (wildcard)`
- `bool haswild (const ex &x)`  
*Check whether x has a wildcard anywhere as a subexpression.*
- `GINAC_DECLARE_UNARCHIVER (wildcard)`
- `ex wild (unsigned label=0)`  
*Create a wildcard object with the specified label.*

## Variables

- static `unarchive\_table\_t unarch_table_instance`
- `GiNaC::evalm_map_function map_evalm`
- `GiNaC::eval_integ_map_function map_eval_integ`
- `template<class OPT>`  
`class\_info< OPT > * class\_info< OPT >::first = nullptr`

- `template<class OPT>`  
`bool class\_info< OPT >::parents_identified = false`
- [tensor](#)
- `const constant Pi ("Pi", PiEvalf, "\\pi", domain::positive)`  
*Pi.*
- `const constant Euler ("Euler", EulerEvalf, "\\gamma_E", domain::positive)`  
*Euler's constant.*
- `const constant Catalan ("Catalan", CatalanEvalf, "G", domain::positive)`  
*Catalan's constant.*
- `static unsigned const crctab [256]`
- `static library\_init library\_initializer`  
*For construction of flyweights, etc.*
- `const basic * \_num0\_bp`
- [idx](#)
- `unsigned force\_include\_tgamma = tgamma\_SERIAL::serial`
- `unsigned force\_include\_zeta1 = zeta1\_SERIAL::serial`
- `template<> GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT\_T(lst, basic, print\_func< print\_context>(&lst::do_print). print\_func< print\_tree>(&lst::do_print_tree))` `template<> bool Is GINAC\_BIND\_UNARCHIVER(lst)`  
*Specialization of [container::info\(\)](#) for lst.*
- `const numeric I = numeric(cln::complex(cln::cl_I(0),cln::cl_I(1)))`  
*Imaginary unit.*
- [\\_numeric\\_digits](#) [Digits](#)  
*Accuracy in decimal digits.*
- `unsigned next\_print\_context\_id = 0`  
*Next free ID for [print\\_context](#) types.*
- `template<class T, template< class > class CP>`  
`registered\_class\_info structure< T, CP >::reg_info = registered\_class\_info(registered\_class\_options(structure::get_class_name("basic", typeid(structure<T, CP>)))`
- `const int version\_major = GINACLIB\_MAJOR\_VERSION`
- `const int version\_minor = GINACLIB\_MINOR\_VERSION`
- `const int version\_micro = GINACLIB\_MICRO\_VERSION`
- `const numeric * \_num\_120\_p`
- `const ex \_ex\_120 = ex(* \_num\_120\_p)`
- `const numeric * \_num\_60\_p`
- `const ex \_ex\_60 = ex(* \_num\_60\_p)`
- `const numeric * \_num\_48\_p`
- `const ex \_ex\_48 = ex(* \_num\_48\_p)`
- `const numeric * \_num\_30\_p`
- `const ex \_ex\_30 = ex(* \_num\_30\_p)`
- `const numeric * \_num\_25\_p`
- `const ex \_ex\_25 = ex(* \_num\_25\_p)`
- `const numeric * \_num\_24\_p`
- `const ex \_ex\_24 = ex(* \_num\_24\_p)`
- `const numeric * \_num\_20\_p`
- `const ex \_ex\_20 = ex(* \_num\_20\_p)`
- `const numeric * \_num\_18\_p`
- `const ex \_ex\_18 = ex(* \_num\_18\_p)`
- `const numeric * \_num\_15\_p`
- `const ex \_ex\_15 = ex(* \_num\_15\_p)`
- `const numeric * \_num\_12\_p`
- `const ex \_ex\_12 = ex(* \_num\_12\_p)`
- `const numeric * \_num\_11\_p`
- `const ex \_ex\_11 = ex(* \_num\_11\_p)`

- const [numeric](#) \* [\\_num\\_10\\_p](#)
- const [ex](#) [\\_ex\\_10](#) = [ex](#)(\*[\\_num\\_10\\_p](#))
- const [numeric](#) \* [\\_num\\_9\\_p](#)
- const [ex](#) [\\_ex\\_9](#) = [ex](#)(\*[\\_num\\_9\\_p](#))
- const [numeric](#) \* [\\_num\\_8\\_p](#)
- const [ex](#) [\\_ex\\_8](#) = [ex](#)(\*[\\_num\\_8\\_p](#))
- const [numeric](#) \* [\\_num\\_7\\_p](#)
- const [ex](#) [\\_ex\\_7](#) = [ex](#)(\*[\\_num\\_7\\_p](#))
- const [numeric](#) \* [\\_num\\_6\\_p](#)
- const [ex](#) [\\_ex\\_6](#) = [ex](#)(\*[\\_num\\_6\\_p](#))
- const [numeric](#) \* [\\_num\\_5\\_p](#)
- const [ex](#) [\\_ex\\_5](#) = [ex](#)(\*[\\_num\\_5\\_p](#))
- const [numeric](#) \* [\\_num\\_4\\_p](#)
- const [ex](#) [\\_ex\\_4](#) = [ex](#)(\*[\\_num\\_4\\_p](#))
- const [numeric](#) \* [\\_num\\_3\\_p](#)
- const [ex](#) [\\_ex\\_3](#) = [ex](#)(\*[\\_num\\_3\\_p](#))
- const [numeric](#) \* [\\_num\\_2\\_p](#)
- const [ex](#) [\\_ex\\_2](#) = [ex](#)(\*[\\_num\\_2\\_p](#))
- const [numeric](#) \* [\\_num\\_1\\_p](#)
- const [ex](#) [\\_ex\\_1](#) = [ex](#)(\*[\\_num\\_1\\_p](#))
- const [numeric](#) \* [\\_num\\_1\\_2\\_p](#)
- const [ex](#) [\\_ex\\_1\\_2](#) = [ex](#)(\*[\\_num\\_1\\_2\\_p](#))
- const [numeric](#) \* [\\_num\\_1\\_3\\_p](#)
- const [ex](#) [\\_ex\\_1\\_3](#) = [ex](#)(\*[\\_num\\_1\\_3\\_p](#))
- const [numeric](#) \* [\\_num\\_1\\_4\\_p](#)
- const [ex](#) [\\_ex\\_1\\_4](#) = [ex](#)(\*[\\_num\\_1\\_4\\_p](#))
- const [numeric](#) \* [\\_num0\\_p](#)
- const [ex](#) [\\_ex0](#) = [ex](#)(\*[\\_num0\\_p](#))
- const [numeric](#) \* [\\_num1\\_4\\_p](#)
- const [ex](#) [\\_ex1\\_4](#) = [ex](#)(\*[\\_num1\\_4\\_p](#))
- const [numeric](#) \* [\\_num1\\_3\\_p](#)
- const [ex](#) [\\_ex1\\_3](#) = [ex](#)(\*[\\_num1\\_3\\_p](#))
- const [numeric](#) \* [\\_num1\\_2\\_p](#)
- const [ex](#) [\\_ex1\\_2](#) = [ex](#)(\*[\\_num1\\_2\\_p](#))
- const [numeric](#) \* [\\_num1\\_p](#)
- const [ex](#) [\\_ex1](#) = [ex](#)(\*[\\_num1\\_p](#))
- const [numeric](#) \* [\\_num2\\_p](#)
- const [ex](#) [\\_ex2](#) = [ex](#)(\*[\\_num2\\_p](#))
- const [numeric](#) \* [\\_num3\\_p](#)
- const [ex](#) [\\_ex3](#) = [ex](#)(\*[\\_num3\\_p](#))
- const [numeric](#) \* [\\_num4\\_p](#)
- const [ex](#) [\\_ex4](#) = [ex](#)(\*[\\_num4\\_p](#))
- const [numeric](#) \* [\\_num5\\_p](#)
- const [ex](#) [\\_ex5](#) = [ex](#)(\*[\\_num5\\_p](#))
- const [numeric](#) \* [\\_num6\\_p](#)
- const [ex](#) [\\_ex6](#) = [ex](#)(\*[\\_num6\\_p](#))
- const [numeric](#) \* [\\_num7\\_p](#)
- const [ex](#) [\\_ex7](#) = [ex](#)(\*[\\_num7\\_p](#))
- const [numeric](#) \* [\\_num8\\_p](#)
- const [ex](#) [\\_ex8](#) = [ex](#)(\*[\\_num8\\_p](#))
- const [numeric](#) \* [\\_num9\\_p](#)
- const [ex](#) [\\_ex9](#) = [ex](#)(\*[\\_num9\\_p](#))
- const [numeric](#) \* [\\_num10\\_p](#)
- const [ex](#) [\\_ex10](#) = [ex](#)(\*[\\_num10\\_p](#))
- const [numeric](#) \* [\\_num11\\_p](#)

- const `ex_ex11` = `ex(*_num11_p)`
- const `numeric *_num12_p`
- const `ex_ex12` = `ex(*_num12_p)`
- const `numeric *_num15_p`
- const `ex_ex15` = `ex(*_num15_p)`
- const `numeric *_num18_p`
- const `ex_ex18` = `ex(*_num18_p)`
- const `numeric *_num20_p`
- const `ex_ex20` = `ex(*_num20_p)`
- const `numeric *_num24_p`
- const `ex_ex24` = `ex(*_num24_p)`
- const `numeric *_num25_p`
- const `ex_ex25` = `ex(*_num25_p)`
- const `numeric *_num30_p`
- const `ex_ex30` = `ex(*_num30_p)`
- const `numeric *_num48_p`
- const `ex_ex48` = `ex(*_num48_p)`
- const `numeric *_num60_p`
- const `ex_ex60` = `ex(*_num60_p)`
- const `numeric *_num120_p`
- const `ex_ex120` = `ex(*_num120_p)`

## 5.1.1 Typedef Documentation

### 5.1.1.1 `archive_node_id`

```
typedef unsigned GiNaC::archive_node_id
```

Numerical ID value to refer to an `archive_node`.

### 5.1.1.2 `archive_atom`

```
typedef unsigned GiNaC::archive_atom
```

Numerical ID value to refer to a string.

### 5.1.1.3 `synthesize_func`

```
typedef basic *(* GiNaC::synthesize_func) ()
```

### 5.1.1.4 `unarchive_map_t`

```
typedef std::map<std::string, synthesize_func> GiNaC::unarchive_map_t
```

### 5.1.1.5 `exvector`

```
typedef std::vector<ex> GiNaC::exvector
```

#### 5.1.1.6 exset

```
typedef std::set<ex, ex_is_less> GiNaC::exset
```

#### 5.1.1.7 exmap

```
typedef std::map<ex, ex, ex_is_less> GiNaC::exmap
```

#### 5.1.1.8 evalffunctype

```
typedef ex(* GiNaC::evalffunctype) ()
```

#### 5.1.1.9 FUNCP\_1P

```
typedef double(* GiNaC::FUNCP_1P) (double)
```

Function pointer with one function parameter.

#### 5.1.1.10 FUNCP\_2P

```
typedef double(* GiNaC::FUNCP_2P) (double, double)
```

Function pointer with two function parameters.

#### 5.1.1.11 FUNCP\_CUBA

```
typedef void(* GiNaC::FUNCP_CUBA) (const int *, const double[], const int *, double[])
```

Function pointer for use with the CUBA library ( <http://www.feynarts.de/cuba>).

#### 5.1.1.12 epvector

```
typedef std::vector<expair> GiNaC::epvector
```

expair-vector

#### 5.1.1.13 epp

```
typedef epvector::iterator GiNaC::epp
```

expair-vector pointer

#### 5.1.1.14 `exprseq`

```
typedef container<std::vector> GiNaC::exprseq
```

#### 5.1.1.15 `paramset`

```
typedef std::multiset<unsigned> GiNaC::paramset
```

#### 5.1.1.16 `eval_funcp`

```
typedef ex(* GiNaC::eval_funcp) ()
```

#### 5.1.1.17 `evalf_funcp`

```
typedef ex(* GiNaC::evalf_funcp) ()
```

#### 5.1.1.18 `conjugate_funcp`

```
typedef ex(* GiNaC::conjugate_funcp) ()
```

#### 5.1.1.19 `real_part_funcp`

```
typedef ex(* GiNaC::real_part_funcp) ()
```

#### 5.1.1.20 `imag_part_funcp`

```
typedef ex(* GiNaC::imag_part_funcp) ()
```

#### 5.1.1.21 `expand_funcp`

```
typedef ex(* GiNaC::expand_funcp) ()
```

#### 5.1.1.22 `derivative_funcp`

```
typedef ex(* GiNaC::derivative_funcp) ()
```

#### 5.1.1.23 `expl_derivative_funcp`

```
typedef ex(* GiNaC::expl_derivative_funcp) ()
```

#### 5.1.1.24 power\_funcp

```
typedef ex(* GiNaC::power_funcp) ()
```

#### 5.1.1.25 series\_funcp

```
typedef ex(* GiNaC::series_funcp) ()
```

#### 5.1.1.26 print\_funcp

```
typedef void(* GiNaC::print_funcp) ()
```

#### 5.1.1.27 info\_funcp

```
typedef bool(* GiNaC::info_funcp) ()
```

#### 5.1.1.28 eval\_funcp\_1

```
typedef ex(* GiNaC::eval_funcp_1) (const ex &)
```

#### 5.1.1.29 evalf\_funcp\_1

```
typedef ex(* GiNaC::evalf_funcp_1) (const ex &)
```

#### 5.1.1.30 conjugate\_funcp\_1

```
typedef ex(* GiNaC::conjugate_funcp_1) (const ex &)
```

#### 5.1.1.31 real\_part\_funcp\_1

```
typedef ex(* GiNaC::real_part_funcp_1) (const ex &)
```

#### 5.1.1.32 imag\_part\_funcp\_1

```
typedef ex(* GiNaC::imag_part_funcp_1) (const ex &)
```

#### 5.1.1.33 expand\_funcp\_1

```
typedef ex(* GiNaC::expand_funcp_1) (const ex &, unsigned)
```

#### 5.1.1.34 derivative\_funcp\_1

```
typedef ex(* GiNaC::derivative_funcp_1) (const ex &, unsigned)
```

#### 5.1.1.35 expl\_derivative\_funcp\_1

```
typedef ex(* GiNaC::expl_derivative_funcp_1) (const ex &, const symbol &)
```

#### 5.1.1.36 power\_funcp\_1

```
typedef ex(* GiNaC::power_funcp_1) (const ex &, const ex &)
```

#### 5.1.1.37 series\_funcp\_1

```
typedef ex(* GiNaC::series_funcp_1) (const ex &, const relational &, int, unsigned)
```

#### 5.1.1.38 print\_funcp\_1

```
typedef void(* GiNaC::print_funcp_1) (const ex &, const print_context &)
```

#### 5.1.1.39 info\_funcp\_1

```
typedef bool(* GiNaC::info_funcp_1) (const ex &, unsigned)
```

#### 5.1.1.40 eval\_funcp\_2

```
typedef ex(* GiNaC::eval_funcp_2) (const ex &, const ex &)
```

#### 5.1.1.41 evalf\_funcp\_2

```
typedef ex(* GiNaC::evalf_funcp_2) (const ex &, const ex &)
```

#### 5.1.1.42 conjugate\_funcp\_2

```
typedef ex(* GiNaC::conjugate_funcp_2) (const ex &, const ex &)
```

#### 5.1.1.43 real\_part\_funcp\_2

```
typedef ex(* GiNaC::real_part_funcp_2) (const ex &, const ex &)
```



#### 5.1.1.44 imag\_part\_funcp\_2

```
typedef ex(* GiNaC::imag_part_funcp_2) (const ex &, const ex &)
```

#### 5.1.1.45 expand\_funcp\_2

```
typedef ex(* GiNaC::expand_funcp_2) (const ex &, const ex &, unsigned)
```

#### 5.1.1.46 derivative\_funcp\_2

```
typedef ex(* GiNaC::derivative_funcp_2) (const ex &, const ex &, unsigned)
```

#### 5.1.1.47 expl\_derivative\_funcp\_2

```
typedef ex(* GiNaC::expl_derivative_funcp_2) (const ex &, const ex &, const symbol &)
```

#### 5.1.1.48 power\_funcp\_2

```
typedef ex(* GiNaC::power_funcp_2) (const ex &, const ex &, const ex &)
```

#### 5.1.1.49 series\_funcp\_2

```
typedef ex(* GiNaC::series_funcp_2) (const ex &, const ex &, const relational &, int, unsigned)
```

#### 5.1.1.50 print\_funcp\_2

```
typedef void(* GiNaC::print_funcp_2) (const ex &, const ex &, const print_context &)
```

#### 5.1.1.51 info\_funcp\_2

```
typedef bool(* GiNaC::info_funcp_2) (const ex &, const ex &, unsigned)
```

#### 5.1.1.52 eval\_funcp\_3

```
typedef ex(* GiNaC::eval_funcp_3) (const ex &, const ex &, const ex &)
```

#### 5.1.1.53 evalf\_funcp\_3

```
typedef ex(* GiNaC::evalf_funcp_3) (const ex &, const ex &, const ex &)
```

#### 5.1.1.54 conjugate\_funcp\_3

```
typedef ex(* GiNaC::conjugate_funcp_3) (const ex &, const ex &, const ex &)
```

#### 5.1.1.55 real\_part\_funcp\_3

```
typedef ex(* GiNaC::real_part_funcp_3) (const ex &, const ex &, const ex &)
```

#### 5.1.1.56 imag\_part\_funcp\_3

```
typedef ex(* GiNaC::imag_part_funcp_3) (const ex &, const ex &, const ex &)
```

#### 5.1.1.57 expand\_funcp\_3

```
typedef ex(* GiNaC::expand_funcp_3) (const ex &, const ex &, const ex &, unsigned)
```

#### 5.1.1.58 derivative\_funcp\_3

```
typedef ex(* GiNaC::derivative_funcp_3) (const ex &, const ex &, const ex &, unsigned)
```

#### 5.1.1.59 expl\_derivative\_funcp\_3

```
typedef ex(* GiNaC::expl_derivative_funcp_3) (const ex &, const ex &, const ex &, const symbol
&)
```

#### 5.1.1.60 power\_funcp\_3

```
typedef ex(* GiNaC::power_funcp_3) (const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.61 series\_funcp\_3

```
typedef ex(* GiNaC::series_funcp_3) (const ex &, const ex &, const ex &, const relational &, int, unsigned)
```

#### 5.1.1.62 print\_funcp\_3

```
typedef void(* GiNaC::print_funcp_3) (const ex &, const ex &, const ex &, const print_context
&)
```

#### 5.1.1.63 info\_funcp\_3

```
typedef bool(* GiNaC::info_funcp_3) (const ex &, const ex &, const ex &, unsigned)
```

#### 5.1.1.64 eval\_funcp\_4

```
typedef ex(* GiNaC::eval_funcp_4) (const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.65 evalf\_funcp\_4

```
typedef ex(* GiNaC::evalf_funcp_4) (const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.66 conjugate\_funcp\_4

```
typedef ex(* GiNaC::conjugate_funcp_4) (const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.67 real\_part\_funcp\_4

```
typedef ex(* GiNaC::real_part_funcp_4) (const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.68 imag\_part\_funcp\_4

```
typedef ex(* GiNaC::imag_part_funcp_4) (const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.69 expand\_funcp\_4

```
typedef ex(* GiNaC::expand_funcp_4) (const ex &, const ex &, const ex &, const ex &, unsigned)
```

#### 5.1.1.70 derivative\_funcp\_4

```
typedef ex(* GiNaC::derivative_funcp_4) (const ex &, const ex &, const ex &, const ex &, unsigned)
```

#### 5.1.1.71 expl\_derivative\_funcp\_4

```
typedef ex(* GiNaC::expl_derivative_funcp_4) (const ex &, const ex &, const ex &, const ex &,
const symbol &)
```

#### 5.1.1.72 power\_funcp\_4

```
typedef ex(* GiNaC::power_funcp_4) (const ex &, const ex &, const ex &, const ex &, const ex
&)
```

#### 5.1.1.73 series\_funcp\_4

```
typedef ex(* GiNaC::series_funcp_4) (const ex &, const ex &, const ex &, const ex &, const
relational &, int, unsigned)
```

#### 5.1.1.74 print\_funcp\_4

```
typedef void(* GiNaC::print_funcp_4) (const ex &, const ex &, const ex &, const ex &, const
print_context &)
```

#### 5.1.1.75 info\_funcp\_4

```
typedef bool(* GiNaC::info_funcp_4) (const ex &, const ex &, const ex &, const ex &, unsigned)
```

#### 5.1.1.76 eval\_funcp\_5

```
typedef ex(* GiNaC::eval_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.77 evalf\_funcp\_5

```
typedef ex(* GiNaC::evalf_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex
&)
```

#### 5.1.1.78 conjugate\_funcp\_5

```
typedef ex(* GiNaC::conjugate_funcp_5) (const ex &, const ex &, const ex &, const ex &, const
ex &)
```

#### 5.1.1.79 real\_part\_funcp\_5

```
typedef ex(* GiNaC::real_part_funcp_5) (const ex &, const ex &, const ex &, const ex &, const
ex &)
```

#### 5.1.1.80 imag\_part\_funcp\_5

```
typedef ex(* GiNaC::imag_part_funcp_5) (const ex &, const ex &, const ex &, const ex &, const
ex &)
```

#### 5.1.1.81 expand\_funcp\_5

```
typedef ex(* GiNaC::expand_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex
&, unsigned)
```

#### 5.1.1.82 derivative\_funcp\_5

```
typedef ex(* GiNaC::derivative_funcp_5) (const ex &, const ex &, const ex &, const ex &, const
ex &, unsigned)
```

#### 5.1.1.83 expl\_derivative\_funcp\_5

```
typedef ex(* GiNaC::expl_derivative_funcp_5) (const ex &, const ex &, const ex &, const ex &,
const ex &, const symbol &)
```

#### 5.1.1.84 power\_funcp\_5

```
typedef ex(* GiNaC::power_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &)
```

#### 5.1.1.85 series\_funcp\_5

```
typedef ex(* GiNaC::series_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex
&, const relational &, int, unsigned)
```

#### 5.1.1.86 print\_funcp\_5

```
typedef void(* GiNaC::print_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex
&, const print_context &)
```

#### 5.1.1.87 info\_funcp\_5

```
typedef bool(* GiNaC::info_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex
&, unsigned)
```

#### 5.1.1.88 eval\_funcp\_6

```
typedef ex(* GiNaC::eval_funcp_6) (const ex &, const ex &, const ex &, const ex &, const ex &,
const ex &)
```

#### 5.1.1.89 evalf\_funcp\_6

```
typedef ex(* GiNaC::evalf_funcp_6) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &)
```

#### 5.1.1.90 conjugate\_funcp\_6

```
typedef ex(* GiNaC::conjugate_funcp_6) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &)
```

#### 5.1.1.91 real\_part\_funcp\_6

```
typedef ex(* GiNaC::real_part_funcp_6) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &)
```

**5.1.1.92 imag\_funcp\_6**

```
typedef ex(* GiNaC::imag_funcp_6) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &)
```

**5.1.1.93 expand\_funcp\_6**

```
typedef ex(* GiNaC::expand_funcp_6) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, unsigned)
```

**5.1.1.94 derivative\_funcp\_6**

```
typedef ex(* GiNaC::derivative_funcp_6) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, unsigned)
```

**5.1.1.95 expl\_derivative\_funcp\_6**

```
typedef ex(* GiNaC::expl_derivative_funcp_6) (const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const symbol &)
```

**5.1.1.96 power\_funcp\_6**

```
typedef ex(* GiNaC::power_funcp_6) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &)
```

**5.1.1.97 series\_funcp\_6**

```
typedef ex(* GiNaC::series_funcp_6) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const relational &, int, unsigned)
```

**5.1.1.98 print\_funcp\_6**

```
typedef void(* GiNaC::print_funcp_6) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const print_context &)
```

**5.1.1.99 info\_funcp\_6**

```
typedef bool(* GiNaC::info_funcp_6) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, unsigned)
```

**5.1.1.100 eval\_funcp\_7**

```
typedef ex(* GiNaC::eval_funcp_7) (const ex &, const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &)
```

#### 5.1.1.101 evalf\_funcp\_7

```
typedef ex(* GiNaC::evalf_funcp_7) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &)
```

#### 5.1.1.102 conjugate\_funcp\_7

```
typedef ex(* GiNaC::conjugate_funcp_7) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &)
```

#### 5.1.1.103 real\_part\_funcp\_7

```
typedef ex(* GiNaC::real_part_funcp_7) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &)
```

#### 5.1.1.104 imag\_part\_funcp\_7

```
typedef ex(* GiNaC::imag_part_funcp_7) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &)
```

#### 5.1.1.105 expand\_funcp\_7

```
typedef ex(* GiNaC::expand_funcp_7) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, unsigned)
```

#### 5.1.1.106 derivative\_funcp\_7

```
typedef ex(* GiNaC::derivative_funcp_7) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, unsigned)
```

#### 5.1.1.107 expl\_derivative\_funcp\_7

```
typedef ex(* GiNaC::expl_derivative_funcp_7) (const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &, const symbol &)
```

#### 5.1.1.108 power\_funcp\_7

```
typedef ex(* GiNaC::power_funcp_7) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &)
```

#### 5.1.1.109 series\_funcp\_7

```
typedef ex(* GiNaC::series_funcp_7) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const relational &, int, unsigned)
```

#### 5.1.1.110 print\_funcp\_7

```
typedef void(* GiNaC::print_funcp_7) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const print_context &)
```

#### 5.1.1.111 info\_funcp\_7

```
typedef bool(* GiNaC::info_funcp_7) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, unsigned)
```

#### 5.1.1.112 eval\_funcp\_8

```
typedef ex(* GiNaC::eval_funcp_8) (const ex &, const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &)
```

#### 5.1.1.113 evalf\_funcp\_8

```
typedef ex(* GiNaC::evalf_funcp_8) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &)
```

#### 5.1.1.114 conjugate\_funcp\_8

```
typedef ex(* GiNaC::conjugate_funcp_8) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.115 real\_part\_funcp\_8

```
typedef ex(* GiNaC::real_part_funcp_8) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.116 imag\_part\_funcp\_8

```
typedef ex(* GiNaC::imag_part_funcp_8) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.117 expand\_funcp\_8

```
typedef ex(* GiNaC::expand_funcp_8) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, unsigned)
```

#### 5.1.1.118 derivative\_funcp\_8

```
typedef ex(* GiNaC::derivative_funcp_8) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, unsigned)
```



#### 5.1.1.119 expl\_derivative\_funcp\_8

```
typedef ex(* GiNaC::expl_derivative_funcp_8) (const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &, const ex &, const symbol &)
```

#### 5.1.1.120 power\_funcp\_8

```
typedef ex(* GiNaC::power_funcp_8) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.121 series\_funcp\_8

```
typedef ex(* GiNaC::series_funcp_8) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const relational &, int, unsigned)
```

#### 5.1.1.122 print\_funcp\_8

```
typedef void(* GiNaC::print_funcp_8) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const print_context &)
```

#### 5.1.1.123 info\_funcp\_8

```
typedef bool(* GiNaC::info_funcp_8) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, unsigned)
```

#### 5.1.1.124 eval\_funcp\_9

```
typedef ex(* GiNaC::eval_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.125 evalf\_funcp\_9

```
typedef ex(* GiNaC::evalf_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.126 conjugate\_funcp\_9

```
typedef ex(* GiNaC::conjugate_funcp_9) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.127 real\_part\_funcp\_9

```
typedef ex(* GiNaC::real_part_funcp_9) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &)
```

**5.1.1.128 imag\_part\_funcp\_9**

```
typedef ex(* GiNaC::imag_part_funcp_9) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &)
```

**5.1.1.129 expand\_funcp\_9**

```
typedef ex(* GiNaC::expand_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, unsigned)
```

**5.1.1.130 derivative\_funcp\_9**

```
typedef ex(* GiNaC::derivative_funcp_9) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

**5.1.1.131 expl\_derivative\_funcp\_9**

```
typedef ex(* GiNaC::expl_derivative_funcp_9) (const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &, const ex &, const ex &, const symbol &)
```

**5.1.1.132 power\_funcp\_9**

```
typedef ex(* GiNaC::power_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &)
```

**5.1.1.133 series\_funcp\_9**

```
typedef ex(* GiNaC::series_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const relational &, int, unsigned)
```

**5.1.1.134 print\_funcp\_9**

```
typedef void(* GiNaC::print_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const print_context &)
```

**5.1.1.135 info\_funcp\_9**

```
typedef bool(* GiNaC::info_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, unsigned)
```

**5.1.1.136 eval\_funcp\_10**

```
typedef ex(* GiNaC::eval_funcp_10) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.137 evalf\_funcp\_10

```
typedef ex(* GiNaC::evalf_funcp_10) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.138 conjugate\_funcp\_10

```
typedef ex(* GiNaC::conjugate_funcp_10) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.139 real\_part\_funcp\_10

```
typedef ex(* GiNaC::real_part_funcp_10) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.140 imag\_part\_funcp\_10

```
typedef ex(* GiNaC::imag_part_funcp_10) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.141 expand\_funcp\_10

```
typedef ex(* GiNaC::expand_funcp_10) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

#### 5.1.1.142 derivative\_funcp\_10

```
typedef ex(* GiNaC::derivative_funcp_10) (const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

#### 5.1.1.143 expl\_derivative\_funcp\_10

```
typedef ex(* GiNaC::expl_derivative_funcp_10) (const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const symbol &)
```

#### 5.1.1.144 power\_funcp\_10

```
typedef ex(* GiNaC::power_funcp_10) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.145 series\_funcp\_10

```
typedef ex(* GiNaC::series_funcp_10) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const relational &, int,
unsigned)
```

**5.1.1.146 print\_funcp\_10**

```
typedef void(* GiNaC::print_funcp_10) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const print_context &)
```

**5.1.1.147 info\_funcp\_10**

```
typedef bool(* GiNaC::info_funcp_10) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

**5.1.1.148 eval\_funcp\_11**

```
typedef ex(* GiNaC::eval_funcp_11) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

**5.1.1.149 evalf\_funcp\_11**

```
typedef ex(* GiNaC::evalf_funcp_11) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

**5.1.1.150 conjugate\_funcp\_11**

```
typedef ex(* GiNaC::conjugate_funcp_11) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

**5.1.1.151 real\_part\_funcp\_11**

```
typedef ex(* GiNaC::real_part_funcp_11) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

**5.1.1.152 imag\_part\_funcp\_11**

```
typedef ex(* GiNaC::imag_part_funcp_11) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

**5.1.1.153 expand\_funcp\_11**

```
typedef ex(* GiNaC::expand_funcp_11) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

**5.1.1.154 derivative\_funcp\_11**

```
typedef ex(* GiNaC::derivative_funcp_11) (const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

#### 5.1.1.155 expl\_derivative\_funcp\_11

```
typedef ex(* GiNaC::expl_derivative_funcp_11) (const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
symbol &)
```

#### 5.1.1.156 power\_funcp\_11

```
typedef ex(* GiNaC::power_funcp_11) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.157 series\_funcp\_11

```
typedef ex(* GiNaC::series_funcp_11) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const relational &,
int, unsigned)
```

#### 5.1.1.158 print\_funcp\_11

```
typedef void(* GiNaC::print_funcp_11) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const print_context
&)
```

#### 5.1.1.159 info\_funcp\_11

```
typedef bool(* GiNaC::info_funcp_11) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

#### 5.1.1.160 eval\_funcp\_12

```
typedef ex(* GiNaC::eval_funcp_12) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.161 evalf\_funcp\_12

```
typedef ex(* GiNaC::evalf_funcp_12) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

#### 5.1.1.162 conjugate\_funcp\_12

```
typedef ex(* GiNaC::conjugate_funcp_12) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

**5.1.1.163 real\_part\_funcp\_12**

```
typedef ex(* GiNaC::real_part_funcp_12) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

**5.1.1.164 imag\_part\_funcp\_12**

```
typedef ex(* GiNaC::imag_part_funcp_12) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

**5.1.1.165 expand\_funcp\_12**

```
typedef ex(* GiNaC::expand_funcp_12) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &,
unsigned)
```

**5.1.1.166 derivative\_funcp\_12**

```
typedef ex(* GiNaC::derivative_funcp_12) (const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex
&, unsigned)
```

**5.1.1.167 expl\_derivative\_funcp\_12**

```
typedef ex(* GiNaC::expl_derivative_funcp_12) (const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex
&, const symbol &)
```

**5.1.1.168 power\_funcp\_12**

```
typedef ex(* GiNaC::power_funcp_12) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
ex &)
```

**5.1.1.169 series\_funcp\_12**

```
typedef ex(* GiNaC::series_funcp_12) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
relational &, int, unsigned)
```

**5.1.1.170 print\_funcp\_12**

```
typedef void(* GiNaC::print_funcp_12) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &,
const print_context &)
```

#### 5.1.1.171 info\_funcp\_12

```
typedef bool(* GiNaC::info_funcp_12) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
unsigned)
```

#### 5.1.1.172 eval\_funcp\_13

```
typedef ex(* GiNaC::eval_funcp_13) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
ex &)
```

#### 5.1.1.173 evalf\_funcp\_13

```
typedef ex(* GiNaC::evalf_funcp_13) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
ex &)
```

#### 5.1.1.174 conjugate\_funcp\_13

```
typedef ex(* GiNaC::conjugate_funcp_13) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
const ex &)
```

#### 5.1.1.175 real\_part\_funcp\_13

```
typedef ex(* GiNaC::real_part_funcp_13) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
const ex &)
```

#### 5.1.1.176 imag\_part\_funcp\_13

```
typedef ex(* GiNaC::imag_part_funcp_13) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
const ex &)
```

#### 5.1.1.177 expand\_funcp\_13

```
typedef ex(* GiNaC::expand_funcp_13) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
ex &, unsigned)
```

#### 5.1.1.178 derivative\_funcp\_13

```
typedef ex(* GiNaC::derivative_funcp_13) (const ex &, const ex &, const ex &, const ex &, const
const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, unsigned)
```

**5.1.1.179 expl\_derivative\_funcp\_13**

```
typedef ex(* GiNaC::expl_derivative_funcp_13) (const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const symbol &)
```

**5.1.1.180 power\_funcp\_13**

```
typedef ex(* GiNaC::power_funcp_13) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &)
```

**5.1.1.181 series\_funcp\_13**

```
typedef ex(* GiNaC::series_funcp_13) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
ex &, const relational &, int, unsigned)
```

**5.1.1.182 print\_funcp\_13**

```
typedef void(* GiNaC::print_funcp_13) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &,
const ex &, const print_context &)
```

**5.1.1.183 info\_funcp\_13**

```
typedef bool(* GiNaC::info_funcp_13) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
ex &, unsigned)
```

**5.1.1.184 eval\_funcp\_14**

```
typedef ex(* GiNaC::eval_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &)
```

**5.1.1.185 evalf\_funcp\_14**

```
typedef ex(* GiNaC::evalf_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &)
```

**5.1.1.186 conjugate\_funcp\_14**

```
typedef ex(* GiNaC::conjugate_funcp_14) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &)
```



**5.1.1.187 real\_part\_funcp\_14**

```
typedef ex(* GiNaC::real_part_funcp_14) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &)
```

**5.1.1.188 imag\_part\_funcp\_14**

```
typedef ex(* GiNaC::imag_part_funcp_14) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &)
```

**5.1.1.189 expand\_funcp\_14**

```
typedef ex(* GiNaC::expand_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, unsigned)
```

**5.1.1.190 derivative\_funcp\_14**

```
typedef ex(* GiNaC::derivative_funcp_14) (const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, unsigned)
```

**5.1.1.191 expl\_derivative\_funcp\_14**

```
typedef ex(* GiNaC::expl_derivative_funcp_14) (const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const symbol &)
```

**5.1.1.192 power\_funcp\_14**

```
typedef ex(* GiNaC::power_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &)
```

**5.1.1.193 series\_funcp\_14**

```
typedef ex(* GiNaC::series_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const relational &, int, unsigned)
```

**5.1.1.194 print\_funcp\_14**

```
typedef void(* GiNaC::print_funcp_14) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const print_context &)
```

#### 5.1.1.195 info\_funcp\_14

```
typedef bool(* GiNaC::info_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, unsigned)
```

#### 5.1.1.196 eval\_funcp\_exvector

```
typedef ex(* GiNaC::eval_funcp_exvector) (const exvector &)
```

#### 5.1.1.197 evalf\_funcp\_exvector

```
typedef ex(* GiNaC::evalf_funcp_exvector) (const exvector &)
```

#### 5.1.1.198 conjugate\_funcp\_exvector

```
typedef ex(* GiNaC::conjugate_funcp_exvector) (const exvector &)
```

#### 5.1.1.199 real\_part\_funcp\_exvector

```
typedef ex(* GiNaC::real_part_funcp_exvector) (const exvector &)
```

#### 5.1.1.200 imag\_part\_funcp\_exvector

```
typedef ex(* GiNaC::imag_part_funcp_exvector) (const exvector &)
```

#### 5.1.1.201 expand\_funcp\_exvector

```
typedef ex(* GiNaC::expand_funcp_exvector) (const exvector &, unsigned)
```

#### 5.1.1.202 derivative\_funcp\_exvector

```
typedef ex(* GiNaC::derivative_funcp_exvector) (const exvector &, unsigned)
```

#### 5.1.1.203 expl\_derivative\_funcp\_exvector

```
typedef ex(* GiNaC::expl_derivative_funcp_exvector) (const exvector &, const symbol &)
```

#### 5.1.1.204 power\_funcp\_exvector

```
typedef ex(* GiNaC::power_funcp_exvector) (const exvector &, const ex &)
```

**5.1.1.205 series\_funcp\_exvector**

```
typedef ex(* GiNaC::series_funcp_exvector) (const exvector &, const relational &, int, unsigned)
```

**5.1.1.206 print\_funcp\_exvector**

```
typedef void(* GiNaC::print_funcp_exvector) (const exvector &, const print_context &)
```

**5.1.1.207 info\_funcp\_exvector**

```
typedef bool(* GiNaC::info_funcp_exvector) (const exvector &, unsigned)
```

**5.1.1.208 exhashmap**

```
template<typename T, class Hash = std::hash<ex>, class KeyEqual = std::equal_to<ex>, class
Allocator = std::allocator<std::pair<const ex, T>>>
using GiNaC::exhashmap = std::unordered_map<ex, T, Hash, KeyEqual, Allocator>
```

**5.1.1.209 spmap**

```
typedef std::map<spmapkey, ex> GiNaC::spmap
```

**5.1.1.210 lookup\_map**

```
typedef map<error_and_integral, ex, error_and_integral_is_less> GiNaC::lookup_map
```

**5.1.1.211 lst**

```
typedef container< std::list > GiNaC::lst
```

**5.1.1.212 uintvector**

```
typedef std::vector<std::size_t> GiNaC::uintvector
```

**5.1.1.213 unsignedvector**

```
typedef std::vector<unsigned> GiNaC::unsignedvector
```

**5.1.1.214 exvectorvector**

```
typedef std::vector<exvector> GiNaC::exvectorvector
```

### 5.1.1.215 sym\_desc\_vec

```
typedef std::vector<sym_desc> GiNaC::sym_desc_vec
```

### 5.1.1.216 digits\_changed\_callback

```
typedef void(* GiNaC::digits_changed_callback) (long)
```

Function pointer to implement callbacks in the case 'Digits' gets changed.

Main purpose of such callbacks is to adjust look-up tables of certain functions to the new precision. Parameter contains the signed difference between new Digits and old Digits.

### 5.1.1.217 print\_context\_class\_info

```
typedef class_info<print_context_options> GiNaC::print_context_class_info
```

### 5.1.1.218 registered\_class\_info

```
typedef class_info<registered_class_options> GiNaC::registered_class_info
```

## 5.1.2 Enumeration Type Documentation

### 5.1.2.1 anonymous enum

anonymous enum

Enumerator

|                     |
|---------------------|
| callback_registered |
|---------------------|

## 5.1.3 Function Documentation

### 5.1.3.1 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT() [1/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 add ,
 expairseq ,
 print_func< print_context > &::do_print, print_func< print_latex > &::do_←
print_latex, print_func< print_csrc > &::do_print_csrc, print_func< print_tree > &::do_←
print_tree, print_func< print_python_repr > &::do_print_python_repr)
```

References [GiNaC::add::do\\_print\(\)](#), [GiNaC::add::do\\_print\\_csrc\(\)](#), [GiNaC::add::do\\_print\\_latex\(\)](#), [GiNaC::add::do\\_print\\_python\\_repr\(\)](#), and [GiNaC::basic::do\\_print\\_tree\(\)](#).

Referenced by [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#), [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#), [print\\_func< print\\_dflt >\(\)](#), [print\\_func< print\\_dflt >\(\)](#), and [print\\_func< print\\_dflt >\(\)](#).

#### 5.1.3.2 GINAC\_BIND\_UNARCHIVER() [1/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 add)
```

#### 5.1.3.3 GINAC\_DECLARE\_UNARCHIVER() [1/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 add)
```

#### 5.1.3.4 write\_unsigned()

```
static void GiNaC::write_unsigned (
 std::ostream & os,
 unsigned val) [static]
```

Write unsigned integer quantity to stream.

Referenced by [GiNaC::archive::operator<<](#), and [GiNaC::archive\\_node::operator<<](#).

#### 5.1.3.5 read\_unsigned()

```
static unsigned GiNaC::read_unsigned (
 std::istream & is) [static]
```

Read unsigned integer quantity from stream.

Referenced by [GiNaC::archive::operator>>](#), and [GiNaC::archive\\_node::operator>>](#).

#### 5.1.3.6 operator<<() [1/16]

```
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const archive_node & n)
```

Write [archive\\_node](#) to binary data stream.

#### 5.1.3.7 operator<<() [2/16]

```
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const archive & ar)
```

Write archive to binary data stream.

**5.1.3.8 operator>>() [1/3]**

```
std::istream & GiNaC::operator>> (
 std::istream & is,
 archive_node & n)
```

Read [archive\\_node](#) from binary data stream.

**5.1.3.9 operator>>() [2/3]**

```
std::istream & GiNaC::operator>> (
 std::istream & is,
 archive & ar)
```

Read archive from binary data stream.

**5.1.3.10 find\_factory\_fcn()**

```
static synthesize_func GiNaC::find_factory_fcn (
 const std::string & name) [static]
```

References [GiNaC::unarchive\\_table\\_t::find\(\)](#).

Referenced by [GiNaC::archive\\_node::unarchive\(\)](#).

**5.1.3.11 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT() [2/33]**

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 basic ,
 void ,
 print_func< print_context > &::do_print. print_func< print_tree > &::do_print↵
 _tree. print_func< print_python_repr > &::do_print_python_repr)
```

basic copy constructor: implicitly assumes that the other class is of the exact same type (as it's used by duplicate()), so it can copy the tinfo\_key and the hash value.

References [GiNaC::basic::do\\_print\(\)](#), [GiNaC::basic::do\\_print\\_python\\_repr\(\)](#), and [GiNaC::basic::do\\_print\\_tree\(\)](#).

**5.1.3.12 is\_a()** [1/3]

```
template<class T>
bool GiNaC::is_a (
 const basic & obj) [inline]
```

Check if *obj* is a *T*, including base classes.

Referenced by [abs\\_power\(\)](#), [GiNaC::matrix::add\\_indexed\(\)](#), [atan2\\_eval\(\)](#), [atan\\_series\(\)](#), [atanh\\_series\(\)](#), [base\\_and\\_index\(\)](#), [beta\\_series\(\)](#), [canonicalize\\_clifford\(\)](#), [GiNaC::clifford::clifford\(\)](#), [clifford\\_max\\_label\(\)](#), [clifford\\_moebius\\_map\(\)](#), [clifford\\_moebius\\_map\(\)](#), [clifford\\_prime\(\)](#), [clifford\\_star\\_bar\(\)](#), [clifford\\_to\\_lst\(\)](#), [clifford\\_unit\(\)](#), [GiNaC::basic::collect\(\)](#), [collect\\_symbols\(\)](#), [color\\_d\(\)](#), [color\\_f\(\)](#), [color\\_T\(\)](#), [color\\_trace\(\)](#), [GiNaC::expairseq::construct\\_from\\_2\\_ex\(\)](#), [GiNaC::cliffordunit::contract\\_with\(\)](#), [GiNaC::diracgamma::contract\\_with\(\)](#), [GiNaC::matrix::contract\\_with\(\)](#), [GiNaC::spinmetric::contract\\_with\(\)](#), [GiNaC::su3d::contract\\_with\(\)](#), [GiNaC::su3f::contract\\_with\(\)](#), [GiNaC::su3t::contract\\_with\(\)](#), [GiNaC::tensdelta::contract\\_with\(\)](#), [GiNaC::tensepsilon::contract\\_with\(\)](#), [GiNaC::tensmetric::contract\\_with\(\)](#), [convert\\_H\\_to\\_Li\(\)](#), [csgn\\_power\(\)](#), [delta\\_tensor\(\)](#), [GiNaC::power::derivative\(\)](#), [dirac\\_gamma\(\)](#), [dirac\\_trace\(\)](#), [GiNaC::add::do\\_print\\_csrg\(\)](#), [GiNaC::mul::do\\_print\\_csrg\(\)](#), [GiNaC::numeric::do\\_print\\_csrg\(\)](#), [GiNaC::power::do\\_print\\_csrg\(\)](#), [epsilon\\_tensor\(\)](#), [epsilon\\_tensor\(\)](#), [GiNaC::function::eval\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::matrix::eval\\_indexed\(\)](#), [GiNaC::minkmetric::eval\\_indexed\(\)](#), [GiNaC::spinmetric::eval\\_indexed\(\)](#), [GiNaC::su3d::eval\\_indexed\(\)](#), [GiNaC::su3f::eval\\_indexed\(\)](#), [GiNaC::tensdelta::eval\\_indexed\(\)](#), [GiNaC::tensepsilon::eval\\_indexed\(\)](#), [GiNaC::tensmetric::eval\\_indexed\(\)](#), [GiNaC::integral::eval\\_integ\(\)](#), [GiNaC::clifford::eval\\_ncmul\(\)](#), [GiNaC::color::eval\\_ncmul\(\)](#), [GiNaC::add::evalm\(\)](#), [GiNaC::mul::evalm\(\)](#), [GiNaC::ncmul::evalm\(\)](#), [GiNaC::power::evalm\(\)](#), [GiNaC::expairseq::expairseq\(\)](#), [GiNaC::expairseq::expairseq\(\)](#), [GiNaC::integral::expand\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::power::expand\(\)](#), [expand\\_dummy\\_sum\(\)](#), [find\\_common\\_factor\(\)](#), [fsolve\(\)](#), [G2\\_eval\(\)](#), [G2\\_evalf\(\)](#), [G3\\_eval\(\)](#), [G3\\_evalf\(\)](#), [gcd\(\)](#), [gcd\\_pf\\_pow\(\)](#), [get\\_all\\_dummy\\_indices\(\)](#), [get\\_all\\_dummy\\_indices\\_safely\(\)](#), [get\\_clifford\\_comp\(\)](#), [get\\_dim\\_uint\(\)](#), [get\\_first\\_symbol\(\)](#), [GiNaC::clifford::get\\_metric\(\)](#), [GINAC\\_BIND\\_UNARCHIVER\(\)](#), [H\\_deriv\(\)](#), [H\\_eval\(\)](#), [H\\_evalf\(\)](#), [H\\_print\\_latex\(\)](#), [GiNaC::make\\_flat\\_inserter::handle\\_factor\(\)](#), [GiNaC::mul::has\(\)](#), [GiNaC::power::has\(\)](#), [hasindex\(\)](#), [haswild\(\)](#), [GiNaC::symbolset::insert\\_symbols\(\)](#), [GiNaC::integral::integral\(\)](#), [GiNaC::ex::is\\_a\(\)](#), [is\\_dirac\\_slash\(\)](#), [is\\_dummy\\_pair\(\)](#), [GiNaC::idx::is\\_dummy\\_pair\\_same\\_type\(\)](#), [GiNaC::container< C >::is\\_equal\\_same\\_type\(\)](#), [GiNaC::fderivative::is\\_equal\\_same\\_type\(\)](#), [GiNaC::function::is\\_equal\\_same\\_type\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::is\\_equal\\_same\\_type\(\)](#), [GiNaC::symbol::is\\_equal\\_same\\_type\(\)](#), [iterated\\_integral\\_evalf\\_impl\(\)](#), [lcmcoeff\(\)](#), [Li\\_deriv\(\)](#), [Li\\_eval\(\)](#), [Li\\_evalf\(\)](#), [Li\\_print\\_latex\(\)](#), [Li\\_series\(\)](#), [log\\_series\(\)](#), [lorentz\\_eps\(\)](#), [lorentz\\_g\(\)](#), [lst\\_to\\_clifford\(\)](#), [lst\\_to\\_matrix\(\)](#), [GiNaC::expairseq::make\\_flat\(\)](#), [GiNaC::expairseq::make\\_flat\(\)](#), [GiNaC::expairseq::map\(\)](#), [GiNaC::clifford::match\\_same\\_type\(\)](#), [GiNaC::color::match\\_same\\_type\(\)](#), [GiNaC::fderivative::match\\_same\\_type\(\)](#), [GiNaC::function::match\\_same\\_type\(\)](#), [GiNaC::idx::match\\_same\\_type\(\)](#), [GiNaC::spinidx::match\\_same\\_type\(\)](#), [GiNaC::varidx::match\\_same\\_type\(\)](#), [metric\\_tensor\(\)](#), [minimal\\_dim\(\)](#), [multiply\\_lcm\(\)](#), [GiNaC::basic::normal\(\)](#), [GiNaC::ex\\_base\\_is\\_less::operator\(\)](#), [GiNaC::is\\_not\\_a\\_clifford::operator\(\)](#), [GiNaC::spmapkey::operator<\(\)](#), [GiNaC::spmapkey::operator==\(\)](#), [Order\\_series\(\)](#), [GiNaC::function::print\(\)](#), [GiNaC::idx::print\\_index\(\)](#), [print\\_real\\_number\(\)](#), [GiNaC::indexed::printindices\(\)](#), [GiNaC::pseries::pseries\(\)](#), [GiNaC::pseries::pseries\(\)](#), [GiNaC::symbol::read\\_archive\(\)](#), [remove\\_dirac\\_ONE\(\)](#), [rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::tensor::replace\\_contr\\_index\(\)](#), [replace\\_with\\_symbol\(\)](#), [GiNaC::indexed::reposition\\_dummy\\_indices\(\)](#), [GiNaC::indexed::return\\_type\(\)](#), [S\\_evalf\(\)](#), [GiNaC::clifford::same\\_metric\(\)](#), [GiNaC::matrix::scalar\\_mul\\_indexed\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::pseries::series\(\)](#), [GiNaC::symbol::series\(\)](#), [GiNaC::indexed::simplify\\_indexed\(\)](#), [GiNaC::indexed::simplify\\_indexed\\_product\(\)](#), [spinor\\_metric\(\)](#), [GiNaC::spmapkey::spmapkey\(\)](#), [sqrfree\(\)](#), [GiNaC::clifford::subs\(\)](#), [GiNaC::container< C >::subs\(\)](#), [GiNaC::idx::subs\(\)](#), [subsvalue\(\)](#), [tan\\_series\(\)](#), [tanh\\_series\(\)](#), [GiNaC::indexed::validate\(\)](#), [zeta1\\_print\\_latex\(\)](#), and [zeta2\\_print\\_latex\(\)](#).

**5.1.3.13 is\_exactly\_a()** [1/2]

```
template<class T>
bool GiNaC::is_exactly_a (
 const basic & obj) [inline]
```

Check if *obj* is a *T*, not including base classes.

Referenced by [abs\\_eval\(\)](#), [abs\\_evalf\(\)](#), [abs\\_expand\(\)](#), [acos\\_conjugate\(\)](#), [acos\\_evalf\(\)](#), [acosh\\_conjugate\(\)](#), [acosh\\_evalf\(\)](#), [adaptivesimpson\(\)](#), [GiNaC::symmetry::add\(\)](#), [GiNaC::mul::algebraic\\_subs\\_mul\(\)](#), [GiNaC::ncmul::append\\_factors\(\)](#), [asin\\_conjugate\(\)](#), [asin\\_evalf\(\)](#), [asinh\\_conjugate\(\)](#), [asinh\\_evalf\(\)](#), [atan2\\_evalf\(\)](#), [atan\\_conjugate\(\)](#), [atan\\_evalf\(\)](#),

[atanh\\_conjugate\(\)](#), [atanh\\_evalf\(\)](#), [beta\\_evalf\(\)](#), [binomial\\_eval\(\)](#), [GiNaC::mul::can\\_be\\_further\\_expanded\(\)](#), [GiNaC::mul::can\\_make\\_flat\(\)](#), [GiNaC::symmetry::canonicalize](#), [canonicalize\\_clifford\(\)](#), [GiNaC::power::coeff\(\)](#), [GiNaC::pseries::coeff\(\)](#), [collect\\_common\\_factors\(\)](#), [collect\\_symbols\(\)](#), [color\\_trace\(\)](#), [GiNaC::add::combine\\_ex\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::expairseq::combine\\_ex\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::mul::combine\\_ex\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::expairseq::combine\\_overall\\_coeff\(\)](#), [GiNaC::mul::combine\\_overall\\_coeff\(\)](#), [GiNaC::mul::combine\\_overall\\_coeff\(\)](#), [GiNaC::add::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::expairseq::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::mul::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [conjugate\\_evalf\(\)](#), [GiNaC::expairseq::construct\\_from\\_2\\_ex\(\)](#), [GiNaC::expairseq::construct\\_from\\_expairseq\\_ex\(\)](#), [GiNaC::su3d::contract\\_with\(\)](#), [GiNaC::su3f::contract\\_with\(\)](#), [GiNaC::su3t::contract\\_with\(\)](#), [GiNaC::tensepsilon::contract\\_with\(\)](#), [cos\\_eval\(\)](#), [cos\\_evalf\(\)](#), [cosh\\_eval\(\)](#), [cosh\\_evalf\(\)](#), [GiNaC::ncmul::count\\_factors\(\)](#), [csgn\\_eval\(\)](#), [csgn\\_evalf\(\)](#), [decomp\\_rational\(\)](#), [GiNaC::power::degree\(\)](#), [dirac\\_trace\(\)](#), [divide\(\)](#), [divide\\_in\\_z\(\)](#), [GiNaC::mul::do\\_print\\_latex\(\)](#), [GiNaC::power::do\\_print\\_latex\(\)](#), [GiNaC::add::eval\(\)](#), [GiNaC::indexed::eval\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::integral::evalf\(\)](#), [GiNaC::power::evalf\(\)](#), [GiNaC::power::evalm\(\)](#), [exp\\_evalf\(\)](#), [exp\\_expand\(\)](#), [GiNaC::expair::expair\(\)](#), [GiNaC::expairseq::expair\\_needs\\_further\\_processing\(\)](#), [GiNaC::mul::expair\\_needs\\_further\\_processing\(\)](#), [GiNaC::indexed::expand\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::ncmul::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::expand\\_add\(\)](#), [GiNaC::power::expand\\_add\(\)](#), [GiNaC::power::expand\\_mul\(\)](#), [factorial\\_eval\(\)](#), [factorial\\_print\\_dflt\\_latex\(\)](#), [find\\_common\\_factor\(\)](#), [find\\_variant\\_indices\(\)](#), [frac\\_cancel\(\)](#), [gcd\(\)](#), [gcd\\_pf\\_mul\(\)](#), [gcd\\_pf\\_pow\(\)](#), [get\\_first\\_symbol\(\)](#), [GiNaC::numeric::has\(\)](#), [heur\\_gcd\\_z\(\)](#), [idx\\_symmetrization\(\)](#), [imag\\_part\\_evalf\(\)](#), [GiNaC::add::integer\\_content\(\)](#), [GiNaC::mul::integer\\_content\(\)](#), [GiNaC::expairseq::is\\_canonical\(\)](#), [GiNaC::expair::is\\_canonical\\_numeric\(\)](#), [GiNaC::idx::is\\_dim\\_numeric\(\)](#), [GiNaC::idx::is\\_dim\\_symbolic\(\)](#), [GiNaC::idx::is\\_dummy\\_pair\\_symbolic\(\)](#), [GiNaC::constant::is\\_equal\\_same\\_type\(\)](#), [GiNaC::numeric::is\\_equal\\_same\\_type\(\)](#), [GiNaC::ex::is\\_exactly\\_a\(\)](#), [GiNaC::idx::is\\_numeric\(\)](#), [GiNaC::idx::is\\_symbolic\(\)](#), [is\\_the\\_function\(\)](#), [lcm\(\)](#), [lcmcoeff\(\)](#), [GiNaC::power::ldegree\(\)](#), [lgamma\\_conjugate\(\)](#), [lgamma\\_evalf\(\)](#), [Li2\\_conjugate\(\)](#), [Li2\\_evalf\(\)](#), [log\\_conjugate\(\)](#), [log\\_evalf\(\)](#), [log\\_expand\(\)](#), [lsolve\(\)](#), [GiNaC::expairseq::make\\_flat\(\)](#), [GiNaC::basic::match\(\)](#), [GiNaC::expairseq::match\(\)](#), [GiNaC::matrix::match\\_same\\_type\(\)](#), [GiNaC::relational::match\\_same\\_type\(\)](#), [GiNaC::add::max\\_coefficient\(\)](#), [GiNaC::mul::max\\_coefficient\(\)](#), [minimal\\_dim\(\)](#), [multiply\\_lcm\(\)](#), [number\\_of\\_type\(\)](#), [GiNaC::relational::operator\\_safe\\_bool\(\)](#), [GiNaC::sy\\_is\\_less::operator\(\)](#), [GiNaC::sy\\_swap::operator\(\)](#), [GiNaC::basic::operator\[\]\(\)](#), [GiNaC::basic::operator\[\]\(\)](#), [Order\\_eval\(\)](#), [Order\\_power\(\)](#), [GiNaC::matrix::pivot\(\)](#), [GiNaC::matrix::pow\(\)](#), [prem\(\)](#), [GiNaC::idx::print\\_index\(\)](#), [product\\_to\\_exvector\(\)](#), [psi1\\_evalf\(\)](#), [psi2\\_evalf\(\)](#), [quo\(\)](#), [real\\_part\\_evalf\(\)](#), [rem\(\)](#), [rename\\_dummy\\_indices\(\)](#), [rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::indexed::reposition\\_dummy\\_indices](#), [GiNaC::add::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::indexed::simplify\\_indexed\(\)](#), [GiNaC::indexed::simplify\\_indexed\\_product](#), [sin\\_eval\(\)](#), [sin\\_evalf\(\)](#), [sinh\\_eval\(\)](#), [sinh\\_evalf\(\)](#), [GiNaC::add::smod\(\)](#), [GiNaC::mul::smod\(\)](#), [GiNaC::add::split\\_ex\\_to\\_pair\(\)](#), [GiNaC::mul::split\\_ex\\_to\\_pair\(\)](#), [sprem\(\)](#), [sqfree\(\)](#), [sr\\_gcd\(\)](#), [step\\_eval\(\)](#), [step\\_evalf\(\)](#), [GiNaC::expairseq::subs\(\)](#), [GiNaC::expairseq::subschildren\(\)](#), [GiNaC::symminfo::symminfo\(\)](#), [tan\\_eval\(\)](#), [tan\\_evalf\(\)](#), [tanh\\_eval\(\)](#), [tanh\\_evalf\(\)](#), [tgamma\\_evalf\(\)](#), [GiNaC::power::to\\_polynomial\(\)](#), [tryfactsubs\(\)](#), [GiNaC::indexed::validate\(\)](#), [zeta1\\_deriv\(\)](#), [zeta1\\_eval\(\)](#), [zeta1\\_evalf\(\)](#), [zeta2\\_deriv\(\)](#), [zeta2\\_eval\(\)](#), and [zeta2\\_evalf\(\)](#).

#### 5.1.3.14 `dynallocate()` [1/2]

```

template<class B, typename... Args>
B & GiNaC::dynallocate (
 Args &&... args) [inline]

```

Constructs a new (class basic or derived) B object on the heap.

This function picks the object's ctor based on the given argument types.

This helps the constructor of ex from basic (or a derived class B) because then the constructor doesn't have to duplicate the object onto the heap. See [ex::construct\\_from\\_basic\(const basic &\)](#) for more information.

References [GiNaC::status\\_flags::dynallocated](#).

Referenced by [abs\\_expand\(\)](#), [GiNaC::numeric::add\\_dyn\(\)](#), [antisymmetric2\(\)](#), [antisymmetric3\(\)](#), [antisymmetric4\(\)](#), [base\\_and\\_index\(\)](#), [clifford\\_moebius\\_map\(\)](#), [clifford\\_star\\_bar\(\)](#), [clifford\\_unit\(\)](#), [GiNaC::add::coeff\(\)](#), [GiNaC::mul::coeff\(\)](#), [GiNaC::ncmul::coeff\(\)](#), [GiNaC::basic::collect\(\)](#), [color\\_d\(\)](#), [color\\_f\(\)](#), [color\\_ONE\(\)](#), [color\\_T\(\)](#), [color\\_trace\(\)](#), [GiNaC::add::combine\\_ex\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::diracgammaL::conjugate\(\)](#), [GiNaC::diracgammaR::conjugate\(\)](#), [GiNaC::integral::conjugate\(\)](#), [GiNaC::ncmul::conjugate\(\)](#), [GiNaC::power::conjugate\(\)](#), [GiNaC::pseries::conjugate\(\)](#), [GiNaC::ex::construct\\_from\\_double\(\)](#), [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), [GiNaC::ex::construct\\_from\\_uint\(\)](#), [GiNaC::ex::construct\\_from\\_ulong\(\)](#), [GiNaC::ex::construct\\_from\\_ulonglong\(\)](#),



[delta\\_tensor\(\)](#), [GiNaC::add::derivative\(\)](#), [GiNaC::mul::derivative\(\)](#), [GiNaC::ncmul::derivative\(\)](#), [GiNaC::power::derivative\(\)](#), [diag\\_matrix\(\)](#), [diag\\_matrix\(\)](#), [dirac\\_gamma\(\)](#), [dirac\\_gamma5\(\)](#), [dirac\\_gammaL\(\)](#), [dirac\\_gammaR\(\)](#), [dirac\\_ONE\(\)](#), [dirac\\_slash\(\)](#), [GiNaC::numeric::div\\_dyn\(\)](#), [divide\(\)](#), [divide\\_in\\_z\(\)](#), [epsilon\\_tensor\(\)](#), [epsilon\\_tensor\(\)](#), [GiNaC::add::eval\(\)](#), [GiNaC::expairseq::eval\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::ncmul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::pseries::eval\\_integ\(\)](#), [GiNaC::clifford::eval\\_ncmul\(\)](#), [GiNaC::integral::evalf\(\)](#), [GiNaC::mul::evalf\(\)](#), [GiNaC::power::evalf\(\)](#), [GiNaC::pseries::evalf\(\)](#), [GiNaC::add::evalm\(\)](#), [GiNaC::mul::evalm\(\)](#), [GiNaC::ncmul::evalm\(\)](#), [GiNaC::power::evalm\(\)](#), [GiNaC::pseries::evalm\(\)](#), [exadd\(\)](#), [exminus\(\)](#), [exmul\(\)](#), [exp\\_expand\(\)](#), [GiNaC::add::expand\(\)](#), [GiNaC::integral::expand\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::ncmul::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::pseries::expand\(\)](#), [GiNaC::power::expand\\_add\(\)](#), [GiNaC::power::expand\\_add\\_2\(\)](#), [GiNaC::power::expand\\_mul\(\)](#), [find\\_common\\_factor\(\)](#), [frac\\_cancel\(\)](#), [gcd\\_pf\\_mul\(\)](#), [get\\_clifford\\_comp\(\)](#), [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#), [GiNaC::ncmul::hold\\_ncmul\(\)](#), [GiNaC::add::imag\\_part\(\)](#), [GiNaC::pseries::imag\\_part\(\)](#), [index0\(\)](#), [index1\(\)](#), [index2\(\)](#), [index3\(\)](#), [interpolate\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [log\\_series\(\)](#), [lorentz\\_eps\(\)](#), [lorentz\\_g\(\)](#), [lst\\_to\\_matrix\(\)](#), [GiNaC::power::map\(\)](#), [GiNaC::relational::map\(\)](#), [metric\\_tensor\(\)](#), [GiNaC::numeric::mul\\_dyn\(\)](#), [GiNaC::pseries::mul\\_series\(\)](#), [multiply\\_lcm\(\)](#), [GiNaC::basic::normal\(\)](#), [GiNaC::mul::normal\(\)](#), [GiNaC::numeric::normal\(\)](#), [GiNaC::power::normal\(\)](#), [GiNaC::pseries::normal\(\)](#), [GiNaC::symbol::normal\(\)](#), [not\\_symmetric\(\)](#), [pow\(\)](#), [pow\(\)](#), [GiNaC::function::power\(\)](#), [GiNaC::pseries::power\\_const\(\)](#), [GiNaC::numeric::power\\_dyn\(\)](#), [quo\(\)](#), [GiNaC::add::real\\_part\(\)](#), [GiNaC::pseries::real\\_part\(\)](#), [GiNaC::add::recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::mul::recombine\\_pair\\_to\\_ex\(\)](#), [reduced\\_matrix\(\)](#), [GiNaC::ncmul::reeval\\_ncmul\(\)](#), [rem\(\)](#), [rename\\_dummy\\_indices\\_uniquely\(\)](#), [replace\\_with\\_symbol\(\)](#), [replace\\_with\\_symbol\(\)](#), [GiNaC::integral::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::indexed::simplify\\_indexed\(\)](#), [GiNaC::add::smod\(\)](#), [GiNaC::mul::smod\(\)](#), [spinor\\_metric\(\)](#), [GiNaC::add::split\\_ex\\_to\\_pair\(\)](#), [GiNaC::numeric::sub\\_dyn\(\)](#), [sub\\_matrix\(\)](#), [GiNaC::power::subs\(\)](#), [GiNaC::pseries::subs\(\)](#), [symbolic\\_matrix\(\)](#), [symm\(\)](#), [symmetric2\(\)](#), [symmetric3\(\)](#), [symmetric4\(\)](#), [GiNaC::ncmul::thiscontainer\(\)](#), [GiNaC::ncmul::thiscontainer\(\)](#), [GiNaC::add::thisexpairseq\(\)](#), [GiNaC::add::thisexpairseq\(\)](#), [GiNaC::mul::thisexpairseq\(\)](#), [GiNaC::mul::thisexpairseq\(\)](#), and [unit\\_matrix\(\)](#).

#### 5.1.3.15 `dynallocate()` [2/2]

```

template<class B>
B & GiNaC::dynallocate (
 std::initializer_list< ex > il) [inline]

```

Constructs a new (class basic or derived) B object on the heap.

This function is needed for [GiNaC](#) classes which have public ctors from initializer lists of expressions (which are not a type and not captured by the variadic template version).

References [GiNaC::status\\_flags::dynallocated](#).

#### 5.1.3.16 `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()` [3/33]

```

GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 clifford ,
 indexed ,
 print_func< print_dflt > &::do_print_dflt. print_func< print_latex > &::do_↵
print_latex. print_func< print_tree > &::do_print_tree)

```

References [GiNaC::clifford::do\\_print\\_dflt\(\)](#), [GiNaC::clifford::do\\_print\\_latex\(\)](#), and [GiNaC::clifford::do\\_print\\_tree\(\)](#).

#### 5.1.3.17 `print_func< print_dflt >()` [1/3]

```

GiNaC::print_func< print_dflt > (
 &diracone::do_print) &

```

References [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**5.1.3.18 GINAC\_BIND\_UNARCHIVER()** [2/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 clifford)
```

**5.1.3.19 GINAC\_BIND\_UNARCHIVER()** [3/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 cliffordunit)
```

**5.1.3.20 GINAC\_BIND\_UNARCHIVER()** [4/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 diracone)
```

**5.1.3.21 GINAC\_BIND\_UNARCHIVER()** [5/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 diracgamma)
```

**5.1.3.22 GINAC\_BIND\_UNARCHIVER()** [6/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 diracgamma5)
```

**5.1.3.23 GINAC\_BIND\_UNARCHIVER()** [7/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 diracgammaL)
```

**5.1.3.24 GINAC\_BIND\_UNARCHIVER()** [8/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 diracgammaR)
```

**5.1.3.25 is\_dirac\_slash()**

```
static bool GiNaC::is_dirac_slash (
 const ex & seq0) [static]
```

References [is\\_a\(\)](#).

Referenced by [GiNaC::clifford::do\\_print\\_dflt\(\)](#), and [GiNaC::clifford::do\\_print\\_latex\(\)](#).

### 5.1.3.26 base\_and\_index()

```
static void GiNaC::base_and_index (
 const ex & c,
 ex & b,
 ex & i) [static]
```

This function decomposes  $\gamma_\mu \rightarrow (1, \mu)$  and  $a \rightarrow (a.ix, ix)$

References [\\_ex0](#), [\\_ex1](#), [base\\_and\\_index\(\)](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [is\\_a\(\)](#), and [GiNaC::varidx::toggle\\_variance\(\)](#).

Referenced by [base\\_and\\_index\(\)](#), [canonicalize\\_clifford\(\)](#), [GiNaC::diracgamma::contract\\_with\(\)](#), and [dirac\\_trace\(\)](#).

### 5.1.3.27 dirac\_ONE()

```
ex GiNaC::dirac_ONE (
 unsigned char rl = 0)
```

Create a Clifford unity object.

#### Parameters

|           |                      |
|-----------|----------------------|
| <i>rl</i> | Representation label |
|-----------|----------------------|

#### Returns

newly constructed object

References [dynallocate\(\)](#).

Referenced by [canonicalize\\_clifford\(\)](#), [clifford\\_to\\_lst\(\)](#), [GiNaC::add::coeff\(\)](#), [GiNaC::cliffordunit::contract\\_with\(\)](#), [GiNaC::diracgamma::contract\\_with\(\)](#), [dirac\\_trace\(\)](#), [GiNaC::clifford::eval\\_ncmul\(\)](#), and [lst\\_to\\_clifford\(\)](#).

### 5.1.3.28 get\_dim\_uint()

```
static unsigned GiNaC::get_dim_uint (
 const ex & e) [static]
```

References [ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), and [GiNaC::info\\_flags::posint](#).

Referenced by [clifford\\_unit\(\)](#), and [lst\\_to\\_clifford\(\)](#).

### 5.1.3.29 clifford\_unit()

```
ex GiNaC::clifford_unit (
 const ex & mu,
 const ex & metr,
 unsigned char rl = 0)
```

Create a Clifford unit object.

## Parameters

|             |                                                                                     |
|-------------|-------------------------------------------------------------------------------------|
| <i>mu</i>   | Index (must be of class <code>varidx</code> or a derived class)                     |
| <i>metr</i> | Metric (should be indexed, <code>tensmetric</code> or a derived class, or a matrix) |
| <i>rl</i>   | Representation label                                                                |

## Returns

newly constructed Clifford unit object

References [GiNaC::matrix::cols\(\)](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [get\\_dim\\_uint\(\)](#), [GiNaC::ex::get\\_free\\_indices\(\)](#), [is\\_a\(\)](#), [not\\_symmetric\(\)](#), [GiNaC::matrix::rows\(\)](#), and [symmetric2\(\)](#).

Referenced by [clifford\\_moebius\\_map\(\)](#), and [lst\\_to\\_clifford\(\)](#).

**5.1.3.30 `dirac_gamma()`**

```
ex GiNaC::dirac_gamma (
 const ex & mu,
 unsigned char rl = 0)
```

Create a Dirac gamma object.

## Parameters

|           |                                                                 |
|-----------|-----------------------------------------------------------------|
| <i>mu</i> | Index (must be of class <code>varidx</code> or a derived class) |
| <i>rl</i> | Representation label                                            |

## Returns

newly constructed gamma object

References [dynallocate\(\)](#), [ex\\_to\(\)](#), [is\\_a\(\)](#), and [symmetric2\(\)](#).

**5.1.3.31 `dirac_gamma5()`**

```
ex GiNaC::dirac_gamma5 (
 unsigned char rl = 0)
```

Create a Dirac gamma5 object.

## Parameters

|           |                      |
|-----------|----------------------|
| <i>rl</i> | Representation label |
|-----------|----------------------|

## Returns

newly constructed object

References [dynallocate\(\)](#).

Referenced by [dirac\\_trace\(\)](#).

**5.1.3.32 `dirac_gammaL()`**

```
ex GiNaC::dirac_gammaL (
 unsigned char rl = 0)
```

Create a Dirac gammaL object.

## Parameters

|           |                      |
|-----------|----------------------|
| <i>rl</i> | Representation label |
|-----------|----------------------|

## Returns

newly constructed object

References [dynallocate\(\)](#).

Referenced by [dirac\\_trace\(\)](#).

**5.1.3.33 dirac\_gammaR()**

```
ex GiNaC::dirac_gammaR (
 unsigned char rl = 0)
```

Create a Dirac gammaR object.

## Parameters

|           |                      |
|-----------|----------------------|
| <i>rl</i> | Representation label |
|-----------|----------------------|

## Returns

newly constructed object

References [dynallocate\(\)](#).

Referenced by [dirac\\_trace\(\)](#).

**5.1.3.34 dirac\_slash()**

```
ex GiNaC::dirac_slash (
 const ex & e,
 const ex & dim,
 unsigned char rl = 0)
```

Create a term of the form  $e_\mu * \gamma_\mu$  with a unique index  $\mu$ .

## Parameters

|            |                      |
|------------|----------------------|
| <i>e</i>   | Original expression  |
| <i>dim</i> | Dimension of index   |
| <i>rl</i>  | Representation label |

References [dynallocate\(\)](#), and [symmetric2\(\)](#).

Referenced by [GiNaC::diracgamma::contract\\_with\(\)](#).

### 5.1.3.35 `get_representation_label()` [1/2]

```
static unsigned char GiNaC::get_representation_label (
 const return_type_t & ti) [static]
```

Extract representation label from tinfo key (as returned by `return_type_tinfo()`).

References [GiNaC::return\\_type\\_t::rl](#).

Referenced by [canonicalize\\_clifford\(\)](#), [clifford\\_to\\_lst\(\)](#), [color\\_trace\(\)](#), [GiNaC::su3d::contract\\_with\(\)](#), [GiNaC::su3f::contract\\_with\(\)](#), [dirac\\_trace\(\)](#), [lst\\_to\\_clifford\(\)](#), and [remove\\_dirac\\_ONE\(\)](#).

### 5.1.3.36 `trace_string()`

```
static ex GiNaC::trace_string (
 exvector::const_iterator ix,
 size_t num) [static]
```

Take trace of a string of an even number of Dirac gammas given a vector of indices.

References [lorentz\\_g\(\)](#), and [trace\\_string\(\)](#).

Referenced by [dirac\\_trace\(\)](#), and [trace\\_string\(\)](#).

### 5.1.3.37 `dirac_trace()` [1/3]

```
ex GiNaC::dirac_trace (
 const ex & e,
 const std::set< unsigned char > & rls,
 const ex & trONE = 4)
```

Calculate dirac traces over the specified set of representation labels.

The computed trace is a linear functional that is equal to the usual trace only in  $D = 4$  dimensions. In particular, the functional is not always cyclic in  $D \neq 4$  dimensions when `gamma5` is involved.

#### Parameters

|              |                                                           |
|--------------|-----------------------------------------------------------|
| <i>e</i>     | Expression to take the trace of                           |
| <i>rls</i>   | Set of representation labels                              |
| <i>trONE</i> | Expression to be returned as the trace of the unit matrix |

References [\\_ex0](#), [\\_ex1](#), [\\_ex4](#), [base\\_and\\_index\(\)](#), [dirac\\_gamma5\(\)](#), [dirac\\_gammaL\(\)](#), [dirac\\_gammaR\(\)](#), [dirac\\_ONE\(\)](#), [dirac\\_trace\(\)](#), [ex\\_to\(\)](#), [expand\(\)](#), [get\\_representation\\_label\(\)](#), [l](#), [is\\_a\(\)](#), [is\\_clifford\\_tinfo\(\)](#), [is\\_exactly\\_a\(\)](#), [lorentz\\_eps\(\)](#), [lorentz\\_g\(\)](#), [GiNaC::ex::map\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [permutation\\_sign\(\)](#), [GiNaC::ex::return\\_type\\_tinfo\(\)](#), [simplify\\_indexed\(\)](#), [GiNaC::ex::subs\(\)](#), and [trace\\_string\(\)](#).

Referenced by [dirac\\_trace\(\)](#), [dirac\\_trace\(\)](#), and [dirac\\_trace\(\)](#).

### 5.1.3.38 `dirac_trace()` [2/3]

```
ex GiNaC::dirac_trace (
 const ex & e,
 const lst & rll,
 const ex & trONE = 4)
```

Calculate dirac traces over the specified list of representation labels.

The computed trace is a linear functional that is equal to the usual trace only in  $D = 4$  dimensions. In particular, the functional is not always cyclic in  $D \neq 4$  dimensions when `gamma5` is involved.

## Parameters

|              |                                                           |
|--------------|-----------------------------------------------------------|
| <i>e</i>     | Expression to take the trace of                           |
| <i>rl</i>    | List of representation labels                             |
| <i>trONE</i> | Expression to be returned as the trace of the unit matrix |

References [dirac\\_trace\(\)](#), [ex\\_to\(\)](#), [GiNaC::info\\_flags::nonnegint](#), and [to\\_int\(\)](#).

**5.1.3.39 dirac\_trace()** [3/3]

```
ex GiNaC::dirac_trace (
 const ex & e,
 unsigned char rl = 0,
 const ex & trONE = 4)
```

Calculate the trace of an expression containing gamma objects with a specified representation label.

The computed trace is a linear functional that is equal to the usual trace only in  $D = 4$  dimensions. In particular, the functional is not always cyclic in  $D \neq 4$  dimensions when gamma5 is involved.

## Parameters

|              |                                                           |
|--------------|-----------------------------------------------------------|
| <i>e</i>     | Expression to take the trace of                           |
| <i>rl</i>    | Representation label                                      |
| <i>trONE</i> | Expression to be returned as the trace of the unit matrix |

References [dirac\\_trace\(\)](#).

**5.1.3.40 canonicalize\_clifford()**

```
ex GiNaC::canonicalize_clifford (
 const ex & e)
```

Bring all products of clifford objects in an expression into a canonical order.

This is not necessarily the most simple form but it will allow to check two expressions for equality.

References [\\_ex2](#), [base\\_and\\_index\(\)](#), [canonicalize\\_clifford\(\)](#), [dirac\\_ONE\(\)](#), [ex\\_to\(\)](#), [get\\_representation\\_label\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [is\\_clifford\\_tinfo\(\)](#), [is\\_exactly\\_a\(\)](#), [lhs\(\)](#), [GiNaC::info\\_flags::list](#), [GiNaC::ex::map\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::return\\_types::noncommutative](#), [rhs\(\)](#), [GiNaC::ex::simplify\\_indexed\(\)](#), [simplify\\_indexed\(\)](#), [GiNaC::ex::subs\(\)](#), and [GiNaC::ex::to\\_rational\(\)](#).

Referenced by [canonicalize\\_clifford\(\)](#), [clifford\\_moebius\\_map\(\)](#), [clifford\\_to\\_lst\(\)](#), and [remove\\_dirac\\_ONE\(\)](#).

**5.1.3.41 clifford\_star\_bar()**

```
ex GiNaC::clifford_star_bar (
 const ex & e,
 bool do_bar,
 unsigned options)
```

An auxillary function performing [clifford\\_star\(\)](#) and [clifford\\_bar\(\)](#).

References [clifford\\_star\\_bar\(\)](#), [dynallocate\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [GiNaC::info\\_flags::list](#), [GiNaC::ex::map\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [pow\(\)](#).

Referenced by [clifford\\_bar\(\)](#), [clifford\\_star\(\)](#), and [clifford\\_star\\_bar\(\)](#).

#### 5.1.3.42 clifford\_prime()

```
ex GiNaC::clifford_prime (
 const ex & e)
```

Automorphism of the Clifford algebra, simply changes signs of all clifford units.

References [clifford\\_prime\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [GiNaC::info\\_flags::list](#), [GiNaC::ex::map\(\)](#), [GiNaC::ex::op\(\)](#), and [pow\(\)](#).

Referenced by [clifford\\_prime\(\)](#), and [clifford\\_to\\_lst\(\)](#).

#### 5.1.3.43 remove\_dirac\_ONE()

```
ex GiNaC::remove_dirac_ONE (
 const ex & e,
 unsigned char rl = 0,
 unsigned options = 0)
```

Replaces dirac\_ONE's (with a representation\_label no less than rl) in e with 1.

For the default value rl = 0 remove all of them. Aborts if e contains any clifford\_unit with representation\_label to be removed.

##### Parameters

|                |                               |
|----------------|-------------------------------|
| <i>e</i>       | Expression to be processed    |
| <i>rl</i>      | Value of representation label |
| <i>options</i> | Defines some internal use     |

References [canonicalize\\_clifford\(\)](#), [ex\\_to\(\)](#), [expand\\_dummy\\_sum\(\)](#), [get\\_representation\\_label\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [GiNaC::info\\_flags::list](#), [GiNaC::ex::map\(\)](#), [GiNaC::ex::op\(\)](#), [pow\(\)](#), and [remove\\_dirac\\_ONE\(\)](#).

Referenced by [clifford\\_norm\(\)](#), [clifford\\_to\\_lst\(\)](#), and [remove\\_dirac\\_ONE\(\)](#).

#### 5.1.3.44 clifford\_max\_label()

```
int GiNaC::clifford_max_label (
 const ex & e,
 bool ignore_ONE = false)
```

Returns the maximal representation label of a clifford object if e contains at least one, otherwise returns -1.

##### Parameters

|                   |                                                         |
|-------------------|---------------------------------------------------------|
| <i>e</i>          | Expression to be processed                              |
| <i>ignore_ONE</i> | defines if clifford_ONE should be ignored in the search |

References [clifford\\_max\\_label\(\)](#), [ex\\_to\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [clifford\\_max\\_label\(\)](#), and [GiNaC::add::coeff\(\)](#).



**5.1.3.45 clifford\_norm()**

```
ex GiNaC::clifford_norm (
 const ex & e)
```

Calculation of the norm in the Clifford algebra.

References [clifford\\_bar\(\)](#), [remove\\_dirac\\_ONE\(\)](#), and [sqrt\(\)](#).

Referenced by [clifford\\_inverse\(\)](#).

**5.1.3.46 clifford\_inverse()**

```
ex GiNaC::clifford_inverse (
 const ex & e)
```

Calculation of the inverse in the Clifford algebra.

References [clifford\\_bar\(\)](#), [clifford\\_norm\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), and [pow\(\)](#).

Referenced by [clifford\\_moebius\\_map\(\)](#).

**5.1.3.47 lst\_to\_clifford() [1/2]**

```
ex GiNaC::lst_to_clifford (
 const ex & v,
 const ex & mu,
 const ex & metr,
 unsigned char rl = 0)
```

List or vector conversion into the Clifford vector.

**Parameters**

|             |                                                                        |
|-------------|------------------------------------------------------------------------|
| <i>v</i>    | List or vector of coordinates                                          |
| <i>mu</i>   | Index (must be of class varidx or a derived class)                     |
| <i>metr</i> | Metric (should be indexed, tensmetric or a derived class, or a matrix) |
| <i>rl</i>   | Representation label                                                   |

**Returns**

Clifford vector with given components

References [clifford\\_unit\(\)](#), [ex\\_to\(\)](#), and [lst\\_to\\_clifford\(\)](#).

Referenced by [clifford\\_moebius\\_map\(\)](#), and [lst\\_to\\_clifford\(\)](#).

**5.1.3.48 lst\_to\_clifford() [2/2]**

```
ex GiNaC::lst_to_clifford (
 const ex & v,
 const ex & e)
```

List or vector conversion into the Clifford vector.

## Parameters

|          |                               |
|----------|-------------------------------|
| <i>v</i> | List or vector of coordinates |
| <i>e</i> | Clifford unit object          |

## Returns

Clifford vector with given components

References [cols\(\)](#), [dirac\\_ONE\(\)](#), [ex\\_to\(\)](#), [get\\_dim\\_uint\(\)](#), [get\\_representation\\_label\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [GiNaC::info\\_flags::list](#), [nops\(\)](#), [GiNaC::ex::op\(\)](#), [rows\(\)](#), and [sub\\_matrix\(\)](#).

5.1.3.49 [get\\_clifford\\_comp\(\)](#)

```
static ex GiNaC::get_clifford_comp (
 const ex & e,
 const ex & c,
 bool root = true) [static]
```

Auxiliary structure to define a function for stripping one Clifford unit from vectors.

Used in [clifford\\_to\\_lst\(\)](#).

References [dynallocate\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [get\\_all\\_dummy\\_indices\(\)](#), [get\\_clifford\\_comp\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::info\\_flags::list](#), [GiNaC::ex::map\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [op\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [clifford\\_to\\_lst\(\)](#), and [get\\_clifford\\_comp\(\)](#).

5.1.3.50 [clifford\\_to\\_lst\(\)](#)

```
lst GiNaC::clifford_to_lst (
 const ex & e,
 const ex & c,
 bool algebraic = true)
```

An inverse function to [lst\\_to\\_clifford\(\)](#).

For given Clifford vector extracts its components with respect to given Clifford unit. Obtained components may contain Clifford units with a different metric. Extraction is based on the algebraic formula  $(e * c.i + c.i * e) / \text{pow}(e.i, 2)$  for non-degenerate cases (i.e. neither  $\text{pow}(e.i, 2) = 0$ ).

## Parameters

|                  |                                                                                            |
|------------------|--------------------------------------------------------------------------------------------|
| <i>e</i>         | Clifford expression to be decomposed into components                                       |
| <i>c</i>         | Clifford unit defining the metric for splitting (should have numeric dimension of indices) |
| <i>algebraic</i> | Use algebraic or symbolic algorithm for extractions                                        |

## Returns

List of components of a Clifford vector

References [GiNaC::container< C >::append\(\)](#), [canonicalize\\_clifford\(\)](#), [clifford\\_prime\(\)](#), [dirac\\_ONE\(\)](#), [ex\\_to\(\)](#), [expand\\_dummy\\_sum\(\)](#), [get\\_clifford\\_comp\(\)](#), [get\\_representation\\_label\(\)](#), [GINAC\\_ASSERT](#), [is\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::ex::op\(\)](#), [pow\(\)](#), [GiNaC::container< C >::remove\\_all\(\)](#), [remove\\_dirac\\_ONE\(\)](#), [simplify\\_indexed\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [clifford\\_moebius\\_map\(\)](#).

**5.1.3.51 clifford\_moebius\_map()** [1/2]

```
ex GiNaC::clifford_moebius_map (
 const ex & a,
 const ex & b,
 const ex & c,
 const ex & d,
 const ex & v,
 const ex & G,
 unsigned char rl = 0)
```

Calculations of Moebius transformations (conformal map) defined by a 2x2 Clifford matrix (a b\c d) in linear spaces with arbitrary signature.

The expression is  $(a * x + b)/(c * x + d)$ , where x is a vector build from list v with metric G. (see Jan Cnops. An introduction to {D}irac operators on manifolds, v.24 of Progress in Mathematical Physics. Birkhauser Boston Inc., Boston, MA, 2002.)

**Parameters**

|           |                                                                                            |
|-----------|--------------------------------------------------------------------------------------------|
| <i>a</i>  | (1,1) entry of the defining matrix                                                         |
| <i>b</i>  | (1,2) entry of the defining matrix                                                         |
| <i>c</i>  | (2,1) entry of the defining matrix                                                         |
| <i>d</i>  | (2,2) entry of the defining matrix                                                         |
| <i>v</i>  | Vector to be transformed                                                                   |
| <i>G</i>  | Metric of the surrounding space, may be a Clifford unit then the next parameter is ignored |
| <i>rl</i> | Representation label                                                                       |

**Returns**

List of components of the transformed vector

References [canonicalize\\_clifford\(\)](#), [clifford\\_inverse\(\)](#), [clifford\\_to\\_lst\(\)](#), [clifford\\_unit\(\)](#), [cols\(\)](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [G\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [GiNaC::info\\_flags::list](#), [lst\\_to\\_clifford\(\)](#), [rows\(\)](#), and [simplify\\_indexed\(\)](#).

Referenced by [clifford\\_moebius\\_map\(\)](#).

**5.1.3.52 clifford\_moebius\_map()** [2/2]

```
ex GiNaC::clifford_moebius_map (
 const ex & M,
 const ex & v,
 const ex & G,
 unsigned char rl = 0)
```

The second form of Moebius transformations defined by a 2x2 Clifford matrix M This function takes the transformation matrix M as a single entity.

**Parameters**

|           |                                                                                            |
|-----------|--------------------------------------------------------------------------------------------|
| <i>M</i>  | the defining matrix                                                                        |
| <i>v</i>  | Vector to be transformed                                                                   |
| <i>G</i>  | Metric of the surrounding space, may be a Clifford unit then the next parameter is ignored |
| <i>rl</i> | Representation label                                                                       |

**Returns**

List of components of the transformed vector

References [clifford\\_moebius\\_map\(\)](#), [cols\(\)](#), [ex\\_to\(\)](#), [G\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::op\(\)](#), and [rows\(\)](#).

**5.1.3.53 GINAC\_DECLARE\_UNARCHIVER()** [2/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 clifford)
```

**5.1.3.54 GINAC\_DECLARE\_UNARCHIVER()** [3/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 diracone)
```

**5.1.3.55 GINAC\_DECLARE\_UNARCHIVER()** [4/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 cliffordunit)
```

**5.1.3.56 GINAC\_DECLARE\_UNARCHIVER()** [5/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 diracgamma)
```

**5.1.3.57 GINAC\_DECLARE\_UNARCHIVER()** [6/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 diracgamma5)
```

**5.1.3.58 GINAC\_DECLARE\_UNARCHIVER()** [7/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 diracgammaL)
```

**5.1.3.59 GINAC\_DECLARE\_UNARCHIVER()** [8/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 diracgammaR)
```

**5.1.3.60 is\_clifford\_tinfo()**

```
bool GiNaC::is_clifford_tinfo (
 const return_type_t & ti) [inline]
```

Check whether a given [return\\_type\\_t](#) object (as returned by [return\\_type\\_tinfo\(\)](#)) is that of a clifford object (with an arbitrary representation label).

## Parameters

|           |           |
|-----------|-----------|
| <i>ti</i> | tinfo key |
|-----------|-----------|

References [GiNaC::return\\_type\\_t::tinfo](#).

Referenced by [canonicalize\\_clifford\(\)](#), [GiNaC::ncmul::conjugate\(\)](#), and [dirac\\_trace\(\)](#).

**5.1.3.61 clifford\_bar()**

```
ex GiNaC::clifford_bar (
 const ex & e) [inline]
```

Main anti-automorphism of the Clifford algebra: makes reversion and changes signs of all clifford units.

References [clifford\\_star\\_bar\(\)](#).

Referenced by [clifford\\_inverse\(\)](#), and [clifford\\_norm\(\)](#).

**5.1.3.62 clifford\_star()**

```
ex GiNaC::clifford_star (
 const ex & e) [inline]
```

Reversion of the Clifford algebra, reverse the order of all clifford units in ncmul.

References [clifford\\_star\\_bar\(\)](#).

**5.1.3.63 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT() [4/33]**

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 su3one ,
 tensor ,
 print_func< print_dflt > &::do_print, print_func< print_latex > &::do_print_↵
 latex)
```

References [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**5.1.3.64 print\_func< print\_dflt >() [2/3]**

```
GiNaC::print_func< print_dflt > (
 &su3t::do_print) &
```

References [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**5.1.3.65 GINAC\_BIND\_UNARCHIVER() [9/49]**

```
GiNaC::GINAC_BIND_UNARCHIVER (
 color)
```

**5.1.3.66 GINAC\_BIND\_UNARCHIVER()** [10/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 su3one)
```

**5.1.3.67 GINAC\_BIND\_UNARCHIVER()** [11/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 su3t)
```

**5.1.3.68 GINAC\_BIND\_UNARCHIVER()** [12/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 su3f)
```

**5.1.3.69 GINAC\_BIND\_UNARCHIVER()** [13/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 su3d)
```

References [is\\_a\(\)](#).

**5.1.3.70 permute\_free\_index\_to\_front()**

```
static ex GiNaC::permute_free_index_to_front (
 const exvector & iv3,
 const exvector & iv2,
 int & sig) [static]
```

Given a vector iv3 of three indices and a vector iv2 of two indices that is a subset of iv3, return the (free) index that is in iv3 but not in iv2 and the sign introduced by permuting that index to the front.

**Parameters**

|            |                                              |
|------------|----------------------------------------------|
| <i>iv3</i> | Vector of 3 indices                          |
| <i>iv2</i> | Vector of 2 indices, must be a subset of iv3 |
| <i>sig</i> | Returns sign introduced by index permutation |

**Returns**

the free index (the one that is in iv3 but not in iv2)

References [GINAC\\_ASSERT](#), and [TEST\\_PERMUTATION](#).

Referenced by [GiNaC::su3d::contract\\_with\(\)](#), and [GiNaC::su3f::contract\\_with\(\)](#).

**5.1.3.71 color\_ONE()**

```
ex GiNaC::color_ONE (
 unsigned char r1 = 0)
```

Create the su(3) unity element.

This is an indexed object, although it has no indices.

## Parameters

|           |                      |
|-----------|----------------------|
| <i>rl</i> | Representation label |
|-----------|----------------------|

## Returns

newly constructed unity element

References [dynallocate\(\)](#).

Referenced by [GiNaC::su3t::contract\\_with\(\)](#).

**5.1.3.72 color\_T()**

```
ex GiNaC::color_T (
 const ex & a,
 unsigned char rl = 0)
```

Create an su(3) generator.

## Parameters

|           |                      |
|-----------|----------------------|
| <i>a</i>  | Index                |
| <i>rl</i> | Representation label |

## Returns

newly constructed unity generator

References [dynallocate\(\)](#), [ex\\_to\(\)](#), and [is\\_a\(\)](#).

Referenced by [color\\_trace\(\)](#), [GiNaC::su3d::contract\\_with\(\)](#), and [GiNaC::su3f::contract\\_with\(\)](#).

**5.1.3.73 color\_f()**

```
ex GiNaC::color_f (
 const ex & a,
 const ex & b,
 const ex & c)
```

Create an su(3) antisymmetric structure constant.

## Parameters

|          |              |
|----------|--------------|
| <i>a</i> | First index  |
| <i>b</i> | Second index |
| <i>c</i> | Third index  |

## Returns

newly constructed structure constant

References [antisymmetric3\(\)](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), and [is\\_a\(\)](#).

Referenced by [color\\_h\(\)](#).

#### 5.1.3.74 `color_d()`

```
ex GiNaC::color_d (
 const ex & a,
 const ex & b,
 const ex & c)
```

Create an  $su(3)$  symmetric structure constant.

##### Parameters

|          |              |
|----------|--------------|
| <i>a</i> | First index  |
| <i>b</i> | Second index |
| <i>c</i> | Third index  |

##### Returns

newly constructed structure constant

References [dynamallocate\(\)](#), [ex\\_to\(\)](#), [is\\_a\(\)](#), and [symmetric3\(\)](#).

Referenced by [color\\_h\(\)](#).

#### 5.1.3.75 `color_h()`

```
ex GiNaC::color_h (
 const ex & a,
 const ex & b,
 const ex & c)
```

This returns the linear combination  $d.a.b.c + l*f.a.b.c$ .

References [color\\_d\(\)](#), [color\\_f\(\)](#), and [l](#).

Referenced by [color\\_trace\(\)](#).

#### 5.1.3.76 `is_color_tinfo()`

```
static bool GiNaC::is_color_tinfo (
 const return_type_t & ti) [static]
```

Check whether a given tinfo key (as returned by [return\\_type\\_tinfo\(\)](#)) is that of a color object (with an arbitrary representation label).

References [GiNaC::return\\_type\\_t::tinfo](#).

Referenced by [color\\_trace\(\)](#).



**5.1.3.77 `get_representation_label()` [2/2]**

```
static unsigned char GiNaC::get_representation_label (
 const return_type_t & ti) [static]
```

Extract representation label from tinfo key (as returned by `return_type_tinfo()`).

References [GiNaC::return\\_type\\_t::rl](#).

**5.1.3.78 `color_trace()` [1/3]**

```
ex GiNaC::color_trace (
 const ex & e,
 const std::set< unsigned char > & rls)
```

Calculate color traces over the specified set of representation labels.

## Parameters

|            |                                 |
|------------|---------------------------------|
| <i>e</i>   | Expression to take the trace of |
| <i>rls</i> | Set of representation labels    |

References [\\_ex0](#), [\\_ex1](#), [\\_ex3](#), [color\\_h\(\)](#), [color\\_T\(\)](#), [color\\_trace\(\)](#), [delta\\_tensor\(\)](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [get\\_representation\\_label\(\)](#), [is\\_a\(\)](#), [is\\_color\\_tinfo\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::map\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [GiNaC::ex::return\\_type\\_tinfo\(\)](#).

Referenced by [color\\_trace\(\)](#), [color\\_trace\(\)](#), [color\\_trace\(\)](#), and [GiNaC::su3t::contract\\_with\(\)](#).

**5.1.3.79 color\_trace()** [2/3]

```
ex GiNaC::color_trace (
 const ex & e,
 const lst & rll)
```

Calculate color traces over the specified list of representation labels.

## Parameters

|            |                                 |
|------------|---------------------------------|
| <i>e</i>   | Expression to take the trace of |
| <i>rll</i> | List of representation labels   |

References [color\\_trace\(\)](#), [ex\\_to\(\)](#), [GiNaC::info\\_flags::nonnegint](#), and [to\\_int\(\)](#).

**5.1.3.80 color\_trace()** [3/3]

```
ex GiNaC::color_trace (
 const ex & e,
 unsigned char rl = 0)
```

Calculate the trace of an expression containing color objects with a specified representation label.

## Parameters

|           |                                 |
|-----------|---------------------------------|
| <i>e</i>  | Expression to take the trace of |
| <i>rl</i> | Representation label            |

References [color\\_trace\(\)](#).

**5.1.3.81 GINAC\_DECLARE\_UNARCHIVER()** [9/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 color)
```

**5.1.3.82 GINAC\_DECLARE\_UNARCHIVER()** [10/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 su3one)
```

**5.1.3.83 GINAC\_DECLARE\_UNARCHIVER()** [11/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 su3t)
```

**5.1.3.84 GINAC\_DECLARE\_UNARCHIVER()** [12/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 su3f)
```

**5.1.3.85 GINAC\_DECLARE\_UNARCHIVER()** [13/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 su3d)
```

**5.1.3.86 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [5/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 constant ,
 basic ,
 print_func< print_context > &::do_print. print_func< print_latex > &::do_↵
print_latex. print_func< print_tree > &::do_print_tree. print_func< print_python_repr > &↵
::do_print_python_repr) const
```

References [GiNaC::constant::do\\_print\(\)](#), [GiNaC::constant::do\\_print\\_latex\(\)](#), [GiNaC::constant::do\\_print\\_python\\_repr\(\)](#), [GiNaC::constant::do\\_print\\_tree\(\)](#), [GiNaC::status\\_flags::evaluated](#), and [GiNaC::status\\_flags::expanded](#).

**5.1.3.87 GINAC\_BIND\_UNARCHIVER()** [14/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 constant)
```

**5.1.3.88 GINAC\_DECLARE\_UNARCHIVER()** [14/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 constant)
```

#### 5.1.3.89 `crc32()`

```
static unsigned GiNaC::crc32 (
 const char * c,
 const unsigned len,
 const unsigned crcinit) [static]
```

References [crctab](#).

#### 5.1.3.90 `are_ex_trivially_equal()`

```
bool GiNaC::are_ex_trivially_equal (
 const ex & e1,
 const ex & e2) [inline]
```

Compare two objects of class quickly without doing a deep tree traversal.

##### Returns

"true" if they are equal "false" if equality cannot be established quickly (e1 and e2 may still be equal, in this case).

Referenced by [GiNaC::add::conjugate\(\)](#), [GiNaC::container< std::vector >::conjugate\(\)](#), [GiNaC::expair::conjugate\(\)](#), [GiNaC::expairseq::conjugate\(\)](#), [GiNaC::integral::conjugate\(\)](#), [GiNaC::matrix::conjugate\(\)](#), [GiNaC::mul::conjugate\(\)](#), [GiNaC::power::conjugate\(\)](#), [GiNaC::pseries::conjugate\(\)](#), [GiNaC::pseries::eval\\_integ\(\)](#), [GiNaC::integral::evalf\(\)](#), [GiNaC::pseries::evalm\(\)](#), [GiNaC::indexed::expand\(\)](#), [GiNaC::integral::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::expairseq::expand\(\)](#), [GiNaC::mul::expandchildren\(\)](#), [GiNaC::ncmul::expandchildren\(\)](#), [GiNaC::expairseq::make\\_flat\(\)](#), [GiNaC::make\\_flat\\_inserter::make\\_flat\(\)](#), [GiNaC::basic::map\(\)](#), [GiNaC::idx::map\(\)](#), [GiNaC::power::map\(\)](#), [GiNaC::relational::map\(\)](#), [GiNaC::const\\_iterator::operator==\(\)](#), [GiNaC::internal::\\_iter\\_rep::operator==\(\)](#), [GiNaC::basic::subs\(\)](#), [GiNaC::clifford::subs\(\)](#), [GiNaC::idx::subs\(\)](#), [GiNaC::power::subs\(\)](#), [GiNaC::relational::subs\(\)](#), [GiNaC::container< C >::subchildren\(\)](#), and [GiNaC::expairseq::subchildren\(\)](#).

#### 5.1.3.91 `operator<<()` [3/16]

```
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const exvector & e)
```

References [get\\_print\\_context\(\)](#).

#### 5.1.3.92 `operator<<()` [4/16]

```
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const exset & e)
```

References [get\\_print\\_context\(\)](#).

**5.1.3.93 operator<<()** [5/16]

```
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const exmap & e)
```

References [get\\_print\\_context\(\)](#).

**5.1.3.94 nops()** [1/2]

```
size_t GiNaC::nops (
 const ex & thisex) [inline]
```

References [GiNaC::ex::nops\(\)](#).

Referenced by [GiNaC::container< C >::do\\_print\\_tree\(\)](#), [GiNaC::container< C >::let\\_op\(\)](#), [lst\\_to\\_clifford\(\)](#), and [GiNaC::container< C >::op\(\)](#).

**5.1.3.95 expand()** [1/2]

```
ex GiNaC::expand (
 const ex & thisex,
 unsigned options = 0) [inline]
```

References [GiNaC::ex::expand\(\)](#).

Referenced by [dirac\\_trace\(\)](#), [divide\(\)](#), [divide\\_in\\_z\(\)](#), [gcd\(\)](#), [gcd\\_pf\\_pow\(\)](#), [log\\_expand\(\)](#), [prem\(\)](#), [quo\(\)](#), [rem\(\)](#), and [sprem\(\)](#).

**5.1.3.96 conjugate()**

```
ex GiNaC::conjugate (
 const ex & thisex) [inline]
```

References [GiNaC::ex::conjugate\(\)](#).

Referenced by [conjugate\\_expl\\_derivative\(\)](#).

**5.1.3.97 real\_part()**

```
ex GiNaC::real_part (
 const ex & thisex) [inline]
```

References [GiNaC::ex::real\\_part\(\)](#).

Referenced by [cos\\_imag\\_part\(\)](#), [cos\\_real\\_part\(\)](#), [cosh\\_imag\\_part\(\)](#), [cosh\\_real\\_part\(\)](#), [exp\\_imag\\_part\(\)](#), [exp\\_real\\_part\(\)](#), [log\\_imag\\_part\(\)](#), [real\\_part\\_expl\\_derivative\(\)](#), [sin\\_imag\\_part\(\)](#), [sin\\_real\\_part\(\)](#), [sinh\\_imag\\_part\(\)](#), [sinh\\_real\\_part\(\)](#), [tan\\_imag\\_part\(\)](#), [tan\\_real\\_part\(\)](#), [tanh\\_imag\\_part\(\)](#), and [tanh\\_real\\_part\(\)](#).

### 5.1.3.98 `imag_part()`

```
ex GiNaC::imag_part (
 const ex & thisex) [inline]
```

References [GiNaC::ex::imag\\_part\(\)](#).

Referenced by [cos\\_imag\\_part\(\)](#), [cos\\_real\\_part\(\)](#), [cosh\\_imag\\_part\(\)](#), [cosh\\_real\\_part\(\)](#), [exp\\_imag\\_part\(\)](#), [exp\\_real\\_part\(\)](#), [imag\\_part\\_expl\\_derivative\(\)](#), [log\\_imag\\_part\(\)](#), [sin\\_imag\\_part\(\)](#), [sin\\_real\\_part\(\)](#), [sinh\\_imag\\_part\(\)](#), [sinh\\_real\\_part\(\)](#), [tan\\_imag\\_part\(\)](#), [tan\\_real\\_part\(\)](#), [tanh\\_imag\\_part\(\)](#), and [tanh\\_real\\_part\(\)](#).

### 5.1.3.99 `has()`

```
bool GiNaC::has (
 const ex & thisex,
 const ex & pattern,
 unsigned options = 0) [inline]
```

References [GiNaC::ex::has\(\)](#).

### 5.1.3.100 `find()`

```
bool GiNaC::find (
 const ex & thisex,
 const ex & pattern,
 exset & found) [inline]
```

References [GiNaC::ex::find\(\)](#).

### 5.1.3.101 `is_polynomial()`

```
bool GiNaC::is_polynomial (
 const ex & thisex,
 const ex & vars) [inline]
```

References [GiNaC::ex::is\\_polynomial\(\)](#).

### 5.1.3.102 `degree()`

```
int GiNaC::degree (
 const ex & thisex,
 const ex & s) [inline]
```

References [GiNaC::ex::degree\(\)](#).

Referenced by [replace\\_with\\_symbol\(\)](#), and [sqrfree\\_parfrac\(\)](#).

#### 5.1.3.103 ldegree()

```
int GiNaC::ldegree (
 const ex & thisex,
 const ex & s) [inline]
```

References [GiNaC::ex::ldegree\(\)](#).

#### 5.1.3.104 coeff()

```
ex GiNaC::coeff (
 const ex & thisex,
 const ex & s,
 int n = 1) [inline]
```

References [GiNaC::ex::coeff\(\)](#).

Referenced by [GiNaC::make\\_flat\\_inserter::handle\\_factor\(\)](#), [iterated\\_integral\\_evalf\\_impl\(\)](#), [log\\_series\(\)](#), and [sqrfree\\_parfrac\(\)](#).

#### 5.1.3.105 numer() [1/2]

```
ex GiNaC::numer (
 const ex & thisex) [inline]
```

References [GiNaC::ex::numer\(\)](#).

Referenced by [decomp\\_rational\(\)](#), [GiNaC::power::imag\\_part\(\)](#), [GiNaC::add::integer\\_content\(\)](#), [print\\_real\\_csrc\(\)](#), [GiNaC::power::real\\_part\(\)](#), [replace\\_with\\_symbol\(\)](#), and [sqrfree\\_parfrac\(\)](#).

#### 5.1.3.106 denom() [1/2]

```
ex GiNaC::denom (
 const ex & thisex) [inline]
```

References [GiNaC::ex::denom\(\)](#).

Referenced by [decomp\\_rational\(\)](#), [GiNaC::add::integer\\_content\(\)](#), [lcmcoeff\(\)](#), [print\\_real\\_csrc\(\)](#), [replace\\_with\\_symbol\(\)](#), and [sqrfree\\_parfrac\(\)](#).

#### 5.1.3.107 numer\_denom()

```
ex GiNaC::numer_denom (
 const ex & thisex) [inline]
```

References [GiNaC::ex::numer\\_denom\(\)](#).

Referenced by [decomp\\_rational\(\)](#), and [sqrfree\\_parfrac\(\)](#).

#### 5.1.3.108 normal()

```
ex GiNaC::normal (
 const ex & thisex) [inline]
```

References [GiNaC::ex::normal\(\)](#).

Referenced by [fsolve\(\)](#), [GiNaC::normal\\_map\\_function::operator\(\)\(\)](#), and [replace\\_with\\_symbol\(\)](#).

#### 5.1.3.109 to\_rational()

```
ex GiNaC::to_rational (
 const ex & thisex,
 exmap & repl) [inline]
```

References [GiNaC::ex::to\\_rational\(\)](#).

#### 5.1.3.110 to\_polynomial()

```
ex GiNaC::to_polynomial (
 const ex & thisex,
 exmap & repl) [inline]
```

References [GiNaC::ex::to\\_polynomial\(\)](#).

#### 5.1.3.111 collect()

```
ex GiNaC::collect (
 const ex & thisex,
 const ex & s,
 bool distributed = false) [inline]
```

References [GiNaC::ex::collect\(\)](#).

#### 5.1.3.112 eval()

```
ex GiNaC::eval (
 const ex & thisex) [inline]
```

References [GiNaC::ex::eval\(\)](#).

#### 5.1.3.113 evalf() [1/2]

```
ex GiNaC::evalf (
 const ex & thisex) [inline]
```

References [GiNaC::ex::evalf\(\)](#).

Referenced by [beta\\_evalf\(\)](#), [eta\\_evalf\(\)](#), [GiNaC::evalf\\_map\\_function::operator\(\)\(\)](#), and [zeta2\\_evalf\(\)](#).



#### 5.1.3.114 evalm()

```
ex GiNaC::evalm (
 const ex & thisex) [inline]
```

References [GiNaC::ex::evalm\(\)](#).

Referenced by [GiNaC::evalm\\_map\\_function::operator>\(\)\(\)](#).

#### 5.1.3.115 eval\_integ()

```
ex GiNaC::eval_integ (
 const ex & thisex) [inline]
```

References [GiNaC::ex::eval\\_integ\(\)](#).

Referenced by [GiNaC::eval\\_integ\\_map\\_function::operator>\(\)\(\)](#).

#### 5.1.3.116 diff()

```
ex GiNaC::diff (
 const ex & thisex,
 const symbol & s,
 unsigned nth = 1) [inline]
```

References [GiNaC::ex::diff\(\)](#).

Referenced by [GiNaC::derivative\\_map\\_function::operator>\(\)\(\)](#).

#### 5.1.3.117 series()

```
ex GiNaC::series (
 const ex & thisex,
 const ex & r,
 int order,
 unsigned options = 0) [inline]
```

References [GiNaC::ex::series\(\)](#).

Referenced by [atan\\_series\(\)](#), [atanh\\_series\(\)](#), [Li2\\_series\(\)](#), and [log\\_series\(\)](#).

#### 5.1.3.118 match()

```
bool GiNaC::match (
 const ex & thisex,
 const ex & pattern,
 exmap & repl_lst) [inline]
```

References [GiNaC::ex::match\(\)](#).

**5.1.3.119 simplify\_indexed()** [1/3]

```
ex GiNaC::simplify_indexed (
 const ex & thisex,
 unsigned options = 0) [inline]
```

References [GiNaC::ex::simplify\\_indexed\(\)](#).

Referenced by [canonicalize\\_clifford\(\)](#), [clifford\\_moebius\\_map\(\)](#), [clifford\\_to\\_lst\(\)](#), [dirac\\_trace\(\)](#), [GiNaC::ex::simplify\\_indexed\(\)](#), [GiNaC::ex::simplify\\_indexed\(\)](#), [GiNaC::indexed::simplify\\_indexed](#), and [GiNaC::indexed::simplify\\_indexed\\_product](#).

**5.1.3.120 simplify\_indexed()** [2/3]

```
ex GiNaC::simplify_indexed (
 const ex & thisex,
 const scalar_products & sp,
 unsigned options = 0) [inline]
```

References [GiNaC::ex::simplify\\_indexed\(\)](#).

**5.1.3.121 symmetrize()** [1/4]

```
ex GiNaC::symmetrize (
 const ex & thisex) [inline]
```

References [GiNaC::ex::symmetrize\(\)](#).

Referenced by [idx\\_symmetrization\(\)](#), [GiNaC::ex::symmetrize\(\)](#), [symmetrize\(\)](#), and [symmetrize\\_cyclic\(\)](#).

**5.1.3.122 symmetrize()** [2/4]

```
ex GiNaC::symmetrize (
 const ex & thisex,
 const lst & l) [inline]
```

References [GiNaC::ex::symmetrize\(\)](#).

**5.1.3.123 antisymmetrize()** [1/4]

```
ex GiNaC::antisymmetrize (
 const ex & thisex) [inline]
```

References [GiNaC::ex::antisymmetrize\(\)](#).

Referenced by [antisymmetrize\(\)](#), and [GiNaC::ex::antisymmetrize\(\)](#).

**5.1.3.124 antisymmetrize()** [2/4]

```
ex GiNaC::antisymmetrize (
 const ex & thisex,
 const lst & l) [inline]
```

References [GiNaC::ex::antisymmetrize\(\)](#).

**5.1.3.125 symmetrize\_cyclic()** [1/4]

```
ex GiNaC::symmetrize_cyclic (
 const ex & thisex) [inline]
```

References [GiNaC::ex::symmetrize\\_cyclic\(\)](#).

Referenced by [GiNaC::ex::symmetrize\\_cyclic\(\)](#), and [GiNaC::ex::symmetrize\\_cyclic\(\)](#).

**5.1.3.126 symmetrize\_cyclic()** [2/4]

```
ex GiNaC::symmetrize_cyclic (
 const ex & thisex,
 const lst & l) [inline]
```

References [GiNaC::ex::symmetrize\\_cyclic\(\)](#).

**5.1.3.127 op()**

```
ex GiNaC::op (
 const ex & thisex,
 size_t i) [inline]
```

References [GiNaC::ex::op\(\)](#).

Referenced by [get\\_clifford\\_comp\(\)](#), [Li2\\_series\(\)](#), and [rename\\_dummy\\_indices\(\)](#).

**5.1.3.128 lhs()**

```
ex GiNaC::lhs (
 const ex & thisex) [inline]
```

References [GiNaC::ex::lhs\(\)](#).

Referenced by [canonicalize\\_clifford\(\)](#), [GiNaC::ptr< T >::operator!=](#), [GiNaC::ptr< T >::operator!=](#), [GiNaC::const\\_iterator::operator-](#), [GiNaC::ptr< T >::operator==](#), and [GiNaC::ptr< T >::operator==](#).

**5.1.3.129 rhs()**

```
ex GiNaC::rhs (
 const ex & thisex) [inline]
```

References [GiNaC::ex::rhs\(\)](#).

Referenced by [canonicalize\\_clifford\(\)](#), [lsolve\(\)](#), [GiNaC::ptr< T >::operator!=](#), [GiNaC::ptr< T >::operator!=\(\)](#), [GiNaC::ptr< T >::operator!=](#), [GiNaC::const\\_iterator::operator-](#), [GiNaC::ptr< T >::operator<<](#), [GiNaC::ptr< T >::operator==](#), [GiNaC::ptr< T >::operator==\(\)](#), [GiNaC::ptr< T >::operator==](#), [GiNaC::matrix::solve\(\)](#), and [sqfree\\_parfrac\(\)](#).

**5.1.3.130 is\_zero()** [1/2]

```
bool GiNaC::is_zero (
 const ex & thisex) [inline]
```

References [GiNaC::ex::is\\_zero\(\)](#).

Referenced by [cosh\\_eval\(\)](#), [GiNaC::matrix::determinant\(\)](#), [GiNaC::matrix::determinant\\_minor\(\)](#), [GiNaC::tensepsilon::eval\\_indexed\(\)](#), [GiNaC::matrix::fraction\\_free\\_elimination\(\)](#), [GiNaC::matrix::gauss\\_elimination\(\)](#), [GiNaC::matrix::markowitz\\_elimination\(\)](#), [GiNaC::matrix::mul\(\)](#), [GiNaC::relational::operator safe\\_bool\(\)](#), [GiNaC::matrix::pivot\(\)](#), [sinh\\_eval\(\)](#), and [tanh\\_eval\(\)](#).

**5.1.3.131 swap()** [1/2]

```
void GiNaC::swap (
 ex & e1,
 ex & e2) [inline]
```

References [GiNaC::ex::swap\(\)](#).

Referenced by [permutation\\_sign\(\)](#), and [GiNaC::matrix::pivot\(\)](#).

**5.1.3.132 subs()** [1/3]

```
ex GiNaC::subs (
 const ex & thisex,
 const exmap & m,
 unsigned options = 0) [inline]
```

References [GiNaC::ex::subs\(\)](#).

Referenced by [Li2\\_series\(\)](#).

**5.1.3.133 subs()** [2/3]

```
ex GiNaC::subs (
 const ex & thisex,
 const lst & ls,
 const lst & lr,
 unsigned options = 0) [inline]
```

References [GiNaC::ex::subs\(\)](#).

#### 5.1.3.134 subs() [3/3]

```
ex GiNaC::subs (
 const ex & thisex,
 const ex & e,
 unsigned options = 0) [inline]
```

References [GiNaC::ex::subs\(\)](#).

#### 5.1.3.135 is\_a() [2/3]

```
template<class T>
bool GiNaC::is_a (
 const ex & obj) [inline]
```

Check if ex is a handle to a T, including base classes.

#### 5.1.3.136 is\_exactly\_a() [2/2]

```
template<class T>
bool GiNaC::is_exactly_a (
 const ex & obj) [inline]
```

Check if ex is a handle to a T, not including base classes.

#### 5.1.3.137 ex\_to()

```
template<class T>
const T & GiNaC::ex_to (
 const ex & e) [inline]
```

Return a reference to the basic-derived class T object embedded in an expression.

This is fast but unsafe: the result is undefined if the expression does not contain a T object at its top level. Hence, you should generally check the type of e first. Also, you shouldn't cache the returned reference because [GiNaC's](#) garbage collector may destroy the referenced object any time it's used in another expression.

##### Parameters

|   |            |
|---|------------|
| e | expression |
|---|------------|

##### Returns

reference to object of class T

See also

[is\\_exactly\\_a<class T>\(\)](#)

Referenced by [abs\\_eval\(\)](#), [abs\\_evalf\(\)](#), [abs\\_power\(\)](#), [acos\\_eval\(\)](#), [acos\\_evalf\(\)](#), [acosh\\_eval\(\)](#), [acosh\\_evalf\(\)](#), [adaptivesimpson\(\)](#), [GiNaC::symmetry::add\(\)](#), [GiNaC::matrix::add\\_indexed\(\)](#), [GiNaC::pseries::add\\_series\(\)](#), [antisymmetric2\(\)](#), [antisymmetric3\(\)](#), [antisymmetric4\(\)](#), [asin\\_eval\(\)](#), [asin\\_evalf\(\)](#), [asinh\\_conjugate\(\)](#), [asinh\\_eval\(\)](#), [asinh\\_evalf\(\)](#), [atan2\\_eval\(\)](#), [atan2\\_evalf\(\)](#), [atan\\_conjugate\(\)](#), [atan\\_eval\(\)](#), [atan\\_evalf\(\)](#), [atan\\_series\(\)](#), [atanh\\_eval\(\)](#), [atanh\\_evalf\(\)](#), [atanh\\_series\(\)](#), [base\\_and\\_index\(\)](#), [beta\\_eval\(\)](#), [beta\\_evalf\(\)](#), [beta\\_series\(\)](#), [binomial\\_eval\(\)](#), [GiNaC::mul::can\\_be\\_further\\_expanded\(\)](#), [GiNaC::symmetry::canonicalize](#), [canonicalize\\_clifford\(\)](#), [clifford\\_max\\_label\(\)](#), [clifford\\_moebius\\_map\(\)](#), [clifford\\_moebius\\_map\(\)](#), [clifford\\_to\\_lst\(\)](#), [clifford\\_unit\(\)](#), [GiNaC::basic::coeff\(\)](#), [GiNaC::ncmul::coeff\(\)](#), [GiNaC::power::coeff\(\)](#), [GiNaC::pseries::coeff\(\)](#), [GiNaC::basic::collect\(\)](#), [color\\_d\(\)](#), [color\\_f\(\)](#), [color\\_T\(\)](#), [color\\_trace\(\)](#), [color\\_trace\(\)](#), [GiNaC::add::combine\\_ex\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::expairseq::combine\\_overall\\_coeff\(\)](#), [GiNaC::expairseq::combine\\_overall\\_coeff\(\)](#), [GiNaC::mul::combine\\_overall\\_coeff\(\)](#), [GiNaC::mul::combine\\_overall\\_coeff\(\)](#), [GiNaC::add::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::expairseq::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::expairseq::combine\\_conjugate\\_evalf\(\)](#), [conjugate\\_expl\\_derivative\(\)](#), [GiNaC::expairseq::construct\\_from\\_2\\_ex\(\)](#), [GiNaC::expairseq::construct\\_from\\_2\\_exp](#), [GiNaC::expairseq::construct\\_from\\_expairseq\\_ex\(\)](#), [GiNaC::cliffordunit::contract\\_with\(\)](#), [GiNaC::diracgamma::contract\\_with\(\)](#), [GiNaC::matrix::contract\\_with\(\)](#), [GiNaC::spinmetric::contract\\_with\(\)](#), [GiNaC::su3d::contract\\_with\(\)](#), [GiNaC::su3f::contract\\_with\(\)](#), [GiNaC::su3t::contract\\_with\(\)](#), [cos\\_eval\(\)](#), [cos\\_evalf\(\)](#), [cosh\\_eval\(\)](#), [cosh\\_evalf\(\)](#), [csgn\\_eval\(\)](#), [csgn\\_evalf\(\)](#), [csgn\\_power\(\)](#), [csgn\\_series\(\)](#), [GiNaC::basic::degree\(\)](#), [GiNaC::mul::degree\(\)](#), [GiNaC::ncmul::degree\(\)](#), [GiNaC::power::degree\(\)](#), [GiNaC::pseries::degree\(\)](#), [dirac\\_gamma\(\)](#), [dirac\\_trace\(\)](#), [dirac\\_trace\(\)](#), [divide\(\)](#), [divide\\_in\\_z\(\)](#), [GiNaC::add::do\\_print\\_csrf\(\)](#), [GiNaC::idx::do\\_print\\_csrf\(\)](#), [GiNaC::mul::do\\_print\\_csrf\(\)](#), [GiNaC::power::do\\_print\\_csrf\(\)](#), [GiNaC::integral::do\\_print\\_latex\(\)](#), [GiNaC::mul::do\\_print\\_latex\(\)](#), [GiNaC::power::do\\_print\\_latex\(\)](#), [EllipticE\\_evalf\(\)](#), [EllipticK\\_evalf\(\)](#), [epsilon\\_tensor\(\)](#), [epsilon\\_tensor\(\)](#), [eta\\_eval\(\)](#), [eta\\_evalf\(\)](#), [GiNaC::function::eval\(\)](#), [GiNaC::indexed::eval\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::matrix::eval\\_indexed\(\)](#), [GiNaC::minkmetric::eval\\_indexed\(\)](#), [GiNaC::spinmetric::eval\\_indexed\(\)](#), [GiNaC::su3d::eval\\_indexed\(\)](#), [GiNaC::su3f::eval\\_indexed\(\)](#), [GiNaC::tensdelta::eval\\_indexed\(\)](#), [GiNaC::tensepsilon::eval\\_indexed\(\)](#), [GiNaC::tensmetric::eval\\_indexed\(\)](#), [GiNaC::clifford::eval\\_ncmul\(\)](#), [GiNaC::add::evalm\(\)](#), [GiNaC::mul::evalm\(\)](#), [GiNaC::ncmul::evalm\(\)](#), [GiNaC::power::evalm\(\)](#), [exp\\_eval\(\)](#), [exp\\_evalf\(\)](#), [GiNaC::mul::expair\\_needs\\_further\\_processing\(\)](#), [GiNaC::basic::expand\(\)](#), [GiNaC::indexed::expand\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::expand\\_add\(\)](#), [GiNaC::power::expand\\_add\\_2\(\)](#), [expand\\_dummy\\_sum\(\)](#), [GiNaC::power::expand\\_mul\(\)](#), [factorial\\_eval\(\)](#), [find\\_free\\_and\\_dummy\(\)](#), [frac\\_cancel\(\)](#), [fsolve\(\)](#), [G2\\_eval\(\)](#), [G2\\_evalf\(\)](#), [G3\\_eval\(\)](#), [G3\\_evalf\(\)](#), [gcd\(\)](#), [gcd\\_pf\\_pow\(\)](#), [generalised\\_Bernoulli\\_number\(\)](#), [get\\_all\\_dummy\\_indices\(\)](#), [get\\_all\\_dummy\\_indices\\_safely\(\)](#), [get\\_clifford\\_comp\(\)](#), [get\\_dim\\_uint\(\)](#), [GiNaC::clifford::get\\_metric\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::get\\_numerical\\_value\(\)](#), [GiNaC::Kronecker\\_dz\\_kernel::get\\_numerical\\_value\(\)](#), [GiNaC::integration\\_kernel::get\\_numerical\\_value\\_impl\(\)](#), [H\\_deriv\(\)](#), [H\\_eval\(\)](#), [H\\_evalf\(\)](#), [H\\_print\\_latex\(\)](#), [GiNaC::numeric::has\(\)](#), [GiNaC::power::has\(\)](#), [GiNaC::symmetry::has\\_cyclic\(\)](#), [GiNaC::symmetry::has\\_nonsymmetric\(\)](#), [heur\\_gcd\\_z\(\)](#), [GiNaC::power::imag\\_part\(\)](#), [imag\\_part\\_evalf\(\)](#), [imag\\_part\\_expl\\_derivative\(\)](#), [index0\(\)](#), [index1\(\)](#), [index2\(\)](#), [index3\(\)](#), [GiNaC::add::integer\\_content\(\)](#), [GiNaC::mul::integer\\_content\(\)](#), [is\\_discriminant\\_of\\_quadratic\\_number\\_field\(\)](#), [is\\_dummy\\_pair\(\)](#), [GiNaC::basic::is\\_polynomial\(\)](#), [is\\_the\\_function\(\)](#), [iterated\\_integral\\_evalf\\_impl\(\)](#), [kronecker\\_symbol\(\)](#), [lcm\(\)](#), [lcmcoeff\(\)](#), [GiNaC::basic::ldegree\(\)](#), [GiNaC::mul::ldegree\(\)](#), [GiNaC::ncmul::ldegree\(\)](#), [GiNaC::power::ldegree\(\)](#), [GiNaC::pseries::ldegree\(\)](#), [lgamma\\_eval\(\)](#), [lgamma\\_evalf\(\)](#), [lgamma\\_series\(\)](#), [Li2\\_eval\(\)](#), [Li2\\_evalf\(\)](#), [Li2\\_series\(\)](#), [Li\\_eval\(\)](#), [Li\\_evalf\(\)](#), [Li\\_print\\_latex\(\)](#), [log\\_eval\(\)](#), [log\\_evalf\(\)](#), [log\\_expand\(\)](#), [log\\_series\(\)](#), [lorentz\\_eps\(\)](#), [lsolve\(\)](#), [lst\\_to\\_clifford\(\)](#), [lst\\_to\\_clifford\(\)](#), [lst\\_to\\_matrix\(\)](#), [GiNaC::expairseq::make\\_flat\(\)](#), [GiNaC::expairseq::make\\_flat\(\)](#), [GiNaC::basic::match\(\)](#), [GiNaC::expairseq::match\(\)](#), [GiNaC::wildcard::match\(\)](#), [GiNaC::add::max\\_coefficient\(\)](#), [GiNaC::mul::max\\_coefficient\(\)](#), [GiNaC::pseries::mul\\_series\(\)](#), [multiply\\_lcm\(\)](#), [GiNaC::add::normal\(\)](#), [GiNaC::mul::normal\(\)](#), [GiNaC::power::normal\(\)](#), [not\\_symmetric\(\)](#), [GiNaC::relational::operator safe\\_bool\(\)](#), [GiNaC::idx\\_is\\_equal\\_ignore\\_dim::operator\(\)](#), [GiNaC::sy\\_is\\_less::operator\(\)](#), [GiNaC::sy\\_swap::operator\(\)](#), [GiNaC::basic::operator\[\]\(\)](#), [GiNaC::basic::operator\[\]\(\)](#), [Order\\_eval\(\)](#), [Order\\_series\(\)](#), [GiNaC::matrix::pivot\(\)](#), [GiNaC::matrix::pow\(\)](#), [GiNaC::add::print\\_add\(\)](#), [GiNaC::mul::print\\_overall\\_coeff\(\)](#), [GiNaC::indexed::printindices\(\)](#), [psi1\\_eval\(\)](#), [psi1\\_evalf\(\)](#), [psi1\\_series\(\)](#), [psi2\\_eval\(\)](#), [psi2\\_evalf\(\)](#), [psi2\\_series\(\)](#), [GiNaC::Eisenstein\\_h\\_kernel::q\\_expansion\\_modular\\_form\(\)](#), [GiNaC::Eisenstein\\_kernel::q\\_expansion\\_modular\\_form\(\)](#), [GiNaC::indexed::read\\_archive\(\)](#), [GiNaC::symbol::read\\_archive\(\)](#), [GiNaC::symmetry::read\\_archive\(\)](#), [GiNaC::power::real\\_part\(\)](#), [real\\_part\\_evalf\(\)](#), [real\\_part\\_expl\\_derivative\(\)](#), [GiNaC::add::recombine\\_pair\\_to\\_ex\(\)](#), [remove\\_dirac\\_ONE\(\)](#), [rename\\_dummy\\_indices\\_uniquely\(\)](#), [rename\\_dummy\\_indices\\_uniquely\(\)](#), [rename\\_dummy\\_indices\\_uniquely\(\)](#), [rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::tensor::replace\\_contr\\_index\(\)](#), [replace\\_with\\_symbol\(\)](#), [GiNaC::indexed::reposition\\_dummy](#), [S\\_eval\(\)](#), [S\\_evalf\(\)](#), [GiNaC::clifford::same\\_metric\(\)](#), [GiNaC::matrix::scalar\\_mul\\_indexed\(\)](#), [GiNaC::add::series\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::integral::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::pseries::series\(\)](#), [GiNaC::symbol::series\(\)](#), [GiNaC::integration\\_kernel::series\\_coeff\(\)](#), [GiNaC::Ebar\\_kernel::series\\_coeff\\_impl\(\)](#), [GiNaC::ELi\\_kernel::series\\_coeff\\_impl\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::series\\_coeff\\_impl\(\)](#), [GiNaC::Kronecker\\_dz\\_kernel::series\\_c](#), [GiNaC::multiple\\_polylog\\_kernel::series\\_coeff\\_impl\(\)](#), [series\\_to\\_poly\(\)](#), [GiNaC::indexed::simplify\\_indexed](#), [GiNaC::indexed::simplify\\_in](#), [sin\\_eval\(\)](#), [sin\\_evalf\(\)](#), [sinh\\_eval\(\)](#), [sinh\\_evalf\(\)](#), [GiNaC::add::smod\(\)](#), [GiNaC::mul::smod\(\)](#), [spinor\\_metric\(\)](#),

[GiNaC::add::split\\_ex\\_to\\_pair\(\)](#), [GiNaC::mul::split\\_ex\\_to\\_pair\(\)](#), [sqrtfree\(\)](#), [sqrtfree\\_parfrac\(\)](#), [step\\_eval\(\)](#), [step\\_evalf\(\)](#), [step\\_series\(\)](#), [GiNaC::clifford::subs\(\)](#), [GiNaC::container< C >::subs\(\)](#), [GiNaC::expairseq::subs\(\)](#), [GiNaC::power::subs\(\)](#), [GiNaC::basic::subs\\_one\\_level\(\)](#), [symmetric2\(\)](#), [symmetric3\(\)](#), [symmetric4\(\)](#), [tan\\_eval\(\)](#), [tan\\_evalf\(\)](#), [tanh\\_eval\(\)](#), [tanh\\_evalf\(\)](#), [tgamma\\_eval\(\)](#), [tgamma\\_evalf\(\)](#), [tgamma\\_series\(\)](#), [GiNaC::indexed::thiscontainer\(\)](#), [GiNaC::indexed::thiscontainer\(\)](#), [tryfactsubs\(\)](#), [GiNaC::indexed::validate\(\)](#), [zeta1\\_eval\(\)](#), [zeta1\\_evalf\(\)](#), [zeta1\\_print\\_latex\(\)](#), [zeta2\\_eval\(\)](#), [zeta2\\_evalf\(\)](#), and [zeta2\\_print\\_latex\(\)](#).

### 5.1.3.138 compile\_ex() [1/3]

```

void GiNaC::compile_ex (
 const ex & expr,
 const symbol & sym,
 FUNCP_1P & fp,
 const std::string filename = "")

```

Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.

The function pointer has type [FUNCP\\_1P](#).

#### Parameters

|                 |                                                                                                             |
|-----------------|-------------------------------------------------------------------------------------------------------------|
| <i>expr</i>     | Expression to be compiled                                                                                   |
| <i>sym</i>      | Symbol from the expression to become the function parameter                                                 |
| <i>fp</i>       | Returned function pointer                                                                                   |
| <i>filename</i> | Name of the intermediate source code and so-file. If supplied, these intermediate files will not be deleted |

### 5.1.3.139 compile\_ex() [2/3]

```

void GiNaC::compile_ex (
 const ex & expr,
 const symbol & sym1,
 const symbol & sym2,
 FUNCP_2P & fp,
 const std::string filename = "")

```

Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.

The function pointer has type [FUNCP\\_2P](#).

#### Parameters

|                 |                                                                                                             |
|-----------------|-------------------------------------------------------------------------------------------------------------|
| <i>expr</i>     | Expression to be compiled                                                                                   |
| <i>sym1</i>     | Symbol from the expression to become the first function parameter                                           |
| <i>sym2</i>     | Symbol from the expression to become the second function parameter                                          |
| <i>fp</i>       | Returned function pointer                                                                                   |
| <i>filename</i> | Name of the intermediate source code and so-file. If supplied, these intermediate files will not be deleted |

**5.1.3.140 compile\_ex()** [3/3]

```
void GiNaC::compile_ex (
 const lst & exprs,
 const lst & syms,
 FUNCP_CUBA & fp,
 const std::string filename = "")
```

Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.

The function pointer has type [FUNCP\\_CUBA](#).

**Parameters**

|                 |                                                                                                             |
|-----------------|-------------------------------------------------------------------------------------------------------------|
| <i>exprs</i>    | List of expression to be compiled                                                                           |
| <i>syms</i>     | Symbols from the expression to become the function parameters                                               |
| <i>fp</i>       | Returned function pointer                                                                                   |
| <i>filename</i> | Name of the intermediate source code and so-file. If supplied, these intermediate files will not be deleted |

**5.1.3.141 link\_ex()** [1/3]

```
void GiNaC::link_ex (
 const std::string filename,
 FUNCP_1P & fp)
```

Opens an existing so-file and returns a function pointer of type [FUNCP\\_1P](#) to the contained function.

The so-file has to be generated by `compile_ex` in advance.

**Parameters**

|                 |                                      |
|-----------------|--------------------------------------|
| <i>filename</i> | Name of the so-file to open and link |
| <i>fp</i>       | Returned function pointer            |

**5.1.3.142 link\_ex()** [2/3]

```
void GiNaC::link_ex (
 const std::string filename,
 FUNCP_2P & fp)
```

Opens an existing so-file and returns a function pointer of type [FUNCP\\_2P](#) to the contained function.

The so-file has to be generated by `compile_ex` in advance.

**Parameters**

|                 |                                      |
|-----------------|--------------------------------------|
| <i>filename</i> | Name of the so-file to open and link |
| <i>fp</i>       | Returned function pointer            |



**5.1.3.143 link\_ex()** [3/3]

```
void GiNaC::link_ex (
 const std::string filename,
 FUNCP_CUBA & fp)
```

Opens an existing so-file and returns a function pointer of type [FUNCP\\_CUBA](#) to the contained function.

The so-file has to be generated by `compile_ex` in advance.

**Parameters**

|                 |                                      |
|-----------------|--------------------------------------|
| <i>filename</i> | Name of the so-file to open and link |
| <i>fp</i>       | Returned function pointer            |

**5.1.3.144 unlink\_ex()**

```
void GiNaC::unlink_ex (
 const std::string filename)
```

Closes all linked .so files that have the supplied filename.

**Parameters**

|                 |                              |
|-----------------|------------------------------|
| <i>filename</i> | Name of the so-file to close |
|-----------------|------------------------------|

**5.1.3.145 swap()** [2/2]

```
void GiNaC::swap (
 expair & e1,
 expair & e2) [inline]
```

References [GiNaC::expair::swap\(\)](#).

**5.1.3.146 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [6/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 expairseq ,
 basic ,
 print_func< print_context > &::do_print. print_func< print_tree > &::do_print←
 _tree)
```

References [GiNaC::expairseq::do\\_print\(\)](#), and [GiNaC::expairseq::do\\_print\\_tree\(\)](#).

### 5.1.3.147 conjugateepvector()

```
epvector * GiNaC::conjugateepvector (
 const epvector &)
```

Complex conjugate every element of an epvector.

Returns zero if this does not change anything.

References [GiNaC::expair::conjugate\(\)](#), and [GiNaC::expair::is\\_equal\(\)](#).

Referenced by [GiNaC::expairseq::conjugate\(\)](#), and [GiNaC::pseries::conjugate\(\)](#).

### 5.1.3.148 factor()

```
ex GiNaC::factor (
 const ex & poly,
 unsigned options)
```

Interface function to the outside world.

Factorizes univariate and multivariate polynomials.

It uses [factor1\(\)](#) on each of the explicitly present factors of poly.

The default option is [factor\\_options::polynomial](#), which means that [factor\(\)](#) will only factorize an expression if it is a proper polynomial (i.e. the flag [info\\_flags::polynomial](#) is set). Given the option [factor\\_options::all](#), [factor\(\)](#) will factorize all subexpressions, e.g. polynomials containing functions or polynomials inside function arguments.

#### Parameters

|    |                |                                           |
|----|----------------|-------------------------------------------|
| in | <i>poly</i>    | expression to factorize                   |
| in | <i>options</i> | see <a href="#">GiNaC::factor_options</a> |

#### Returns

factorized expression

References [pow\(\)](#).

Referenced by [algebraic\\_match\\_mul\\_with\\_mul\(\)](#), [collect\\_common\\_factors\(\)](#), [GiNaC::ncmul::eval\(\)](#), [GiNaC::power::expand\\_add\(\)](#), [GiNaC::mul::expandchildren\(\)](#), [find\\_common\\_factor\(\)](#), [GiNaC::mul::find\\_real\\_imag\(\)](#), [GiNaC::mul::info\(\)](#), [GiNaC::mul::series\(\)](#), and [sqrfree\\_pfrac\(\)](#).

### 5.1.3.149 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT() [7/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 fail ,
 basic ,
 print_func< print_context > &::do_print, print_func< print_tree > &::do_print←
_tree)
```

References [GiNaC::fail::do\\_print\(\)](#), [GiNaC::basic::do\\_print\\_tree\(\)](#), and [GINAC\\_BIND\\_UNARCHIVER](#).

**5.1.3.150 GINAC\_DECLARE\_UNARCHIVER()** [15/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 fail)
```

**5.1.3.151 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [8/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 fderivative ,
 function ,
 print_func< print_context > &::do_print, print_func< print_latex > &::do_↵
print_latex, print_func< print_csrc > &::do_print_csrc, print_func< print_tree > &::do_↵
print_tree)
```

References [GiNaC::fderivative::do\\_print\(\)](#), [GiNaC::fderivative::do\\_print\\_csrc\(\)](#), [GiNaC::fderivative::do\\_print\\_latex\(\)](#), and [GiNaC::fderivative::do\\_print\\_tree\(\)](#).

**5.1.3.152 GINAC\_BIND\_UNARCHIVER()** [15/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 fderivative)
```

**5.1.3.153 GINAC\_DECLARE\_UNARCHIVER()** [16/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 fderivative)
```

**5.1.3.154 GINAC\_BIND\_UNARCHIVER()** [16/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 function)
```

**5.1.3.155 GINAC\_DECLARE\_UNARCHIVER()** [17/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 function)
```

**5.1.3.156 is\_the\_function()**

```
template<typename T>
bool GiNaC::is_the_function (
 const ex & x) [inline]
```

References [ex\\_to\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [is\\_the\\_function< G\\_SERIAL >\(\)](#), [is\\_the\\_function< iterated\\_integral\\_SERIAL >\(\)](#), [is\\_the\\_function< psi\\_SERIAL >\(\)](#), and [is\\_the\\_function< zeta\\_SERIAL >\(\)](#).

**5.1.3.157 make\_hash\_seed()**

```
static unsigned GiNaC::make_hash_seed (
 const std::type_info & tinfo) [inline], [static]
```

We need a hash function which gives different values for objects of different types.

Hence we need some unique integer for each type. Fortunately, standard C++ RTTI class 'type\_info' stores a pointer to mangled type name. Normally this pointer is the same for all objects of the same type (although it changes from run to run), so it can be used for computing hashes. However, on some platforms (such as woe32) the pointer returned by type\_info::name() might be different even for objects of the same type! Hence we need to resort to comparing string representation of the (mangled) type names. This is quite expensive, so we compare crc32 hashes of those strings. We might get more hash collisions (and slower evaluation as a result), but being a bit slower is much better than being wrong.

References [golden\\_ratio\\_hash\(\)](#).

Referenced by [GiNaC::basic::calchash\(\)](#), [GiNaC::expairseq::calchash\(\)](#), [GiNaC::function::calchash\(\)](#), [GiNaC::idx::calchash\(\)](#), [GiNaC::relational::calchash\(\)](#), [GiNaC::symbol::calchash\(\)](#), [GiNaC::symmetry::calchash\(\)](#), and [GiNaC::wildcard::calchash\(\)](#).

**5.1.3.158 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT() [9/33]**

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 idx ,
 basic ,
 print_func< print_context > &::do_print. print_func< print_latex > &::do_↵
print_latex. print_func< print_csrc > &::do_print_csrc. print_func< print_tree > &::do_↵
print_tree)
```

References [GiNaC::idx::do\\_print\(\)](#), [GiNaC::idx::do\\_print\\_csrc\(\)](#), [GiNaC::idx::do\\_print\\_latex\(\)](#), and [GiNaC::idx::do\\_print\\_tree\(\)](#).

**5.1.3.159 print\_func< print\_context >()**

```
GiNaC::print_func< print_context > (
 &varidx::do_print) &
```

**5.1.3.160 GINAC\_BIND\_UNARCHIVER() [17/49]**

```
GiNaC::GINAC_BIND_UNARCHIVER (
 idx)
```

**5.1.3.161 GINAC\_BIND\_UNARCHIVER() [18/49]**

```
GiNaC::GINAC_BIND_UNARCHIVER (
 varidx)
```

**5.1.3.162 GINAC\_BIND\_UNARCHIVER() [19/49]**

```
GiNaC::GINAC_BIND_UNARCHIVER (
 spinidx)
```

**5.1.3.163 is\_dummy\_pair()** [1/2]

```
bool GiNaC::is_dummy_pair (
 const idx & i1,
 const idx & i2)
```

Check whether two indices form a dummy pair.

References [GiNaC::idx::is\\_dummy\\_pair\\_same\\_type\(\)](#).

Referenced by [GiNaC::matrix::contract\\_with\(\)](#), [GiNaC::spinmetric::contract\\_with\(\)](#), [GiNaC::matrix::eval\\_indexed\(\)](#), [GiNaC::tensdelta::eval\\_indexed\(\)](#), [find\\_free\\_and\\_dummy\(\)](#), [GiNaC::indexed::has\\_dummy\\_index\\_for\(\)](#), [is\\_dummy\\_pair\(\)](#), [GiNaC::is\\_summation\\_idx::operator\(\)](#), [GiNaC::tensor::replace\\_contr\\_index\(\)](#), and [GiNaC::indexed::reposition\\_dummy\\_indices](#).

**5.1.3.164 is\_dummy\_pair()** [2/2]

```
bool GiNaC::is_dummy_pair (
 const ex & e1,
 const ex & e2)
```

Check whether two expressions form a dummy index pair.

References [ex\\_to\(\)](#), [is\\_a\(\)](#), and [is\\_dummy\\_pair\(\)](#).

**5.1.3.165 find\_free\_and\_dummy()** [1/2]

```
void GiNaC::find_free_and_dummy (
 exvector::const_iterator it,
 exvector::const_iterator itend,
 exvector & out_free,
 exvector & out_dummy)
```

Given a vector of indices, split them into two vectors, one containing the free indices, the other containing the dummy indices (numeric indices are neither free nor dummy ones).

**Parameters**

|                  |                                            |
|------------------|--------------------------------------------|
| <i>it</i>        | Pointer to start of index vector           |
| <i>itend</i>     | Pointer to end of index vector             |
| <i>out_free</i>  | Vector of free indices (returned, sorted)  |
| <i>out_dummy</i> | Vector of dummy indices (returned, sorted) |

References [ex\\_to\(\)](#), [is\\_dummy\\_pair\(\)](#), and [shaker\\_sort\(\)](#).

Referenced by [GiNaC::su3d::contract\\_with\(\)](#), [count\\_dummy\\_indices\(\)](#), [count\\_free\\_indices\(\)](#), [find\\_dummy\\_indices\(\)](#), [find\\_free\\_and\\_dummy\(\)](#), [get\\_all\\_dummy\\_indices\\_safely\(\)](#), [GiNaC::indexed::get\\_dummy\\_indices\(\)](#), [GiNaC::indexed::get\\_free\\_indices\(\)](#), [GiNaC::mul::get\\_free\\_indices\(\)](#), [GiNaC::ncmul::get\\_free\\_indices\(\)](#), [GiNaC::indexed::simplify\\_indexed](#), and [GiNaC::indexed::simplify\\_indexed\\_product](#).

**5.1.3.166 minimal\_dim()**

```
ex GiNaC::minimal_dim (
 const ex & dim1,
 const ex & dim2)
```

Return the minimum of two index dimensions.

If this is undecidable, throw an exception. Numeric dimensions are always considered "smaller" than symbolic dimensions.

References [is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [GiNaC::diracgamma::contract\\_with\(\)](#), [GiNaC::idx::minimal\\_dim\(\)](#), and [GiNaC::indexed::simplify\\_indexed\\_product](#).

**5.1.3.167 GINAC\_DECLARE\_UNARCHIVER()** [18/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 idx)
```

**5.1.3.168 GINAC\_DECLARE\_UNARCHIVER()** [19/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 varidx)
```

**5.1.3.169 GINAC\_DECLARE\_UNARCHIVER()** [20/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 spinidx)
```

**5.1.3.170 find\_free\_and\_dummy()** [2/2]

```
void GiNaC::find_free_and_dummy (
 const exvector & v,
 exvector & out_free,
 exvector & out_dummy) [inline]
```

Given a vector of indices, split them into two vectors, one containing the free indices, the other containing the dummy indices (numeric indices are neither free nor dummy ones).

**Parameters**

|                  |                                            |
|------------------|--------------------------------------------|
| <i>v</i>         | Index vector                               |
| <i>out_free</i>  | Vector of free indices (returned, sorted)  |
| <i>out_dummy</i> | Vector of dummy indices (returned, sorted) |

References [find\\_free\\_and\\_dummy\(\)](#).

**5.1.3.171 find\_dummy\_indices()**

```
void GiNaC::find_dummy_indices (
 const exvector & v,
 exvector & out_dummy) [inline]
```

Given a vector of indices, find the dummy indices.

## Parameters

|                  |                                            |
|------------------|--------------------------------------------|
| <i>v</i>         | Index vector                               |
| <i>out_dummy</i> | Vector of dummy indices (returned, sorted) |

References [find\\_free\\_and\\_dummy\(\)](#).

Referenced by [GiNaC::indexed::get\\_dummy\\_indices\(\)](#).

**5.1.3.172 count\_dummy\_indices()**

```
size_t GiNaC::count_dummy_indices (
 const exvector & v) [inline]
```

Count the number of dummy index pairs in an index vector.

References [find\\_free\\_and\\_dummy\(\)](#).

**5.1.3.173 count\_free\_indices()**

```
size_t GiNaC::count_free_indices (
 const exvector & v) [inline]
```

Count the number of dummy index pairs in an index vector.

References [find\\_free\\_and\\_dummy\(\)](#).

**5.1.3.174 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT() [10/33]**

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 indexed ,
 exprseq ,
 print_func< print_context > &::do_print. print_func< print_latex > &::do_↵
print_latex. print_func< print_tree > &::do_print_tree)
```

References [GiNaC::indexed::do\\_print\(\)](#), [GiNaC::indexed::do\\_print\\_latex\(\)](#), [GiNaC::indexed::do\\_print\\_tree\(\)](#), and [not\\_symmetric\(\)](#).

**5.1.3.175 GINAC\_BIND\_UNARCHIVER() [20/49]**

```
GiNaC::GINAC_BIND_UNARCHIVER (
 indexed)
```

**5.1.3.176 indices\_consistent()**

```
static bool GiNaC::indices_consistent (
 const exvector & v1,
 const exvector & v2) [static]
```

Check whether two sorted index vectors are consistent (i.e. equal).

Referenced by [GiNaC::add::get\\_free\\_indices\(\)](#), and [GiNaC::indexed::simplify\\_indexed](#).

**5.1.3.177 number\_of\_type()**

```
template<class T>
size_t GiNaC::number_of_type (
 const exvector & v)
```

References [is\\_exactly\\_a\(\)](#).

Referenced by [rename\\_dummy\\_indices\(\)](#).

**5.1.3.178 rename\_dummy\_indices()**

```
template<class T>
static ex GiNaC::rename_dummy_indices (
 const ex & e,
 exvector & global_dummy_indices,
 exvector & local_dummy_indices) [static]
```

Rename dummy indices in an expression.

**Parameters**

|                             |                                                                                                                                  |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| <i>e</i>                    | Expression to work on                                                                                                            |
| <i>local_dummy_indices</i>  | The set of dummy indices that appear in the expression "e"                                                                       |
| <i>global_dummy_indices</i> | The set of dummy indices that have appeared before and which we would like to use in "e", too. This gets updated by the function |

References [GINAC\\_ASSERT](#), [is\\_exactly\\_a\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [number\\_of\\_type\(\)](#), [op\(\)](#), [shaker\\_sort\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [GiNaC::indexed::simplify\\_indexed](#), and [GiNaC::indexed::simplify\\_indexed\\_product](#).

**5.1.3.179 find\_variant\_indices()**

```
static void GiNaC::find_variant_indices (
 const exvector & v,
 exvector & variant_indices) [static]
```

Given a set of indices, extract those of class `varidx`.

References [is\\_exactly\\_a\(\)](#).

Referenced by [GiNaC::indexed::simplify\\_indexed](#), and [GiNaC::indexed::simplify\\_indexed\\_product](#).

**5.1.3.180 reposition\_dummy\_indices()**

```
bool GiNaC::reposition_dummy_indices (
 ex & e,
 exvector & variant_dummy_indices,
 exvector & moved_indices)
```

Raise/lower dummy indices in a single indexed objects to canonicalize their variance.



## Parameters

|                              |                                                                                     |
|------------------------------|-------------------------------------------------------------------------------------|
| <i>e</i>                     | Object to work on                                                                   |
| <i>variant_dummy_indices</i> | The set of indices that might need repositioning (will be changed by this function) |
| <i>moved_indices</i>         | The set of indices that have been repositioned (will be changed by this function)   |

## Returns

true if 'e' was changed

Referenced by [GiNaC::indexed::simplify\\_indexed](#), and [GiNaC::indexed::simplify\\_indexed\\_product](#).

**5.1.3.181 product\_to\_exvector()**

```
static void GiNaC::product_to_exvector (
 const ex & e,
 exvector & v,
 bool & non_commutative) [static]
```

References [\\_ex2](#), [GINAC\\_ASSERT](#), [GiNaC::ex::is\\_equal\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [get\\_all\\_dummy\\_indices\(\)](#), and [GiNaC::indexed::simplify\\_indexed\\_product](#).

**5.1.3.182 idx\_symmetrization()**

```
template<class T>
ex GiNaC::idx_symmetrization (
 const ex & r,
 const exvector & local_dummy_indices)
```

References [is\\_exactly\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), and [symmetrize\(\)](#).

Referenced by [GiNaC::indexed::simplify\\_indexed](#), and [GiNaC::indexed::simplify\\_indexed\\_product](#).

**5.1.3.183 simplify\_indexed() [3/3]**

```
ex GiNaC::simplify_indexed (
 const ex & e,
 exvector & free_indices,
 exvector & dummy_indices,
 const scalar_products & sp)
```

Simplify indexed expression, return list of free indices.

**5.1.3.184 `simplify_indexed_product()`**

```
ex GiNaC::simplify_indexed_product (
 const ex & e,
 exvector & free_indices,
 exvector & dummy_indices,
 const scalar_products & sp)
```

Simplify product of indexed expressions (commutative, noncommutative and simple squares), return list of free indices.

Referenced by [GiNaC::indexed::simplify\\_indexed](#), and [GiNaC::indexed::simplify\\_indexed\\_product](#).

**5.1.3.185 `hasindex()`**

```
bool GiNaC::hasindex (
 const ex & x,
 const ex & sym)
```

References [hasindex\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [hasindex\(\)](#), and [GiNaC::indexed::simplify\\_indexed](#).

**5.1.3.186 `get_all_dummy_indices_safely()`**

```
exvector GiNaC::get_all_dummy_indices_safely (
 const ex & e)
```

More reliable version of the form.

The former assumes that e is an expanded expression.

References [ex\\_to\(\)](#), [find\\_free\\_and\\_dummy\(\)](#), [get\\_all\\_dummy\\_indices\\_safely\(\)](#), [GiNaC::ex::get\\_free\\_indices\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [GiNaC::mul::expand\(\)](#), [get\\_all\\_dummy\\_indices\\_safely\(\)](#), [GiNaC::make\\_flat\\_inserter::handle\\_factor\(\)](#), [rename\\_dummy\\_indices\\_uniquely\(\)](#), and [rename\\_dummy\\_indices\\_uniquely\(\)](#).

**5.1.3.187 `get_all_dummy_indices()`**

```
exvector GiNaC::get_all_dummy_indices (
 const ex & e)
```

Returns all dummy indices from the exvector.

Returns all dummy indices from the expression.

References [ex\\_to\(\)](#), [is\\_a\(\)](#), and [product\\_to\\_exvector\(\)](#).

Referenced by [expand\\_dummy\\_sum\(\)](#), [GiNaC::power::expand\\_mul\(\)](#), and [get\\_clifford\\_comp\(\)](#).

**5.1.3.188 rename\_dummy\_indices\_uniquely()** [1/4]

```
lst GiNaC::rename_dummy_indices_uniquely (
 const exvector & va,
 const exvector & vb)
```

Similar to above, where va and vb are the same and the return value is a list of two lists for substitution in b.

References [dynallocate\(\)](#), [ex\\_to\(\)](#), [is\\_a\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [GiNaC::expairseq::construct\\_from\\_2\\_ex\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::ncmul::expand\(\)](#), [GiNaC::power::expand\\_mul\(\)](#), [GiNaC::make\\_flat\\_inserter::handle\\_factor\(\)](#), [rename\\_dummy\\_indices\\_uniquely\(\)](#), [rename\\_dummy\\_indices\\_uniquely\(\)](#), and [rename\\_dummy\\_indices\\_uniquely\(\)](#).

**5.1.3.189 rename\_dummy\_indices\_uniquely()** [2/4]

```
ex GiNaC::rename_dummy_indices_uniquely (
 const exvector & va,
 const exvector & vb,
 const ex & b)
```

Same as above, where va and vb contain the indices of a and b and are sorted.

References [ex\\_to\(\)](#), [GiNaC::subs\\_options::no\\_index\\_renaming](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::ex::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [rename\\_dummy\\_indices\\_uniquely\(\)](#), and [GiNaC::ex::subs\(\)](#).

**5.1.3.190 rename\_dummy\_indices\_uniquely()** [3/4]

```
ex GiNaC::rename_dummy_indices_uniquely (
 const ex & a,
 const ex & b)
```

Returns b with all dummy indices, which are common with a, renamed.

References [ex\\_to\(\)](#), [get\\_all\\_dummy\\_indices\\_safely\(\)](#), [GiNaC::subs\\_options::no\\_index\\_renaming](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::ex::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [rename\\_dummy\\_indices\\_uniquely\(\)](#), and [GiNaC::ex::subs\(\)](#).

**5.1.3.191 rename\_dummy\_indices\_uniquely()** [4/4]

```
ex GiNaC::rename_dummy_indices_uniquely (
 exvector & va,
 const ex & b,
 bool modify_va)
```

Returns b with all dummy indices, which are listed in va, renamed if modify\_va is set to TRUE all dummy indices of b will be appended to va.

References [GiNaC::ex::begin\(\)](#), [GiNaC::ex::end\(\)](#), [ex\\_to\(\)](#), [get\\_all\\_dummy\\_indices\\_safely\(\)](#), [GiNaC::subs\\_options::no\\_index\\_renaming](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::ex::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [rename\\_dummy\\_indices\\_uniquely\(\)](#), and [GiNaC::ex::subs\(\)](#).

**5.1.3.192 expand\_dummy\_sum()**

```
ex GiNaC::expand_dummy_sum (
 const ex & e,
 bool subs_idx = false)
```

This function returns the given expression with expanded sums for all dummy index summations, where the dimensionality of the dummy index is a nonnegative integer.

Optionally all indices with a variance will be substituted by indices with the corresponding numeric values without variance.

## Parameters

|                 |                                                            |
|-----------------|------------------------------------------------------------|
| <i>e</i>        | the given expression                                       |
| <i>subs_idx</i> | indicates if variance of dummy indices should be neglected |

References [ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [expand\\_dummy\\_sum\(\)](#), [get\\_all\\_dummy\\_indices\(\)](#), [idx](#), [is\\_a\(\)](#), [GiNaC::ex::map\(\)](#), [GiNaC::info\\_flags::nonnegint](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [clifford\\_to\\_lst\(\)](#), [expand\\_dummy\\_sum\(\)](#), and [remove\\_dirac\\_ONE\(\)](#).

### 5.1.3.193 GINAC\_DECLARE\_UNARCHIVER() [21/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 indexed)
```

### 5.1.3.194 conjugate\_evalf()

```
static ex GiNaC::conjugate_evalf (
 const ex & arg) [static]
```

References [ex\\_to\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

### 5.1.3.195 conjugate\_eval()

```
static ex GiNaC::conjugate_eval (
 const ex & arg) [static]
```

References [GiNaC::ex::conjugate\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

### 5.1.3.196 conjugate\_print\_latex()

```
static void GiNaC::conjugate_print_latex (
 const ex & arg,
 const print_context & c) [static]
```

References [GiNaC::ex::print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

### 5.1.3.197 conjugate\_conjugate()

```
static ex GiNaC::conjugate_conjugate (
 const ex & arg) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.198 conjugate\_expl\_derivative()**

```
static ex GiNaC::conjugate_expl_derivative (
 const ex & arg,
 const symbol & s) [static]
```

References [conjugate\(\)](#), [GiNaC::ex::diff\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::symbol::info\(\)](#), and [GiNaC::info\\_flags::real](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.199 conjugate\_real\_part()**

```
static ex GiNaC::conjugate_real_part (
 const ex & arg) [static]
```

References [GiNaC::ex::real\\_part\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.200 conjugate\_imag\_part()**

```
static ex GiNaC::conjugate_imag_part (
 const ex & arg) [static]
```

References [GiNaC::ex::imag\\_part\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.201 func\_arg\_info()**

```
static bool GiNaC::func_arg_info (
 const ex & arg,
 unsigned inf) [static]
```

References [GiNaC::info\\_flags::cinteger](#), [GiNaC::info\\_flags::cinteger\\_polynomial](#), [GiNaC::info\\_flags::crational](#), [GiNaC::info\\_flags::crational\\_polynomial](#), [GiNaC::info\\_flags::even](#), [GiNaC::info\\_flags::has\\_indices](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::info\\_flags::integer\\_polynomial](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::negint](#), [GiNaC::info\\_flags::nonnegative](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::info\\_flags::odd](#), [GiNaC::info\\_flags::polynomial](#), [GiNaC::info\\_flags::posint](#), [GiNaC::info\\_flags::positive](#), [GiNaC::info\\_flags::prime](#), [GiNaC::info\\_flags::rational](#), [GiNaC::info\\_flags::rational\\_function](#), [GiNaC::info\\_flags::rational\\_polynomial](#), and [GiNaC::info\\_flags::real](#).

Referenced by [conjugate\\_info\(\)](#).

**5.1.3.202 conjugate\_info()**

```
static bool GiNaC::conjugate_info (
 const ex & arg,
 unsigned inf) [static]
```

References [func\\_arg\\_info\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.203 REGISTER\_FUNCTION()** [1/36]

```
GiNaC::REGISTER_FUNCTION (
 conjugate_function ,
 eval_func(conjugate_eval). evalf_func(conjugate_evalf). expl_derivative_↔
func(conjugate_expl_derivative). info_func(conjugate_info). print_func< print_latex >(conjugate_print_latex
conjugate_func(conjugate_conjugate). real_part_func(conjugate_real_part). imag_part_func(conjugate_imag_part
set_name("conjugate","conjugate"))
```

References [conjugate\\_conjugate\(\)](#), [conjugate\\_eval\(\)](#), [conjugate\\_evalf\(\)](#), [conjugate\\_expl\\_derivative\(\)](#), [conjugate\\_imag\\_part\(\)](#), [conjugate\\_info\(\)](#), [conjugate\\_print\\_latex\(\)](#), and [conjugate\\_real\\_part\(\)](#).

**5.1.3.204 real\_part\_evalf()**

```
static ex GiNaC::real_part_evalf (
 const ex & arg) [static]
```

References [ex\\_to\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.205 real\_part\_eval()**

```
static ex GiNaC::real_part_eval (
 const ex & arg) [static]
```

References [GiNaC::ex::real\\_part\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.206 real\_part\_print\_latex()**

```
static void GiNaC::real_part_print_latex (
 const ex & arg,
 const print_context & c) [static]
```

References [GiNaC::ex::print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.207 real\_part\_conjugate()**

```
static ex GiNaC::real_part_conjugate (
 const ex & arg) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.208 real\_part\_real\_part()**

```
static ex GiNaC::real_part_real_part (
 const ex & arg) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.209 real\_part\_imag\_part()**

```
static ex GiNaC::real_part_imag_part (
 const ex & arg) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.210 real\_part\_expl\_derivative()**

```
static ex GiNaC::real_part_expl_derivative (
 const ex & arg,
 const symbol & s) [static]
```

References [GiNaC::ex::diff\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::symbol::info\(\)](#), [GiNaC::info\\_flags::real](#), and [real\\_part\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.211 REGISTER\_FUNCTION() [2/36]**

```
GiNaC::REGISTER_FUNCTION (
 real_part_function ,
 eval_func(real_part_eval). evalf_func(real_part_evalf). expl_derivative_↵
func(real_part_expl_derivative). print_func< print_latex >(real_part_print_latex). conjugate_↵
_func(real_part_conjugate). real_part_func(real_part_real_part). imag_part_func(real_part_imag_part).
set_name("real_part","real_part"))
```

References [real\\_part\\_conjugate\(\)](#), [real\\_part\\_eval\(\)](#), [real\\_part\\_evalf\(\)](#), [real\\_part\\_expl\\_derivative\(\)](#), [real\\_part\\_imag\\_part\(\)](#), [real\\_part\\_print\\_latex\(\)](#), and [real\\_part\\_real\\_part\(\)](#).

**5.1.3.212 imag\_part\_evalf()**

```
static ex GiNaC::imag_part_evalf (
 const ex & arg) [static]
```

References [ex\\_to\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.213 `imag_part_eval()`**

```
static ex GiNaC::imag_part_eval (
 const ex & arg) [static]
```

References [GiNaC::ex::imag\\_part\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.214 `imag_part_print_latex()`**

```
static void GiNaC::imag_part_print_latex (
 const ex & arg,
 const print_context & c) [static]
```

References [GiNaC::ex::print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.215 `imag_part_conjugate()`**

```
static ex GiNaC::imag_part_conjugate (
 const ex & arg) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.216 `imag_part_real_part()`**

```
static ex GiNaC::imag_part_real_part (
 const ex & arg) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.217 `imag_part_imag_part()`**

```
static ex GiNaC::imag_part_imag_part (
 const ex & arg) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.218 `imag_part_expl_derivative()`**

```
static ex GiNaC::imag_part_expl_derivative (
 const ex & arg,
 const symbol & s) [static]
```

References [GiNaC::ex::diff\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [imag\\_part\(\)](#), [GiNaC::symbol::info\(\)](#), and [GiNaC::info\\_flags::real](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).



**5.1.3.219 REGISTER\_FUNCTION()** [3/36]

```
GiNaC::REGISTER_FUNCTION (
 imag_part_function ,
 eval_func(imag_part_eval). evalf_func(imag_part_evalf). expl_derivative_↔
func(imag_part_expl_derivative). print_func< print_latex >(imag_part_print_latex). conjugate_↔
_func(imag_part_conjugate). real_part_func(imag_part_real_part). imag_part_func(imag_part_imag_part).
set_name("imag_part","imag_part"))
```

References [imag\\_part\\_conjugate\(\)](#), [imag\\_part\\_eval\(\)](#), [imag\\_part\\_evalf\(\)](#), [imag\\_part\\_expl\\_derivative\(\)](#), [imag\\_part\\_imag\\_part\(\)](#), [imag\\_part\\_print\\_latex\(\)](#), and [imag\\_part\\_real\\_part\(\)](#).

**5.1.3.220 abs\_evalf()**

```
static ex GiNaC::abs_evalf (
 const ex & arg) [static]
```

References [abs\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.221 abs\_eval()**

```
static ex GiNaC::abs_eval (
 const ex & arg) [static]
```

References [abs\(\)](#), [ex\\_to\(\)](#), [exp\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_ex\\_the\\_function](#), [is\\_exactly\\_a\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::nonnegative](#), [GiNaC::ex::op\(\)](#), [GiNaC::info\\_flags::positive](#), [pow\(\)](#), [GiNaC::info\\_flags::real](#), [GiNaC::ex::real\\_part\(\)](#), and [step\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.222 abs\_expand()**

```
static ex GiNaC::abs_expand (
 const ex & arg,
 unsigned options) [static]
```

References [abs\(\)](#), [GiNaC::ex::begin\(\)](#), [dynallocate\(\)](#), [GiNaC::ex::end\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::expand\\_options::expand\\_function](#), [GiNaC::expand\\_options::expand\\_transcendental](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::basic::hold\(\)](#), [is\\_exactly\\_a\(\)](#), and [GiNaC::ex::nops\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.223 abs\_expl\_derivative()**

```
static ex GiNaC::abs_expl_derivative (
 const ex & arg,
 const symbol & s) [static]
```

References [abs\(\)](#), [GiNaC::ex::conjugate\(\)](#), and [GiNaC::ex::diff\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.224 `abs_print_latex()`

```
static void GiNaC::abs_print_latex (
 const ex & arg,
 const print_context & c) [static]
```

References [GiNaC::ex::print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.225 `abs_print_csrc_float()`

```
static void GiNaC::abs_print_csrc_float (
 const ex & arg,
 const print_context & c) [static]
```

References [GiNaC::ex::print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.226 `abs_conjugate()`

```
static ex GiNaC::abs_conjugate (
 const ex & arg) [static]
```

References [abs\(\)](#), and [GiNaC::basic::hold\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.227 `abs_real_part()`

```
static ex GiNaC::abs_real_part (
 const ex & arg) [static]
```

References [abs\(\)](#), and [GiNaC::basic::hold\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.228 `abs_imag_part()`

```
static ex GiNaC::abs_imag_part (
 const ex & arg) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.229 abs\_power()**

```
static ex GiNaC::abs_power (
 const ex & arg,
 const ex & exp) [static]
```

References [abs\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::info\\_flags::even](#), [ex\\_to\(\)](#), [exp\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [is\\_even\(\)](#), [pow\(\)](#), and [GiNaC::info\\_flags::real](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.230 abs\_info()**

```
bool GiNaC::abs_info (
 const ex & arg,
 unsigned inf)
```

References [GiNaC::info\\_flags::even](#), [GiNaC::info\\_flags::has\\_indices](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::nonnegative](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::info\\_flags::odd](#), [GiNaC::info\\_flags::positive](#), [GiNaC::info\\_flags::prime](#), and [GiNaC::info\\_flags::real](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.231 REGISTER\_FUNCTION() [4/36]**

```
GiNaC::REGISTER_FUNCTION (
 abs ,
 eval_func(abs_eval) . evalf_func(abs_evalf) . expand_func(abs_expand) . expl_↵
 derivative_func(abs_expl_derivative) . info_func(abs_info) . print_func< print_latex >(abs_print_latex) .
 print_func< print_csrc_float >(abs_print_csrc_float) . print_func< print_csrc_double >(abs_print_csrc_float)
 conjugate_func(abs_conjugate) . real_part_func(abs_real_part) . imag_part_func(abs_imag_part) .
 power_func(abs_power))
```

References [abs\(\)](#), [abs\\_conjugate\(\)](#), [abs\\_eval\(\)](#), [abs\\_evalf\(\)](#), [abs\\_expand\(\)](#), [abs\\_expl\\_derivative\(\)](#), [abs\\_imag\\_part\(\)](#), [abs\\_info\(\)](#), [abs\\_power\(\)](#), [abs\\_print\\_csrc\\_float\(\)](#), [abs\\_print\\_latex\(\)](#), and [abs\\_real\\_part\(\)](#).

**5.1.3.232 step\_evalf()**

```
static ex GiNaC::step_evalf (
 const ex & arg) [static]
```

References [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_exactly\\_a\(\)](#), and [step\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.233 step\_eval()**

```
static ex GiNaC::step_eval (
 const ex & arg) [static]
```

References [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::numeric::imag\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::numeric::is\\_real\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::numeric::real\(\)](#), and [step\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.234 `step_series()`

```
static ex GiNaC::step_series (
 const ex & arg,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [\\_ex0](#), [ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::info\\_flags::numeric](#), [step\(\)](#), [GiNaC::ex::subs\(\)](#), and [GiNaC::series\\_options::suppress\\_branchcut](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.235 `step_conjugate()`

```
static ex GiNaC::step_conjugate (
 const ex & arg) [static]
```

References [GiNaC::basic::hold\(\)](#), and [step\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.236 `step_real_part()`

```
static ex GiNaC::step_real_part (
 const ex & arg) [static]
```

References [GiNaC::basic::hold\(\)](#), and [step\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.237 `step_imag_part()`

```
static ex GiNaC::step_imag_part (
 const ex & arg) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.238 `REGISTER_FUNCTION()` [5/36]

```
GiNaC::REGISTER_FUNCTION (
 step ,
 eval_func(step_eval) . evalf_func(step_evalf) . series_func(step_series) . conjugate←
_func(step_conjugate) . real_part_func(step_real_part) . imag_part_func(step_imag_part))
```

References [step\(\)](#), [step\\_conjugate\(\)](#), [step\\_eval\(\)](#), [step\\_evalf\(\)](#), [step\\_imag\\_part\(\)](#), [step\\_real\\_part\(\)](#), and [step\\_series\(\)](#).

#### 5.1.3.239 csgn\_evalf()

```
static ex GiNaC::csgn_evalf (
 const ex & arg) [static]
```

References [csgn\(\)](#), [ex\\_to\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.240 csgn\_eval()

```
static ex GiNaC::csgn_eval (
 const ex & arg) [static]
```

References [csgn\(\)](#), [ex\\_to\(\)](#), [I](#), [GiNaC::numeric::imag\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::numeric::is\\_real\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [GiNaC::numeric::real\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.241 csgn\_series()

```
static ex GiNaC::csgn_series (
 const ex & arg,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [\\_ex0](#), [csgn\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::ex::subs\(\)](#), and [GiNaC::series\\_options::suppress\\_branchcut](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.242 csgn\_conjugate()

```
static ex GiNaC::csgn_conjugate (
 const ex & arg) [static]
```

References [csgn\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.243 csgn\_real\_part()

```
static ex GiNaC::csgn_real_part (
 const ex & arg) [static]
```

References [csgn\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.244 csgn\_imag\_part()**

```
static ex GiNaC::csgn_imag_part (
 const ex & arg) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.245 csgn\_power()**

```
static ex GiNaC::csgn_power (
 const ex & arg,
 const ex & exp) [static]
```

References [\\_ex2](#), [csgn\(\)](#), [ex\\_to\(\)](#), [exp\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_a\(\)](#), [is\\_odd\(\)](#), and [GiNaC::info\\_flags::positive](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.246 REGISTER\_FUNCTION() [6/36]**

```
GiNaC::REGISTER_FUNCTION (
 csgn ,
 eval_func(csgn_eval) . evalf_func(csgn_evalf) . series_func(csgn_series) . conjugate↔
 _func(csgn_conjugate) . real_part_func(csgn_real_part) . imag_part_func(csgn_imag_part) . power↔
 _func(csgn_power))
```

References [csgn\(\)](#), [csgn\\_conjugate\(\)](#), [csgn\\_eval\(\)](#), [csgn\\_evalf\(\)](#), [csgn\\_imag\\_part\(\)](#), [csgn\\_power\(\)](#), [csgn\\_real\\_part\(\)](#), and [csgn\\_series\(\)](#).

**5.1.3.247 eta\_evalf()**

```
static ex GiNaC::eta_evalf (
 const ex & x,
 const ex & y) [static]
```

References [\\_ex0](#), [csgn\(\)](#), [evalf\(\)](#), [ex\\_to\(\)](#), [I](#), [imag\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::numeric::is\\_negative\(\)](#), [GiNaC::numeric::is\\_real\(\)](#), [GiNaC::info\\_flags::numeric](#), [Pi](#), and [GiNaC::info\\_flags::positive](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.248 eta\_eval()**

```
static ex GiNaC::eta_eval (
 const ex & x,
 const ex & y) [static]
```

References [\\_ex0](#), [csgn\(\)](#), [ex\\_to\(\)](#), [I](#), [imag\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::numeric::is\\_negative\(\)](#), [GiNaC::numeric::is\\_real\(\)](#), [GiNaC::info\\_flags::numeric](#), [Pi](#), and [GiNaC::info\\_flags::positive](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.249 eta\_series()**

```
static ex GiNaC::eta_series (
 const ex & x,
 const ex & y,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [ex0](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::info\\_flags::numeric](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.250 eta\_conjugate()**

```
static ex GiNaC::eta_conjugate (
 const ex & x,
 const ex & y) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.251 eta\_real\_part()**

```
static ex GiNaC::eta_real_part (
 const ex & x,
 const ex & y) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.252 eta\_imag\_part()**

```
static ex GiNaC::eta_imag_part (
 const ex & x,
 const ex & y) [static]
```

References [I](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.253 REGISTER\_FUNCTION() [7/36]**

```
GiNaC::REGISTER_FUNCTION (
 eta ,
 eval_func(eta_eval). evalf_func(eta_evalf). series_func(eta_series). latex↵
_name("\\eta"). set_symmetry(sy_symm(0, 1)). conjugate_func(eta_conjugate). real_part_↵
func(eta_real_part). imag_part_func(eta_imag_part))
```

References [eta\\_conjugate\(\)](#), [eta\\_eval\(\)](#), [eta\\_evalf\(\)](#), [eta\\_imag\\_part\(\)](#), [eta\\_real\\_part\(\)](#), and [eta\\_series\(\)](#).

**5.1.3.254 Li2\_evalf()**

```
static ex GiNaC::Li2_evalf (
 const ex & x) [static]
```

References [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_exactly\\_a\(\)](#), and [Li2\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.255 Li2\_eval()**

```
static ex GiNaC::Li2_eval (
 const ex & x) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex12](#), [\\_ex1\\_2](#), [\\_ex2](#), [\\_ex6](#), [\\_ex\\_1](#), [\\_ex\\_1\\_2](#), [\\_ex\\_48](#), [Catalan](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [Li2\(\)](#), [log\(\)](#), [GiNaC::info\\_flags::numeric](#), and [Pi](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.256 Li2\_deriv()**

```
static ex GiNaC::Li2_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [\\_ex1](#), [GINAC\\_ASSERT](#), and [log\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.257 Li2\_series() [1/2]**

```
static ex GiNaC::Li2_series (
 const ex & x,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex2](#), [\\_num2\\_p](#), [ex\\_to\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [is\\_real\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::relational::lhs\(\)](#), [Li2\(\)](#), [log\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::ex::nops\(\)](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::ex::op\(\)](#), [op\(\)](#), [Pi](#), [pow\(\)](#), [GiNaC::relational::rhs\(\)](#), [GiNaC::ex::series\(\)](#), [series\(\)](#), [GiNaC::ex::subs\(\)](#), [subs\(\)](#), [GiNaC::series\\_options::suppress\\_branchcut](#), and [zeta\(\)](#).

Referenced by [Li2\\_projection\(\)](#), and [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.258 Li2\_conjugate()**

```
static ex GiNaC::Li2_conjugate (
 const ex & x) [static]
```

References [\\_num1\\_p](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::imag\\_part\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [Li2\(\)](#), and [GiNaC::info\\_flags::negative](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).



**5.1.3.259 REGISTER\_FUNCTION() [8/36]**

```
GiNaC::REGISTER_FUNCTION (
 Li2 ,
 eval_func(Li2_eval). evalf_func(Li2_evalf). derivative_func(Li2_deriv). series←
_func(Li2_series). conjugate_func(Li2_conjugate). latex_name("\\mathrm{Li}_2"))
```

References [Li2\(\)](#), [Li2\\_conjugate\(\)](#), [Li2\\_deriv\(\)](#), [Li2\\_eval\(\)](#), [Li2\\_evalf\(\)](#), and [Li2\\_series\(\)](#).

**5.1.3.260 Li3\_eval()**

```
static ex GiNaC::Li3_eval (
 const ex & x) [static]
```

References [GiNaC::ex::is\\_zero\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.261 REGISTER\_FUNCTION() [9/36]**

```
GiNaC::REGISTER_FUNCTION (
 Li3 ,
 eval_func(Li3_eval). latex_name("\\mathrm{Li}_3"))
```

References [Li3\\_eval\(\)](#).

**5.1.3.262 zetaderiv\_eval()**

```
static ex GiNaC::zetaderiv_eval (
 const ex & n,
 const ex & x) [static]
```

References [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::info\\_flags::numeric](#), and [zeta\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.263 zetaderiv\_deriv()**

```
static ex GiNaC::zetaderiv_deriv (
 const ex & n,
 const ex & x,
 unsigned deriv_param) [static]
```

References [GINAC\\_ASSERT](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.264 REGISTER\_FUNCTION() [10/36]**

```
GiNaC::REGISTER_FUNCTION (
 zetaderiv ,
 eval_func(zetaderiv_eval). derivative_func(zetaderiv_deriv). latex_name("\\zeta^\\prime")
)
```

References [zetaderiv\\_deriv\(\)](#), and [zetaderiv\\_eval\(\)](#).

**5.1.3.265 factorial\_evalf()**

```
static ex GiNaC::factorial_evalf (
 const ex & x) [static]
```

References [factorial\(\)](#), and [GiNaC::basic::hold\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.266 factorial\_eval()**

```
static ex GiNaC::factorial_eval (
 const ex & x) [static]
```

References [ex\\_to\(\)](#), [factorial\(\)](#), [GiNaC::basic::hold\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.267 factorial\_print\_dflt\_latex()**

```
static void GiNaC::factorial_print_dflt_latex (
 const ex & x,
 const print_context & c) [static]
```

References [is\\_exactly\\_a\(\)](#), [GiNaC::ex::print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.268 factorial\_conjugate()**

```
static ex GiNaC::factorial_conjugate (
 const ex & x) [static]
```

References [factorial\(\)](#), and [GiNaC::basic::hold\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.269 factorial\_real\_part()**

```
static ex GiNaC::factorial_real_part (
 const ex & x) [static]
```

References [factorial\(\)](#), and [GiNaC::basic::hold\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.270 factorial\_imag\_part()**

```
static ex GiNaC::factorial_imag_part (
 const ex & x) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.271 REGISTER\_FUNCTION() [11/36]**

```
GiNaC::REGISTER_FUNCTION (
 factorial ,
 eval_func(factorial_eval). evalf_func(factorial_evalf). print_func< print_dflt
>(factorial_print_dflt_latex). print_func< print_latex >(factorial_print_dflt_latex). conjugate←
_func(factorial_conjugate). real_part_func(factorial_real_part). imag_part_func(factorial_imag_part)
)
```

References [factorial\(\)](#), [factorial\\_conjugate\(\)](#), [factorial\\_eval\(\)](#), [factorial\\_evalf\(\)](#), [factorial\\_imag\\_part\(\)](#), [factorial\\_print\\_dflt\\_latex\(\)](#), and [factorial\\_real\\_part\(\)](#).

**5.1.3.272 binomial\_evalf()**

```
static ex GiNaC::binomial_evalf (
 const ex & x,
 const ex & y) [static]
```

References [binomial\(\)](#), and [GiNaC::basic::hold\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.273 binomial\_sym()**

```
static ex GiNaC::binomial_sym (
 const ex & x,
 const numeric & y) [static]
```

References [\\_ex0](#), [\\_ex1](#), [binomial\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::is\\_nonneg\\_integer\(\)](#), and [GiNaC::numeric::to\\_int\(\)](#).

Referenced by [binomial\\_eval\(\)](#).

**5.1.3.274 binomial\_eval()**

```
static ex GiNaC::binomial_eval (
 const ex & x,
 const ex & y) [static]
```

References [binomial\(\)](#), [binomial\\_sym\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_exactly\\_a\(\)](#), and [is\\_integer\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.275 binomial\_conjugate()**

```
static ex GiNaC::binomial_conjugate (
 const ex & x,
 const ex & y) [static]
```

References [binomial\(\)](#), and [GiNaC::basic::hold\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.276 binomial\_real\_part()**

```
static ex GiNaC::binomial_real_part (
 const ex & x,
 const ex & y) [static]
```

References [binomial\(\)](#), and [GiNaC::basic::hold\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.277 binomial\_imag\_part()**

```
static ex GiNaC::binomial_imag_part (
 const ex & x,
 const ex & y) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.278 REGISTER\_FUNCTION() [12/36]**

```
GiNaC::REGISTER_FUNCTION (
 binomial ,
 eval_func(binomial_eval) . evalf_func(binomial_evalf) . conjugate_func(binomial_conjugate) .
 real_part_func(binomial_real_part) . imag_part_func(binomial_imag_part))
```

References [binomial\(\)](#), [binomial\\_conjugate\(\)](#), [binomial\\_eval\(\)](#), [binomial\\_evalf\(\)](#), [binomial\\_imag\\_part\(\)](#), and [binomial\\_real\\_part\(\)](#).

#### 5.1.3.279 Order\_eval()

```
static ex GiNaC::Order_eval (
 const ex & x) [static]
```

References [\\_ex0](#), [\\_ex1](#), [ex\\_to\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::expairseq::nops\(\)](#), and [GiNaC::expairseq::op\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.280 Order\_series()

```
static ex GiNaC::Order_series (
 const ex & x,
 const relational & r,
 int order,
 unsigned options) [static]
```

References [\\_ex1](#), [ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [is\\_a\(\)](#), [GiNaC::ex::ldegree\(\)](#), and [GiNaC::relational::lhs\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.281 Order\_conjugate()

```
static ex GiNaC::Order_conjugate (
 const ex & x) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.282 Order\_real\_part()

```
static ex GiNaC::Order_real_part (
 const ex & x) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.283 Order\_imag\_part()

```
static ex GiNaC::Order_imag_part (
 const ex & x) [static]
```

References [GiNaC::ex::info\(\)](#), and [GiNaC::info\\_flags::real](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.284 Order\_power()

```
static ex GiNaC::Order_power (
 const ex & x,
 const ex & e) [static]
```

References [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::info\\_flags::posint](#), and [pow\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

### 5.1.3.285 Order\_expl\_derivative()

```
static ex GiNaC::Order_expl_derivative (
 const ex & arg,
 const symbol & s) [static]
```

References [GiNaC::ex::diff\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

### 5.1.3.286 REGISTER\_FUNCTION() [13/36]

```
GiNaC::REGISTER_FUNCTION (
 Order ,
 eval_func(Order_eval). series_func(Order_series). latex_name("\\mathcal{O}").
 expl_derivative_func(Order_expl_derivative). conjugate_func(Order_conjugate). real_part_func(
 func(Order_real_part). imag_part_func(Order_imag_part). power_func(Order_power))
```

References [Order\\_conjugate\(\)](#), [Order\\_eval\(\)](#), [Order\\_expl\\_derivative\(\)](#), [Order\\_imag\\_part\(\)](#), [Order\\_power\(\)](#), [Order\\_real\\_part\(\)](#), and [Order\\_series\(\)](#).

### 5.1.3.287 Isolve()

```
ex GiNaC::lsolve (
 const ex & eqns,
 const ex & symbols,
 unsigned options = solve_algo::automatic)
```

Factorial function.

Binomial function. Order term function (for truncated power series).

References [GiNaC::container< C >::append\(\)](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::matrix::cols\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::info\\_flags::exprseq](#), [GINAC\\_ASSERT](#), [GiNaC::symbolset::has\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::info\\_flags::list](#), [Isolve\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::info\\_flags::relation\\_equal](#), [rhs\(\)](#), [GiNaC::matrix::rows\(\)](#), [GiNaC::matrix::solve\(\)](#), and [GiNaC::info\\_flags::symbol](#).

Referenced by [Isolve\(\)](#).

### 5.1.3.288 fsolve()

```
const numeric GiNaC::fsolve (
 const ex & f,
 const symbol & x,
 const numeric & x1,
 const numeric & x2)
```

Find a real root of real-valued function f(x) numerically within a given interval.

The function must change sign across interval. Uses Newton- Raphson method combined with bisection in order to guarantee convergence.

## Parameters

|           |                      |
|-----------|----------------------|
| <i>f</i>  | Function f(x)        |
| <i>x</i>  | Symbol f(x)          |
| <i>x1</i> | lower interval limit |
| <i>x2</i> | upper interval limit |

## Exceptions

|                      |                           |
|----------------------|---------------------------|
| <i>runtime_error</i> | (if interval is invalid). |
|----------------------|---------------------------|

References [GiNaC::ex::diff\(\)](#), [GiNaC::ex::evalf\(\)](#), [ex\\_to\(\)](#), [is\\_a\(\)](#), [is\\_real\(\)](#), [GiNaC::numeric::is\\_real\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [GiNaC::ex::lhs\(\)](#), [normal\(\)](#), [GiNaC::ex::rhs\(\)](#), and [GiNaC::ex::subs\(\)](#).

**5.1.3.289 zeta()** [1/3]

```
template<typename T1>
function GiNaC::zeta (
 const T1 & p1) [inline]
```

References [GiNaC::zeta1\\_SERIAL::serial](#).

Referenced by [Li2\\_series\(\)](#), [Li\\_eval\(\)](#), [psi2\\_eval\(\)](#), [S\\_eval\(\)](#), [zeta1\\_eval\(\)](#), [zeta1\\_evalf\(\)](#), [zeta2\\_eval\(\)](#), [zeta2\\_evalf\(\)](#), and [zetaderiv\\_eval\(\)](#).

**5.1.3.290 zeta()** [2/3]

```
template<typename T1, typename T2>
function GiNaC::zeta (
 const T1 & p1,
 const T2 & p2) [inline]
```

References [GiNaC::zeta2\\_SERIAL::serial](#).

**5.1.3.291 is\_the\_function< zeta\_SERIAL >()**

```
template<>
bool GiNaC::is_the_function< zeta_SERIAL > (
 const ex & x) [inline]
```

References [is\\_the\\_function\(\)](#).

**5.1.3.292 G()** [1/2]

```
template<typename T1, typename T2>
function GiNaC::G (
 const T1 & x,
 const T2 & y) [inline]
```

References [GiNaC::G2\\_SERIAL::serial](#).

Referenced by [clifford\\_moebius\\_map\(\)](#), [clifford\\_moebius\\_map\(\)](#), [G2\\_eval\(\)](#), [G2\\_evalf\(\)](#), [G3\\_eval\(\)](#), and [G3\\_evalf\(\)](#).

**5.1.3.293 G()** [2/2]

```
template<typename T1, typename T2, typename T3>
function GiNaC::G (
 const T1 & x,
 const T2 & s,
 const T3 & y) [inline]
```

References [GiNaC::G3\\_SERIAL::serial](#).

**5.1.3.294 is\_the\_function< G\_SERIAL >()**

```
template<>
bool GiNaC::is_the_function< G_SERIAL > (
 const ex & x) [inline]
```

References [is\\_the\\_function\(\)](#).

**5.1.3.295 psi()** [1/4]

```
template<typename T1>
function GiNaC::psi (
 const T1 & p1) [inline]
```

References [GiNaC::psi1\\_SERIAL::serial](#).

Referenced by [beta\\_deriv\(\)](#), [lgamma\\_deriv\(\)](#), [psi1\\_deriv\(\)](#), [psi1\\_eval\(\)](#), [psi1\\_evalf\(\)](#), [psi1\\_series\(\)](#), [psi2\\_deriv\(\)](#), [psi2\\_eval\(\)](#), [psi2\\_evalf\(\)](#), [psi2\\_series\(\)](#), [sr\\_gcd\(\)](#), and [tgamma\\_deriv\(\)](#).

**5.1.3.296 psi()** [2/4]

```
template<typename T1, typename T2>
function GiNaC::psi (
 const T1 & p1,
 const T2 & p2) [inline]
```

References [GiNaC::psi2\\_SERIAL::serial](#).

**5.1.3.297 is\_the\_function< psi\_SERIAL >()**

```
template<>
bool GiNaC::is_the_function< psi_SERIAL > (
 const ex & x) [inline]
```

References [is\\_the\\_function\(\)](#).



**5.1.3.298 iterated\_integral()** [1/2]

```
template<typename T1, typename T2>
function GiNaC::iterated_integral (
 const T1 & kernel_lst,
 const T2 & lambda) [inline]
```

References [GiNaC::iterated\\_integral2\\_SERIAL::serial](#).

Referenced by [iterated\\_integral2\\_eval\(\)](#), [iterated\\_integral3\\_eval\(\)](#), and [iterated\\_integral\\_evalf\\_impl\(\)](#).

**5.1.3.299 iterated\_integral()** [2/2]

```
template<typename T1, typename T2, typename T3>
function GiNaC::iterated_integral (
 const T1 & kernel_lst,
 const T2 & lambda,
 const T3 & N_trunc) [inline]
```

References [GiNaC::iterated\\_integral3\\_SERIAL::serial](#).

**5.1.3.300 is\_the\_function< iterated\_integral\_SERIAL >()**

```
template<>
bool GiNaC::is_the_function< iterated_integral_SERIAL > (
 const ex & x) [inline]
```

References [is\\_the\\_function\(\)](#).

**5.1.3.301 is\_order\_function()**

```
bool GiNaC::is_order_function (
 const ex & e) [inline]
```

Check whether a function is the Order (O(n)) function.

References [is\\_ex\\_the\\_function](#).

Referenced by [GiNaC::pseries::add\\_series\(\)](#), [GiNaC::pseries::convert\\_to\\_poly\(\)](#), [GiNaC::pseries::derivative\(\)](#), [GiNaC::pseries::is\\_terminating\(\)](#), [GiNaC::pseries::mul\\_const\(\)](#), [GiNaC::pseries::mul\\_series\(\)](#), [GiNaC::pseries::op\(\)](#), [GiNaC::pseries::power\\_const\(\)](#), [GiNaC::pseries::print\\_series\(\)](#), and [GiNaC::integral::series\(\)](#).

**5.1.3.302 convert\_H\_to\_Li()**

```
ex GiNaC::convert_H_to_Li (
 const ex & parameterlst,
 const ex & arg)
```

Converts a given list containing parameters for H in Remiddi/Vermaseren notation into the corresponding [GiNaC](#) functions.

References [is\\_a\(\)](#).

**5.1.3.303 EllipticK\_evalf()**

```
static ex GiNaC::EllipticK_evalf (
 const ex & k) [static]
```

References [GiNaC::ex::evalf\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::numeric](#), [Pi](#), and [sqrt\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.304 EllipticK\_eval()**

```
static ex GiNaC::EllipticK_eval (
 const ex & k) [static]
```

References [\\_ex0](#), [GiNaC::info\\_flags::crational](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::numeric](#), and [Pi](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.305 EllipticK\_deriv()**

```
static ex GiNaC::EllipticK_deriv (
 const ex & k,
 unsigned deriv_param) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.306 EllipticK\_series()**

```
static ex GiNaC::EllipticK_series (
 const ex & k,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex\\_1](#), [GiNaC::subs\\_options::no\\_pattern](#), [Pi](#), [pow\(\)](#), [GiNaC::ex::series\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.307 EllipticK\_print\_latex()**

```
static void GiNaC::EllipticK_print_latex (
 const ex & k,
 const print_context & c) [static]
```

References [GiNaC::ex::print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.308 REGISTER\_FUNCTION() [14/36]**

```
GiNaC::REGISTER_FUNCTION (
 EllipticK ,
 evalf_func(EllipticK_evalf). eval_func(EllipticK_eval). derivative_func(EllipticK_deriv).
 series_func(EllipticK_series). print_func< print_latex >(EllipticK_print_latex). do_not_↵
 evalf_params())
```

References [EllipticK\\_deriv\(\)](#), [EllipticK\\_eval\(\)](#), [EllipticK\\_evalf\(\)](#), [EllipticK\\_print\\_latex\(\)](#), and [EllipticK\\_series\(\)](#).

**5.1.3.309 EllipticE\_evalf()**

```
static ex GiNaC::EllipticE_evalf (
 const ex & k) [static]
```

References [GiNaC::ex::evalf\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::numeric](#), [Pi](#), and [sqrt\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.310 EllipticE\_eval()**

```
static ex GiNaC::EllipticE_eval (
 const ex & k) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex\\_1](#), [GiNaC::info\\_flags::crational](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::numeric](#), and [Pi](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.311 EllipticE\_deriv()**

```
static ex GiNaC::EllipticE_deriv (
 const ex & k,
 unsigned deriv_param) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.312 EllipticE\_series()**

```
static ex GiNaC::EllipticE_series (
 const ex & k,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex\\_1](#), [GiNaC::subs\\_options::no\\_pattern](#), [Pi](#), [pow\(\)](#), [GiNaC::ex::series\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.313 EllipticE\_print\_latex()**

```
static void GiNaC::EllipticE_print_latex (
 const ex & k,
 const print_context & c) [static]
```

References [GiNaC::ex::print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.314 REGISTER\_FUNCTION() [15/36]**

```
GiNaC::REGISTER_FUNCTION (
 EllipticE ,
 evalf_func(EllipticE_evalf). eval_func(EllipticE_eval). derivative_func(EllipticE_deriv).
 series_func(EllipticE_series). print_func< print_latex >(EllipticE_print_latex). do_not_↵
 evalf_params())
```

References [EllipticE\\_deriv\(\)](#), [EllipticE\\_eval\(\)](#), [EllipticE\\_evalf\(\)](#), [EllipticE\\_print\\_latex\(\)](#), and [EllipticE\\_series\(\)](#).

**5.1.3.315 iterated\_integral\_evalf\_impl()**

```
static ex GiNaC::iterated_integral_evalf_impl (
 const ex & kernel_lst,
 const ex & lambda,
 const ex & N_trunc) [static]
```

References [coeff\(\)](#), [Digits](#), [GiNaC::ex::evalf\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [iterated\\_integral\(\)](#), [GiNaC::info\\_flags::list](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::container< C >::nops\(\)](#), and [GiNaC::info\\_flags::numeric](#).

Referenced by [iterated\\_integral2\\_evalf\(\)](#), and [iterated\\_integral3\\_evalf\(\)](#).

**5.1.3.316 iterated\_integral2\_evalf()**

```
static ex GiNaC::iterated_integral2_evalf (
 const ex & kernel_lst,
 const ex & lambda) [static]
```

References [iterated\\_integral\\_evalf\\_impl\(\)](#).

**5.1.3.317 iterated\_integral3\_evalf()**

```
static ex GiNaC::iterated_integral3_evalf (
 const ex & kernel_lst,
 const ex & lambda,
 const ex & N_trunc) [static]
```

References [iterated\\_integral\\_evalf\\_impl\(\)](#).

**5.1.3.318 iterated\_integral2\_eval()**

```
static ex GiNaC::iterated_integral2_eval (
 const ex & kernel_lst,
 const ex & lambda) [static]
```

References [GiNaC::info\\_flags::crational](#), [GiNaC::function::evalf\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [iterated\\_integral\(\)](#), and [GiNaC::info\\_flags::numeric](#).

**5.1.3.319 iterated\_integral3\_eval()**

```
static ex GiNaC::iterated_integral3_eval (
 const ex & kernel_lst,
 const ex & lambda,
 const ex & N_trunc) [static]
```

References [GiNaC::info\\_flags::crational](#), [GiNaC::function::evalf\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [iterated\\_integral\(\)](#), and [GiNaC::info\\_flags::numeric](#).

**5.1.3.320 lgamma\_evalf()**

```
static ex GiNaC::lgamma_evalf (
 const ex & x) [static]
```

References [ex\\_to\(\)](#), [is\\_exactly\\_a\(\)](#), and [lgamma\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.321 lgamma\_eval()**

```
static ex GiNaC::lgamma_eval (
 const ex & x) [static]
```

Evaluation of  $\lgamma(x)$ , the natural logarithm of the Gamma function.

Handles integer arguments as a special case.

**Exceptions**

|                                                  |                      |
|--------------------------------------------------|----------------------|
| <a href="#">GiNaC::pole_error("lgamma_eval()</a> | logarithmic pole",0) |
|--------------------------------------------------|----------------------|

References [\\_ex\\_1](#), [ex\\_to\(\)](#), [factorial\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [is\\_rational\(\)](#), [lgamma\(\)](#), [log\(\)](#), [GiNaC::info\\_flags::numeric](#), and [GiNaC::info\\_flags::posint](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.322 lgamma\_deriv()**

```
static ex GiNaC::lgamma_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [GINAC\\_ASSERT](#), and [psi\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.323 lgamma\_series()**

```
static ex GiNaC::lgamma_series (
 const ex & arg,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [\\_ex1](#), [ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [lgamma\(\)](#), [log\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::info\\_flags::positive](#), [GiNaC::basic::series\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.324 lgamma\_conjugate()**

```
static ex GiNaC::lgamma_conjugate (
 const ex & x) [static]
```

References [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::imag\\_part\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [lgamma\(\)](#), and [GiNaC::info\\_flags::positive](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.325 REGISTER\_FUNCTION() [16/36]**

```
GiNaC::REGISTER_FUNCTION (
 lgamma ,
 eval_func(lgamma_eval). evalf_func(lgamma_evalf). derivative_func(lgamma_deriv).
 series_func(lgamma_series). conjugate_func(lgamma_conjugate). latex_name("\\log \\Gamma"))
```

References [lgamma\(\)](#), [lgamma\\_conjugate\(\)](#), [lgamma\\_deriv\(\)](#), [lgamma\\_eval\(\)](#), [lgamma\\_evalf\(\)](#), and [lgamma\\_series\(\)](#).

**5.1.3.326 tgamma\_evalf()**

```
static ex GiNaC::tgamma_evalf (
 const ex & x) [static]
```

References [ex\\_to\(\)](#), [is\\_exactly\\_a\(\)](#), and [tgamma\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.327 tgamma\_eval()**

```
static ex GiNaC::tgamma_eval (
 const ex & x) [static]
```

Evaluation of  $\text{tgamma}(x)$ , the true Gamma function.

Knows about integer arguments, half-integer arguments and that's it. Somebody ought to provide some good numerical evaluation some day...

## Exceptions

|                                                        |
|--------------------------------------------------------|
| <code>pole_error("tgamma_eval() simple pole",0)</code> |
|--------------------------------------------------------|

References [\\_num1\\_2\\_p](#), [\\_num1\\_p](#), [\\_num2\\_p](#), [\\_num\\_2\\_p](#), [abs\(\)](#), [GiNaC::numeric::div\(\)](#), [doublefactorial\(\)](#), [ex\\_to\(\)](#), [factorial\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::numeric::is\\_even\(\)](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::is\\_positive\(\)](#), [is\\_rational\(\)](#), [GiNaC::numeric::mul\(\)](#), [GiNaC::info\\_flags::numeric](#), [Pi](#), [pow\(\)](#), [sqrt\(\)](#), [GiNaC::numeric::sub\(\)](#), and [tgamma\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.328 tgamma\_deriv()**

```
static ex GiNaC::tgamma_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [GINAC\\_ASSERT](#), [psi\(\)](#), and [tgamma\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.329 tgamma\_series()**

```
static ex GiNaC::tgamma_series (
 const ex & arg,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [\\_ex1](#), [ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::info\\_flags::positive](#), [GiNaC::ex::series\(\)](#), [GiNaC::ex::subs\(\)](#), and [tgamma\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.330 tgamma\_conjugate()**

```
static ex GiNaC::tgamma_conjugate (
 const ex & x) [static]
```

References [GiNaC::ex::conjugate\(\)](#), and [tgamma\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.331 REGISTER\_FUNCTION() [17/36]**

```
GiNaC::REGISTER_FUNCTION (
 tgamma ,
 eval_func(tgamma_eval). evalf_func(tgamma_evalf). derivative_func(tgamma_deriv).
 series_func(tgamma_series). conjugate_func(tgamma_conjugate). latex_name("\\Gamma"))
```

References [tgamma\(\)](#), [tgamma\\_conjugate\(\)](#), [tgamma\\_deriv\(\)](#), [tgamma\\_eval\(\)](#), [tgamma\\_evalf\(\)](#), and [tgamma\\_series\(\)](#).

**5.1.3.332 beta\_evalf()**

```
static ex GiNaC::beta_evalf (
 const ex & x,
 const ex & y) [static]
```

References [ex\\_to\(\)](#), [exp\(\)](#), [is\\_exactly\\_a\(\)](#), and [lgamma\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.333 beta\_eval()**

```
static ex GiNaC::beta_eval (
 const ex & x,
 const ex & y) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_num\\_1\\_p](#), [evalf\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [is\\_integer\(\)](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::is\\_negative\(\)](#), [is\\_positive\(\)](#), [is\\_rational\(\)](#), [is\\_real\(\)](#), [GiNaC::numeric::is\\_real\(\)](#), [GiNaC::info\\_flags::numeric](#), [pow\(\)](#), and [tgamma\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.334 beta\_deriv()**

```
static ex GiNaC::beta_deriv (
 const ex & x,
 const ex & y,
 unsigned deriv_param) [static]
```

References [GINAC\\_ASSERT](#), and [psi\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.335 beta\_series()**

```
static ex GiNaC::beta_series (
 const ex & arg1,
 const ex & arg2,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [is\\_a\(\)](#), [GiNaC::relational::lhs\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::info\\_flags::positive](#), [GiNaC::ex::subs\(\)](#), and [tgamma\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.336 REGISTER\_FUNCTION() [18/36]**

```
GiNaC::REGISTER_FUNCTION (
 beta ,
 eval_func(beta_eval). evalf_func(beta_evalf). derivative_func(beta_deriv).
 series_func(beta_series). latex_name("\\mathrm{B}"). set_symmetry(sy_symm(0, 1)))
```

References [beta\\_deriv\(\)](#), [beta\\_eval\(\)](#), [beta\\_evalf\(\)](#), and [beta\\_series\(\)](#).



**5.1.3.337 psi1\_evalf()**

```
static ex GiNaC::psi1_evalf (
 const ex & x) [static]
```

References [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_exactly\\_a\(\)](#), and [psi\(\)](#).

**5.1.3.338 psi1\_eval()**

```
static ex GiNaC::psi1_eval (
 const ex & x) [static]
```

Evaluation of digamma-function  $\psi(x)$ .

Somebody ought to provide some good numerical evaluation some day...

References [\\_ex1\\_2](#), [\\_ex2](#), [\\_num2\\_p](#), [\\_num\\_1\\_p](#), [Euler](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::numeric::inverse\(\)](#), [is\\_integer\(\)](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::is\\_positive\(\)](#), [log\(\)](#), [GiNaC::info\\_flags::numeric](#), [pow\(\)](#), and [psi\(\)](#).

**5.1.3.339 psi1\_deriv()**

```
static ex GiNaC::psi1_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [\\_ex1](#), [GINAC\\_ASSERT](#), and [psi\(\)](#).

**5.1.3.340 psi1\_series()**

```
static ex GiNaC::psi1_series (
 const ex & arg,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [\\_ex1](#), [\\_ex\\_1](#), [ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::info\\_flags::positive](#), [psi\(\)](#), [GiNaC::power::series\(\)](#), and [GiNaC::ex::subs\(\)](#).

**5.1.3.341 psi2\_evalf()**

```
static ex GiNaC::psi2_evalf (
 const ex & n,
 const ex & x) [static]
```

References [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_exactly\\_a\(\)](#), and [psi\(\)](#).

### 5.1.3.342 psi2\_eval()

```
static ex GiNaC::psi2_eval (
 const ex & n,
 const ex & x) [static]
```

Evaluation of polygamma-function  $\psi(n,x)$ .

Somebody ought to provide some good numerical evaluation some day...

References [\\_ex1](#), [\\_ex1\\_2](#), [\\_ex\\_1](#), [\\_num1\\_2\\_p](#), [\\_num1\\_p](#), [\\_num2\\_p](#), [\\_num\\_1\\_p](#), [ex\\_to\(\)](#), [factorial\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::numeric::is\\_equal\(\)](#), [is\\_integer\(\)](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::is\\_positive\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [log\(\)](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::info\\_flags::posint](#), [pow\(\)](#), [psi\(\)](#), [tgamma\(\)](#), and [zeta\(\)](#).

### 5.1.3.343 psi2\_deriv()

```
static ex GiNaC::psi2_deriv (
 const ex & n,
 const ex & x,
 unsigned deriv_param) [static]
```

References [\\_ex1](#), [GINAC\\_ASSERT](#), and [psi\(\)](#).

### 5.1.3.344 psi2\_series()

```
static ex GiNaC::psi2_series (
 const ex & n,
 const ex & arg,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [\\_ex1](#), [\\_ex\\_1](#), [ex\\_to\(\)](#), [factorial\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::info\\_flags::positive](#), [psi\(\)](#), and [GiNaC::ex::subs\(\)](#).

### 5.1.3.345 G2\_evalf()

```
static ex GiNaC::G2_evalf (
 const ex & x_,
 const ex & y) [static]
```

References [\\_ex0](#), [\\_ex1](#), [ex\\_to\(\)](#), [factorial\(\)](#), [G\(\)](#), [GiNaC::basic::hold\(\)](#), [imag\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [is\\_real\(\)](#), [log\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::info\\_flags::positive](#), and [pow\(\)](#).

### 5.1.3.346 G2\_eval()

```
static ex GiNaC::G2_eval (
 const ex & x_,
 const ex & y) [static]
```

References [\\_ex0](#), [\\_ex1](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [factorial\(\)](#), [G\(\)](#), [GiNaC::basic::hold\(\)](#), [imag\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [is\\_real\(\)](#), [log\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::info\\_flags::positive](#), and [pow\(\)](#).

**5.1.3.347 G3\_evalf()**

```
static ex GiNaC::G3_evalf (
 const ex & x_,
 const ex & s_,
 const ex & y) [static]
```

References [\\_ex0](#), [\\_ex1](#), [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), [ex\\_to\(\)](#), [factorial\(\)](#), [G\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [log\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::info\\_flags::positive](#), [pow\(\)](#), and [GiNaC::info\\_flags::real](#).

**5.1.3.348 G3\_eval()**

```
static ex GiNaC::G3_eval (
 const ex & x_,
 const ex & s_,
 const ex & y) [static]
```

References [\\_ex0](#), [\\_ex1](#), [GiNaC::container< C >::begin\(\)](#), [GiNaC::info\\_flags::crational](#), [GiNaC::container< C >::end\(\)](#), [ex\\_to\(\)](#), [factorial\(\)](#), [G\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [log\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::info\\_flags::positive](#), [pow\(\)](#), and [GiNaC::info\\_flags::real](#).

**5.1.3.349 Li\_evalf()**

```
static ex GiNaC::Li_evalf (
 const ex & m_,
 const ex & x_) [static]
```

References [\\_ex0](#), [\\_ex1](#), [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), [GiNaC::ex::evalf\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::container< C >::op\(\)](#), and [GiNaC::info\\_flags::posint](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.350 Li\_eval()**

```
static ex GiNaC::Li_eval (
 const ex & m_,
 const ex & x_) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex2](#), [\\_ex\\_1](#), [\\_ex\\_48](#), [GiNaC::container< C >::append\(\)](#), [GiNaC::container< C >::begin\(\)](#), [Catalan](#), [GiNaC::info\\_flags::crational](#), [GiNaC::container< C >::end\(\)](#), [ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [I](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [log\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::info\\_flags::numeric](#), [Pi](#), [GiNaC::info\\_flags::posint](#), [pow\(\)](#), and [zeta\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

### 5.1.3.351 Li\_series()

```
static ex GiNaC::Li_series (
 const ex & m,
 const ex & x,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [\\_ex1](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::info\\_flags::numeric](#), [pow\(\)](#), [GiNaC::ex::series\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

### 5.1.3.352 Li\_deriv()

```
static ex GiNaC::Li_deriv (
 const ex & m_,
 const ex & x_,
 unsigned deriv_param) [static]
```

References [\\_ex0](#), [GINAC\\_ASSERT](#), [is\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

### 5.1.3.353 Li\_print\_latex()

```
static void GiNaC::Li_print_latex (
 const ex & m_,
 const ex & x_,
 const print_context & c) [static]
```

References [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), [ex\\_to\(\)](#), [is\\_a\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

### 5.1.3.354 REGISTER\_FUNCTION() [19/36]

```
GiNaC::REGISTER_FUNCTION (
 Li ,
 evalf_func(Li_evalf). eval_func(Li_eval). series_func(Li_series). derivative_↵
func(Li_deriv). print_func< print_latex >(Li_print_latex). do_not_evalf_params())
```

References [Li\\_deriv\(\)](#), [Li\\_eval\(\)](#), [Li\\_evalf\(\)](#), [Li\\_print\\_latex\(\)](#), and [Li\\_series\(\)](#).

### 5.1.3.355 S\_evalf()

```
static ex GiNaC::S_evalf (
 const ex & n,
 const ex & p,
 const ex & x) [static]
```

References [GiNaC::ex::evalf\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), and [GiNaC::info\\_flags::posint](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.356 S\_eval()**

```
static ex GiNaC::S_eval (
 const ex & n,
 const ex & p,
 const ex & x) [static]
```

References [\\_ex0](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [factorial\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [log\(\)](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::info\\_flags::posint](#), [pow\(\)](#), [to\\_int\(\)](#), and [zeta\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.357 S\_series()**

```
static ex GiNaC::S_series (
 const ex & n,
 const ex & p,
 const ex & x,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [\\_ex1](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::info\\_flags::posint](#), [pow\(\)](#), [GiNaC::ex::series\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.358 S\_deriv()**

```
static ex GiNaC::S_deriv (
 const ex & n,
 const ex & p,
 const ex & x,
 unsigned deriv_param) [static]
```

References [\\_ex0](#), and [GINAC\\_ASSERT](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.359 S\_print\_latex()**

```
static void GiNaC::S_print_latex (
 const ex & n,
 const ex & p,
 const ex & x,
 const print_context & c) [static]
```

References [GiNaC::ex::print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.360 REGISTER\_FUNCTION() [20/36]**

```
GiNaC::REGISTER_FUNCTION (
 S ,
 evalf_func(S_evalf). eval_func(S_eval). series_func(S_series). derivative_↔
func(S_deriv). print_func< print_latex >(S_print_latex). do_not_evalf_params())
```

References [S\\_deriv\(\)](#), [S\\_eval\(\)](#), [S\\_evalf\(\)](#), [S\\_print\\_latex\(\)](#), and [S\\_series\(\)](#).

**5.1.3.361 H\_evalf()**

```
static ex GiNaC::H_evalf (
 const ex & x1,
 const ex & x2) [static]
```

References [GiNaC::container< C >::append\(\)](#), [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), [GiNaC::ex::evalf\(\)](#), [ex\\_to\(\)](#), [l](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [is\\_a\(\)](#), [GiNaC::container< C >::let\\_op\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::ex::op\(\)](#), [Pi](#), [GiNaC::ex::subs\(\)](#), and [to\\_int\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.362 H\_eval()**

```
static ex GiNaC::H_eval (
 const ex & m_,
 const ex & x) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex\\_1](#), [GiNaC::container< C >::begin\(\)](#), [GiNaC::info\\_flags::crational](#), [GiNaC::container< C >::end\(\)](#), [ex\\_to\(\)](#), [factorial\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [is\\_a\(\)](#), [log\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::info\\_flags::numeric](#), [pow\(\)](#), and [step\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.363 H\_series()**

```
static ex GiNaC::H_series (
 const ex & m,
 const ex & x,
 const relational & rel,
 int order,
 unsigned options) [static]
```

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.364 H\_deriv()**

```
static ex GiNaC::H_deriv (
 const ex & m_,
 const ex & x,
 unsigned deriv_param) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex\\_1](#), [GiNaC::container< C >::begin\(\)](#), [ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [is\\_a\(\)](#), and [GiNaC::container< C >::remove\\_first\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.365 H\_print\_latex()**

```
static void GiNaC::H_print_latex (
 const ex & m_,
 const ex & x,
 const print_context & c) [static]
```

References [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), [ex\\_to\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.366 REGISTER\_FUNCTION() [21/36]**

```
GiNaC::REGISTER_FUNCTION (
 H ,
 evalf_func(H_evalf). eval_func(H_eval). series_func(H_series). derivative_↔
func(H_deriv). print_func< print_latex >(H_print_latex). do_not_evalf_params())
```

References [H\\_deriv\(\)](#), [H\\_eval\(\)](#), [H\\_evalf\(\)](#), [H\\_print\\_latex\(\)](#), and [H\\_series\(\)](#).

**5.1.3.367 zeta1\_evalf()**

```
static ex GiNaC::zeta1_evalf (
 const ex & x) [static]
```

References [GiNaC::container< C >::begin\(\)](#), [Digits](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::info\\_flags::posint](#), and [zeta\(\)](#).

Referenced by [zeta1\\_eval\(\)](#).

**5.1.3.368 zeta1\_eval()**

```
static ex GiNaC::zeta1_eval (
 const ex & m) [static]
```

References [\\_ex0](#), [\\_ex\\_1\\_2](#), [\\_num1\\_p](#), [\\_num2\\_p](#), [abs\(\)](#), [bernoulli\(\)](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [factorial\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::numeric::info\(\)](#), [GiNaC::numeric::is\\_equal\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::info\\_flags::odd](#), [GiNaC::ex::op\(\)](#), [Pi](#), [GiNaC::info\\_flags::posint](#), [pow\(\)](#), [zeta\(\)](#), and [zeta1\\_evalf\(\)](#).

**5.1.3.369 zeta1\_deriv()**

```
static ex GiNaC::zeta1_deriv (
 const ex & m,
 unsigned deriv_param) [static]
```

References [\\_ex0](#), [\\_ex1](#), [GINAC\\_ASSERT](#), and [is\\_exactly\\_a\(\)](#).

**5.1.3.370 zeta1\_print\_latex()**

```
static void GiNaC::zeta1_print_latex (
 const ex & m_,
 const print_context & c) [static]
```

References [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), [ex\\_to\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::print\(\)](#), and [GiNaC::print\\_context::s](#).

**5.1.3.371 zeta2\_evalf()**

```
static ex GiNaC::zeta2_evalf (
 const ex & x,
 const ex & s) [static]
```

References [GiNaC::container< C >::begin\(\)](#), [evalf\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::info\\_flags::posint](#), and [zeta\(\)](#).

**5.1.3.372 zeta2\_eval()**

```
static ex GiNaC::zeta2_eval (
 const ex & m,
 const ex & s_) [static]
```

References [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::info\\_flags::positive](#), and [zeta\(\)](#).

**5.1.3.373 zeta2\_deriv()**

```
static ex GiNaC::zeta2_deriv (
 const ex & m,
 const ex & s,
 unsigned deriv_param) [static]
```

References [\\_ex0](#), [\\_ex1](#), [GINAC\\_ASSERT](#), [GiNaC::ex::info\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::op\(\)](#), and [GiNaC::info\\_flags::positive](#).

**5.1.3.374 zeta2\_print\_latex()**

```
static void GiNaC::zeta2_print_latex (
 const ex & m_,
 const ex & s_,
 const print_context & c) [static]
```

References [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), [ex\\_to\(\)](#), [is\\_a\(\)](#), and [GiNaC::print\\_context::s](#).

**5.1.3.375 exp\_evalf()**

```
static ex GiNaC::exp_evalf (
 const ex & x) [static]
```

References [ex\\_to\(\)](#), [exp\(\)](#), [GiNaC::basic::hold\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).



**5.1.3.376 exp\_eval()**

```
static ex GiNaC::exp_eval (
 const ex & x) [static]
```

References [\\_ex1](#), [\\_ex2](#), [\\_ex\\_1](#), [\\_num0\\_p](#), [\\_num1\\_p](#), [\\_num2\\_p](#), [\\_num3\\_p](#), [\\_num4\\_p](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [exp\(\)](#), [GiNaC::basic::hold\(\)](#), [l](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::numeric::is\\_equal\(\)](#), [is\\_ex\\_the\\_function](#), [GiNaC::ex::is\\_zero\(\)](#), [log\(\)](#), [mod\(\)](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::ex::op\(\)](#), and [Pi](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.377 exp\_expand()**

```
static ex GiNaC::exp_expand (
 const ex & arg,
 unsigned options) [static]
```

References [GiNaC::ex::begin\(\)](#), [dynallocate\(\)](#), [GiNaC::ex::end\(\)](#), [exp\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::expand\\_options::expand\\_function](#), [GiNaC::expand\\_options::expand\\_transcendental](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::basic::hold\(\)](#), [is\\_exactly\\_a\(\)](#), and [GiNaC::ex::nops\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.378 exp\_deriv()**

```
static ex GiNaC::exp_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [exp\(\)](#), and [GINAC\\_ASSERT](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.379 exp\_real\_part()**

```
static ex GiNaC::exp_real_part (
 const ex & x) [static]
```

References [cos\(\)](#), [exp\(\)](#), [imag\\_part\(\)](#), and [real\\_part\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.380 exp\_imag\_part()**

```
static ex GiNaC::exp_imag_part (
 const ex & x) [static]
```

References [exp\(\)](#), [imag\\_part\(\)](#), [real\\_part\(\)](#), and [sin\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.381 exp\_conjugate()**

```
static ex GiNaC::exp_conjugate (
 const ex & x) [static]
```

References [GiNaC::ex::conjugate\(\)](#), and [exp\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.382 exp\_power()**

```
static ex GiNaC::exp_power (
 const ex & x,
 const ex & a) [static]
```

References [\\_ex\\_1](#), [exp\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::nonnegative](#), and [GiNaC::info\\_flags::real](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.383 exp\_info()**

```
static bool GiNaC::exp_info (
 const ex & x,
 unsigned inf) [static]
```

References [GiNaC::info\\_flags::expanded](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::nonnegative](#), [GiNaC::info\\_flags::positive](#), and [GiNaC::info\\_flags::real](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#), and [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.384 REGISTER\_FUNCTION() [22/36]**

```
GiNaC::REGISTER_FUNCTION (
 exp ,
 eval_func(exp_eval). evalf_func(exp_evalf). info_func(exp_info). expand_↔
func(exp_expand). derivative_func(exp_deriv). real_part_func(exp_real_part). imag_part_↔
func(exp_imag_part). conjugate_func(exp_conjugate). power_func(exp_power). latex_name("\\exp")
)
```

References [exp\(\)](#), [exp\\_conjugate\(\)](#), [exp\\_deriv\(\)](#), [exp\\_eval\(\)](#), [exp\\_evalf\(\)](#), [exp\\_expand\(\)](#), [exp\\_imag\\_part\(\)](#), [exp\\_info\(\)](#), [exp\\_power\(\)](#), and [exp\\_real\\_part\(\)](#).

**5.1.3.385 log\_evalf()**

```
static ex GiNaC::log_evalf (
 const ex & x) [static]
```

References [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_exactly\\_a\(\)](#), and [log\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.386 log\_eval()**

```
static ex GiNaC::log_eval (
 const ex & x) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex1\\_2](#), [\\_ex\\_1\\_2](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [exp\(\)](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [is\\_ex\\_the\\_function](#), [GiNaC::ex::is\\_zero\(\)](#), [log\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::ex::op\(\)](#), [Pi](#), [GiNaC::info\\_flags::rational](#), and [GiNaC::info\\_flags::real](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.387 log\_deriv()**

```
static ex GiNaC::log_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [\\_ex\\_1](#), and [GINAC\\_ASSERT](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.388 log\_series()**

```
static ex GiNaC::log_series (
 const ex & arg,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex\\_1](#), [GiNaC::pseries::add\\_series\(\)](#), [coeff\(\)](#), [GiNaC::pseries::coeff\(\)](#), [csgn\(\)](#), [GiNaC::ex::diff\(\)](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [I](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [GiNaC::pseries::is\\_terminating\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::pseries::ldegree\(\)](#), [GiNaC::relational::lhs\(\)](#), [log\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::pseries::nops\(\)](#), [Pi](#), [GiNaC::info\\_flags::positive](#), [pow\(\)](#), [GiNaC::relational::rhs\(\)](#), [GiNaC::ex::series\(\)](#), [series\(\)](#), [GiNaC::ex::subs\(\)](#), and [GiNaC::series\\_options::suppress\\_branchcut](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.389 log\_real\_part()**

```
static ex GiNaC::log_real_part (
 const ex & x) [static]
```

References [abs\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [log\(\)](#), and [GiNaC::info\\_flags::nonnegative](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.390 log\_imag\_part()**

```
static ex GiNaC::log_imag_part (
 const ex & x) [static]
```

References [imag\\_part\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::nonnegative](#), and [real\\_part\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.391 log\_expand()**

```
static ex GiNaC::log_expand (
 const ex & arg,
 unsigned options) [static]
```

References [\\_ex1](#), [\\_ex\\_1](#), [GiNaC::ex::begin\(\)](#), [GiNaC::ex::end\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [expand\(\)](#), [GiNaC::expand\\_options::expand\\_function\\_args](#), [GiNaC::expand\\_options::expand\\_transcendental](#), [GiNaC::basic::hold\(\)](#), [GiNaC::info\\_flags::indefinite](#), [GiNaC::ex::info\(\)](#), [is\\_exactly\\_a\(\)](#), [log\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::ex::nops\(\)](#), [GiNaC::info\\_flags::positive](#), [GiNaC::status\\_flags::purely\\_indefinite](#), and [GiNaC::basic::setflag\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.392 log\_conjugate()**

```
static ex GiNaC::log_conjugate (
 const ex & x) [static]
```

References [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::imag\\_part\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [log\(\)](#), and [GiNaC::info\\_flags::positive](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.393 log\_info()**

```
static bool GiNaC::log_info (
 const ex & x,
 unsigned inf) [static]
```

References [GiNaC::info\\_flags::expanded](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::positive](#), and [GiNaC::info\\_flags::real](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.394 REGISTER\_FUNCTION() [23/36]**

```
GiNaC::REGISTER_FUNCTION (
 log ,
 eval_func(log_eval). evalf_func(log_evalf). info_func(log_info). expand_↔
func(log_expand). derivative_func(log_deriv). series_func(log_series). real_part_func(log_real_part).
imag_part_func(log_imag_part). conjugate_func(log_conjugate). latex_name("\\ln"))
```

References [log\(\)](#), [log\\_conjugate\(\)](#), [log\\_deriv\(\)](#), [log\\_eval\(\)](#), [log\\_evalf\(\)](#), [log\\_expand\(\)](#), [log\\_imag\\_part\(\)](#), [log\\_info\(\)](#), [log\\_real\\_part\(\)](#), and [log\\_series\(\)](#).

**5.1.3.395 sin\_evalf()**

```
static ex GiNaC::sin_evalf (
 const ex & x) [static]
```

References [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_exactly\\_a\(\)](#), and [sin\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.396 sin\_eval()**

```
static ex GiNaC::sin_eval (
 const ex & x) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex1\\_2](#), [\\_ex1\\_3](#), [\\_ex1\\_4](#), [\\_ex2](#), [\\_ex3](#), [\\_ex5](#), [\\_ex6](#), [\\_ex60](#), [\\_ex\\_1](#), [\\_ex\\_1\\_2](#), [\\_ex\\_1\\_3](#), [\\_ex\\_1\\_4](#), [\\_num0\\_p](#), [\\_num10\\_p](#), [\\_num120\\_p](#), [\\_num15\\_p](#), [\\_num18\\_p](#), [\\_num20\\_p](#), [\\_num25\\_p](#), [\\_num30\\_p](#), [\\_num5\\_p](#), [\\_num60\\_p](#), [\\_num6\\_p](#), [acos\(\)](#), [asin\(\)](#), [atan\(\)](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::numeric::is\\_equal\(\)](#), [is\\_ex\\_the\\_function](#), [is\\_exactly\\_a\(\)](#), [mod\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::ex::op\(\)](#), [Pi](#), [sin\(\)](#), and [sqrt\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.397 sin\_deriv()**

```
static ex GiNaC::sin_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [cos\(\)](#), and [GINAC\\_ASSERT](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.398 sin\_real\_part()**

```
static ex GiNaC::sin_real_part (
 const ex & x) [static]
```

References [cosh\(\)](#), [imag\\_part\(\)](#), [real\\_part\(\)](#), and [sin\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.399 sin\_imag\_part()**

```
static ex GiNaC::sin_imag_part (
 const ex & x) [static]
```

References [cos\(\)](#), [imag\\_part\(\)](#), [real\\_part\(\)](#), and [sinh\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.400 sin\_conjugate()**

```
static ex GiNaC::sin_conjugate (
 const ex & x) [static]
```

References [GiNaC::ex::conjugate\(\)](#), and [sin\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.401 trig\_info()**

```
static bool GiNaC::trig_info (
 const ex & x,
 unsigned inf) [static]
```

References [GiNaC::info\\_flags::expanded](#), [GiNaC::ex::info\(\)](#), and [GiNaC::info\\_flags::real](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#), [REGISTER\\_FUNCTION\(\)](#), and [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.402 REGISTER\_FUNCTION() [24/36]**

```
GiNaC::REGISTER_FUNCTION (
 sin ,
 eval_func(sin_eval) . evalf_func(sin_evalf) . info_func(trig_info) . derivative_↵
func(sin_deriv) . real_part_func(sin_real_part) . imag_part_func(sin_imag_part) . conjugate_↵
func(sin_conjugate) . latex_name("\\sin"))
```

References [sin\(\)](#), [sin\\_conjugate\(\)](#), [sin\\_deriv\(\)](#), [sin\\_eval\(\)](#), [sin\\_evalf\(\)](#), [sin\\_imag\\_part\(\)](#), [sin\\_real\\_part\(\)](#), and [trig\\_info\(\)](#).

**5.1.3.403 cos\_evalf()**

```
static ex GiNaC::cos_evalf (
 const ex & x) [static]
```

References [cos\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.404 cos\_eval()**

```
static ex GiNaC::cos_eval (
 const ex & x) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex1\\_2](#), [\\_ex1\\_3](#), [\\_ex1\\_4](#), [\\_ex2](#), [\\_ex3](#), [\\_ex5](#), [\\_ex6](#), [\\_ex60](#), [\\_ex\\_1](#), [\\_ex\\_1\\_2](#), [\\_ex\\_1\\_3](#), [\\_ex\\_1\\_4](#), [\\_num0\\_p](#), [\\_num10\\_p](#), [\\_num120\\_p](#), [\\_num12\\_p](#), [\\_num15\\_p](#), [\\_num20\\_p](#), [\\_num24\\_p](#), [\\_num25\\_p](#), [\\_num30\\_p](#), [\\_num5\\_p](#), [\\_num60\\_p](#), [acos\(\)](#), [asin\(\)](#), [atan\(\)](#), [cos\(\)](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::numeric::is\\_equal\(\)](#), [is\\_ex\\_the\\_function](#), [is\\_exactly\\_a\(\)](#), [mod\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::ex::op\(\)](#), [Pi](#), and [sqrt\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.405 cos\_deriv()**

```
static ex GiNaC::cos_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [GINAC\\_ASSERT](#), and [sin\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.406 cos\_real\_part()**

```
static ex GiNaC::cos_real_part (
 const ex & x) [static]
```

References [cos\(\)](#), [cosh\(\)](#), [imag\\_part\(\)](#), and [real\\_part\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.407 cos\_imag\_part()**

```
static ex GiNaC::cos_imag_part (
 const ex & x) [static]
```

References [imag\\_part\(\)](#), [real\\_part\(\)](#), [sin\(\)](#), and [sinh\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.408 cos\_conjugate()**

```
static ex GiNaC::cos_conjugate (
 const ex & x) [static]
```

References [GiNaC::ex::conjugate\(\)](#), and [cos\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.409 REGISTER\_FUNCTION() [25/36]**

```
GiNaC::REGISTER_FUNCTION (
 cos ,
 eval_func(cos_eval) . info_func(trig_info) . evalf_func(cos_evalf) . derivative_↔
func(cos_deriv) . real_part_func(cos_real_part) . imag_part_func(cos_imag_part) . conjugate_↔
func(cos_conjugate) . latex_name("\\cos"))
```

References [cos\(\)](#), [cos\\_conjugate\(\)](#), [cos\\_deriv\(\)](#), [cos\\_eval\(\)](#), [cos\\_evalf\(\)](#), [cos\\_imag\\_part\(\)](#), [cos\\_real\\_part\(\)](#), and [trig\\_info\(\)](#).

**5.1.3.410 tan\_evalf()**

```
static ex GiNaC::tan_evalf (
 const ex & x) [static]
```

References [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_exactly\\_a\(\)](#), and [tan\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.411 tan\_eval()**

```
static ex GiNaC::tan_eval (
 const ex & x) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex1\\_3](#), [\\_ex2](#), [\\_ex3](#), [\\_ex60](#), [\\_ex\\_1](#), [\\_ex\\_1\\_2](#), [\\_num0\\_p](#), [\\_num10\\_p](#), [\\_num15\\_p](#), [\\_num20\\_p](#), [\\_num25\\_p](#), [\\_num30\\_p](#), [\\_num5\\_p](#), [\\_num60\\_p](#), [acos\(\)](#), [asin\(\)](#), [atan\(\)](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::numeric::is\\_equal\(\)](#), [is\\_ex\\_the\\_function](#), [is\\_exactly\\_a\(\)](#), [mod\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::ex::op\(\)](#), [Pi](#), [sqrt\(\)](#), and [tan\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.412 tan\_deriv()**

```
static ex GiNaC::tan_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [\\_ex1](#), [\\_ex2](#), [GINAC\\_ASSERT](#), and [tan\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.413 tan\_real\_part()**

```
static ex GiNaC::tan_real_part (
 const ex & x) [static]
```

References [imag\\_part\(\)](#), [real\\_part\(\)](#), and [tan\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.414 tan\_imag\_part()**

```
static ex GiNaC::tan_imag_part (
 const ex & x) [static]
```

References [imag\\_part\(\)](#), [real\\_part\(\)](#), [tan\(\)](#), and [tanh\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.415 tan\_series()**

```
static ex GiNaC::tan_series (
 const ex & x,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [cos\(\)](#), [GINAC\\_ASSERT](#), [is\\_a\(\)](#), [GiNaC::relational::lhs\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::info\\_flags::odd](#), [Pi](#), [sin\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).



**5.1.3.416 tan\_conjugate()**

```
static ex GiNaC::tan_conjugate (
 const ex & x) [static]
```

References [GiNaC::ex::conjugate\(\)](#), and [tan\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.417 REGISTER\_FUNCTION() [26/36]**

```
GiNaC::REGISTER_FUNCTION (
 tan ,
 eval_func(tan_eval). evalf_func(tan_evalf). info_func(trig_info). derivative←
 _func(tan_deriv). series_func(tan_series). real_part_func(tan_real_part). imag_part←
 func(tan_imag_part). conjugate_func(tan_conjugate). latex_name("\\tan"))
```

References [tan\(\)](#), [tan\\_conjugate\(\)](#), [tan\\_deriv\(\)](#), [tan\\_eval\(\)](#), [tan\\_evalf\(\)](#), [tan\\_imag\\_part\(\)](#), [tan\\_real\\_part\(\)](#), [tan\\_series\(\)](#), and [trig\\_info\(\)](#).

**5.1.3.418 asin\_evalf()**

```
static ex GiNaC::asin_evalf (
 const ex & x) [static]
```

References [asin\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.419 asin\_eval()**

```
static ex GiNaC::asin_eval (
 const ex & x) [static]
```

References [\\_ex1](#), [\\_ex1\\_2](#), [\\_ex\\_1](#), [\\_ex\\_1\\_2](#), [asin\(\)](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::numeric](#), and [Pi](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.420 asin\_deriv()**

```
static ex GiNaC::asin_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [\\_ex2](#), [\\_ex\\_1\\_2](#), and [GINAC\\_ASSERT](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.421 asin\_conjugate()**

```
static ex GiNaC::asin_conjugate (
 const ex & x) [static]
```

References [\\_num1\\_p](#), [\\_num\\_1\\_p](#), [asin\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::imag\\_part\(\)](#), [is\\_exactly\\_a\(\)](#), and [GiNaC::ex::is\\_zero\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.422 asin\_info()**

```
static bool GiNaC::asin_info (
 const ex & x,
 unsigned inf) [static]
```

References [GiNaC::info\\_flags::expanded](#), and [GiNaC::ex::info\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [REGISTER\\_FUNCTION\(\)](#), and [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.423 REGISTER\_FUNCTION() [27/36]**

```
GiNaC::REGISTER_FUNCTION (
 asin ,
 eval_func(asin_eval) . evalf_func(asin_evalf) . info_func(asin_info) . derivative↔
 _func(asin_deriv) . conjugate_func(asin_conjugate) . latex_name("\\arcsin"))
```

References [asin\(\)](#), [asin\\_conjugate\(\)](#), [asin\\_deriv\(\)](#), [asin\\_eval\(\)](#), [asin\\_evalf\(\)](#), and [asin\\_info\(\)](#).

**5.1.3.424 acos\_evalf()**

```
static ex GiNaC::acos_evalf (
 const ex & x) [static]
```

References [acos\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.425 acos\_eval()**

```
static ex GiNaC::acos_eval (
 const ex & x) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex1\\_2](#), [\\_ex1\\_3](#), [\\_ex\\_1](#), [\\_ex\\_1\\_2](#), [acos\(\)](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::numeric](#), and [Pi](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.426 acos\_deriv()**

```
static ex GiNaC::acos_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [\\_ex2](#), [\\_ex\\_1\\_2](#), and [GINAC\\_ASSERT](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.427 acos\_conjugate()**

```
static ex GiNaC::acos_conjugate (
 const ex & x) [static]
```

References [\\_num1\\_p](#), [\\_num\\_1\\_p](#), [acos\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::imag\\_part\(\)](#), [is\\_exactly\\_a\(\)](#), and [GiNaC::ex::is\\_zero\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.428 REGISTER\_FUNCTION() [28/36]**

```
GiNaC::REGISTER_FUNCTION (
 acos ,
 eval_func(acos_eval) . evalf_func(acos_evalf) . info_func(asin_info) . derivative↔
 _func(acos_deriv) . conjugate_func(acos_conjugate) . latex_name("\\arccos"))
```

References [acos\(\)](#), [acos\\_conjugate\(\)](#), [acos\\_deriv\(\)](#), [acos\\_eval\(\)](#), [acos\\_evalf\(\)](#), and [asin\\_info\(\)](#).

**5.1.3.429 atan\_evalf()**

```
static ex GiNaC::atan_evalf (
 const ex & x) [static]
```

References [atan\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.430 atan\_eval()**

```
static ex GiNaC::atan_eval (
 const ex & x) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex1\\_4](#), [\\_ex\\_1](#), [\\_ex\\_1\\_4](#), [atan\(\)](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::numeric](#), and [Pi](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.431 atan\_deriv()**

```
static ex GiNaC::atan_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [\\_ex1](#), [\\_ex2](#), [\\_ex\\_1](#), and [GINAC\\_ASSERT](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.432 atan\_series()**

```
static ex GiNaC::atan_series (
 const ex & arg,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex1\\_2](#), [\\_ex\\_1](#), [\\_ex\\_1\\_2](#), [abs\(\)](#), [atan\(\)](#), [csgn\(\)](#), [ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [I](#), [is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::relational::lhs\(\)](#), [log\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::ex::op\(\)](#), [Pi](#), [GiNaC::info\\_flags::real](#), [GiNaC::relational::rhs\(\)](#), [series\(\)](#), [GiNaC::ex::subs\(\)](#), and [GiNaC::series\\_options::suppress\\_branchcut](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.433 atan\_conjugate()**

```
static ex GiNaC::atan_conjugate (
 const ex & x) [static]
```

References [\\_num1\\_p](#), [\\_num\\_1\\_p](#), [atan\(\)](#), [GiNaC::ex::conjugate\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::imag\\_part\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [GiNaC::info\\_flags::real](#), and [GiNaC::ex::real\\_part\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.434 atan\_info()**

```
static bool GiNaC::atan_info (
 const ex & x,
 unsigned inf) [static]
```

References [GiNaC::info\\_flags::expanded](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::nonnegative](#), [GiNaC::info\\_flags::positive](#), and [GiNaC::info\\_flags::real](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [REGISTER\\_FUNCTION\(\)](#), and [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.435 REGISTER\_FUNCTION() [29/36]**

```
GiNaC::REGISTER_FUNCTION (
 atan ,
 eval_func(atan_eval). evalf_func(atan_evalf). info_func(atan_info). derivative←
_func(atan_deriv). series_func(atan_series). conjugate_func(atan_conjugate). latex_name("\\arctan")
)
```

References [atan\(\)](#), [atan\\_conjugate\(\)](#), [atan\\_deriv\(\)](#), [atan\\_eval\(\)](#), [atan\\_evalf\(\)](#), [atan\\_info\(\)](#), and [atan\\_series\(\)](#).

**5.1.3.436 atan2\_evalf()**

```
static ex GiNaC::atan2_evalf (
 const ex & y,
 const ex & x) [static]
```

References [atan\(\)](#), [ex\\_to\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.437 atan2\_eval()**

```
static ex GiNaC::atan2_eval (
 const ex & y,
 const ex & x) [static]
```

References [\\_ex0](#), [\\_ex1\\_2](#), [\\_ex1\\_4](#), [\\_ex\\_1\\_2](#), [\\_ex\\_1\\_4](#), [atan\(\)](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::info\\_flags::negative](#), [Pi](#), [GiNaC::info\\_flags::positive](#), and [GiNaC::info\\_flags::real](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.438 atan2\_deriv()**

```
static ex GiNaC::atan2_deriv (
 const ex & y,
 const ex & x,
 unsigned deriv_param) [static]
```

References [\\_ex2](#), [\\_ex\\_1](#), and [GINAC\\_ASSERT](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.439 atan2\_info()**

```
static bool GiNaC::atan2_info (
 const ex & y,
 const ex & x,
 unsigned inf) [static]
```

References [GiNaC::info\\_flags::expanded](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::nonnegative](#), [GiNaC::info\\_flags::positive](#), and [GiNaC::info\\_flags::real](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.440 REGISTER\_FUNCTION() [30/36]**

```
GiNaC::REGISTER_FUNCTION (
 atan2 ,
 eval_func(atan2_eval) . evalf_func(atan2_evalf) . info_func(atan2_info) . evalf_↵
func(atan2_evalf) . derivative_func(atan2_deriv))
```

References [atan2\\_deriv\(\)](#), [atan2\\_eval\(\)](#), [atan2\\_evalf\(\)](#), and [atan2\\_info\(\)](#).

**5.1.3.441 `sinh_evalf()`**

```
static ex GiNaC::sinh_evalf (
 const ex & x) [static]
```

References [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_exactly\\_a\(\)](#), and [sinh\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.442 `sinh_eval()`**

```
static ex GiNaC::sinh_eval (
 const ex & x) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex2](#), [\\_ex\\_1\\_2](#), [acosh\(\)](#), [asinh\(\)](#), [atanh\(\)](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [is\\_ex\\_the\\_function](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [is\\_zero\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::ex::op\(\)](#), [Pi](#), [real\(\)](#), [sin\(\)](#), [sinh\(\)](#), and [sqrt\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.443 `sinh_deriv()`**

```
static ex GiNaC::sinh_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [cosh\(\)](#), and [GINAC\\_ASSERT](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.444 `sinh_real_part()`**

```
static ex GiNaC::sinh_real_part (
 const ex & x) [static]
```

References [cos\(\)](#), [imag\\_part\(\)](#), [real\\_part\(\)](#), and [sinh\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.445 `sinh_imag_part()`**

```
static ex GiNaC::sinh_imag_part (
 const ex & x) [static]
```

References [cosh\(\)](#), [imag\\_part\(\)](#), [real\\_part\(\)](#), and [sin\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.446 sinh\_conjugate()**

```
static ex GiNaC::sinh_conjugate (
 const ex & x) [static]
```

References [GiNaC::ex::conjugate\(\)](#), and [sinh\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.447 REGISTER\_FUNCTION() [31/36]**

```
GiNaC::REGISTER_FUNCTION (
 sinh ,
 eval_func(sinh_eval). evalf_func(sinh_evalf). info_func(atan_info). derivative↔
_func(sinh_deriv). real_part_func(sinh_real_part). imag_part_func(sinh_imag_part). conjugate↔
_func(sinh_conjugate). latex_name("\\sinh"))
```

References [atan\\_info\(\)](#), [sinh\(\)](#), [sinh\\_conjugate\(\)](#), [sinh\\_deriv\(\)](#), [sinh\\_eval\(\)](#), [sinh\\_evalf\(\)](#), [sinh\\_imag\\_part\(\)](#), and [sinh\\_real\\_part\(\)](#).

**5.1.3.448 cosh\_evalf()**

```
static ex GiNaC::cosh_evalf (
 const ex & x) [static]
```

References [cosh\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.449 cosh\_eval()**

```
static ex GiNaC::cosh_eval (
 const ex & x) [static]
```

References [\\_ex1](#), [\\_ex2](#), [\\_ex\\_1\\_2](#), [acosh\(\)](#), [asinh\(\)](#), [atanh\(\)](#), [cos\(\)](#), [cosh\(\)](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [is\\_ex\\_the\\_function](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [is\\_zero\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::ex::op\(\)](#), [Pi](#), [real\(\)](#), and [sqrt\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.450 cosh\_deriv()**

```
static ex GiNaC::cosh_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [GINAC\\_ASSERT](#), and [sinh\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.451 cosh\_real\_part()**

```
static ex GiNaC::cosh_real_part (
 const ex & x) [static]
```

References [cos\(\)](#), [cosh\(\)](#), [imag\\_part\(\)](#), and [real\\_part\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.452 cosh\_imag\_part()**

```
static ex GiNaC::cosh_imag_part (
 const ex & x) [static]
```

References [imag\\_part\(\)](#), [real\\_part\(\)](#), [sin\(\)](#), and [sinh\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.453 cosh\_conjugate()**

```
static ex GiNaC::cosh_conjugate (
 const ex & x) [static]
```

References [GiNaC::ex::conjugate\(\)](#), and [cosh\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.454 REGISTER\_FUNCTION() [32/36]**

```
GiNaC::REGISTER_FUNCTION (
 cosh ,
 eval_func(cosh_eval) . evalf_func(cosh_evalf) . info_func(exp_info) . derivative↔
 _func(cosh_deriv) . real_part_func(cosh_real_part) . imag_part_func(cosh_imag_part) . conjugate↔
 _func(cosh_conjugate) . latex_name("\\cosh"))
```

References [cosh\(\)](#), [cosh\\_conjugate\(\)](#), [cosh\\_deriv\(\)](#), [cosh\\_eval\(\)](#), [cosh\\_evalf\(\)](#), [cosh\\_imag\\_part\(\)](#), [cosh\\_real\\_part\(\)](#), and [exp\\_info\(\)](#).

**5.1.3.455 tanh\_evalf()**

```
static ex GiNaC::tanh_evalf (
 const ex & x) [static]
```

References [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_exactly\\_a\(\)](#), and [tanh\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).



**5.1.3.456 tanh\_eval()**

```
static ex GiNaC::tanh_eval (
 const ex & x) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex2](#), [\\_ex\\_1](#), [\\_ex\\_1\\_2](#), [acosh\(\)](#), [asinh\(\)](#), [atanh\(\)](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [is\\_ex\\_the\\_function](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [is\\_zero\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::ex::op\(\)](#), [Pi](#), [real\(\)](#), [sqrt\(\)](#), [tan\(\)](#), and [tanh\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.457 tanh\_deriv()**

```
static ex GiNaC::tanh_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [\\_ex1](#), [\\_ex2](#), [GINAC\\_ASSERT](#), and [tanh\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.458 tanh\_series()**

```
static ex GiNaC::tanh_series (
 const ex & x,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [cosh\(\)](#), [GINAC\\_ASSERT](#), [I](#), [is\\_a\(\)](#), [GiNaC::relational::lhs\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::info\\_flags::odd](#), [Pi](#), [sinh\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.459 tanh\_real\_part()**

```
static ex GiNaC::tanh_real_part (
 const ex & x) [static]
```

References [imag\\_part\(\)](#), [real\\_part\(\)](#), [tan\(\)](#), and [tanh\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.460 tanh\_imag\_part()**

```
static ex GiNaC::tanh_imag_part (
 const ex & x) [static]
```

References [imag\\_part\(\)](#), [real\\_part\(\)](#), [tan\(\)](#), and [tanh\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.461 tanh\_conjugate()**

```
static ex GiNaC::tanh_conjugate (
 const ex & x) [static]
```

References [GiNaC::ex::conjugate\(\)](#), and [tanh\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.462 REGISTER\_FUNCTION() [33/36]**

```
GiNaC::REGISTER_FUNCTION (
 tanh ,
 eval_func(tanh_eval). evalf_func(tanh_evalf). info_func(atan_info). derivative↔
 _func(tanh_deriv). series_func(tanh_series). real_part_func(tanh_real_part). imag_part_↔
 func(tanh_imag_part). conjugate_func(tanh_conjugate). latex_name("\\tanh"))
```

References [atan\\_info\(\)](#), [tanh\(\)](#), [tanh\\_conjugate\(\)](#), [tanh\\_deriv\(\)](#), [tanh\\_eval\(\)](#), [tanh\\_evalf\(\)](#), [tanh\\_imag\\_part\(\)](#), [tanh\\_real\\_part\(\)](#), and [tanh\\_series\(\)](#).

**5.1.3.463 asinh\_evalf()**

```
static ex GiNaC::asinh_evalf (
 const ex & x) [static]
```

References [asinh\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.464 asinh\_eval()**

```
static ex GiNaC::asinh_eval (
 const ex & x) [static]
```

References [\\_ex0](#), [asinh\(\)](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::info\\_flags::negative](#), and [GiNaC::info\\_flags::numeric](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.465 asinh\_deriv()**

```
static ex GiNaC::asinh_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [\\_ex1](#), [\\_ex2](#), [\\_ex\\_1\\_2](#), and [GINAC\\_ASSERT](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.466 asinh\_conjugate()**

```
static ex GiNaC::asinh_conjugate (
 const ex & x) [static]
```

References [\\_num1\\_p](#), [\\_num\\_1\\_p](#), [asinh\(\)](#), [GiNaC::ex::conjugate\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::imag\\_part\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [GiNaC::info\\_flags::real](#), and [GiNaC::ex::real\\_part\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.467 REGISTER\_FUNCTION() [34/36]**

```
GiNaC::REGISTER_FUNCTION (
 asinh ,
 eval_func(asinh_eval) . evalf_func(asinh_evalf) . info_func(atan_info) . derivative←
_func(asinh_deriv) . conjugate_func(asinh_conjugate))
```

References [asinh\(\)](#), [asinh\\_conjugate\(\)](#), [asinh\\_deriv\(\)](#), [asinh\\_eval\(\)](#), [asinh\\_evalf\(\)](#), and [atan\\_info\(\)](#).

**5.1.3.468 acosh\_evalf()**

```
static ex GiNaC::acosh_evalf (
 const ex & x) [static]
```

References [acosh\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.469 acosh\_eval()**

```
static ex GiNaC::acosh_eval (
 const ex & x) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex\\_1](#), [acosh\(\)](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::numeric](#), and [Pi](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.470 acosh\_deriv()**

```
static ex GiNaC::acosh_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [\\_ex1](#), [\\_ex\\_1](#), [\\_ex\\_1\\_2](#), and [GINAC\\_ASSERT](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.471 acosh\_conjugate()**

```
static ex GiNaC::acosh_conjugate (
 const ex & x) [static]
```

References [\\_num1\\_p](#), [acosh\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::imag\\_part\(\)](#), [is\\_exactly\\_a\(\)](#), and [GiNaC::ex::is\\_zero\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.472 REGISTER\_FUNCTION() [35/36]**

```
GiNaC::REGISTER_FUNCTION (
 acosh ,
 eval_func(acosh_eval) . evalf_func(acosh_evalf) . info_func(asin_info) . derivative←
 _func(acosh_deriv) . conjugate_func(acosh_conjugate))
```

References [acosh\(\)](#), [acosh\\_conjugate\(\)](#), [acosh\\_deriv\(\)](#), [acosh\\_eval\(\)](#), [acosh\\_evalf\(\)](#), and [asin\\_info\(\)](#).

**5.1.3.473 atanh\_evalf()**

```
static ex GiNaC::atanh_evalf (
 const ex & x) [static]
```

References [atanh\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), and [is\\_exactly\\_a\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.474 atanh\_eval()**

```
static ex GiNaC::atanh_eval (
 const ex & x) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex\\_1](#), [atanh\(\)](#), [GiNaC::info\\_flags::crational](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::info\\_flags::negative](#), and [GiNaC::info\\_flags::numeric](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.475 atanh\_deriv()**

```
static ex GiNaC::atanh_deriv (
 const ex & x,
 unsigned deriv_param) [static]
```

References [\\_ex1](#), [\\_ex2](#), [\\_ex\\_1](#), and [GINAC\\_ASSERT](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.476 atanh\_series()**

```
static ex GiNaC::atanh_series (
 const ex & arg,
 const relational & rel,
 int order,
 unsigned options) [static]
```

References [\\_ex0](#), [\\_ex1](#), [\\_ex1\\_2](#), [\\_ex\\_1](#), [\\_ex\\_1\\_2](#), [abs\(\)](#), [atanh\(\)](#), [csgn\(\)](#), [ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [I](#), [is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::relational::lhs\(\)](#), [log\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::ex::op\(\)](#), [Pi](#), [GiNaC::info\\_flags::real](#), [GiNaC::relational::rhs\(\)](#), [series\(\)](#), [GiNaC::ex::subs\(\)](#), and [GiNaC::series\\_options::suppress\\_branchcut](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.477 atanh\_conjugate()**

```
static ex GiNaC::atanh_conjugate (
 const ex & x) [static]
```

References [\\_num1\\_p](#), [\\_num\\_1\\_p](#), [atanh\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::imag\\_part\(\)](#), [is\\_exactly\\_a\(\)](#), and [GiNaC::ex::is\\_zero\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.478 REGISTER\_FUNCTION() [36/36]**

```
GiNaC::REGISTER_FUNCTION (
 atanh ,
 eval_func(atanh_eval) . evalf_func(atanh_evalf) . info_func(asin_info) . derivative←
_func(atanh_deriv) . series_func(atanh_series) . conjugate_func(atanh_conjugate))
```

References [asin\\_info\(\)](#), [atanh\(\)](#), [atanh\\_conjugate\(\)](#), [atanh\\_deriv\(\)](#), [atanh\\_eval\(\)](#), [atanh\\_evalf\(\)](#), and [atanh\\_series\(\)](#).

**5.1.3.479 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT() [11/33]**

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 integral ,
 basic ,
 print_func< print_dflt > &::do_print . print_func< print_python > &::do_print .
print_func< print_latex > &::do_print_latex)
```

References [GiNaC::integral::do\\_print\(\)](#), [GiNaC::integral::do\\_print\\_latex\(\)](#), and [dynallocate\(\)](#).

**5.1.3.480 subsvalue()**

```
ex GiNaC::subsvalue (
 const ex & var,
 const ex & value,
 const ex & fun)
```

References [GiNaC::ex::evalf\(\)](#), [is\\_a\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [adaptivesimpson\(\)](#).

**5.1.3.481 adaptivesimpson()**

```
GiNaC::ex GiNaC::adaptivesimpson (
 const ex & x,
 const ex & a_in,
 const ex & b_in,
 const ex & f,
 const ex & error)
```

Numeric integration routine based upon the "Adaptive Quadrature" one in "Numerical Analysis" by Burden and Faires.

Parameters are integration variable, left boundary, right boundary, function to be integrated and the relative integration error. The function should evalf into a number after substituting the integration variable by a number. Another thing to note is that this implementation is no good at integrating functions with discontinuities.

References [abs\(\)](#), [GiNaC::ex::evalf\(\)](#), [ex\\_to\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::integral::max\\_integration\\_level](#), [GiNaC::ex::subs\(\)](#), and [subsvalue\(\)](#).

Referenced by [GiNaC::integral::evalf\(\)](#).

**5.1.3.482 GINAC\_BIND\_UNARCHIVER() [21/49]**

```
GiNaC::GINAC_BIND_UNARCHIVER (
 integral)
```

**5.1.3.483 GINAC\_DECLARE\_UNARCHIVER() [22/51]**

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 integral)
```

References [GiNaC::integral::relative\\_integration\\_error](#).

**5.1.3.484 ifactor()**

```
ex GiNaC::ifactor (
 const numeric & n)
```

Returns the decomposition of the positive integer n into prime numbers in the form `lst( lst(p1,...,pr), lst(a1,...,ar) )` such that  $n = p_1^{a_1} \dots p_r^{a_r}$ .

References [GiNaC::container< C >::append\(\)](#), [irem\(\)](#), [GiNaC::numeric::is\\_pos\\_integer\(\)](#), and [GiNaC::info\\_flags::prime](#).

Referenced by [is\\_discriminant\\_of\\_quadratic\\_number\\_field\(\)](#), and [kronecker\\_symbol\(\)](#).

**5.1.3.485 is\_discriminant\_of\_quadratic\_number\_field()**

```
bool GiNaC::is_discriminant_of_quadratic_number_field (
 const numeric & n)
```

Returns true if the integer  $n$  is either one or the discriminant of a quadratic number field.

Returns false otherwise.

Ref.: Toshitsune Miyake, Modular Forms, Chapter 3.1

References [abs\(\)](#), [ex\\_to\(\)](#), [ifactor\(\)](#), [is\\_discriminant\\_of\\_quadratic\\_number\\_field\(\)](#), [GiNaC::numeric::is\\_odd\(\)](#), [mod\(\)](#), [GiNaC::container< C >::nops\(\)](#), and [GiNaC::container< C >::op\(\)](#).

Referenced by [is\\_discriminant\\_of\\_quadratic\\_number\\_field\(\)](#).

**5.1.3.486 kronecker\_symbol()**

```
numeric GiNaC::kronecker_symbol (
 const numeric & a,
 const numeric & n)
```

Returns the Kronecker symbol  $a$ : integer  $n$ : integer.

This routine defines  $\text{kronecker\_symbol}(1,0) = 1$   $\text{kronecker\_symbol}(-1,0) = 1$   $\text{kronecker\_symbol}(a,0) = 0$ ,  $a \neq 1, -1$

In particular  $\text{kronecker\_symbol}(-1,0) = 1$  (in agreement with Sage)

Ref.: Toshitsune Miyake, Modular Forms, Chapter 3.1

References [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), [ex\\_to\(\)](#), [ifactor\(\)](#), [GiNaC::numeric::is\\_even\(\)](#), [GiNaC::container< C >::op\(\)](#), and [pow\(\)](#).

Referenced by [primitive\\_dirichlet\\_character\(\)](#).

**5.1.3.487 primitive\_dirichlet\_character()**

```
numeric GiNaC::primitive_dirichlet_character (
 const numeric & n,
 const numeric & a)
```

Defines a primitive Dirichlet character through the Kronecker symbol.

$n$ : integer  $a$ : discriminant of a quadratic field  $|a|$ : conductor

The character takes the values  $-1, 0, 1$ .

References [kronecker\\_symbol\(\)](#).

Referenced by [dirichlet\\_character\(\)](#), and [generalised\\_Bernoulli\\_number\(\)](#).

**5.1.3.488 `dirichlet_character()`**

```
numeric GiNaC::dirichlet_character (
 const numeric & n,
 const numeric & a,
 const numeric & N)
```

Defines a Dirichlet character through the Kronecker symbol.

n: integer a: discriminant of a quadratic field  $|a|$ : conductor N: modulus, needs to be multiple of  $|a|$

The character takes the values -1,0,1.

References [gcd\(\)](#), and [primitive\\_dirichlet\\_character\(\)](#).

**5.1.3.489 `generalised_Bernoulli_number()`**

```
numeric GiNaC::generalised_Bernoulli_number (
 const numeric & k,
 const numeric & b)
```

The generalised Bernoulli number.

k: index / modular weight

b: discriminant of a quadratic field, defines primitive character  $\psi$   $M=|b|$ : conductor of primitive character  $\psi$

The generalised Bernoulli number is computed from the series expansion of the generating function. The generating function is given in eq.(34), arXiv:1704.08895

References [abs\(\)](#), [GiNaC::ex::coeff\(\)](#), [ex\\_to\(\)](#), [exp\(\)](#), [factorial\(\)](#), [primitive\\_dirichlet\\_character\(\)](#), [GiNaC::ex::series\(\)](#), [series\\_to\\_poly\(\)](#), and [GiNaC::numeric::to\\_int\(\)](#).

**5.1.3.490 `Bernoulli_polynomial()`**

```
ex GiNaC::Bernoulli_polynomial (
 const numeric & k,
 const ex & x)
```

The Bernoulli polynomials.

References [GiNaC::ex::coeff\(\)](#), [exp\(\)](#), [factorial\(\)](#), [GiNaC::ex::series\(\)](#), [series\\_to\\_poly\(\)](#), and [GiNaC::numeric::to\\_int\(\)](#).

Referenced by [GiNaC::Eisenstein\\_h\\_kernel::coefficient\\_a0\(\)](#).

**5.1.3.491 `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()` [12/33]**

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 integration_kernel ,
 basic ,
 print_func< print_context > &::do_print)
```

References [GiNaC::integration\\_kernel::do\\_print\(\)](#).



**5.1.3.492 GINAC\_BIND\_UNARCHIVER()** [22/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 integration_kernel)
```

**5.1.3.493 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [13/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 basic_log_kernel ,
 integration_kernel ,
 print_func< print_context > &::do_print)
```

References [GiNaC::basic\\_log\\_kernel::do\\_print\(\)](#).

**5.1.3.494 GINAC\_BIND\_UNARCHIVER()** [23/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 basic_log_kernel)
```

**5.1.3.495 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [14/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 multiple_polylog_kernel ,
 integration_kernel ,
 print_func< print_context > &::do_print)
```

References [\\_ex1](#), [GiNaC::multiple\\_polylog\\_kernel::do\\_print\(\)](#), and [GiNaC::multiple\\_polylog\\_kernel::multiple\\_polylog\\_kernel\(\)](#).

**5.1.3.496 GINAC\_BIND\_UNARCHIVER()** [24/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 multiple_polylog_kernel)
```

**5.1.3.497 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [15/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 ELi_kernel ,
 integration_kernel ,
 print_func< print_context > &::do_print)
```

References [\\_ex0](#), and [GiNaC::ELi\\_kernel::do\\_print\(\)](#).

**5.1.3.498 GINAC\_BIND\_UNARCHIVER()** [25/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 ELi_kernel)
```

**5.1.3.499 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [16/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 Ebar_kernel ,
 integration_kernel ,
 print_func< print_context > &::do_print)
```

References [\\_ex0](#), and [GiNaC::Ebar\\_kernel::do\\_print\(\)](#).

**5.1.3.500 GINAC\_BIND\_UNARCHIVER()** [26/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 Ebar_kernel)
```

**5.1.3.501 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [17/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 Kronecker_dtau_kernel ,
 integration_kernel ,
 print_func< print_context > &::do_print)
```

References [\\_ex0](#), [\\_ex1](#), and [GiNaC::Kronecker\\_dtau\\_kernel::do\\_print\(\)](#).

**5.1.3.502 GINAC\_BIND\_UNARCHIVER()** [27/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 Kronecker_dtau_kernel)
```

**5.1.3.503 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [18/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 Kronecker_dz_kernel ,
 integration_kernel ,
 print_func< print_context > &::do_print)
```

References [\\_ex0](#), [\\_ex1](#), and [GiNaC::Kronecker\\_dz\\_kernel::do\\_print\(\)](#).

**5.1.3.504 GINAC\_BIND\_UNARCHIVER()** [28/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 Kronecker_dz_kernel)
```

**5.1.3.505 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [19/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 Eisenstein_kernel ,
 integration_kernel ,
 print_func< print_context > &::do_print)
```

References [\\_ex0](#), [\\_ex1](#), and [GiNaC::Eisenstein\\_kernel::do\\_print\(\)](#).

**5.1.3.506 GINAC\_BIND\_UNARCHIVER()** [29/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 Eisenstein_kernel)
```

**5.1.3.507 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [20/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 Eisenstein_h_kernel ,
 integration_kernel ,
 print_func< print_context > &::do_print)
```

References [\\_ex0](#), [\\_ex1](#), and [GiNaC::Eisenstein\\_h\\_kernel::do\\_print\(\)](#).

**5.1.3.508 GINAC\_BIND\_UNARCHIVER()** [30/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 Eisenstein_h_kernel)
```

**5.1.3.509 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [21/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 modular_form_kernel ,
 integration_kernel ,
 print_func< print_context > &::do_print)
```

References [\\_ex0](#), [\\_ex1](#), and [GiNaC::modular\\_form\\_kernel::do\\_print\(\)](#).

**5.1.3.510 GINAC\_BIND\_UNARCHIVER()** [31/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 modular_form_kernel)
```

**5.1.3.511 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [22/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 user_defined_kernel ,
 integration_kernel ,
 print_func< print_context > &::do_print)
```

References [\\_ex0](#), and [GiNaC::user\\_defined\\_kernel::do\\_print\(\)](#).

**5.1.3.512 GINAC\_BIND\_UNARCHIVER()** [32/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 user_defined_kernel)
```

**5.1.3.513 GINAC\_DECLARE\_UNARCHIVER()** [23/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 integration_kernel)
```

**5.1.3.514 GINAC\_DECLARE\_UNARCHIVER()** [24/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 basic_log_kernel)
```

**5.1.3.515 GINAC\_DECLARE\_UNARCHIVER()** [25/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 multiple_polylog_kernel)
```

**5.1.3.516 GINAC\_DECLARE\_UNARCHIVER()** [26/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 ELi_kernel)
```

**5.1.3.517 GINAC\_DECLARE\_UNARCHIVER()** [27/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 Ebar_kernel)
```

**5.1.3.518 GINAC\_DECLARE\_UNARCHIVER()** [28/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 Kronecker_dtau_kernel)
```

**5.1.3.519 GINAC\_DECLARE\_UNARCHIVER()** [29/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 Kronecker_dz_kernel)
```

**5.1.3.520 GINAC\_DECLARE\_UNARCHIVER()** [30/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 Eisenstein_kernel)
```

**5.1.3.521 GINAC\_DECLARE\_UNARCHIVER()** [31/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 Eisenstein_h_kernel)
```

**5.1.3.522 GINAC\_DECLARE\_UNARCHIVER()** [32/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 modular_form_kernel)
```

**5.1.3.523 GINAC\_DECLARE\_UNARCHIVER()** [33/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 user_defined_kernel)
```

**5.1.3.524 GINAC\_DECLARE\_UNARCHIVER()** [34/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 lst)
```

**5.1.3.525 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [23/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 matrix ,
 basic ,
 print_func< print_context > &::do_print, print_func< print_latex > &::do_↵
print_latex, print_func< print_tree > &::do_print_tree, print_func< print_python_repr > &↵
::do_print_python_repr)
```

Default ctor.

Initializes to 1 x 1-dimensional zero-matrix.

References [\\_ex0](#), [GiNaC::matrix::do\\_print\(\)](#), [GiNaC::matrix::do\\_print\\_latex\(\)](#), [GiNaC::matrix::do\\_print\\_python\\_repr\(\)](#), [GiNaC::basic::do\\_print\\_tree\(\)](#), and [GiNaC::status\\_flags::not\\_shareable](#).

**5.1.3.526 GINAC\_BIND\_UNARCHIVER()** [33/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 matrix)
```

**5.1.3.527 lst\_to\_matrix()**

```
ex GiNaC::lst_to_matrix (
 const lst & l)
```

Convert list of lists to matrix.

References [cols\(\)](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [is\\_a\(\)](#), [GiNaC::container< C >::nops\(\)](#), and [rows\(\)](#).

**5.1.3.528 diag\_matrix()** [1/2]

```
ex GiNaC::diag_matrix (
 const lst & l)
```

Convert list of diagonal elements to matrix.

References [dynallocate\(\)](#), and [GiNaC::container< C >::nops\(\)](#).

**5.1.3.529 diag\_matrix()** [2/2]

```
ex GiNaC::diag_matrix (
 std::initializer_list< ex > l)
```

References [dynallocate\(\)](#).

**5.1.3.530 unit\_matrix()** [1/2]

```
ex GiNaC::unit_matrix (
 unsigned r,
 unsigned c)
```

Create an r times c unit matrix.

References [\\_ex1](#), [dynallocate\(\)](#), [GiNaC::status\\_flags::evaluated](#), and [GiNaC::basic::setflag\(\)](#).

Referenced by [unit\\_matrix\(\)](#).

**5.1.3.531 symbolic\_matrix()** [1/2]

```
ex GiNaC::symbolic_matrix (
 unsigned r,
 unsigned c,
 const std::string & base_name,
 const std::string & tex_base_name)
```

Create an r times c matrix of newly generated symbols consisting of the given base name plus the numeric row/column position of each element.

The base name for LaTeX output is specified separately.

References [dynallocate\(\)](#), [GiNaC::status\\_flags::evaluated](#), and [GiNaC::basic::setflag\(\)](#).

Referenced by [symbolic\\_matrix\(\)](#).

#### 5.1.3.532 `reduced_matrix()`

```
ex GiNaC::reduced_matrix (
 const matrix & m,
 unsigned r,
 unsigned c)
```

Return the reduced matrix that is formed by deleting the *r*th row and *c*th column of matrix *m*.

The determinant of the result is the Minor *r*, *c*.

References [cols\(\)](#), [GiNaC::matrix::cols\(\)](#), [dynallocate\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::matrix::rows\(\)](#), [rows\(\)](#), and [GiNaC::basic::setflag\(\)](#).

#### 5.1.3.533 `sub_matrix()`

```
ex GiNaC::sub_matrix (
 const matrix & m,
 unsigned r,
 unsigned nr,
 unsigned c,
 unsigned nc)
```

Return the *nr* times *nc* submatrix starting at position *r*, *c* of matrix *m*.

References [GiNaC::matrix::cols\(\)](#), [dynallocate\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::matrix::rows\(\)](#), and [GiNaC::basic::setflag\(\)](#).

Referenced by [lst\\_to\\_clifford\(\)](#).

#### 5.1.3.534 `GINAC_DECLARE_UNARCHIVER()` [35/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 matrix)
```

#### 5.1.3.535 `nops()` [2/2]

```
size_t GiNaC::nops (
 const matrix & m) [inline]
```

References [GiNaC::matrix::nops\(\)](#).

#### 5.1.3.536 `expand()` [2/2]

```
ex GiNaC::expand (
 const matrix & m,
 unsigned options = 0) [inline]
```

References [GiNaC::basic::expand\(\)](#).

#### 5.1.3.537 evalf() [2/2]

```
ex GiNaC::evalf (
 const matrix & m) [inline]
```

References [GiNaC::basic::evalf\(\)](#).

#### 5.1.3.538 rows()

```
unsigned GiNaC::rows (
 const matrix & m) [inline]
```

References [GiNaC::matrix::rows\(\)](#).

Referenced by [clifford\\_moebius\\_map\(\)](#), [clifford\\_moebius\\_map\(\)](#), [lst\\_to\\_clifford\(\)](#), [lst\\_to\\_matrix\(\)](#), and [reduced\\_matrix\(\)](#).

#### 5.1.3.539 cols()

```
unsigned GiNaC::cols (
 const matrix & m) [inline]
```

References [GiNaC::matrix::cols\(\)](#).

Referenced by [clifford\\_moebius\\_map\(\)](#), [clifford\\_moebius\\_map\(\)](#), [lst\\_to\\_clifford\(\)](#), [lst\\_to\\_matrix\(\)](#), and [reduced\\_matrix\(\)](#).

#### 5.1.3.540 transpose()

```
matrix GiNaC::transpose (
 const matrix & m) [inline]
```

References [GiNaC::matrix::transpose\(\)](#).

#### 5.1.3.541 determinant()

```
ex GiNaC::determinant (
 const matrix & m,
 unsigned options = determinant_algo::automatic) [inline]
```

References [GiNaC::determinant\\_algo::automatic](#), and [GiNaC::matrix::determinant\(\)](#).

#### 5.1.3.542 trace()

```
ex GiNaC::trace (
 const matrix & m) [inline]
```

References [GiNaC::matrix::trace\(\)](#).



#### 5.1.3.543 charpoly()

```
ex GiNaC::charpoly (
 const matrix & m,
 const ex & lambda) [inline]
```

References [GiNaC::matrix::charpoly\(\)](#).

#### 5.1.3.544 inverse() [1/3]

```
matrix GiNaC::inverse (
 const matrix & m) [inline]
```

References [GiNaC::solve\\_algo::automatic](#), and [GiNaC::matrix::inverse\(\)](#).

#### 5.1.3.545 inverse() [2/3]

```
matrix GiNaC::inverse (
 const matrix & m,
 unsigned algo) [inline]
```

References [GiNaC::matrix::inverse\(\)](#).

#### 5.1.3.546 rank() [1/2]

```
unsigned GiNaC::rank (
 const matrix & m) [inline]
```

References [GiNaC::matrix::rank\(\)](#).

#### 5.1.3.547 rank() [2/2]

```
unsigned GiNaC::rank (
 const matrix & m,
 unsigned solve_algo) [inline]
```

References [GiNaC::matrix::rank\(\)](#).

#### 5.1.3.548 unit\_matrix() [2/2]

```
ex GiNaC::unit_matrix (
 unsigned x) [inline]
```

Create a x times x unit matrix.

References [unit\\_matrix\(\)](#).

### 5.1.3.549 `symbolic_matrix()` [2/2]

```
ex GiNaC::symbolic_matrix (
 unsigned r,
 unsigned c,
 const std::string & base_name) [inline]
```

Create an  $r$  times  $c$  matrix of newly generated symbols consisting of the given base name plus the numeric row/column position of each element.

References [symbolic\\_matrix\(\)](#).

### 5.1.3.550 `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()` [24/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 mul ,
 expairseq ,
 print_func< print_context > &::do_print. print_func< print_latex > &::do_↵
print_latex. print_func< print_csrc > &::do_print_csrc. print_func< print_tree > &::do_↵
print_tree. print_func< print_python_repr > &::do_print_python_repr)
```

References [GiNaC::mul::do\\_print\(\)](#), [GiNaC::mul::do\\_print\\_csrc\(\)](#), [GiNaC::mul::do\\_print\\_latex\(\)](#), [GiNaC::mul::do\\_print\\_python\\_repr\(\)](#), and [GiNaC::basic::do\\_print\\_tree\(\)](#).

### 5.1.3.551 `tryfactsubs()`

```
bool GiNaC::tryfactsubs (
 const ex & origfactor,
 const ex & patternfactor,
 int & nummatches,
 exmap & repls)
```

References [ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::match\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [algebraic\\_match\\_mul\\_with\\_mul\(\)](#), [GiNaC::mul::algebraic\\_subs\\_mul\(\)](#), and [GiNaC::power::subs\(\)](#).

### 5.1.3.552 `algebraic_match_mul_with_mul()`

```
bool GiNaC::algebraic_match_mul_with_mul (
 const mul & e,
 const ex & pat,
 exmap & repls,
 int factor,
 int & nummatches,
 const std::vector< bool > & substed,
 std::vector< bool > & matched)
```

Checks whether  $e$  matches to the pattern  $pat$  and the (possibly to be updated) list of replacements  $repls$ .

This matching is in the sense of algebraic substitutions. Matching starts with  $pat.op(factor)$  of the pattern because the factors before this one have already been matched. The (possibly updated) number of matches is in  $nummatches$ .  $substed[i]$  is true for factors that already have been replaced by previous substitutions and  $matched[i]$  is true for factors that have been matched by the current match.

References [algebraic\\_match\\_mul\\_with\\_mul\(\)](#), [factor\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::ex::nops\(\)](#), [GiNaC::expairseq::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::expairseq::op\(\)](#), and [tryfactsubs\(\)](#).

Referenced by [algebraic\\_match\\_mul\\_with\\_mul\(\)](#), [GiNaC::mul::algebraic\\_subs\\_mul\(\)](#), and [GiNaC::mul::has\(\)](#).

**5.1.3.553 GINAC\_BIND\_UNARCHIVER()** [34/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 mul)
```

**5.1.3.554 GINAC\_DECLARE\_UNARCHIVER()** [36/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 mul)
```

**5.1.3.555 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [25/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 ncmul ,
 exprseq ,
 print_func< print_context > &::do_print. print_func< print_tree > &::do_print↔
 _tree. print_func< print_csrc > &::do_print_csrc. print_func< print_python_repr > &::do_↔
 print_csrc)
```

References [GiNaC::ncmul::do\\_print\(\)](#), [GiNaC::ncmul::do\\_print\\_csrc\(\)](#), and [GiNaC::basic::do\\_print\\_tree\(\)](#).

**5.1.3.556 reeval\_ncmul()**

```
ex GiNaC::reeval_ncmul (
 const exvector & v)
```

Referenced by [GiNaC::clifford::eval\\_ncmul\(\)](#).

**5.1.3.557 hold\_ncmul()**

```
ex GiNaC::hold_ncmul (
 const exvector & v)
```

Referenced by [GiNaC::basic::eval\\_ncmul\(\)](#), [GiNaC::clifford::eval\\_ncmul\(\)](#), [GiNaC::color::eval\\_ncmul\(\)](#), and [GiNaC::structure< T, ComparisonPolicy >::eval\\_ncmul\(\)](#).

**5.1.3.558 GINAC\_BIND\_UNARCHIVER()** [35/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 ncmul)
```

**5.1.3.559 GINAC\_DECLARE\_UNARCHIVER()** [37/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 ncmul)
```

**5.1.3.560 get\_first\_symbol()**

```
static bool GiNaC::get_first_symbol (
 const ex & e,
 ex & x) [static]
```

Return pointer to first symbol found in expression.

Due to [GiNaC](#)'s internal ordering of terms, it may not be obvious which symbol this function returns for a given expression.

## Parameters

|          |                               |
|----------|-------------------------------|
| <i>e</i> | expression to search          |
| <i>x</i> | first symbol found (returned) |

## Returns

"false" if no symbol was found, "true" otherwise

References [get\\_first\\_symbol\(\)](#), [is\\_a\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [divide\(\)](#), [frac\\_cancel\(\)](#), [get\\_first\\_symbol\(\)](#), and [GiNaC::ex::unit\(\)](#).

**5.1.3.561 add\_symbol()**

```
static void GiNaC::add_symbol (
 const ex & s,
 sym_desc_vec & v) [static]
```

Referenced by [collect\\_symbols\(\)](#).

**5.1.3.562 collect\_symbols()**

```
static void GiNaC::collect_symbols (
 const ex & e,
 sym_desc_vec & v) [static]
```

References [add\\_symbol\(\)](#), [collect\\_symbols\(\)](#), [is\\_a\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [collect\\_symbols\(\)](#), and [get\\_symbol\\_stats\(\)](#).

**5.1.3.563 get\_symbol\_stats()**

```
static void GiNaC::get_symbol_stats (
 const ex & a,
 const ex & b,
 sym_desc_vec & v) [static]
```

Collect statistical information about symbols in polynomials.

This function fills in a vector of "sym\_desc" structs which contain information about the highest and lowest degrees of all symbols that appear in two polynomials. The vector is then sorted by minimum degree (lowest to highest). The information gathered by this function is used by the GCD routines to identify trivial factors and to determine which variable to choose as the main variable for GCD computation.

## Parameters

|          |                                                        |
|----------|--------------------------------------------------------|
| <i>a</i> | first multivariate polynomial                          |
| <i>b</i> | second multivariate polynomial                         |
| <i>v</i> | vector of <a href="#">sym_desc</a> structs (filled in) |

References [collect\\_symbols\(\)](#), [GiNaC::ex::degree\(\)](#), [GiNaC::ex::lcoeff\(\)](#), [GiNaC::ex::ldegree\(\)](#), and [GiNaC::ex::nops\(\)](#).

Referenced by [divide\\_in\\_z\(\)](#), [gcd\(\)](#), and [sqrfree\(\)](#).

**5.1.3.564 lcmcoeff()**

```
static numeric GiNaC::lcmcoeff (
 const ex & e,
 const numeric & l) [static]
```

References [\\_num1\\_p](#), [denom\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_a\(\)](#), [is\\_exactly\\_a\(\)](#), [lcm\(\)](#), [lcmcoeff\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [pow\(\)](#), and [GiNaC::info\\_flags::rational](#).

Referenced by [heur\\_gcd\(\)](#), [lcm\\_of\\_coefficients\\_denominators\(\)](#), [lcmcoeff\(\)](#), and [multiply\\_lcm\(\)](#).

**5.1.3.565 lcm\_of\_coefficients\_denominators()**

```
static numeric GiNaC::lcm_of_coefficients_denominators (
 const ex & e) [static]
```

Compute LCM of denominators of coefficients of a polynomial.

Given a polynomial with rational coefficients, this function computes the LCM of the denominators of all coefficients. This can be used to bring a polynomial from  $\mathbb{Q}[X]$  to  $\mathbb{Z}[X]$ .

**Parameters**

|          |                                                |
|----------|------------------------------------------------|
| <i>e</i> | multivariate polynomial (need not be expanded) |
|----------|------------------------------------------------|

**Returns**

LCM of denominators of coefficients

References [\\_num1\\_p](#), and [lcmcoeff\(\)](#).

Referenced by [frac\\_cancel\(\)](#), [heur\\_gcd\(\)](#), and [sqrfree\(\)](#).

**5.1.3.566 multiply\_lcm()**

```
static ex GiNaC::multiply_lcm (
 const ex & e,
 const numeric & lcm) [static]
```

Bring polynomial from  $\mathbb{Q}[X]$  to  $\mathbb{Z}[X]$  by multiplying in the previously determined LCM of the coefficient's denominators.

**Parameters**

|            |                                                |
|------------|------------------------------------------------|
| <i>e</i>   | multivariate polynomial (need not be expanded) |
| <i>lcm</i> | LCM to multiply in                             |

References [\\_num1\\_p](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [is\\_a\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::numeric::is\\_rational\(\)](#), [lcm\(\)](#), [lcmcoeff\(\)](#), [multiply\\_lcm\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [pow\(\)](#).

Referenced by [frac\\_cancel\(\)](#), [multiply\\_lcm\(\)](#), and [sqrfree\(\)](#).

**5.1.3.567 quo()**

```
ex GiNaC::quo (
 const ex & a,
 const ex & b,
 const ex & x,
 bool check_args)
```

Quotient  $q(x)$  of polynomials  $a(x)$  and  $b(x)$  in  $\mathbb{Q}[x]$ .

It satisfies  $a(x)=b(x)*q(x)+r(x)$ .

## Parameters

|                   |                                                                                       |
|-------------------|---------------------------------------------------------------------------------------|
| <i>a</i>          | first polynomial in x (dividend)                                                      |
| <i>b</i>          | second polynomial in x (divisor)                                                      |
| <i>x</i>          | a and b are polynomials in x                                                          |
| <i>check_args</i> | check whether a and b are polynomials with rational coefficients (defaults to "true") |

## Returns

quotient of a and b in  $\mathbb{Q}[x]$

References [\\_ex1](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::degree\(\)](#), [divide\(\)](#), [dynallocate\(\)](#), [GiNaC::ex::expand\(\)](#), [expand\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [pow\(\)](#), and [GiNaC::info\\_flags::rational\\_polynomial](#).

Referenced by [decomp\\_rational\(\)](#), [GiNaC::ex::primpart\(\)](#), [sqrfree\\_parfrac\(\)](#), [sqrfree\\_yun\(\)](#), and [GiNaC::ex::unitcontprim\(\)](#).

**5.1.3.568 rem()**

```
ex GiNaC::rem (
 const ex & a,
 const ex & b,
 const ex & x,
 bool check_args)
```

Remainder  $r(x)$  of polynomials  $a(x)$  and  $b(x)$  in  $\mathbb{Q}[x]$ .

It satisfies  $a(x)=b(x)*q(x)+r(x)$ .

## Parameters

|                   |                                                                                       |
|-------------------|---------------------------------------------------------------------------------------|
| <i>a</i>          | first polynomial in x (dividend)                                                      |
| <i>b</i>          | second polynomial in x (divisor)                                                      |
| <i>x</i>          | a and b are polynomials in x                                                          |
| <i>check_args</i> | check whether a and b are polynomials with rational coefficients (defaults to "true") |

## Returns

remainder of  $a(x)$  and  $b(x)$  in  $\mathbb{Q}[x]$

References [\\_ex0](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::degree\(\)](#), [divide\(\)](#), [dynallocate\(\)](#), [GiNaC::ex::expand\(\)](#), [expand\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [pow\(\)](#), and [GiNaC::info\\_flags::rational\\_polynomial](#).

Referenced by [decomp\\_rational\(\)](#), and [sqrfree\\_parfrac\(\)](#).

**5.1.3.569 decomp\_rational()**

```
ex GiNaC::decomp_rational (
 const ex & a,
 const ex & x)
```

Decompose rational function  $a(x)=N(x)/D(x)$  into  $P(x)+n(x)/D(x)$  with  $\text{degree}(n, x) < \text{degree}(D, x)$ .

## Parameters

|          |                                    |
|----------|------------------------------------|
| <i>a</i> | rational function in <i>x</i>      |
| <i>x</i> | <i>a</i> is a function of <i>x</i> |

## Returns

decomposed function.

References [denom\(\)](#), [is\\_exactly\\_a\(\)](#), [numer\(\)](#), [numer\\_denom\(\)](#), [GiNaC::ex::op\(\)](#), [quo\(\)](#), and [rem\(\)](#).

**5.1.3.570 prem()**

```
ex GiNaC::prem (
 const ex & a,
 const ex & b,
 const ex & x,
 bool check_args)
```

Pseudo-remainder of polynomials *a*(*x*) and *b*(*x*) in  $\mathbb{Q}[x]$ .

## Parameters

|                   |                                                                                                     |
|-------------------|-----------------------------------------------------------------------------------------------------|
| <i>a</i>          | first polynomial in <i>x</i> (dividend)                                                             |
| <i>b</i>          | second polynomial in <i>x</i> (divisor)                                                             |
| <i>x</i>          | <i>a</i> and <i>b</i> are polynomials in <i>x</i>                                                   |
| <i>check_args</i> | check whether <i>a</i> and <i>b</i> are polynomials with rational coefficients (defaults to "true") |

## Returns

pseudo-remainder of *a*(*x*) and *b*(*x*) in  $\mathbb{Q}[x]$

References [\\_ex0](#), [\\_ex1](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::degree\(\)](#), [GiNaC::ex::expand\(\)](#), [expand\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [pow\(\)](#), and [GiNaC::info\\_flags::rational\\_polynomial](#).

Referenced by [sr\\_gcd\(\)](#).

**5.1.3.571 sprem()**

```
ex GiNaC::sprem (
 const ex & a,
 const ex & b,
 const ex & x,
 bool check_args)
```

Sparse pseudo-remainder of polynomials *a*(*x*) and *b*(*x*) in  $\mathbb{Q}[x]$ .

## Parameters

|                   |                                                                                                     |
|-------------------|-----------------------------------------------------------------------------------------------------|
| <i>a</i>          | first polynomial in <i>x</i> (dividend)                                                             |
| <i>b</i>          | second polynomial in <i>x</i> (divisor)                                                             |
| <i>x</i>          | <i>a</i> and <i>b</i> are polynomials in <i>x</i>                                                   |
| <i>check_args</i> | check whether <i>a</i> and <i>b</i> are polynomials with rational coefficients (defaults to "true") |

**Returns**

sparse pseudo-remainder of  $a(x)$  and  $b(x)$  in  $\mathbb{Q}[x]$

References [\\_ex0](#), [\\_ex1](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::degree\(\)](#), [GiNaC::ex::expand\(\)](#), [expand\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [pow\(\)](#), and [GiNaC::info\\_flags::rational\\_polynomial](#).

**5.1.3.572 divide()**

```
bool GiNaC::divide (
 const ex & a,
 const ex & b,
 ex & q,
 bool check_args)
```

Exact polynomial division of  $a(X)$  by  $b(X)$  in  $\mathbb{Q}[X]$ .

**Parameters**

|                   |                                                                                       |
|-------------------|---------------------------------------------------------------------------------------|
| <i>a</i>          | first multivariate polynomial (dividend)                                              |
| <i>b</i>          | second multivariate polynomial (divisor)                                              |
| <i>q</i>          | quotient (returned)                                                                   |
| <i>check_args</i> | check whether a and b are polynomials with rational coefficients (defaults to "true") |

**Returns**

"true" when exact division succeeds (quotient returned in q), "false" otherwise (q left untouched)

References [\\_ex0](#), [\\_ex1](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::degree\(\)](#), [divide\(\)](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [expand\(\)](#), [get\\_first\\_symbol\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [pow\(\)](#), and [GiNaC::info\\_flags::rational\\_polynomial](#).

Referenced by [divide\(\)](#), [find\\_common\\_factor\(\)](#), [GiNaC::matrix::fraction\\_free\\_elimination\(\)](#), [gcd\(\)](#), [quo\(\)](#), and [rem\(\)](#).

**5.1.3.573 divide\_in\_z()**

```
static bool GiNaC::divide_in_z (
 const ex & a,
 const ex & b,
 ex & q,
 sym_desc_vec::const_iterator var) [static]
```

Exact polynomial division of  $a(X)$  by  $b(X)$  in  $\mathbb{Z}[X]$ .

This functions works like [divide\(\)](#) but the input and output polynomials are in  $\mathbb{Z}[X]$  instead of  $\mathbb{Q}[X]$  (i.e. they have integer coefficients). Unlike [divide\(\)](#), it doesn't check whether the input polynomials really are integer polynomials, so be careful of what you pass in. Also, you have to run [get\\_symbol\\_stats\(\)](#) over the input polynomials before calling this function and pass an iterator to the first element of the [sym\\_desc](#) vector. This function is used internally by the [heur\\_gcd\(\)](#).



## Parameters

|            |                                                                         |
|------------|-------------------------------------------------------------------------|
| <i>a</i>   | first multivariate polynomial (dividend)                                |
| <i>b</i>   | second multivariate polynomial (divisor)                                |
| <i>q</i>   | quotient (returned)                                                     |
| <i>var</i> | iterator to first element of vector of <a href="#">sym_desc</a> structs |

## Returns

"true" when exact division succeeds (the quotient is returned in q), "false" otherwise.

## See also

[get\\_symbol\\_stats](#), [heur\\_gcd](#)

References [\\_ex0](#), [\\_ex1](#), [\\_num0\\_p](#), [\\_num1\\_p](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::degree\(\)](#), [divide\\_in\\_z\(\)](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [expand\(\)](#), [get\\_symbol\\_stats\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::numeric::inverse\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::ex::op\(\)](#), [pow\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [divide\\_in\\_z\(\)](#), [heur\\_gcd\\_z\(\)](#), and [sr\\_gcd\(\)](#).

5.1.3.574 [sr\\_gcd\(\)](#)

```
static ex GiNaC::sr_gcd (
 const ex & a,
 const ex & b,
 sym_desc_vec::const_iterator var) [static]
```

Compute GCD of multivariate polynomials using the subresultant PRS algorithm.

This function is used internally by [gcd\(\)](#).

## Parameters

|            |                                                                         |
|------------|-------------------------------------------------------------------------|
| <i>a</i>   | first multivariate polynomial                                           |
| <i>b</i>   | second multivariate polynomial                                          |
| <i>var</i> | iterator to first element of vector of <a href="#">sym_desc</a> structs |

## Returns

the GCD as a new expression

## See also

[gcd](#)

References [\\_ex0](#), [\\_ex1](#), [GiNaC::ex::content\(\)](#), [GiNaC::ex::degree\(\)](#), [divide\\_in\\_z\(\)](#), [GiNaC::ex::expand\(\)](#), [gcd\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::ex::lcoeff\(\)](#), [pow\(\)](#), [prem\(\)](#), [GiNaC::ex::primpart\(\)](#), and [psi\(\)](#).

Referenced by [gcd\(\)](#).

### 5.1.3.575 interpolate()

```
static ex GiNaC::interpolate (
 const ex & gamma,
 const numeric & xi,
 const ex & x,
 int degree_hint = 1) [static]
```

xi-adic polynomial interpolation

References [dynallocate\(\)](#), [GiNaC::numeric::inverse\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [pow\(\)](#), and [GiNaC::ex::smod\(\)](#).

Referenced by [heur\\_gcd\\_z\(\)](#).

### 5.1.3.576 heur\_gcd\_z()

```
static bool GiNaC::heur_gcd_z (
 ex & res,
 const ex & a,
 const ex & b,
 ex * ca,
 ex * cb,
 sym_desc_vec::const_iterator var) [static]
```

Compute GCD of multivariate polynomials using the heuristic GCD algorithm.

[get\\_symbol\\_stats\(\)](#) must have been called previously with the input polynomials and an iterator to the first element of the [sym\\_desc](#) vector passed in. This function is used internally by [gcd\(\)](#).

#### Parameters

|            |                                                                                  |
|------------|----------------------------------------------------------------------------------|
| <i>a</i>   | first integer multivariate polynomial (expanded)                                 |
| <i>b</i>   | second integer multivariate polynomial (expanded)                                |
| <i>ca</i>  | cofactor of polynomial a (returned), nullptr to suppress calculation of cofactor |
| <i>cb</i>  | cofactor of polynomial b (returned), nullptr to suppress calculation of cofactor |
| <i>var</i> | iterator to first element of vector of <a href="#">sym_desc</a> structs          |
| <i>res</i> | the GCD (returned)                                                               |

#### Returns

true if GCD was computed, false otherwise.

#### See also

[gcd](#)

#### Exceptions

|                                 |
|---------------------------------|
| <a href="#">gcdheu_failed()</a> |
|---------------------------------|

References [GiNaC::ex::degree\(\)](#), [divide\\_in\\_z\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [gcd\(\)](#), [heur\\_gcd\\_z\(\)](#), [GiNaC::numeric::int\\_length\(\)](#), [GiNaC::ex::integer\\_content\(\)](#), [interpolate\(\)](#), [GiNaC::numeric::inverse\(\)](#), [iquo\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [isqrt\(\)](#), [GiNaC::ex::max\\_coefficient\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [heur\\_gcd\(\)](#), and [heur\\_gcd\\_z\(\)](#).

**5.1.3.577** `heur_gcd()`

```
static bool GiNaC::heur_gcd (
 ex & res,
 const ex & a,
 const ex & b,
 ex * ca,
 ex * cb,
 sym_desc_vec::const_iterator var) [static]
```

Compute GCD of multivariate polynomials using the heuristic GCD algorithm.

`get_symbol_stats()` must have been called previously with the input polynomials and an iterator to the first element of the `sym_desc` vector passed in. This function is used internally by `gcd()`.

**Parameters**

|            |                                                                                  |
|------------|----------------------------------------------------------------------------------|
| <i>a</i>   | first rational multivariate polynomial (expanded)                                |
| <i>b</i>   | second rational multivariate polynomial (expanded)                               |
| <i>ca</i>  | cofactor of polynomial a (returned), nullptr to suppress calculation of cofactor |
| <i>cb</i>  | cofactor of polynomial b (returned), nullptr to suppress calculation of cofactor |
| <i>var</i> | iterator to first element of vector of <code>sym_desc</code> structs             |
| <i>res</i> | the GCD (returned)                                                               |

**Returns**

true if GCD was computed, false otherwise.

**See also**

[heur\\_gcd\\_z](#)  
[gcd](#)

References [heur\\_gcd\\_z\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer\\_polynomial](#), [lcm\\_of\\_coefficients\\_denominators\(\)](#), and [lcmcoeff\(\)](#).

Referenced by [gcd\(\)](#).

**5.1.3.578** `gcd_pf_pow()`

```
static ex GiNaC::gcd_pf_pow (
 const ex & a,
 const ex & b,
 ex * ca,
 ex * cb) [static]
```

References [\\_ex1](#), [ex\\_to\(\)](#), [expand\(\)](#), [gcd\(\)](#), [gcd\\_pf\\_pow\(\)](#), [gcd\\_pf\\_pow\\_pow\(\)](#), [GINAC\\_ASSERT](#), [is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::ldegree\(\)](#), [GiNaC::ex::op\(\)](#), and [pow\(\)](#).

Referenced by [gcd\(\)](#), and [gcd\\_pf\\_pow\(\)](#).

### 5.1.3.579 gcd\_pf\_mul()

```
static ex GiNaC::gcd_pf_mul (
 const ex & a,
 const ex & b,
 ex * ca,
 ex * cb) [static]
```

References [dynallocate\(\)](#), [gcd\(\)](#), [gcd\\_pf\\_mul\(\)](#), [GINAC\\_ASSERT](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [gcd\(\)](#), and [gcd\\_pf\\_mul\(\)](#).

### 5.1.3.580 gcd() [1/2]

```
ex GiNaC::gcd (
 const ex & a,
 const ex & b,
 ex * ca,
 ex * cb,
 bool check_args,
 unsigned options)
```

Compute GCD (Greatest Common Divisor) of multivariate polynomials  $a(X)$  and  $b(X)$  in  $\mathbb{Z}[X]$ .

Optionally also compute the cofactors of  $a$  and  $b$ , defined by  $a = ca * \text{gcd}(a, b)$  and  $b = cb * \text{gcd}(a, b)$ .

#### Parameters

|                   |                                                                                           |
|-------------------|-------------------------------------------------------------------------------------------|
| <i>a</i>          | first multivariate polynomial                                                             |
| <i>b</i>          | second multivariate polynomial                                                            |
| <i>ca</i>         | pointer to expression that will receive the cofactor of $a$ , or nullptr                  |
| <i>cb</i>         | pointer to expression that will receive the cofactor of $b$ , or nullptr                  |
| <i>check_args</i> | check whether $a$ and $b$ are polynomials with rational coefficients (defaults to "true") |
| <i>options</i>    | see <a href="#">GiNaC::gcd_options</a>                                                    |

#### Returns

the GCD as a new expression

References [\\_ex0](#), [\\_ex1](#), [divide\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [expand\(\)](#), [gcd\(\)](#), [gcd\\_pf\\_mul\(\)](#), [gcd\\_pf\\_pow\(\)](#), [get\\_symbol\\_stats\(\)](#), [heur\\_gcd\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::integer\\_content\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [GiNaC::gcd\\_options::no\\_heur\\_gcd](#), [GiNaC::gcd\\_options::no\\_part\\_fa](#), [GiNaC::subs\\_options::no\\_pattern](#), [pow\(\)](#), [GiNaC::info\\_flags::rational\\_polynomial](#), [sr\\_gcd\(\)](#), [GiNaC::ex::subs\(\)](#), [GiNaC::ex::unitcontprim\(\)](#), and [GiNaC::gcd\\_options::use\\_sr\\_gcd](#).

Referenced by [GiNaC::ex::content\(\)](#), [dirichlet\\_character\(\)](#), [find\\_common\\_factor\(\)](#), [frac\\_cancel\(\)](#), [gcd\(\)](#), [gcd\\_pf\\_mul\(\)](#), [gcd\\_pf\\_pow\(\)](#), [gcd\\_pf\\_pow\\_pow\(\)](#), [heur\\_gcd\\_z\(\)](#), [GiNaC::add::integer\\_content\(\)](#), [lcm\(\)](#), [GiNaC::add::normal\(\)](#), [sqrfree\\_yun\(\)](#), and [sr\\_gcd\(\)](#).

**5.1.3.581 gcd\_pf\_pow\_pow()**

```
static ex GiNaC::gcd_pf_pow_pow (
 const ex & a,
 const ex & b,
 ex * ca,
 ex * cb) [static]
```

References [\\_ex1](#), [gcd\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::ex::op\(\)](#), and [pow\(\)](#).

Referenced by [gcd\\_pf\\_pow\(\)](#).

**5.1.3.582 lcm() [1/2]**

```
ex GiNaC::lcm (
 const ex & a,
 const ex & b,
 bool check_args)
```

Compute LCM (Least Common Multiple) of multivariate polynomials in  $\mathbb{Z}[X]$ .

**Parameters**

|                   |                                                                                       |
|-------------------|---------------------------------------------------------------------------------------|
| <i>a</i>          | first multivariate polynomial                                                         |
| <i>b</i>          | second multivariate polynomial                                                        |
| <i>check_args</i> | check whether a and b are polynomials with rational coefficients (defaults to "true") |

**Returns**

the LCM as a new expression

References [ex\\_to\(\)](#), [gcd\(\)](#), [GiNaC::ex::info\(\)](#), [is\\_exactly\\_a\(\)](#), [lcm\(\)](#), and [GiNaC::info\\_flags::rational\\_polynomial](#).

Referenced by [GiNaC::add::integer\\_content\(\)](#), [lcm\(\)](#), [lcmcoeff\(\)](#), [multiply\\_lcm\(\)](#), and [sqrfree\(\)](#).

**5.1.3.583 sqrfree\_yun()**

```
static epvector GiNaC::sqrfree_yun (
 const ex & a,
 const symbol & x) [static]
```

Compute square-free factorization of multivariate polynomial  $a(x)$  using Yun's algorithm.

Used internally by [sqrfree\(\)](#).

**Parameters**

|          |                                                                                                                      |
|----------|----------------------------------------------------------------------------------------------------------------------|
| <i>a</i> | multivariate polynomial over $\mathbb{Z}[X]$ , treated here as univariate polynomial in $x$ (needs not be expanded). |
| <i>x</i> | variable to factor in                                                                                                |

**Returns**

vector of expairs (factor, exponent), sorted by exponents

References [\\_ex1](#), [GiNaC::ex::diff\(\)](#), [gcd\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), and [quo\(\)](#).

Referenced by [sqrfree\(\)](#), and [sqrfree\\_parfrac\(\)](#).

### 5.1.3.584 `sqrfree()`

```
ex GiNaC::sqrfree (
 const ex & a,
 const lst & l)
```

Compute a square-free factorization of a multivariate polynomial in  $\mathbb{Q}[X]$ .

#### Parameters

|          |                                                                      |
|----------|----------------------------------------------------------------------|
| <i>a</i> | multivariate polynomial over $\mathbb{Q}[X]$ (needs not be expanded) |
| <i>l</i> | lst of variables to factor in, may be left empty for autodetection   |

#### Returns

a square-free factorization of *a*.

#### Note

A polynomial  $p(X) \in C[X]$  is said *square-free* if, whenever any two polynomials  $q(X)$  and  $r(X)$  are such that

$$p(X) = q(X)^2 r(X),$$

we have  $q(X) \in C$ . This means that  $p(X)$  has no repeated factors, apart eventually from constants. Given a polynomial  $p(X) \in C[X]$ , we say that the decomposition

$$p(X) = b \cdot p_1(X)^{a_1} \cdot p_2(X)^{a_2} \cdots p_r(X)^{a_r}$$

is a *square-free factorization* of  $p(X)$  if the following conditions hold:

1.  $b \in C$  and  $b \neq 0$ ;
2.  $a_i$  is a positive integer for  $i = 1, \dots, r$ ;
3. the degree of the polynomial  $p_i$  is strictly positive for  $i = 1, \dots, r$ ;
4. the polynomial  $\prod_{i=1}^r p_i(X)$  is square-free.

Square-free factorizations need not be unique. For example, if  $a_i$  is even, we could change the polynomial  $p_i(X)$  into  $-p_i(X)$ . Observe also that the factors  $p_i(X)$  need not be irreducible polynomials.

References `_ex0`, `GiNaC::container< C >::append()`, `ex_to()`, `get_symbol_stats()`, `is_a()`, `is_exactly_a()`, `lcm()`, `lcm_of_coefficients_denominators()`, `multiply_lcm()`, `GiNaC::container< C >::nops()`, `GiNaC::container< C >::op()`, `GiNaC::container< C >::remove_first()`, `sqrfree()`, and `sqrfree_yun()`.

Referenced by `sqrfree()`.

### 5.1.3.585 `sqrfree_parfrac()`

```
ex GiNaC::sqrfree_parfrac (
 const ex & a,
 const symbol & x)
```

Compute square-free partial fraction decomposition of rational function  $a(x)$ .

## Parameters

|          |                                                                                  |
|----------|----------------------------------------------------------------------------------|
| <i>a</i> | rational function over $\mathbb{Z}[x]$ , treated as univariate polynomial in $x$ |
| <i>x</i> | variable to factor in                                                            |

## Returns

decomposed rational function

References [\\_ex1](#), [GiNaC::basic::coeff\(\)](#), [coeff\(\)](#), [GiNaC::ex::coeff\(\)](#), [degree\(\)](#), [denom\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [factor\(\)](#), [GINAC\\_ASSERT](#), [number\(\)](#), [number\\_denom\(\)](#), [GiNaC::ex::op\(\)](#), [pow\(\)](#), [quo\(\)](#), [rem\(\)](#), [rhs\(\)](#), [GiNaC::matrix::solve\(\)](#), [sqrtfree\\_yun\(\)](#), and [to\\_int\(\)](#).

5.1.3.586 `replace_with_symbol()` [1/2]

```
static ex GiNaC::replace_with_symbol (
 const ex & e,
 exmap & repl,
 exmap & rev_lookup,
 lst & modifier) [static]
```

Create a symbol for replacing the expression "e" (or return a previously assigned symbol).

The symbol and expression are appended to `repl`, for a later application of [subs\(\)](#). An entry in the replacement table `repl` can be changed in some cases. If it was altered, we need to provide the modifier for the previously build expressions. The modifier is an (ordered) list, because those substitutions need to be done in the incremental order. As an example let us consider a rationalisation of the expression  $e = \exp(2x) \cdot \cos(\exp(2x)+1) \cdot \exp(x)$ . The first factor [GiNaC](#) denotes by something like `symbol1` and will record:  $e = \text{symbol1} \cdot \cos(\text{symbol1} + 1) \cdot \exp(x)$  `repl = {symbol1 :  $\exp(2x)$ }`. Similarly, the second factor would be denoted as `symbol2` and we will have  $e = \text{symbol1} \cdot \text{symbol2} \cdot \exp(x)$  `repl = {symbol1 :  $\exp(2x)$ , symbol2 :  $\cos(\text{symbol1} + 1)$ }`. Denoting the third term as `symbol3` [GiNaC](#) is willing to re-think  $\exp(2x)$  as  $\text{symbol3}^2$  rather than just `symbol1`. Here are two issues: 1) The replacement "`symbol1 -> symbol3^2`" in the previous part of the expression needs to be done outside of the present routine; 2) The pair "`symbol1 :  $\exp(2x)$` " shall be deleted from the replacement table `repl`. However, this will create illegal substitution "`symbol2 :  $\cos(\text{symbol1} + 1)$` " with undefined `symbol1`. These both problems are mitigated through the additions of the record "`symbol1==symbol3^2`" to the list modifier. Changed length of the modifier signals to the calling code that the previous portion of the expression needs to be altered (it solves 1). Thus [GiNaC](#) can record now  $e = \text{symbol3}^2 \cdot \text{symbol2} \cdot \text{symbol3}$  `repl = {symbol2 :  $\cos(\text{symbol1} + 1)$ , symbol3 :  $\exp(x)$ }` `modifier = {symbol1==symbol3^2}`. Then, doing the backward substitutions the list modifier will be used to restore such iterative substitutions in the right way (this solves 2).

## See also

[ex::normal](#)

References [\\_ex\\_1](#), [GiNaC::container< C >::append\(\)](#), [degree\(\)](#), [denom\(\)](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [exp\(\)](#), [GiNaC::ex::find\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [is\\_ex\\_the\\_function](#), [is\\_integer\(\)](#), [is\\_rational\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [normal\(\)](#), [number\(\)](#), [GiNaC::ex::op\(\)](#), [pow\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [GiNaC::basic::normal\(\)](#), [GiNaC::numeric::normal\(\)](#), [GiNaC::power::normal\(\)](#), [GiNaC::pseries::normal\(\)](#), [GiNaC::basic::to\\_polynomial\(\)](#), [GiNaC::numeric::to\\_polynomial\(\)](#), [GiNaC::power::to\\_polynomial\(\)](#), [GiNaC::basic::to\\_rational\(\)](#), [GiNaC::numeric::to\\_rational\(\)](#), and [GiNaC::power::to\\_rational\(\)](#).

**5.1.3.587 replace\_with\_symbol()** [2/2]

```
static ex GiNaC::replace_with_symbol (
 const ex & e,
 exmap & repl) [static]
```

Create a symbol for replacing the expression "e" (or return a previously assigned symbol).

The symbol and expression are appended to repl, and the symbol is returned.

See also

[basic::to\\_rational](#)

[basic::to\\_polynomial](#)

References [dynallocate\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), and [GiNaC::ex::subs\(\)](#).

**5.1.3.588 frac\_cancel()**

```
static ex GiNaC::frac_cancel (
 const ex & n,
 const ex & d) [static]
```

Fraction cancellation.

Parameters

|          |             |
|----------|-------------|
| <i>n</i> | numerator   |
| <i>d</i> | denominator |

Returns

cancelled fraction {n, d} as a list

References [\\_ex1](#), [\\_ex\\_1](#), [\\_num1\\_p](#), [GiNaC::numeric::denom\(\)](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [gcd\(\)](#), [get\\_first\\_symbol\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::ex::is\\_equal\(\)](#), [is\\_exactly\\_a\(\)](#), [is\\_negative\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [lcm\\_of\\_coefficients\\_denominators\(\)](#), [multiply\\_lcm\(\)](#), [GiNaC::numeric::numer\(\)](#), and [GiNaC::ex::unit\(\)](#).

Referenced by [GiNaC::add::normal\(\)](#), and [GiNaC::mul::normal\(\)](#).

**5.1.3.589 find\_common\_factor()**

```
static ex GiNaC::find_common_factor (
 const ex & e,
 ex & factor,
 exmap & repl) [static]
```

Remove the common factor in the terms of a sum 'e' by calculating the GCD, and multiply it into the expression 'factor' (which needs to be initialized to 1, unless you're accumulating factors).

References [\\_ex0](#), [\\_ex1](#), [divide\(\)](#), [dynallocate\(\)](#), [factor\(\)](#), [find\\_common\\_factor\(\)](#), [gcd\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [pow\(\)](#), and [GiNaC::ex::to\\_polynomial\(\)](#).

Referenced by [collect\\_common\\_factors\(\)](#), and [find\\_common\\_factor\(\)](#).



**5.1.3.590 collect\_common\_factors()**

```
ex GiNaC::collect_common_factors (
 const ex & e)
```

Collect common factors in sums.

This converts expressions like 'a\*(b\*x+b\*y)' to 'a\*b\*(x+y)'.

References [factor\(\)](#), [find\\_common\\_factor\(\)](#), [is\\_exactly\\_a\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [GiNaC::power::to\\_polynomial\(\)](#).

**5.1.3.591 resultant()**

```
ex GiNaC::resultant (
 const ex & e1,
 const ex & e2,
 const ex & s)
```

Resultant of two expressions e1,e2 with respect to symbol s.

Method: Compute determinant of Sylvester matrix of e1,e2,s.

References [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::degree\(\)](#), [GiNaC::matrix::determinant\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::ldegree\(\)](#), and [GiNaC::info\\_flags::polynomial](#).

**5.1.3.592 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT() [26/33]**

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 numeric ,
 basic ,
 print_func< print_context > &::do_print. print_func< print_latex > &::do_↵
print_latex. print_func< print_csrc > &::do_print_csrc. print_func< print_csrc_cl_N > &↵
::do_print_csrc_cl_N. print_func< print_tree > &::do_print_tree. print_func< print_python_repr
> &::do_print_python_repr)
```

default ctor.

Numerically it initializes to an integer zero.

References [GiNaC::numeric::do\\_print\(\)](#), [GiNaC::numeric::do\\_print\\_csrc\(\)](#), [GiNaC::numeric::do\\_print\\_csrc\\_cl\\_N\(\)](#), [GiNaC::numeric::do\\_print\\_latex\(\)](#), [GiNaC::numeric::do\\_print\\_python\\_repr\(\)](#), [GiNaC::numeric::do\\_print\\_tree\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [GiNaC::numeric::value](#).

**5.1.3.593 make\_real\_float()**

```
static const cln::cl_F GiNaC::make_real_float (
 const cln::cl_idcoded_float & dec) [static]
```

Construct a floating point number from sign, mantissa, and exponent.

Referenced by [read\\_real\\_float\(\)](#).

**5.1.3.594 read\_real\_float()**

```
static const cln::cl_F GiNaC::read_real_float (
 std::istream & s) [static]
```

Read serialized floating point number.

References [make\\_real\\_float\(\)](#).

Referenced by [GiNaC::numeric::read\\_archive\(\)](#).

**5.1.3.595 GINAC\_BIND\_UNARCHIVER() [36/49]**

```
GiNaC::GINAC_BIND_UNARCHIVER (
 numeric)
```

**5.1.3.596 write\_real\_float()**

```
static void GiNaC::write_real_float (
 std::ostream & s,
 const cln::cl_R & n) [static]
```

Referenced by [GiNaC::numeric::archive\(\)](#).

**5.1.3.597 print\_real\_number()**

```
static void GiNaC::print_real_number (
 const print_context & c,
 const cln::cl_R & x) [static]
```

Helper function to print a real number in a nicer way than is CLN's default.

Instead of printing 42.0L0 this just prints 42.0 to ostream os and instead of 3.99168L7 it prints 3.99168E7. This is fine in [GiNaC](#) as long as it only uses cl\_LF and no other floating point types that we might want to visibly distinguish from cl\_LF.

See also

[numeric::print\(\)](#)

References [is\\_a\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::numeric::print\\_numeric\(\)](#), and [print\\_real\\_cl\\_N\(\)](#).

**5.1.3.598 print\_integer\_csrc()**

```
static void GiNaC::print_integer_csrc (
 const print_context & c,
 const cln::cl_I & x) [static]
```

Helper function to print integer number in C++ source format.

See also

[numeric::print\(\)](#)

References [GiNaC::print\\_context::s](#).

Referenced by [print\\_real\\_csrc\(\)](#).

**5.1.3.599 print\_real\_csrc()**

```
static void GiNaC::print_real_csrc (
 const print_context & c,
 const cln::cl_R & x) [static]
```

Helper function to print real number in C++ source format.

See also

[numeric::print\(\)](#)

References [denom\(\)](#), [numer\(\)](#), [print\\_integer\\_csrc\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::numeric::do\\_print\\_csrc\(\)](#).

**5.1.3.600 coerce()**

```
template<typename T1, typename T2>
static bool GiNaC::coerce (
 T1 & dst,
 const T2 & arg) [inline], [static]
```

Referenced by [print\\_real\\_cl\\_N\(\)](#).

**5.1.3.601 coerce< int, [cln::cl\\_I](#) >()**

```
template<>
bool GiNaC::coerce< int, cln::cl_I > (
 int & dst,
 const cln::cl_I & arg) [inline]
```

Check if CLN integer can be converted into int.

See also

<https://www.ginac.de/pipermail/cln-list/2006-October/000248.html>

**5.1.3.602 `coerce< unsigned int, cln::cl_I >()`**

```
template<>
bool GiNaC::coerce< unsigned int, cln::cl_I > (
 unsigned int & dst,
 const cln::cl_I & arg) [inline]
```

**5.1.3.603 `print_real_cl_N()`**

```
static void GiNaC::print_real_cl_N (
 const print_context & c,
 const cln::cl_R & x) [static]
```

Helper function to print real number in C++ source format using `cl_N` types.

See also

[numeric::print\(\)](#)

References [coerce\(\)](#), [Digits](#), [print\\_real\\_number\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::numeric::do\\_print\\_csrc\\_cl\\_N\(\)](#).

**5.1.3.604 `exp()`**

```
const numeric GiNaC::exp (
 const numeric & x)
```

Exponential function.

Returns

arbitrary precision numerical  $\exp(x)$ .

References [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [abs\\_eval\(\)](#), [abs\\_power\(\)](#), [Bernoulli\\_polynomial\(\)](#), [beta\\_evalf\(\)](#), [GiNaC::Eisenstein\\_h\\_kernel::coefficient\\_an\(\)](#), [csgn\\_power\(\)](#), [GiNaC::power::do\\_print\\_csrc\(\)](#), [exp\\_conjugate\(\)](#), [exp\\_deriv\(\)](#), [exp\\_eval\(\)](#), [exp\\_evalf\(\)](#), [exp\\_expand\(\)](#), [exp\\_imag\\_part\(\)](#), [exp\\_power\(\)](#), [exp\\_real\\_part\(\)](#), [generalised\\_Bernoulli\\_number\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::get\\_numerical\\_val](#), [GiNaC::power::imag\\_part\(\)](#), [log\\_eval\(\)](#), [print\\_sym\\_pow\(\)](#), [GiNaC::power::real\\_part\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [replace\\_with\\_symbol\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::series\\_coeff\\_impl\(\)](#), [GiNaC::Kronecker\\_dz\\_kernel::s](#) and [tgamma\(\)](#).

**5.1.3.605 `log()`**

```
const numeric GiNaC::log (
 const numeric & x)
```

Natural logarithm.

## Parameters

|          |                |
|----------|----------------|
| <i>x</i> | complex number |
|----------|----------------|

## Returns

arbitrary precision numerical  $\log(x)$ .

## Exceptions

|                                                 |
|-------------------------------------------------|
| <i>pole_error("log()", logarithmic pole",0)</i> |
|-------------------------------------------------|

References [GiNaC::numeric::is\\_zero\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [atan\\_series\(\)](#), [atanh\\_series\(\)](#), [GiNaC::power::derivative\(\)](#), [GiNaC::integral::eval\\_integ\(\)](#), [exp\\_eval\(\)](#), [G2\\_eval\(\)](#), [G2\\_evalf\(\)](#), [G3\\_eval\(\)](#), [G3\\_evalf\(\)](#), [H\\_eval\(\)](#), [GiNaC::power::imag\\_part\(\)](#), [lgamma\(\)](#), [lgamma\\_eval\(\)](#), [lgamma\\_series\(\)](#), [Li2\\_deriv\(\)](#), [Li2\\_eval\(\)](#), [Li2\\_series\(\)](#), [Li\\_eval\(\)](#), [log\\_conjugate\(\)](#), [log\\_eval\(\)](#), [log\\_evalf\(\)](#), [log\\_expand\(\)](#), [log\\_real\\_part\(\)](#), [log\\_series\(\)](#), [psi1\\_eval\(\)](#), [psi2\\_eval\(\)](#), [GiNaC::power::real\\_part\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [S\\_eval\(\)](#), and [GiNaC::power::series\(\)](#).

**5.1.3.606 sin()**

```
const numeric GiNaC::sin (
 const numeric & x)
```

Numeric sine (trigonometric function).

## Returns

arbitrary precision numerical  $\sin(x)$ .

References [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [GiNaC::Eisenstein\\_h\\_kernel::coefficient\\_a0\(\)](#), [cos\\_deriv\(\)](#), [cos\\_imag\\_part\(\)](#), [cosh\\_imag\\_part\(\)](#), [exp\\_imag\\_part\(\)](#), [GiNaC::power::imag\\_part\(\)](#), [lgamma\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [sin\\_conjugate\(\)](#), [sin\\_eval\(\)](#), [sin\\_evalf\(\)](#), [sin\\_real\\_part\(\)](#), [sinh\\_eval\(\)](#), [sinh\\_imag\\_part\(\)](#), and [tan\\_series\(\)](#).

**5.1.3.607 cos()**

```
const numeric GiNaC::cos (
 const numeric & x)
```

Numeric cosine (trigonometric function).

## Returns

arbitrary precision numerical  $\cos(x)$ .

References [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [GiNaC::Eisenstein\\_h\\_kernel::coefficient\\_a0\(\)](#), [cos\\_conjugate\(\)](#), [cos\\_eval\(\)](#), [cos\\_evalf\(\)](#), [cos\\_real\\_part\(\)](#), [cosh\\_eval\(\)](#), [cosh\\_real\\_part\(\)](#), [exp\\_real\\_part\(\)](#), [GiNaC::power::real\\_part\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [sin\\_deriv\(\)](#), [sin\\_imag\\_part\(\)](#), [sinh\\_real\\_part\(\)](#), and [tan\\_series\(\)](#).

### 5.1.3.608 tan()

```
const numeric GiNaC::tan (
 const numeric & x)
```

Numeric tangent (trigonometric function).

#### Returns

arbitrary precision numerical tan(x).

References [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#), [tan\\_conjugate\(\)](#), [tan\\_deriv\(\)](#), [tan\\_eval\(\)](#), [tan\\_evalf\(\)](#), [tan\\_imag\\_part\(\)](#), [tan\\_real\\_part\(\)](#), [tanh\\_eval\(\)](#), [tanh\\_imag\\_part\(\)](#), and [tanh\\_real\\_part\(\)](#).

### 5.1.3.609 asin()

```
const numeric GiNaC::asin (
 const numeric & x)
```

Numeric inverse sine (trigonometric function).

#### Returns

arbitrary precision numerical asin(x).

References [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [asin\\_conjugate\(\)](#), [asin\\_eval\(\)](#), [asin\\_evalf\(\)](#), [cos\\_eval\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [sin\\_eval\(\)](#), and [tan\\_eval\(\)](#).

### 5.1.3.610 acos()

```
const numeric GiNaC::acos (
 const numeric & x)
```

Numeric inverse cosine (trigonometric function).

#### Returns

arbitrary precision numerical acos(x).

References [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [acos\\_conjugate\(\)](#), [acos\\_eval\(\)](#), [acos\\_evalf\(\)](#), [cos\\_eval\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [sin\\_eval\(\)](#), and [tan\\_eval\(\)](#).

### 5.1.3.611 atan() [1/2]

```
const numeric GiNaC::atan (
 const numeric & x)
```

Numeric arcustangent.

## Parameters

|          |                |
|----------|----------------|
| <i>x</i> | complex number |
|----------|----------------|

## Returns

$\operatorname{atan}(x)$

## Exceptions

|                           |                                             |
|---------------------------|---------------------------------------------|
| <i>pole_error("atan()</i> | logarithmic pole",0) if $x==1$ or $x==-1$ . |
|---------------------------|---------------------------------------------|

References [\\_num1\\_p](#), [abs\(\)](#), [GiNaC::numeric::imag\(\)](#), [GiNaC::numeric::is\\_real\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [GiNaC::numeric::real\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [atan2\\_eval\(\)](#), [atan2\\_evalf\(\)](#), [atan\\_conjugate\(\)](#), [atan\\_eval\(\)](#), [atan\\_evalf\(\)](#), [atan\\_series\(\)](#), [cos\\_eval\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [sin\\_eval\(\)](#), and [tan\\_eval\(\)](#).

**5.1.3.612 atan()** [2/2]

```
const numeric GiNaC::atan (
 const numeric & y,
 const numeric & x)
```

Numeric arcustangent of two arguments, analytically continued in a suitable way.

## Parameters

|          |                |
|----------|----------------|
| <i>y</i> | complex number |
| <i>x</i> | complex number |

## Returns

$-i \log((x+iy)/\sqrt{x^2+y^2})$ , which is equal to  $\operatorname{atan}(y/x)$  if  $y$  and  $x$  are both real.

## Exceptions

|                           |                                                 |
|---------------------------|-------------------------------------------------|
| <i>pole_error("atan()</i> | logarithmic pole",0) if $y/x==1$ or $y/x==-1$ . |
|---------------------------|-------------------------------------------------|

References [\\_num0\\_p](#), [GiNaC::numeric::is\\_real\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

**5.1.3.613 sinh()**

```
const numeric GiNaC::sinh (
 const numeric & x)
```

Numeric hyperbolic sine (trigonometric function).

## Returns

arbitrary precision numerical  $\sinh(x)$ .

References [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [cos\\_imag\\_part\(\)](#), [cosh\\_deriv\(\)](#), [cosh\\_imag\\_part\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [sin\\_imag\\_part\(\)](#), [sinh\\_conjugate\(\)](#), [sinh\\_eval\(\)](#), [sinh\\_evalf\(\)](#), [sinh\\_real\\_part\(\)](#), and [tanh\\_series\(\)](#).

#### 5.1.3.614 `cosh()`

```
const numeric GiNaC::cosh (
 const numeric & x)
```

Numeric hyperbolic cosine (trigonometric function).

##### Returns

arbitrary precision numerical  $\cosh(x)$ .

References [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [cos\\_real\\_part\(\)](#), [cosh\\_conjugate\(\)](#), [cosh\\_eval\(\)](#), [cosh\\_evalf\(\)](#), [cosh\\_real\\_part\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [sin\\_real\\_part\(\)](#), [sinh\\_deriv\(\)](#), [sinh\\_imag\\_part\(\)](#), and [tanh\\_series\(\)](#).

#### 5.1.3.615 `tanh()`

```
const numeric GiNaC::tanh (
 const numeric & x)
```

Numeric hyperbolic tangent (trigonometric function).

##### Returns

arbitrary precision numerical  $\tanh(x)$ .

References [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [REGISTER\\_FUNCTION\(\)](#), [tan\\_imag\\_part\(\)](#), [tanh\\_conjugate\(\)](#), [tanh\\_deriv\(\)](#), [tanh\\_eval\(\)](#), [tanh\\_evalf\(\)](#), [tanh\\_imag\\_part\(\)](#), and [tanh\\_real\\_part\(\)](#).

#### 5.1.3.616 `asinh()`

```
const numeric GiNaC::asinh (
 const numeric & x)
```

Numeric inverse hyperbolic sine (trigonometric function).

##### Returns

arbitrary precision numerical  $\operatorname{asinh}(x)$ .

References [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [asinh\\_conjugate\(\)](#), [asinh\\_eval\(\)](#), [asinh\\_evalf\(\)](#), [cosh\\_eval\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [sinh\\_eval\(\)](#), and [tanh\\_eval\(\)](#).



**5.1.3.617 acosh()**

```
const numeric GiNaC::acosh (
 const numeric & x)
```

Numeric inverse hyperbolic cosine (trigonometric function).

**Returns**

arbitrary precision numerical acosh(x).

References [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [acosh\\_conjugate\(\)](#), [acosh\\_eval\(\)](#), [acosh\\_evalf\(\)](#), [cosh\\_eval\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [sinh\\_eval\(\)](#), and [tanh\\_eval\(\)](#).

**5.1.3.618 atanh()**

```
const numeric GiNaC::atanh (
 const numeric & x)
```

Numeric inverse hyperbolic tangent (trigonometric function).

**Returns**

arbitrary precision numerical atanh(x).

References [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [atanh\\_conjugate\(\)](#), [atanh\\_eval\(\)](#), [atanh\\_evalf\(\)](#), [atanh\\_series\(\)](#), [cosh\\_eval\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [sinh\\_eval\(\)](#), and [tanh\\_eval\(\)](#).

**5.1.3.619 Li2\_series() [2/2]**

```
static cln::cl_N GiNaC::Li2_series (
 const cln::cl_N & x,
 const cln::float_format_t & prec) [static]
```

Numeric evaluation of Dilogarithm within circle of convergence (unit circle) using a power series.

**5.1.3.620 Li2\_projection()**

```
static cln::cl_N GiNaC::Li2_projection (
 const cln::cl_N & x,
 const cln::float_format_t & prec) [static]
```

Folds Li2's argument inside a small rectangle to enhance convergence.

References [Li2\\_projection\(\)](#), and [Li2\\_series\(\)](#).

Referenced by [Li2\\_\(\)](#), and [Li2\\_projection\(\)](#).

**5.1.3.621 Li2\_()**

```
const cln::cl_N GiNaC::Li2_ (
 const cln::cl_N & value)
```

Numeric evaluation of Dilogarithm.

The domain is the entire complex plane, the branch cut lies along the positive real axis, starting at 1 and continuous with quadrant IV.

**Returns**

arbitrary precision numerical Li2(x).

References [Li2\\_projection\(\)](#).

Referenced by [Li2\(\)](#).

**5.1.3.622 Li2()**

```
const numeric GiNaC::Li2 (
 const numeric & x)
```

References [\\_num0\\_p](#), [Li2\\_\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [Li2\\_conjugate\(\)](#), [Li2\\_eval\(\)](#), [Li2\\_evalf\(\)](#), [Li2\\_series\(\)](#), and [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.623 zeta() [3/3]**

```
const numeric GiNaC::zeta (
 const numeric & x)
```

Numeric evaluation of Riemann's Zeta function.

Currently works only for integer arguments.

References [GiNaC::numeric::is\\_real\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

**5.1.3.624 guess\_precision()**

```
static cln::float_format_t GiNaC::guess_precision (
 const cln::cl_N & x) [static]
```

Referenced by [lgamma\(\)](#), and [tgamma\(\)](#).

**5.1.3.625 lgamma()** [1/2]

```
const cln::cl_N GiNaC::lgamma (
 const cln::cl_N & x)
```

The Gamma function.

Use the Lanczos approximation. If the coefficients used here are not sufficiently many or sufficiently accurate, more can be calculated using the program `doc/examples/lanczos.cpp`. In that case, be sure to read the comments in that file.

References [GiNaC::lanczos\\_coeffs::calc\\_lanczos\\_A\(\)](#), [GiNaC::lanczos\\_coeffs::get\\_order\(\)](#), [guess\\_precision\(\)](#), [lgamma\(\)](#), [log\(\)](#), [sin\(\)](#), and [GiNaC::lanczos\\_coeffs::sufficiently\\_accurate\(\)](#).

Referenced by [beta\\_evalf\(\)](#), [lgamma\(\)](#), [lgamma\(\)](#), [lgamma\\_conjugate\(\)](#), [lgamma\\_eval\(\)](#), [lgamma\\_evalf\(\)](#), [lgamma\\_series\(\)](#), and [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.626 lgamma()** [2/2]

```
const numeric GiNaC::lgamma (
 const numeric & x)
```

References [lgamma\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

**5.1.3.627 tgamma()** [1/2]

```
const cln::cl_N GiNaC::tgamma (
 const cln::cl_N & x)
```

References [GiNaC::lanczos\\_coeffs::calc\\_lanczos\\_A\(\)](#), [exp\(\)](#), [GiNaC::lanczos\\_coeffs::get\\_order\(\)](#), [guess\\_precision\(\)](#), [sqrt\(\)](#), [GiNaC::lanczos\\_coeffs::sufficiently\\_accurate\(\)](#), and [tgamma\(\)](#).

Referenced by [beta\\_eval\(\)](#), [beta\\_series\(\)](#), [psi2\\_eval\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [tgamma\(\)](#), [tgamma\(\)](#), [tgamma\\_conjugate\(\)](#), [tgamma\\_deriv\(\)](#), [tgamma\\_eval\(\)](#), [tgamma\\_evalf\(\)](#), and [tgamma\\_series\(\)](#).

**5.1.3.628 tgamma()** [2/2]

```
const numeric GiNaC::tgamma (
 const numeric & x)
```

References [tgamma\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

**5.1.3.629 psi()** [3/4]

```
const numeric GiNaC::psi (
 const numeric & x)
```

The psi function (aka polygamma function).

This is only a stub!

**5.1.3.630 psi() [4/4]**

```
const numeric GiNaC::psi (
 const numeric & n,
 const numeric & x)
```

The psi functions (aka polygamma functions).

This is only a stub!

**5.1.3.631 factorial()**

```
const numeric GiNaC::factorial (
 const numeric & n)
```

Factorial combinatorial function.

**Parameters**

|     |                           |
|-----|---------------------------|
| $n$ | integer argument $\geq 0$ |
|-----|---------------------------|

**Exceptions**

|                    |                                      |
|--------------------|--------------------------------------|
| <i>range_error</i> | (argument must be integer $\geq 0$ ) |
|--------------------|--------------------------------------|

References [GiNaC::numeric::is\\_nonneg\\_integer\(\)](#), and [GiNaC::numeric::to\\_int\(\)](#).

Referenced by [Bernoulli\\_polynomial\(\)](#), [factorial\\_conjugate\(\)](#), [factorial\\_eval\(\)](#), [factorial\\_evalf\(\)](#), [factorial\\_real\\_part\(\)](#), [G2\\_eval\(\)](#), [G2\\_evalf\(\)](#), [G3\\_eval\(\)](#), [G3\\_evalf\(\)](#), [generalised\\_Bernoulli\\_number\(\)](#), [H\\_eval\(\)](#), [lgamma\\_eval\(\)](#), [multinomial\\_coefficient\(\)](#), [psi2\\_eval\(\)](#), [psi2\\_series\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [S\\_eval\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::series\\_coeff\\_impl\(\)](#), [GiNaC::Kronecker\\_dz\\_kernel::series\\_coeff\\_impl\(\)](#), [symm\(\)](#), [tgamma\\_eval\(\)](#), and [zeta1\\_eval\(\)](#).

**5.1.3.632 doublefactorial()**

```
const numeric GiNaC::doublefactorial (
 const numeric & n)
```

The double factorial combinatorial function.

(Scarcely used, but still useful in cases, like for exact results of  $tgamma(n+1/2)$  for instance.)

**Parameters**

|     |                            |
|-----|----------------------------|
| $n$ | integer argument $\geq -1$ |
|-----|----------------------------|

**Returns**

$n!! == n * (n-2) * (n-4) * \dots * (\{1|2\})$  with  $0!! == (-1)!! == 1$

## Exceptions

|                          |                                       |
|--------------------------|---------------------------------------|
| <code>range_error</code> | (argument must be integer $\geq -1$ ) |
|--------------------------|---------------------------------------|

References [\\_num1\\_p](#), [\\_num\\_1\\_p](#), [GiNaC::numeric::is\\_equal\(\)](#), [GiNaC::numeric::is\\_nonneg\\_integer\(\)](#), and [GiNaC::numeric::to\\_int\(\)](#).

Referenced by [tgamma\\_eval\(\)](#).

**5.1.3.633 binomial()**

```
const numeric GiNaC::binomial (
 const numeric & n,
 const numeric & k)
```

The Binomial coefficients.

It computes the binomial coefficients. For integer  $n$  and  $k$  and positive  $n$  this is the number of ways of choosing  $k$  objects from  $n$  distinct objects. If  $n$  is a negative integer, the formula  $\text{binomial}(n,k) == (-1)^k * \text{binomial}(k-n-1,k)$  (if  $k \geq 0$ )  $\text{binomial}(n,k) == (-1)^{(n-k)} * \text{binomial}(-k-1,n-k)$  (otherwise) is used to compute the result.

References [\\_num0\\_p](#), [\\_num1\\_p](#), [\\_num\\_1\\_p](#), [binomial\(\)](#), [GiNaC::numeric::compare\(\)](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::is\\_nonneg\\_integer\(\)](#), and [GiNaC::numeric::to\\_int\(\)](#).

Referenced by [binomial\(\)](#), [binomial\\_conjugate\(\)](#), [binomial\\_eval\(\)](#), [binomial\\_evalf\(\)](#), [binomial\\_real\\_part\(\)](#), [binomial\\_sym\(\)](#), [GiNaC::power::expand\\_add\(\)](#), [GiNaC::power::imag\\_part\(\)](#), [GiNaC::power::real\\_part\(\)](#), and [REGISTER\\_FUNCTION\(\)](#).

**5.1.3.634 bernoulli()**

```
const numeric GiNaC::bernoulli (
 const numeric & nn)
```

Bernoulli number.

The  $n$ th Bernoulli number is the coefficient of  $x^n/n!$  in the expansion of the function  $x/(e^x-1)$ .

## Returns

the  $n$ th Bernoulli number (a rational number).

## Exceptions

|                          |                                      |
|--------------------------|--------------------------------------|
| <code>range_error</code> | (argument must be integer $\geq 0$ ) |
|--------------------------|--------------------------------------|

References [\\_num1\\_p](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::is\\_negative\(\)](#), and [GiNaC::numeric::to\\_int\(\)](#).

Referenced by [GiNaC::Kronecker\\_dtau\\_kernel::series\\_coeff\\_impl\(\)](#), [GiNaC::Kronecker\\_dz\\_kernel::series\\_coeff\\_impl\(\)](#), and [zeta1\\_eval\(\)](#).

**5.1.3.635 fibonacci()**

```
const numeric GiNaC::fibonacci (
 const numeric & n)
```

Fibonacci number.

The  $n$ th Fibonacci number  $F(n)$  is defined by the recurrence formula  $F(n) == F(n-1) + F(n-2)$  with  $F(0) == 0$  and  $F(1) == 1$ .

## Parameters

|     |            |
|-----|------------|
| $n$ | an integer |
|-----|------------|

## Returns

the nth Fibonacci number  $F(n)$  (an integer number)

## Exceptions

|                          |                               |
|--------------------------|-------------------------------|
| <code>range_error</code> | (argument must be an integer) |
|--------------------------|-------------------------------|

References [\\_num0\\_p](#), [fibonacci\(\)](#), [GiNaC::numeric::is\\_even\(\)](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::is\\_negative\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [fibonacci\(\)](#).

**5.1.3.636 abs()**

```
const numeric GiNaC::abs (
 const numeric & x)
```

Absolute value.

References [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [abs\\_conjugate\(\)](#), [abs\\_eval\(\)](#), [abs\\_evalf\(\)](#), [abs\\_expand\(\)](#), [abs\\_expl\\_derivative\(\)](#), [abs\\_power\(\)](#), [abs\\_real\\_part\(\)](#), [adaptivesimpson\(\)](#), [atan\(\)](#), [atan\\_series\(\)](#), [atanh\\_series\(\)](#), [GiNaC::power::eval\(\)](#), [generalised\\_Bernoulli\\_number\(\)](#), [GiNaC::power::imag\\_part\(\)](#), [GiNaC::mul::integer\\_content\(\)](#), [GiNaC::numeric::integer\\_content\(\)](#), [is\\_discriminant\\_of\\_quadratic\\_number\(\)](#), [log\\_real\\_part\(\)](#), [GiNaC::add::max\\_coefficient\(\)](#), [GiNaC::mul::max\\_coefficient\(\)](#), [GiNaC::numeric::max\\_coefficient\(\)](#), [GiNaC::matrix::pivot\(\)](#), [GiNaC::power::real\\_part\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [tgamma\\_eval\(\)](#), [GiNaC::ex::unitcontprim\(\)](#), and [zeta1\\_eval\(\)](#).

**5.1.3.637 mod()**

```
const numeric GiNaC::mod (
 const numeric & a,
 const numeric & b)
```

Modulus (in positive representation).

In general,  $\text{mod}(a,b)$  has the sign of  $b$  or is zero, and  $\text{rem}(a,b)$  has the sign of  $a$  or is zero. This is different from Maple's  $\text{modp}$ , where the sign of  $b$  is ignored. It is in agreement with Mathematica's  $\text{Mod}$ .

## Returns

$a \bmod b$  in the range  $[0, \text{abs}(b)-1]$  with sign of  $b$  if both are integer, 0 otherwise.

References [\\_num0\\_p](#), [GiNaC::numeric::is\\_integer\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [GiNaC::Eisenstein\\_h\\_kernel::coefficient\\_a0\(\)](#), [GiNaC::Eisenstein\\_h\\_kernel::coefficient\\_an\(\)](#), [cos\\_eval\(\)](#), [exp\\_eval\(\)](#), [is\\_discriminant\\_of\\_quadratic\\_number\\_field\(\)](#), [sin\\_eval\(\)](#), and [tan\\_eval\(\)](#).

**5.1.3.638 smod()**

```
const numeric GiNaC::smod (
 const numeric & a_,
 const numeric & b_)
```

Modulus (in symmetric representation).

**Returns**

$a \bmod b$  in the range  $[-\text{iquo}(\text{abs}(b),2), \text{iquo}(\text{abs}(b),2)]$ .

References [\\_num0\\_p](#), [GiNaC::numeric::is\\_integer\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [GiNaC::add::smod\(\)](#), [GiNaC::mul::smod\(\)](#), and [GiNaC::numeric::smod\(\)](#).

**5.1.3.639 irem() [1/2]**

```
const numeric GiNaC::irem (
 const numeric & a,
 const numeric & b)
```

Numeric integer remainder.

Equivalent to Maple's `irem(a,b)` as far as sign conventions are concerned. In general, `mod(a,b)` has the sign of `b` or is zero, and `irem(a,b)` has the sign of `a` or is zero.

**Returns**

remainder of  $a/b$  if both are integer, 0 otherwise.

**Exceptions**

|                       |                                               |
|-----------------------|-----------------------------------------------|
| <i>overflow_error</i> | (division by zero) if <code>b</code> is zero. |
|-----------------------|-----------------------------------------------|

References [\\_num0\\_p](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [GiNaC::Eisenstein\\_h\\_kernel::coefficient\\_a0\(\)](#), [GiNaC::Eisenstein\\_h\\_kernel::coefficient\\_an\(\)](#), and [ifactor\(\)](#).

**5.1.3.640 irem() [2/2]**

```
const numeric GiNaC::irem (
 const numeric & a,
 const numeric & b,
 numeric & q)
```

Numeric integer remainder.

Equivalent to Maple's `irem(a,b,'q')` it obeys the relation `irem(a,b,q) == a - q*b`. In general, `mod(a,b)` has the sign of `b` or is zero, and `irem(a,b)` has the sign of `a` or is zero.

**Returns**

remainder of  $a/b$  and quotient stored in `q` if both are integer, 0 otherwise.

## Exceptions

|                             |                                  |
|-----------------------------|----------------------------------|
| <code>overflow_error</code> | (division by zero) if b is zero. |
|-----------------------------|----------------------------------|

References [\\_num0\\_p](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

**5.1.3.641 iquo()** [1/2]

```
const numeric GiNaC::iquo (
 const numeric & a,
 const numeric & b)
```

Numeric integer quotient.

Equivalent to Maple's `iquo` as far as sign conventions are concerned.

## Returns

truncated quotient of  $a/b$  if both are integer, 0 otherwise.

## Exceptions

|                             |                                  |
|-----------------------------|----------------------------------|
| <code>overflow_error</code> | (division by zero) if b is zero. |
|-----------------------------|----------------------------------|

References [\\_num0\\_p](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [GiNaC::power::eval\(\)](#), and [heur\\_gcd\\_z\(\)](#).

**5.1.3.642 iquo()** [2/2]

```
const numeric GiNaC::iquo (
 const numeric & a,
 const numeric & b,
 numeric & r)
```

Numeric integer quotient.

Equivalent to Maple's `iquo(a,b,'r')` it obeys the relation  $r == a - \text{iquo}(a,b,r)*b$ .

## Returns

truncated quotient of  $a/b$  and remainder stored in `r` if both are integer, 0 otherwise.

## Exceptions

|                             |                                  |
|-----------------------------|----------------------------------|
| <code>overflow_error</code> | (division by zero) if b is zero. |
|-----------------------------|----------------------------------|

References [\\_num0\\_p](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).



**5.1.3.643 gcd()** [2/2]

```
const numeric GiNaC::gcd (
 const numeric & a,
 const numeric & b)
```

Greatest Common Divisor.

**Returns**

The GCD of two numbers if both are integer, a numerical 1 if they are not.

References [\\_num1\\_p](#), [GiNaC::numeric::is\\_integer\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

**5.1.3.644 lcm()** [2/2]

```
const numeric GiNaC::lcm (
 const numeric & a,
 const numeric & b)
```

Least Common Multiple.

**Returns**

The LCM of two numbers if both are integer, the product of those two numbers if they are not.

References [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::mul\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

**5.1.3.645 sqrt()** [1/2]

```
const numeric GiNaC::sqrt (
 const numeric & x)
```

Numeric square root.

If possible, sqrt(x) should respect squares of exact numbers, i.e. sqrt(4) should return integer 2.

**Parameters**

|          |                  |
|----------|------------------|
| <i>x</i> | numeric argument |
|----------|------------------|

**Returns**

square root of *x*. Branch cut along negative real axis, the negative real axis itself where  $\text{imag}(x)=0$  and  $\text{real}(x)<0$  belongs to the upper part where  $\text{imag}(x)>0$ .

References [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [clifford\\_norm\(\)](#), [cos\\_eval\(\)](#), [cosh\\_eval\(\)](#), [EllipticE\\_evalf\(\)](#), [EllipticK\\_evalf\(\)](#), [GiNaC::su3d::eval\\_indexed\(\)](#), [GiNaC::su3f::eval\\_indexed\(\)](#), [sin\\_eval\(\)](#), [sinh\\_eval\(\)](#), [tan\\_eval\(\)](#), [tanh\\_eval\(\)](#), [tgamma\(\)](#), and [tgamma\\_eval\(\)](#).

#### 5.1.3.646 isqrt()

```
const numeric GiNaC::isqrt (
 const numeric & x)
```

Integer numeric square root.

References [\\_num0\\_p](#), [GiNaC::numeric::is\\_integer\(\)](#), and [GiNaC::numeric::to\\_cl\\_N\(\)](#).

Referenced by [heur\\_gcd\\_z\(\)](#).

#### 5.1.3.647 PiEvalf()

```
ex GiNaC::PiEvalf ()
```

Floating point evaluation of Archimedes' constant Pi.

#### 5.1.3.648 EulerEvalf()

```
ex GiNaC::EulerEvalf ()
```

Floating point evaluation of Euler's constant gamma.

#### 5.1.3.649 CatalanEvalf()

```
ex GiNaC::CatalanEvalf ()
```

Floating point evaluation of Catalan's constant.

#### 5.1.3.650 operator<<() [6/16]

```
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const _numeric_digits & e)
```

References [GiNaC::\\_numeric\\_digits::print\(\)](#).

#### 5.1.3.651 GINAC\_DECLARE\_UNARCHIVER() [38/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 numeric)
```

References [Digits](#), and [I](#).

**5.1.3.652 pow()** [1/3]

```
const numeric GiNaC::pow (
 const numeric & x,
 const numeric & y) [inline]
```

References [GiNaC::numeric::power\(\)](#).

Referenced by [abs\\_eval\(\)](#), [abs\\_power\(\)](#), [GiNaC::mul::algebraic\\_subs\\_mul\(\)](#), [beta\\_eval\(\)](#), [clifford\\_inverse\(\)](#), [clifford\\_prime\(\)](#), [clifford\\_star\\_bar\(\)](#), [clifford\\_to\\_lst\(\)](#), [GiNaC::Eisenstein\\_h\\_kernel::coefficient\\_an\(\)](#), [GiNaC::basic::collect\(\)](#), [GiNaC::mul::combine\\_ex\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::mul::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::pseries::convert\\_to\\_poly\(\)](#), [GiNaC::mul::derivative\(\)](#), [GiNaC::power::derivative\(\)](#), [divide\(\)](#), [divide\\_in\\_z\(\)](#), [EllipticE\\_series\(\)](#), [EllipticK\\_series\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::power::evalm\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::expand\\_add\(\)](#), [factor\(\)](#), [find\\_common\\_factor\(\)](#), [G2\\_eval\(\)](#), [G2\\_evalf\(\)](#), [G3\\_eval\(\)](#), [G3\\_evalf\(\)](#), [gcd\(\)](#), [gcd\\_pf\\_pow\(\)](#), [gcd\\_pf\\_pow\\_pow\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::get\\_numerical\\_value\(\)](#), [GiNaC::Kronecker\\_dz\\_kernel::get\\_numerical\\_value\(\)](#), [H\\_eval\(\)](#), [GiNaC::power::imag\\_part\(\)](#), [interpolate\(\)](#), [kronecker\\_symbol\(\)](#), [GiNaC::integration\\_kernel::Laurent\\_series\(\)](#), [lcmcoeff\(\)](#), [Li2\\_series\(\)](#), [Li\\_eval\(\)](#), [Li\\_series\(\)](#), [log\\_series\(\)](#), [multiply\\_lcm\(\)](#), [GiNaC::power::normal\(\)](#), [GiNaC::pseries::op\(\)](#), [Order\\_power\(\)](#), [GiNaC::pseries::power\\_const\(\)](#), [prem\(\)](#), [GiNaC::pseries::print\\_series\(\)](#), [psi1\\_eval\(\)](#), [psi2\\_eval\(\)](#), [GiNaC::Eisenstein\\_h\\_kernel::q\\_expansion\\_modular\\_form\(\)](#), [quo\(\)](#), [GiNaC::power::real\\_part\(\)](#), [rem\(\)](#), [remove\\_dirac\\_ONE\(\)](#), [replace\\_with\\_symbol\(\)](#), [S\\_eval\(\)](#), [S\\_series\(\)](#), [GiNaC::modular\\_form\\_kernel::series\(\)](#), [GiNaC::Kronecker\\_dz\\_kernel::series\\_coeff\\_impl\(\)](#), [sprem\(\)](#), [sqrfree\\_parfrac\(\)](#), [sr\\_gcd\(\)](#), [GiNaC::power::subs\(\)](#), [tgamma\\_eval\(\)](#), [GiNaC::power::to\\_polynomial\(\)](#), [GiNaC::power::to\\_rational\(\)](#), and [zeta1\\_eval\(\)](#).

**5.1.3.653 inverse()** [3/3]

```
const numeric GiNaC::inverse (
 const numeric & x) [inline]
```

References [GiNaC::numeric::inverse\(\)](#).

**5.1.3.654 step()**

```
numeric GiNaC::step (
 const numeric & x) [inline]
```

References [GiNaC::numeric::step\(\)](#).

Referenced by [abs\\_eval\(\)](#), [H\\_eval\(\)](#), [REGISTER\\_FUNCTION\(\)](#), [step\\_conjugate\(\)](#), [step\\_eval\(\)](#), [step\\_evalf\(\)](#), [step\\_real\\_part\(\)](#), and [step\\_series\(\)](#).

**5.1.3.655 csgn()**

```
int GiNaC::csgn (
 const numeric & x) [inline]
```

References [GiNaC::numeric::csgn\(\)](#).

Referenced by [atan\\_series\(\)](#), [atanh\\_series\(\)](#), [csgn\\_conjugate\(\)](#), [csgn\\_eval\(\)](#), [csgn\\_evalf\(\)](#), [csgn\\_power\(\)](#), [csgn\\_real\\_part\(\)](#), [csgn\\_series\(\)](#), [eta\\_eval\(\)](#), [eta\\_evalf\(\)](#), [log\\_series\(\)](#), and [REGISTER\\_FUNCTION\(\)](#).

#### 5.1.3.656 `is_zero()` [2/2]

```
bool GiNaC::is_zero (
 const numeric & x) [inline]
```

References [GiNaC::numeric::is\\_zero\(\)](#).

#### 5.1.3.657 `is_positive()`

```
bool GiNaC::is_positive (
 const numeric & x) [inline]
```

References [GiNaC::numeric::is\\_positive\(\)](#).

Referenced by [beta\\_eval\(\)](#).

#### 5.1.3.658 `is_negative()`

```
bool GiNaC::is_negative (
 const numeric & x) [inline]
```

References [GiNaC::numeric::is\\_negative\(\)](#).

Referenced by [GiNaC::power::do\\_print\\_latex\(\)](#), [GiNaC::power::eval\(\)](#), and [frac\\_cancel\(\)](#).

#### 5.1.3.659 `is_integer()`

```
bool GiNaC::is_integer (
 const numeric & x) [inline]
```

References [GiNaC::numeric::is\\_integer\(\)](#).

Referenced by [beta\\_eval\(\)](#), [binomial\\_eval\(\)](#), [GiNaC::power::coeff\(\)](#), [GiNaC::power::degree\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::ldegree\(\)](#), [GiNaC::pseries::power\\_const\(\)](#), [psi1\\_eval\(\)](#), [psi2\\_eval\(\)](#), [replace\\_with\\_symbol\(\)](#), and [GiNaC::power::series\(\)](#).

#### 5.1.3.660 `is_pos_integer()`

```
bool GiNaC::is_pos_integer (
 const numeric & x) [inline]
```

References [GiNaC::numeric::is\\_pos\\_integer\(\)](#).

Referenced by [GiNaC::power::expand\\_add\(\)](#), and [GiNaC::power::expand\\_add\\_2\(\)](#).

#### 5.1.3.661 `is_nonneg_integer()`

```
bool GiNaC::is_nonneg_integer (
 const numeric & x) [inline]
```

References [GiNaC::numeric::is\\_nonneg\\_integer\(\)](#).

**5.1.3.662 is\_even()**

```
bool GiNaC::is_even (
 const numeric & x) [inline]
```

References [GiNaC::numeric::is\\_even\(\)](#).

Referenced by [abs\\_power\(\)](#), and [GiNaC::Kronecker\\_dz\\_kernel::series\\_coeff\\_impl\(\)](#).

**5.1.3.663 is\_odd()**

```
bool GiNaC::is_odd (
 const numeric & x) [inline]
```

References [GiNaC::numeric::is\\_odd\(\)](#).

Referenced by [csgn\\_power\(\)](#).

**5.1.3.664 is\_prime()**

```
bool GiNaC::is_prime (
 const numeric & x) [inline]
```

References [GiNaC::numeric::is\\_prime\(\)](#).

**5.1.3.665 is\_rational()**

```
bool GiNaC::is_rational (
 const numeric & x) [inline]
```

References [GiNaC::numeric::is\\_rational\(\)](#).

Referenced by [beta\\_eval\(\)](#), [lgamma\\_eval\(\)](#), [replace\\_with\\_symbol\(\)](#), and [tgamma\\_eval\(\)](#).

**5.1.3.666 is\_real()**

```
bool GiNaC::is_real (
 const numeric & x) [inline]
```

References [GiNaC::numeric::is\\_real\(\)](#).

Referenced by [beta\\_eval\(\)](#), [fsolve\(\)](#), [G2\\_eval\(\)](#), [G2\\_evalf\(\)](#), and [Li2\\_series\(\)](#).

**5.1.3.667 is\_cinteger()**

```
bool GiNaC::is_cinteger (
 const numeric & x) [inline]
```

References [GiNaC::numeric::is\\_cinteger\(\)](#).

**5.1.3.668 is\_crational()**

```
bool GiNaC::is_crational (
 const numeric & x) [inline]
```

References [GiNaC::numeric::is\\_crational\(\)](#).

**5.1.3.669 to\_int()**

```
int GiNaC::to_int (
 const numeric & x) [inline]
```

References [GiNaC::numeric::to\\_int\(\)](#).

Referenced by [color\\_trace\(\)](#), [dirac\\_trace\(\)](#), [H\\_evalf\(\)](#), [GiNaC::basic::operator\[\]\(\)](#), [GiNaC::basic::operator\[\]\(\)](#), [GiNaC::pseries::power\\_const\(\)](#), [S\\_eval\(\)](#), [GiNaC::power::series\(\)](#), and [sqrfree\\_parfrac\(\)](#).

**5.1.3.670 to\_long()**

```
long GiNaC::to_long (
 const numeric & x) [inline]
```

References [GiNaC::numeric::to\\_long\(\)](#).

**5.1.3.671 to\_double()**

```
double GiNaC::to_double (
 const numeric & x) [inline]
```

References [GiNaC::numeric::to\\_double\(\)](#).

**5.1.3.672 real()**

```
const numeric GiNaC::real (
 const numeric & x) [inline]
```

References [GiNaC::numeric::real\(\)](#).

Referenced by [cosh\\_eval\(\)](#), [sinh\\_eval\(\)](#), and [tanh\\_eval\(\)](#).

**5.1.3.673 imag()**

```
const numeric GiNaC::imag (
 const numeric & x) [inline]
```

References [GiNaC::numeric::imag\(\)](#).

Referenced by [eta\\_eval\(\)](#), [eta\\_evalf\(\)](#), [G2\\_eval\(\)](#), and [G2\\_evalf\(\)](#).

**5.1.3.674 numer()** [2/2]

```
const numeric GiNaC::numer (
 const numeric & x) [inline]
```

References [GiNaC::numeric::numer\(\)](#).

**5.1.3.675 denom()** [2/2]

```
const numeric GiNaC::denom (
 const numeric & x) [inline]
```

References [GiNaC::numeric::denom\(\)](#).

**5.1.3.676 exadd()**

```
static const ex GiNaC::exadd (
 const ex & lh,
 const ex & rh) [inline], [static]
```

Used internally by [operator+\(\)](#) to add two ex objects.

References [dynallocate\(\)](#).

Referenced by [operator+\(\)](#), [operator++\(\)](#), [operator++\(\)](#), [operator+=\(\)](#), [operator-\(\)](#), [operator--\(\)](#), [operator--\(\)](#), and [operator-=\(\)](#).

**5.1.3.677 exmul()**

```
static const ex GiNaC::exmul (
 const ex & lh,
 const ex & rh) [inline], [static]
```

Used internally by [operator\\*\(\)](#) to multiply two ex objects.

References [GiNaC::return\\_types::commutative](#), [dynallocate\(\)](#), and [GiNaC::ex::return\\_type\(\)](#).

Referenced by [operator\\*\(\)](#), [operator\\*=\(\(\)\)](#), [operator/\(\)](#), and [operator/=\(\(\)\)](#).

**5.1.3.678 exminus()**

```
static const ex GiNaC::exminus (
 const ex & lh) [inline], [static]
```

Used internally by [operator-\(\)](#) and friends to change the sign of an argument.

References [\\_ex\\_1](#), and [dynallocate\(\)](#).

Referenced by [operator-\(\)](#), [operator-\(\)](#), and [operator-=\(\)](#).

**5.1.3.679 operator+()** [1/4]

```
const ex GiNaC::operator+ (
 const ex & lh,
 const ex & rh)
```

References [exadd\(\)](#).

**5.1.3.680 operator-()** [1/4]

```
const ex GiNaC::operator- (
 const ex & lh,
 const ex & rh)
```

References [exadd\(\)](#), and [exminus\(\)](#).

**5.1.3.681 operator\*()** [1/2]

```
const ex GiNaC::operator* (
 const ex & lh,
 const ex & rh)
```

References [exmul\(\)](#).

**5.1.3.682 operator/()** [1/2]

```
const ex GiNaC::operator/ (
 const ex & lh,
 const ex & rh)
```

References [\\_ex\\_1](#), and [exmul\(\)](#).

**5.1.3.683 operator+()** [2/4]

```
const numeric GiNaC::operator+ (
 const numeric & lh,
 const numeric & rh)
```

References [GiNaC::numeric::add\(\)](#).

**5.1.3.684 operator-()** [2/4]

```
const numeric GiNaC::operator- (
 const numeric & lh,
 const numeric & rh)
```

References [GiNaC::numeric::sub\(\)](#).



**5.1.3.685 operator\*()** [2/2]

```
const numeric GiNaC::operator* (
 const numeric & lh,
 const numeric & rh)
```

References [GiNaC::numeric::mul\(\)](#).

**5.1.3.686 operator/()** [2/2]

```
const numeric GiNaC::operator/ (
 const numeric & lh,
 const numeric & rh)
```

References [GiNaC::numeric::div\(\)](#).

**5.1.3.687 operator+=()** [1/2]

```
ex & GiNaC::operator+= (
 ex & lh,
 const ex & rh)
```

References [exadd\(\)](#).

**5.1.3.688 operator-=()** [1/2]

```
ex & GiNaC::operator-= (
 ex & lh,
 const ex & rh)
```

References [exadd\(\)](#), and [exminus\(\)](#).

**5.1.3.689 operator\*=()** [1/2]

```
ex & GiNaC::operator*= (
 ex & lh,
 const ex & rh)
```

References [exmul\(\)](#).

**5.1.3.690 operator/=()** [1/2]

```
ex & GiNaC::operator/= (
 ex & lh,
 const ex & rh)
```

References [\\_ex\\_1](#), and [exmul\(\)](#).

**5.1.3.691 operator+=()** [2/2]

```
numeric & GiNaC::operator+= (
 numeric & lh,
 const numeric & rh)
```

References [GiNaC::numeric::add\(\)](#).

**5.1.3.692 operator-=()** [2/2]

```
numeric & GiNaC::operator-= (
 numeric & lh,
 const numeric & rh)
```

References [GiNaC::numeric::sub\(\)](#).

**5.1.3.693 operator\*=()** [2/2]

```
numeric & GiNaC::operator*= (
 numeric & lh,
 const numeric & rh)
```

References [GiNaC::numeric::mul\(\)](#).

**5.1.3.694 operator/=(** [2/2]

```
numeric & GiNaC::operator/= (
 numeric & lh,
 const numeric & rh)
```

References [GiNaC::numeric::div\(\)](#).

**5.1.3.695 operator+()** [3/4]

```
const ex GiNaC::operator+ (
 const ex & lh)
```

**5.1.3.696 operator-()** [3/4]

```
const ex GiNaC::operator- (
 const ex & lh)
```

References [exminus\(\)](#).

**5.1.3.697 operator+()** [4/4]

```
const numeric GiNaC::operator+ (
 const numeric & lh)
```

**5.1.3.698 operator-() [4/4]**

```
const numeric GiNaC::operator- (
 const numeric & lh)
```

References [\\_num\\_1\\_p](#).

**5.1.3.699 operator++() [1/4]**

```
ex & GiNaC::operator++ (
 ex & rh)
```

Expression prefix increment.

Adds 1 and returns incremented ex.

References [\\_ex1](#), and [exadd\(\)](#).

**5.1.3.700 operator--() [1/4]**

```
ex & GiNaC::operator-- (
 ex & rh)
```

Expression prefix decrement.

Subtracts 1 and returns decremented ex.

References [\\_ex\\_1](#), and [exadd\(\)](#).

**5.1.3.701 operator++() [2/4]**

```
const ex GiNaC::operator++ (
 ex & lh,
 int)
```

Expression postfix increment.

Returns the ex and leaves the original incremented by 1.

References [\\_ex1](#), and [exadd\(\)](#).

**5.1.3.702 operator--() [2/4]**

```
const ex GiNaC::operator-- (
 ex & lh,
 int)
```

Expression postfix decrement.

Returns the ex and leaves the original decremented by 1.

References [\\_ex\\_1](#), and [exadd\(\)](#).

**5.1.3.703 operator++()** [3/4]

```
numeric & GiNaC::operator++ (
 numeric & rh)
```

Numeric prefix increment.

Adds 1 and returns incremented number.

References [\\_num1\\_p](#), and [GiNaC::numeric::add\(\)](#).

**5.1.3.704 operator--()** [3/4]

```
numeric & GiNaC::operator-- (
 numeric & rh)
```

Numeric prefix decrement.

Subtracts 1 and returns decremented number.

References [\\_num\\_1\\_p](#), and [GiNaC::numeric::add\(\)](#).

**5.1.3.705 operator++()** [4/4]

```
const numeric GiNaC::operator++ (
 numeric & lh,
 int)
```

Numeric postfix increment.

Returns the number and leaves the original incremented by 1.

References [\\_num1\\_p](#), and [GiNaC::numeric::add\(\)](#).

**5.1.3.706 operator--()** [4/4]

```
const numeric GiNaC::operator-- (
 numeric & lh,
 int)
```

Numeric postfix decrement.

Returns the number and leaves the original decremented by 1.

References [\\_num\\_1\\_p](#), and [GiNaC::numeric::add\(\)](#).

**5.1.3.707 operator==()**

```
const relational GiNaC::operator== (
 const ex & lh,
 const ex & rh)
```

References [GiNaC::relational::equal](#).

**5.1.3.708 operator"!=()**

```
const relational GiNaC::operator!= (
 const ex & lh,
 const ex & rh)
```

References [GiNaC::relational::not\\_equal](#).

**5.1.3.709 operator<()**

```
const relational GiNaC::operator< (
 const ex & lh,
 const ex & rh)
```

References [GiNaC::relational::less](#).

**5.1.3.710 operator<=()**

```
const relational GiNaC::operator<= (
 const ex & lh,
 const ex & rh)
```

References [GiNaC::relational::less\\_or\\_equal](#).

**5.1.3.711 operator>()**

```
const relational GiNaC::operator> (
 const ex & lh,
 const ex & rh)
```

References [GiNaC::relational::greater](#).

**5.1.3.712 operator>=()**

```
const relational GiNaC::operator>= (
 const ex & lh,
 const ex & rh)
```

References [GiNaC::relational::greater\\_or\\_equal](#).

**5.1.3.713 my\_ios\_index()**

```
static int GiNaC::my_ios_index () [static]
```

Referenced by [get\\_print\\_context\(\)](#), and [set\\_print\\_context\(\)](#).

**5.1.3.714 my\_ios\_callback()**

```
static void GiNaC::my_ios_callback (
 std::ios_base::event ev,
 std::ios_base & s,
 int i) [static]
```

Referenced by [set\\_print\\_context\(\)](#).

**5.1.3.715 get\_print\_context()**

```
static print_context * GiNaC::get_print_context (
 std::ios_base & s) [inline], [static]
```

References [my\\_ios\\_index\(\)](#).

Referenced by [get\\_print\\_options\(\)](#), [operator<<\(\)](#), [operator<<\(\)](#), [operator<<\(\)](#), [operator<<\(\)](#), and [set\\_print\\_options\(\)](#).

**5.1.3.716 set\_print\_context()**

```
static void GiNaC::set_print_context (
 std::ios_base & s,
 const print_context & c) [static]
```

References [callback\\_registered](#), [my\\_ios\\_callback\(\)](#), [my\\_ios\\_index\(\)](#), and [GiNaC::print\\_context::options](#).

Referenced by [csrc\(\)](#), [csrc\\_cl\\_N\(\)](#), [csrc\\_double\(\)](#), [csrc\\_float\(\)](#), [dflt\(\)](#), [latex\(\)](#), [python\(\)](#), [python\\_repr\(\)](#), [set\\_print\\_options\(\)](#), and [tree\(\)](#).

**5.1.3.717 get\_print\_options()**

```
static unsigned GiNaC::get_print_options (
 std::ios_base & s) [inline], [static]
```

References [get\\_print\\_context\(\)](#), and [GiNaC::print\\_context::options](#).

Referenced by [index\\_dimensions\(\)](#), and [no\\_index\\_dimensions\(\)](#).

**5.1.3.718 set\_print\_options()**

```
static void GiNaC::set_print_options (
 std::ostream & s,
 unsigned options) [static]
```

References [get\\_print\\_context\(\)](#), [GiNaC::print\\_context::options](#), and [set\\_print\\_context\(\)](#).

Referenced by [dflt\(\)](#), [index\\_dimensions\(\)](#), and [no\\_index\\_dimensions\(\)](#).

**5.1.3.719 operator<<() [7/16]**

```
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const ex & e)
```

References [get\\_print\\_context\(\)](#), and [GiNaC::ex::print\(\)](#).

**5.1.3.720 operator>>() [3/3]**

```
std::istream & GiNaC::operator>> (
 std::istream & is,
 ex & e)
```

**5.1.3.721 dflt()**

```
std::ostream & GiNaC::dflt (
 std::ostream & os)
```

References [set\\_print\\_context\(\)](#), and [set\\_print\\_options\(\)](#).

**5.1.3.722 latex()**

```
std::ostream & GiNaC::latex (
 std::ostream & os)
```

References [set\\_print\\_context\(\)](#).

**5.1.3.723 python()**

```
std::ostream & GiNaC::python (
 std::ostream & os)
```

References [set\\_print\\_context\(\)](#).

**5.1.3.724 python\_repr()**

```
std::ostream & GiNaC::python_repr (
 std::ostream & os)
```

References [set\\_print\\_context\(\)](#).

**5.1.3.725 tree()**

```
std::ostream & GiNaC::tree (
 std::ostream & os)
```

References [set\\_print\\_context\(\)](#).

Referenced by [GiNaC::class\\_info< OPT >::dump\\_hierarchy\(\)](#).

#### 5.1.3.726 `csrc()`

```
std::ostream & GiNaC::csrc (
 std::ostream & os)
```

References [set\\_print\\_context\(\)](#).

#### 5.1.3.727 `csrc_float()`

```
std::ostream & GiNaC::csrc_float (
 std::ostream & os)
```

References [set\\_print\\_context\(\)](#).

#### 5.1.3.728 `csrc_double()`

```
std::ostream & GiNaC::csrc_double (
 std::ostream & os)
```

References [set\\_print\\_context\(\)](#).

#### 5.1.3.729 `csrc_cl_N()`

```
std::ostream & GiNaC::csrc_cl_N (
 std::ostream & os)
```

References [set\\_print\\_context\(\)](#).

#### 5.1.3.730 `index_dimensions()`

```
std::ostream & GiNaC::index_dimensions (
 std::ostream & os)
```

References [get\\_print\\_options\(\)](#), [GiNaC::print\\_options::print\\_index\\_dimensions](#), and [set\\_print\\_options\(\)](#).

#### 5.1.3.731 `no_index_dimensions()`

```
std::ostream & GiNaC::no_index_dimensions (
 std::ostream & os)
```

References [get\\_print\\_options\(\)](#), [GiNaC::print\\_options::print\\_index\\_dimensions](#), and [set\\_print\\_options\(\)](#).



**5.1.3.732 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [27/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 power ,
 basic ,
 print_func< print_dflt > &::do_print_dflt. print_func< print_latex > &::do_↵
 _print_latex. print_func< print_csrc > &::do_print_csrc. print_func< print_python > &↵
 ::do_print_python. print_func< print_python_repr > &::do_print_python_repr. print_func<
 print_csrc_cl_N > &::do_print_csrc_cl_N)
```

References [GiNaC::power::do\\_print\\_csrc\(\)](#), [GiNaC::power::do\\_print\\_csrc\\_cl\\_N\(\)](#), [GiNaC::power::do\\_print\\_dflt\(\)](#), [GiNaC::power::do\\_print\\_latex\(\)](#), [GiNaC::power::do\\_print\\_python\(\)](#), and [GiNaC::power::do\\_print\\_python\\_repr\(\)](#).

**5.1.3.733 print\_sym\_pow()**

```
static void GiNaC::print_sym_pow (
 const print_context & c,
 const symbol & x,
 int exp) [static]
```

References [exp\(\)](#), [GiNaC::basic::print\(\)](#), [print\\_sym\\_pow\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::power::do\\_print\\_csrc\(\)](#), and [print\\_sym\\_pow\(\)](#).

**5.1.3.734 GINAC\_BIND\_UNARCHIVER()** [37/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 power)
```

**5.1.3.735 GINAC\_DECLARE\_UNARCHIVER()** [39/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 power)
```

**5.1.3.736 pow()** [2/3]

```
ex GiNaC::pow (
 const ex & b,
 const ex & e) [inline]
```

Symbolic exponentiation.

Returns a power-object as a new expression.

**Parameters**

|          |                         |
|----------|-------------------------|
| <i>b</i> | the basis expression    |
| <i>e</i> | the exponent expression |

References [dynallocate\(\)](#).

**5.1.3.737 pow()** [3/3]

```
template<typename T1, typename T2>
ex GiNaC::pow (
 const T1 & b,
 const T2 & e) [inline]
```

References [dynallocate\(\)](#).

**5.1.3.738 sqrt()** [2/2]

```
ex GiNaC::sqrt (
 const ex & a) [inline]
```

Square root expression.

Returns a power-object with exponent 1/2.

References [\\_ex1\\_2](#).

**5.1.3.739 is\_a()** [3/3]

```
template<class T>
bool GiNaC::is_a (
 const print_context & obj) [inline]
```

Check if obj is a T, including base classes.

**5.1.3.740 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [28/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 pseries ,
 basic ,
 print_func< print_context > &::do_print. print_func< print_latex > &::do_↵
print_latex. print_func< print_tree > &::do_print_tree. print_func< print_python > &::do_↵
print_python. print_func< print_python_repr > &::do_print_python_repr)
```

References [GiNaC::pseries::do\\_print\(\)](#), [GiNaC::pseries::do\\_print\\_latex\(\)](#), [GiNaC::pseries::do\\_print\\_python\(\)](#), [GiNaC::pseries::do\\_print\\_python\\_repr\(\)](#), and [GiNaC::pseries::do\\_print\\_tree\(\)](#).

**5.1.3.741 GINAC\_BIND\_UNARCHIVER()** [38/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 pseries)
```

**5.1.3.742 GINAC\_DECLARE\_UNARCHIVER()** [40/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 pseries)
```

**5.1.3.743 series\_to\_poly()**

```
ex GiNaC::series_to_poly (
 const ex & e) [inline]
```

Convert the pseries object embedded in an expression to an ordinary polynomial in the expansion variable.

The result is undefined if the expression does not contain a pseries object at its top level.

## Parameters

|          |            |
|----------|------------|
| <i>e</i> | expression |
|----------|------------|

## Returns

polynomial expression

## See also

[is\\_a<>](#)

[pseries::convert\\_to\\_poly](#)

References [ex\\_to\(\)](#).

Referenced by [Bernoulli\\_polynomial\(\)](#), [generalised\\_Bernoulli\\_number\(\)](#), [GiNaC::modular\\_form\\_kernel::is\\_numeric\(\)](#), and [GiNaC::modular\\_form\\_kernel::Laurent\\_series\(\)](#).

**5.1.3.744 is\_terminating()**

```
bool GiNaC::is_terminating (
 const pseries & s) [inline]
```

References [GiNaC::pseries::is\\_terminating\(\)](#).

**5.1.3.745 make\_return\_type\_t()**

```
template<typename T>
return_type_t GiNaC::make_return_type_t (
 const unsigned rl = 0) [inline]
```

References [GiNaC::return\\_type\\_t::rl](#), and [GiNaC::return\\_type\\_t::tinfo](#).

Referenced by [GiNaC::add::return\\_type\\_tinfo\(\)](#), [GiNaC::clifford::return\\_type\\_tinfo\(\)](#), [GiNaC::color::return\\_type\\_tinfo\(\)](#), [GiNaC::function::return\\_type\\_tinfo\(\)](#), [GiNaC::mul::return\\_type\\_tinfo\(\)](#), [GiNaC::ncmul::return\\_type\\_tinfo\(\)](#), and [GiNaC::function\\_options::set\\_return\\_type\(\)](#).

**5.1.3.746 set\_print\_func() [1/2]**

```
template<class Alg, class Ctx, class T, class C>
void GiNaC::set_print_func (
 void f(const T &, const C &c, unsigned) [extern]
```

Add or replace a print method.

**5.1.3.747 set\_print\_func() [2/2]**

```
template<class Alg, class Ctx, class T, class C>
void GiNaC::set_print_func (
 void(T::* f)(const C &, unsigned)) [extern]
```

Add or replace a print method.

**5.1.3.748 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [29/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 relational ,
 basic ,
 print_func< print_context > &::do_print. print_func< print_tree > &::do_print↔
 _tree. print_func< print_python_repr > &::do_print_python_repr)
```

References [GiNaC::relational::do\\_print\(\)](#), [GiNaC::relational::do\\_print\\_python\\_repr\(\)](#), and [GiNaC::basic::do\\_print\\_tree\(\)](#).

**5.1.3.749 GINAC\_BIND\_UNARCHIVER()** [39/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 relational)
```

**5.1.3.750 print\_operator()**

```
static void GiNaC::print_operator (
 const print_context & c,
 relational::operators o) [static]
```

References [GiNaC::relational::equal](#), [GiNaC::relational::greater](#), [GiNaC::relational::greater\\_or\\_equal](#), [GiNaC::relational::less](#), [GiNaC::relational::less\\_or\\_equal](#), [GiNaC::relational::not\\_equal](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::relational::do\\_print\(\)](#), and [GiNaC::relational::do\\_print\\_python\\_repr\(\)](#).

**5.1.3.751 GINAC\_DECLARE\_UNARCHIVER()** [41/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 relational)
```

**5.1.3.752 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [30/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 symbol ,
 basic ,
 print_func< print_context > &::do_print. print_func< print_latex > &::do_↔
 print_latex. print_func< print_tree > &::do_print_tree. print_func< print_python_repr > &↔
 ::do_print_python_repr)
```

References [GiNaC::symbol::do\\_print\(\)](#), [GiNaC::symbol::do\\_print\\_latex\(\)](#), [GiNaC::symbol::do\\_print\\_python\\_repr\(\)](#), [GiNaC::symbol::do\\_print\\_tree\(\)](#), [GiNaC::status\\_flags::evaluated](#), and [GiNaC::status\\_flags::expanded](#).

**5.1.3.753 get\_default\_TeX\_name()**

```
static const std::string & GiNaC::get_default_TeX_name (
 const std::string & name) [static]
```

Return default TeX name for symbol.

This recognizes some greek letters.

Referenced by [GiNaC::symbol::do\\_print\\_latex\(\)](#), and [GiNaC::symbol::get\\_TeX\\_name\(\)](#).

**5.1.3.754 GINAC\_BIND\_UNARCHIVER()** [40/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 symbol)
```

**5.1.3.755 GINAC\_BIND\_UNARCHIVER()** [41/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 realsymbol)
```

**5.1.3.756 GINAC\_BIND\_UNARCHIVER()** [42/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 possymbol)
```

References [GiNaC::symbol::next\\_serial](#).

**5.1.3.757 GINAC\_DECLARE\_UNARCHIVER()** [42/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 symbol)
```

**5.1.3.758 GINAC\_DECLARE\_UNARCHIVER()** [43/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 realsymbol)
```

**5.1.3.759 GINAC\_DECLARE\_UNARCHIVER()** [44/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 possymbol)
```

**5.1.3.760 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [31/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 symmetry ,
 basic ,
 print_func< print_context > &::do_print, print_func< print_tree > &::do_print↵
 _tree)
```

References [GiNaC::symmetry::do\\_print\(\)](#), [GiNaC::symmetry::do\\_print\\_tree\(\)](#), [GiNaC::status\\_flags::evaluated](#), and [GiNaC::status\\_flags::expanded](#).

**5.1.3.761 GINAC\_BIND\_UNARCHIVER()** [43/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 symmetry)
```

**5.1.3.762 index0()**

```
static const symmetry & GiNaC::index0 () [static]
```

References [dynallocate\(\)](#), and [ex\\_to\(\)](#).

Referenced by [antisymmetric2\(\)](#), [antisymmetric3\(\)](#), [antisymmetric4\(\)](#), [symmetric2\(\)](#), [symmetric3\(\)](#), and [symmetric4\(\)](#).

**5.1.3.763 index1()**

```
static const symmetry & GiNaC::index1 () [static]
```

References [dynallocate\(\)](#), and [ex\\_to\(\)](#).

Referenced by [antisymmetric2\(\)](#), [antisymmetric3\(\)](#), [antisymmetric4\(\)](#), [symmetric2\(\)](#), [symmetric3\(\)](#), and [symmetric4\(\)](#).

**5.1.3.764 index2()**

```
static const symmetry & GiNaC::index2 () [static]
```

References [dynallocate\(\)](#), and [ex\\_to\(\)](#).

Referenced by [antisymmetric3\(\)](#), [antisymmetric4\(\)](#), [symmetric3\(\)](#), and [symmetric4\(\)](#).

**5.1.3.765 index3()**

```
static const symmetry & GiNaC::index3 () [static]
```

References [dynallocate\(\)](#), and [ex\\_to\(\)](#).

Referenced by [antisymmetric4\(\)](#), and [symmetric4\(\)](#).

**5.1.3.766 not\_symmetric()**

```
const symmetry & GiNaC::not_symmetric ()
```

References [dynallocate\(\)](#), and [ex\\_to\(\)](#).

Referenced by [GiNaC::clifford::clifford\(\)](#), [GiNaC::clifford::clifford\(\)](#), [clifford\\_unit\(\)](#), [GiNaC::color::color\(\)](#), [GiNaC::color::color\(\)](#), [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::indexed::indexed\(\)](#), and [GiNaC::indexed::read\\_archive\(\)](#).

**5.1.3.767 symmetric2()**

```
const symmetry & GiNaC::symmetric2 ()
```

References [dynallocate\(\)](#), [ex\\_to\(\)](#), [index0\(\)](#), [index1\(\)](#), and [GiNaC::symmetry::symmetric](#).

Referenced by [clifford\\_unit\(\)](#), [delta\\_tensor\(\)](#), [dirac\\_gamma\(\)](#), [dirac\\_slash\(\)](#), [GiNaC::clifford::get\\_metric\(\)](#), [lorentz\\_g\(\)](#), and [metric\\_tensor\(\)](#).

**5.1.3.768 symmetric3()**

```
const symmetry & GiNaC::symmetric3 ()
```

References [dynallocate\(\)](#), [ex\\_to\(\)](#), [index0\(\)](#), [index1\(\)](#), [index2\(\)](#), and [GiNaC::symmetry::symmetric](#).

Referenced by [color\\_d\(\)](#).

**5.1.3.769 symmetric4()**

```
const symmetry & GiNaC::symmetric4 ()
```

References [dynallocate\(\)](#), [ex\\_to\(\)](#), [index0\(\)](#), [index1\(\)](#), [index2\(\)](#), [index3\(\)](#), and [GiNaC::symmetry::symmetric](#).

**5.1.3.770 antisymmetric2()**

```
const symmetry & GiNaC::antisymmetric2 ()
```

References [GiNaC::symmetry::antisymmetric](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [index0\(\)](#), and [index1\(\)](#).

Referenced by [epsilon\\_tensor\(\)](#), and [spinor\\_metric\(\)](#).

**5.1.3.771 antisymmetric3()**

```
const symmetry & GiNaC::antisymmetric3 ()
```

References [GiNaC::symmetry::antisymmetric](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [index0\(\)](#), [index1\(\)](#), and [index2\(\)](#).

Referenced by [color\\_f\(\)](#), and [epsilon\\_tensor\(\)](#).

**5.1.3.772 antisymmetric4()**

```
const symmetry & GiNaC::antisymmetric4 ()
```

References [GiNaC::symmetry::antisymmetric](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [index0\(\)](#), [index1\(\)](#), [index2\(\)](#), and [index3\(\)](#).

Referenced by [lorentz\\_eps\(\)](#).

**5.1.3.773 canonicalize()**

```
int GiNaC::canonicalize (
 exvector::iterator v,
 const symmetry & symm)
```

Canonicalize the order of elements of an expression vector, according to the symmetry properties defined in a symmetry tree.

## Parameters

|             |                            |
|-------------|----------------------------|
| <i>v</i>    | Start of expression vector |
| <i>symm</i> | Root node of symmetry tree |

## Returns

the overall sign introduced by the reordering (+1, -1 or 0) or `numeric_limits<int>::max()` if nothing changed

Referenced by [GiNaC::symmetry::canonicalize](#), [GiNaC::function::eval\(\)](#), and [GiNaC::indexed::eval\(\)](#).

**5.1.3.774 symm()**

```
static ex GiNaC::symm (
 const ex & e,
 exvector::const_iterator first,
 exvector::const_iterator last,
 bool asymmetric) [static]
```

References [GiNaC::container< C >::append\(\)](#), [class\\_info< OPT >::first](#), [dynallocate\(\)](#), [factorial\(\)](#), [GiNaC::subs\\_options::no\\_index\\_recurse](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::container< C >::op\(\)](#), [permutation\\_sign\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [antisymmetrize\(\)](#), [GiNaC::ex::antisymmetrize\(\)](#), [GiNaC::symmetry::canonicalize](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::indexed::read\\_archive\(\)](#), [GiNaC::symmetry::sy\\_swap](#), [GiNaC::ex::symmetrize\(\)](#), and [symmetrize\(\)](#).

**5.1.3.775 symmetrize()** [3/4]

```
ex GiNaC::symmetrize (
 const ex & e,
 exvector::const_iterator first,
 exvector::const_iterator last)
```

Symmetrize expression over a set of objects (symbols, indices).

References [class\\_info< OPT >::first](#), and [symm\(\)](#).

**5.1.3.776 antisymmetrize()** [3/4]

```
ex GiNaC::antisymmetrize (
 const ex & e,
 exvector::const_iterator first,
 exvector::const_iterator last)
```

Antisymmetrize expression over a set of objects (symbols, indices).

References [class\\_info< OPT >::first](#), and [symm\(\)](#).



**5.1.3.777 symmetrize\_cyclic()** [3/4]

```
ex GiNaC::symmetrize_cyclic (
 const ex & e,
 exvector::const_iterator first,
 exvector::const_iterator last)
```

Symmetrize expression by cyclic permutation over a set of objects (symbols, indices).

References [GiNaC::container< C >::append\(\)](#), [class\\_info< OPT >::first](#), [GiNaC::subs\\_options::no\\_index\\_renaming](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::container< C >::remove\\_first\(\)](#), and [GiNaC::ex::subs\(\)](#).

**5.1.3.778 GINAC\_DECLARE\_UNARCHIVER()** [45/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 symmetry)
```

**5.1.3.779 sy\_none()** [1/4]

```
symmetry GiNaC::sy_none () [inline]
```

**5.1.3.780 sy\_none()** [2/4]

```
symmetry GiNaC::sy_none (
 const symmetry & c1,
 const symmetry & c2) [inline]
```

References [GiNaC::symmetry::none](#).

**5.1.3.781 sy\_none()** [3/4]

```
symmetry GiNaC::sy_none (
 const symmetry & c1,
 const symmetry & c2,
 const symmetry & c3) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::none](#).

**5.1.3.782 sy\_none()** [4/4]

```
symmetry GiNaC::sy_none (
 const symmetry & c1,
 const symmetry & c2,
 const symmetry & c3,
 const symmetry & c4) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::none](#).

**5.1.3.783 sy\_symm() [1/4]**

```
symmetry GiNaC::sy_symm () [inline]
```

References [GiNaC::symmetry::set\\_type\(\)](#), and [GiNaC::symmetry::symmetric](#).

Referenced by [GiNaC::indexed::read\\_archive\(\)](#).

**5.1.3.784 sy\_symm() [2/4]**

```
symmetry GiNaC::sy_symm (
 const symmetry & c1,
 const symmetry & c2) [inline]
```

References [GiNaC::symmetry::symmetric](#).

**5.1.3.785 sy\_symm() [3/4]**

```
symmetry GiNaC::sy_symm (
 const symmetry & c1,
 const symmetry & c2,
 const symmetry & c3) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::symmetric](#).

**5.1.3.786 sy\_symm() [4/4]**

```
symmetry GiNaC::sy_symm (
 const symmetry & c1,
 const symmetry & c2,
 const symmetry & c3,
 const symmetry & c4) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::symmetric](#).

**5.1.3.787 sy\_anti() [1/4]**

```
symmetry GiNaC::sy_anti () [inline]
```

References [GiNaC::symmetry::antisymmetric](#), and [GiNaC::symmetry::set\\_type\(\)](#).

Referenced by [GiNaC::indexed::read\\_archive\(\)](#).

**5.1.3.788 sy\_anti() [2/4]**

```
symmetry GiNaC::sy_anti (
 const symmetry & c1,
 const symmetry & c2) [inline]
```

References [GiNaC::symmetry::antisymmetric](#).

**5.1.3.789 sy\_anti() [3/4]**

```
symmetry GiNaC::sy_anti (
 const symmetry & c1,
 const symmetry & c2,
 const symmetry & c3) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::antisymmetric](#).

**5.1.3.790 sy\_anti() [4/4]**

```
symmetry GiNaC::sy_anti (
 const symmetry & c1,
 const symmetry & c2,
 const symmetry & c3,
 const symmetry & c4) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::antisymmetric](#).

**5.1.3.791 sy\_cycl() [1/4]**

```
symmetry GiNaC::sy_cycl () [inline]
```

References [GiNaC::symmetry::cyclic](#), and [GiNaC::symmetry::set\\_type\(\)](#).

**5.1.3.792 sy\_cycl() [2/4]**

```
symmetry GiNaC::sy_cycl (
 const symmetry & c1,
 const symmetry & c2) [inline]
```

References [GiNaC::symmetry::cyclic](#).

**5.1.3.793 sy\_cycl() [3/4]**

```
symmetry GiNaC::sy_cycl (
 const symmetry & c1,
 const symmetry & c2,
 const symmetry & c3) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::cyclic](#).

**5.1.3.794 sy\_cycl() [4/4]**

```
symmetry GiNaC::sy_cycl (
 const symmetry & c1,
 const symmetry & c2,
 const symmetry & c3,
 const symmetry & c4) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::cyclic](#).

**5.1.3.795 symmetrize()** [4/4]

```
ex GiNaC::symmetrize (
 const ex & e,
 const exvector & v) [inline]
```

Symmetrize expression over a set of objects (symbols, indices).

References [GiNaC::ex::begin\(\)](#), and [symmetrize\(\)](#).

**5.1.3.796 antisymmetrize()** [4/4]

```
ex GiNaC::antisymmetrize (
 const ex & e,
 const exvector & v) [inline]
```

Antisymmetrize expression over a set of objects (symbols, indices).

References [antisymmetrize\(\)](#), and [GiNaC::ex::begin\(\)](#).

**5.1.3.797 symmetrize\_cyclic()** [4/4]

```
ex GiNaC::symmetrize_cyclic (
 const ex & e,
 const exvector & v) [inline]
```

Symmetrize expression by cyclic permutation over a set of objects (symbols, indices).

References [GiNaC::ex::begin\(\)](#), and [symmetrize\(\)](#).

**5.1.3.798 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [32/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 tensdelta ,
 tensor ,
 print_func< print_dflt > &::do_print, print_func< print_latex > &::do_print_↵
 latex)
```

References [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**5.1.3.799 print\_func< print\_dflt >()** [3/3]

```
GiNaC::print_func< print_dflt > (
 &tensmetric::do_print) &
```

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), and [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**5.1.3.800 GINAC\_BIND\_UNARCHIVER()** [44/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 minkmetric)
```

**5.1.3.801 GINAC\_BIND\_UNARCHIVER()** [45/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 tensepsilon)
```

**5.1.3.802 GINAC\_BIND\_UNARCHIVER()** [46/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 tensdelta)
```

**5.1.3.803 GINAC\_BIND\_UNARCHIVER()** [47/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 tensmetric)
```

**5.1.3.804 GINAC\_BIND\_UNARCHIVER()** [48/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 spinmetric)
```

**5.1.3.805 delta\_tensor()**

```
ex GiNaC::delta_tensor (
 const ex & i1,
 const ex & i2)
```

Create a delta tensor with specified indices.

The indices must be of class `idx` or a subclass. The delta tensor is always symmetric and its trace is the dimension of the index space.

**Parameters**

|           |              |
|-----------|--------------|
| <i>i1</i> | First index  |
| <i>i2</i> | Second index |

**Returns**

newly constructed delta tensor

References [dynallocate\(\)](#), [is\\_a\(\)](#), and [symmetric2\(\)](#).

Referenced by [color\\_trace\(\)](#), [GiNaC::spinmetric::contract\\_with\(\)](#), [GiNaC::su3d::contract\\_with\(\)](#), [GiNaC::su3f::contract\\_with\(\)](#), [GiNaC::tensepsilon::contract\\_with\(\)](#), and [GiNaC::tensmetric::eval\\_indexed\(\)](#).

### 5.1.3.806 metric\_tensor()

```
ex GiNaC::metric_tensor (
 const ex & i1,
 const ex & i2)
```

Create a symmetric metric tensor with specified indices.

The indices must be of class varidx or a subclass. A metric tensor with one covariant and one contravariant index is equivalent to the delta tensor.

#### Parameters

|           |              |
|-----------|--------------|
| <i>i1</i> | First index  |
| <i>i2</i> | Second index |

#### Returns

newly constructed metric tensor

References [dynallocate\(\)](#), [is\\_a\(\)](#), and [symmetric2\(\)](#).

Referenced by [GiNaC::tensepsilon::contract\\_with\(\)](#).

### 5.1.3.807 lorentz\_g()

```
ex GiNaC::lorentz_g (
 const ex & i1,
 const ex & i2,
 bool pos_sig = false)
```

Create a Minkowski metric tensor with specified indices.

The indices must be of class varidx or a subclass. The Lorentz metric is a symmetric tensor with a matrix representation of  $\text{diag}(1, -1, -1, \dots)$  (negative signature, the default) or  $\text{diag}(-1, 1, 1, \dots)$  (positive signature).

#### Parameters

|                |                                   |
|----------------|-----------------------------------|
| <i>i1</i>      | First index                       |
| <i>i2</i>      | Second index                      |
| <i>pos_sig</i> | Whether the signature is positive |

#### Returns

newly constructed Lorentz metric tensor

References [dynallocate\(\)](#), [is\\_a\(\)](#), and [symmetric2\(\)](#).

Referenced by [GiNaC::diracgamma::contract\\_with\(\)](#), [GiNaC::tensepsilon::contract\\_with\(\)](#), [dirac\\_trace\(\)](#), and [trace\\_string\(\)](#).

### 5.1.3.808 spinor\_metric()

```
ex GiNaC::spinor_metric (
 const ex & i1,
 const ex & i2)
```

Create a spinor metric tensor with specified indices.

The indices must be of class spinidx or a subclass and have a dimension of 2. The spinor metric is an antisymmetric tensor with a matrix representation of  $\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$ .

## Parameters

|           |              |
|-----------|--------------|
| <i>i1</i> | First index  |
| <i>i2</i> | Second index |

## Returns

newly constructed spinor metric tensor

References [antisymmetric2\(\)](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), and [is\\_a\(\)](#).

**5.1.3.809 epsilon\_tensor()** [1/2]

```
ex GiNaC::epsilon_tensor (
 const ex & i1,
 const ex & i2)
```

Create an epsilon tensor in a Euclidean space with two indices.

The indices must be of class `idx` or a subclass, and have a dimension of 2.

## Parameters

|           |              |
|-----------|--------------|
| <i>i1</i> | First index  |
| <i>i2</i> | Second index |

## Returns

newly constructed epsilon tensor

References [\\_ex2](#), [antisymmetric2\(\)](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), and [GiNaC::ex::op\(\)](#).

**5.1.3.810 epsilon\_tensor()** [2/2]

```
ex GiNaC::epsilon_tensor (
 const ex & i1,
 const ex & i2,
 const ex & i3)
```

Create an epsilon tensor in a Euclidean space with three indices.

The indices must be of class `idx` or a subclass, and have a dimension of 3.

## Parameters

|           |              |
|-----------|--------------|
| <i>i1</i> | First index  |
| <i>i2</i> | Second index |
| <i>i3</i> | Third index  |

## Returns

newly constructed epsilon tensor

References [\\_ex3](#), [antisymmetric3\(\)](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), and [GiNaC::ex::op\(\)](#).

**5.1.3.811 lorentz\_eps()**

```
ex GiNaC::lorentz_eps (
 const ex & i1,
 const ex & i2,
 const ex & i3,
 const ex & i4,
 bool pos_sig = false)
```

Create an epsilon tensor in a Minkowski space with four indices.

The indices must be of class `varidx` or a subclass, and have a dimension of 4.

**Parameters**

|                |                                                 |
|----------------|-------------------------------------------------|
| <i>i1</i>      | First index                                     |
| <i>i2</i>      | Second index                                    |
| <i>i3</i>      | Third index                                     |
| <i>i4</i>      | Fourth index                                    |
| <i>pos_sig</i> | Whether the signature of the metric is positive |

**Returns**

newly constructed epsilon tensor

References [\\_ex4](#), [antisymmetric4\(\)](#), [dynallocate\(\)](#), [ex\\_to\(\)](#), [GiNaC::basic::hold\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [dirac\\_trace\(\)](#).

**5.1.3.812 GINAC\_DECLARE\_UNARCHIVER()** [46/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 tensdelta)
```

**5.1.3.813 GINAC\_DECLARE\_UNARCHIVER()** [47/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 tensmetric)
```

**5.1.3.814 GINAC\_DECLARE\_UNARCHIVER()** [48/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 minkmetric)
```

**5.1.3.815 GINAC\_DECLARE\_UNARCHIVER()** [49/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 spinmetric)
```



**5.1.3.816 GINAC\_DECLARE\_UNARCHIVER()** [50/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 tensepsilon)
```

**5.1.3.817 log2()**

```
unsigned GiNaC::log2 (
 unsigned n)
```

Integer binary logarithm.

Referenced by [GiNaC::remember\\_table::remember\\_table\(\)](#).

**5.1.3.818 multinomial\_coefficient()**

```
const numeric GiNaC::multinomial_coefficient (
 const std::vector< unsigned > & p)
```

Compute the multinomial coefficient  $n!$

$/(p_1! * p_2! * \dots * p_k!)$  where  $n = p_1 + p_2 + \dots + p_k$ , i.e.  $p$  is a partition of  $n$ .

References [GiNaC::numeric::add\(\)](#), [GiNaC::numeric::div\(\)](#), [factorial\(\)](#), and [GiNaC::numeric::mul\(\)](#).

Referenced by [GiNaC::power::expand\\_add\(\)](#).

**5.1.3.819 rotate\_left()**

```
unsigned GiNaC::rotate_left (
 unsigned n) [inline]
```

Rotate bits of unsigned value by one bit to the left.

This can be necessary if the user wants to define its own hashes.

Referenced by [GiNaC::basic::calchash\(\)](#), [GiNaC::expairseq::calchash\(\)](#), [GiNaC::function::calchash\(\)](#), [GiNaC::idx::calchash\(\)](#), [GiNaC::relational::calchash\(\)](#), and [GiNaC::symmetry::calchash\(\)](#).

**5.1.3.820 compare\_pointers()**

```
template<class T>
int GiNaC::compare_pointers (
 const T * a,
 const T * b) [inline]
```

Compare two pointers (just to establish some sort of canonical order).

**Returns**

-1, 0, or 1

Referenced by [GiNaC::basic::compare\\_same\\_type\(\)](#).

**5.1.3.821 golden\_ratio\_hash()**

```
unsigned GiNaC::golden_ratio_hash (
 uintptr_t n) [inline]
```

Truncated multiplication with golden ratio, for computing hash values.

Referenced by [GiNaC::constant::calchash\(\)](#), [GiNaC::function::calchash\(\)](#), [GiNaC::numeric::calchash\(\)](#), [GiNaC::symbol::calchash\(\)](#), [GiNaC::wildcard::calchash\(\)](#), and [make\\_hash\\_seed\(\)](#).

**5.1.3.822 permutation\_sign() [1/2]**

```
template<class It>
int GiNaC::permutation_sign (
 It first,
 It last)
```

References [class\\_info< OPT >::first](#), [swap\(\)](#), and [std::swap\(\)](#).

Referenced by [GiNaC::symmetry::canonicalize](#), [GiNaC::matrix::determinant\(\)](#), [dirac\\_trace\(\)](#), [GiNaC::tensepsilon::eval\\_indexed\(\)](#), and [symm\(\)](#).

**5.1.3.823 permutation\_sign() [2/2]**

```
template<class It, class Cmp, class Swap>
int GiNaC::permutation_sign (
 It first,
 It last,
 Cmp comp,
 Swap swapit)
```

References [class\\_info< OPT >::first](#).

**5.1.3.824 shaker\_sort()**

```
template<class It, class Cmp, class Swap>
void GiNaC::shaker_sort (
 It first,
 It last,
 Cmp comp,
 Swap swapit)
```

References [class\\_info< OPT >::first](#).

Referenced by [GiNaC::symmetry::canonicalize](#), [find\\_free\\_and\\_dummy\(\)](#), and [rename\\_dummy\\_indices\(\)](#).

**5.1.3.825 cyclic\_permutation()**

```
template<class It, class Swap>
void GiNaC::cyclic_permutation (
 It first,
 It last,
 It new_first,
 Swap swapit)
```

References [class\\_info< OPT >::first](#).

Referenced by [GiNaC::symmetry::canonicalize](#).

**5.1.3.826 format\_index\_value()** [1/2]

```
template<typename T>
std::enable_if< has_distance< T >::value, typename std::iterator_traits< T >::difference_type
>::type GiNaC::format_index_value (
 const T & a,
 const T & b)
```

For printing a multi-index: If the templates are used, where T is an iterator, printing the address where the iterator points to is not meaningful.

However, we may print the difference to the starting point.

Referenced by [operator<<\(\)](#), [operator<<\(\)](#), [operator<<\(\)](#), [operator<<\(\)](#), [operator<<\(\)](#), [operator<<\(\)](#), [operator<<\(\)](#), and [operator<<\(\)](#).

**5.1.3.827 format\_index\_value()** [2/2]

```
template<typename T>
std::enable_if<!has_distance< T >::value, T >::type GiNaC::format_index_value (
 const T & a,
 const T & b)
```

For all other cases we simply print the value.

**5.1.3.828 operator<<()** [8/16]

```
template<class T>
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const basic_multi_iterator< T > & v) [inline]
```

Output operator.

A multi\_iterator prints out as [basic\\_multi\\_iterator](#)(  $n_0, n_1, \dots$ ).

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [format\\_index\\_value\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#).

**5.1.3.829 operator<<() [9/16]**

```
template<class T>
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const multi_iterator_ordered< T > & v) [inline]
```

Output operator.

A [multi\\_iterator\\_ordered](#) prints out as [multi\\_iterator\\_ordered](#)( $n_0, n_1, \dots$ ).

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [format\\_index\\_value\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#).

**5.1.3.830 operator<<() [10/16]**

```
template<class T>
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const multi_iterator_ordered_eq< T > & v) [inline]
```

Output operator.

A [multi\\_iterator\\_ordered\\_eq](#) prints out as [multi\\_iterator\\_ordered\\_eq](#)( $n_0, n_1, \dots$ ).

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [format\\_index\\_value\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#).

**5.1.3.831 operator<<() [11/16]**

```
template<class T>
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const multi_iterator_ordered_eq_indv< T > & v) [inline]
```

Output operator.

A [multi\\_iterator\\_ordered\\_eq\\_indv](#) prints out as [multi\\_iterator\\_ordered\\_eq\\_indv](#)( $n_0, n_1, \dots$ ).

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [format\\_index\\_value\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#).

**5.1.3.832 operator<<() [12/16]**

```
template<class T>
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const multi_iterator_counter< T > & v) [inline]
```

Output operator.

A [multi\\_iterator\\_counter](#) prints out as [multi\\_iterator\\_counter](#)( $n_0, n_1, \dots$ ).

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [format\\_index\\_value\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#).

**5.1.3.833 operator<<() [13/16]**

```
template<class T>
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const multi_iterator_counter_indv< T > & v) [inline]
```

Output operator.

A `multi_iterator_counter_indv` prints out as `multi_iterator_counter_indv(  $n_0, n_1, \dots$  )`.

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [format\\_index\\_value\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#).

**5.1.3.834 operator<<() [14/16]**

```
template<class T>
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const multi_iterator_permutation< T > & v) [inline]
```

Output operator.

A `multi_iterator_permutation` prints out as `multi_iterator_permutation(  $n_0, n_1, \dots$  )`.

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [format\\_index\\_value\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#).

**5.1.3.835 operator<<() [15/16]**

```
template<class T>
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const multi_iterator_shuffle< T > & v) [inline]
```

Output operator.

A `multi_iterator_shuffle` prints out as `multi_iterator_shuffle(  $n_0, n_1, \dots$  )`.

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [format\\_index\\_value\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#).

**5.1.3.836 operator<<() [16/16]**

```
template<class T>
std::ostream & GiNaC::operator<< (
 std::ostream & os,
 const multi_iterator_shuffle_prime< T > & v) [inline]
```

Output operator.

A `multi_iterator_shuffle_prime` prints out as `multi_iterator_shuffle_prime(  $n_0, n_1, \dots$  )`.

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [format\\_index\\_value\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#).

**5.1.3.837 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT()** [33/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
 wildcard ,
 basic ,
 print_func< print_context > &::do_print. print_func< print_tree > &::do_print←
_tree. print_func< print_python_repr > &::do_print_python_repr)
```

References [GiNaC::wildcard::do\\_print\(\)](#), [GiNaC::wildcard::do\\_print\\_python\\_repr\(\)](#), [GiNaC::wildcard::do\\_print\\_tree\(\)](#), [GiNaC::status\\_flags::evaluated](#), and [GiNaC::status\\_flags::expanded](#).

**5.1.3.838 GINAC\_BIND\_UNARCHIVER()** [49/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
 wildcard)
```

**5.1.3.839 haswild()**

```
bool GiNaC::haswild (
 const ex & x)
```

Check whether x has a wildcard anywhere as a subexpression.

References [haswild\(\)](#), [is\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [GiNaC::integral::eval\(\)](#), and [haswild\(\)](#).

**5.1.3.840 GINAC\_DECLARE\_UNARCHIVER()** [51/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
 wildcard)
```

**5.1.3.841 wild()**

```
ex GiNaC::wild (
 unsigned label = 0) [inline]
```

Create a wildcard object with the specified label.

Referenced by [GiNaC::spmapkey::spmapkey\(\)](#).

**5.1.4 Variable Documentation****5.1.4.1 unarch\_table\_instance**

```
unarchive_table_t GiNaC::unarch_table_instance [static]
```

#### 5.1.4.2 map\_evalm

`GiNaC::evalm_map_function` `GiNaC::map_evalm`

Referenced by [GiNaC::basic::evalm\(\)](#).

#### 5.1.4.3 map\_eval\_integ

`GiNaC::eval_integ_map_function` `GiNaC::map_eval_integ`

Referenced by [GiNaC::basic::eval\\_integ\(\)](#).

#### 5.1.4.4 class\_info< OPT >::first

```
template<class OPT>
class_info<OPT>* GiNaC::class_info< OPT >::first = nullptr
```

Referenced by [antisymmetrize\(\)](#), [GiNaC::symmetry::canonicalize](#), [GiNaC::expairseq::construct\\_from\\_expairseq\\_ex\(\)](#), [cyclic\\_permutation\(\)](#), [GiNaC::mul::do\\_print\(\)](#), [GiNaC::clifford::eval\\_ncmul\(\)](#), [permutation\\_sign\(\)](#), [permutation\\_sign\(\)](#), [GiNaC::add::print\\_add\(\)](#), [GiNaC::indexed::printindices\(\)](#), [shaker\\_sort\(\)](#), [GiNaC::indexed::simplify\\_indexed](#), [symm\(\)](#), [symmetrize\(\)](#), and [symmetrize\\_cyclic\(\)](#).

#### 5.1.4.5 class\_info< OPT >::parents\_identified

```
template<class OPT>
bool GiNaC::class_info< OPT >::parents_identified = false
```

#### 5.1.4.6 tensor

`GiNaC::tensor`

#### 5.1.4.7 Pi

```
const constant GiNaC::Pi (
 "Pi" ,
 PiEvalf ,
 "\\pi" ,
 domain::positive)
```

Pi.

(3.14159...) Diverts straight into CLN for [evalf\(\)](#).

Referenced by [acos\\_eval\(\)](#), [acosh\\_eval\(\)](#), [asin\\_eval\(\)](#), [atan2\\_eval\(\)](#), [atan\\_eval\(\)](#), [atan\\_series\(\)](#), [atanh\\_series\(\)](#), [GiNaC::Eisenstein\\_h\\_kernel::coefficient\\_a0\(\)](#), [GiNaC::Eisenstein\\_h\\_kernel::coefficient\\_an\(\)](#), [cos\\_eval\(\)](#), [cosh\\_eval\(\)](#), [EllipticE\\_eval\(\)](#), [EllipticE\\_evalf\(\)](#), [EllipticE\\_series\(\)](#), [EllipticK\\_eval\(\)](#), [EllipticK\\_evalf\(\)](#), [EllipticK\\_series\(\)](#), [eta\\_eval\(\)](#), [eta\\_evalf\(\)](#), [exp\\_eval\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::get\\_numerical\\_value\(\)](#), [GiNaC::Kronecker\\_dz\\_kernel::get\\_numerical\\_value\(\)](#), [H\\_evalf\(\)](#), [Li2\\_eval\(\)](#), [Li2\\_series\(\)](#), [Li\\_eval\(\)](#), [log\\_eval\(\)](#), [log\\_series\(\)](#), [GiNaC::constant::read\\_archive\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::series\\_coeff\\_impl\(\)](#), [sinh\\_eval\(\)](#), [sinh\\_evalf\(\)](#), [tan\\_eval\(\)](#), [tan\\_series\(\)](#), [tanh\\_eval\(\)](#), [tanh\\_series\(\)](#), [tgamma\\_eval\(\)](#), and [zeta1\\_eval\(\)](#).

#### 5.1.4.8 Euler

```
const constant GiNaC::Euler (
 "Euler" ,
 EulerEvalf ,
 "\\gamma_E" ,
 domain::positive)
```

Euler's constant.

(0.57721...) Sometimes called Euler-Mascheroni constant. Diverts straight into CLN for [evalf\(\)](#).

Referenced by [psi1\\_eval\(\)](#), and [GiNaC::constant::read\\_archive\(\)](#).

#### 5.1.4.9 Catalan

```
const constant GiNaC::Catalan (
 "Catalan" ,
 CatalanEvalf ,
 "G" ,
 domain::positive)
```

Catalan's constant.

(0.91597...) Diverts straight into CLN for [evalf\(\)](#).

Referenced by [Li2\\_eval\(\)](#), [Li\\_eval\(\)](#), and [GiNaC::constant::read\\_archive\(\)](#).

#### 5.1.4.10 crctab

```
unsigned const GiNaC::crctab[256] [static]
```

Referenced by [crc32\(\)](#).

#### 5.1.4.11 library\_initializer

```
library_init GiNaC::library_initializer [static]
```

For construction of flyweights, etc.

#### 5.1.4.12 \_num0\_bp

```
const basic * GiNaC::_num0_bp
```

Referenced by [GiNaC::ex::ex\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.13 idx

```
GiNaC::idx
```

Referenced by [expand\\_dummy\\_sum\(\)](#).



#### 5.1.4.14 force\_include\_tgamma

```
unsigned GiNaC::force_include_tgamma = tgamma_SERIAL::serial
```

#### 5.1.4.15 force\_include\_zeta1

```
unsigned GiNaC::force_include_zeta1 = zeta1_SERIAL::serial
```

#### 5.1.4.16 GINAC\_BIND\_UNARCHIVER

```
template<>
GINAC_IMPLEMENT_REGISTERED_CLASS_OPT_T(lst, basic, print_func< print_context >(&lst::do_print),
print_func< print_tree >(&lst::do_print_tree)) template<> bool ls GiNaC::GINAC_BIND_UNARCHIVER(
 (lst) (
 lst)
```

Specialization of [container::info\(\)](#) for `lst`.

Referenced by [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

#### 5.1.4.17 I

```
const numeric GiNaC::I = numeric(cln::complex(cln::cl_I(0),cln::cl_I(1)))
```

Imaginary unit.

This is not a constant but a numeric since we are natively handing complex numbers anyways, so in each expression containing an `I` it is automatically eval'ed away anyhow.

Referenced by [acosh\\_eval\(\)](#), [atan\\_eval\(\)](#), [atan\\_series\(\)](#), [atanh\\_series\(\)](#), [GiNaC::Eisenstein\\_h\\_kernel::coefficient\\_a0\(\)](#), [GiNaC::Eisenstein\\_h\\_kernel::coefficient\\_an\(\)](#), [color\\_h\(\)](#), [GiNaC::su3f::contract\\_with\(\)](#), [cosh\\_eval\(\)](#), [csgn\\_eval\(\)](#), [dirac\\_trace\(\)](#), [eta\\_eval\(\)](#), [eta\\_evalf\(\)](#), [eta\\_imag\\_part\(\)](#), [exp\\_eval\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::get\\_numerical\\_value\(\)](#), [GiNaC::Kronecker\\_dz\\_kernel::get\\_numerical\\_value\(\)](#), [GINAC\\_DECLARE\\_UNARCHIVER\(\)](#), [H\\_evalf\(\)](#), [GiNaC::numeric::has\(\)](#), [Li2\\_eval\(\)](#), [Li2\\_series\(\)](#), [Li\\_eval\(\)](#), [log\\_eval\(\)](#), [log\\_series\(\)](#), [GiNaC::numeric::normal\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::series\\_coeff\\_impl\(\)](#), [GiNaC::Kronecker\\_dz\\_kernel::series\\_coeff\\_impl\(\)](#), [sinh\\_eval\(\)](#), [step\\_eval\(\)](#), [tanh\\_eval\(\)](#), [tanh\\_series\(\)](#), [GiNaC::numeric::to\\_polynomial\(\)](#) and [GiNaC::numeric::to\\_rational\(\)](#).

#### 5.1.4.18 Digits

```
_numeric_digits GiNaC::Digits
```

Accuracy in decimal digits.

Only object of this type! Can be set using assignment from C++ unsigned ints and evaluated like any built-in type.

Referenced by [GiNaC::integration\\_kernel::get\\_numerical\\_value\\_impl\(\)](#), [GINAC\\_DECLARE\\_UNARCHIVER\(\)](#), [iterated\\_integral\\_evalf\\_impl\(\)](#), [GiNaC::numeric::numeric\(\)](#), [print\\_real\\_cl\\_N\(\)](#), and [zeta1\\_evalf\(\)](#).

#### 5.1.4.19 `next_print_context_id`

```
unsigned GiNaC::next_print_context_id = 0
```

Next free ID for [print\\_context](#) types.

#### 5.1.4.20 `structure< T, CP >::reg_info`

```
template<class T, template< class > class CP>
registered_class_info GiNaC::structure< T, CP >::reg_info = registered_class_info(registered_class_options(st
"basic", typeid(structure<T, CP>)))
```

Referenced by [GiNaC::basic::print\\_dispatch\(\)](#).

#### 5.1.4.21 `version_major`

```
const int GiNaC::version_major = GINACLIB_MAJOR_VERSION
```

#### 5.1.4.22 `version_minor`

```
const int GiNaC::version_minor = GINACLIB_MINOR_VERSION
```

#### 5.1.4.23 `version_micro`

```
const int GiNaC::version_micro = GINACLIB_MICRO_VERSION
```

#### 5.1.4.24 `_num_120_p`

```
const numeric * GiNaC::_num_120_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.25 `_ex_120`

```
const ex GiNaC::_ex_120 = ex(*_num_120_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.26 `_num_60_p`

```
const numeric * GiNaC::_num_60_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.27 `_ex_60`

```
const ex GiNaC::_ex_60 = ex(*_num_60_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.28 `_num_48_p`

```
const numeric * GiNaC::_num_48_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.29 `_ex_48`

```
const ex GiNaC::_ex_48 = ex(*_num_48_p)
```

Referenced by [Li2\\_eval\(\)](#), [Li\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.30 `_num_30_p`

```
const numeric * GiNaC::_num_30_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.31 `_ex_30`

```
const ex GiNaC::_ex_30 = ex(*_num_30_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.32 `_num_25_p`

```
const numeric * GiNaC::_num_25_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.33 `_ex_25`

```
const ex GiNaC::_ex_25 = ex(*_num_25_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.34 `_num_24_p`

```
const numeric * GiNaC::_num_24_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.35 `_ex_24`

```
const ex GiNaC::_ex_24 = ex(*_num_24_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.36 `_num_20_p`

```
const numeric * GiNaC::_num_20_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.37 `_ex_20`

```
const ex GiNaC::_ex_20 = ex(*_num_20_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.38 `_num_18_p`

```
const numeric * GiNaC::_num_18_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.39 `_ex_18`

```
const ex GiNaC::_ex_18 = ex(*_num_18_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.40 `_num_15_p`

```
const numeric * GiNaC::_num_15_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.41 `_ex_15`

```
const ex GiNaC::_ex_15 = ex(*_num_15_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.42 `_num_12_p`

```
const numeric * GiNaC::_num_12_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.43 `_ex_12`

```
const ex GiNaC::_ex_12 = ex(*_num_12_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.44 `_num_11_p`

```
const numeric * GiNaC::_num_11_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.45 `_ex_11`

```
const ex GiNaC::_ex_11 = ex(*_num_11_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.46 `_num_10_p`

```
const numeric * GiNaC::_num_10_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.47 `_ex_10`

```
const ex GiNaC::_ex_10 = ex(*_num_10_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.48 `_num_9_p`

```
const numeric * GiNaC::_num_9_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.49 `_ex_9`

```
const ex GiNaC::_ex_9 = ex(*_num_9_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.50 `_num_8_p`

```
const numeric * GiNaC::_num_8_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.51 `_ex_8`

```
const ex GiNaC::_ex_8 = ex(*_num_8_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.52 `_num_7_p`

```
const numeric * GiNaC::_num_7_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.53 `_ex_7`

```
const ex GiNaC::_ex_7 = ex(*_num_7_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.54 `_num_6_p`

```
const numeric * GiNaC::_num_6_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.55 `_ex_6`

```
const ex GiNaC::_ex_6 = ex(*_num_6_p)
```

Referenced by [GiNaC::su3d::eval\\_indexed\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.56 `_num_5_p`

```
const numeric * GiNaC::_num_5_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.57 `_ex_5`

```
const ex GiNaC::_ex_5 = ex(*_num_5_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.58 `_num_4_p`

```
const numeric * GiNaC::_num_4_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.59 `_ex_4`

```
const ex GiNaC::_ex_4 = ex(*_num_4_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.60 `_num_3_p`

```
const numeric * GiNaC::_num_3_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.61 `_ex_3`

```
const ex GiNaC::_ex_3 = ex(*_num_3_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.62 `_num_2_p`

```
const numeric * GiNaC::_num_2_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), and [tgamma\\_eval\(\)](#).

#### 5.1.4.63 `_ex_2`

```
const ex GiNaC::_ex_2 = ex(*_num_2_p)
```

Referenced by [GiNaC::diracgamma::contract\\_with\(\)](#), [GiNaC::spinmetric::contract\\_with\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.64 `_num_1_p`

```
const numeric * GiNaC::_num_1_p
```

Referenced by [acos\\_conjugate\(\)](#), [asin\\_conjugate\(\)](#), [asinh\\_conjugate\(\)](#), [atan\\_conjugate\(\)](#), [atanh\\_conjugate\(\)](#), [beta\\_eval\(\)](#), [binomial\(\)](#), [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), [GiNaC::add::do\\_print\\_csrc\(\)](#), [doublefactorial\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [operator-\(\)](#), [operator--\(\)](#), [operator--\(\)](#), [GiNaC::add::print\\_add\(\)](#), [GiNaC::mul::print\\_overall\\_coeff\(\)](#), [psi1\\_eval\(\)](#), and [psi2\\_eval\(\)](#).

**5.1.4.65** `_ex_1`

```
const ex GiNaC::_ex_1 = ex(*_num_1_p)
```

Referenced by [acos\\_eval\(\)](#), [acosh\\_deriv\(\)](#), [acosh\\_eval\(\)](#), [asin\\_eval\(\)](#), [atan2\\_deriv\(\)](#), [atan\\_deriv\(\)](#), [atan\\_eval\(\)](#), [atan\\_series\(\)](#), [atanh\\_deriv\(\)](#), [atanh\\_eval\(\)](#), [atanh\\_series\(\)](#), [GiNaC::diracgamma5::conjugate\(\)](#), [cos\\_eval\(\)](#), [GiNaC::power::derivative\(\)](#), [GiNaC::add::do\\_print\\_csrc\(\)](#), [GiNaC::mul::do\\_print\\_csrc\(\)](#), [GiNaC::power::do\\_print\\_csrc\(\)](#), [GiNaC::power::do\\_print\\_csrc\\_cl\\_N\(\)](#), [EllipticE\\_eval\(\)](#), [EllipticE\\_series\(\)](#), [EllipticK\\_series\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::minkmetric::eval\\_indexed\(\)](#), [GiNaC::spinmetric::eval\\_indexed\(\)](#), [exminus\(\)](#), [exp\\_eval\(\)](#), [exp\\_power\(\)](#), [GiNaC::power::expand\(\)](#), [frac\\_cancel\(\)](#), [H\\_deriv\(\)](#), [H\\_eval\(\)](#), [lgamma\\_eval\(\)](#), [Li2\\_eval\(\)](#), [Li\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [log\\_deriv\(\)](#), [log\\_expand\(\)](#), [log\\_series\(\)](#), [operator--\(\)](#), [operator--\(\)](#), [operator/\(\)](#), [operator/\(\)](#), [psi1\\_series\(\)](#), [psi2\\_eval\(\)](#), [psi2\\_series\(\)](#), [replace\\_with\\_symbol\(\)](#), [sin\\_eval\(\)](#), [tan\\_eval\(\)](#), [tanh\\_eval\(\)](#), [GiNaC::power::to\\_polynomial\(\)](#), [GiNaC::ex::unit\(\)](#), [GiNaC::ex::unitcontprim\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

**5.1.4.66** `_num_1_2_p`

```
const numeric * GiNaC::_num_1_2_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#).

**5.1.4.67** `_ex_1_2`

```
const ex GiNaC::_ex_1_2 = ex(*_num_1_2_p)
```

Referenced by [acos\\_deriv\(\)](#), [acos\\_eval\(\)](#), [acosh\\_deriv\(\)](#), [asin\\_deriv\(\)](#), [asin\\_eval\(\)](#), [asinh\\_deriv\(\)](#), [atan2\\_eval\(\)](#), [atan\\_series\(\)](#), [atanh\\_series\(\)](#), [cos\\_eval\(\)](#), [cosh\\_eval\(\)](#), [GiNaC::su3d::eval\\_indexed\(\)](#), [GiNaC::su3f::eval\\_indexed\(\)](#), [Li2\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [log\\_eval\(\)](#), [sin\\_eval\(\)](#), [sinh\\_eval\(\)](#), [tan\\_eval\(\)](#), [tanh\\_eval\(\)](#), [zeta1\\_eval\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

**5.1.4.68** `_num_1_3_p`

```
const numeric * GiNaC::_num_1_3_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#).

**5.1.4.69** `_ex_1_3`

```
const ex GiNaC::_ex_1_3 = ex(*_num_1_3_p)
```

Referenced by [cos\\_eval\(\)](#), [GiNaC::su3d::eval\\_indexed\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [sin\\_eval\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

**5.1.4.70** `_num_1_4_p`

```
const numeric * GiNaC::_num_1_4_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#).



5.1.4.71 `_ex_1_4`

```
const ex GiNaC::_ex_1_4 = ex(*_num_1_4_p)
```

Referenced by [atan2\\_eval\(\)](#), [atan\\_eval\(\)](#), [cos\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [sin\\_eval\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

5.1.4.72 `_num0_p`

```
const numeric * GiNaC::_num0_p
```

Referenced by [GiNaC::numeric::add\\_dyn\(\)](#), [atan\(\)](#), [binomial\(\)](#), [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), [GiNaC::ex::construct\\_from\\_uint\(\)](#), [GiNaC::ex::construct\\_from\\_ulong\(\)](#), [cos\\_eval\(\)](#), [divide\\_in\\_z\(\)](#), [GiNaC::power::eval\(\)](#), [exp\\_eval\(\)](#), [GiNaC::mul::expand\(\)](#), [fibonacci\(\)](#), [GiNaC::numeric::has\(\)](#), [GiNaC::add::integer\\_content\(\)](#), [iquo\(\)](#), [iquo\(\)](#), [irem\(\)](#), [irem\(\)](#), [isqrt\(\)](#), [Li2\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [mod\(\)](#), [GiNaC::relational::operator safe\\_bool\(\)](#), [GiNaC::numeric::power\(\)](#), [GiNaC::numeric::power\\_dyn\(\)](#), [sin\\_eval\(\)](#), [smod\(\)](#), [GiNaC::numeric::sub\\_dyn\(\)](#), and [tan\\_eval\(\)](#).

5.1.4.73 `_ex0`

```
const ex GiNaC::_ex0 = ex(*_num0_p)
```

Referenced by [acos\\_eval\(\)](#), [acosh\\_eval\(\)](#), [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [GiNaC::pseries::add\\_series\(\)](#), [asinh\\_eval\(\)](#), [atan2\\_eval\(\)](#), [atan\\_eval\(\)](#), [atan\\_series\(\)](#), [atanh\\_eval\(\)](#), [atanh\\_series\(\)](#), [base\\_and\\_index\(\)](#), [beta\\_eval\(\)](#), [binomial\\_sym\(\)](#), [GiNaC::relational::canonical\(\)](#), [GiNaC::add::coeff\(\)](#), [GiNaC::basic::coeff\(\)](#), [GiNaC::mul::coeff\(\)](#), [GiNaC::ncmul::coeff\(\)](#), [GiNaC::numeric::coeff\(\)](#), [GiNaC::power::coeff\(\)](#), [GiNaC::pseries::coeff\(\)](#), [GiNaC::basic::collect\(\)](#), [color\\_trace\(\)](#), [GiNaC::ex::content\(\)](#), [cos\\_eval\(\)](#), [csgn\\_series\(\)](#), [GiNaC::expairseq::default\\_overall\\_coeff\(\)](#), [GiNaC::basic::derivative\(\)](#), [GiNaC::constant::derivative\(\)](#), [GiNaC::idx::derivative\(\)](#), [GiNaC::indexed::derivative\(\)](#), [GiNaC::symbol::derivative\(\)](#), [GiNaC::matrix::determinant\(\)](#), [GiNaC::matrix::determinant\\_minor\(\)](#), [dirac\\_trace\(\)](#), [divide\(\)](#), [divide\\_in\\_z\(\)](#), [GiNaC::matrix::division\\_free\\_elimination\(\)](#), [EllipticE\\_eval\(\)](#), [EllipticE\\_series\(\)](#), [EllipticK\\_eval\(\)](#), [EllipticK\\_series\(\)](#), [eta\\_eval\(\)](#), [eta\\_evalf\(\)](#), [eta\\_series\(\)](#), [GiNaC::function::eval\(\)](#), [GiNaC::indexed::eval\(\)](#), [GiNaC::integral::eval\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::minkmetric::eval\\_indexed\(\)](#), [GiNaC::spinmetric::eval\\_indexed\(\)](#), [GiNaC::su3d::eval\\_indexed\(\)](#), [GiNaC::su3f::eval\\_indexed\(\)](#), [GiNaC::tensdelta::eval\\_indexed\(\)](#), [GiNaC::tensepsilon::eval\\_indexed\(\)](#), [GiNaC::clifford::eval\\_ncmul\(\)](#), [GiNaC::indexed::expand\(\)](#), [find\\_common\\_factor\(\)](#), [GiNaC::matrix::fraction\\_free\\_elimination\(\)](#), [G2\\_eval\(\)](#), [G2\\_evalf\(\)](#), [G3\\_eval\(\)](#), [G3\\_evalf\(\)](#), [GiNaC::matrix::gauss\\_elimination\(\)](#), [gcd\(\)](#), [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASSES\(\)](#), [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASSES\\_OPT\(\)](#), [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASSES\\_OPT\(\)](#), [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASSES\\_OPT\(\)](#), [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASSES\\_OPT\(\)](#), [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASSES\\_OPT\(\)](#), [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASSES\\_OPT\(\)](#), [H\\_deriv\(\)](#), [H\\_eval\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [Li2\\_eval\(\)](#), [Li2\\_series\(\)](#), [Li\\_deriv\(\)](#), [Li\\_eval\(\)](#), [Li\\_evalf\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [log\\_eval\(\)](#), [log\\_series\(\)](#), [GiNaC::matrix::markowitz\\_elimination\(\)](#), [GiNaC::matrix::matrix\(\)](#), [GiNaC::matrix::matrix\(\)](#), [GiNaC::pseries::mul\\_series\(\)](#), [Order\\_eval\(\)](#), [GiNaC::pseries::power\\_const\(\)](#), [prem\(\)](#), [GiNaC::ex::primpart\(\)](#), [rem\(\)](#), [S\\_deriv\(\)](#), [S\\_eval\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::ex::series\(\)](#), [GiNaC::symbol::series\(\)](#), [GiNaC::indexed::simplify\\_indexed\\_product\(\)](#), [sin\\_eval\(\)](#), [sinh\\_eval\(\)](#), [sprem\(\)](#), [sqrfree\(\)](#), [sr\\_gcd\(\)](#), [step\\_series\(\)](#), [tan\\_eval\(\)](#), [tanh\\_eval\(\)](#), [GiNaC::ex::unitcontprim\(\)](#), [zeta1\\_deriv\(\)](#), [zeta1\\_eval\(\)](#), [zeta2\\_deriv\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

5.1.4.74 `_num1_4_p`

```
const numeric * GiNaC::_num1_4_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.75 `_ex1_4`

```
const ex GiNaC::_ex1_4 = ex(*_num1_4_p)
```

Referenced by [atan2\\_eval\(\)](#), [atan\\_eval\(\)](#), [cos\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [sin\\_eval\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.76 `_num1_3_p`

```
const numeric * GiNaC::_num1_3_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.77 `_ex1_3`

```
const ex GiNaC::_ex1_3 = ex(*_num1_3_p)
```

Referenced by [acos\\_eval\(\)](#), [cos\\_eval\(\)](#), [GiNaC::su3d::eval\\_indexed\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [sin\\_eval\(\)](#), [tan\\_eval\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.78 `_num1_2_p`

```
const numeric * GiNaC::_num1_2_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), [psi2\\_eval\(\)](#), and [tgamma\\_eval\(\)](#).

#### 5.1.4.79 `_ex1_2`

```
const ex GiNaC::_ex1_2 = ex(*_num1_2_p)
```

Referenced by [acos\\_eval\(\)](#), [asin\\_eval\(\)](#), [atan2\\_eval\(\)](#), [atan\\_series\(\)](#), [atanh\\_series\(\)](#), [cos\\_eval\(\)](#), [GiNaC::power::do\\_print\\_dflt\(\)](#), [GiNaC::power::do\\_print\\_latex\(\)](#), [GiNaC::su3d::eval\\_indexed\(\)](#), [GiNaC::su3f::eval\\_indexed\(\)](#), [GiNaC::clifford::get\\_metric\(\)](#), [Li2\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [log\\_eval\(\)](#), [psi1\\_eval\(\)](#), [psi2\\_eval\(\)](#), [sin\\_eval\(\)](#), [sqrt\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.80 `_num1_p`

```
const numeric * GiNaC::_num1_p
```

Referenced by [acos\\_conjugate\(\)](#), [acosh\\_conjugate\(\)](#), [asin\\_conjugate\(\)](#), [asinh\\_conjugate\(\)](#), [atan\(\)](#), [atan\\_conjugate\(\)](#), [atanh\\_conjugate\(\)](#), [bernoulli\(\)](#), [binomial\(\)](#), [GiNaC::add::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), [GiNaC::ex::construct\\_from\\_uint\(\)](#), [GiNaC::ex::construct\\_from\\_ulong\(\)](#), [GiNaC::numeric::denom\(\)](#), [GiNaC::numeric::div\\_dyn\(\)](#), [divide\\_in\\_z\(\)](#), [GiNaC::add::do\\_print\\_csrc\(\)](#), [doublefactorial\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [exp\\_eval\(\)](#), [GiNaC::power::expand\\_add\(\)](#), [frac\\_cancel\(\)](#), [gcd\(\)](#), [GiNaC::mul::info\(\)](#), [GiNaC::add::integer\\_content\(\)](#), [GiNaC::basic::integer\\_content\(\)](#), [lcm\\_of\\_coefficients\\_denominators\(\)](#), [lcmcoeff\(\)](#), [Li2\\_conjugate\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [GiNaC::basic::max\\_coefficient\(\)](#), [GiNaC::numeric::mul\\_dyn\(\)](#), [multiply\\_lcm\(\)](#), [operator++\(\)](#), [operator++\(\)](#), [GiNaC::matrix::pow\(\)](#), [GiNaC::numeric::power\(\)](#), [GiNaC::numeric::power\\_dyn\(\)](#), [GiNaC::add::print\\_add\(\)](#), [GiNaC::mul::print\\_overall\\_coeff\(\)](#), [psi2\\_eval\(\)](#), [GiNaC::add::recombine\\_pair\\_to\\_ex\(\)](#), [tgamma\\_eval\(\)](#), and [zeta1\\_eval\(\)](#).

5.1.4.81 `_ex1`

```
const ex GiNaC::_ex1 = ex(*_num1_p)
```

Referenced by `acos_eval()`, `acosh_deriv()`, `acosh_eval()`, `GiNaC::pseries::add_series()`, `asin_eval()`, `asinh_deriv()`, `atan_deriv()`, `atan_eval()`, `atan_series()`, `atanh_deriv()`, `atanh_eval()`, `atanh_series()`, `base_and_index()`, `beta_eval()`, `binomial_sym()`, `GiNaC::basic::coeff()`, `GiNaC::ncmul::coeff()`, `GiNaC::power::coeff()`, `GiNaC::basic::collect()`, `color_trace()`, `GiNaC::add::combine_ex_with_coeff_to_pair()`, `GiNaC::mul::combine_ex_with_coeff_to_pair()`, `GiNaC::add::combine_pair_with_coeff_to_pair()`, `GiNaC::mul::combine_pair_with_coeff_to_pair()`, `GiNaC::cliffordunit::contract_with()`, `GiNaC::diracgamma::contract_with()`, `GiNaC::matrix::contract_with()`, `GiNaC::spinmetric::contract_with()`, `GiNaC::su3d::contract_with()`, `GiNaC::su3f::contract_with()`, `GiNaC::su3t::contract_with()`, `GiNaC::tensepsilon::contract_with()`, `cos_eval()`, `cosh_eval()`, `GiNaC::mul::default_overall_coeff()`, `GiNaC::mul::derivative()`, `GiNaC::power::derivative()`, `GiNaC::symbol::derivative()`, `GiNaC::matrix::determinant_minor()`, `dirac_trace()`, `divide()`, `divide_in_z()`, `GiNaC::add::do_print_csrc()`, `GiNaC::mul::do_print_csrc()`, `EllipticE_eval()`, `EllipticE_series()`, `EllipticK_series()`, `GiNaC::mul::eval()`, `GiNaC::ncmul::eval()`, `GiNaC::power::eval()`, `GiNaC::minkmetric::eval_indexed()`, `GiNaC::spinmetric::eval_indexed()`, `GiNaC::tensdelta::eval_indexed()`, `GiNaC::mul::evalm()`, `exp_eval()`, `GiNaC::expairseq::expair_needs_further_processing()`, `GiNaC::mul::expair_needs_further_processing()`, `GiNaC::mul::expand()`, `GiNaC::ncmul::expand()`, `GiNaC::power::expand()`, `GiNaC::power::expand_add()`, `GiNaC::power::expand_add()`, `GiNaC::power::expand_mul()`, `find_common_factor()`, `frac_cancel()`, `GiNaC::matrix::fraction_free_elimination()`, `G2_eval()`, `G2_evalf()`, `G3_eval()`, `G3_evalf()`, `gcd()`, `gcd_pf_pow()`, `gcd_pf_pow_pow()`, `GINAC_IMPLEMENT_REGISTERED_CLASS`, `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()`, `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()`, `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()`, `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()`, `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()`, `H_deriv()`, `H_eval()`, `GiNaC::ncmul::hold_ncmul`, `GiNaC::power::imag_part()`, `GiNaC::matrix::inverse()`, `lgamma_series()`, `Li2_deriv()`, `Li2_eval()`, `Li2_series()`, `Li_eval()`, `Li_evalf()`, `Li_series()`, `GiNaC::library_init::library_init()`, `log_eval()`, `log_expand()`, `log_series()`, `GiNaC::expairseq::make_flat()`, `GiNaC::expairseq::make_flat()`, `GiNaC::mul::mul()`, `GiNaC::mul::mul()`, `GiNaC::mul::mul()`, `GiNaC::mul::mul()`, `GiNaC::mul::mul()`, `GiNaC::pseries::mul_series()`, `GiNaC::basic::normal()`, `GiNaC::power::normal()`, `GiNaC::pseries::normal()`, `GiNaC::symbol::normal()`, `operator++()`, `operator++()`, `Order_eval()`, `Order_series()`, `GiNaC::matrix::pow()`, `GiNaC::pseries::power_const()`, `prem()`, `GiNaC::ex::primpart()`, `GiNaC::pseries::print_series()`, `psi1_deriv()`, `psi1_series()`, `psi2_deriv()`, `psi2_eval()`, `psi2_series()`, `quo()`, `GiNaC::power::real_part()`, `GiNaC::mul::recombine_pair_to_ex()`, `GiNaC::tensor::replace_contr_index()`, `S_series()`, `GiNaC::add::series()`, `GiNaC::basic::series()`, `GiNaC::integral::series()`, `GiNaC::mul::series()`, `GiNaC::power::series()`, `GiNaC::pseries::series()`, `GiNaC::symbol::series()`, `GiNaC::indexed::simplify_indexed_product`, `sin_eval()`, `sinh_eval()`, `GiNaC::add::split_ex_to_pair()`, `GiNaC::expairseq::split_ex_to_pair()`, `GiNaC::mul::split_ex_to_pair()`, `sprem()`, `sqrfree_parfrac()`, `sqrfree_yun()`, `sr_gcd()`, `tan_deriv()`, `tan_eval()`, `tanh_deriv()`, `tanh_eval()`, `tgamma_series()`, `GiNaC::expairseq::to_polynomial()`, `GiNaC::expairseq::to_rational()`, `GiNaC::ex::unit()`, `unit_matrix()`, `GiNaC::ex::unitcontprim()`, `zeta1_deriv()`, `zeta2_deriv()`, and `GiNaC::library_init::~library_init()`.

5.1.4.82 `_num2_p`

```
const numeric * GiNaC::_num2_p
```

Referenced by `GiNaC::ex::construct_from_int()`, `GiNaC::ex::construct_from_long()`, `GiNaC::ex::construct_from_uint()`, `GiNaC::ex::construct_from_ulong()`, `exp_eval()`, `GiNaC::power::expand_add_2()`, `Li2_series()`, `GiNaC::library_init::library_init()`, `GiNaC::matrix::pow()`, `psi1_eval()`, `psi2_eval()`, `tgamma_eval()`, and `zeta1_eval()`.

5.1.4.83 `_ex2`

```
const ex GiNaC::_ex2 = ex(*_num2_p)
```

Referenced by `acos_deriv()`, `asin_deriv()`, `asinh_deriv()`, `atan2_deriv()`, `atan_deriv()`, `atanh_deriv()`, `canonicalize_clifford()`, `GiNaC::diracgamma::contract_with()`, `GiNaC::spinmetric::contract_with()`, `cos_eval()`, `cosh_eval()`, `csgn_power()`, `epsilon_tensor()`, `exp_eval()`, `GiNaC::power::expand_add_2()`, `Li2_eval()`, `Li2_series()`, `Li_eval()`, `GiNaC::library_init::library_init()`, `product_to_exvector()`, `psi1_eval()`, `GiNaC::indexed::simplify_indexed`, `sin_eval()`, `sinh_eval()`, `tan_deriv()`, `tan_eval()`, `tanh_deriv()`, `tanh_eval()`, and `GiNaC::library_init::~library_init()`.

#### 5.1.4.84 `_num3_p`

```
const numeric * GiNaC::_num3_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), [GiNaC::ex::construct\\_from\\_uint\(\)](#), [GiNaC::ex::construct\\_from\\_ulong\(\)](#), [exp\\_eval\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.85 `_ex3`

```
const ex GiNaC::_ex3 = ex(*_num3_p)
```

Referenced by [color\\_trace\(\)](#), [cos\\_eval\(\)](#), [epsilon\\_tensor\(\)](#), [GiNaC::su3d::eval\\_indexed\(\)](#), [GiNaC::su3f::eval\\_indexed\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [sin\\_eval\(\)](#), [tan\\_eval\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.86 `_num4_p`

```
const numeric * GiNaC::_num4_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), [GiNaC::ex::construct\\_from\\_uint\(\)](#), [GiNaC::ex::construct\\_from\\_ulong\(\)](#), [exp\\_eval\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.87 `_ex4`

```
const ex GiNaC::_ex4 = ex(*_num4_p)
```

Referenced by [dirac\\_trace\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [lorentz\\_eps\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.88 `_num5_p`

```
const numeric * GiNaC::_num5_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), [GiNaC::ex::construct\\_from\\_uint\(\)](#), [GiNaC::ex::construct\\_from\\_ulong\(\)](#), [cos\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [sin\\_eval\(\)](#), and [tan\\_eval\(\)](#).

#### 5.1.4.89 `_ex5`

```
const ex GiNaC::_ex5 = ex(*_num5_p)
```

Referenced by [cos\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [sin\\_eval\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.90 `_num6_p`

```
const numeric * GiNaC::_num6_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), [GiNaC::ex::construct\\_from\\_uint\(\)](#), [GiNaC::ex::construct\\_from\\_ulong\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), and [sin\\_eval\(\)](#).

#### 5.1.4.91 `_ex6`

```
const ex GiNaC::_ex6 = ex(*_num6_p)
```

Referenced by [cos\\_eval\(\)](#), [Li2\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [sin\\_eval\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.92 `_num7_p`

```
const numeric * GiNaC::_num7_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), [GiNaC::ex::construct\\_from\\_uint\(\)](#), [GiNaC::ex::construct\\_from\\_ulong\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.93 `_ex7`

```
const ex GiNaC::_ex7 = ex(*_num7_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.94 `_num8_p`

```
const numeric * GiNaC::_num8_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), [GiNaC::ex::construct\\_from\\_uint\(\)](#), [GiNaC::ex::construct\\_from\\_ulong\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.95 `_ex8`

```
const ex GiNaC::_ex8 = ex(*_num8_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.96 `_num9_p`

```
const numeric * GiNaC::_num9_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), [GiNaC::ex::construct\\_from\\_uint\(\)](#), [GiNaC::ex::construct\\_from\\_ulong\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.97 `_ex9`

```
const ex GiNaC::_ex9 = ex(*_num9_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.98 `_num10_p`

```
const numeric * GiNaC::_num10_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), [GiNaC::ex::construct\\_from\\_uint\(\)](#), [GiNaC::ex::construct\\_from\\_ulong\(\)](#), [cos\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [sin\\_eval\(\)](#), and [tan\\_eval\(\)](#).

#### 5.1.4.99 `_ex10`

```
const ex GiNaC::_ex10 = ex(*_num10_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.100 `_num11_p`

```
const numeric * GiNaC::_num11_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), [GiNaC::ex::construct\\_from\\_uint\(\)](#), [GiNaC::ex::construct\\_from\\_ulong\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.101 `_ex11`

```
const ex GiNaC::_ex11 = ex(*_num11_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.102 `_num12_p`

```
const numeric * GiNaC::_num12_p
```

Referenced by [GiNaC::ex::construct\\_from\\_int\(\)](#), [GiNaC::ex::construct\\_from\\_long\(\)](#), [GiNaC::ex::construct\\_from\\_uint\(\)](#), [GiNaC::ex::construct\\_from\\_ulong\(\)](#), [cos\\_eval\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.103 `_ex12`

```
const ex GiNaC::_ex12 = ex(*_num12_p)
```

Referenced by [Li2\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.104 `_num15_p`

```
const numeric * GiNaC::_num15_p
```

Referenced by [cos\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [sin\\_eval\(\)](#), and [tan\\_eval\(\)](#).

#### 5.1.4.105 `_ex15`

```
const ex GiNaC::_ex15 = ex(*_num15_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.106 `_num18_p`

```
const numeric * GiNaC::_num18_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [sin\\_eval\(\)](#).

#### 5.1.4.107 `_ex18`

```
const ex GiNaC::_ex18 = ex(*_num18_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.108 `_num20_p`

```
const numeric * GiNaC::_num20_p
```

Referenced by [cos\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [sin\\_eval\(\)](#), and [tan\\_eval\(\)](#).

#### 5.1.4.109 `_ex20`

```
const ex GiNaC::_ex20 = ex(*_num20_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.110 `_num24_p`

```
const numeric * GiNaC::_num24_p
```

Referenced by [cos\\_eval\(\)](#), and [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.111 `_ex24`

```
const ex GiNaC::_ex24 = ex(*_num24_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.112 `_num25_p`

```
const numeric * GiNaC::_num25_p
```

Referenced by [cos\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [sin\\_eval\(\)](#), and [tan\\_eval\(\)](#).

#### 5.1.4.113 `_ex25`

```
const ex GiNaC::_ex25 = ex(*_num25_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.114 `_num30_p`

```
const numeric * GiNaC::_num30_p
```

Referenced by [cos\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [sin\\_eval\(\)](#), and [tan\\_eval\(\)](#).

#### 5.1.4.115 `_ex30`

```
const ex GiNaC::_ex30 = ex(*_num30_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.116 `_num48_p`

```
const numeric * GiNaC::_num48_p
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#).

#### 5.1.4.117 `_ex48`

```
const ex GiNaC::_ex48 = ex(*_num48_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.118 `_num60_p`

```
const numeric * GiNaC::_num60_p
```

Referenced by [cos\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [sin\\_eval\(\)](#), and [tan\\_eval\(\)](#).

#### 5.1.4.119 `_ex60`

```
const ex GiNaC::_ex60 = ex(*_num60_p)
```

Referenced by [cos\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), [sin\\_eval\(\)](#), [tan\\_eval\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

#### 5.1.4.120 `_num120_p`

```
const numeric * GiNaC::_num120_p
```

Referenced by [cos\\_eval\(\)](#), [GiNaC::library\\_init::library\\_init\(\)](#), and [sin\\_eval\(\)](#).



5.1.4.121 `_ex120`

```
const ex GiNaC::_ex120 = ex(*_num120_p)
```

Referenced by [GiNaC::library\\_init::library\\_init\(\)](#), and [GiNaC::library\\_init::~~library\\_init\(\)](#).

## 5.2 GiNaC::internal Namespace Reference

### Classes

- struct [\\_iter\\_rep](#)

## 5.3 std Namespace Reference

### Classes

- struct [equal\\_to< GiNaC::ex >](#)  
*Specialization of `std::equal_to()` for `ex` objects.*
- struct [hash< GiNaC::ex >](#)  
*Specialization of `std::hash()` for `ex` objects.*
- struct [less< GiNaC::ptr< T > >](#)  
*Specialization of `std::less` for `ptr<T>` to enable ordering of `ptr<T>` objects (e.g.*

### Functions

- template<> void [swap](#) ([GiNaC::ex](#) &a, [GiNaC::ex](#) &b)  
*Specialization of `std::swap()` for `ex` objects.*

### 5.3.1 Function Documentation

#### 5.3.1.1 `swap()`

```
template<>
void std::swap (
 GiNaC::ex & a,
 GiNaC::ex & b) [inline]
```

Specialization of [std::swap\(\)](#) for `ex` objects.

References [GiNaC::ex::swap\(\)](#).

Referenced by [GiNaC::su3d::eval\\_indexed\(\)](#), [GiNaC::su3f::eval\\_indexed\(\)](#), [GiNaC::matrix::markowitz\\_elimination\(\)](#), and [GiNaC::permutation\\_sign\(\)](#).



## Chapter 6

# Class Documentation

### 6.1 GiNaC::internal::\_iter\_rep Struct Reference

```
#include <ex.h>
```

Collaboration diagram for GiNaC::internal::\_iter\_rep:



## Public Member Functions

- [\\_iter\\_rep](#) (const [ex](#) &[e\\_](#), [size\\_t](#) [i\\_](#), [size\\_t](#) [i\\_end\\_](#))
- bool [operator==](#) (const [\\_iter\\_rep](#) &[other](#)) const noexcept
- bool [operator!=](#) (const [\\_iter\\_rep](#) &[other](#)) const noexcept

## Public Attributes

- [ex](#) [e](#)
- [size\\_t](#) [i](#)
- [size\\_t](#) [i\\_end](#)

## 6.1.1 Constructor & Destructor Documentation

### 6.1.1.1 [\\_iter\\_rep](#)()

```
GiNaC::internal::_iter_rep::_iter_rep (
 const ex & e_,
 size_t i_,
 size_t i_end_) [inline]
```

References [e](#), [i](#), and [i\\_end](#).

Referenced by [operator!=\(\)](#), and [operator==\(\)](#).

## 6.1.2 Member Function Documentation

### 6.1.2.1 [operator==\(\)](#)

```
bool GiNaC::internal::_iter_rep::operator== (
 const _iter_rep & other) const [inline], [noexcept]
```

References [\\_iter\\_rep\(\)](#), [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [e](#), and [i](#).

### 6.1.2.2 [operator"!=\(\)](#)

```
bool GiNaC::internal::_iter_rep::operator!= (
 const _iter_rep & other) const [inline], [noexcept]
```

References [\\_iter\\_rep\(\)](#).

## 6.1.3 Member Data Documentation

### 6.1.3.1 [e](#)

```
ex GiNaC::internal::_iter_rep::e
```

Referenced by [\\_iter\\_rep\(\)](#), [GiNaC::const\\_postorder\\_iterator::descend\(\)](#), [GiNaC::const\\_preorder\\_iterator::increment\(\)](#), and [operator==\(\)](#).

### 6.1.3.2 i

```
size_t GiNaC::internal::_iter_rep::i
```

Referenced by [\\_iter\\_rep\(\)](#), [GiNaC::const\\_postorder\\_iterator::descend\(\)](#), [GiNaC::const\\_preorder\\_iterator::increment\(\)](#), and [operator==\(\)](#).

### 6.1.3.3 i\_end

```
size_t GiNaC::internal::_iter_rep::i_end
```

Referenced by [\\_iter\\_rep\(\)](#), and [GiNaC::const\\_preorder\\_iterator::increment\(\)](#).

The documentation for this struct was generated from the following file:

- [ex.h](#)

## 6.2 GiNaC::\_numeric\_digits Class Reference

This class is used to instantiate a global singleton object Digits which behaves just like Maple's Digits.

```
#include <numeric.h>
```

### Public Member Functions

- [\\_numeric\\_digits](#) ()  
*\_numeric\_digits* default ctor, checking for singleton invariance.
- [\\_numeric\\_digits](#) & [operator=](#) (long prec)  
*Assign a native long to global Digits object.*
- [operator long](#) ()  
*Convert global Digits object to native type long.*
- void [print](#) (std::ostream &os) const  
*Append global Digits object to ostream.*
- void [add\\_callback](#) ([digits\\_changed\\_callback](#) callback)  
*Add a new callback function.*

### Private Attributes

- long [digits](#)  
*Number of decimal digits.*
- std::vector< [digits\\_changed\\_callback](#) > [callbacklist](#)

### Static Private Attributes

- static bool [too\\_late](#) = false  
*Already one object present.*

### 6.2.1 Detailed Description

This class is used to instantiate a global singleton object Digits which behaves just like Maple's Digits.

We need an object rather than a dumbier basic type since as a side-effect we let it change `cl_default_float_format` when it gets changed. The only other meaningful thing to do with it is converting it to an unsigned, for temporarily storing its value e.g. The user must not create an own working object of this class! Since C++ forces us to make the class definition visible in order to use an object we put in a flag which prevents other objects of that class to be created.

### 6.2.2 Constructor & Destructor Documentation

#### 6.2.2.1 `_numeric_digits()`

```
GiNaC::_numeric_digits::_numeric_digits ()
```

`_numeric_digits` default ctor, checking for singleton invariance.

References `digits`, and `too_late`.

Referenced by `operator=()`.

### 6.2.3 Member Function Documentation

#### 6.2.3.1 `operator=()`

```
_numeric_digits & GiNaC::_numeric_digits::operator= (
 long prec)
```

Assign a native long to global Digits object.

References `_numeric_digits()`, `callbacklist`, and `digits`.

#### 6.2.3.2 `operator long()`

```
GiNaC::_numeric_digits::operator long ()
```

Convert global Digits object to native type long.

References `digits`.

#### 6.2.3.3 `print()`

```
void GiNaC::_numeric_digits::print (
 std::ostream & os) const
```

Append global Digits object to ostream.

References `digits`.

Referenced by `GiNaC::operator<<()`.

#### 6.2.3.4 add\_callback()

```
void GiNaC::_numeric_digits::add_callback (
 digits_changed_callback callback)
```

Add a new callback function.

References [callbacklist](#).

### 6.2.4 Member Data Documentation

#### 6.2.4.1 digits

```
long GiNaC::_numeric_digits::digits [private]
```

Number of decimal digits.

Referenced by [\\_numeric\\_digits\(\)](#), [operator long\(\)](#), [operator=\(\)](#), and [print\(\)](#).

#### 6.2.4.2 too\_late

```
bool GiNaC::_numeric_digits::too_late = false [static], [private]
```

Already one object present.

Referenced by [\\_numeric\\_digits\(\)](#).

#### 6.2.4.3 callbacklist

```
std::vector<digits_changed_callback> GiNaC::_numeric_digits::callbacklist [private]
```

Referenced by [add\\_callback\(\)](#), and [operator=\(\)](#).

The documentation for this class was generated from the following files:

- [numeric.h](#)
- [numeric.cpp](#)

### 6.3 GiNaC::add Class Reference

Sum of expressions.

```
#include <add.h>
```

Inheritance diagram for GiNaC::add:





Collaboration diagram for GiNaC::add:



### Public Member Functions

- `add` (const `ex` &lh, const `ex` &rh)
- `add` (const `exvector` &v)
- `add` (const `epvector` &v)
- `add` (const `epvector` &v, const `ex` &oc)
- `add` (`epvector` &&v)
- `add` (`epvector` &&v, const `ex` &oc)
- unsigned `precedence` () const override  
Return relative operator precedence (for parenthezing output).
- bool `info` (unsigned inf) const override  
Information about the object.
- bool `is_polynomial` (const `ex` &var) const override  
Check whether this is a polynomial in the given variables.
- int `degree` (const `ex` &s) const override  
Return degree of highest power in object s.

- `int ldegree (const ex &s) const` override  
*Return degree of lowest power in object s.*
- `ex coeff (const ex &s, int n=1) const` override  
*Return coefficient of degree n in object s.*
- `ex eval ()` const override  
*Perform automatic term rewriting rules in this class.*
- `ex evalm ()` const override  
*Evaluate sums, products and integer powers of matrices.*
- `ex series (const relational &r, int order, unsigned options=0) const` override  
*Implementation of [ex::series\(\)](#) for sums.*
- `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier) const` override  
*Implementation of [ex::normal\(\)](#) for a sum.*
- `numeric integer_content ()` const override
- `ex smod (const numeric &xi) const` override  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- `numeric max_coefficient ()` const override  
*Implementation [ex::max\\_coefficient\(\)](#).*
- `ex conjugate ()` const override
- `ex real_part ()` const override
- `ex imag_part ()` const override
- `exvector get_free_indices ()` const override  
*Return a vector containing the free indices of an expression.*
- `ex eval_ncmul (const exvector &v) const` override

## Public Member Functions inherited from [GiNaC::expairseq](#)

- `expairseq (const ex &lh, const ex &rh)`
- `expairseq (const exvector &v)`
- `expairseq (const epvector &v, const ex &oc, bool do_index_renaming=false)`
- `expairseq (epvector &&vp, const ex &oc, bool do_index_renaming=false)`
- `unsigned precedence ()` const override  
*Return relative operator precedence (for parenthezing output).*
- `bool info (unsigned inf) const` override  
*Information about the object.*
- `size_t nops ()` const override  
*Number of operands/members.*
- `ex op (size_t i) const` override  
*Return operand/member at position i.*
- `ex map (map\_function &f) const` override  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- `ex eval ()` const override  
*Perform coefficient-wise automatic term rewriting rules in this class.*
- `ex to_rational (exmap &repl) const` override  
*Implementation of [ex::to\\_rational\(\)](#) for expairseqs.*
- `ex to_polynomial (exmap &repl) const` override  
*Implementation of [ex::to\\_polynomial\(\)](#) for expairseqs.*
- `bool match (const ex &pattern, exmap &repl_lst) const` override  
*Check whether the expression matches a given pattern.*
- `ex subs (const exmap &m, unsigned options=0) const` override  
*Substitute a set of objects by arbitrary expressions.*
- `ex conjugate ()` const override
- `void archive (archive\_node &n) const` override  
*Save (serialize) the object into archive node.*
- `void read_archive (const archive\_node &n, lst &syms) override`  
*Load (deserialize) the object from an archive node.*

## Public Member Functions inherited from GiNaC::basic

- virtual `~basic()`  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic(const basic &other)`
- `const basic & operator= (const basic &other)`  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate() const`  
*Create a clone of this object on the heap.*
- virtual `ex evalf() const`  
*Evaluate object numerically.*
- virtual `ex eval_integ() const`  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed(const basic &i) const`  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual `void print(const print_context &c, unsigned level=0) const`  
*Output to stream.*
- virtual `void dbgprint() const`  
*Little wrapper around print to be called within a debugger.*
- virtual `void dbgprinttree() const`  
*Little wrapper around printtree to be called within a debugger.*
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`
- virtual `ex & let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual `bool has(const ex &other, unsigned options=0) const`  
*Test for occurrence of a pattern.*
- virtual `void accept(GiNaC::visitor &v) const`
- virtual `ex collect(const ex &s, bool distributed=false) const`  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex add_indexed(const ex &self, const ex &other) const`  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed(const ex &self, const numeric &other) const`  
*Multiply an indexed expression with a scalar.*
- virtual `bool contract_with(exvector::iterator self, exvector::iterator other, exvector &v) const`  
*Try to contract two indexed expressions that appear in the same product.*
- `template<class T>`  
`void print_dispatch(const print_context &c, unsigned level) const`  
*Like print(), but dispatch to the specified class.*
- `void print_dispatch(const registered_class_info &ri, const print_context &c, unsigned level) const`  
*Like print(), but dispatch to the specified class.*
- `ex subs_one_level(const exmap &m, unsigned options) const`  
*Helper function for subs().*
- `ex diff(const symbol &s, unsigned nth=1) const`  
*Default interface of nth derivative ex::diff(s, n).*
- `int compare(const basic &other) const`  
*Compare objects syntactically to establish canonical ordering.*
- `bool is_equal(const basic &other) const`  
*Test for syntactic equality.*

- const [basic](#) & [hold](#) () const  
*Stop further evaluation.*
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const  
*Set some [status\\_flags](#).*
- const [basic](#) & [clearflag](#) (unsigned f) const  
*Clear some [status\\_flags](#).*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Member Functions

- [ex derivative](#) (const [symbol](#) &s) const override  
*Implementation of [ex::diff\(\)](#) for a sum.*
- unsigned [return\\_type](#) () const override
- [return\\_type\\_t](#) [return\\_type\\_tinfo](#) () const override
- [ex thisexpairseq](#) (const [epvector](#) &v, const [ex](#) &oc, bool do\_index\_renaming=false) const override  
*Create an object of this type.*
- [ex thisexpairseq](#) ([epvector](#) &&vp, const [ex](#) &oc, bool do\_index\_renaming=false) const override
- [expair split\\_ex\\_to\\_pair](#) (const [ex](#) &e) const override  
*Form an expair from an ex, using the corresponding semantics.*
- [expair combine\\_ex\\_with\\_coeff\\_to\\_pair](#) (const [ex](#) &e, const [ex](#) &c) const override
- [expair combine\\_pair\\_with\\_coeff\\_to\\_pair](#) (const [expair](#) &p, const [ex](#) &c) const override
- [ex recombine\\_pair\\_to\\_ex](#) (const [expair](#) &p) const override  
*Form an ex out of an expair, using the corresponding semantics.*
- [ex expand](#) (unsigned options=0) const override  
*Expand expression, i.e.*
- void [print\\_add](#) (const [print\\_context](#) &c, const char \*openbrace, const char \*closebrace, const char \*mul\_sym, unsigned level) const
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_latex](#) (const [print\\_latex](#) &c, unsigned level) const
- void [do\\_print\\_csrc](#) (const [print\\_csrc](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::expairseq](#)

- bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if two objects of same type are equal.*
- unsigned [return\\_type](#) () const override
- unsigned [calchash](#) () const override  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- [ex expand](#) (unsigned options=0) const override  
*Expand expression, i.e.*

- virtual void `printseq` (const `print_context` &c, char delim, unsigned this\_precedence, unsigned upper\_precedence) const
- virtual void `printpair` (const `print_context` &c, const `expair` &p, unsigned upper\_precedence) const
- virtual bool `expair_needs_further_processing` (epp it)
- virtual `ex` `default_overall_coeff` () const
- virtual void `combine_overall_coeff` (const `ex` &c)
- virtual void `combine_overall_coeff` (const `ex` &c1, const `ex` &c2)
- virtual bool `can_make_flat` (const `expair` &p) const
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
- void `construct_from_2_ex` (const `ex` &lh, const `ex` &rh)
- void `construct_from_2_expairseq` (const `expairseq` &s1, const `expairseq` &s2)
- void `construct_from_expairseq_ex` (const `expairseq` &s, const `ex` &e)
- void `construct_from_exvector` (const `exvector` &v)
- void `construct_from_epvector` (const `epvector` &v, bool do\_index\_renaming=false)
- void `construct_from_epvector` (`epvector` &&v, bool do\_index\_renaming=false)
- void `make_flat` (const `exvector` &v)  
*Combine this expairseq with argument exvector.*
- void `make_flat` (const `epvector` &v, bool do\_index\_renaming=false)  
*Combine this expairseq with argument epvector.*
- void `canonicalize` ()  
*Brings this expairseq into a sorted (canonical) form.*
- void `combine_same_terms_sorted_seq` ()  
*Compact a presorted expairseq by combining all matching expairs to one each.*
- bool `is_canonical` () const  
*Check if this expairseq is in sorted (canonical) form.*
- `epvector` `expandchildren` (unsigned options) const  
*Member-wise expand the expairs in this sequence.*
- `epvector` `evalchildren` () const  
*Member-wise evaluate the expairs in this sequence.*
- `epvector` `subchildren` (const `exmap` &m, unsigned options=0) const  
*Member-wise substitute in this sequence.*

### Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- void `ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void `do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

## Friends

- class [mul](#)
- class [power](#)

## Additional Inherited Members

### Protected Attributes inherited from [GiNaC::expairseq](#)

- [epvector seq](#)
- [ex overall\\_coeff](#)

### Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
of type [status\\_flags](#)
- unsigned [hashvalue](#)  
hash value

## 6.3.1 Detailed Description

Sum of expressions.

## 6.3.2 Constructor & Destructor Documentation

### 6.3.2.1 `add()` [1/6]

```
GiNaC::add::add (
 const ex & lh,
 const ex & rh)
```

References [GiNaC::\\_ex0](#), [GiNaC::expairseq::construct\\_from\\_2\\_ex\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::expairseq::is\\_canonical\(\)](#), and [GiNaC::expairseq::overall\\_coeff](#).

Referenced by [conjugate\(\)](#), and [power](#).

### 6.3.2.2 `add()` [2/6]

```
GiNaC::add::add (
 const exvector & v)
```

References [GiNaC::\\_ex0](#), [GiNaC::expairseq::construct\\_from\\_exvector\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::expairseq::is\\_canonical\(\)](#), and [GiNaC::expairseq::overall\\_coeff](#).

**6.3.2.3 add() [3/6]**

```
GiNaC::add::add (
 const epvector & v)
```

References [GiNaC::\\_ex0](#), [GiNaC::expairseq::construct\\_from\\_epvector\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::expairseq::is\\_canonical\(\)](#), and [GiNaC::expairseq::overall\\_coeff](#).

**6.3.2.4 add() [4/6]**

```
GiNaC::add::add (
 const epvector & v,
 const ex & oc)
```

References [GiNaC::expairseq::construct\\_from\\_epvector\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::expairseq::is\\_canonical\(\)](#), and [GiNaC::expairseq::overall\\_coeff](#).

**6.3.2.5 add() [5/6]**

```
GiNaC::add::add (
 epvector && v)
```

References [GiNaC::\\_ex0](#), [GiNaC::expairseq::construct\\_from\\_epvector\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::expairseq::is\\_canonical\(\)](#), and [GiNaC::expairseq::overall\\_coeff](#).

**6.3.2.6 add() [6/6]**

```
GiNaC::add::add (
 epvector && v,
 const ex & oc)
```

References [GiNaC::expairseq::construct\\_from\\_epvector\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::expairseq::is\\_canonical\(\)](#), and [GiNaC::expairseq::overall\\_coeff](#).

**6.3.3 Member Function Documentation****6.3.3.1 precedence()**

```
unsigned GiNaC::add::precedence () const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

References [precedence\(\)](#).

Referenced by [do\\_print\\_csrc\(\)](#), [precedence\(\)](#), and [print\\_add\(\)](#).

### 6.3.3.2 info()

```
bool GiNaC::add::info (
 unsigned inf) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info\\_flags::cinteger](#), [GiNaC::info\\_flags::cinteger\\_polynomial](#), [GiNaC::info\\_flags::crational](#), [GiNaC::info\\_flags::crational\\_polynomial](#), [GiNaC::info\\_flags::even](#), [info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::info\\_flags::integer\\_polynomial](#), [GiNaC::info\\_flags::nonnegative](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::expairseq::overall\\_coeff](#), [GiNaC::info\\_flags::polynomial](#), [GiNaC::info\\_flags::posint](#), [GiNaC::info\\_flags::positive](#), [GiNaC::info\\_flags::rational](#), [GiNaC::info\\_flags::rational\\_function](#), [GiNaC::info\\_flags::rational\\_polynomial](#), [GiNaC::info\\_flags::real](#), [recombine\\_pair\\_to\\_ex\(\)](#), and [GiNaC::expairseq::seq](#).

Referenced by [info\(\)](#).

### 6.3.3.3 is\_polynomial()

```
bool GiNaC::add::is_polynomial (
 const ex & var) const [override], [virtual]
```

Check whether this is a polynomial in the given variables.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::expairseq::seq](#).

### 6.3.3.4 degree()

```
int GiNaC::add::degree (
 const ex & s) const [override], [virtual]
```

Return degree of highest power in object *s*.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::expairseq::overall\\_coeff](#), and [GiNaC::expairseq::seq](#).

### 6.3.3.5 ldegree()

```
int GiNaC::add::ldegree (
 const ex & s) const [override], [virtual]
```

Return degree of lowest power in object *s*.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::expairseq::overall\\_coeff](#), and [GiNaC::expairseq::seq](#).



### 6.3.3.6 coeff()

```
ex GiNaC::add::coeff (
 const ex & s,
 int n = 1) const [override], [virtual]
```

Return coefficient of degree n in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::clifford\\_max\\_label\(\)](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ncmul::coeff\(\)](#), [GiNaC::dirac\\_ONE\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), and [GiNaC::expairseq::seq](#).

Referenced by [print\\_add\(\)](#), and [smod\(\)](#).

### 6.3.3.7 eval()

```
ex GiNaC::add::eval () const [override], [virtual]
```

Perform automatic term rewriting rules in this class.

In the following x stands for a symbolic variables of type ex and c stands for such an expression that contain a plain number.

- $+(;c) \rightarrow c$
- $+(x;0) \rightarrow x$

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::commutative](#), [GiNaC::dynallocate\(\)](#), [GiNaC::expairseq::evalchildren\(\)](#), [GiNaC::status\\_flags::evaluate](#), [GiNaC::basic::flags](#), [GINAC\\_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::expairseq::seq](#), and [unlikely](#).

### 6.3.3.8 evalm()

```
ex GiNaC::add::evalm () const [override], [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::matrix::add\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::ex::evalm\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::expairseq::seq](#), and [split\\_ex\\_to\\_pair\(\)](#).

### 6.3.3.9 series()

```
ex GiNaC::add::series (
 const relational & r,
 int order,
 unsigned options = 0) const [override], [virtual]
```

Implementation of [ex::series\(\)](#) for sums.

This performs series addition when adding pseries objects.

See also

[ex::series](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::expairseq::op\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), and [GiNaC::expairseq::seq](#).

### 6.3.3.10 normal()

```
ex GiNaC::add::normal (
 exmap & repl,
 exmap & rev_lookup,
 lst & modifier) const [override], [virtual]
```

Implementation of [ex::normal\(\)](#) for a sum.

It expands terms and performs fractional addition.

See also

[ex::normal](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex\\_to\(\)](#), [expand\(\)](#), [GiNaC::frac\\_cancel\(\)](#), [GiNaC::gcd\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::ex::normal\(\)](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), and [GiNaC::expairseq::seq](#).

### 6.3.3.11 integer\_content()

```
numeric GiNaC::add::integer_content () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_num0\\_p](#), [GiNaC::\\_num1\\_p](#), [GiNaC::denom\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::gcd\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::lcm\(\)](#), [GiNaC::numer\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), and [GiNaC::expairseq::seq](#).

### 6.3.3.12 smod()

```
ex GiNaC::add::smod (
 const numeric & xi) const [override], [virtual]
```

Apply symmetric modular homomorphism to an expanded multivariate polynomial.

This function is usually used internally by [heur\\_gcd\(\)](#).

## Parameters

|      |         |
|------|---------|
| $xi$ | modulus |
|------|---------|

## Returns

mapped polynomial

## See also

[heur\\_gcd](#)

Reimplemented from [GiNaC::basic](#).

References [coeff\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [GiNaC::expairseq::seq](#), and [GiNaC::smod\(\)](#).

**6.3.3.13 max\_coefficient()**

```
numeric GiNaC::add::max_coefficient () const [override], [virtual]
```

Implementation [ex::max\\_coefficient\(\)](#).

## See also

[heur\\_gcd](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::abs\(\)](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), and [GiNaC::expairseq::seq](#).

**6.3.3.14 conjugate()**

```
ex GiNaC::add::conjugate () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [add\(\)](#), [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [conjugate\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::expairseq::nops\(\)](#), and [GiNaC::expairseq::op\(\)](#).

Referenced by [conjugate\(\)](#).

**6.3.3.15 real\_part()**

```
ex GiNaC::add::real_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::coeff\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [GiNaC::info\\_flags::real](#), [GiNaC::ex::real\\_part\(\)](#), [recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::expairseq::seq](#), and [split\\_ex\\_to\\_pair\(\)](#).

**6.3.3.16 imag\_part()**

```
ex GiNaC::add::imag_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::coeff\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::ex::imag\\_part\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [GiNaC::info\\_flags::real](#), [recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::expairseq::seq](#), and [split\\_ex\\_to\\_pair\(\)](#).

**6.3.3.17 get\_free\_indices()**

```
exvector GiNaC::add::get_free_indices () const [override], [virtual]
```

Return a vector containing the free indices of an expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::get\\_free\\_indices\(\)](#), [GiNaC::indices\\_consistent\(\)](#), [GiNaC::expairseq::nops\(\)](#), and [GiNaC::expairseq::op\(\)](#).

**6.3.3.18 eval\_ncmul()**

```
ex GiNaC::add::eval_ncmul (
 const exvector & v) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::expairseq::seq](#).

**6.3.3.19 derivative()**

```
ex GiNaC::add::derivative (
 const symbol & y) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for a sum.

It differentiates each term.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::dynallocate\(\)](#), and [GiNaC::expairseq::seq](#).

**6.3.3.20 return\_type()**

```
unsigned GiNaC::add::return_type () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::commutative](#), and [GiNaC::expairseq::seq](#).

**6.3.3.21 return\_type\_tinfo()**

```
return_type_t GiNaC::add::return_type_tinfo () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::make\\_return\\_type\\_t\(\)](#), and [GiNaC::expairseq::seq](#).

**6.3.3.22 thisexpairseq() [1/2]**

```
ex GiNaC::add::thisexpairseq (
 const epvector & v,
 const ex & oc,
 bool do_index_renaming = false) const [override], [protected], [virtual]
```

Create an object of this type.

This method works similar to a constructor. It is useful because expairseq has (at least) two possible different semantics but we want to inherit methods thus avoiding code duplication. Sometimes a method in expairseq has to create a new one of the same semantics, which cannot be done by a ctor because the name (add, mul,...) is unknown on the expairseq level. In order for this trick to work a derived class must of course override this definition.

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::dynallocate\(\)](#).

**6.3.3.23 thisexpairseq() [2/2]**

```
ex GiNaC::add::thisexpairseq (
 epvector && vp,
 const ex & oc,
 bool do_index_renaming = false) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::dynallocate\(\)](#).

**6.3.3.24 split\_ex\_to\_pair()**

```
expair GiNaC::add::split_ex_to_pair (
 const ex & e) const [override], [protected], [virtual]
```

Form an expair from an ex, using the corresponding semantics.

See also

[expairseq::recombine\\_pair\\_to\\_ex\(\)](#)

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::\\_ex1](#), [GiNaC::basic::clearflag\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::status\\_flags::hash\\_calculated](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [mul](#), and [GiNaC::expairseq::overall\\_coeff](#).

Referenced by [evalm\(\)](#), [imag\\_part\(\)](#), and [real\\_part\(\)](#).

### 6.3.3.25 combine\_ex\_with\_coeff\_to\_pair()

```
expair GiNaC::add::combine_ex_with_coeff_to_pair (
 const ex & e,
 const ex & c) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::\\_ex1](#), [GiNaC::basic::clearflag\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::status\\_flags::hash\\_calculated](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [likely](#), [mul](#), and [GiNaC::expairseq::overall\\_coeff](#).

### 6.3.3.26 combine\_pair\_with\_coeff\_to\_pair()

```
expair GiNaC::add::combine_pair_with_coeff_to_pair (
 const expair & p,
 const ex & c) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::\\_ex1](#), [GiNaC::\\_num1\\_p](#), [GiNaC::expair::coeff](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [GiNaC::expair::rest](#).

Referenced by [GiNaC::mul::eval\(\)](#), and [GiNaC::power::expand\\_add\\_2\(\)](#).

### 6.3.3.27 recombine\_pair\_to\_ex()

```
ex GiNaC::add::recombine_pair_to_ex (
 const expair & p) const [override], [protected], [virtual]
```

Form an ex out of an expair, using the corresponding semantics.

See also

[expairseq::split\\_ex\\_to\\_pair\(\)](#)

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::\\_num1\\_p](#), [GiNaC::expair::coeff](#), [GiNaC::dynallocate\(\)](#), [GiNaC::ex\\_to\(\)](#), and [GiNaC::expair::rest](#).

Referenced by [eval\(\)](#), [evalm\(\)](#), [GiNaC::power::expand\(\)](#), [imag\\_part\(\)](#), [info\(\)](#), [normal\(\)](#), and [real\\_part\(\)](#).

### 6.3.3.28 expand()

```
ex GiNaC::add::expand (
 unsigned options = 0) const [override], [protected], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::dynallocate\(\)](#), [GiNaC::expairseq::expandchildren\(\)](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::expairseq::overall\\_coeff](#), and [GiNaC::basic::setflag\(\)](#).

Referenced by [normal\(\)](#).

**6.3.3.29 print\_add()**

```
void GiNaC::add::print_add (
 const print_context & c,
 const char * openbrace,
 const char * closebrace,
 const char * mul_sym,
 unsigned level) const [protected]
```

References [GiNaC::\\_num1\\_p](#), [GiNaC::\\_num\\_1\\_p](#), [GiNaC::class\\_info< OPT >::first](#), [coeff\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [precedence\(\)](#), [GiNaC::basic::print\(\)](#), [GiNaC::print\\_context::s](#), and [GiNaC::expairseq::seq](#).

Referenced by [do\\_print\(\)](#), and [do\\_print\\_latex\(\)](#).

**6.3.3.30 do\_print()**

```
void GiNaC::add::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [print\\_add\(\)](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.3.3.31 do\_print\_latex()**

```
void GiNaC::add::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

References [print\\_add\(\)](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.3.3.32 do\_print\_csrc()**

```
void GiNaC::add::do_print_csrc (
 const print_csrc & c,
 unsigned level) const [protected]
```

References [GiNaC::\\_ex1](#), [GiNaC::\\_ex\\_1](#), [GiNaC::\\_num1\\_p](#), [GiNaC::\\_num\\_1\\_p](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [GiNaC::info\\_flags::positive](#), [precedence\(\)](#), [GiNaC::info\\_flags::real](#), [GiNaC::print\\_context::s](#), and [GiNaC::expairseq::seq](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.3.3.33 do\_print\_python\_repr()**

```
void GiNaC::add::do_print_python_repr (
 const print_python_repr & c,
 unsigned level) const [protected]
```

References [GiNaC::expairseq::nops\(\)](#), [GiNaC::expairseq::op\(\)](#), [GiNaC::ex::print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.3.4 Friends And Related Symbol Documentation

### 6.3.4.1 mul

```
friend class mul [friend]
```

References [mul](#).

Referenced by [combine\\_ex\\_with\\_coeff\\_to\\_pair\(\)](#), [mul](#), and [split\\_ex\\_to\\_pair\(\)](#).

### 6.3.4.2 power

```
friend class power [friend]
```

References [add\(\)](#), and [power](#).

Referenced by [power](#).

The documentation for this class was generated from the following files:

- [add.h](#)
- [add.cpp](#)
- [indexed.cpp](#)
- [normal.cpp](#)
- [pseries.cpp](#)

## 6.4 GiNaC::archive Class Reference

This class holds archived versions of [GiNaC](#) expressions (class [ex](#)).

```
#include <archive.h>
```

### Classes

- struct [archived\\_ex](#)  
*Archived expression descriptor.*



## Public Member Functions

- [archive](#) ()
- [~archive](#) ()
- [archive](#) (const [ex](#) &e)  
*Construct archive from expression using the default name "ex".*
- [archive](#) (const [ex](#) &e, const char \*n)  
*Construct archive from expression using the specified name.*
- void [archive\\_ex](#) (const [ex](#) &e, const char \*name)  
*Archive an expression.*
- [ex unarchive\\_ex](#) (const [lst](#) &sym\_lst, const char \*name) const  
*Retrieve expression from archive by name.*
- [ex unarchive\\_ex](#) (const [lst](#) &sym\_lst, unsigned index=0) const  
*Retrieve expression from archive by index.*
- [ex unarchive\\_ex](#) (const [lst](#) &sym\_lst, std::string &name, unsigned index=0) const  
*Retrieve expression and its name from archive by index.*
- unsigned [num\\_expressions](#) () const  
*Return number of archived expressions.*
- const [archive\\_node](#) & [get\\_top\\_node](#) (unsigned index=0) const  
*Return reference to top node of an expression specified by index.*
- void [clear](#) ()  
*Clear all archived expressions.*
- [archive\\_node\\_id add\\_node](#) (const [archive\\_node](#) &n)  
*Add [archive\\_node](#) to archive if the corresponding expression is not already archived.*
- [archive\\_node](#) & [get\\_node](#) ([archive\\_node\\_id](#) id)  
*Retrieve [archive\\_node](#) by ID.*
- void [forget](#) ()  
*Delete cached unarchived expressions in all [archive\\_nodes](#) (mainly for debugging).*
- void [prinraw](#) (std::ostream &os) const  
*Print archive to stream in ugly raw format (for debugging).*
- [archive\\_atom atomize](#) (const std::string &s) const  
*Atomize a string (i.e.*
- const std::string & [unatomize](#) ([archive\\_atom](#) id) const  
*Unatomize a string (i.e.*

## Private Types

- typedef std::map< std::string, [archive\\_atom](#) >::const\_iterator [inv\\_at\\_cit](#)  
*The map of from strings to indices of the atoms vectors allows for faster archiving.*

## Private Attributes

- std::vector< [archive\\_node](#) > [nodes](#)  
*Vector of archived nodes.*
- std::vector< [archived\\_ex](#) > [exprs](#)  
*Vector of archived expression descriptors.*
- std::vector< std::string > [atoms](#)  
*Vector of atomized strings (using a vector allows faster unarchiving).*
- std::map< std::string, [archive\\_atom](#) > [inverse\\_atoms](#)
- std::map< [ex](#), [archive\\_node\\_id](#), [ex\\_is\\_less](#) > [exprtable](#)  
*Map of stored expressions to nodes for faster archiving.*

## Friends

- `std::ostream & operator<< (std::ostream &os, const archive &ar)`  
*Write archive to binary data stream.*
- `std::istream & operator>> (std::istream &is, archive &ar)`  
*Read archive from binary data stream.*

## 6.4.1 Detailed Description

This class holds archived versions of [GiNaC](#) expressions (class `ex`).

An archive can be constructed from an expression and then written to a stream; or it can be read from a stream and then unarchived, yielding back the expression. Archives can hold multiple expressions which can be referred to by name or index number. The main component of the archive class is a vector of `archive_nodes` which each store one object of class `basic` (or a derived class).

## 6.4.2 Member Typedef Documentation

### 6.4.2.1 `inv_at_cit`

```
typedef std::map<std::string, archive_atom>::const_iterator GiNaC::archive::inv_at_cit [private]
```

The map of from strings to indices of the atoms vectors allows for faster archiving.

## 6.4.3 Constructor & Destructor Documentation

### 6.4.3.1 `archive()` [1/3]

```
GiNaC::archive::archive () [inline]
```

Referenced by `operator<<`, and `operator>>`.

### 6.4.3.2 `~archive()`

```
GiNaC::archive::~~archive () [inline]
```

### 6.4.3.3 `archive()` [2/3]

```
GiNaC::archive::archive (
 const ex & e) [inline]
```

Construct archive from expression using the default name "ex".

References [archive\\_ex\(\)](#).

#### 6.4.3.4 archive() [3/3]

```
GiNaC::archive::archive (
 const ex & e,
 const char * n) [inline]
```

Construct archive from expression using the specified name.

References [archive\\_ex\(\)](#).

### 6.4.4 Member Function Documentation

#### 6.4.4.1 archive\_ex()

```
void GiNaC::archive::archive_ex (
 const ex & e,
 const char * name)
```

Archive an expression.

##### Parameters

|             |                                           |
|-------------|-------------------------------------------|
| <i>e</i>    | the expression to be archived             |
| <i>name</i> | name under which the expression is stored |

References [add\\_node\(\)](#), [atomize\(\)](#), and [exprs](#).

Referenced by [archive\(\)](#), and [archive\(\)](#).

#### 6.4.4.2 unarchive\_ex() [1/3]

```
ex GiNaC::archive::unarchive_ex (
 const lst & sym_lst,
 const char * name) const
```

Retrieve expression from archive by name.

##### Parameters

|                |                             |
|----------------|-----------------------------|
| <i>sym_lst</i> | list of pre-defined symbols |
| <i>name</i>    | name of expression          |

References [atomize\(\)](#), [exprs](#), and [nodes](#).

#### 6.4.4.3 unarchive\_ex() [2/3]

```
ex GiNaC::archive::unarchive_ex (
 const lst & sym_lst,
 unsigned index = 0) const
```

Retrieve expression from archive by index.

## Parameters

|                |                             |
|----------------|-----------------------------|
| <i>sym_lst</i> | list of pre-defined symbols |
| <i>index</i>   | index of expression         |

## See also

count\_expressions

References [exprs](#), and [nodes](#).

**6.4.4.4 unarchive\_ex() [3/3]**

```
ex GiNaC::archive::unarchive_ex (
 const lst & sym_lst,
 std::string & name,
 unsigned index = 0) const
```

Retrieve expression and its name from archive by index.

## Parameters

|                |                                     |
|----------------|-------------------------------------|
| <i>sym_lst</i> | list of pre-defined symbols         |
| <i>name</i>    | receives the name of the expression |
| <i>index</i>   | index of expression                 |

## See also

count\_expressions

References [exprs](#), [nodes](#), and [unatomize\(\)](#).

**6.4.4.5 num\_expressions()**

```
unsigned GiNaC::archive::num_expressions () const
```

Return number of archived expressions.

References [exprs](#).

**6.4.4.6 get\_top\_node()**

```
const archive_node & GiNaC::archive::get_top_node (
 unsigned index = 0) const
```

Return reference to top node of an expression specified by index.

References [exprs](#), and [nodes](#).

#### 6.4.4.7 clear()

```
void GiNaC::archive::clear ()
```

Clear all archived expressions.

References [atoms](#), [exprs](#), [exprtable](#), [inverse\\_atoms](#), and [nodes](#).

#### 6.4.4.8 add\_node()

```
archive_node_id GiNaC::archive::add_node (
 const archive_node & n)
```

Add [archive\\_node](#) to archive if the corresponding expression is not already archived.

##### Returns

ID of archived node

References [exprtable](#), [GiNaC::archive\\_node::get\\_ex\(\)](#), [GiNaC::archive\\_node::has\\_ex\(\)](#), and [nodes](#).

Referenced by [archive\\_ex\(\)](#).

#### 6.4.4.9 get\_node()

```
archive_node & GiNaC::archive::get_node (
 archive_node_id id)
```

Retrieve [archive\\_node](#) by ID.

References [nodes](#).

#### 6.4.4.10 forget()

```
void GiNaC::archive::forget ()
```

Delete cached unarchived expressions in all [archive\\_nodes](#) (mainly for debugging).

References [GiNaC::archive\\_node::forget\(\)](#), and [nodes](#).

#### 6.4.4.11 printraw()

```
void GiNaC::archive::printraw (
 std::ostream & os) const
```

Print archive to stream in ugly raw format (for debugging).

References [atoms](#), [exprs](#), [nodes](#), and [unatomize\(\)](#).

#### 6.4.4.12 `atomize()`

```
archive_atom GiNaC::archive::atomize (
 const std::string & s) const
```

Atomize a string (i.e.

convert it into an ID number that uniquely represents the string).

References [atoms](#), and [inverse\\_atoms](#).

Referenced by [archive\\_ex\(\)](#), and [unarchive\\_ex\(\)](#).

#### 6.4.4.13 `unatomize()`

```
const std::string & GiNaC::archive::unatomize (
 archive_atom id) const
```

Unatomize a string (i.e.

convert the ID number back to the string).

References [atoms](#).

Referenced by [printraw\(\)](#), and [unarchive\\_ex\(\)](#).

### 6.4.5 Friends And Related Symbol Documentation

#### 6.4.5.1 `operator<<`

```
std::ostream & operator<< (
 std::ostream & os,
 const archive & ar) [friend]
```

Write archive to binary data stream.

References [archive\(\)](#), [atoms](#), [exprs](#), [GINACLIB\\_ARCHIVE\\_VERSION](#), [nodes](#), and [GiNaC::write\\_unsigned\(\)](#).

#### 6.4.5.2 `operator>>`

```
std::istream & operator>> (
 std::istream & is,
 archive & ar) [friend]
```

Read archive from binary data stream.

References [archive\(\)](#), [atoms](#), [exprs](#), [GINACLIB\\_ARCHIVE\\_AGE](#), [GINACLIB\\_ARCHIVE\\_VERSION](#), [inverse\\_atoms](#), [nodes](#), and [GiNaC::read\\_unsigned\(\)](#).

## 6.4.6 Member Data Documentation

### 6.4.6.1 nodes

```
std::vector<archive_node> GiNaC::archive::nodes [private]
```

Vector of archived nodes.

Referenced by [add\\_node\(\)](#), [clear\(\)](#), [forget\(\)](#), [get\\_node\(\)](#), [get\\_top\\_node\(\)](#), [operator<<](#), [operator>>](#), [printraw\(\)](#), [unarchive\\_ex\(\)](#), [unarchive\\_ex\(\)](#), and [unarchive\\_ex\(\)](#).

### 6.4.6.2 exprs

```
std::vector<archived_ex> GiNaC::archive::exprs [private]
```

Vector of archived expression descriptors.

Referenced by [archive\\_ex\(\)](#), [clear\(\)](#), [get\\_top\\_node\(\)](#), [num\\_expressions\(\)](#), [operator<<](#), [operator>>](#), [printraw\(\)](#), [unarchive\\_ex\(\)](#), [unarchive\\_ex\(\)](#), and [unarchive\\_ex\(\)](#).

### 6.4.6.3 atoms

```
std::vector<std::string> GiNaC::archive::atoms [mutable], [private]
```

Vector of atomized strings (using a vector allows faster unarchiving).

Referenced by [atomize\(\)](#), [clear\(\)](#), [operator<<](#), [operator>>](#), [printraw\(\)](#), and [unatomize\(\)](#).

### 6.4.6.4 inverse\_atoms

```
std::map<std::string, archive_atom> GiNaC::archive::inverse_atoms [mutable], [private]
```

Referenced by [atomize\(\)](#), [clear\(\)](#), and [operator>>](#).

### 6.4.6.5 exprtable

```
std::map<ex, archive_node_id, ex_is_less> GiNaC::archive::exprtable [mutable], [private]
```

Map of stored expressions to nodes for faster archiving.

Referenced by [add\\_node\(\)](#), and [clear\(\)](#).

The documentation for this class was generated from the following files:

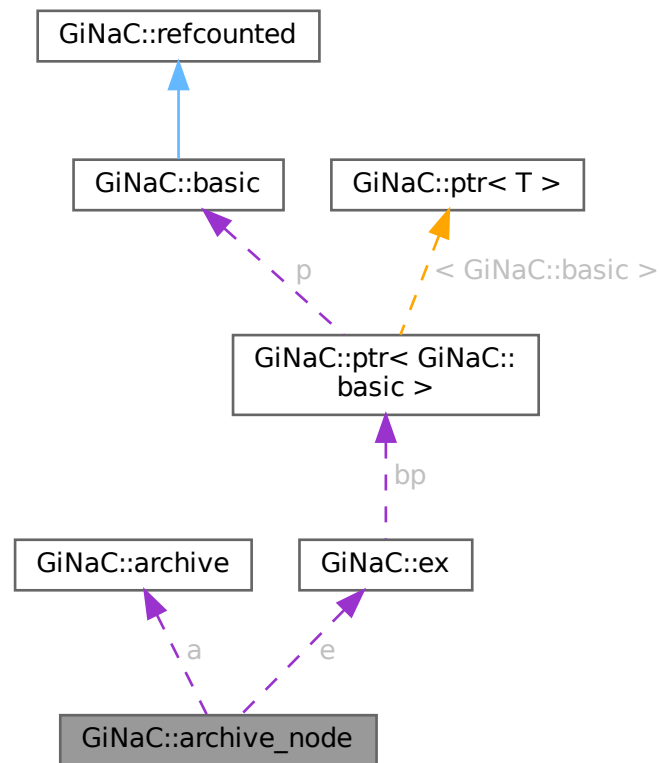
- [archive.h](#)
- [archive.cpp](#)

## 6.5 GiNaC::archive\_node Class Reference

This class stores all properties needed to record/retrieve the state of one object of class basic (or a derived class).

```
#include <archive.h>
```

Collaboration diagram for GiNaC::archive\_node:



### Classes

- struct [archive\\_node\\_cit\\_range](#)
- struct [property](#)  
*Archived property (data type, name and associated data)*
- struct [property\\_info](#)  
*Information about a stored property.*

### Public Types

- enum [property\\_type](#) { [PTYPE\\_BOOL](#) , [PTYPE\\_UNSIGNED](#) , [PTYPE\\_STRING](#) , [PTYPE\\_NODE](#) }
- typedef std::vector< [property\\_info](#) > [propinfovector](#)
- typedef std::vector< [property](#) >::const\_iterator [archive\\_node\\_cit](#)



## Public Member Functions

- [archive\\_node](#) ([archive](#) &ar)
- [archive\\_node](#) ([archive](#) &ar, const [ex](#) &expr)  
*Recursively construct archive node from expression.*
- const [archive\\_node](#) & [operator=](#) (const [archive\\_node](#) &other)  
*Assignment operator of [archive\\_node](#).*
- void [add\\_bool](#) (const std::string &name, bool value)  
*Add property of type "bool" to node.*
- void [add\\_unsigned](#) (const std::string &name, unsigned value)  
*Add property of type "unsigned int" to node.*
- void [add\\_string](#) (const std::string &name, const std::string &value)  
*Add property of type "string" to node.*
- void [add\\_ex](#) (const std::string &name, const [ex](#) &value)  
*Add property of type "ex" to node.*
- bool [find\\_bool](#) (const std::string &name, bool &ret, unsigned index=0) const  
*Retrieve property of type "bool" from node.*
- bool [find\\_unsigned](#) (const std::string &name, unsigned &ret, unsigned index=0) const  
*Retrieve property of type "unsigned" from node.*
- bool [find\\_string](#) (const std::string &name, std::string &ret, unsigned index=0) const  
*Retrieve property of type "string" from node.*
- [archive\\_node\\_cit](#) [find\\_first](#) (const std::string &name) const  
*Find the location in the vector of properties of the first/last property with a given name.*
- [archive\\_node\\_cit](#) [find\\_last](#) (const std::string &name) const
- [archive\\_node\\_cit](#) [range](#) [find\\_property\\_range](#) (const std::string &name1, const std::string &name2) const  
*Find a range of locations in the vector of properties.*
- bool [find\\_ex](#) (const std::string &name, [ex](#) &ret, [lst](#) &sym\_lst, unsigned index=0) const  
*Retrieve property of type "ex" from node.*
- void [find\\_ex\\_by\\_loc](#) ([archive\\_node\\_cit](#) loc, [ex](#) &ret, [lst](#) &sym\_lst) const  
*Retrieve property of type "ex" from the node if it is known that this node in fact contains such a property at the given location.*
- const [archive\\_node](#) & [find\\_ex\\_node](#) (const std::string &name, unsigned index=0) const  
*Retrieve property of type "ex" from node, returning the node of the sub-expression.*
- void [get\\_properties](#) ([propinfovector](#) &v) const  
*Return vector of properties stored in node.*
- [ex](#) [unarchive](#) ([lst](#) &sym\_lst) const  
*Convert archive node to [GiNaC](#) expression.*
- bool [has\\_same\\_ex\\_as](#) (const [archive\\_node](#) &other) const  
*Check if the [archive\\_node](#) stores the same expression as another [archive\\_node](#).*
- bool [has\\_ex](#) () const
- [ex](#) [get\\_ex](#) () const
- void [forget](#) ()  
*Delete cached unarchived expressions from node (for debugging).*
- void [prinraw](#) (std::ostream &os) const  
*Output [archive\\_node](#) to stream in ugly raw format (for debugging).*

## Private Attributes

- [archive](#) & [a](#)  
*Reference to the archive to which this node belongs.*
- `std::vector< property > props`  
*Vector of stored properties.*
- `bool has\_expression`  
*Flag indicating whether a cached unarchived representation of this node exists.*
- `ex e`  
*The cached unarchived representation of this node (if any).*

## Friends

- `std::ostream & operator<< (std::ostream &os, const archive\_node &ar)`  
*Write [archive\\_node](#) to binary data stream.*
- `std::istream & operator>> (std::istream &is, archive\_node &ar)`  
*Read [archive\\_node](#) from binary data stream.*

## 6.5.1 Detailed Description

This class stores all properties needed to record/retrieve the state of one object of class `basic` (or a derived class).

Each property is addressed by its name and data type.

## 6.5.2 Member Typedef Documentation

### 6.5.2.1 `propinfovector`

```
typedef std::vector<property_info> GiNaC::archive_node::propinfovector
```

### 6.5.2.2 `archive_node_cit`

```
typedef std::vector<property>::const_iterator GiNaC::archive_node::archive_node_cit
```

## 6.5.3 Member Enumeration Documentation

### 6.5.3.1 `property_type`

```
enum GiNaC::archive_node::property_type
```

Property data types.

#### Enumerator

|                             |  |
|-----------------------------|--|
| <code>PTYPE_BOOL</code>     |  |
| <code>PTYPE_UNSIGNED</code> |  |
| <code>PTYPE_STRING</code>   |  |
| <code>PTYPE_NODE</code>     |  |

## 6.5.4 Constructor & Destructor Documentation

### 6.5.4.1 archive\_node() [1/2]

```
GiNaC::archive_node::archive_node (
 archive & ar) [inline]
```

References [a](#), and [has\\_expression](#).

Referenced by [add\\_ex\(\)](#), [find\\_ex\\_node\(\)](#), [has\\_same\\_ex\\_as\(\)](#), [operator<<](#), [operator=\(\)](#), and [operator>>](#).

### 6.5.4.2 archive\_node() [2/2]

```
GiNaC::archive_node::archive_node (
 archive & ar,
 const ex & expr)
```

Recursively construct archive node from expression.

References [a](#), [GiNaC::ex::bp](#), [e](#), and [has\\_expression](#).

## 6.5.5 Member Function Documentation

### 6.5.5.1 operator=()

```
const archive_node & GiNaC::archive_node::operator= (
 const archive_node & other)
```

Assignment operator of [archive\\_node](#).

References [archive\\_node\(\)](#), [e](#), [has\\_expression](#), and [props](#).

### 6.5.5.2 add\_bool()

```
void GiNaC::archive_node::add_bool (
 const std::string & name,
 bool value)
```

Add property of type "bool" to node.

References [a](#), [props](#), and [PTYPE\\_BOOL](#).

Referenced by [GiNaC::minkmetric::archive\(\)](#), [GiNaC::spinidx::archive\(\)](#), [GiNaC::tensepsilon::archive\(\)](#), and [GiNaC::varidx::archive\(\)](#).

### 6.5.5.3 add\_unsigned()

```
void GiNaC::archive_node::add_unsigned (
 const std::string & name,
 unsigned value)
```

Add property of type "unsigned int" to node.

References [a](#), [props](#), and [PTYPE\\_UNSIGNED](#).

Referenced by [GiNaC::clifford::archive\(\)](#), [GiNaC::color::archive\(\)](#), [GiNaC::fderivative::archive\(\)](#), [GiNaC::matrix::archive\(\)](#), [GiNaC::relational::archive\(\)](#), [GiNaC::symmetry::archive\(\)](#), and [GiNaC::wildcard::archive\(\)](#).

### 6.5.5.4 add\_string()

```
void GiNaC::archive_node::add_string (
 const std::string & name,
 const std::string & value)
```

Add property of type "string" to node.

References [a](#), [props](#), and [PTYPE\\_STRING](#).

Referenced by [GiNaC::basic::archive\(\)](#), [GiNaC::constant::archive\(\)](#), [GiNaC::function::archive\(\)](#), [GiNaC::numeric::archive\(\)](#), and [GiNaC::symbol::archive\(\)](#).

### 6.5.5.5 add\_ex()

```
void GiNaC::archive_node::add_ex (
 const std::string & name,
 const ex & value)
```

Add property of type "ex" to node.

References [a](#), [archive\\_node\(\)](#), [props](#), and [PTYPE\\_NODE](#).

Referenced by [GiNaC::clifford::archive\(\)](#), [GiNaC::container< std::vector >::archive\(\)](#), [GiNaC::expairseq::archive\(\)](#), [GiNaC::idx::archive\(\)](#), [GiNaC::indexed::archive\(\)](#), [GiNaC::integral::archive\(\)](#), [GiNaC::matrix::archive\(\)](#), [GiNaC::power::archive\(\)](#), [GiNaC::pseries::archive\(\)](#), [GiNaC::relational::archive\(\)](#), and [GiNaC::symmetry::archive\(\)](#).

### 6.5.5.6 find\_bool()

```
bool GiNaC::archive_node::find_bool (
 const std::string & name,
 bool & ret,
 unsigned index = 0) const
```

Retrieve property of type "bool" from node.

#### Returns

"true" if property was found, "false" otherwise

References [a](#), [props](#), and [PTYPE\\_BOOL](#).

Referenced by [GiNaC::minkmetric::read\\_archive\(\)](#), [GiNaC::spinidx::read\\_archive\(\)](#), [GiNaC::tensepsilon::read\\_archive\(\)](#), and [GiNaC::varidx::read\\_archive\(\)](#).

#### 6.5.5.7 find\_unsigned()

```
bool GiNaC::archive_node::find_unsigned (
 const std::string & name,
 unsigned & ret,
 unsigned index = 0) const
```

Retrieve property of type "unsigned" from node.

##### Returns

"true" if property was found, "false" otherwise

References [a](#), [props](#), and [PTYPE\\_UNSIGNED](#).

Referenced by [GiNaC::clifford::read\\_archive\(\)](#), [GiNaC::color::read\\_archive\(\)](#), [GiNaC::fderivative::read\\_archive\(\)](#), [GiNaC::indexed::read\\_archive\(\)](#), [GiNaC::matrix::read\\_archive\(\)](#), [GiNaC::relational::read\\_archive\(\)](#), [GiNaC::symmetry::read\\_archive\(\)](#), and [GiNaC::wildcard::read\\_archive\(\)](#).

#### 6.5.5.8 find\_string()

```
bool GiNaC::archive_node::find_string (
 const std::string & name,
 std::string & ret,
 unsigned index = 0) const
```

Retrieve property of type "string" from node.

##### Returns

"true" if property was found, "false" otherwise

References [a](#), [props](#), and [PTYPE\\_STRING](#).

Referenced by [GiNaC::constant::read\\_archive\(\)](#), [GiNaC::function::read\\_archive\(\)](#), [GiNaC::numeric::read\\_archive\(\)](#), [GiNaC::symbol::read\\_archive\(\)](#), and [unarchive\(\)](#).

#### 6.5.5.9 find\_first()

```
archive_node::archive_node_cit GiNaC::archive_node::find_first (
 const std::string & name) const
```

Find the location in the vector of properties of the first/last property with a given name.

References [a](#), and [props](#).

#### 6.5.5.10 find\_last()

```
archive_node::archive_node_cit GiNaC::archive_node::find_last (
 const std::string & name) const
```

References [a](#), and [props](#).

### 6.5.5.11 find\_property\_range()

```
archive_node::archive_node_cit_range GiNaC::archive_node::find_property_range (
 const std::string & name1,
 const std::string & name2) const
```

Find a range of locations in the vector of properties.

The result begins at the first property with name1 and ends one past the last property with name2.

References [a](#), [GiNaC::archive\\_node::archive\\_node\\_cit\\_range::begin](#), [GiNaC::archive\\_node::archive\\_node\\_cit\\_range::end](#), and [props](#).

Referenced by [GiNaC::container< std::vector >::read\\_archive\(\)](#), [GiNaC::expairseq::read\\_archive\(\)](#), [GiNaC::matrix::read\\_archive\(\)](#), and [GiNaC::pseries::read\\_archive\(\)](#).

### 6.5.5.12 find\_ex()

```
bool GiNaC::archive_node::find_ex (
 const std::string & name,
 ex & ret,
 lst & sym_lst,
 unsigned index = 0) const
```

Retrieve property of type "ex" from node.

#### Returns

"true" if property was found, "false" otherwise

References [a](#), [props](#), and [PTYPE\\_NODE](#).

Referenced by [GiNaC::clifford::read\\_archive\(\)](#), [GiNaC::expairseq::read\\_archive\(\)](#), [GiNaC::idx::read\\_archive\(\)](#), [GiNaC::indexed::read\\_archive\(\)](#), [GiNaC::integral::read\\_archive\(\)](#), [GiNaC::power::read\\_archive\(\)](#), [GiNaC::pseries::read\\_archive\(\)](#), [GiNaC::relational::read\\_archive\(\)](#), and [GiNaC::symmetry::read\\_archive\(\)](#).

### 6.5.5.13 find\_ex\_by\_loc()

```
void GiNaC::archive_node::find_ex_by_loc (
 archive_node_cit loc,
 ex & ret,
 lst & sym_lst) const
```

Retrieve property of type "ex" from the node if it is known that this node in fact contains such a property at the given location.

This is much more efficient than the preceding function.

References [a](#).

Referenced by [GiNaC::container< std::vector >::read\\_archive\(\)](#), [GiNaC::expairseq::read\\_archive\(\)](#), [GiNaC::matrix::read\\_archive\(\)](#), and [GiNaC::pseries::read\\_archive\(\)](#).

#### 6.5.5.14 find\_ex\_node()

```
const archive_node & GiNaC::archive_node::find_ex_node (
 const std::string & name,
 unsigned index = 0) const
```

Retrieve property of type "ex" from node, returning the node of the sub-expression.

References [a](#), [archive\\_node\(\)](#), [props](#), and [PTYPE\\_NODE](#).

#### 6.5.5.15 get\_properties()

```
void GiNaC::archive_node::get_properties (
 propinfovector & v) const
```

Return vector of properties stored in node.

References [a](#), and [props](#).

#### 6.5.5.16 unarchive()

```
ex GiNaC::archive_node::unarchive (
 lst & sym_lst) const
```

Convert archive node to [GiNaC](#) expression.

References [GiNaC::status\\_flags::dynallocated](#), [e](#), [GiNaC::find\\_factory\\_fcn\(\)](#), [find\\_string\(\)](#), and [has\\_expression](#).

#### 6.5.5.17 has\_same\_ex\_as()

```
bool GiNaC::archive_node::has_same_ex_as (
 const archive_node & other) const
```

Check if the [archive\\_node](#) stores the same expression as another [archive\\_node](#).

##### Returns

"true" if expressions are the same

References [archive\\_node\(\)](#), [GiNaC::ex::bp](#), [e](#), and [has\\_expression](#).

#### 6.5.5.18 has\_ex()

```
bool GiNaC::archive_node::has_ex () const [inline]
```

References [has\\_expression](#).

Referenced by [GiNaC::archive::add\\_node\(\)](#).

#### 6.5.5.19 `get_ex()`

```
ex GiNaC::archive_node::get_ex () const [inline]
```

References [e](#).

Referenced by [GiNaC::archive::add\\_node\(\)](#).

#### 6.5.5.20 `forget()`

```
void GiNaC::archive_node::forget ()
```

Delete cached unarchived expressions from node (for debugging).

References [e](#), and [has\\_expression](#).

Referenced by [GiNaC::archive::forget\(\)](#).

#### 6.5.5.21 `printraw()`

```
void GiNaC::archive_node::printraw (
 std::ostream & os) const
```

Output [archive\\_node](#) to stream in ugly raw format (for debugging).

References [a](#), [e](#), [has\\_expression](#), [props](#), [PTYPE\\_BOOL](#), [PTYPE\\_NODE](#), [PTYPE\\_STRING](#), and [PTYPE\\_UNSIGNED](#).

### 6.5.6 Friends And Related Symbol Documentation

#### 6.5.6.1 `operator<<`

```
std::ostream & operator<< (
 std::ostream & os,
 const archive_node & ar) [friend]
```

Write [archive\\_node](#) to binary data stream.

References [archive\\_node\(\)](#), [props](#), and [GiNaC::write\\_unsigned\(\)](#).

#### 6.5.6.2 `operator>>`

```
std::istream & operator>> (
 std::istream & is,
 archive_node & ar) [friend]
```

Read [archive\\_node](#) from binary data stream.

References [archive\\_node\(\)](#), [props](#), and [GiNaC::read\\_unsigned\(\)](#).



## 6.5.7 Member Data Documentation

### 6.5.7.1 a

```
archive& GiNaC::archive_node::a [private]
```

Reference to the archive to which this node belongs.

Referenced by [add\\_bool\(\)](#), [add\\_ex\(\)](#), [add\\_string\(\)](#), [add\\_unsigned\(\)](#), [archive\\_node\(\)](#), [archive\\_node\(\)](#), [find\\_bool\(\)](#), [find\\_ex\(\)](#), [find\\_ex\\_by\\_loc\(\)](#), [find\\_ex\\_node\(\)](#), [find\\_first\(\)](#), [find\\_last\(\)](#), [find\\_property\\_range\(\)](#), [find\\_string\(\)](#), [find\\_unsigned\(\)](#), [get\\_properties\(\)](#), and [printraw\(\)](#).

### 6.5.7.2 props

```
std::vector<property> GiNaC::archive_node::props [private]
```

Vector of stored properties.

Referenced by [add\\_bool\(\)](#), [add\\_ex\(\)](#), [add\\_string\(\)](#), [add\\_unsigned\(\)](#), [find\\_bool\(\)](#), [find\\_ex\(\)](#), [find\\_ex\\_node\(\)](#), [find\\_first\(\)](#), [find\\_last\(\)](#), [find\\_property\\_range\(\)](#), [find\\_string\(\)](#), [find\\_unsigned\(\)](#), [get\\_properties\(\)](#), [operator<<](#), [operator=\(\)](#), [operator>>](#), and [printraw\(\)](#).

### 6.5.7.3 has\_expression

```
bool GiNaC::archive_node::has_expression [mutable], [private]
```

Flag indicating whether a cached unarchived representation of this node exists.

Referenced by [archive\\_node\(\)](#), [archive\\_node\(\)](#), [forget\(\)](#), [has\\_ex\(\)](#), [has\\_same\\_ex\\_as\(\)](#), [operator=\(\)](#), [printraw\(\)](#), and [unarchive\(\)](#).

### 6.5.7.4 e

```
ex GiNaC::archive_node::e [mutable], [private]
```

The cached unarchived representation of this node (if any).

Referenced by [archive\\_node\(\)](#), [forget\(\)](#), [get\\_ex\(\)](#), [has\\_same\\_ex\\_as\(\)](#), [operator=\(\)](#), [printraw\(\)](#), and [unarchive\(\)](#).

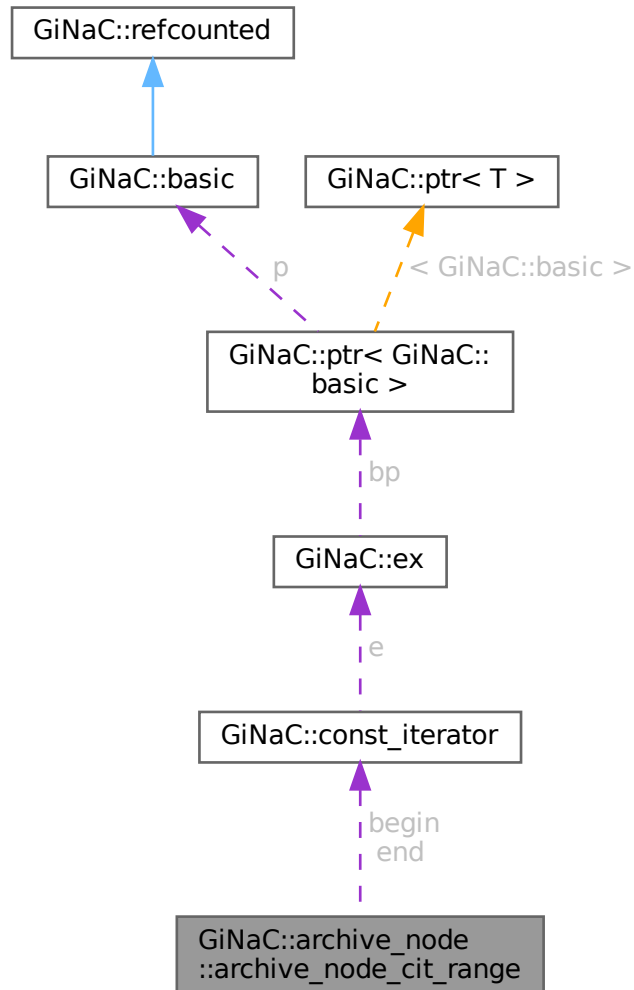
The documentation for this class was generated from the following files:

- [archive.h](#)
- [archive.cpp](#)

## 6.6 GiNaC::archive\_node::archive\_node\_cit\_range Struct Reference

```
#include <archive.h>
```

Collaboration diagram for GiNaC::archive\_node::archive\_node\_cit\_range:



### Public Attributes

- [archive\\_node\\_cit begin](#)
- [archive\\_node\\_cit end](#)

### 6.6.1 Member Data Documentation

#### 6.6.1.1 begin

[archive\\_node\\_cit](#) GiNaC::archive\_node::archive\_node\_cit\_range::begin

Referenced by [GiNaC::archive\\_node::find\\_property\\_range\(\)](#).

### 6.6.1.2 end

`archive_node_cit` GiNaC::archive\_node::archive\_node\_cit\_range::end

Referenced by [GiNaC::archive\\_node::find\\_property\\_range\(\)](#).

The documentation for this struct was generated from the following file:

- [archive.h](#)

## 6.7 GiNaC::archive::archived\_ex Struct Reference

Archived expression descriptor.

### Public Member Functions

- [archived\\_ex](#) ()
- [archived\\_ex](#) ([archive\\_atom](#) n, [archive\\_node\\_id](#) node)

### Public Attributes

- [archive\\_atom](#) name  
*Name of expression.*
- [archive\\_node\\_id](#) root  
*ID of root node.*

### 6.7.1 Detailed Description

Archived expression descriptor.

### 6.7.2 Constructor & Destructor Documentation

#### 6.7.2.1 archived\_ex() [1/2]

```
GiNaC::archive::archived_ex::archived_ex () [inline]
```

#### 6.7.2.2 archived\_ex() [2/2]

```
GiNaC::archive::archived_ex::archived_ex (
 archive_atom n,
 archive_node_id node) [inline]
```

References [name](#), and [root](#).

## 6.7.3 Member Data Documentation

### 6.7.3.1 name

`archive_atom` GiNaC::archive::archived\_ex::name

Name of expression.

Referenced by `archived_ex()`.

### 6.7.3.2 root

`archive_node_id` GiNaC::archive::archived\_ex::root

ID of root node.

Referenced by `archived_ex()`.

The documentation for this struct was generated from the following file:

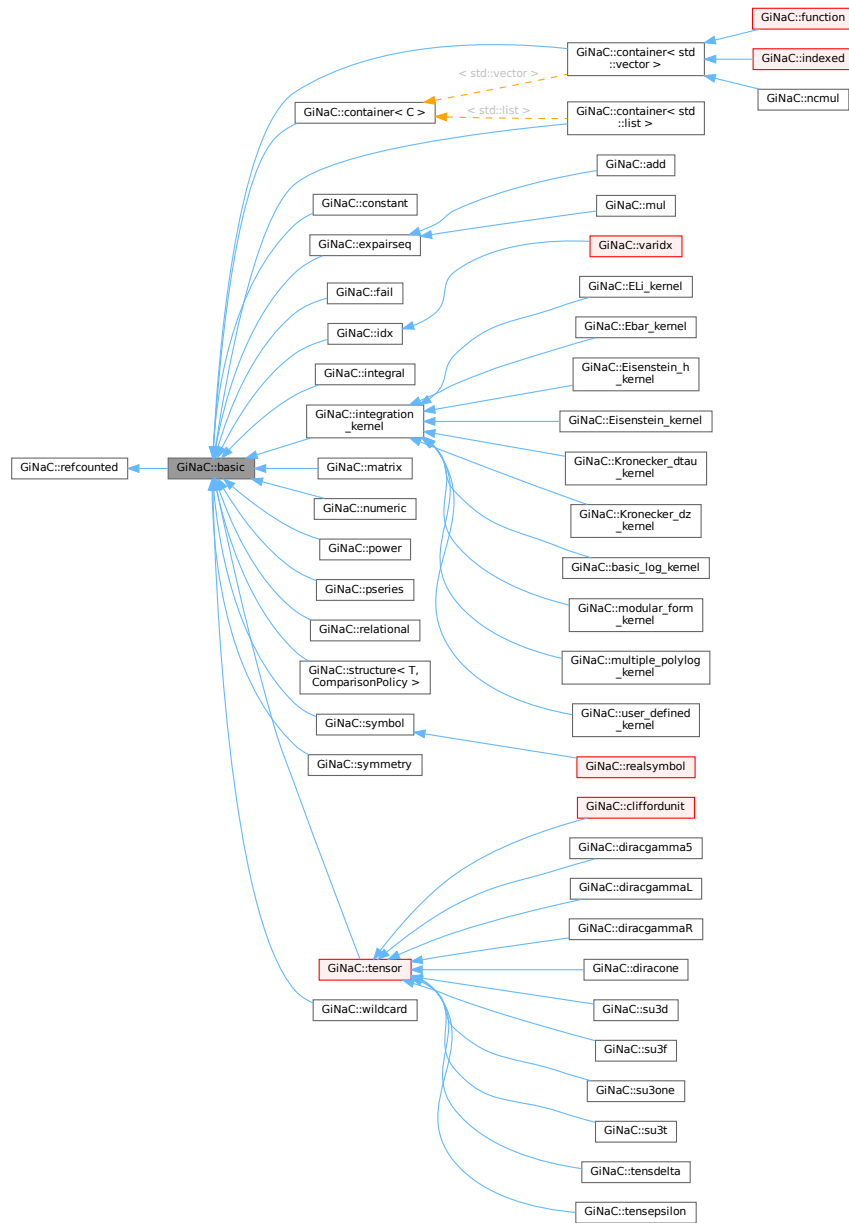
- `archive.h`

## 6.8 GiNaC::basic Class Reference

This class is the ABC (abstract base class) of GiNaC's class hierarchy.

```
#include <basic.h>
```

Inheritance diagram for GiNaC::basic:



Collaboration diagram for GiNaC::basic:



## Public Member Functions

- virtual `~basic()`  
*basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic(const basic &other)`
- `const basic &operator=(const basic &other)`  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate() const`  
*Create a clone of this object on the heap.*
- virtual `ex eval() const`  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf() const`  
*Evaluate object numerically.*
- virtual `ex evalm() const`  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ() const`  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed(const basic &i) const`  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual `void print(const print_context &c, unsigned level=0) const`  
*Output to stream.*
- virtual `void dbgprint() const`  
*Little wrapper around `print` to be called within a debugger.*
- virtual `void dbgprnttree() const`  
*Little wrapper around `prnttree` to be called within a debugger.*
- virtual `unsigned precedence() const`  
*Return relative operator precedence (for parenthezing output).*
- virtual `bool info(unsigned inf) const`  
*Information about the object.*
- virtual `size_t nops() const`  
*Number of operands/members.*
- virtual `ex op(size_t i) const`  
*Return operand/member at position `i`.*
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`

- virtual `ex & let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual `bool has (const ex &other, unsigned options=0) const`  
*Test for occurrence of a pattern.*
- virtual `bool match (const ex &pattern, exmap &repls) const`  
*Check whether the expression matches a given pattern.*
- virtual `ex subs (const exmap &m, unsigned options=0) const`  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map (map_function &f) const`  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual `void accept (GiNaC::visitor &v) const`
- virtual `bool is_polynomial (const ex &var) const`  
*Check whether this is a polynomial in the given variables.*
- virtual `int degree (const ex &s) const`  
*Return degree of highest power in object s.*
- virtual `int ldegree (const ex &s) const`  
*Return degree of lowest power in object s.*
- virtual `ex coeff (const ex &s, int n=1) const`  
*Return coefficient of degree n in object s.*
- virtual `ex expand (unsigned options=0) const`  
*Expand expression, i.e.*
- virtual `ex collect (const ex &s, bool distributed=false) const`  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series (const relational &r, int order, unsigned options=0) const`  
*Default implementation of ex::series().*
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier) const`  
*Default implementation of ex::normal().*
- virtual `ex to_rational (exmap &repl) const`  
*Default implementation of ex::to\_rational().*
- virtual `ex to_polynomial (exmap &repl) const`
- virtual `numeric integer_content () const`
- virtual `ex smod (const numeric &xi) const`  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient () const`  
*Implementation ex::max\_coefficient().*
- virtual `exvector get_free_indices () const`  
*Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed (const ex &self, const ex &other) const`  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed (const ex &self, const numeric &other) const`  
*Multiply an indexed expression with a scalar.*
- virtual `bool contract_with (exvector::iterator self, exvector::iterator other, exvector &v) const`  
*Try to contract two indexed expressions that appear in the same product.*
- virtual `unsigned return_type () const`
- virtual `return_type_t return_type_tinfo () const`
- virtual `ex conjugate () const`
- virtual `ex real_part () const`
- virtual `ex imag_part () const`

- `template<class T>`  
void `print_dispatch` (const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- virtual void `archive` (`archive_node` &n) const  
*Save (serialize) the object into archive node.*
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)  
*Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- const `basic` & `hold` () const  
*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const  
*Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual `ex derivative` (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned `calchash` () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void `do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*



## Protected Attributes

- unsigned [flags](#)  
of type [status\\_flags](#)
- unsigned [hashvalue](#)  
hash value

## Friends

- class [ex](#)

## 6.8.1 Detailed Description

This class is the ABC (abstract base class) of [GiNaC](#)'s class hierarchy.

## 6.8.2 Constructor & Destructor Documentation

### 6.8.2.1 [basic\(\)](#) [1/2]

```
GiNaC::basic::basic () [inline], [protected]
```

References [basic\(\)](#), and [flags](#).

Referenced by [basic\(\)](#), [basic\(\)](#), [clearflag\(\)](#), [compare\(\)](#), [compare\\_same\\_type\(\)](#), [duplicate\(\)](#), [eval\\_indexed\(\)](#), [GiNaC::matrix::eval\\_indexed\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::eval\\_indexed\(\)](#), [hold\(\)](#), [GiNaC::idx::is\\_dummy\\_pair\\_same\\_type\(\)](#), [is\\_equal\(\)](#), [is\\_equal\\_same\\_type\(\)](#), [GiNaC::constant::is\\_equal\\_same\\_type\(\)](#), [GiNaC::container< C >::is\\_equal\\_same\\_type\(\)](#), [GiNaC::container< std::vector >::is\\_equal\\_same\\_type\(\)](#), [GiNaC::expairseq::is\\_equal\\_same\\_type\(\)](#), [GiNaC::numeric::is\\_equal\\_same\\_type\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::is\\_equal\\_same\\_type\(\)](#), [GiNaC::symbol::is\\_equal\\_same\\_type\(\)](#), [map\(\)](#), [match\\_same\\_type\(\)](#), [GiNaC::idx::match\\_same\\_type\(\)](#), [GiNaC::matrix::match\\_same\\_type\(\)](#), [GiNaC::relational::match\\_same\\_type\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::match\\_same\\_type\(\)](#), [operator=\(\)](#), [setflag\(\)](#), [subs\(\)](#), and [GiNaC::symmetry::sy\\_swap](#).

### 6.8.2.2 [~basic\(\)](#)

```
virtual GiNaC::basic::~~basic () [inline], [virtual]
```

[basic](#) destructor, virtual because class [ex](#) will delete objects of derived classes via a [basic\\*](#).

References [GiNaC::status\\_flags::dynallocated](#), [flags](#), [GiNaC::refcounted::get\\_refcount\(\)](#), and [GINAC\\_ASSERT](#).

### 6.8.2.3 [basic\(\)](#) [2/2]

```
GiNaC::basic::basic (
 const basic & other)
```

References [basic\(\)](#).

## 6.8.3 Member Function Documentation

### 6.8.3.1 operator=()

```
const basic & GiNaC::basic::operator= (
 const basic & other)
```

basic assignment operator: the other object might be of a derived class.

References [basic\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [flags](#), [GiNaC::status\\_flags::hash\\_calculated](#), [hashvalue](#), [operator=\(\)](#), and [GiNaC::refcounted::set\\_refcount\(\)](#).

Referenced by [operator=\(\)](#).

### 6.8.3.2 duplicate()

```
virtual basic * GiNaC::basic::duplicate () const [inline], [virtual]
```

Create a clone of this object on the heap.

One can think of this as simulating a virtual copy constructor which is needed for instance by the refcounted construction of an ex from a basic.

Reimplemented in [GiNaC::possymbol](#), and [GiNaC::realsymbol](#).

References [basic\(\)](#), [GiNaC::status\\_flags::dynamallocated](#), and [setflag\(\)](#).

Referenced by [GiNaC::ex::construct\\_from\\_basic\(\)](#), [map\(\)](#), [GiNaC::idx::map\(\)](#), [GiNaC::idx::replace\\_dim\(\)](#), [subs\(\)](#), [GiNaC::idx::subs\(\)](#), [GiNaC::spinidx::toggle\\_dot\(\)](#), [GiNaC::varidx::toggle\\_variance\(\)](#), and [GiNaC::spinidx::toggle\\_variance\\_dot\(\)](#).

### 6.8.3.3 eval()

```
ex GiNaC::basic::eval () const [virtual]
```

Perform automatic non-interruptive term rewriting rules.

Reimplemented in [GiNaC::add](#), [GiNaC::expairseq](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::structure< T, ComparisonPolicy>](#), and [GiNaC::symbol](#).

References [eval\(\)](#), [ex](#), and [hold\(\)](#).

Referenced by [GiNaC::ex::construct\\_from\\_basic\(\)](#), and [eval\(\)](#).

### 6.8.3.4 evalf()

```
ex GiNaC::basic::evalf () const [virtual]
```

Evaluate object numerically.

Reimplemented in [GiNaC::constant](#), [GiNaC::function](#), [GiNaC::idx](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), and [GiNaC::symbol](#).

References [evalf\(\)](#), [ex](#), [map\(\)](#), and [nops\(\)](#).

Referenced by [evalf\(\)](#), [GiNaC::evalf\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::get\\_numerical\\_value\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::series](#), and [GiNaC::Kronecker\\_dz\\_kernel::series\\_coeff\\_impl\(\)](#).

### 6.8.3.5 evalm()

```
ex GiNaC::basic::evalm () const [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented in [GiNaC::add](#), [GiNaC::matrix](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::power](#), [GiNaC::pseries](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [evalm\(\)](#), [ex](#), [map\(\)](#), [GiNaC::map\\_evalm](#), and [nops\(\)](#).

Referenced by [evalm\(\)](#).

### 6.8.3.6 eval\_integ()

```
ex GiNaC::basic::eval_integ () const [virtual]
```

Evaluate integrals, if result is known.

Reimplemented in [GiNaC::integral](#), and [GiNaC::pseries](#).

References [eval\\_integ\(\)](#), [ex](#), [map\(\)](#), [GiNaC::map\\_eval\\_integ](#), and [nops\(\)](#).

Referenced by [eval\\_integ\(\)](#).

### 6.8.3.7 eval\_ncmul()

```
ex GiNaC::basic::eval_ncmul (
 const exvector & v) const [protected], [virtual]
```

Reimplemented in [GiNaC::add](#), [GiNaC::clifford](#), [GiNaC::color](#), [GiNaC::function](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::power](#), [GiNaC::relational](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [eval\\_ncmul\(\)](#), [ex](#), and [GiNaC::hold\\_ncmul\(\)](#).

Referenced by [eval\\_ncmul\(\)](#).

### 6.8.3.8 eval\_indexed()

```
ex GiNaC::basic::eval_indexed (
 const basic & i) const [virtual]
```

Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.

Reimplemented in [GiNaC::matrix](#), [GiNaC::minkmetric](#), [GiNaC::spinmetric](#), [GiNaC::structure< T, ComparisonPolicy >](#), [GiNaC::su3d](#), [GiNaC::su3f](#), [GiNaC::tensdelta](#), [GiNaC::tensepsilon](#), and [GiNaC::tensmetric](#).

References [basic\(\)](#), [eval\\_indexed\(\)](#), and [ex](#).

Referenced by [eval\\_indexed\(\)](#).

### 6.8.3.9 print()

```
void GiNaC::basic::print (
 const print_context & c,
 unsigned level = 0) const [virtual]
```

Output to stream.

This performs double dispatch on the dynamic type of \*this and the dynamic type of the supplied print context.

## Parameters

|              |                                                                                                           |
|--------------|-----------------------------------------------------------------------------------------------------------|
| <i>c</i>     | print context object that describes the output formatting                                                 |
| <i>level</i> | value that is used to identify the precedence or indentation level for placing parentheses and formatting |

Reimplemented in [GiNaC::fderivative](#), [GiNaC::function](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [print\(\)](#), and [print\\_dispatch\(\)](#).

Referenced by [dbgprint\(\)](#), [dbgprinttree\(\)](#), [print\(\)](#), [GiNaC::fderivative::print\(\)](#), [GiNaC::add::print\\_add\(\)](#), [GiNaC::mul::print\\_overall\\_coeff\(\)](#), [GiNaC::pseries::print\\_series\(\)](#), and [GiNaC::print\\_sym\\_pow\(\)](#).

#### 6.8.3.10 dbgprint()

```
void GiNaC::basic::dbgprint () const [virtual]
```

Little wrapper around print to be called within a debugger.

This is needed because you cannot call `foo.print(cout)` from within the debugger because it might not know what `cout` is. This method can be invoked with no argument and it will simply print to `stdout`.

##### See also

[basic::print](#)

[basic::dbgprinttree](#)

References [dbgprint\(\)](#), and [print\(\)](#).

Referenced by [dbgprint\(\)](#).

#### 6.8.3.11 dbgprinttree()

```
void GiNaC::basic::dbgprinttree () const [virtual]
```

Little wrapper around printtree to be called within a debugger.

##### See also

[basic::dbgprint](#)

References [dbgprinttree\(\)](#), and [print\(\)](#).

Referenced by [dbgprinttree\(\)](#).

### 6.8.3.12 precedence()

```
unsigned GiNaC::basic::precedence () const [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented in [GiNaC::add](#), [GiNaC::clifford](#), [GiNaC::container< C >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::vector >](#), [GiNaC::container< std::vector >](#), [GiNaC::expairseq](#), [GiNaC::function](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::relational](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [precedence\(\)](#).

Referenced by [precedence\(\)](#).

### 6.8.3.13 info()

```
bool GiNaC::basic::info (
 unsigned inf) const [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented in [GiNaC::add](#), [GiNaC::constant](#), [GiNaC::container< C >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::vector >](#), [GiNaC::container< std::vector >](#), [GiNaC::expairseq](#), [GiNaC::function](#), [GiNaC::idx](#), [GiNaC::indexed](#), [GiNaC::minkmetric](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::relational](#), [GiNaC::spinmetric](#), [GiNaC::structure< T, ComparisonPolicy >](#), [GiNaC::symbol](#), [GiNaC::tensdelta](#), [GiNaC::tensepsilon](#), and [GiNaC::tensmetric](#).

References [info\(\)](#).

Referenced by [GiNaC::matrix::gauss\\_elimination\(\)](#), [info\(\)](#), [GiNaC::function::info\(\)](#), and [GiNaC::matrix::solve\(\)](#).

### 6.8.3.14 nops()

```
size_t GiNaC::basic::nops () const [virtual]
```

Number of operands/members.

Reimplemented in [GiNaC::clifford](#), [GiNaC::container< C >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::vector >](#), [GiNaC::container< std::vector >](#), [GiNaC::Ebar\\_kernel](#), [GiNaC::Eisenstein\\_h\\_kernel](#), [GiNaC::Eisenstein\\_kernel](#), [GiNaC::ELi\\_kernel](#), [GiNaC::expairseq](#), [GiNaC::idx](#), [GiNaC::integral](#), [GiNaC::Kronecker\\_dtau\\_kernel](#), [GiNaC::Kronecker\\_dz\\_kernel](#), [GiNaC::matrix](#), [GiNaC::modular\\_form\\_kernel](#), [GiNaC::multiple\\_polylog\\_kernel](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::relational](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::user\\_defined\\_kernel](#).

References [nops\(\)](#).

Referenced by [calchash\(\)](#), [derivative\(\)](#), [do\\_print\\_tree\(\)](#), [GiNaC::matrix::eval\\_indexed\(\)](#), [GiNaC::minkmetric::eval\\_indexed\(\)](#), [GiNaC::spinmetric::eval\\_indexed\(\)](#), [GiNaC::su3d::eval\\_indexed\(\)](#), [GiNaC::su3f::eval\\_indexed\(\)](#), [GiNaC::tensepsilon::eval\\_indexed\(\)](#), [GiNaC::tensmetric::eval\\_indexed\(\)](#), [eval\\_integ\(\)](#), [evalf\(\)](#), [evalm\(\)](#), [expand\(\)](#), [has\(\)](#), [map\(\)](#), [match\(\)](#), [nops\(\)](#), [normal\(\)](#), and [subs\(\)](#).

### 6.8.3.15 op()

```
ex GiNaC::basic::op (
 size_t i) const [virtual]
```

Return operand/member at position i.

Reimplemented in [GiNaC::clifford](#), [GiNaC::container< C >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::vector >](#), [GiNaC::container< std::vector >](#), [GiNaC::Ebar\\_kernel](#), [GiNaC::Eisenstein\\_h\\_kernel](#), [GiNaC::Eisenstein\\_kernel](#), [GiNaC::ELi\\_kernel](#), [GiNaC::expairseq](#), [GiNaC::idx](#), [GiNaC::integral](#), [GiNaC::Kronecker\\_dtau\\_kernel](#), [GiNaC::Kronecker\\_dz\\_kernel](#), [GiNaC::matrix](#), [GiNaC::modular\\_form\\_kernel](#), [GiNaC::multiple\\_polylog\\_kernel](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::relational](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::user\\_defined\\_kernel](#).

References [ex](#), and [op\(\)](#).

Referenced by [calchash\(\)](#), [do\\_print\\_tree\(\)](#), [GiNaC::matrix::eval\\_indexed\(\)](#), [GiNaC::minkmetric::eval\\_indexed\(\)](#), [GiNaC::spinmetric::eval\\_indexed\(\)](#), [GiNaC::su3d::eval\\_indexed\(\)](#), [GiNaC::su3f::eval\\_indexed\(\)](#), [GiNaC::tensepsilon::eval\\_indexed\(\)](#), [GiNaC::tensmetric::eval\\_indexed\(\)](#), [has\(\)](#), [map\(\)](#), [match\(\)](#), [op\(\)](#), [operator\[\]\(\)](#), [operator\[\]\(\)](#), and [subs\(\)](#).

### 6.8.3.16 operator[]() [1/4]

```
ex GiNaC::basic::operator[] (
 const ex & index) const [virtual]
```

Reimplemented in [GiNaC::structure< T, ComparisonPolicy >](#).

References [ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [op\(\)](#), [operator\[\]\(\)](#), and [GiNaC::to\\_int\(\)](#).

Referenced by [operator\[\]\(\)](#), [operator\[\]\(\)](#), [operator\[\]\(\)](#), and [operator\[\]\(\)](#).

### 6.8.3.17 operator[]() [2/4]

```
ex GiNaC::basic::operator[] (
 size_t i) const [virtual]
```

Reimplemented in [GiNaC::structure< T, ComparisonPolicy >](#).

References [ex](#), [op\(\)](#), and [operator\[\]\(\)](#).

### 6.8.3.18 let\_op()

```
ex & GiNaC::basic::let_op (
 size_t i) [virtual]
```

Return modifiable operand/member at position i.

Reimplemented in [GiNaC::clifford](#), [GiNaC::container< C >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::vector >](#), [GiNaC::container< std::vector >](#), [GiNaC::Ebar\\_kernel](#), [GiNaC::Eisenstein\\_h\\_kernel](#), [GiNaC::Eisenstein\\_kernel](#), [GiNaC::ELi\\_kernel](#), [GiNaC::integral](#), [GiNaC::Kronecker\\_dtau\\_kernel](#), [GiNaC::Kronecker\\_dz\\_kernel](#), [GiNaC::matrix](#), [GiNaC::modular\\_form\\_kernel](#), [GiNaC::multiple\\_polylog\\_kernel](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::user\\_defined\\_kernel](#).

References [ensure\\_if\\_modifiable\(\)](#), [ex](#), and [let\\_op\(\)](#).

Referenced by [let\\_op\(\)](#), [map\(\)](#), [operator\[\]\(\)](#), [operator\[\]\(\)](#), and [subs\(\)](#).

**6.8.3.19 operator[]()** [3/4]

```
ex & GiNaC::basic::operator[] (
 const ex & index) [virtual]
```

Reimplemented in [GiNaC::structure< T, ComparisonPolicy >](#).

References [ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [let\\_op\(\)](#), [operator\[\]\(\)](#), and [GiNaC::to\\_int\(\)](#).

**6.8.3.20 operator[]()** [4/4]

```
ex & GiNaC::basic::operator[] (
 size_t i) [virtual]
```

Reimplemented in [GiNaC::structure< T, ComparisonPolicy >](#).

References [ex](#), [let\\_op\(\)](#), and [operator\[\]\(\)](#).

**6.8.3.21 has()**

```
bool GiNaC::basic::has (
 const ex & pattern,
 unsigned options = 0) const [virtual]
```

Test for occurrence of a pattern.

An object 'has' a pattern if it matches the pattern itself or one of the children 'has' it. As a consequence (according to the definition of children) given  $e=x+y+z$ ,  $e.has(x)$  is true but  $e.has(x+y)$  is false.

Reimplemented in [GiNaC::mul](#), [GiNaC::numeric](#), [GiNaC::power](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [ex](#), [has\(\)](#), [match\(\)](#), [nops\(\)](#), and [op\(\)](#).

Referenced by [has\(\)](#), [GiNaC::mul::has\(\)](#), [GiNaC::power::has\(\)](#), [is\\_polynomial\(\)](#), and [series\(\)](#).

**6.8.3.22 match()**

```
bool GiNaC::basic::match (
 const ex & pattern,
 exmap & repl_lst) const [virtual]
```

Check whether the expression matches a given pattern.

For every wildcard object in the pattern, a pair with the wildcard as a key and matching expression as a value is added to `repl_lst`.

Reimplemented in [GiNaC::expairseq](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::wildcard](#).

References [ex](#), [GiNaC::ex\\_to\(\)](#), [is\\_equal\(\)](#), [is\\_equal\\_same\\_type\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [match\(\)](#), [match\\_same\\_type\(\)](#), [nops\(\)](#), [GiNaC::ex::nops\(\)](#), [op\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [has\(\)](#), [match\(\)](#), and [subs\\_one\\_level\(\)](#).

### 6.8.3.23 match\_same\_type()

```
bool GiNaC::basic::match_same_type (
 const basic & other) const [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is\\_equal\\_same\\_type\(\)](#) is automatically used instead of [match\\_same\\_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented in [GiNaC::clifford](#), [GiNaC::color](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::idx](#), [GiNaC::matrix](#), [GiNaC::relational](#), [GiNaC::spinidx](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::varidx](#).

References [basic\(\)](#), and [match\\_same\\_type\(\)](#).

Referenced by [match\(\)](#), and [match\\_same\\_type\(\)](#).

### 6.8.3.24 subs()

```
ex GiNaC::basic::subs (
 const exmap & m,
 unsigned options = 0) const [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented in [GiNaC::clifford](#), [GiNaC::container< C >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::vector >](#), [GiNaC::container< std::vector >](#), [GiNaC::expairseq](#), [GiNaC::idx](#), [GiNaC::matrix](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::relational](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::symbol](#).

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [basic\(\)](#), [clearflag\(\)](#), [duplicate\(\)](#), [ex](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::status\\_flags::hash\\_calculated](#), [let\\_op\(\)](#), [nops\(\)](#), [op\(\)](#), [subs\(\)](#), [GiNaC::ex::subs\(\)](#), and [subs\\_one\\_level\(\)](#).

Referenced by [GiNaC::tensmetric::eval\\_indexed\(\)](#), and [subs\(\)](#).

### 6.8.3.25 map()

```
ex GiNaC::basic::map (
 map_function & f) const [virtual]
```

Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).

Reimplemented in [GiNaC::expairseq](#), [GiNaC::idx](#), [GiNaC::power](#), [GiNaC::relational](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [basic\(\)](#), [clearflag\(\)](#), [duplicate\(\)](#), [ex](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::status\\_flags::hash\\_calculated](#), [let\\_op\(\)](#), [map\(\)](#), [nops\(\)](#), and [op\(\)](#).

Referenced by [derivative\(\)](#), [eval\\_integ\(\)](#), [evalf\(\)](#), [evalm\(\)](#), [expand\(\)](#), [map\(\)](#), and [normal\(\)](#).



**6.8.3.26 accept()**

```
virtual void GiNaC::basic::accept (
 GiNaC::visitor & v) const [inline], [virtual]
```

**6.8.3.27 is\_polynomial()**

```
bool GiNaC::basic::is_polynomial (
 const ex & var) const [virtual]
```

Check whether this is a polynomial in the given variables.

Reimplemented in [GiNaC::add](#), [GiNaC::constant](#), [GiNaC::mul](#), [GiNaC::numeric](#), [GiNaC::power](#), and [GiNaC::symbol](#).

References [ex](#), [GiNaC::ex\\_to\(\)](#), [has\(\)](#), [is\\_equal\(\)](#), and [is\\_polynomial\(\)](#).

Referenced by [is\\_polynomial\(\)](#).

**6.8.3.28 degree()**

```
int GiNaC::basic::degree (
 const ex & s) const [virtual]
```

Return degree of highest power in object s.

Reimplemented in [GiNaC::add](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [degree\(\)](#), [ex](#), [GiNaC::ex\\_to\(\)](#), and [is\\_equal\(\)](#).

Referenced by [collect\(\)](#), and [degree\(\)](#).

**6.8.3.29 ldegree()**

```
int GiNaC::basic::ldegree (
 const ex & s) const [virtual]
```

Return degree of lowest power in object s.

Reimplemented in [GiNaC::add](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [ex](#), [GiNaC::ex\\_to\(\)](#), [is\\_equal\(\)](#), and [ldegree\(\)](#).

Referenced by [collect\(\)](#), and [ldegree\(\)](#).

### 6.8.3.30 `coeff()`

```
ex GiNaC::basic::coeff (
 const ex & s,
 int n = 1) const [virtual]
```

Return coefficient of degree n in object s.

Reimplemented in [GiNaC::add](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [coeff\(\)](#), [ex](#), [GiNaC::ex\\_to\(\)](#), and [is\\_equal\(\)](#).

Referenced by [coeff\(\)](#), [collect\(\)](#), [GiNaC::expairseq::read\\_archive\(\)](#), [series\(\)](#), [GiNaC::indexed::simplify\\_indexed](#), and [GiNaC::sqrfree\\_pfrac\(\)](#).

### 6.8.3.31 `expand()`

```
ex GiNaC::basic::expand (
 unsigned options = 0) const [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented in [GiNaC::add](#), [GiNaC::expairseq](#), [GiNaC::function](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::power](#), [GiNaC::pseries](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [ex](#), [GiNaC::ex\\_to\(\)](#), [expand\(\)](#), [GiNaC::status\\_flags::expanded](#), [map\(\)](#), [nops\(\)](#), and [setflag\(\)](#).

Referenced by [collect\(\)](#), [expand\(\)](#), [GiNaC::expand\(\)](#), [GiNaC::matrix::fraction\\_free\\_elimination\(\)](#), and [GiNaC::matrix::pivot\(\)](#).

### 6.8.3.32 `collect()`

```
ex GiNaC::basic::collect (
 const ex & s,
 bool distributed = false) const [virtual]
```

Sort expanded expression in terms of powers of some object(s).

#### Parameters

|                    |                                                            |
|--------------------|------------------------------------------------------------|
| <i>s</i>           | object(s) to sort in                                       |
| <i>distributed</i> | recursive or distributed form (only used when s is a list) |

Reimplemented in [GiNaC::pseries](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [coeff\(\)](#), [GiNaC::ex::coeff\(\)](#), [collect\(\)](#), [GiNaC::ex::collect\(\)](#), [degree\(\)](#), [GiNaC::ex::degree\(\)](#), [GiNaC::dynallocate\(\)](#), [ex](#), [GiNaC::ex\\_to\(\)](#), [expand\(\)](#), [GiNaC::is\\_a\(\)](#), [ldegree\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [GiNaC::pow\(\)](#).

Referenced by [collect\(\)](#).

### 6.8.3.33 derivative()

```
ex GiNaC::basic::derivative (
 const symbol & s) const [protected], [virtual]
```

Default implementation of [ex::diff\(\)](#).

It maps the operation on the operands (or returns 0 when the object has no operands).

See also

[ex::diff](#)

Reimplemented in [GiNaC::add](#), [GiNaC::constant](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::idx](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::structure< T, ComparisonPolicy>](#), and [GiNaC::symbol](#).

References [GiNaC::\\_ex0](#), [derivative\(\)](#), [ex](#), [map\(\)](#), and [nops\(\)](#).

Referenced by [derivative\(\)](#), and [diff\(\)](#).

### 6.8.3.34 series()

```
ex GiNaC::basic::series (
 const relational & r,
 int order,
 unsigned options = 0) const [virtual]
```

Default implementation of [ex::series\(\)](#).

This performs Taylor expansion.

See also

[ex::series](#)

Reimplemented in [GiNaC::add](#), [GiNaC::Eisenstein\\_h\\_kernel](#), [GiNaC::Eisenstein\\_kernel](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::integral](#), [GiNaC::integration\\_kernel](#), [GiNaC::modular\\_form\\_kernel](#), [GiNaC::mul](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::structure< T, ComparisonPolicy>](#), and [GiNaC::symbol](#).

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [coeff\(\)](#), [GiNaC::ex::diff\(\)](#), [GiNaC::numeric::div\(\)](#), [ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [has\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::relational::lhs\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [GiNaC::lgamma\\_series\(\)](#), [GiNaC::fderivative::series\(\)](#), [GiNaC::function::series\(\)](#), and [GiNaC::power::series\(\)](#).

### 6.8.3.35 normal()

```
ex GiNaC::basic::normal (
 exmap & repl,
 exmap & rev_lookup,
 lst & modifier) const [virtual]
```

Default implementation of [ex::normal\(\)](#).

It normalizes the children and replaces the object with a temporary symbol.

See also

[ex::normal](#)

Reimplemented in [GiNaC::add](#), [GiNaC::mul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::symbol](#).

References [GiNaC::\\_ex1](#), [GiNaC::dynallocate\(\)](#), [ex](#), [GiNaC::ex::info\(\)](#), [GiNaC::is\\_a\(\)](#), [map\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::subs\\_options::no\\_pattern](#), [nops\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::replace\\_with\\_symbol\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [GiNaC::matrix::markowitz\\_elimination\(\)](#), and [GiNaC::matrix::solve\(\)](#).

### 6.8.3.36 to\_rational()

```
ex GiNaC::basic::to_rational (
 exmap & repl) const [virtual]
```

Default implementation of [ex::to\\_rational\(\)](#).

This replaces the object with a temporary symbol.

Reimplemented in [GiNaC::expairseq](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::symbol](#).

References [ex](#), and [GiNaC::replace\\_with\\_symbol\(\)](#).

### 6.8.3.37 to\_polynomial()

```
ex GiNaC::basic::to_polynomial (
 exmap & repl) const [virtual]
```

Reimplemented in [GiNaC::expairseq](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::symbol](#).

References [ex](#), and [GiNaC::replace\\_with\\_symbol\(\)](#).

### 6.8.3.38 integer\_content()

```
numeric GiNaC::basic::integer_content () const [virtual]
```

Reimplemented in [GiNaC::add](#), [GiNaC::mul](#), [GiNaC::numeric](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::\\_num1\\_p](#).

### 6.8.3.39 smod()

```
ex GiNaC::basic::smod (
 const numeric & xi) const [virtual]
```

Apply symmetric modular homomorphism to an expanded multivariate polynomial.

This function is usually used internally by [heur\\_gcd\(\)](#).

## Parameters

|      |         |
|------|---------|
| $xi$ | modulus |
|------|---------|

## Returns

mapped polynomial

## See also

[heur\\_gcd](#)

Reimplemented in [GiNaC::add](#), [GiNaC::mul](#), [GiNaC::numeric](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [ex](#).

**6.8.3.40 max\_coefficient()**

```
numeric GiNaC::basic::max_coefficient () const [virtual]
```

Implementation [ex::max\\_coefficient\(\)](#).

## See also

[heur\\_gcd](#)

Reimplemented in [GiNaC::add](#), [GiNaC::mul](#), [GiNaC::numeric](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::\\_num1\\_p](#).

**6.8.3.41 get\_free\_indices()**

```
exvector GiNaC::basic::get_free_indices () const [virtual]
```

Return a vector containing the free indices of an expression.

Reimplemented in [GiNaC::add](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [get\\_free\\_indices\(\)](#).

Referenced by [get\\_free\\_indices\(\)](#).

**6.8.3.42 add\_indexed()**

```
ex GiNaC::basic::add_indexed (
 const ex & self,
 const ex & other) const [virtual]
```

Add two indexed expressions.

They are guaranteed to be of class [indexed](#) (or a subclass) and their indices are compatible. This function is used internally by [simplify\\_indexed\(\)](#).

## Parameters

|              |                                                           |
|--------------|-----------------------------------------------------------|
| <i>self</i>  | First indexed expression; its base object is <i>*this</i> |
| <i>other</i> | Second indexed expression                                 |

## Returns

sum of self and other

## See also

[ex::simplify\\_indexed\(\)](#)

Reimplemented in [GiNaC::matrix](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [add\\_indexed\(\)](#), and [ex](#).

Referenced by [add\\_indexed\(\)](#).

**6.8.3.43 scalar\_mul\_indexed()**

```
ex GiNaC::basic::scalar_mul_indexed (
 const ex & self,
 const numeric & other) const [virtual]
```

Multiply an indexed expression with a scalar.

This function is used internally by [simplify\\_indexed\(\)](#).

## Parameters

|              |                                                     |
|--------------|-----------------------------------------------------|
| <i>self</i>  | Indexed expression; its base object is <i>*this</i> |
| <i>other</i> | Numeric value                                       |

## Returns

product of self and other

## See also

[ex::simplify\\_indexed\(\)](#)

Reimplemented in [GiNaC::matrix](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [ex](#), and [scalar\\_mul\\_indexed\(\)](#).

Referenced by [scalar\\_mul\\_indexed\(\)](#).

**6.8.3.44 contract\_with()**

```
bool GiNaC::basic::contract_with (
 exvector::iterator self,
 exvector::iterator other,
 exvector & v) const [virtual]
```

Try to contract two indexed expressions that appear in the same product.

If a contraction exists, the function overwrites one or both of the expressions and returns true. Otherwise it returns false. It is guaranteed that both expressions are of class `indexed` (or a subclass) and that at least one dummy index has been found. This functions is used internally by [simplify\\_indexed\(\)](#).

## Parameters

|              |                                                               |
|--------------|---------------------------------------------------------------|
| <i>self</i>  | Pointer to first indexed expression; its base object is *this |
| <i>other</i> | Pointer to second indexed expression                          |
| <i>v</i>     | The complete vector of factors                                |

## Returns

true if the contraction was successful, false otherwise

## See also

[ex::simplify\\_indexed\(\)](#)

Reimplemented in [GiNaC::cliffordunit](#), [GiNaC::diracgamma](#), [GiNaC::matrix](#), [GiNaC::spinmetric](#), [GiNaC::structure< T, ComparisonPolicy>](#), [GiNaC::su3d](#), [GiNaC::su3f](#), [GiNaC::su3t](#), [GiNaC::tensdelta](#), [GiNaC::tensepsilon](#), and [GiNaC::tensmetric](#).

References [contract\\_with\(\)](#).

Referenced by [contract\\_with\(\)](#).

**6.8.3.45 return\_type()**

```
unsigned GiNaC::basic::return_type () const [virtual]
```

Reimplemented in [GiNaC::add](#), [GiNaC::clifford](#), [GiNaC::color](#), [GiNaC::expairseq](#), [GiNaC::fail](#), [GiNaC::function](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::matrix](#), [GiNaC::minkmetric](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::power](#), [GiNaC::relational](#), [GiNaC::structure< T, ComparisonPolicy>](#), [GiNaC::su3d](#), [GiNaC::su3f](#), [GiNaC::tensdelta](#), [GiNaC::tensepsilon](#), [GiNaC::tensmetric](#), and [GiNaC::tensor](#).

References [GiNaC::return\\_types::commutative](#), and [return\\_type\(\)](#).

Referenced by [return\\_type\(\)](#).

**6.8.3.46 return\_type\_tinfo()**

```
return_type_t GiNaC::basic::return_type_tinfo () const [virtual]
```

Reimplemented in [GiNaC::add](#), [GiNaC::clifford](#), [GiNaC::color](#), [GiNaC::function](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::power](#), [GiNaC::relational](#), and [GiNaC::structure< T, ComparisonPolicy>](#).

References [return\\_type\\_tinfo\(\)](#), [GiNaC::return\\_type\\_t::rl](#), and [GiNaC::return\\_type\\_t::tinfo](#).

Referenced by [return\\_type\\_tinfo\(\)](#).

#### 6.8.3.47 conjugate()

```
ex GiNaC::basic::conjugate () const [virtual]
```

Reimplemented in [GiNaC::add](#), [GiNaC::constant](#), [GiNaC::container< C >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::vector >](#), [GiNaC::container< std::vector >](#), [GiNaC::diracgamma5](#), [GiNaC::diracgammaL](#), [GiNaC::diracgammaR](#), [GiNaC::expairseq](#), [GiNaC::function](#), [GiNaC::integral](#), [GiNaC::matrix](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::realsymbol](#), [GiNaC::spinidx](#), and [GiNaC::symbol](#).

References [conjugate\(\)](#), and [ex](#).

Referenced by [conjugate\(\)](#).

#### 6.8.3.48 real\_part()

```
ex GiNaC::basic::real_part () const [virtual]
```

Reimplemented in [GiNaC::add](#), [GiNaC::constant](#), [GiNaC::container< C >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::vector >](#), [GiNaC::container< std::vector >](#), [GiNaC::function](#), [GiNaC::indexed](#), [GiNaC::matrix](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::realsymbol](#), and [GiNaC::symbol](#).

References [ex](#), and [real\\_part\(\)](#).

Referenced by [real\\_part\(\)](#), [GiNaC::function::real\\_part\(\)](#), and [GiNaC::ncmul::real\\_part\(\)](#).

#### 6.8.3.49 imag\_part()

```
ex GiNaC::basic::imag_part () const [virtual]
```

Reimplemented in [GiNaC::add](#), [GiNaC::constant](#), [GiNaC::container< C >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::vector >](#), [GiNaC::container< std::vector >](#), [GiNaC::function](#), [GiNaC::indexed](#), [GiNaC::matrix](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::realsymbol](#), and [GiNaC::symbol](#).

References [ex](#), and [imag\\_part\(\)](#).

Referenced by [imag\\_part\(\)](#), [GiNaC::function::imag\\_part\(\)](#), and [GiNaC::ncmul::imag\\_part\(\)](#).

#### 6.8.3.50 compare\_same\_type()

```
int GiNaC::basic::compare_same_type (
 const basic & other) const [protected], [virtual]
```

Returns order relation between two objects of same type.

This needs to be implemented by each class. It may never return anything else than 0, signalling equality, or +1 and -1 signalling inequality and determining the canonical ordering. (Perl hackers will wonder why C++ doesn't feature the spaceship operator `<=>` for denoting just this.)

References [basic\(\)](#), [GiNaC::compare\\_pointers\(\)](#), and [compare\\_same\\_type\(\)](#).

Referenced by [compare\(\)](#), [compare\\_same\\_type\(\)](#), [GiNaC::symbol::derivative\(\)](#), and [is\\_equal\\_same\\_type\(\)](#).



### 6.8.3.51 is\_equal\_same\_type()

```
bool GiNaC::basic::is_equal_same_type (
 const basic & other) const [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare\\_same\\_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented in [GiNaC::constant](#), [GiNaC::container< C >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::vector >](#), [GiNaC::container< std::vector >](#), [GiNaC::expairseq](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::numeric](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::symbol](#).

References [basic\(\)](#), [compare\\_same\\_type\(\)](#), and [is\\_equal\\_same\\_type\(\)](#).

Referenced by [is\\_equal\(\)](#), [is\\_equal\\_same\\_type\(\)](#), and [match\(\)](#).

### 6.8.3.52 calchash()

```
unsigned GiNaC::basic::calchash () const [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented in [GiNaC::constant](#), [GiNaC::expairseq](#), [GiNaC::function](#), [GiNaC::idx](#), [GiNaC::numeric](#), [GiNaC::relational](#), [GiNaC::structure< T, ComparisonPolicy >](#), [GiNaC::symbol](#), [GiNaC::symmetry](#), and [GiNaC::wildcard](#).

References [calchash\(\)](#), [GiNaC::status\\_flags::evaluated](#), [flags](#), [GiNaC::status\\_flags::hash\\_calculated](#), [hashvalue](#), [GiNaC::make\\_hash\\_seed\(\)](#), [nops\(\)](#), [op\(\)](#), [GiNaC::rotate\\_left\(\)](#), and [setflag\(\)](#).

Referenced by [calchash\(\)](#), and [gethash\(\)](#).

### 6.8.3.53 print\_dispatch() [1/2]

```
template<class T>
void GiNaC::basic::print_dispatch (
 const print_context & c,
 unsigned level) const [inline]
```

Like [print\(\)](#), but dispatch to the specified class.

Can be used by implementations of print methods to dispatch to the method of the superclass.

See also

[basic::print](#)

References [print\\_dispatch\(\)](#).

Referenced by [GiNaC::clifford::do\\_print\\_dflt\(\)](#), [GiNaC::clifford::do\\_print\\_latex\(\)](#), [print\(\)](#), [print\\_dispatch\(\)](#), and [print\\_dispatch\(\)](#).

### 6.8.3.54 `print_dispatch()` [2/2]

```
void GiNaC::basic::print_dispatch (
 const registered_class_info & ri,
 const print_context & c,
 unsigned level) const
```

Like [print\(\)](#), but dispatch to the specified class.

Can be used by implementations of print methods to dispatch to the method of the superclass.

See also

[basic::print](#)

References [GiNaC::print\\_context\\_options::get\\_id\(\)](#), [GiNaC::class\\_info< OPT >::get\\_parent\(\)](#), [GiNaC::class\\_info< OPT >::options](#), [print\\_dispatch\(\)](#), and [GiNaC::structure< T, CP >::reg\\_info](#).

### 6.8.3.55 `archive()`

```
void GiNaC::basic::archive (
 archive_node & n) const [virtual]
```

Save (serialize) the object into archive node.

Archive the object.

Losely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented in [GiNaC::clifford](#), [GiNaC::color](#), [GiNaC::constant](#), [GiNaC::container< C >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::vector >](#), [GiNaC::container< std::vector >](#), [GiNaC::expairseq](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::idx](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::matrix](#), [GiNaC::minkmetric](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::relational](#), [GiNaC::spinidx](#), [GiNaC::symbol](#), [GiNaC::symmetry](#), [GiNaC::tensepsilon](#), [GiNaC::varidx](#), and [GiNaC::wildcard](#).

References [GiNaC::archive\\_node::add\\_string\(\)](#), and [archive\(\)](#).

Referenced by [archive\(\)](#).

### 6.8.3.56 `read_archive()`

```
void GiNaC::basic::read_archive (
 const archive_node & n,
 lst & syms) [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive\\_node](#).

Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented in [GiNaC::clifford](#), [GiNaC::color](#), [GiNaC::constant](#), [GiNaC::container< C >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::list >](#), [GiNaC::container< std::vector >](#), [GiNaC::container< std::vector >](#), [GiNaC::expairseq](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::idx](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::matrix](#), [GiNaC::minkmetric](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::relational](#), [GiNaC::spinidx](#), [GiNaC::symbol](#), [GiNaC::symmetry](#), [GiNaC::tensepsilon](#), [GiNaC::varidx](#), and [GiNaC::wildcard](#).

References [read\\_archive\(\)](#).

Referenced by [read\\_archive\(\)](#).

**6.8.3.57 subs\_one\_level()**

```
ex GiNaC::basic::subs_one_level (
 const exmap & m,
 unsigned options) const
```

Helper function for [subs\(\)](#).

Does not recurse into subexpressions.

References [ex](#), [GiNaC::ex\\_to\(\)](#), [match\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), and [subs\\_one\\_level\(\)](#).

Referenced by [GiNaC::mul::algebraic\\_subs\\_mul\(\)](#), [subs\(\)](#), [GiNaC::container< C >::subs\(\)](#), [GiNaC::expairseq::subs\(\)](#), [GiNaC::numeric::subs\(\)](#), [GiNaC::power::subs\(\)](#), [GiNaC::relational::subs\(\)](#), [GiNaC::symbol::subs\(\)](#), and [subs\\_one\\_level\(\)](#).

**6.8.3.58 diff()**

```
ex GiNaC::basic::diff (
 const symbol & s,
 unsigned nth = 1) const
```

Default interface of nth derivative [ex::diff\(s, n\)](#).

It should be called instead of [::derivative\(s\)](#) for first derivatives and for nth derivatives it just recurses down.

**Parameters**

|            |                            |
|------------|----------------------------|
| <i>s</i>   | symbol to differentiate in |
| <i>nth</i> | order of differentiation   |

**See also**

[ex::diff](#)

References [derivative\(\)](#), [diff\(\)](#), [GiNaC::ex::diff\(\)](#), [GiNaC::status\\_flags::evaluated](#), [ex](#), [flags](#), and [GiNaC::ex::is\\_zero\(\)](#).

Referenced by [GiNaC::mul::derivative\(\)](#), and [diff\(\)](#).

**6.8.3.59 compare()**

```
int GiNaC::basic::compare (
 const basic & other) const
```

Compare objects syntactically to establish canonical ordering.

All compare functions return: -1 for \*this less than other, 0 equal, 1 greater.

References [basic\(\)](#), [compare\(\)](#), [compare\\_same\\_type\(\)](#), and [gethash\(\)](#).

Referenced by [compare\(\)](#).

### 6.8.3.60 is\_equal()

```
bool GiNaC::basic::is_equal (
 const basic & other) const
```

Test for syntactic equality.

This is only a quick test, meaning objects should be in the same domain. You might have to [.expand\(\)](#), [.normal\(\)](#) objects first, depending on the domain of your computation, to get a more reliable answer.

See also

[is\\_equal\\_same\\_type](#)

References [basic\(\)](#), [gethash\(\)](#), [is\\_equal\(\)](#), and [is\\_equal\\_same\\_type\(\)](#).

Referenced by [coeff\(\)](#), [GiNaC::ncmul::coeff\(\)](#), [GiNaC::power::coeff\(\)](#), [degree\(\)](#), [GiNaC::ncmul::degree\(\)](#), [GiNaC::power::degree\(\)](#), [is\\_equal\(\)](#), [is\\_polynomial\(\)](#), [ldegree\(\)](#), [GiNaC::ncmul::ldegree\(\)](#), [GiNaC::power::ldegree\(\)](#), [match\(\)](#), and [GiNaC::wildcard::match\(\)](#).

### 6.8.3.61 hold()

```
const basic & GiNaC::basic::hold () const
```

Stop further evaluation.

See also

[basic::eval](#)

References [basic\(\)](#), [GiNaC::status\\_flags::evaluated](#), [hold\(\)](#), and [setflag\(\)](#).

Referenced by [GiNaC::abs\\_conjugate\(\)](#), [GiNaC::abs\\_eval\(\)](#), [GiNaC::abs\\_evalf\(\)](#), [GiNaC::abs\\_expand\(\)](#), [GiNaC::abs\\_power\(\)](#), [GiNaC::abs\\_real\\_part\(\)](#), [GiNaC::acos\\_eval\(\)](#), [GiNaC::acos\\_evalf\(\)](#), [GiNaC::acosh\\_eval\(\)](#), [GiNaC::acosh\\_evalf\(\)](#), [GiNaC::asin\\_eval\(\)](#), [GiNaC::asin\\_evalf\(\)](#), [GiNaC::asinh\\_eval\(\)](#), [GiNaC::asinh\\_evalf\(\)](#), [GiNaC::atan\\_eval\(\)](#), [GiNaC::atan\\_evalf\(\)](#), [GiNaC::atanh\\_eval\(\)](#), [GiNaC::atanh\\_evalf\(\)](#), [GiNaC::binomial\\_conjugate\(\)](#), [GiNaC::binomial\\_eval\(\)](#), [GiNaC::binomial\\_evalf\(\)](#), [GiNaC::binomial\\_real\\_part\(\)](#), [GiNaC::binomial\\_sym\(\)](#), [GiNaC::conjugate\\_expl\\_derivative\(\)](#), [GiNaC::cos\\_eval\(\)](#), [GiNaC::cos\\_evalf\(\)](#), [GiNaC::cosh\\_eval\(\)](#), [GiNaC::cosh\\_evalf\(\)](#), [GiNaC::csgn\\_power\(\)](#), [GiNaC::epsilon\\_tensor\(\)](#), [GiNaC::epsilon\\_tensor\(\)](#), [GiNaC::add::eval\(\)](#), [eval\(\)](#), [GiNaC::expairseq::eval\(\)](#), [GiNaC::fderivative::eval\(\)](#), [GiNaC::function::eval\(\)](#), [GiNaC::integral::eval\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::numeric::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::pseries::eval\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::eval\(\)](#), [GiNaC::matrix::eval\\_indexed\(\)](#), [GiNaC::spinmetric::eval\\_indexed\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::eval\\_indexed\(\)](#), [GiNaC::su3d::eval\\_indexed\(\)](#), [GiNaC::su3f::eval\\_indexed\(\)](#), [GiNaC::tensepsilon::eval\\_indexed\(\)](#), [GiNaC::tensmetric::eval\\_indexed\(\)](#), [GiNaC::exp\\_eval\(\)](#), [GiNaC::exp\\_evalf\(\)](#), [GiNaC::exp\\_expand\(\)](#), [GiNaC::exp\\_power\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::factorial\\_conjugate\(\)](#), [GiNaC::factorial\\_eval\(\)](#), [GiNaC::factorial\\_evalf\(\)](#), [GiNaC::factorial\\_real\\_part\(\)](#), [GiNaC::G2\\_eval\(\)](#), [GiNaC::G2\\_evalf\(\)](#), [GiNaC::G3\\_eval\(\)](#), [GiNaC::G3\\_evalf\(\)](#), [hold\(\)](#), [GiNaC::imag\\_part\\_expl\\_derivative\(\)](#), [GiNaC::iterated\\_integral2\\_eval\(\)](#), [GiNaC::iterated\\_integral3\\_eval\(\)](#), [GiNaC::iterated\\_integral\\_evalf\\_impl\(\)](#), [GiNaC::Li2\\_conjugate\(\)](#), [GiNaC::Li2\\_eval\(\)](#), [GiNaC::Li2\\_evalf\(\)](#), [GiNaC::log\\_eval\(\)](#), [GiNaC::log\\_evalf\(\)](#), [GiNaC::log\\_expand\(\)](#), [GiNaC::log\\_real\\_part\(\)](#), [GiNaC::lorentz\\_eps\(\)](#), [GiNaC::Order\\_power\(\)](#), [GiNaC::psi1\\_eval\(\)](#), [GiNaC::psi1\\_evalf\(\)](#), [GiNaC::psi2\\_eval\(\)](#), [GiNaC::psi2\\_evalf\(\)](#), [GiNaC::real\\_part\\_expl\\_derivative\(\)](#), [GiNaC::sin\\_eval\(\)](#), [GiNaC::sin\\_evalf\(\)](#), [GiNaC::sinh\\_eval\(\)](#), [GiNaC::sinh\\_evalf\(\)](#), [GiNaC::step\\_conjugate\(\)](#), [GiNaC::step\\_eval\(\)](#), [GiNaC::step\\_evalf\(\)](#), [GiNaC::step\\_real\\_part\(\)](#), [GiNaC::tan\\_eval\(\)](#), [GiNaC::tan\\_evalf\(\)](#), [GiNaC::tanh\\_eval\(\)](#), [GiNaC::tanh\\_evalf\(\)](#), [GiNaC::zeta1\\_eval\(\)](#), [GiNaC::zeta1\\_evalf\(\)](#), [GiNaC::zeta2\\_eval\(\)](#), [GiNaC::zeta2\\_evalf\(\)](#), and [GiNaC::zetaderiv\\_eval\(\)](#).

### 6.8.3.62 gethash()

```
unsigned GiNaC::basic::gethash () const [inline]
```

References [calchash\(\)](#), [flags](#), [GiNaC::status\\_flags::hash\\_calculated](#), and [hashvalue](#).

Referenced by [GiNaC::remember\\_table::add\\_entry\(\)](#), [compare\(\)](#), [is\\_equal\(\)](#), [GiNaC::remember\\_table\\_entry::is\\_equal\(\)](#), and [GiNaC::remember\\_table::lookup\\_entry\(\)](#).

### 6.8.3.63 setflag()

```
const basic & GiNaC::basic::setflag (
 unsigned f) const [inline]
```

Set some [status\\_flags](#).

References [basic\(\)](#), and [flags](#).

Referenced by [calchash\(\)](#), [GiNaC::constant::calchash\(\)](#), [GiNaC::expairseq::calchash\(\)](#), [GiNaC::function::calchash\(\)](#), [GiNaC::idx::calchash\(\)](#), [GiNaC::numeric::calchash\(\)](#), [GiNaC::relational::calchash\(\)](#), [GiNaC::symbol::calchash\(\)](#), [GiNaC::symmetry::calchash\(\)](#), [GiNaC::wildcard::calchash\(\)](#), [GiNaC::constant::constant\(\)](#), [GiNaC::constant::constant\(\)](#), [GiNaC::container< std::vector >::container\(\)](#), [GiNaC::container< std::vector >::container\(\)](#), [GiNaC::container< std::vector >::container\(\)](#), [duplicate\(\)](#), [GiNaC::possymbol::duplicate\(\)](#), [GiNaC::realsymbol::duplicate\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::add::expand\(\)](#), [expand\(\)](#), [GiNaC::expairseq::expand\(\)](#), [GiNaC::function::expand\(\)](#), [GiNaC::integral::expand\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::ncmul::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::expand\\_mul\(\)](#), [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#), [hold\(\)](#), [GiNaC::expairseq::info\(\)](#), [GiNaC::mul::info\(\)](#), [GiNaC::power::info\(\)](#), [GiNaC::log\\_expand\(\)](#), [GiNaC::matrix::matrix\(\)](#), [GiNaC::matrix::matrix\(\)](#), [GiNaC::matrix::matrix\(\)](#), [GiNaC::matrix::matrix\(\)](#), [GiNaC::matrix::matrix\(\)](#), [GiNaC::numeric::numeric\(\)](#), [GiNaC::numeric::numeric\(\)](#), [GiNaC::numeric::numeric\(\)](#), [GiNaC::numeric::numeric\(\)](#), [GiNaC::numeric::numeric\(\)](#), [GiNaC::numeric::numeric\(\)](#), [GiNaC::numeric::numeric\(\)](#), [GiNaC::numeric::numeric\(\)](#), [GiNaC::numeric::numeric\(\)](#), [GiNaC::numeric::numeric\(\)](#), [GiNaC::numeric::numeric\(\)](#), [GiNaC::container< std::vector >::read\\_archive\(\)](#), [GiNaC::numeric::read\\_archive\(\)](#), [GiNaC::symbol::read\\_archive\(\)](#), [GiNaC::wildcard::read\\_archive\(\)](#), [GiNaC::reduced\\_matrix\(\)](#), [GiNaC::sub\\_matrix\(\)](#), [GiNaC::symbol::symbol\(\)](#), [GiNaC::symbol::symbol\(\)](#), [GiNaC::symbolic\\_matrix\(\)](#), [GiNaC::symmetry::symmetry\(\)](#), [GiNaC::symmetry::symmetry\(\)](#), [GiNaC::unit\\_matrix\(\)](#), and [GiNaC::wildcard::wildcard\(\)](#).

### 6.8.3.64 clearflag()

```
const basic & GiNaC::basic::clearflag (
 unsigned f) const [inline]
```

Clear some [status\\_flags](#).

References [basic\(\)](#), and [flags](#).

Referenced by [GiNaC::add::combine\\_ex\\_with\\_coeff\\_to\\_pair\(\)](#), [ensure\\_if\\_modifiable\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::function::function\(\)](#), [GiNaC::expairseq::info\(\)](#), [GiNaC::power::info\(\)](#), [map\(\)](#), [GiNaC::idx::map\(\)](#), [GiNaC::idx::replace\\_dim\(\)](#), [GiNaC::mul::smod\(\)](#), [GiNaC::add::split\\_ex\\_to\\_pair\(\)](#), [subs\(\)](#), [GiNaC::idx::subs\(\)](#), [GiNaC::spinidx::toggle\\_dot\(\)](#), [GiNaC::varidx::toggle\\_variance\(\)](#), and [GiNaC::spinidx::toggle\\_variance\\_dot\(\)](#).

### 6.8.3.65 ensure\_if\_modifiable()

```
void GiNaC::basic::ensure_if_modifiable () const [protected]
```

Ensure the object may be modified without hurting others, throws if this is not the case.

References [clearflag\(\)](#), [ensure\\_if\\_modifiable\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::refcounted::get\\_refcount\(\)](#), and [GiNaC::status\\_flags::hash\\_calculated](#).

Referenced by [GiNaC::container< C >::append\(\)](#), [GiNaC::matrix::division\\_free\\_elimination\(\)](#), [ensure\\_if\\_modifiable\(\)](#), [GiNaC::matrix::fraction\\_free\\_elimination\(\)](#), [GiNaC::matrix::gauss\\_elimination\(\)](#), [let\\_op\(\)](#), [GiNaC::clifford::let\\_op\(\)](#), [GiNaC::container< C >::let\\_op\(\)](#), [GiNaC::Ebar\\_kernel::let\\_op\(\)](#), [GiNaC::Eisenstein\\_h\\_kernel::let\\_op\(\)](#), [GiNaC::Eisenstein\\_kernel::let\\_op\(\)](#), [GiNaC::ELi\\_kernel::let\\_op\(\)](#), [GiNaC::integral::let\\_op\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::let\\_op\(\)](#), [GiNaC::Kronecker\\_dz\\_kernel::let\\_op\(\)](#), [GiNaC::matrix::let\\_op\(\)](#), [GiNaC::modular\\_form\\_kernel::let\\_op\(\)](#), [GiNaC::multiple\\_polylog\\_kernel::let\\_op\(\)](#), [GiNaC::user\\_defined\\_kernel::let\\_op\(\)](#), [GiNaC::matrix::operator\(\)](#), [GiNaC::matrix::pivot\(\)](#), [GiNaC::container< C >::prepend\(\)](#), [GiNaC::container< C >::remove\\_all\(\)](#), [GiNaC::container< C >::remove\\_first\(\)](#), [GiNaC::container< C >::remove\\_last\(\)](#), [GiNaC::container< C >::sort\(\)](#), and [GiNaC::container< C >::unique\(\)](#).

### 6.8.3.66 do\_print()

```
void GiNaC::basic::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

Default output to stream.

References [do\\_print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [do\\_print\(\)](#), and [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.8.3.67 do\_print\_tree()

```
void GiNaC::basic::do_print_tree (
 const print_tree & c,
 unsigned level) const [protected]
```

Tree output to stream.

References [GiNaC::print\\_tree::delta\\_indent](#), [do\\_print\\_tree\(\)](#), [flags](#), [hashvalue](#), [nops\(\)](#), [op\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [do\\_print\\_tree\(\)](#), [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#), [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#), [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#), [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#), [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#), and [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.8.3.68 do\_print\_python\_repr()

```
void GiNaC::basic::do_print_python_repr (
 const print_python_repr & c,
 unsigned level) const [protected]
```

Python parsable output to stream.

References [do\\_print\\_python\\_repr\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [do\\_print\\_python\\_repr\(\)](#), and [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.8.4 Friends And Related Symbol Documentation

### 6.8.4.1 ex

friend class `ex` [friend]

References `ex`.

Referenced by `add_indexed()`, `GiNaC::matrix::add_indexed()`, `GiNaC::structure< T, ComparisonPolicy >::add_indexed()`, `GiNaC::pseries::add_series()`, `GiNaC::container< C >::append()`, `GiNaC::container< std::vector >::append()`, `GiNaC::relational::canonical()`, `GiNaC::matrix::charpoly()`, `coeff()`, `GiNaC::numeric::coeff()`, `GiNaC::power::coeff()`, `GiNaC::pseries::coeff()`, `GiNaC::structure< T, ComparisonPolicy >::coeff()`, `GiNaC::pseries::coeffop()`, `collect()`, `GiNaC::pseries::collect()`, `GiNaC::structure< T, ComparisonPolicy >::collect()`, `GiNaC::expairseq::combine_ex_with_coeff_to_pair()`, `GiNaC::expairseq::combine_overall_coeff()`, `GiNaC::expairseq::combine_overall_coeff()`, `GiNaC::expairseq::combine_pair_with_coeff()`, `conjugate()`, `GiNaC::constant::conjugate()`, `GiNaC::container< std::vector >::conjugate()`, `GiNaC::expairseq::conjugate()`, `GiNaC::integral::conjugate()`, `GiNaC::matrix::conjugate()`, `GiNaC::numeric::conjugate()`, `GiNaC::power::conjugate()`, `GiNaC::pseries::conjugate()`, `GiNaC::symbol::conjugate()`, `GiNaC::expairseq::construct_from_2_ex()`, `GiNaC::expairseq::construct_from_2_ex()`, `GiNaC::pseries::convert_to_poly()`, `GiNaC::expairseq::default_overall_coeff()`, `degree()`, `GiNaC::integral::degree()`, `GiNaC::numeric::degree()`, `GiNaC::power::degree()`, `GiNaC::pseries::degree()`, `GiNaC::structure< T, ComparisonPolicy >::degree()`, `derivative()`, `GiNaC::constant::derivative()`, `GiNaC::idx::derivative()`, `GiNaC::integral::derivative()`, `GiNaC::numeric::derivative()`, `GiNaC::power::derivative()`, `GiNaC::pseries::derivative()`, `GiNaC::structure< T, ComparisonPolicy >::derivative()`, `GiNaC::symbol::derivative()`, `GiNaC::matrix::determinant()`, `GiNaC::matrix::determinant_minor()`, `diff()`, `GiNaC::mul::do_print_csrc()`, `eval()`, `GiNaC::expairseq::eval()`, `GiNaC::function::eval()`, `GiNaC::indexed::eval()`, `GiNaC::integral::eval()`, `GiNaC::numeric::eval()`, `GiNaC::power::eval()`, `GiNaC::pseries::eval()`, `GiNaC::structure< T, ComparisonPolicy >::eval()`, `GiNaC::symbol::eval()`, `eval_indexed()`, `GiNaC::matrix::eval_indexed()`, `GiNaC::structure< T, ComparisonPolicy >::eval_indexed()`, `eval_integ()`, `GiNaC::integral::eval_integ()`, `GiNaC::pseries::eval_integ()`, `eval_ncmul()`, `GiNaC::integral::eval_ncmul()`, `GiNaC::power::eval_ncmul()`, `GiNaC::relational::eval_ncmul()`, `GiNaC::structure< T, ComparisonPolicy >::eval_ncmul()`, `evalf()`, `GiNaC::constant::evalf()`, `GiNaC::idx::evalf()`, `GiNaC::integral::evalf()`, `GiNaC::numeric::evalf()`, `GiNaC::power::evalf()`, `GiNaC::pseries::evalf()`, `GiNaC::symbol::evalf()`, `evalm()`, `GiNaC::matrix::evalm()`, `GiNaC::power::evalm()`, `GiNaC::pseries::evalm()`, `GiNaC::structure< T, ComparisonPolicy >::evalm()`, `ex`, `GiNaC::expairseq::expairseq()`, `GiNaC::expairseq::expairseq()`, `GiNaC::expairseq::expairseq()`, `expand()`, `GiNaC::expairseq::expand()`, `GiNaC::integral::expand()`, `GiNaC::power::expand()`, `GiNaC::pseries::expand()`, `GiNaC::structure< T, ComparisonPolicy >::expand()`, `GiNaC::power::expand_add()`, `GiNaC::power::expand_add_2()`, `GiNaC::power::expand_mul()`, `GiNaC::expairseq::expandchildren()`, `GiNaC::pseries::exponop()`, `GiNaC::matrix::fraction_free_elimination()`, `GiNaC::matrix::gauss_elimination()`, `GiNaC::idx::get_dim()`, `GiNaC::integration_kernel::get_numerical_value()`, `GiNaC::integration_kernel::get_numerical_value_impl()`, `GiNaC::pseries::get_point()`, `GiNaC::integration_kernel::get_series_coeff()`, `GiNaC::idx::get_value()`, `GiNaC::pseries::get_var()`, `has()`, `GiNaC::numeric::has()`, `GiNaC::power::has()`, `GiNaC::structure< T, ComparisonPolicy >::has()`, `GiNaC::idx::idx()`, `imag_part()`, `GiNaC::constant::imag_part()`, `GiNaC::container< std::vector >::imag_part()`, `GiNaC::matrix::imag_part()`, `GiNaC::numeric::imag_part()`, `GiNaC::power::imag_part()`, `GiNaC::pseries::imag_part()`, `GiNaC::symbol::imag_part()`, `GiNaC::integral::integral()`, `is_polynomial()`, `GiNaC::constant::is_polynomial()`, `GiNaC::numeric::is_polynomial()`, `GiNaC::power::is_polynomial()`, `GiNaC::symbol::is_polynomial()`, `GiNaC::integration_kernel::Laurent_series()`, `ldegree()`, `GiNaC::integral::ldegree()`, `GiNaC::numeric::ldegree()`, `GiNaC::power::ldegree()`, `GiNaC::pseries::ldegree()`, `GiNaC::structure< T, ComparisonPolicy >::ldegree()`, `let_op()`, `GiNaC::container< C >::let_op()`, `GiNaC::container< std::vector >::let_op()`, `GiNaC::integral::let_op()`, `GiNaC::matrix::let_op()`, `GiNaC::structure< T, ComparisonPolicy >::let_op()`, `GiNaC::relational::lhs()`, `GiNaC::expairseq::make_flat()`, `GiNaC::expairseq::make_flat()`, `map()`, `GiNaC::expairseq::map()`, `GiNaC::idx::map()`, `GiNaC::power::map()`, `GiNaC::relational::map()`, `GiNaC::structure< T, ComparisonPolicy >::map()`, `GiNaC::matrix::markowitz_elimination()`, `match()`, `GiNaC::expairseq::match()`, `GiNaC::structure< T, ComparisonPolicy >::match()`, `GiNaC::wildcard::match()`, `GiNaC::idx::minimal_dim()`, `GiNaC::pseries::mul_const()`, `GiNaC::matrix::mul_scalar()`, `GiNaC::pseries::mul_series()`, `normal()`, `GiNaC::numeric::normal()`, `GiNaC::power::normal()`, `GiNaC::pseries::normal()`, `GiNaC::structure< T, ComparisonPolicy >::normal()`, `GiNaC::symbol::normal()`, `op()`, `GiNaC::container< C >::op()`, `GiNaC::container< std::vector >::op()`, `GiNaC::expairseq::op()`, `GiNaC::idx::op()`, `GiNaC::integral::op()`, `GiNaC::matrix::op()`, `GiNaC::power::op()`, `GiNaC::pseries::op()`, `GiNaC::relational::op()`, `GiNaC::structure< T, ComparisonPolicy >::op()`, `GiNaC::relational::operator safe_bool()`, `GiNaC::matrix::operator()`, `GiNaC::matrix::operator()`, `operator[]()`, `operator[]()`, `operator[]()`, `operator[]()`, `operator[]()`, `GiNaC::structure< T, ComparisonPolicy >::operator[]()`, `GiNaC::structure< T, ComparisonPolicy >::operator[]()`, `GiNaC::structure< T, ComparisonPolicy >::operator[]()`, `GiNaC::matrix::pow()`, `GiNaC::power::power()`, `GiNaC::power::power()`, `GiNaC::pseries::power_const()`, `GiNaC::container< C >::prepend()`, `GiNaC::container< std::vector >::prepend()`, `GiNaC::pseries::pseries()`, `GiNaC::pseries::pseries()`, `GiNaC::container< std::vector >::read_archive()`, `GiNaC::expairseq::read_archive()`

[GiNaC::matrix::read\\_archive\(\)](#), [GiNaC::pseries::read\\_archive\(\)](#), [GiNaC::symmetry::read\\_archive\(\)](#), [real\\_part\(\)](#),  
[GiNaC::constant::real\\_part\(\)](#), [GiNaC::container< std::vector >::real\\_part\(\)](#), [GiNaC::matrix::real\\_part\(\)](#), [GiNaC::numeric::real\\_part\(\)](#),  
[GiNaC::power::real\\_part\(\)](#), [GiNaC::pseries::real\\_part\(\)](#), [GiNaC::symbol::real\\_part\(\)](#), [GiNaC::expairseq::recombine\\_pair\\_to\\_ex\(\)](#),  
[GiNaC::relational::relational\(\)](#), [GiNaC::tensor::replace\\_contr\\_index\(\)](#), [GiNaC::idx::replace\\_dim\(\)](#), [GiNaC::relational::rhs\(\)](#),  
[scalar\\_mul\\_indexed\(\)](#), [GiNaC::matrix::scalar\\_mul\\_indexed\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::scalar\\_mul\\_indexed\(\)](#),  
[series\(\)](#), [GiNaC::integral::series\(\)](#), [GiNaC::integration\\_kernel::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::pseries::series\(\)](#),  
[GiNaC::structure< T, ComparisonPolicy >::series\(\)](#), [GiNaC::symbol::series\(\)](#), [GiNaC::integration\\_kernel::series\\_coeff\(\)](#),  
[GiNaC::matrix::set\(\)](#), [smod\(\)](#), [GiNaC::numeric::smod\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::smod\(\)](#),  
[GiNaC::matrix::solve\(\)](#), [GiNaC::expairseq::split\\_ex\\_to\\_pair\(\)](#), [subs\(\)](#), [GiNaC::container< C >::subs\(\)](#), [GiNaC::container< std::vector >::subs\(\)](#),  
[GiNaC::expairseq::subs\(\)](#), [GiNaC::idx::subs\(\)](#), [GiNaC::matrix::subs\(\)](#), [GiNaC::numeric::subs\(\)](#), [GiNaC::power::subs\(\)](#),  
[GiNaC::pseries::subs\(\)](#), [GiNaC::relational::subs\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::subs\(\)](#), [GiNaC::symbol::subs\(\)](#),  
[subs\\_one\\_level\(\)](#), [GiNaC::container< C >::subchildren\(\)](#), [GiNaC::expairseq::subchildren\(\)](#), [GiNaC::container< std::vector >::thiscontainer\(\)](#),  
[GiNaC::container< std::vector >::thiscontainer\(\)](#), [GiNaC::expairseq::thisexpairseq\(\)](#), [GiNaC::expairseq::thisexpairseq\(\)](#),  
[to\\_polynomial\(\)](#), [GiNaC::expairseq::to\\_polynomial\(\)](#), [GiNaC::numeric::to\\_polynomial\(\)](#), [GiNaC::power::to\\_polynomial\(\)](#),  
[GiNaC::structure< T, ComparisonPolicy >::to\\_polynomial\(\)](#), [GiNaC::symbol::to\\_polynomial\(\)](#), [to\\_rational\(\)](#),  
[GiNaC::expairseq::to\\_rational\(\)](#), [GiNaC::numeric::to\\_rational\(\)](#), [GiNaC::power::to\\_rational\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::to\\_rational\(\)](#),  
[GiNaC::symbol::to\\_rational\(\)](#), and [GiNaC::matrix::trace\(\)](#).

## 6.8.5 Member Data Documentation

### 6.8.5.1 flags

`unsigned GiNaC::basic::flags [mutable], [protected]`

of type [status\\_flags](#)

Referenced by [basic\(\)](#), [calchash\(\)](#), [GiNaC::expairseq::calchash\(\)](#), [GiNaC::function::calchash\(\)](#), [GiNaC::idx::calchash\(\)](#),  
[GiNaC::relational::calchash\(\)](#), [GiNaC::symmetry::calchash\(\)](#), [clearflag\(\)](#), [GiNaC::ex::construct\\_from\\_basic\(\)](#), [diff\(\)](#),  
[do\\_print\\_tree\(\)](#), [GiNaC::clifford::do\\_print\\_tree\(\)](#), [GiNaC::constant::do\\_print\\_tree\(\)](#), [GiNaC::container< C >::do\\_print\\_tree\(\)](#),  
[GiNaC::expairseq::do\\_print\\_tree\(\)](#), [GiNaC::fderivative::do\\_print\\_tree\(\)](#), [GiNaC::idx::do\\_print\\_tree\(\)](#), [GiNaC::indexed::do\\_print\\_tree\(\)](#),  
[GiNaC::numeric::do\\_print\\_tree\(\)](#), [GiNaC::pseries::do\\_print\\_tree\(\)](#), [GiNaC::spinidx::do\\_print\\_tree\(\)](#), [GiNaC::symbol::do\\_print\\_tree\(\)](#),  
[GiNaC::symmetry::do\\_print\\_tree\(\)](#), [GiNaC::varidx::do\\_print\\_tree\(\)](#), [GiNaC::wildcard::do\\_print\\_tree\(\)](#), [GiNaC::add::eval\(\)](#),  
[GiNaC::expairseq::eval\(\)](#), [GiNaC::function::eval\(\)](#), [GiNaC::integral::eval\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::ncmul::eval\(\)](#),  
[GiNaC::power::eval\(\)](#), [GiNaC::integral::eval\\_integ\(\)](#), [GiNaC::integral::expand\(\)](#), [gethash\(\)](#), [GiNaC::expairseq::info\(\)](#),  
[GiNaC::mul::info\(\)](#), [GiNaC::power::info\(\)](#), [operator=\(\)](#), [GiNaC::function::print\(\)](#), [setflag\(\)](#), and [~basic\(\)](#).

### 6.8.5.2 hashvalue

`unsigned GiNaC::basic::hashvalue [mutable], [protected]`

hash value

Referenced by [calchash\(\)](#), [GiNaC::constant::calchash\(\)](#), [GiNaC::expairseq::calchash\(\)](#), [GiNaC::function::calchash\(\)](#),  
[GiNaC::idx::calchash\(\)](#), [GiNaC::numeric::calchash\(\)](#), [GiNaC::relational::calchash\(\)](#), [GiNaC::symbol::calchash\(\)](#),  
[GiNaC::symmetry::calchash\(\)](#), [GiNaC::wildcard::calchash\(\)](#), [do\\_print\\_tree\(\)](#), [GiNaC::clifford::do\\_print\\_tree\(\)](#),  
[GiNaC::constant::do\\_print\\_tree\(\)](#), [GiNaC::container< C >::do\\_print\\_tree\(\)](#), [GiNaC::expairseq::do\\_print\\_tree\(\)](#),  
[GiNaC::fderivative::do\\_print\\_tree\(\)](#), [GiNaC::idx::do\\_print\\_tree\(\)](#), [GiNaC::indexed::do\\_print\\_tree\(\)](#), [GiNaC::numeric::do\\_print\\_tree\(\)](#),  
[GiNaC::pseries::do\\_print\\_tree\(\)](#), [GiNaC::spinidx::do\\_print\\_tree\(\)](#), [GiNaC::symbol::do\\_print\\_tree\(\)](#), [GiNaC::symmetry::do\\_print\\_tree\(\)](#),  
[GiNaC::varidx::do\\_print\\_tree\(\)](#), [GiNaC::wildcard::do\\_print\\_tree\(\)](#), [gethash\(\)](#), [operator=\(\)](#), and [GiNaC::function::print\(\)](#).

The documentation for this class was generated from the following files:

- [basic.h](#)
- [basic.cpp](#)
- [normal.cpp](#)
- [pseries.cpp](#)

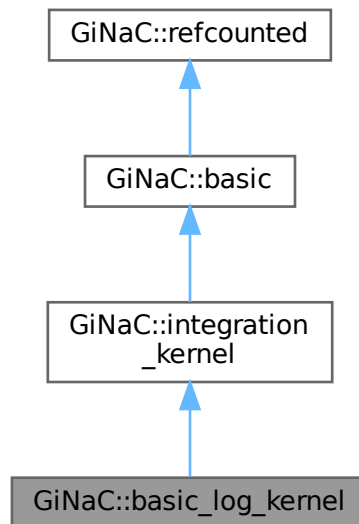


## 6.9 GiNaC::basic\_log\_kernel Class Reference

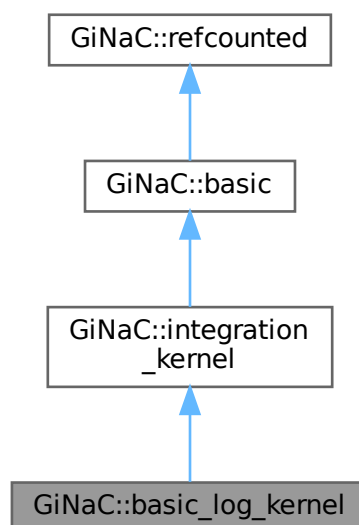
The basic integration kernel with a logarithmic singularity at the origin.

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::basic\_log\_kernel:



Collaboration diagram for GiNaC::basic\_log\_kernel:



### Protected Member Functions

- `cln::cl_N_series_coeff_impl` (int i) const override  
*For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.*
- void `do_print` (const `print_context` &c, unsigned level) const

### Protected Member Functions inherited from `GiNaC::integration_kernel`

- virtual bool `uses_Laurent_series` () const  
*Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).*
- `ex get_numerical_value_impl` (const `ex` &lambda, const `ex` &pre, int shift, int N\_trunc) const  
*The actual implementation for computing a numerical value for the integrand.*
- void `do_print` (const `print_context` &c, unsigned level) const

### Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual `ex derivative` (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned `calchash` () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void `do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

### Additional Inherited Members

### Public Member Functions inherited from `GiNaC::integration_kernel`

- `ex series` (const `relational` &r, int order, unsigned options=0) const override  
*Default implementation of `ex::series()`.*
- virtual bool `has_trailing_zero` (void) const  
*This routine returns true, if the integration kernel has a trailing zero.*
- virtual bool `is_numeric` (void) const  
*This routine returns true, if the integration kernel can be evaluated numerically.*
- virtual `ex Laurent_series` (const `ex` &x, int order) const

- Returns the Laurent series, starting possibly with the pole term.*
- virtual `ex get_numerical_value` (const `ex` &lambda, int N\_trunc=0) const  
*Evaluates the integrand at lambda.*
- size\_t `get_cache_size` (void) const  
*Returns the current size of the cache.*
- void `set_cache_step` (int cache\_steps) const  
*Sets the step size by which the cache is increased.*
- `ex get_series_coeff` (int i) const  
*Wrapper around series\_coeff(i), converts cl\_N to numeric.*
- cln::cl\_N `series_coeff` (int i) const  
*Subclasses have either to implement series\_coeff\_impl or the two methods Laurent\_series and uses\_Laurent\_series.*

## Public Member Functions inherited from GiNaC::basic

- virtual `~basic` ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf` () const  
*Evaluate object numerically.*
- virtual `ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree` () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence` () const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool `info` (unsigned inf) const  
*Information about the object.*
- virtual size\_t `nops` () const  
*Number of operands/members.*
- virtual `ex op` (size\_t i) const  
*Return operand/member at position i.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex & let_op` (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[]` (const `ex` &index)

- virtual [ex](#) & [operator\[\]](#) (size\_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const  
*Check whether the expression matches a given pattern.*
- virtual [ex](#) [subs](#) (const [exmap](#) &m, unsigned options=0) const  
*Substitute a set of objects by arbitrary expressions.*
- virtual [ex](#) [map](#) ([map\\_function](#) &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is\\_polynomial](#) (const [ex](#) &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int [degree](#) (const [ex](#) &s) const  
*Return degree of highest power in object s.*
- virtual int [ldegree](#) (const [ex](#) &s) const  
*Return degree of lowest power in object s.*
- virtual [ex](#) [coeff](#) (const [ex](#) &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual [ex](#) [expand](#) (unsigned options=0) const  
*Expand expression, i.e.*
- virtual [ex](#) [collect](#) (const [ex](#) &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual [ex](#) [normal](#) ([exmap](#) &repl, [exmap](#) &rev\_lookup, [lst](#) &modifier) const  
*Default implementation of [ex::normal\(\)](#).*
- virtual [ex](#) [to\\_rational](#) ([exmap](#) &repl) const  
*Default implementation of [ex::to\\_rational\(\)](#).*
- virtual [ex](#) [to\\_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric](#) [integer\\_content](#) () const
- virtual [ex](#) [smod](#) (const [numeric](#) &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual [numeric](#) [max\\_coefficient](#) () const  
*Implementation [ex::max\\_coefficient\(\)](#).*
- virtual [exvector](#) [get\\_free\\_indices](#) () const  
*Return a vector containing the free indices of an expression.*
- virtual [ex](#) [add\\_indexed](#) (const [ex](#) &self, const [ex](#) &other) const  
*Add two indexed expressions.*
- virtual [ex](#) [scalar\\_mul\\_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool [contract\\_with](#) ([exvector::iterator](#) self, [exvector::iterator](#) other, [exvector](#) &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned [return\\_type](#) () const
- virtual [return\\_type\\_t](#) [return\\_type\\_tinfo](#) () const
- virtual [ex](#) [conjugate](#) () const
- virtual [ex](#) [real\\_part](#) () const
- virtual [ex](#) [imag\\_part](#) () const
- template<class T>  
void [print\\_dispatch](#) (const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- void [print\\_dispatch](#) (const [registered\\_class\\_info](#) &ri, const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- virtual void [archive](#) ([archive\\_node](#) &n) const

- *Save (serialize) the object into archive node.*
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
- *Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const
- *Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const
- *Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const
- *Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const
- *Test for syntactic equality.*
- const `basic` & `hold` () const
- *Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
- *Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const
- *Clear some `status_flags`.*

### Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

### Protected Attributes inherited from `GiNaC::integration_kernel`

- int `cache_step_size`
- `std::vector< cln::cl_N >` `series_vec`

### Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`  
of type `status_flags`
- unsigned `hashvalue`  
hash value

## 6.9.1 Detailed Description

The basic integration kernel with a logarithmic singularity at the origin.

This class represents the differential one-form

$$L_0 = \frac{d\lambda}{\lambda}$$

## 6.9.2 Member Function Documentation

### 6.9.2.1 `series_coeff_impl()`

```
cln::cl_N GiNaC::basic_log_kernel::series_coeff_impl (
 int i) const [override], [protected], [virtual]
```

For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.

The  $i$ -th coefficient corresponds to the power  $\lambda^{i-1}$ .

Reimplemented from [GiNaC::integration\\_kernel](#).

References [series\\_coeff\\_impl\(\)](#).

Referenced by [series\\_coeff\\_impl\(\)](#).

### 6.9.2.2 `do_print()`

```
void GiNaC::basic_log_kernel::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [do\\_print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [do\\_print\(\)](#), and [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

The documentation for this class was generated from the following files:

- [integration\\_kernel.h](#)
- [integration\\_kernel.cpp](#)

## 6.10 GiNaC::basic\_multi\_iterator< T > Class Template Reference

[basic\\_multi\\_iterator](#) is a base class.

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for GiNaC::basic\_multi\_iterator< T >:



## Public Member Functions

- [basic\\_multi\\_iterator](#) (void)  
*Default constructor.*
- [basic\\_multi\\_iterator](#) (T [B](#), T [N](#), size\_t k)  
*Construct a multi\_iterator with upper limit N, lower limit B and size k.*
- [basic\\_multi\\_iterator](#) (T [B](#), T [N](#), const std::vector< T > &vv)  
*Construct from a vector.*
- virtual [~basic\\_multi\\_iterator](#) ()  
*Destructor.*
- size\_t [size](#) (void) const  
*Returns the size of a multi\_iterator.*
- bool [overflow](#) (void) const  
*Return the overflow flag.*
- const std::vector< T > & [get\\_vector](#) (void) const  
*Returns a reference to the vector v.*
- T [operator\[\]](#) (size\_t i) const  
*Subscription via [].*
- T & [operator\[\]](#) (size\_t i)  
*Subscription via [].*
- T [operator\(\)](#) (size\_t i) const  
*Subscription via ().*
- T & [operator\(\)](#) (size\_t i)  
*Subscription via ().*
- virtual [basic\\_multi\\_iterator](#)< T > & [init](#) (void)  
*Initialize the multi-index to.*
- virtual [basic\\_multi\\_iterator](#)< T > & [operator++](#) (int)  
*No effect for basic\_multi\_iterator.*

## Protected Attributes

- T [N](#)
- T [B](#)
- std::vector< T > [v](#)
- bool [flag\\_overflow](#)

## Friends

- template<class TT>  
std::ostream & [operator<<](#) (std::ostream &os, const [basic\\_multi\\_iterator](#)< TT > &v)

### 6.10.1 Detailed Description

```
template<class T>
class GiNaC::basic_multi_iterator< T >
```

[basic\\_multi\\_iterator](#) is a base class.

The base class itself does not do anything useful. A typical use of a class derived from [basic\\_multi\\_iterator](#) is

```
multi_iterator_ordered<int> k(0,4,2);
```

```
for(k.init(); !k.overflow(); k++) { std::cout << k << std::endl; }
```

which prints out

```
multi_iterator_ordered(0,1) multi_iterator_ordered(0,2) multi_iterator_ordered(0,3) multi_iterator_ordered(1,2)
multi_iterator_ordered(1,3) multi_iterator_ordered(2,3)
```

Individual components of k can be accessed with k[i] or k(i).

All classes derived from [basic\\_multi\\_iterator](#) follow the same syntax.

### 6.10.2 Constructor & Destructor Documentation

#### 6.10.2.1 basic\_multi\_iterator() [1/3]

```
template<class T>
GiNaC::basic_multi_iterator< T >::basic_multi_iterator (
 void) [inline]
```

Default constructor.

References [B](#), [flag\\_overflow](#), [N](#), and [v](#).

Referenced by [init\(\)](#), [GiNaC::multi\\_iterator\\_counter< T >::init\(\)](#), [GiNaC::multi\\_iterator\\_counter\\_indv< T >::init\(\)](#), [GiNaC::multi\\_iterator\\_ordered< T >::init\(\)](#), [GiNaC::multi\\_iterator\\_ordered\\_eq< T >::init\(\)](#), [GiNaC::multi\\_iterator\\_ordered\\_eq\\_indv< T >::init\(\)](#), [GiNaC::multi\\_iterator\\_permutation< T >::init\(\)](#), [GiNaC::multi\\_iterator\\_shuffle< T >::init\(\)](#), [GiNaC::multi\\_iterator\\_counter< T >::multi\\_iterator\\_counter\(\)](#), [GiNaC::multi\\_iterator\\_counter< T >::multi\\_iterator\\_counter\(\)](#), [GiNaC::multi\\_iterator\\_counter\\_indv< T >::multi\\_iterator\\_counter\\_indv\(\)](#), [GiNaC::multi\\_iterator\\_counter\\_indv< T >::multi\\_iterator\\_counter\\_indv\(\)](#), [GiNaC::multi\\_iterator\\_ordered< T >::multi\\_iterator\\_ordered\(\)](#), [GiNaC::multi\\_iterator\\_ordered< T >::multi\\_iterator\\_ordered\(\)](#), [GiNaC::multi\\_iterator\\_ordered\\_eq< T >::multi\\_iterator\\_ordered\\_eq\(\)](#), [GiNaC::multi\\_iterator\\_ordered\\_eq< T >::multi\\_iterator\\_ordered\\_eq\(\)](#), [GiNaC::multi\\_iterator\\_ordered\\_eq< T >::multi\\_iterator\\_ordered\\_eq\\_indv< T >::multi\\_iterator\\_ordered\\_eq\\_indv\(\)](#), [GiNaC::multi\\_iterator\\_ordered\\_eq\\_indv< T >::multi\\_iterator\\_ordered\\_eq\\_indv\(\)](#), [GiNaC::multi\\_iterator\\_permutation< T >::multi\\_iterator\\_permutation\(\)](#), [GiNaC::multi\\_iterator\\_permutation< T >::multi\\_iterator\\_permutation\(\)](#), [GiNaC::multi\\_iterator\\_shuffle< T >::multi\\_iterator\\_shuffle\(\)](#), [GiNaC::multi\\_iterator\\_shuffle< T >::multi\\_iterator\\_shuffle\(\)](#), [operator++\(\)](#), [GiNaC::multi\\_iterator\\_counter< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_counter\\_indv< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_ordered< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_ordered\\_eq< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_ordered\\_eq\\_indv< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_permutation< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_shuffle< T >::operator++\(\)](#), and [operator<<](#).



### 6.10.2.2 basic\_multi\_iterator() [2/3]

```
template<class T>
GiNaC::basic_multi_iterator< T >::basic_multi_iterator (
 T B,
 T N,
 size_t k) [inline], [explicit]
```

Construct a multi\_iterator with upper limit N, lower limit B and size k .

References [B](#), [flag\\_overflow](#), [N](#), and [v](#).

### 6.10.2.3 basic\_multi\_iterator() [3/3]

```
template<class T>
GiNaC::basic_multi_iterator< T >::basic_multi_iterator (
 T B,
 T N,
 const std::vector< T > & vv) [inline], [explicit]
```

Construct from a vector.

References [B](#), [flag\\_overflow](#), [N](#), and [v](#).

### 6.10.2.4 ~basic\_multi\_iterator()

```
template<class T>
GiNaC::basic_multi_iterator< T >::~~basic_multi_iterator () [inline], [virtual]
```

Destructor.

## 6.10.3 Member Function Documentation

### 6.10.3.1 size()

```
template<class T>
size_t GiNaC::basic_multi_iterator< T >::size (
 void) const [inline]
```

Returns the size of a multi\_iterator.

References [v](#).

Referenced by [GiNaC::multi\\_iterator\\_permutation< T >::get\\_sign\(\)](#), [GiNaC::multi\\_iterator\\_counter< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_counter\\_indv< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_ordered< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_ordered\\_eq< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_ordered\\_eq\\_indv< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_permutation< T >::operator++\(\)](#), [GiNaC::operator<<\(\)](#), [GiNaC::operator<<\(\)](#), [GiNaC::operator<<\(\)](#), [GiNaC::operator<<\(\)](#), [GiNaC::operator<<\(\)](#), [GiNaC::operator<<\(\)](#), [GiNaC::operator<<\(\)](#), [GiNaC::operator<<\(\)](#), and [GiNaC::operator<<\(\)](#).

### 6.10.3.2 overflow()

```
template<class T>
bool GiNaC::basic_multi_iterator< T >::overflow (
 void) const [inline]
```

Return the overflow flag.

References [flag\\_overflow](#).

### 6.10.3.3 get\_vector()

```
template<class T>
const std::vector< T > & GiNaC::basic_multi_iterator< T >::get_vector (
 void) const [inline]
```

Returns a reference to the vector v.

References [v](#).

### 6.10.3.4 operator[]() [1/2]

```
template<class T>
T GiNaC::basic_multi_iterator< T >::operator[] (
 size_t i) const [inline]
```

Subscription via [].

References [v](#).

### 6.10.3.5 operator[]() [2/2]

```
template<class T>
T & GiNaC::basic_multi_iterator< T >::operator[] (
 size_t i) [inline]
```

Subscription via [].

References [v](#).

### 6.10.3.6 operator()() [1/2]

```
template<class T>
T GiNaC::basic_multi_iterator< T >::operator() (
 size_t i) const [inline]
```

Subscription via ()

References [v](#).

### 6.10.3.7 operator() [2/2]

```
template<class T>
T & GiNaC::basic_multi_iterator< T >::operator() (
 size_t i) [inline]
```

Subscription via ()

References [v](#).

### 6.10.3.8 init()

```
template<class T>
basic_multi_iterator< T > & GiNaC::basic_multi_iterator< T >::init (
 void) [inline], [virtual]
```

Initialize the multi-index to.

$$(n_1, n_2, n_3, \dots, n_k) = (B, B, \dots, B)$$

Reimplemented in [GiNaC::multi\\_iterator\\_counter< T >](#), [GiNaC::multi\\_iterator\\_counter\\_indv< T >](#), [GiNaC::multi\\_iterator\\_ordered< T >](#), [GiNaC::multi\\_iterator\\_ordered\\_eq< T >](#), [GiNaC::multi\\_iterator\\_ordered\\_eq\\_indv< T >](#), [GiNaC::multi\\_iterator\\_permutation< T >](#), [GiNaC::multi\\_iterator\\_shuffle< T >](#), and [GiNaC::multi\\_iterator\\_shuffle\\_prime< T >](#).

References [B](#), [basic\\_multi\\_iterator\(\)](#), [flag\\_overflow](#), and [v](#).

### 6.10.3.9 operator++()

```
template<class T>
basic_multi_iterator< T > & GiNaC::basic_multi_iterator< T >::operator++ (
 int) [inline], [virtual]
```

No effect for [basic\\_multi\\_iterator](#).

Reimplemented in [GiNaC::multi\\_iterator\\_counter< T >](#), [GiNaC::multi\\_iterator\\_counter\\_indv< T >](#), [GiNaC::multi\\_iterator\\_ordered< T >](#), [GiNaC::multi\\_iterator\\_ordered\\_eq< T >](#), [GiNaC::multi\\_iterator\\_ordered\\_eq\\_indv< T >](#), [GiNaC::multi\\_iterator\\_permutation< T >](#), and [GiNaC::multi\\_iterator\\_shuffle< T >](#).

References [basic\\_multi\\_iterator\(\)](#).

## 6.10.4 Friends And Related Symbol Documentation

### 6.10.4.1 operator<<

```
template<class T>
template<class TT>
std::ostream & operator<< (
 std::ostream & os,
 const basic_multi_iterator< TT > & v) [friend]
```

References [basic\\_multi\\_iterator\(\)](#), and [v](#).



## 6.10.5.4 flag\_overflow

```
template<class T>
bool GiNaC::basic_multi_iterator< T >::flag_overflow [protected]
```

Referenced by [basic\\_multi\\_iterator\(\)](#), [basic\\_multi\\_iterator\(\)](#), [basic\\_multi\\_iterator\(\)](#), [init\(\)](#), [GiNaC::multi\\_iterator\\_counter< T >::init\(\)](#), [GiNaC::multi\\_iterator\\_counter\\_indv< T >::init\(\)](#), [GiNaC::multi\\_iterator\\_ordered< T >::init\(\)](#), [GiNaC::multi\\_iterator\\_ordered\\_eq< T >::init\(\)](#), [GiNaC::multi\\_iterator\\_ordered\\_eq\\_indv< T >::init\(\)](#), [GiNaC::multi\\_iterator\\_permutation< T >::init\(\)](#), [GiNaC::multi\\_iterator\\_shuffle< T >::init\(\)](#), [GiNaC::multi\\_iterator\\_shuffle\\_prime< T >::init\(\)](#), [GiNaC::multi\\_iterator\\_counter< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_counter\\_indv< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_ordered< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_ordered\\_eq< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_ordered\\_eq\\_indv< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_permutation< T >::operator++\(\)](#), [GiNaC::multi\\_iterator\\_shuffle< T >::operator++\(\)](#), and [overflow\(\)](#).

The documentation for this class was generated from the following file:

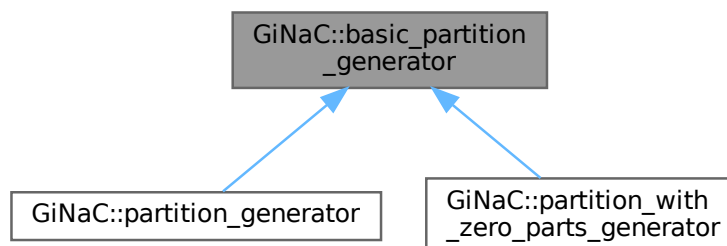
- [utils\\_multi\\_iterator.h](#)

## 6.11 GiNaC::basic\_partition\_generator Class Reference

Base class for generating all bounded combinatorial partitions of an integer  $n$  with exactly  $m$  parts in non-decreasing order.

```
#include <utils.h>
```

Inheritance diagram for GiNaC::basic\_partition\_generator:



Collaboration diagram for `GiNaC::basic_partition_generator`:



## Classes

- struct [mpartition2](#)

## Protected Member Functions

- [basic\\_partition\\_generator](#) (unsigned *n\_*, unsigned *m\_*)

## Protected Attributes

- [mpartition2](#) [mpgen](#)

### 6.11.1 Detailed Description

Base class for generating all bounded combinatorial partitions of an integer *n* with exactly *m* parts in non-decreasing order.

### 6.11.2 Constructor & Destructor Documentation

#### 6.11.2.1 `basic_partition_generator()`

```

GiNaC::basic_partition_generator::basic_partition_generator (
 unsigned n_,
 unsigned m_) [inline], [protected]

```

References [mpgen](#).

Referenced by [GiNaC::partition\\_generator::partition\\_generator\(\)](#), and [GiNaC::partition\\_with\\_zero\\_parts\\_generator::partition\\_with\\_zero\\_parts\\_generator\(\)](#).

### 6.11.3 Member Data Documentation

#### 6.11.3.1 mpgen

`mpartition2` GiNaC::basic\_partition\_generator::mpgen [protected]

Referenced by [basic\\_partition\\_generator\(\)](#), [GiNaC::partition\\_generator::get\(\)](#), [GiNaC::partition\\_with\\_zero\\_parts\\_generator::get\(\)](#), [GiNaC::partition\\_generator::next\(\)](#), and [GiNaC::partition\\_with\\_zero\\_parts\\_generator::next\(\)](#).

The documentation for this class was generated from the following file:

- [utils.h](#)

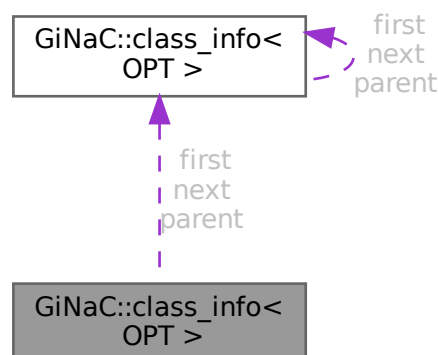
## 6.12 GiNaC::class\_info< OPT > Class Template Reference

```
#include <class_info.h>
```

Inheritance diagram for GiNaC::class\_info< OPT >:



Collaboration diagram for GiNaC::class\_info< OPT >:



## Classes

- struct [tree\\_node](#)

## Public Member Functions

- [class\\_info](#) (const OPT &o)
- [class\\_info](#) \* [get\\_parent](#) () const  
*Get pointer to [class\\_info](#) of parent class (or nullptr).*

## Static Public Member Functions

- static const [class\\_info](#) \* [find](#) (const std::string &class\_name)  
*Find [class\\_info](#) by name.*
- static void [dump\\_hierarchy](#) (bool verbose=false)  
*Dump class hierarchy to std::cout.*

## Public Attributes

- OPT [options](#)

## Static Private Member Functions

- static void [dump\\_tree](#) ([tree\\_node](#) \*n, const std::string &prefix, bool verbose)
- static void [identify\\_parents](#) ()

## Private Attributes

- [class\\_info](#) \* [next](#)
- [class\\_info](#) \* [parent](#)

## Static Private Attributes

- static [class\\_info](#) \* [first](#)
- static bool [parents\\_identified](#)

## 6.12.1 Constructor & Destructor Documentation

### 6.12.1.1 [class\\_info](#)()

```
template<class OPT>
GiNaC::class_info< OPT >::class_info (
 const OPT & o) [inline]
```

Referenced by [dump\\_hierarchy\(\)](#), [find\(\)](#), [identify\\_parents\(\)](#), and [GiNaC::class\\_info< OPT >::tree\\_node::tree\\_node\(\)](#).



## 6.12.2 Member Function Documentation

### 6.12.2.1 get\_parent()

```
template<class OPT>
class_info * GiNaC::class_info< OPT >::get_parent () const [inline]
```

Get pointer to [class\\_info](#) of parent class (or nullptr).

Referenced by [GiNaC::function::print\(\)](#), and [GiNaC::basic::print\\_dispatch\(\)](#).

### 6.12.2.2 find()

```
template<class OPT>
const class_info< OPT > * GiNaC::class_info< OPT >::find (
 const std::string & class_name) [static]
```

Find [class\\_info](#) by name.

References [class\\_info\(\)](#), [find\(\)](#), [first](#), [next](#), and [options](#).

Referenced by [find\(\)](#).

### 6.12.2.3 dump\_hierarchy()

```
template<class OPT>
void GiNaC::class_info< OPT >::dump_hierarchy (
 bool verbose = false) [static]
```

Dump class hierarchy to `std::cout`.

References [class\\_info\(\)](#), [dump\\_tree\(\)](#), [first](#), [identify\\_parents\(\)](#), and [GiNaC::tree\(\)](#).

### 6.12.2.4 dump\_tree()

```
template<class OPT>
void GiNaC::class_info< OPT >::dump_tree (
 tree_node * n,
 const std::string & prefix,
 bool verbose) [static], [private]
```

References [GiNaC::class\\_info< OPT >::tree\\_node::children](#), [dump\\_tree\(\)](#), [GiNaC::class\\_info< OPT >::tree\\_node::info](#), and [options](#).

Referenced by [dump\\_hierarchy\(\)](#), and [dump\\_tree\(\)](#).

### 6.12.2.5 identify\_parents()

```
template<class OPT>
void GiNaC::class_info< OPT >::identify_parents () [static], [private]
```

References [class\\_info\(\)](#), [first](#), and [parents\\_identified](#).

Referenced by [dump\\_hierarchy\(\)](#), and [GiNaC::class\\_info< print\\_context\\_options >::get\\_parent\(\)](#).

## 6.12.3 Member Data Documentation

### 6.12.3.1 options

```
template<class OPT>
OPT GiNaC::class_info< OPT >::options
```

Referenced by [dump\\_tree\(\)](#), [find\(\)](#), [GiNaC::function::print\(\)](#), and [GiNaC::basic::print\\_dispatch\(\)](#).

### 6.12.3.2 first

```
template<class OPT>
class_info* GiNaC::class_info< OPT >::first [static], [private]
```

Referenced by [dump\\_hierarchy\(\)](#), [find\(\)](#), and [identify\\_parents\(\)](#).

### 6.12.3.3 next

```
template<class OPT>
class_info* GiNaC::class_info< OPT >::next [private]
```

Referenced by [find\(\)](#).

### 6.12.3.4 parent

```
template<class OPT>
class_info* GiNaC::class_info< OPT >::parent [mutable], [private]
```

### 6.12.3.5 parents\_identified

```
template<class OPT>
bool GiNaC::class_info< OPT >::parents_identified [static], [private]
```

Referenced by [identify\\_parents\(\)](#).

The documentation for this class was generated from the following file:

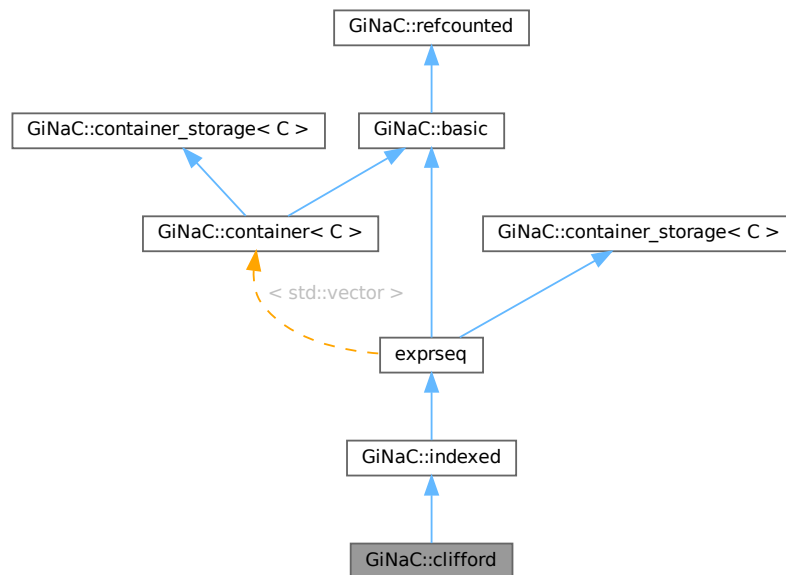
- [class\\_info.h](#)

## 6.13 GiNaC::clifford Class Reference

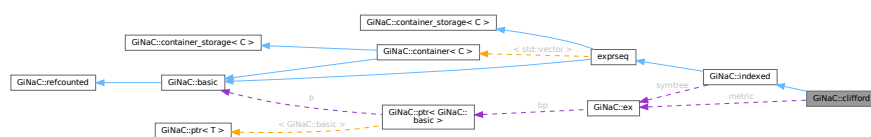
This class holds an object representing an element of the Clifford algebra (the Dirac gamma matrices).

```
#include <clifford.h>
```

Inheritance diagram for GiNaC::clifford:



Collaboration diagram for GiNaC::clifford:



### Public Member Functions

- **clifford** (const **ex** &b, unsigned char rl=0)  
Construct object without any indices.
- **clifford** (const **ex** &b, const **ex** &mu, const **ex** &metr, unsigned char rl=0, int comm\_sign=-1)  
Construct object with one Lorentz index.
- **clifford** (unsigned char rl, const **ex** &metr, int comm\_sign, const **exvector** &v)
- **clifford** (unsigned char rl, const **ex** &metr, int comm\_sign, **exvector** &&v)
- unsigned **precedence** () const override  
Return relative operator precedence (for parenthezing output).
- void **archive** (**archive\_node** &n) const override  
Save (serialize) the object into archive node.

- void `read_archive` (const `archive_node` &n, `lst` &sym\_lst) override  
*Load (deserialize) the object from an archive node.*
- unsigned char `get_representation_label` () const
- `ex` `get_metric` () const
- virtual `ex` `get_metric` (const `ex` &i, const `ex` &j, bool symmetrised=false) const
- bool `same_metric` (const `ex` &other) const
- int `get_commutator_sign` () const
- size\_t `nops` () const override  
*Number of operands/members.*
- `ex` `op` (size\_t i) const override  
*Return operand/member at position i.*
- `ex` & `let_op` (size\_t i) override  
*Return modifiable operand/member at position i.*
- `ex` `subs` (const `exmap` &m, unsigned options=0) const override  
*Substitute a set of objects by arbitrary expressions.*

## Public Member Functions inherited from `GiNaC::indexed`

- `indexed` (const `ex` &b)  
*Construct indexed object with no index.*
- `indexed` (const `ex` &b, const `ex` &i1)  
*Construct indexed object with one index.*
- `indexed` (const `ex` &b, const `ex` &i1, const `ex` &i2)  
*Construct indexed object with two indices.*
- `indexed` (const `ex` &b, const `ex` &i1, const `ex` &i2, const `ex` &i3)  
*Construct indexed object with three indices.*
- `indexed` (const `ex` &b, const `ex` &i1, const `ex` &i2, const `ex` &i3, const `ex` &i4)  
*Construct indexed object with four indices.*
- `indexed` (const `ex` &b, const `symmetry` &symm, const `ex` &i1, const `ex` &i2)  
*Construct indexed object with two indices and a specified symmetry.*
- `indexed` (const `ex` &b, const `symmetry` &symm, const `ex` &i1, const `ex` &i2, const `ex` &i3)  
*Construct indexed object with three indices and a specified symmetry.*
- `indexed` (const `ex` &b, const `symmetry` &symm, const `ex` &i1, const `ex` &i2, const `ex` &i3, const `ex` &i4)  
*Construct indexed object with four indices and a specified symmetry.*
- `indexed` (const `ex` &b, const `exvector` &iv)  
*Construct indexed object with a specified vector of indices.*
- `indexed` (const `ex` &b, const `symmetry` &symm, const `exvector` &iv)  
*Construct indexed object with a specified vector of indices and symmetry.*
- `indexed` (const `symmetry` &symm, const `exprseq` &es)
- `indexed` (const `symmetry` &symm, const `exvector` &v)
- `indexed` (const `symmetry` &symm, `exvector` &&v)
- unsigned `precedence` () const override  
*Return relative operator precedence (for parenthezing output).*
- bool `info` (unsigned inf) const override  
*Information about the object.*
- `ex` `eval` () const override  
*Perform automatic non-interruptive term rewriting rules.*
- `ex` `real_part` () const override
- `ex` `imag_part` () const override
- `exvector` `get_free_indices` () const override  
*Return a vector containing the free indices of an expression.*

- void `archive` (`archive_node` &n) const override  
*Save (a.k.a.*
- void `read_archive` (const `archive_node` &n, `lst` &syms) override  
*Read (a.k.a.*
- bool `all_index_values_are` (unsigned inf) const  
*Check whether all index values have a certain property.*
- `exvector` `get_indices` () const  
*Return a vector containing the object's indices.*
- `exvector` `get_dummy_indices` () const  
*Return a vector containing the dummy indices of the object, if any.*
- `exvector` `get_dummy_indices` (const `indexed` &other) const  
*Return a vector containing the dummy indices in the contraction with another indexed object.*
- bool `has_dummy_index_for` (const `ex` &i) const  
*Check whether the object has an index that forms a dummy index pair with a given index.*
- `ex` `get_symmetry` () const  
*Return symmetry properties.*

### Public Member Functions inherited from `GiNaC::container`< `std::vector` >

- `container` (STLT const &s)
- `container` (STLT &&v)
- `container` (`exvector::const_iterator` b, `exvector::const_iterator` e)
- `container` (`std::initializer_list`< `ex` > il)
- `size_t` `nops` () const override  
*Number of operands/members.*
- `ex` `op` (`size_t` i) const override  
*Return operand/member at position i.*
- `ex` & `let_op` (`size_t` i) override  
*Return modifiable operand/member at position i.*
- `ex` `subs` (const `exmap` &m, unsigned options=0) const override  
*Substitute a set of objects by arbitrary expressions.*
- `container` & `prepend` (const `ex` &b)  
*Add element at front.*
- `container` & `append` (const `ex` &b)  
*Add element at back.*
- `container` & `remove_first` ()  
*Remove first element.*
- `container` & `remove_last` ()  
*Remove last element.*
- `container` & `remove_all` ()  
*Remove all elements.*
- `container` & `sort` ()  
*Sort elements.*
- `container` & `unique` ()  
*Remove adjacent duplicate elements.*
- `const_iterator` `begin` () const
- `const_iterator` `end` () const
- `const_reverse_iterator` `rbegin` () const
- `const_reverse_iterator` `rend` () const
- `container` (STLT const &s)
- `container` (STLT &&v)

- `container` (`exvector::const_iterator b`, `exvector::const_iterator e`)
- `container` (`std::initializer_list< ex > il`)
- `size_t nops ()` const override  
*Number of operands/members.*
- `ex op (size_t i)` const override  
*Return operand/member at position i.*
- `ex & let_op (size_t i)` override  
*Return modifiable operand/member at position i.*
- `ex subs` (`const exmap &m`, `unsigned options=0`) const override  
*Substitute a set of objects by arbitrary expressions.*
- `container & prepend` (`const ex &b`)  
*Add element at front.*
- `container & append` (`const ex &b`)  
*Add element at back.*
- `container & remove_first ()`  
*Remove first element.*
- `container & remove_last ()`  
*Remove last element.*
- `container & remove_all ()`  
*Remove all elements.*
- `container & sort ()`  
*Sort elements.*
- `container & unique ()`  
*Remove adjacent duplicate elements.*
- `const_iterator begin ()` const
- `const_iterator end ()` const
- `const_reverse_iterator rbegin ()` const
- `const_reverse_iterator rend ()` const

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic ()`  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (`const basic &other`)
- `const basic & operator=` (`const basic &other`)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate ()` const  
*Create a clone of this object on the heap.*
- virtual `ex evalf ()` const  
*Evaluate object numerically.*
- virtual `ex evalm ()` const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ ()` const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (`const basic &i`) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (`const print_context &c`, `unsigned level=0`) const  
*Output to stream.*
- virtual void `dbgprint ()` const  
*Little wrapper around print to be called within a debugger.*

- virtual void `dbgprinttree` () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const  
*Check whether the expression matches a given pattern.*
- virtual `ex map` (`map_function` &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept` (GiNaC::visitor &v) const
- virtual bool `is_polynomial` (const `ex` &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const  
*Return degree of highest power in object s.*
- virtual int `ldegree` (const `ex` &s) const  
*Return degree of lowest power in object s.*
- virtual `ex coeff` (const `ex` &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual `ex collect` (const `ex` &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series` (const `relational` &r, int order, unsigned options=0) const  
*Default implementation of `ex::series()`.*
- virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const  
*Default implementation of `ex::normal()`.*
- virtual `ex to_rational` (`exmap` &repl) const  
*Default implementation of `ex::to_rational()`.*
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const  
*Implementation `ex::max_coefficient()`.*
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- template<class T>  
void `print_dispatch` (const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const

- *Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- const `basic` & `hold` () const  
*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const  
*Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- `ex eval_ncmul` (const `exvector` &v) const override  
*Perform automatic simplification on noncommutative product of clifford objects.*
- bool `match_same_type` (const `basic` &other) const override  
*Returns true if the attributes of two objects are similar enough for a match.*
- `ex thiscontainer` (const `exvector` &v) const override  
*Similar to `duplicate()`, but with a preset sequence.*
- `ex thiscontainer` (`exvector` &&v) const override  
*Similar to `duplicate()`, but with a preset sequence (which gets pilfered).*
- unsigned `return_type` () const override
- `return_type_t` `return_type_tinfo` () const override
- void `do_print_dflt` (const `print_dflt` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const
- void `do_print_tree` (const `print_tree` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::indexed`

- `ex derivative` (const `symbol` &s) const override  
*Implementation of `ex::diff()` for an indexed object always returns 0.*
- `ex thiscontainer` (const `exvector` &v) const override  
*Similar to `duplicate()`, but with a preset sequence.*
- `ex thiscontainer` (`exvector` &&v) const override  
*Similar to `duplicate()`, but with a preset sequence (which gets pilfered).*
- unsigned `return_type` () const override
- `return_type_t` `return_type_tinfo` () const override
- `ex expand` (unsigned options=0) const override  
*Expand expression, i.e.*
- void `printindices` (const `print_context` &c, unsigned level) const
- void `print_indexed` (const `print_context` &c, const char \*openbrace, const char \*closebrace, unsigned level) const
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
- void `validate` () const  
*Check whether all indices are of class `idx` and validate the symmetry tree.*



### Protected Member Functions inherited from [GiNaC::container< std::vector >](#)

- [ex conjugate](#) () const override
- bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if two objects of same type are equal.*
- virtual void [printseq](#) (const [print\\_context](#) &c, char openbracket, char delim, char closebracket, unsigned this←\_precedence, unsigned upper\_precedence=0) const  
*Print sequence of contained elements.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const
- void [do\\_print\\_python](#) (const [print\\_python](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const
- [STLT](#) [subchildren](#) (const [exmap](#) &m, unsigned options=0) const
- [ex conjugate](#) () const override
- bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if two objects of same type are equal.*
- virtual void [printseq](#) (const [print\\_context](#) &c, char openbracket, char delim, char closebracket, unsigned this←\_precedence, unsigned upper\_precedence=0) const  
*Print sequence of contained elements.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const
- void [do\\_print\\_python](#) (const [print\\_python](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const
- [STLT](#) [subchildren](#) (const [exmap](#) &m, unsigned options=0) const

### Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

### Protected Member Functions inherited from [GiNaC::container\\_storage< C >](#)

- [container\\_storage](#) ()
- [container\\_storage](#) (size\_t n, const [ex](#) &e)
- [container\\_storage](#) (std::initializer\_list< [ex](#) > il)
- template<class In>  
[container\\_storage](#) (In b, In e)
- void [reserve](#) (size\_t)
- [~container\\_storage](#) ()
- void [reserve](#) (size\_t n)
- void [reserve](#) (std::vector< [ex](#) > &v, size\_t n)

### Protected Attributes

- unsigned char [representation\\_label](#)  
*Representation label to distinguish independent spin lines.*
- [ex metric](#)  
*Metric of the space, all constructors make it an indexed object.*
- int [commutator\\_sign](#)  
*It is the sign in the definition  $e \sim i \ e \sim j \ +/- \ e \sim j \ e \sim i = B(i, j) + B(j, i)$*

### Protected Attributes inherited from [GiNaC::indexed](#)

- [ex symtree](#)  
*Index symmetry (tree of symmetry objects)*

### Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### Protected Attributes inherited from [GiNaC::container\\_storage< C >](#)

- [STLT seq](#)

### Additional Inherited Members

### Public Types inherited from [GiNaC::container< std::vector >](#)

- typedef STLT::const\_iterator [const\\_iterator](#)
- typedef STLT::const\_reverse\_iterator [const\\_reverse\\_iterator](#)

### Protected Types inherited from [GiNaC::container< std::vector >](#)

- typedef [container\\_storage< std::vector >::STLT](#) [STLT](#)

### Protected Types inherited from [GiNaC::container\\_storage< C >](#)

- typedef C< [ex](#) > [STLT](#)

### Static Protected Member Functions inherited from [GiNaC::container< std::vector >](#)

- static unsigned [get\\_default\\_flags](#) ()
- static char [get\\_open\\_delim](#) ()
- static char [get\\_close\\_delim](#) ()
- static unsigned [get\\_default\\_flags](#) ()
- static char [get\\_open\\_delim](#) ()
- static char [get\\_close\\_delim](#) ()

## Static Protected Member Functions inherited from [GiNaC::container\\_storage< C >](#)

- static void [reserve](#) (STLT &, size\_t)

### 6.13.1 Detailed Description

This class holds an object representing an element of the Clifford algebra (the Dirac gamma matrices).

These objects only carry Lorentz indices. Spinor indices are hidden. A representation label (an unsigned 8-bit integer) is used to distinguish elements from different Clifford algebras (objects with different labels commute).

### 6.13.2 Constructor & Destructor Documentation

#### 6.13.2.1 [clifford\(\)](#) [1/4]

```
GiNaC::clifford::clifford (
 const ex & b,
 unsigned char rl = 0)
```

Construct object without any indices.

This constructor is for internal use only. Use the [dirac\\_ONE\(\)](#) function instead.

See also

[dirac\\_ONE](#)

References [clifford\(\)](#), [commutator\\_sign](#), [metric](#), and [representation\\_label](#).

Referenced by [clifford\(\)](#), [eval\\_ncmul\(\)](#), [match\\_same\\_type\(\)](#), [subs\(\)](#), [thiscontainer\(\)](#), and [thiscontainer\(\)](#).

#### 6.13.2.2 [clifford\(\)](#) [2/4]

```
GiNaC::clifford::clifford (
 const ex & b,
 const ex & mu,
 const ex & metr,
 unsigned char rl = 0,
 int comm_sign = -1)
```

Construct object with one Lorentz index.

This constructor is for internal use only. Use the [clifford\\_unit\(\)](#) or [dirac\\_gamma\(\)](#) functions instead.

See also

[clifford\\_unit](#)

[dirac\\_gamma](#)

References [commutator\\_sign](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [metric](#), and [representation\\_label](#).

### 6.13.2.3 clifford() [3/4]

```
GiNaC::clifford::clifford (
 unsigned char rl,
 const ex & metr,
 int comm_sign,
 const exvector & v)
```

References [commutator\\_sign](#), [metric](#), [GiNaC::not\\_symmetric\(\)](#), and [representation\\_label](#).

### 6.13.2.4 clifford() [4/4]

```
GiNaC::clifford::clifford (
 unsigned char rl,
 const ex & metr,
 int comm_sign,
 exvector && v)
```

References [commutator\\_sign](#), [metric](#), [GiNaC::not\\_symmetric\(\)](#), and [representation\\_label](#).

## 6.13.3 Member Function Documentation

### 6.13.3.1 precedence()

```
unsigned GiNaC::clifford::precedence () const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Referenced by [do\\_print\\_dflt\(\)](#), and [do\\_print\\_latex\(\)](#).

### 6.13.3.2 archive()

```
void GiNaC::clifford::archive (
 archive_node & n) const [override], [virtual]
```

Save (serialize) the object into archive node.

Archive the object.

Losely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::add\\_ex\(\)](#), [GiNaC::archive\\_node::add\\_unsigned\(\)](#), [commutator\\_sign](#), [metric](#), and [representation\\_label](#).

### 6.13.3.3 read\_archive()

```
void GiNaC::clifford::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive\\_node](#).

#### Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::basic](#).

References [commutator\\_sign](#), [GiNaC::archive\\_node::find\\_ex\(\)](#), [GiNaC::archive\\_node::find\\_unsigned\(\)](#), [metric](#), and [representation\\_label](#).

### 6.13.3.4 eval\_ncmul()

```
ex GiNaC::clifford::eval_ncmul (
 const exvector & v) const [override], [protected], [virtual]
```

Perform automatic simplification on noncommutative product of clifford objects.

This removes superfluous ONEs, permutes gamma5/L/R's to the front and removes squares of gamma objects.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::class\\_info< OPT >::first](#), [clifford\(\)](#), [GiNaC::dirac\\_ONE\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::ex\\_to\(\)](#), [get\\_commutator\\_sign\(\)](#), [GiNaC::hold\\_ncmul\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::reeval\\_ncmul\(\)](#), [representation\\_label](#), [same\\_metric\(\)](#), and [GiNaC::varidx::toggle\\_variance\(\)](#).

### 6.13.3.5 match\_same\_type()

```
bool GiNaC::clifford::match_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is\\_equal\\_same\\_type\(\)](#) is automatically used instead of [match\\_same\\_type\(\)](#) if [nops\(\)](#) == 0.

#### See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

References [clifford\(\)](#), [commutator\\_sign](#), [get\\_commutator\\_sign\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [representation\\_label](#), and [same\\_metric\(\)](#).

**6.13.3.6 thiscontainer() [1/2]**

```
ex GiNaC::clifford::thiscontainer (
 const exvector & v) const [override], [protected], [virtual]
```

Similar to [duplicate\(\)](#), but with a preset sequence.

Must be overridden by derived classes.

Reimplemented from [GiNaC::container< std::vector >](#).

References [clifford\(\)](#), [commutator\\_sign](#), [metric](#), and [representation\\_label](#).

**6.13.3.7 thiscontainer() [2/2]**

```
ex GiNaC::clifford::thiscontainer (
 exvector && v) const [override], [protected], [virtual]
```

Similar to [duplicate\(\)](#), but with a preset sequence (which gets pilfered).

Must be overridden by derived classes.

Reimplemented from [GiNaC::container< std::vector >](#).

References [clifford\(\)](#), [commutator\\_sign](#), [metric](#), and [representation\\_label](#).

**6.13.3.8 return\_type()**

```
unsigned GiNaC::clifford::return_type () const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::noncommutative](#).

**6.13.3.9 return\_type\_tinfo()**

```
return_type_t GiNaC::clifford::return_type_tinfo () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::make\\_return\\_type\\_t\(\)](#), and [representation\\_label](#).

**6.13.3.10 get\_representation\_label()**

```
unsigned char GiNaC::clifford::get_representation_label () const [inline]
```

References [representation\\_label](#).

Referenced by [GiNaC::cliffordunit::contract\\_with\(\)](#).

**6.13.3.11 get\_metric() [1/2]**

```
ex GiNaC::clifford::get_metric () const [inline]
```

References [metric](#).

Referenced by [GiNaC::cliffordunit::contract\\_with\(\)](#), and [same\\_metric\(\)](#).

**6.13.3.12 get\_metric() [2/2]**

```
ex GiNaC::clifford::get_metric (
 const ex & i,
 const ex & j,
 bool symmetrised = false) const [virtual]
```

References [GiNaC::\\_ex1\\_2](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::indexed::get\\_symmetry\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::is\\_a\(\)](#), [metric](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::indexed::simplify\\_indexed](#), and [GiNaC::symmetric2\(\)](#).

**6.13.3.13 same\_metric()**

```
bool GiNaC::clifford::same_metric (
 const ex & other) const
```

References [GiNaC::ex\\_to\(\)](#), [GiNaC::ex::get\\_free\\_indices\(\)](#), [get\\_metric\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [op\(\)](#), [GiNaC::ex::op\(\)](#), and [GiNaC::indexed::simplify\\_indexed](#).

Referenced by [GiNaC::cliffordunit::contract\\_with\(\)](#), [eval\\_ncmul\(\)](#), and [match\\_same\\_type\(\)](#).

**6.13.3.14 get\_commutator\_sign()**

```
int GiNaC::clifford::get_commutator_sign () const [inline]
```

References [commutator\\_sign](#).

Referenced by [eval\\_ncmul\(\)](#), and [match\\_same\\_type\(\)](#).

**6.13.3.15 nops()**

```
size_t GiNaC::clifford::nops () const [inline], [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

Referenced by [let\\_op\(\)](#), and [op\(\)](#).

**6.13.3.16 op()**

```
ex GiNaC::clifford::op (
 size_t i) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GINAC\\_ASSERT](#), [nops\(\)](#), and [representation\\_label](#).

Referenced by [same\\_metric\(\)](#).

**6.13.3.17 let\_op()**

```
& GiNaC::clifford::let_op (
 size_t i) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [GINAC\\_ASSERT](#), [nops\(\)](#), and [representation\\_label](#).

**6.13.3.18 subs()**

```
ex GiNaC::clifford::subs (
 const exmap & m,
 unsigned options = 0) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [clifford\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::is\\_a\(\)](#), [metric](#), and [GiNaC::ex::subs\(\)](#).

**6.13.3.19 do\_print\_dflt()**

```
void GiNaC::clifford::do_print_dflt (
 const print_dflt & c,
 unsigned level) const [protected]
```

References [GiNaC::is\\_dirac\\_slash\(\)](#), [precedence\(\)](#), [GiNaC::basic::print\\_dispatch\(\)](#), [GiNaC::indexed::printindices\(\)](#), [representation\\_label](#), [GiNaC::print\\_context::s](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).



### 6.13.3.20 do\_print\_latex()

```
void GiNaC::clifford::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

References [GiNaC::is\\_dirac\\_slash\(\)](#), [precedence\(\)](#), [GiNaC::basic::print\\_dispatch\(\)](#), [representation\\_label](#), [GiNaC::print\\_context::s](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.13.3.21 do\_print\_tree()

```
void GiNaC::clifford::do_print_tree (
 const print_tree & c,
 unsigned level) const [protected]
```

References [GiNaC::print\\_tree::delta\\_indent](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [metric](#), [GiNaC::indexed::printindices\(\)](#), [GiNaC::print\\_context::s](#), [GiNaC::container\\_storage< C >::seq](#), and [GiNaC::indexed::symtree](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.13.4 Member Data Documentation

### 6.13.4.1 representation\_label

```
unsigned char GiNaC::clifford::representation_label [protected]
```

Representation label to distinguish independent spin lines.

Referenced by [archive\(\)](#), [clifford\(\)](#), [clifford\(\)](#), [clifford\(\)](#), [clifford\(\)](#), [do\\_print\\_dflt\(\)](#), [do\\_print\\_latex\(\)](#), [eval\\_ncmul\(\)](#), [get\\_representation\\_label\(\)](#), [let\\_op\(\)](#), [match\\_same\\_type\(\)](#), [op\(\)](#), [read\\_archive\(\)](#), [return\\_type\\_tinfo\(\)](#), [thiscontainer\(\)](#), and [thiscontainer\(\)](#).

### 6.13.4.2 metric

```
ex GiNaC::clifford::metric [protected]
```

Metric of the space, all constructors make it an indexed object.

Referenced by [archive\(\)](#), [clifford\(\)](#), [clifford\(\)](#), [clifford\(\)](#), [clifford\(\)](#), [do\\_print\\_tree\(\)](#), [get\\_metric\(\)](#), [get\\_metric\(\)](#), [read\\_archive\(\)](#), [subs\(\)](#), [thiscontainer\(\)](#), and [thiscontainer\(\)](#).

### 6.13.4.3 commutator\_sign

```
int GiNaC::clifford::commutator_sign [protected]
```

It is the sign in the definition  $e \sim i e \sim j \pm e \sim j e \sim i = B(i, j) + B(j, i)$

Referenced by [archive\(\)](#), [clifford\(\)](#), [clifford\(\)](#), [clifford\(\)](#), [clifford\(\)](#), [get\\_commutator\\_sign\(\)](#), [match\\_same\\_type\(\)](#), [read\\_archive\(\)](#), [thiscontainer\(\)](#), and [thiscontainer\(\)](#).

The documentation for this class was generated from the following files:

- [clifford.h](#)
- [clifford.cpp](#)

## 6.14 GiNaC::cliffordunit Class Reference

This class represents the Clifford algebra generators (units).

```
#include <clifford.h>
```

Inheritance diagram for GiNaC::cliffordunit:



Collaboration diagram for GiNaC::cliffordunit:



### Public Member Functions

- bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const override  
*Contraction of a Clifford unit with something else.*

### Public Member Functions inherited from `GiNaC::tensor`

- bool `replace_contr_index` (exvector::iterator self, exvector::iterator other) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).*

### Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic` \* `duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf` () const  
*Evaluate object numerically.*
- virtual `ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*

- virtual `ex eval_integ ()` const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed (const basic &i)` const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print (const print_context &c, unsigned level=0)` const  
*Output to stream.*
- virtual void `dbgprint ()` const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree ()` const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence ()` const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool `info (unsigned inf)` const  
*Information about the object.*
- virtual size\_t `nops ()` const  
*Number of operands/members.*
- virtual `ex op (size_t i)` const  
*Return operand/member at position i.*
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex &let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- virtual `ex &operator[] (const ex &index)`
- virtual `ex &operator[] (size_t i)`
- virtual bool `has (const ex &other, unsigned options=0)` const  
*Test for occurrence of a pattern.*
- virtual bool `match (const ex &pattern, exmap &repls)` const  
*Check whether the expression matches a given pattern.*
- virtual `ex subs (const exmap &m, unsigned options=0)` const  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map (map_function &f)` const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept (GiNaC::visitor &v)` const
- virtual bool `is_polynomial (const ex &var)` const  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree (const ex &s)` const  
*Return degree of highest power in object s.*
- virtual int `ldegree (const ex &s)` const  
*Return degree of lowest power in object s.*
- virtual `ex coeff (const ex &s, int n=1)` const  
*Return coefficient of degree n in object s.*
- virtual `ex expand (unsigned options=0)` const  
*Expand expression, i.e.*
- virtual `ex collect (const ex &s, bool distributed=false)` const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series (const relational &r, int order, unsigned options=0)` const  
*Default implementation of `ex::series()`.*
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier)` const  
*Default implementation of `ex::normal()`.*
- virtual `ex to_rational (exmap &repl)` const  
*Default implementation of `ex::to_rational()`.*

- virtual [ex to\\_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer\\_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual [numeric max\\_coefficient](#) () const  
*Implementation [ex::max\\_coefficient\(\)](#).*
- virtual [exvector get\\_free\\_indices](#) () const  
*Return a vector containing the free indices of an expression.*
- virtual [ex add\\_indexed](#) (const [ex](#) &self, const [ex](#) &other) const  
*Add two indexed expressions.*
- virtual [ex scalar\\_mul\\_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const  
*Multiply an indexed expression with a scalar.*
- virtual [return\\_type\\_t return\\_type\\_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real\\_part](#) () const
- virtual [ex imag\\_part](#) () const
- template<class T>  
void [print\\_dispatch](#) (const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- void [print\\_dispatch](#) (const [registered\\_class\\_info](#) &ri, const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- virtual void [archive](#) ([archive\\_node](#) &n) const  
*Save (serialize) the object into archive node.*
- virtual void [read\\_archive](#) (const [archive\\_node](#) &n, [lst](#) &syms)  
*Load (deserialize) the object from an archive node.*
- [ex subs\\_one\\_level](#) (const [exmap](#) &m, unsigned options) const  
*Helper function for [subs\(\)](#).*
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const  
*Default interface of nth derivative [ex::diff\(s, n\)](#).*
- int [compare](#) (const [basic](#) &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool [is\\_equal](#) (const [basic](#) &other) const  
*Test for syntactic equality.*
- const [basic](#) & [hold](#) () const  
*Stop further evaluation.*
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const  
*Set some [status\\_flags](#).*
- const [basic](#) & [clearflag](#) (unsigned f) const  
*Clear some [status\\_flags](#).*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

### Protected Member Functions

- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

### Protected Member Functions inherited from `GiNaC::tensor`

- unsigned `return_type` () const override

### Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual `ex derivative` (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned `calchash` () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void `do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

### Additional Inherited Members

### Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`  
*of type `status_flags`*
- unsigned `hashvalue`  
*hash value*

## 6.14.1 Detailed Description

This class represents the Clifford algebra generators (units).

## 6.14.2 Member Function Documentation

### 6.14.2.1 `contract_with()`

```
bool GiNaC::cliffordunit::contract_with (
 exvector::iterator self,
 exvector::iterator other,
 exvector & v) const [override], [virtual]
```

Contraction of a Clifford unit with something else.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::diracgamma](#).

References [GiNaC::\\_ex1](#), [GiNaC::dirac\\_ONE\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::clifford::get\\_metric\(\)](#), [GiNaC::clifford::get\\_representation\\_label\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [GiNaC::ex::op\(\)](#), and [GiNaC::clifford::same\\_metric\(\)](#).

### 6.14.2.2 `do_print()`

```
void GiNaC::cliffordunit::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

### 6.14.2.3 `do_print_latex()`

```
void GiNaC::cliffordunit::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

The documentation for this class was generated from the following files:

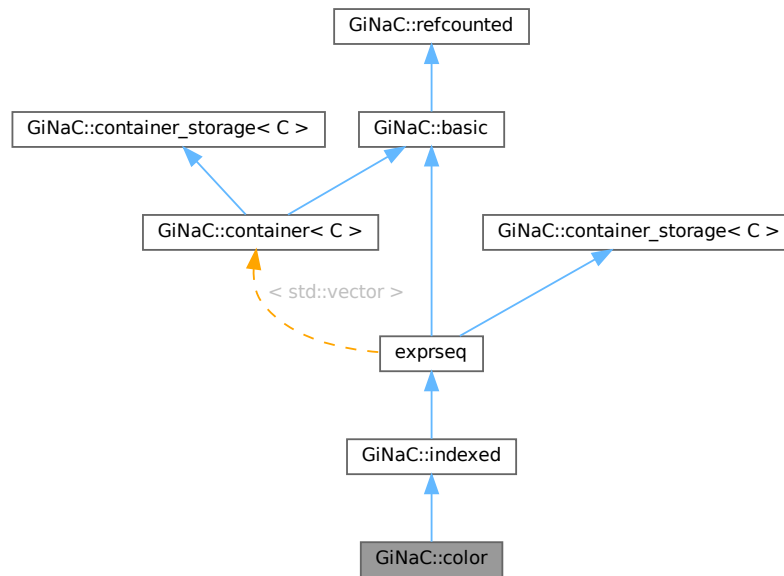
- [clifford.h](#)
- [clifford.cpp](#)

## 6.15 GiNaC::color Class Reference

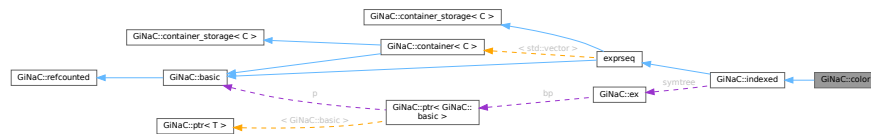
This class holds a generator  $T_a$  or the unity element of the Lie algebra of  $SU(3)$ , as used for calculations in quantum chromodynamics.

```
#include <color.h>
```

Inheritance diagram for GiNaC::color:



Collaboration diagram for GiNaC::color:



## Public Member Functions

- **color** (const **ex** &b, unsigned char rl=0)  
*Construct object without any color index.*
- **color** (const **ex** &b, const **ex** &i1, unsigned char rl=0)  
*Construct object with one color index.*
- **color** (unsigned char rl, const **exvector** &v)
- **color** (unsigned char rl, **exvector** &&v)
- void **archive** (**archive\_node** &n) const override  
*Save (serialize) the object into archive node.*
- void **read\_archive** (const **archive\_node** &n, **lst** &sym\_lst) override  
*Load (deserialize) the object from an archive node.*
- unsigned char **get\_representation\_label** () const



## Public Member Functions inherited from GiNaC::indexed

- `indexed` (const `ex` &b)  
*Construct indexed object with no index.*
- `indexed` (const `ex` &b, const `ex` &i1)  
*Construct indexed object with one index.*
- `indexed` (const `ex` &b, const `ex` &i1, const `ex` &i2)  
*Construct indexed object with two indices.*
- `indexed` (const `ex` &b, const `ex` &i1, const `ex` &i2, const `ex` &i3)  
*Construct indexed object with three indices.*
- `indexed` (const `ex` &b, const `ex` &i1, const `ex` &i2, const `ex` &i3, const `ex` &i4)  
*Construct indexed object with four indices.*
- `indexed` (const `ex` &b, const `symmetry` &symm, const `ex` &i1, const `ex` &i2)  
*Construct indexed object with two indices and a specified symmetry.*
- `indexed` (const `ex` &b, const `symmetry` &symm, const `ex` &i1, const `ex` &i2, const `ex` &i3)  
*Construct indexed object with three indices and a specified symmetry.*
- `indexed` (const `ex` &b, const `symmetry` &symm, const `ex` &i1, const `ex` &i2, const `ex` &i3, const `ex` &i4)  
*Construct indexed object with four indices and a specified symmetry.*
- `indexed` (const `ex` &b, const `exvector` &iv)  
*Construct indexed object with a specified vector of indices.*
- `indexed` (const `ex` &b, const `symmetry` &symm, const `exvector` &iv)  
*Construct indexed object with a specified vector of indices and symmetry.*
- `indexed` (const `symmetry` &symm, const `exprseq` &es)
- `indexed` (const `symmetry` &symm, const `exvector` &v)
- `indexed` (const `symmetry` &symm, `exvector` &&v)
- unsigned `precedence` () const override  
*Return relative operator precedence (for parenthezing output).*
- bool `info` (unsigned inf) const override  
*Information about the object.*
- `ex eval` () const override  
*Perform automatic non-interruptive term rewriting rules.*
- `ex real_part` () const override
- `ex imag_part` () const override
- `exvector get_free_indices` () const override  
*Return a vector containing the free indices of an expression.*
- void `archive` (`archive_node` &n) const override  
*Save (a.k.a.*
- void `read_archive` (const `archive_node` &n, `lst` &syms) override  
*Read (a.k.a.*
- bool `all_index_values_are` (unsigned inf) const  
*Check whether all index values have a certain property.*
- `exvector get_indices` () const  
*Return a vector containing the object's indices.*
- `exvector get_dummy_indices` () const  
*Return a vector containing the dummy indices of the object, if any.*
- `exvector get_dummy_indices` (const `indexed` &other) const  
*Return a vector containing the dummy indices in the contraction with another indexed object.*
- bool `has_dummy_index_for` (const `ex` &i) const  
*Check whether the object has an index that forms a dummy index pair with a given index.*
- `ex get_symmetry` () const  
*Return symmetry properties.*

## Public Member Functions inherited from [GiNaC::container< std::vector >](#)

- [container](#) (STLT const &s)
- [container](#) (STLT &&v)
- [container](#) (exvector::const\_iterator b, exvector::const\_iterator e)
- [container](#) (std::initializer\_list< [ex](#) > il)
- [size\\_t nops](#) () const override  
*Number of operands/members.*
- [ex op](#) (size\_t i) const override  
*Return operand/member at position i.*
- [ex & let\\_op](#) (size\_t i) override  
*Return modifiable operand/member at position i.*
- [ex subs](#) (const [exmap](#) &m, unsigned options=0) const override  
*Substitute a set of objects by arbitrary expressions.*
- [container & prepend](#) (const [ex](#) &b)  
*Add element at front.*
- [container & append](#) (const [ex](#) &b)  
*Add element at back.*
- [container & remove\\_first](#) ()  
*Remove first element.*
- [container & remove\\_last](#) ()  
*Remove last element.*
- [container & remove\\_all](#) ()  
*Remove all elements.*
- [container & sort](#) ()  
*Sort elements.*
- [container & unique](#) ()  
*Remove adjacent duplicate elements.*
- [const\\_iterator begin](#) () const
- [const\\_iterator end](#) () const
- [const\\_reverse\\_iterator rbegin](#) () const
- [const\\_reverse\\_iterator rend](#) () const
- [container](#) (STLT const &s)
- [container](#) (STLT &&v)
- [container](#) (exvector::const\_iterator b, exvector::const\_iterator e)
- [container](#) (std::initializer\_list< [ex](#) > il)
- [size\\_t nops](#) () const override  
*Number of operands/members.*
- [ex op](#) (size\_t i) const override  
*Return operand/member at position i.*
- [ex & let\\_op](#) (size\_t i) override  
*Return modifiable operand/member at position i.*
- [ex subs](#) (const [exmap](#) &m, unsigned options=0) const override  
*Substitute a set of objects by arbitrary expressions.*
- [container & prepend](#) (const [ex](#) &b)  
*Add element at front.*
- [container & append](#) (const [ex](#) &b)  
*Add element at back.*
- [container & remove\\_first](#) ()  
*Remove first element.*
- [container & remove\\_last](#) ()  
*Remove last element.*

- `container & remove_all ()`  
*Remove all elements.*
- `container & sort ()`  
*Sort elements.*
- `container & unique ()`  
*Remove adjacent duplicate elements.*
- `const_iterator begin () const`
- `const_iterator end () const`
- `const_reverse_iterator rbegin () const`
- `const_reverse_iterator rend () const`

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic ()`  
*basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate () const`  
*Create a clone of this object on the heap.*
- virtual `ex evalf () const`  
*Evaluate object numerically.*
- virtual `ex evalm () const`  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ () const`  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed (const basic &i) const`  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print (const print_context &c, unsigned level=0) const`  
*Output to stream.*
- virtual void `dbgprint () const`  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree () const`  
*Little wrapper around printtree to be called within a debugger.*
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual bool `has (const ex &other, unsigned options=0) const`  
*Test for occurrence of a pattern.*
- virtual bool `match (const ex &pattern, exmap &repls) const`  
*Check whether the expression matches a given pattern.*
- virtual `ex map (map_function &f) const`  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept (GiNaC::visitor &v) const`
- virtual bool `is_polynomial (const ex &var) const`  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree (const ex &s) const`  
*Return degree of highest power in object s.*
- virtual int `ldegree (const ex &s) const`  
*Return degree of lowest power in object s.*

- virtual `ex coeff` (const `ex` &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual `ex collect` (const `ex` &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series` (const `relational` &r, int order, unsigned options=0) const  
*Default implementation of `ex::series()`.*
- virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const  
*Default implementation of `ex::normal()`.*
- virtual `ex to_rational` (`exmap` &repl) const  
*Default implementation of `ex::to_rational()`.*
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const  
*Implementation `ex::max_coefficient()`.*
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- template<class T>  
void `print_dispatch` (const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- const `basic` & `hold` () const  
*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const  
*Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- `ex eval_ncmul` (const `exvector` &`v`) const override  
*Perform automatic simplification on noncommutative product of color objects.*
- `bool match_same_type` (const `basic` &`other`) const override  
*Returns true if the attributes of two objects are similar enough for a match.*
- `ex thiscontainer` (const `exvector` &`v`) const override  
*Similar to `duplicate()`, but with a preset sequence.*
- `ex thiscontainer` (`exvector` &&`v`) const override  
*Similar to `duplicate()`, but with a preset sequence (which gets pilfered).*
- `unsigned return_type` () const override
- `return_type_t return_type_tinfo` () const override

## Protected Member Functions inherited from `GiNaC::indexed`

- `ex derivative` (const `symbol` &`s`) const override  
*Implementation of `ex::diff()` for an indexed object always returns 0.*
- `ex thiscontainer` (const `exvector` &`v`) const override  
*Similar to `duplicate()`, but with a preset sequence.*
- `ex thiscontainer` (`exvector` &&`v`) const override  
*Similar to `duplicate()`, but with a preset sequence (which gets pilfered).*
- `unsigned return_type` () const override
- `return_type_t return_type_tinfo` () const override
- `ex expand` (unsigned `options`=0) const override  
*Expand expression, i.e.*
- `void printindices` (const `print_context` &`c`, unsigned `level`) const
- `void print_indexed` (const `print_context` &`c`, const char \*`openbrace`, const char \*`closebrace`, unsigned `level`) const
- `void do_print` (const `print_context` &`c`, unsigned `level`) const
- `void do_print_latex` (const `print_latex` &`c`, unsigned `level`) const
- `void do_print_tree` (const `print_tree` &`c`, unsigned `level`) const
- `void validate` () const  
*Check whether all indices are of class `idx` and validate the symmetry tree.*

## Protected Member Functions inherited from `GiNaC::container< std::vector >`

- `ex conjugate` () const override
- `bool is_equal_same_type` (const `basic` &`other`) const override  
*Returns true if two objects of same type are equal.*
- `virtual void printseq` (const `print_context` &`c`, char `openbracket`, char `delim`, char `closebracket`, unsigned `this↔_precedence`, unsigned `upper_precedence`=0) const  
*Print sequence of contained elements.*
- `void do_print` (const `print_context` &`c`, unsigned `level`) const
- `void do_print_tree` (const `print_tree` &`c`, unsigned `level`) const
- `void do_print_python` (const `print_python` &`c`, unsigned `level`) const
- `void do_print_python_repr` (const `print_python_repr` &`c`, unsigned `level`) const
- `STLT subchildren` (const `exmap` &`m`, unsigned `options`=0) const
- `ex conjugate` () const override
- `bool is_equal_same_type` (const `basic` &`other`) const override  
*Returns true if two objects of same type are equal.*

- virtual void [printseq](#) (const [print\\_context](#) &c, char openbracket, char delim, char closebracket, unsigned this←\_precedence, unsigned upper\_precedence=0) const  
*Print sequence of contained elements.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const
- void [do\\_print\\_python](#) (const [print\\_python](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const
- [STLT](#) [subchildren](#) (const [exmap](#) &m, unsigned options=0) const

### Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

### Protected Member Functions inherited from [GiNaC::container\\_storage< C >](#)

- [container\\_storage](#) ()
- [container\\_storage](#) (size\_t n, const [ex](#) &e)
- [container\\_storage](#) (std::initializer\_list< [ex](#) > il)
- template<class In>  
[container\\_storage](#) (In b, In e)
- void [reserve](#) (size\_t)
- [~container\\_storage](#) ()
- void [reserve](#) (size\_t n)
- void [reserve](#) (std::vector< [ex](#) > &v, size\_t n)

### Private Attributes

- unsigned char [representation\\_label](#)  
*Representation label to distinguish independent color matrices coming from separated fermion lines.*

### Additional Inherited Members

### Public Types inherited from [GiNaC::container< std::vector >](#)

- typedef STLT::const\_iterator [const\\_iterator](#)
- typedef STLT::const\_reverse\_iterator [const\\_reverse\\_iterator](#)

**Protected Types inherited from [GiNaC::container< std::vector >](#)**

- typedef [container\\_storage< std::vector >::STLT](#) [STLT](#)

**Protected Types inherited from [GiNaC::container\\_storage< C >](#)**

- typedef C< [ex](#) > [STLT](#)

**Static Protected Member Functions inherited from [GiNaC::container< std::vector >](#)**

- static unsigned [get\\_default\\_flags](#) ()
- static char [get\\_open\\_delim](#) ()
- static char [get\\_close\\_delim](#) ()
- static unsigned [get\\_default\\_flags](#) ()
- static char [get\\_open\\_delim](#) ()
- static char [get\\_close\\_delim](#) ()

**Static Protected Member Functions inherited from [GiNaC::container\\_storage< C >](#)**

- static void [reserve](#) ([STLT](#) &, size\_t)

**Protected Attributes inherited from [GiNaC::indexed](#)**

- [ex symtree](#)  
*Index symmetry (tree of symmetry objects)*

**Protected Attributes inherited from [GiNaC::basic](#)**

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

**Protected Attributes inherited from [GiNaC::container\\_storage< C >](#)**

- [STLT seq](#)

**6.15.1 Detailed Description**

This class holds a generator `T_a` or the unity element of the Lie algebra of  $SU(3)$ , as used for calculations in quantum chromodynamics.

A representation label (an unsigned 8-bit integer) is used to distinguish elements from different Lie algebras (objects with different labels commute). These objects implement an abstract representation of the group, not a specific matrix representation. The indices used for color objects should not have a variance.

## 6.15.2 Constructor & Destructor Documentation

### 6.15.2.1 `color()` [1/4]

```
GiNaC::color::color (
 const ex & b,
 unsigned char rl = 0)
```

Construct object without any color index.

This constructor is for internal use only. Use the `color_ONE()` function instead.

See also

[color\\_ONE](#)

References [color\(\)](#), and [representation\\_label](#).

Referenced by [color\(\)](#), [eval\\_ncmul\(\)](#), [match\\_same\\_type\(\)](#), [thiscontainer\(\)](#), and [thiscontainer\(\)](#).

### 6.15.2.2 `color()` [2/4]

```
GiNaC::color::color (
 const ex & b,
 const ex & il,
 unsigned char rl = 0)
```

Construct object with one color index.

This constructor is for internal use only. Use the `color_T()` function instead.

See also

[color\\_T](#)

References [representation\\_label](#).

### 6.15.2.3 `color()` [3/4]

```
GiNaC::color::color (
 unsigned char rl,
 const exvector & v)
```

References [GiNaC::not\\_symmetric\(\)](#), and [representation\\_label](#).

### 6.15.2.4 `color()` [4/4]

```
GiNaC::color::color (
 unsigned char rl,
 exvector && v)
```

References [GiNaC::not\\_symmetric\(\)](#), and [representation\\_label](#).



## 6.15.3 Member Function Documentation

### 6.15.3.1 archive()

```
void GiNaC::color::archive (
 archive_node & n) const [override], [virtual]
```

Save (serialize) the object into archive node.

Archive the object.

Losely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::add\\_unsigned\(\)](#), and [representation\\_label](#).

### 6.15.3.2 read\_archive()

```
void GiNaC::color::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive\\_node](#).

#### Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::find\\_unsigned\(\)](#), and [representation\\_label](#).

### 6.15.3.3 eval\_ncmul()

```
ex GiNaC::color::eval_ncmul (
 const exvector & v) const [override], [protected], [virtual]
```

Perform automatic simplification on noncommutative product of color objects.

This removes superfluous ONES.

Reimplemented from [GiNaC::basic](#).

References [color\(\)](#), [eval\\_ncmul\(\)](#), [GiNaC::hold\\_ncmul\(\)](#), [GiNaC::is\\_a\(\)](#), and [representation\\_label](#).

Referenced by [eval\\_ncmul\(\)](#).

#### 6.15.3.4 `match_same_type()`

```
bool GiNaC::color::match_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is\\_equal\\_same\\_type\(\)](#) is automatically used instead of [match\\_same\\_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

References [color\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), and [representation\\_label](#).

#### 6.15.3.5 `thiscontainer()` [1/2]

```
ex GiNaC::color::thiscontainer (
 const exvector & v) const [override], [protected], [virtual]
```

Similar to [duplicate\(\)](#), but with a preset sequence.

Must be overridden by derived classes.

Reimplemented from [GiNaC::container< std::vector >](#).

References [color\(\)](#), and [representation\\_label](#).

#### 6.15.3.6 `thiscontainer()` [2/2]

```
ex GiNaC::color::thiscontainer (
 exvector && v) const [override], [protected], [virtual]
```

Similar to [duplicate\(\)](#), but with a preset sequence (which gets pilfered).

Must be overridden by derived classes.

Reimplemented from [GiNaC::container< std::vector >](#).

References [color\(\)](#), and [representation\\_label](#).

#### 6.15.3.7 `return_type()`

```
unsigned GiNaC::color::return_type () const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::noncommutative](#).

### 6.15.3.8 return\_type\_tinfo()

```
return_type_t GiNaC::color::return_type_tinfo () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::make\\_return\\_type\\_t\(\)](#), and [representation\\_label](#).

### 6.15.3.9 get\_representation\_label()

```
unsigned char GiNaC::color::get_representation_label () const [inline]
```

References [representation\\_label](#).

## 6.15.4 Member Data Documentation

### 6.15.4.1 representation\_label

```
unsigned char GiNaC::color::representation_label [private]
```

Representation label to distinguish independent color matrices coming from separated fermion lines.

Referenced by [archive\(\)](#), [color\(\)](#), [color\(\)](#), [color\(\)](#), [color\(\)](#), [eval\\_ncmul\(\)](#), [get\\_representation\\_label\(\)](#), [match\\_same\\_type\(\)](#), [read\\_archive\(\)](#), [return\\_type\\_tinfo\(\)](#), [thiscontainer\(\)](#), and [thiscontainer\(\)](#).

The documentation for this class was generated from the following files:

- [color.h](#)
- [color.cpp](#)

## 6.16 GiNaC::compare\_all\_equal< T > Class Template Reference

Comparison policy: all structures of one type are equal.

```
#include <structure.h>
```

### Protected Member Functions

- [~compare\\_all\\_equal\(\)](#)

### Static Protected Member Functions

- static bool [struct\\_is\\_equal](#) (const T \*t1, const T \*t2)
- static int [struct\\_compare](#) (const T \*t1, const T \*t2)

### 6.16.1 Detailed Description

```
template<class T>
class GiNaC::compare_all_equal< T >
```

Comparison policy: all structures of one type are equal.

### 6.16.2 Constructor & Destructor Documentation

#### 6.16.2.1 ~compare\_all\_equal()

```
template<class T>
GiNaC::compare_all_equal< T >::~~compare_all_equal () [inline], [protected]
```

### 6.16.3 Member Function Documentation

#### 6.16.3.1 struct\_is\_equal()

```
template<class T>
static bool GiNaC::compare_all_equal< T >::struct_is_equal (
 const T * t1,
 const T * t2) [inline], [static], [protected]
```

#### 6.16.3.2 struct\_compare()

```
template<class T>
static int GiNaC::compare_all_equal< T >::struct_compare (
 const T * t1,
 const T * t2) [inline], [static], [protected]
```

The documentation for this class was generated from the following file:

- [structure.h](#)

## 6.17 GiNaC::compare\_bitwise< T > Class Template Reference

Comparison policy: use bit-wise comparison to compare structures.

```
#include <structure.h>
```

#### Protected Member Functions

- [~compare\\_bitwise \(\)](#)

### Static Protected Member Functions

- static bool [struct\\_is\\_equal](#) (const T \*t1, const T \*t2)
- static int [struct\\_compare](#) (const T \*t1, const T \*t2)

## 6.17.1 Detailed Description

```
template<class T>
class GiNaC::compare_bitwise< T >
```

Comparison policy: use bit-wise comparison to compare structures.

## 6.17.2 Constructor & Destructor Documentation

### 6.17.2.1 ~compare\_bitwise()

```
template<class T>
GiNaC::compare_bitwise< T >::~~compare_bitwise () [inline], [protected]
```

## 6.17.3 Member Function Documentation

### 6.17.3.1 struct\_is\_equal()

```
template<class T>
static bool GiNaC::compare_bitwise< T >::struct_is_equal (
 const T * t1,
 const T * t2) [inline], [static], [protected]
```

### 6.17.3.2 struct\_compare()

```
template<class T>
static int GiNaC::compare_bitwise< T >::struct_compare (
 const T * t1,
 const T * t2) [inline], [static], [protected]
```

The documentation for this class was generated from the following file:

- [structure.h](#)

## 6.18 GiNaC::compare\_std\_less< T > Class Template Reference

Comparison policy: use std::equal\_to/std::less (defaults to operators == and <) to compare structures.

```
#include <structure.h>
```

## Protected Member Functions

- [~compare\\_std\\_less\(\)](#)

## Static Protected Member Functions

- static bool [struct\\_is\\_equal](#) (const T \*t1, const T \*t2)
- static int [struct\\_compare](#) (const T \*t1, const T \*t2)

### 6.18.1 Detailed Description

```
template<class T>
class GiNaC::compare_std_less< T >
```

Comparison policy: use std::equal\_to/std::less (defaults to operators == and <) to compare structures.

### 6.18.2 Constructor & Destructor Documentation

#### 6.18.2.1 ~compare\_std\_less()

```
template<class T>
GiNaC::compare_std_less< T >::~~compare_std_less () [inline], [protected]
```

### 6.18.3 Member Function Documentation

#### 6.18.3.1 struct\_is\_equal()

```
template<class T>
static bool GiNaC::compare_std_less< T >::struct_is_equal (
 const T * t1,
 const T * t2) [inline], [static], [protected]
```

#### 6.18.3.2 struct\_compare()

```
template<class T>
static int GiNaC::compare_std_less< T >::struct_compare (
 const T * t1,
 const T * t2) [inline], [static], [protected]
```

The documentation for this class was generated from the following file:

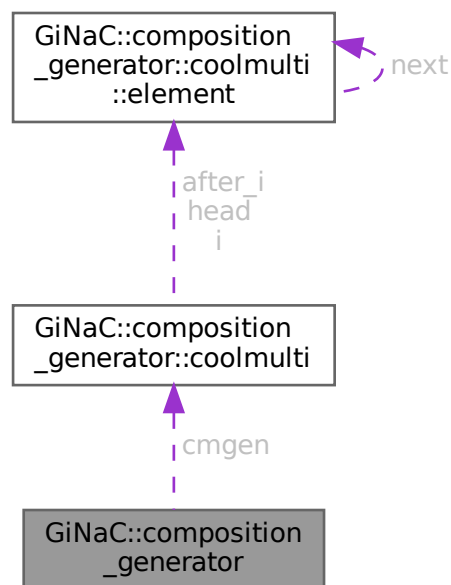
- [structure.h](#)

## 6.19 GiNaC::composition\_generator Class Reference

Generate all compositions of a partition of an integer  $n$ , starting with the compositions which has non-decreasing order.

```
#include <utils.h>
```

Collaboration diagram for GiNaC::composition\_generator:



### Classes

- struct [coolmulti](#)

### Public Member Functions

- [composition\\_generator](#) (const std::vector< unsigned > &partition)
- const std::vector< unsigned > & [get](#) () const
- bool [next](#) ()

### Private Attributes

- struct [GiNaC::composition\\_generator::coolmulti](#) [cmgen](#)
- bool [atend](#)
- bool [trivial](#)
- std::vector< unsigned > [composition](#)
- bool [current\\_updated](#)

### 6.19.1 Detailed Description

Generate all compositions of a partition of an integer *n*, starting with the compositions which has non-decreasing order.

### 6.19.2 Constructor & Destructor Documentation

#### 6.19.2.1 `composition_generator()`

```
GiNaC::composition_generator::composition_generator (
 const std::vector< unsigned > & partition) [inline], [explicit]
```

References [atend](#), [cmgen](#), [composition](#), [current\\_updated](#), and [trivial](#).

### 6.19.3 Member Function Documentation

#### 6.19.3.1 `get()`

```
const std::vector< unsigned > & GiNaC::composition_generator::get () const [inline]
```

References [cmgen](#), [composition](#), [current\\_updated](#), [GiNaC::composition\\_generator::coolmulti::element::next](#), and [GiNaC::composition\\_generator::coolmulti::element::value](#).

Referenced by [GiNaC::power::expand\\_add\(\)](#).

#### 6.19.3.2 `next()`

```
bool GiNaC::composition_generator::next () [inline]
```

References [atend](#), [cmgen](#), [current\\_updated](#), and [trivial](#).

Referenced by [GiNaC::power::expand\\_add\(\)](#).

### 6.19.4 Member Data Documentation

#### 6.19.4.1 `cmgen`

```
struct GiNaC::composition_generator::coolmulti GiNaC::composition_generator::cmgen [private]
```

Referenced by [composition\\_generator\(\)](#), [get\(\)](#), and [next\(\)](#).

#### 6.19.4.2 `atend`

```
bool GiNaC::composition_generator::atend [private]
```

Referenced by [composition\\_generator\(\)](#), and [next\(\)](#).



#### 6.19.4.3 trivial

```
bool GiNaC::composition_generator::trivial [private]
```

Referenced by [composition\\_generator\(\)](#), and [next\(\)](#).

#### 6.19.4.4 composition

```
std::vector<unsigned> GiNaC::composition_generator::composition [mutable], [private]
```

Referenced by [composition\\_generator\(\)](#), and [get\(\)](#).

#### 6.19.4.5 current\_updated

```
bool GiNaC::composition_generator::current_updated [mutable], [private]
```

Referenced by [composition\\_generator\(\)](#), [get\(\)](#), and [next\(\)](#).

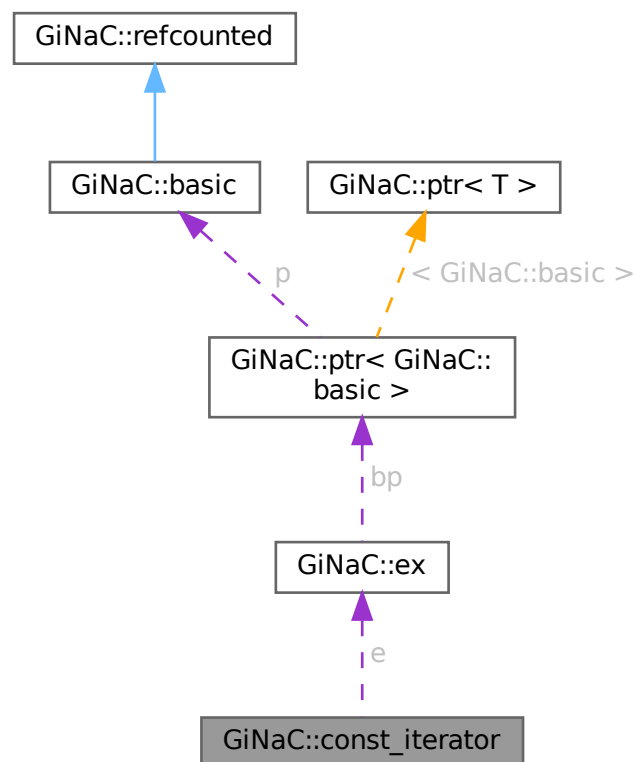
The documentation for this class was generated from the following file:

- [utils.h](#)

## 6.20 GiNaC::const\_iterator Class Reference

```
#include <ex.h>
```

Collaboration diagram for GiNaC::const\_iterator:



## Public Types

- using `iterator_category` = `std::random_access_iterator_tag`
- using `value_type` = `ex`
- using `difference_type` = `ptrdiff_t`
- using `pointer` = `const ex *`
- using `reference` = `const ex &`

## Public Member Functions

- `const_iterator` () noexcept
- `ex operator*` () const
- `std::unique_ptr< ex > operator->` () const
- `ex operator[]` (`difference_type` n) const
- `const_iterator & operator++` () noexcept
- `const_iterator operator++` (int) noexcept
- `const_iterator & operator+=` (`difference_type` n) noexcept
- `const_iterator operator+` (`difference_type` n) const noexcept
- `const_iterator & operator--` () noexcept
- `const_iterator operator--` (int) noexcept
- `const_iterator & operator-=` (`difference_type` n) noexcept
- `const_iterator operator-` (`difference_type` n) const noexcept
- `bool operator==` (const `const_iterator` &other) const noexcept
- `bool operator!=` (const `const_iterator` &other) const noexcept
- `bool operator<` (const `const_iterator` &other) const noexcept
- `bool operator>` (const `const_iterator` &other) const noexcept
- `bool operator<=` (const `const_iterator` &other) const noexcept
- `bool operator>=` (const `const_iterator` &other) const noexcept

## Protected Attributes

- `ex e`
- `size_t i`

## Private Member Functions

- `const_iterator` (const `ex` &`e_`, `size_t i_`) noexcept

## Friends

- class `ex`
- class `const_preorder_iterator`
- class `const_postorder_iterator`
- `const_iterator operator+` (`difference_type` n, const `const_iterator` &`it`) noexcept
- `difference_type operator-` (const `const_iterator` &`lhs`, const `const_iterator` &`rhs`) noexcept

## 6.20.1 Member Typedef Documentation

### 6.20.1.1 `iterator_category`

```
using GiNaC::const_iterator::iterator_category = std::random_access_iterator_tag
```

### 6.20.1.2 value\_type

```
using GiNaC::const_iterator::value_type = ex
```

### 6.20.1.3 difference\_type

```
using GiNaC::const_iterator::difference_type = ptrdiff_t
```

### 6.20.1.4 pointer

```
using GiNaC::const_iterator::pointer = const ex *
```

### 6.20.1.5 reference

```
using GiNaC::const_iterator::reference = const ex &
```

## 6.20.2 Constructor & Destructor Documentation

### 6.20.2.1 const\_iterator() [1/2]

```
GiNaC::const_iterator::const_iterator () [inline], [noexcept]
```

Referenced by [operator!=\(\)](#), [operator+\(\)](#), [operator+](#), [operator++\(\)](#), [operator++\(\)](#), [operator+=\(\)](#), [operator-](#), [operator-\(\)](#), [operator--\(\)](#), [operator--\(\)](#), [operator-=\(\)](#), [operator<\(\)](#), [operator<=\(\)](#), [operator==\(\)](#), [operator>\(\)](#), and [operator>=\(\)](#).

### 6.20.2.2 const\_iterator() [2/2]

```
GiNaC::const_iterator::const_iterator (
 const ex & e_,
 size_t i_) [inline], [private], [noexcept]
```

References [ex](#).

## 6.20.3 Member Function Documentation

### 6.20.3.1 operator\*()

```
ex GiNaC::const_iterator::operator* () const [inline]
```

References [e](#), [ex](#), and [i](#).

### 6.20.3.2 operator->()

```
std::unique_ptr< ex > GiNaC::const_iterator::operator-> () const [inline]
```

References [ex](#).

### 6.20.3.3 operator[]()

```
ex GiNaC::const_iterator::operator[] (
 difference_type n) const [inline]
```

References [e](#), [ex](#), and [i](#).

### 6.20.3.4 operator++() [1/2]

```
const_iterator & GiNaC::const_iterator::operator++ () [inline], [noexcept]
```

References [const\\_iterator\(\)](#), and [i](#).

### 6.20.3.5 operator++() [2/2]

```
const_iterator GiNaC::const_iterator::operator++ (
 int) [inline], [noexcept]
```

References [const\\_iterator\(\)](#), and [i](#).

### 6.20.3.6 operator+=()

```
const_iterator & GiNaC::const_iterator::operator+= (
 difference_type n) [inline], [noexcept]
```

References [const\\_iterator\(\)](#), and [i](#).

### 6.20.3.7 operator+()

```
const_iterator GiNaC::const_iterator::operator+ (
 difference_type n) const [inline], [noexcept]
```

References [const\\_iterator\(\)](#), [e](#), and [i](#).

### 6.20.3.8 operator--() [1/2]

```
const_iterator & GiNaC::const_iterator::operator-- () [inline], [noexcept]
```

References [const\\_iterator\(\)](#), and [i](#).

### 6.20.3.9 operator--() [2/2]

```
const_iterator GiNaC::const_iterator::operator-- (
 int) [inline], [noexcept]
```

References [const\\_iterator\(\)](#), and [i](#).

### 6.20.3.10 operator-=( )

```
const_iterator & GiNaC::const_iterator::operator-= (
 difference_type n) [inline], [noexcept]
```

References [const\\_iterator\(\)](#), and [i](#).

### 6.20.3.11 operator-( )

```
const_iterator GiNaC::const_iterator::operator- (
 difference_type n) const [inline], [noexcept]
```

References [const\\_iterator\(\)](#), [e](#), and [i](#).

### 6.20.3.12 operator==( )

```
bool GiNaC::const_iterator::operator== (
 const const_iterator & other) const [inline], [noexcept]
```

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [const\\_iterator\(\)](#), [e](#), and [i](#).

### 6.20.3.13 operator!=( )

```
bool GiNaC::const_iterator::operator!= (
 const const_iterator & other) const [inline], [noexcept]
```

References [const\\_iterator\(\)](#).

### 6.20.3.14 operator<( )

```
bool GiNaC::const_iterator::operator< (
 const const_iterator & other) const [inline], [noexcept]
```

References [const\\_iterator\(\)](#), and [i](#).

### 6.20.3.15 operator>( )

```
bool GiNaC::const_iterator::operator> (
 const const_iterator & other) const [inline], [noexcept]
```

References [const\\_iterator\(\)](#).

### 6.20.3.16 operator<=( )

```
bool GiNaC::const_iterator::operator<= (
 const const_iterator & other) const [inline], [noexcept]
```

References [const\\_iterator\(\)](#).

### 6.20.3.17 operator>=()

```
bool GiNaC::const_iterator::operator>= (
 const const_iterator & other) const [inline], [noexcept]
```

References [const\\_iterator\(\)](#).

## 6.20.4 Friends And Related Symbol Documentation

### 6.20.4.1 ex

```
friend class ex [friend]
```

References [ex](#).

Referenced by [const\\_iterator\(\)](#), [ex](#), [operator\\*\(\)](#), [operator->\(\)](#), and [operator\[\]\(\)](#).

### 6.20.4.2 const\_preorder\_iterator

```
friend class const_preorder_iterator [friend]
```

References [const\\_preorder\\_iterator](#).

Referenced by [const\\_preorder\\_iterator](#).

### 6.20.4.3 const\_postorder\_iterator

```
friend class const_postorder_iterator [friend]
```

References [const\\_postorder\\_iterator](#).

Referenced by [const\\_postorder\\_iterator](#).

### 6.20.4.4 operator+

```
const_iterator operator+ (
 difference_type n,
 const const_iterator & it) [friend]
```

References [const\\_iterator\(\)](#).

### 6.20.4.5 operator-

```
difference_type operator- (
 const const_iterator & lhs,
 const const_iterator & rhs) [friend]
```

References [const\\_iterator\(\)](#), [GiNaC::lhs\(\)](#), and [GiNaC::rhs\(\)](#).

## 6.20.5 Member Data Documentation

### 6.20.5.1 e

`ex GiNaC::const_iterator::e` [protected]

Referenced by [operator\\*\(\)](#), [operator+\(\)](#), [operator-\(\)](#), [operator==\(\)](#), and [operator\[\]\(\)](#).

### 6.20.5.2 i

`size_t GiNaC::const_iterator::i` [protected]

Referenced by [operator\\*\(\)](#), [operator+\(\)](#), [operator++\(\)](#), [operator++\(\)](#), [operator+=\(\)](#), [operator-\(\)](#), [operator--\(\)](#), [operator--\(\)](#), [operator-=\(\)](#), [operator<\(\)](#), [operator==\(\)](#), and [operator\[\]\(\)](#).

The documentation for this class was generated from the following file:

- [ex.h](#)

## 6.21 GiNaC::const\_postorder\_iterator Class Reference

```
#include <ex.h>
```

### Public Types

- using [iterator\\_category](#) = `std::forward_iterator_tag`
- using [value\\_type](#) = [ex](#)
- using [difference\\_type](#) = `ptrdiff_t`
- using [pointer](#) = `const ex *`
- using [reference](#) = `const ex &`

### Public Member Functions

- [const\\_postorder\\_iterator](#) () noexcept
- [const\\_postorder\\_iterator](#) (const [ex](#) &e, `size_t` n)
- [reference operator\\*](#) () const
- [pointer operator->](#) () const
- [const\\_postorder\\_iterator](#) & [operator++](#) ()
- [const\\_postorder\\_iterator](#) [operator++](#) (`int`)
- `bool` [operator==](#) (const [const\\_postorder\\_iterator](#) &other) const noexcept
- `bool` [operator!=](#) (const [const\\_postorder\\_iterator](#) &other) const noexcept

### Private Member Functions

- `void` [descend](#) ()
- `void` [increment](#) ()

## Private Attributes

- `std::stack< internal::\_iter\_rep, std::vector< internal::\_iter\_rep > > s`

## 6.21.1 Member Typedef Documentation

### 6.21.1.1 `iterator_category`

using `GiNaC::const\_postorder\_iterator::iterator\_category` = `std::forward_iterator_tag`

### 6.21.1.2 `value_type`

using `GiNaC::const\_postorder\_iterator::value\_type` = `ex`

### 6.21.1.3 `difference_type`

using `GiNaC::const\_postorder\_iterator::difference\_type` = `ptrdiff_t`

### 6.21.1.4 `pointer`

using `GiNaC::const\_postorder\_iterator::pointer` = `const ex *`

### 6.21.1.5 `reference`

using `GiNaC::const\_postorder\_iterator::reference` = `const ex &`

## 6.21.2 Constructor & Destructor Documentation

### 6.21.2.1 `const_postorder_iterator()` [1/2]

`GiNaC::const\_postorder\_iterator::const\_postorder\_iterator ()` [`inline`], [`noexcept`]

Referenced by `operator!=\(\)`, `operator++\(\)`, `operator++\(\)`, and `operator==\(\)`.

### 6.21.2.2 `const_postorder_iterator()` [2/2]

`GiNaC::const\_postorder\_iterator::const\_postorder\_iterator (`  
     `const ex & e,`  
     `size_t n)` [`inline`]

References `descend\(\)`, and `s`.



### 6.21.3 Member Function Documentation

#### 6.21.3.1 operator\*()

[reference](#) GiNaC::const\_postorder\_iterator::operator\* () const [inline]

References [s](#).

#### 6.21.3.2 operator->()

[pointer](#) GiNaC::const\_postorder\_iterator::operator-> () const [inline]

References [s](#).

#### 6.21.3.3 operator++() [1/2]

[const\\_postorder\\_iterator](#) & GiNaC::const\_postorder\_iterator::operator++ () [inline]

References [const\\_postorder\\_iterator\(\)](#), and [increment\(\)](#).

#### 6.21.3.4 operator++() [2/2]

[const\\_postorder\\_iterator](#) GiNaC::const\_postorder\_iterator::operator++ (int ) [inline]

References [const\\_postorder\\_iterator\(\)](#), and [increment\(\)](#).

#### 6.21.3.5 operator==( )

bool GiNaC::const\_postorder\_iterator::operator==( const [const\\_postorder\\_iterator](#) & other) const [inline], [noexcept]

References [const\\_postorder\\_iterator\(\)](#), and [s](#).

#### 6.21.3.6 operator!=( )

bool GiNaC::const\_postorder\_iterator::operator!=( const [const\\_postorder\\_iterator](#) & other) const [inline], [noexcept]

References [const\\_postorder\\_iterator\(\)](#).

#### 6.21.3.7 descend()

void GiNaC::const\_postorder\_iterator::descend () [inline], [private]

References [GiNaC::internal::\\_iter\\_rep::e](#), [GiNaC::internal::\\_iter\\_rep::i](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [s](#).

Referenced by [const\\_postorder\\_iterator\(\)](#), and [increment\(\)](#).

### 6.21.3.8 increment()

```
void GiNaC::const_postorder_iterator::increment () [inline], [private]
```

References [descend\(\)](#), and [s](#).

Referenced by [operator++\(\)](#), and [operator++\(\)](#).

## 6.21.4 Member Data Documentation

### 6.21.4.1 s

```
std::stack<internal::_iter_rep, std::vector<internal::_iter_rep> > GiNaC::const_postorder_iterator::s [private]
```

Referenced by [const\\_postorder\\_iterator\(\)](#), [descend\(\)](#), [increment\(\)](#), [operator\\*\(\)](#), [operator->\(\)](#), and [operator==\(\)](#).

The documentation for this class was generated from the following file:

- [ex.h](#)

## 6.22 GiNaC::const\_preorder\_iterator Class Reference

```
#include <ex.h>
```

### Public Types

- using [iterator\\_category](#) = std::forward\_iterator\_tag
- using [value\\_type](#) = [ex](#)
- using [difference\\_type](#) = ptrdiff\_t
- using [pointer](#) = const [ex](#) \*
- using [reference](#) = const [ex](#) &

### Public Member Functions

- [const\\_preorder\\_iterator](#) () noexcept
- [const\\_preorder\\_iterator](#) (const [ex](#) &e, size\_t n)
- [reference operator\\*](#) () const
- [pointer operator->](#) () const
- [const\\_preorder\\_iterator](#) & [operator++](#) ()
- [const\\_preorder\\_iterator](#) [operator++](#) (int)
- bool [operator==](#) (const [const\\_preorder\\_iterator](#) &other) const noexcept
- bool [operator!=](#) (const [const\\_preorder\\_iterator](#) &other) const noexcept

### Private Member Functions

- void [increment](#) ()

### Private Attributes

- `std::stack< internal::\_iter\_rep, std::vector< internal::\_iter\_rep > > s`

## 6.22.1 Member Typedef Documentation

### 6.22.1.1 iterator\_category

using `GiNaC::const_preorder_iterator::iterator_category` = `std::forward_iterator_tag`

### 6.22.1.2 value\_type

using `GiNaC::const_preorder_iterator::value_type` = `ex`

### 6.22.1.3 difference\_type

using `GiNaC::const_preorder_iterator::difference_type` = `ptrdiff_t`

### 6.22.1.4 pointer

using `GiNaC::const_preorder_iterator::pointer` = `const ex *`

### 6.22.1.5 reference

using `GiNaC::const_preorder_iterator::reference` = `const ex &`

## 6.22.2 Constructor & Destructor Documentation

### 6.22.2.1 const\_preorder\_iterator() [1/2]

`GiNaC::const_preorder_iterator::const_preorder_iterator ()` `[inline]`, `[noexcept]`

Referenced by `operator!=()`, `operator++()`, `operator++()`, and `operator==()`.

### 6.22.2.2 const\_preorder\_iterator() [2/2]

`GiNaC::const_preorder_iterator::const_preorder_iterator (`  
     `const ex & e,`  
     `size_t n)` `[inline]`

References [s](#).

## 6.22.3 Member Function Documentation

### 6.22.3.1 `operator*()`

`reference` `GiNaC::const_preorder_iterator::operator* () const [inline]`

References [s](#).

### 6.22.3.2 `operator->()`

`pointer` `GiNaC::const_preorder_iterator::operator-> () const [inline]`

References [s](#).

### 6.22.3.3 `operator++()` [1/2]

`const_preorder_iterator` & `GiNaC::const_preorder_iterator::operator++ () [inline]`

References [const\\_preorder\\_iterator\(\)](#), and [increment\(\)](#).

### 6.22.3.4 `operator++()` [2/2]

`const_preorder_iterator` `GiNaC::const_preorder_iterator::operator++ (`  
`int ) [inline]`

References [const\\_preorder\\_iterator\(\)](#), and [increment\(\)](#).

### 6.22.3.5 `operator==()`

`bool` `GiNaC::const_preorder_iterator::operator== (`  
`const const_preorder_iterator & other) const [inline], [noexcept]`

References [const\\_preorder\\_iterator\(\)](#), and [s](#).

### 6.22.3.6 `operator!=()`

`bool` `GiNaC::const_preorder_iterator::operator!= (`  
`const const_preorder_iterator & other) const [inline], [noexcept]`

References [const\\_preorder\\_iterator\(\)](#).

### 6.22.3.7 `increment()`

`void` `GiNaC::const_preorder_iterator::increment () [inline], [private]`

References [GiNaC::internal::\\_iter\\_rep::e](#), [GiNaC::internal::\\_iter\\_rep::i](#), [GiNaC::internal::\\_iter\\_rep::i\\_end](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [s](#).

Referenced by [operator++\(\)](#), and [operator++\(\)](#).

## 6.22.4 Member Data Documentation

### 6.22.4.1 s

```
std::stack<internal::_iter_rep, std::vector<internal::_iter_rep> > GiNaC::const_preorder_↵
iterator::s [private]
```

Referenced by [const\\_preorder\\_iterator\(\)](#), [increment\(\)](#), [operator\\*\(\)](#), [operator->\(\)](#), and [operator==\(\)](#).

The documentation for this class was generated from the following file:

- [ex.h](#)

## 6.23 GiNaC::constant Class Reference

This class holds constants, symbols with specific numerical value.

```
#include <constant.h>
```

Inheritance diagram for GiNaC::constant:



Collaboration diagram for `GiNaC::constant`:



## Public Member Functions

- `constant` (const std::string &initname, evalfunctype efun=nullptr, const std::string &texname=std::string(), unsigned domain=domain::complex)
- `constant` (const std::string &initname, const numeric &initnumber, const std::string &texname=std::string(), unsigned domain=domain::complex)
- bool `info` (unsigned inf) const override  
*Information about the object.*
- `ex evalf` () const override  
*Evaluate object numerically.*
- bool `is_polynomial` (const ex &var) const override  
*Check whether this is a polynomial in the given variables.*
- `ex conjugate` () const override
- `ex real_part` () const override
- `ex imag_part` () const override
- void `archive` (archive\_node &n) const override  
*Save (serialize) the object into archive node.*
- void `read_archive` (const archive\_node &n, lst &syms) override  
*Load (deserialize) the object from an archive node.*

## Public Member Functions inherited from GiNaC::basic

- virtual `~basic ()`  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate () const`  
*Create a clone of this object on the heap.*
- virtual `ex eval () const`  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalm () const`  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ () const`  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed (const basic &i) const`  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print (const print_context &c, unsigned level=0) const`  
*Output to stream.*
- virtual void `dbgprint () const`  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree () const`  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence () const`  
*Return relative operator precedence (for parenthezing output).*
- virtual size\_t `nops () const`  
*Number of operands/members.*
- virtual `ex op (size_t i) const`  
*Return operand/member at position i.*
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`
- virtual `ex & let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual bool `has (const ex &other, unsigned options=0) const`  
*Test for occurrence of a pattern.*
- virtual bool `match (const ex &pattern, exmap &repls) const`  
*Check whether the expression matches a given pattern.*
- virtual `ex subs (const exmap &m, unsigned options=0) const`  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map (map_function &f) const`  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept (GiNaC::visitor &v) const`
- virtual int `degree (const ex &s) const`  
*Return degree of highest power in object s.*
- virtual int `ldegree (const ex &s) const`  
*Return degree of lowest power in object s.*
- virtual `ex coeff (const ex &s, int n=1) const`  
*Return coefficient of degree n in object s.*
- virtual `ex expand (unsigned options=0) const`

- Expand expression, i.e.*

  - virtual `ex collect` (const `ex` &s, bool distributed=false) const

*Sort expanded expression in terms of powers of some object(s).*

  - virtual `ex series` (const `relational` &r, int order, unsigned options=0) const

*Default implementation of `ex::series()`.*

  - virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const

*Default implementation of `ex::normal()`.*

  - virtual `ex to_rational` (`exmap` &repl) const

*Default implementation of `ex::to_rational()`.*

  - virtual `ex to_polynomial` (`exmap` &repl) const
  - virtual `numeric integer_content` () const
  - virtual `ex smod` (const `numeric` &xi) const

*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

  - virtual `numeric max_coefficient` () const

*Implementation `ex::max_coefficient()`.*

  - virtual `exvector get_free_indices` () const

*Return a vector containing the free indices of an expression.*

  - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const

*Add two indexed expressions.*

  - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const

*Multiply an indexed expression with a scalar.*

  - virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const

*Try to contract two indexed expressions that appear in the same product.*

  - virtual unsigned `return_type` () const
  - virtual `return_type_t return_type_tinfo` () const
  - template<class T>
  - void `print_dispatch` (const `print_context` &c, unsigned level) const

*Like `print()`, but dispatch to the specified class.*

  - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const

*Like `print()`, but dispatch to the specified class.*

  - `ex subs_one_level` (const `exmap` &m, unsigned options) const

*Helper function for `subs()`.*

  - `ex diff` (const `symbol` &s, unsigned nth=1) const

*Default interface of nth derivative `ex::diff(s, n)`.*

  - int `compare` (const `basic` &other) const

*Compare objects syntactically to establish canonical ordering.*

  - bool `is_equal` (const `basic` &other) const

*Test for syntactic equality.*

  - const `basic` & `hold` () const

*Stop further evaluation.*

  - unsigned `gethash` () const
  - const `basic` & `setflag` (unsigned f) const

*Set some `status_flags`.*

  - const `basic` & `clearflag` (unsigned f) const

*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept



## Protected Member Functions

- `ex derivative` (const `symbol` &s) const override  
*Implementation of `ex::diff()` for a constant always returns 0.*
- `bool is_equal_same_type` (const `basic` &other) const override  
*Returns true if two objects of same type are equal.*
- `unsigned calchash` () const override  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- `void do_print` (const `print_context` &c, unsigned level) const
- `void do_print_tree` (const `print_tree` &c, unsigned level) const
- `void do_print_latex` (const `print_latex` &c, unsigned level) const
- `void do_print_python_repr` (const `print_python_repr` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- `virtual ex eval_ncmul` (const `exvector` &v) const
- `virtual bool match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- `virtual int compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- `void ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- `void do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- `void do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- `void do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

## Private Attributes

- `std::string name`  
*printrname of this constant*
- `std::string TeX_name`  
*LaTeX name.*
- `evalffunc type ef`
- `ex number`  
*numerical value this constant `evalf()`s to*
- `unsigned serial`  
*unique serial number for comparison*
- `unsigned domain`  
*numerical value this constant `evalf()`s to*

## Static Private Attributes

- `static unsigned next_serial` = 0

## Additional Inherited Members

### Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
of type [status\\_flags](#)
- unsigned [hashvalue](#)  
hash value

## 6.23.1 Detailed Description

This class holds constants, symbols with specific numerical value.

Each object of this class must either provide their own function to evaluate it to class numeric or provide the constant as a numeric (if it's an exact number).

## 6.23.2 Constructor & Destructor Documentation

### 6.23.2.1 `constant()` [1/2]

```
GiNaC::constant::constant (
 const std::string & initname,
 evalfunctype efun = nullptr,
 const std::string & texname = std::string(),
 unsigned domain = domain::complex)
```

References [constant\(\)](#), [domain](#), [ef](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [name](#), [next\\_serial](#), [serial](#), [GiNaC::basic::setflag\(\)](#), and [TeX\\_name](#).

Referenced by [constant\(\)](#), and [is\\_equal\\_same\\_type\(\)](#).

### 6.23.2.2 `constant()` [2/2]

```
GiNaC::constant::constant (
 const std::string & initname,
 const numeric & initnumber,
 const std::string & texname = std::string(),
 unsigned domain = domain::complex)
```

References [domain](#), [ef](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [name](#), [next\\_serial](#), [number](#), [serial](#), [GiNaC::basic::setflag\(\)](#), and [TeX\\_name](#).

## 6.23.3 Member Function Documentation

### 6.23.3.1 info()

```
bool GiNaC::constant::info (
 unsigned inf) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::basic](#).

References [domain](#), [GiNaC::info\\_flags::nonnegative](#), [GiNaC::info\\_flags::polynomial](#), [GiNaC::domain::positive](#), [GiNaC::info\\_flags::positive](#), [GiNaC::domain::real](#), and [GiNaC::info\\_flags::real](#).

### 6.23.3.2 evalf()

```
ex GiNaC::constant::evalf () const [override], [virtual]
```

Evaluate object numerically.

Reimplemented from [GiNaC::basic](#).

References [ef](#), [GiNaC::basic::ex](#), and [number](#).

### 6.23.3.3 is\_polynomial()

```
bool GiNaC::constant::is_polynomial (
 const ex & var) const [override], [virtual]
```

Check whether this is a polynomial in the given variables.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

### 6.23.3.4 conjugate()

```
ex GiNaC::constant::conjugate () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [domain](#), [GiNaC::basic::ex](#), [GiNaC::domain::positive](#), and [GiNaC::domain::real](#).

### 6.23.3.5 `real_part()`

```
ex GiNaC::constant::real_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [domain](#), [GiNaC::basic::ex](#), [GiNaC::domain::positive](#), and [GiNaC::domain::real](#).

### 6.23.3.6 `imag_part()`

```
ex GiNaC::constant::imag_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [domain](#), [GiNaC::basic::ex](#), [GiNaC::domain::positive](#), and [GiNaC::domain::real](#).

### 6.23.3.7 `archive()`

```
void GiNaC::constant::archive (
 archive_node & n) const [override], [virtual]
```

Save (serialize) the object into archive node.

Archive the object.

Losely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::add\\_string\(\)](#), and [name](#).

### 6.23.3.8 `read_archive()`

```
void GiNaC::constant::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive\\_node](#).

#### Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::Catalan](#), [GiNaC::Euler](#), [GiNaC::archive\\_node::find\\_string\(\)](#), and [GiNaC::Pi](#).

### 6.23.3.9 derivative()

```
ex GiNaC::constant::derivative (
 const symbol & s) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for a constant always returns 0.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), and [GiNaC::basic::ex](#).

### 6.23.3.10 is\_equal\_same\_type()

```
bool GiNaC::constant::is_equal_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare\\_same\\_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::basic\(\)](#), [constant\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [serial](#).

### 6.23.3.11 calchash()

```
unsigned GiNaC::constant::calchash () const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::golden\\_ratio\\_hash\(\)](#), [GiNaC::status\\_flags::hash\\_calculated](#), [GiNaC::basic::hashvalue](#), [serial](#), and [GiNaC::basic::setflag\(\)](#).

### 6.23.3.12 do\_print()

```
void GiNaC::constant::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [name](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.23.3.13 do\_print\_tree()

```
void GiNaC::constant::do_print_tree (
 const print_tree & c,
 unsigned level) const [protected]
```

References [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [name](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.23.3.14 do\_print\_latex()

```
void GiNaC::constant::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

References [GiNaC::print\\_context::s](#), and [TeX\\_name](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.23.3.15 do\_print\_python\_repr()

```
void GiNaC::constant::do_print_python_repr (
 const print_python_repr & c,
 unsigned level) const [protected]
```

References [name](#), [GiNaC::print\\_context::s](#), and [TeX\\_name](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.23.4 Member Data Documentation

### 6.23.4.1 name

```
std::string GiNaC::constant::name [private]
```

printname of this constant

Referenced by [archive\(\)](#), [constant\(\)](#), [constant\(\)](#), [do\\_print\(\)](#), [do\\_print\\_python\\_repr\(\)](#), and [do\\_print\\_tree\(\)](#).

### 6.23.4.2 TeX\_name

```
std::string GiNaC::constant::TeX_name [private]
```

LaTeX name.

Referenced by [constant\(\)](#), [constant\(\)](#), [do\\_print\\_latex\(\)](#), and [do\\_print\\_python\\_repr\(\)](#).

#### 6.23.4.3 ef

```
evalffunctype GiNaC::constant::ef [private]
```

Referenced by [constant\(\)](#), [constant\(\)](#), and [evalf\(\)](#).

#### 6.23.4.4 number

```
ex GiNaC::constant::number [private]
```

numerical value this constant [evalf\(\)](#)s to

Referenced by [constant\(\)](#), and [evalf\(\)](#).

#### 6.23.4.5 serial

```
unsigned GiNaC::constant::serial [private]
```

unique serial number for comparison

Referenced by [calchash\(\)](#), [constant\(\)](#), [constant\(\)](#), and [is\\_equal\\_same\\_type\(\)](#).

#### 6.23.4.6 next\_serial

```
unsigned GiNaC::constant::next_serial = 0 [static], [private]
```

Referenced by [constant\(\)](#), and [constant\(\)](#).

#### 6.23.4.7 domain

```
unsigned GiNaC::constant::domain [private]
```

numerical value this constant [evalf\(\)](#)s to

Referenced by [conjugate\(\)](#), [constant\(\)](#), [constant\(\)](#), [imag\\_part\(\)](#), [info\(\)](#), and [real\\_part\(\)](#).

The documentation for this class was generated from the following files:

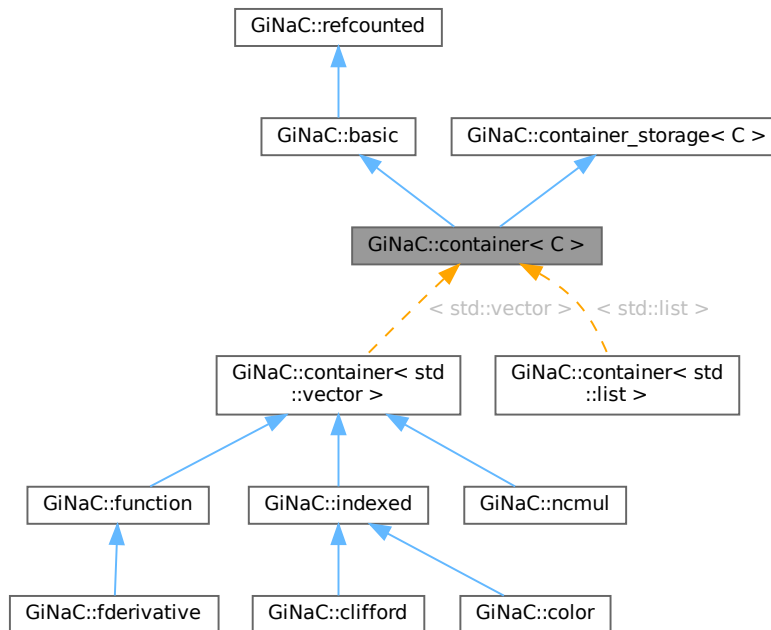
- [constant.h](#)
- [constant.cpp](#)

## 6.24 GiNaC::container< C > Class Template Reference

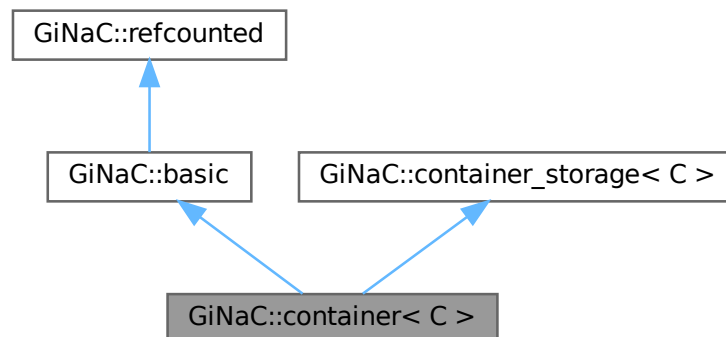
Wrapper template for making [GiNaC](#) classes out of STL containers.

```
#include <container.h>
```

Inheritance diagram for GiNaC::container< C >:



Collaboration diagram for GiNaC::container< C >:





## Public Types

- typedef STLT::const\_iterator [const\\_iterator](#)
- typedef STLT::const\_reverse\_iterator [const\\_reverse\\_iterator](#)

## Public Member Functions

- [container](#) (STLT const &s)
- [container](#) (STLT &&v)
- [container](#) (exvector::const\_iterator b, exvector::const\_iterator e)
- [container](#) (std::initializer\_list< [ex](#) > il)
- bool [info](#) (unsigned inf) const override  
*Information about the object.*
- unsigned [precedence](#) () const override  
*Return relative operator precedence (for parenthezing output).*
- size\_t [nops](#) () const override  
*Number of operands/members.*
- [ex op](#) (size\_t i) const override  
*Return operand/member at position i.*
- [ex](#) & [let\\_op](#) (size\_t i) override  
*Return modifiable operand/member at position i.*
- [ex subs](#) (const [exmap](#) &m, unsigned options=0) const override  
*Substitute a set of objects by arbitrary expressions.*
- void [read\\_archive](#) (const [archive\\_node](#) &n, [lst](#) &sym\_lst) override  
*Load (deserialize) the object from an archive node.*
- void [archive](#) ([archive\\_node](#) &n) const override  
*Archive the object.*
- [container](#) & [prepend](#) (const [ex](#) &b)  
*Add element at front.*
- [container](#) & [append](#) (const [ex](#) &b)  
*Add element at back.*
- [container](#) & [remove\\_first](#) ()  
*Remove first element.*
- [container](#) & [remove\\_last](#) ()  
*Remove last element.*
- [container](#) & [remove\\_all](#) ()  
*Remove all elements.*
- [container](#) & [sort](#) ()  
*Sort elements.*
- [container](#) & [unique](#) ()  
*Remove adjacent duplicate elements.*
- [const\\_iterator](#) [begin](#) () const
- [const\\_iterator](#) [end](#) () const
- [const\\_reverse\\_iterator](#) [rbegin](#) () const
- [const\\_reverse\\_iterator](#) [rend](#) () const

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic ()`  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate () const`  
*Create a clone of this object on the heap.*
- virtual `ex eval () const`  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf () const`  
*Evaluate object numerically.*
- virtual `ex evalm () const`  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ () const`  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed (const basic &i) const`  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual `void print (const print_context &c, unsigned level=0) const`  
*Output to stream.*
- virtual `void dbgprint () const`  
*Little wrapper around print to be called within a debugger.*
- virtual `void dbgprinttree () const`  
*Little wrapper around printtree to be called within a debugger.*
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual `bool has (const ex &other, unsigned options=0) const`  
*Test for occurrence of a pattern.*
- virtual `bool match (const ex &pattern, exmap &repls) const`  
*Check whether the expression matches a given pattern.*
- virtual `ex map (map_function &f) const`  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual `void accept (GiNaC::visitor &v) const`
- virtual `bool is_polynomial (const ex &var) const`  
*Check whether this is a polynomial in the given variables.*
- virtual `int degree (const ex &s) const`  
*Return degree of highest power in object s.*
- virtual `int ldegree (const ex &s) const`  
*Return degree of lowest power in object s.*
- virtual `ex coeff (const ex &s, int n=1) const`  
*Return coefficient of degree n in object s.*
- virtual `ex expand (unsigned options=0) const`  
*Expand expression, i.e.*
- virtual `ex collect (const ex &s, bool distributed=false) const`  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series (const relational &r, int order, unsigned options=0) const`  
*Default implementation of ex::series().*
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier) const`

- virtual `ex to_rational (exmap &repl) const`  
*Default implementation of `ex::normal()`.*
- virtual `ex to_polynomial (exmap &repl) const`  
*Default implementation of `ex::to_rational()`.*
- virtual `numeric integer_content () const`
- virtual `ex smod (const numeric &xi) const`  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient () const`  
*Implementation `ex::max_coefficient()`.*
- virtual `exvector get_free_indices () const`  
*Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed (const ex &self, const ex &other) const`  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed (const ex &self, const numeric &other) const`  
*Multiply an indexed expression with a scalar.*
- virtual `bool contract_with (exvector::iterator self, exvector::iterator other, exvector &v) const`  
*Try to contract two indexed expressions that appear in the same product.*
- virtual `unsigned return_type () const`
- virtual `return_type_t return_type_tinfo () const`
- `template<class T>`  
`void print_dispatch (const print_context &c, unsigned level) const`  
*Like `print()`, but dispatch to the specified class.*
- `void print_dispatch (const registered_class_info &ri, const print_context &c, unsigned level) const`  
*Like `print()`, but dispatch to the specified class.*
- `ex subs_one_level (const exmap &m, unsigned options) const`  
*Helper function for `subs()`.*
- `ex diff (const symbol &s, unsigned nth=1) const`  
*Default interface of `nth` derivative `ex::diff(s, n)`.*
- `int compare (const basic &other) const`  
*Compare objects syntactically to establish canonical ordering.*
- `bool is_equal (const basic &other) const`  
*Test for syntactic equality.*
- `const basic & hold () const`  
*Stop further evaluation.*
- `unsigned gethash () const`
- `const basic & setflag (unsigned f) const`  
*Set some `status_flags`.*
- `const basic & clearflag (unsigned f) const`  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted () noexcept`
- `unsigned int add_reference () noexcept`
- `unsigned int remove_reference () noexcept`
- `unsigned int get_refcount () const noexcept`
- `void set_refcount (unsigned int r) noexcept`

## Protected Types

- `typedef container_storage< C >::STLT STLT`

## Protected Types inherited from `GiNaC::container_storage< C >`

- `typedef C< ex > STLT`

## Protected Member Functions

- `ex conjugate ()` const override
- `ex real_part ()` const override
- `ex imag_part ()` const override
- `bool is_equal_same_type (const basic &other)` const override  
*Returns true if two objects of same type are equal.*
- `virtual ex thiscontainer (const STLT &v)` const  
*Similar to `duplicate()`, but with a preset sequence.*
- `virtual ex thiscontainer (STLT &&v)` const  
*Similar to `duplicate()`, but with a preset sequence (which gets pilfered).*
- `virtual void printseq (const print_context &c, char openbracket, char delim, char closebracket, unsigned this←_precedence, unsigned upper_precedence=0)` const  
*Print sequence of contained elements.*
- `void do_print (const print_context &c, unsigned level)` const
- `void do_print_tree (const print_tree &c, unsigned level)` const
- `void do_print_python (const print_python &c, unsigned level)` const
- `void do_print_python_repr (const print_python_repr &c, unsigned level)` const
- `STLT subchildren (const exmap &m, unsigned options=0)` const

## Protected Member Functions inherited from `GiNaC::basic`

- `basic ()`
- `virtual ex eval_ncmul (const exvector &v)` const
- `virtual bool match_same_type (const basic &other)` const  
*Returns true if the attributes of two objects are similar enough for a match.*
- `virtual ex derivative (const symbol &s)` const  
*Default implementation of `ex::diff()`.*
- `virtual int compare_same_type (const basic &other)` const  
*Returns order relation between two objects of same type.*
- `virtual unsigned calchash ()` const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- `void ensure_if_modifiable ()` const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- `void do_print (const print_context &c, unsigned level)` const  
*Default output to stream.*
- `void do_print_tree (const print_tree &c, unsigned level)` const  
*Tree output to stream.*
- `void do_print_python_repr (const print_python_repr &c, unsigned level)` const  
*Python parsable output to stream.*

**Protected Member Functions inherited from [GiNaC::container\\_storage< C >](#)**

- [container\\_storage](#) ()
- [container\\_storage](#) (size\_t n, const [ex](#) &e)
- [container\\_storage](#) (std::initializer\_list< [ex](#) > il)
- template<class In>  
  [container\\_storage](#) (In b, In e)
- void [reserve](#) (size\_t)
- [~container\\_storage](#) ()
- void [reserve](#) (size\_t n)
- void [reserve](#) (std::vector< [ex](#) > &v, size\_t n)

**Static Protected Member Functions**

- static unsigned [get\\_default\\_flags](#) ()
- static char [get\\_open\\_delim](#) ()
- static char [get\\_close\\_delim](#) ()

**Static Protected Member Functions inherited from [GiNaC::container\\_storage< C >](#)**

- static void [reserve](#) (STLT &, size\_t)

**Private Member Functions**

- void [sort\\_](#) (std::random\_access\_iterator\_tag)
  - void [sort\\_](#) (std::input\_iterator\_tag)
  - void [unique\\_](#) ()
  - void [unique\\_](#) ()
- Specialization of [container::unique\\_\(\)](#) for std::list.*

**Additional Inherited Members****Protected Attributes inherited from [GiNaC::basic](#)**

- unsigned [flags](#)  
  of type [status\\_flags](#)
- unsigned [hashvalue](#)  
  hash value

**Protected Attributes inherited from [GiNaC::container\\_storage< C >](#)**

- [STLT seq](#)

**6.24.1 Detailed Description**

```
template<template< class T, class=std::allocator< T > > class C>
class GiNaC::container< C >
```

Wrapper template for making [GiNaC](#) classes out of STL containers.

## 6.24.2 Member Typedef Documentation

### 6.24.2.1 STL

```
template<template< class T, class=std::allocator< T > > class C>
typedef container_storage<C>::STLT GiNaC::container< C >::STLT [protected]
```

### 6.24.2.2 const\_iterator

```
template<template< class T, class=std::allocator< T > > class C>
typedef STL::const_iterator GiNaC::container< C >::const_iterator
```

### 6.24.2.3 const\_reverse\_iterator

```
template<template< class T, class=std::allocator< T > > class C>
typedef STL::const_reverse_iterator GiNaC::container< C >::const_reverse_iterator
```

## 6.24.3 Constructor & Destructor Documentation

### 6.24.3.1 container() [1/4]

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container< C >::container (
 STL const & s) [inline]
```

Referenced by [append\(\)](#), [is\\_equal\\_same\\_type\(\)](#), [prepend\(\)](#), [remove\\_all\(\)](#), [remove\\_first\(\)](#), [remove\\_last\(\)](#), [sort\(\)](#), [subs\(\)](#), [GiNaC::container< std::vector >::thiscontainer\(\)](#), [GiNaC::container< std::vector >::thiscontainer\(\)](#), and [unique\(\)](#).

### 6.24.3.2 container() [2/4]

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container< C >::container (
 STL && v) [inline], [explicit]
```

### 6.24.3.3 container() [3/4]

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container< C >::container (
 exvector::const_iterator b,
 exvector::const_iterator e) [inline]
```

### 6.24.3.4 container() [4/4]

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container< C >::container (
 std::initializer_list< ex > il) [inline]
```

## 6.24.4 Member Function Documentation

### 6.24.4.1 get\_default\_flags()

```
template<template< class T, class=std::allocator< T > > class C>
static unsigned GiNaC::container< C >::get_default_flags () [inline], [static], [protected]
```

Referenced by [GiNaC::container< std::vector >::container\(\)](#), [GiNaC::container< std::vector >::container\(\)](#), [GiNaC::container< std::vector >::container\(\)](#), [GiNaC::container< std::vector >::container\(\)](#), and [GiNaC::container< std::vector >::re](#)

### 6.24.4.2 get\_open\_delim()

```
template<template< class T, class=std::allocator< T > > class C>
static char GiNaC::container< C >::get_open_delim () [inline], [static], [protected]
```

Referenced by [do\\_print\(\)](#).

### 6.24.4.3 get\_close\_delim()

```
template<template< class T, class=std::allocator< T > > class C>
static char GiNaC::container< C >::get_close_delim () [inline], [static], [protected]
```

Referenced by [do\\_print\(\)](#).

### 6.24.4.4 info()

```
template<template< class T, class=std::allocator< T > > class C>
template bool GiNaC::container< C >::info (
 unsigned inf) const [inline], [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::function](#), [GiNaC::indexed](#), and [GiNaC::ncmul](#).

### 6.24.4.5 precedence()

```
template<template< class T, class=std::allocator< T > > class C>
unsigned GiNaC::container< C >::precedence () const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::function](#), [GiNaC::indexed](#), and [GiNaC::ncmul](#).

Referenced by [do\\_print\(\)](#), [do\\_print\\_python\(\)](#), and [do\\_print\\_python\\_repr\(\)](#).

#### 6.24.4.6 nops()

```
template<template< class T, class=std::allocator< T > > class C>
size_t GiNaC::container< C >::nops () const [inline], [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

Referenced by [GiNaC::ex::denom\(\)](#), [GiNaC::diag\\_matrix\(\)](#), [GiNaC::G2\\_eval\(\)](#), [GiNaC::G2\\_evalf\(\)](#), [GiNaC::G3\\_eval\(\)](#), [GiNaC::G3\\_evalf\(\)](#), [GiNaC::H\\_eval\(\)](#), [GiNaC::H\\_evalf\(\)](#), [GiNaC::container< std::vector >::imag\\_part\(\)](#), [GiNaC::is\\_discriminant\\_of\\_quadratic\\_number\\_field\(\)](#), [GiNaC::iterated\\_integral\\_evalf\\_impl\(\)](#), [GiNaC::Li\\_eval\(\)](#), [GiNaC::Li\\_evalf\(\)](#), [GiNaC::lst\\_to\\_matrix\(\)](#), [GiNaC::add::normal\(\)](#), [GiNaC::basic::normal\(\)](#), [GiNaC::ex::normal\(\)](#), [GiNaC::mul::normal\(\)](#), [GiNaC::power::normal\(\)](#), [GiNaC::ex::numer\(\)](#), [GiNaC::ex::numer\\_denom\(\)](#), [GiNaC::container< std::vector >::real\\_part\(\)](#), [GiNaC::sqrfree\(\)](#), and [GiNaC::ex::subs\(\)](#).

#### 6.24.4.7 op()

```
template<template< class T, class=std::allocator< T > > class C>
ex GiNaC::container< C >::op (
 size_t i) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), [GINAC\\_ASSERT](#), [GiNaC::nops\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [GiNaC::ex::denom\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::G2\\_eval\(\)](#), [GiNaC::G2\\_evalf\(\)](#), [GiNaC::G3\\_eval\(\)](#), [GiNaC::G3\\_evalf\(\)](#), [GiNaC::H\\_evalf\(\)](#), [GiNaC::is\\_discriminant\\_of\\_quadratic\\_number\\_field\(\)](#), [GiNaC::kronecker\\_symbol\(\)](#), [GiNaC::Li\\_evalf\(\)](#), [GiNaC::add::normal\(\)](#), [GiNaC::basic::normal\(\)](#), [GiNaC::ex::normal\(\)](#), [GiNaC::mul::normal\(\)](#), [GiNaC::power::normal\(\)](#), [GiNaC::ex::numer\(\)](#), [GiNaC::ex::numer\\_denom\(\)](#), [GiNaC::rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::sqrfree\(\)](#), [GiNaC::symm\(\)](#), and [GiNaC::symmetrize\\_cyclic\(\)](#).

#### 6.24.4.8 let\_op()

```
template<template< class T, class=std::allocator< T > > class C>
ex & GiNaC::container< C >::let_op (
 size_t i) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [GiNaC::basic::ex](#), [GINAC\\_ASSERT](#), [GiNaC::nops\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [GiNaC::H\\_evalf\(\)](#).



#### 6.24.4.9 subs()

```
template<template< class T, class=std::allocator< T > > class C>
ex GiNaC::container< C >::subs (
 const exmap & m,
 unsigned options = 0) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [container\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::basic::subs\\_one\\_level\(\)](#), [subschildren\(\)](#), and [thiscontainer\(\)](#).

#### 6.24.4.10 read\_archive()

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::read_archive (
 const archive_node & n,
 lst & syms) [inline], [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive\\_node](#).

##### Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::fderivative](#), [GiNaC::function](#), and [GiNaC::indexed](#).

#### 6.24.4.11 archive()

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::archive (
 archive_node & n) const [inline], [override], [virtual]
```

Archive the object.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::fderivative](#), [GiNaC::function](#), and [GiNaC::indexed](#).

#### 6.24.4.12 conjugate()

```
template<template< class T, class=std::allocator< T > > class C>
ex GiNaC::container< C >::conjugate () const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::function](#), and [GiNaC::ncmul](#).

#### 6.24.4.13 real\_part()

```
template<template< class T, class=std::allocator< T > > class C>
ex GiNaC::container< C >::real_part () const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::function](#), [GiNaC::indexed](#), and [GiNaC::ncmul](#).

#### 6.24.4.14 imag\_part()

```
template<template< class T, class=std::allocator< T > > class C>
ex GiNaC::container< C >::imag_part () const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::function](#), [GiNaC::indexed](#), and [GiNaC::ncmul](#).

#### 6.24.4.15 is\_equal\_same\_type()

```
template<template< class T, class=std::allocator< T > > class C>
bool GiNaC::container< C >::is_equal_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare\\_same\\_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::fderivative](#), and [GiNaC::function](#).

References [GiNaC::basic::basic\(\)](#), [container\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).

**6.24.4.16 thiscontainer() [1/2]**

```
template<template< class T, class=std::allocator< T > > class C>
virtual ex GiNaC::container< C >::thiscontainer (
 const STLT & v) const [inline], [protected], [virtual]
```

Similar to [duplicate\(\)](#), but with a preset sequence.

Must be overridden by derived classes.

Reimplemented in [GiNaC::clifford](#), [GiNaC::color](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::indexed](#), and [GiNaC::ncmul](#).

Referenced by [GiNaC::container< std::vector >::conjugate\(\)](#), [GiNaC::container< std::vector >::imag\\_part\(\)](#), [GiNaC::container< std::vector >::real\\_part\(\)](#), and [subs\(\)](#).

**6.24.4.17 thiscontainer() [2/2]**

```
template<template< class T, class=std::allocator< T > > class C>
virtual ex GiNaC::container< C >::thiscontainer (
 STLT && v) const [inline], [protected], [virtual]
```

Similar to [duplicate\(\)](#), but with a preset sequence (which gets pilfered).

Must be overridden by derived classes.

Reimplemented in [GiNaC::clifford](#), [GiNaC::color](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::indexed](#), and [GiNaC::ncmul](#).

**6.24.4.18 printseq()**

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::printseq (
 const print_context & c,
 char openbracket,
 char delim,
 char closebracket,
 unsigned this_precedence,
 unsigned upper_precedence = 0) const [protected], [virtual]
```

Print sequence of contained elements.

References [GiNaC::print\\_context::s](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [do\\_print\(\)](#), [do\\_print\\_python\(\)](#), and [do\\_print\\_python\\_repr\(\)](#).

**6.24.4.19 sort\_() [1/2]**

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::sort_ (
 std::random_access_iterator_tag) [inline], [private]
```

Referenced by [sort\(\)](#).

**6.24.4.20 sort\_()** [2/2]

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::sort_ (
 std::input_iterator_tag) [inline], [private]
```

**6.24.4.21 unique\_()** [1/2]

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::unique_ () [inline], [private]
```

Referenced by [unique\(\)](#).

**6.24.4.22 prepend()**

```
template<template< class T, class=std::allocator< T > > class C>
container< C > & GiNaC::container< C >::prepend (
 const ex & b)
```

Add element at front.

References [container\(\)](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [GiNaC::basic::ex](#), and [GiNaC::container\\_storage< C >::seq](#).

**6.24.4.23 append()**

```
template<template< class T, class=std::allocator< T > > class C>
container< C > & GiNaC::container< C >::append (
 const ex & b)
```

Add element at back.

References [container\(\)](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [GiNaC::basic::ex](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [GiNaC::clifford\\_to\\_lst\(\)](#), [GiNaC::H\\_evalf\(\)](#), [GiNaC::ifactor\(\)](#), [GiNaC::Li\\_eval\(\)](#), [GiNaC::lsolve\(\)](#), [GiNaC::symbol::read\\_archive\(\)](#), [GiNaC::replace\\_with\\_symbol\(\)](#), [GiNaC::sqrfree\(\)](#), [GiNaC::symm\(\)](#), and [GiNaC::symmetrize\\_cyclic\(\)](#).

**6.24.4.24 remove\_first()**

```
template<template< class T, class=std::allocator< T > > class C>
container< C > & GiNaC::container< C >::remove_first ()
```

Remove first element.

References [container\(\)](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [GiNaC::H\\_deriv\(\)](#), [GiNaC::sqrfree\(\)](#), and [GiNaC::symmetrize\\_cyclic\(\)](#).

**6.24.4.25 remove\_last()**

```
template<template< class T, class=std::allocator< T > > class C>
container< C > & GiNaC::container< C >::remove_last ()
```

Remove last element.

References [container\(\)](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).

**6.24.4.26 remove\_all()**

```
template<template< class T, class=std::allocator< T > > class C>
container< C > & GiNaC::container< C >::remove_all ()
```

Remove all elements.

References [container\(\)](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [GiNaC::clifford\\_to\\_lst\(\)](#).

**6.24.4.27 sort()**

```
template<template< class T, class=std::allocator< T > > class C>
container< C > & GiNaC::container< C >::sort ()
```

Sort elements.

References [container\(\)](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), and [sort\\_\(\)](#).

**6.24.4.28 unique()**

```
template<template< class T, class=std::allocator< T > > class C>
container< C > & GiNaC::container< C >::unique ()
```

Remove adjacent duplicate elements.

References [container\(\)](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), and [unique\\_\(\)](#).

**6.24.4.29 begin()**

```
template<template< class T, class=std::allocator< T > > class C>
const_iterator GiNaC::container< C >::begin () const [inline]
```

Referenced by [GiNaC::ex::antisymmetrize\(\)](#), [GiNaC::G3\\_eval\(\)](#), [GiNaC::G3\\_evalf\(\)](#), [GiNaC::H\\_deriv\(\)](#), [GiNaC::H\\_eval\(\)](#), [GiNaC::H\\_evalf\(\)](#), [GiNaC::H\\_print\\_latex\(\)](#), [GiNaC::container< std::vector >::imag\\_part\(\)](#), [GiNaC::kronecker\\_symbol\(\)](#), [GiNaC::Li\\_eval\(\)](#), [GiNaC::Li\\_evalf\(\)](#), [GiNaC::Li\\_print\\_latex\(\)](#), [GiNaC::container< std::vector >::real\\_part\(\)](#), [GiNaC::ex::subs\(\)](#), [GiNaC::ex::symmetrize\(\)](#), [GiNaC::ex::symmetrize\\_cyclic\(\)](#), [GiNaC::zeta1\\_evalf\(\)](#), [GiNaC::zeta1\\_print\\_latex\(\)](#), [GiNaC::zeta2\\_evalf\(\)](#), and [GiNaC::zeta2\\_print\\_latex\(\)](#).

**6.24.4.30 end()**

```
template<template< class T, class=std::allocator< T > > class C>
const_iterator GiNaC::container< C >::end () const [inline]
```

Referenced by [GiNaC::ex::antisymmetrize\(\)](#), [do\\_print\\_tree\(\)](#), [GiNaC::G3\\_eval\(\)](#), [GiNaC::G3\\_evalf\(\)](#), [GiNaC::H\\_eval\(\)](#), [GiNaC::H\\_evalf\(\)](#), [GiNaC::H\\_print\\_latex\(\)](#), [GiNaC::container< std::vector >::imag\\_part\(\)](#), [GiNaC::kronecker\\_symbol\(\)](#), [GiNaC::Li\\_eval\(\)](#), [GiNaC::Li\\_evalf\(\)](#), [GiNaC::Li\\_print\\_latex\(\)](#), [GiNaC::container< std::vector >::real\\_part\(\)](#), [GiNaC::ex::subs\(\)](#), [subschildren\(\)](#), [GiNaC::ex::symmetrize\(\)](#), [GiNaC::ex::symmetrize\\_cyclic\(\)](#), [GiNaC::zeta1\\_print\\_latex\(\)](#), and [GiNaC::zeta2\\_print\\_latex\(\)](#).

**6.24.4.31 rbegin()**

```
template<template< class T, class=std::allocator< T > > class C>
const_reverse_iterator GiNaC::container< C >::rbegin () const [inline]
```

**6.24.4.32 rend()**

```
template<template< class T, class=std::allocator< T > > class C>
const_reverse_iterator GiNaC::container< C >::rend () const [inline]
```

**6.24.4.33 do\_print()**

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [get\\_close\\_delim\(\)](#), [get\\_open\\_delim\(\)](#), [precedence\(\)](#), and [printseq\(\)](#).

**6.24.4.34 do\_print\_tree()**

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::do_print_tree (
 const print_tree & c,
 unsigned level) const [protected]
```

References [GiNaC::print\\_tree::delta\\_indent](#), [end\(\)](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [GiNaC::nops\(\)](#), [GiNaC::print\\_context::s](#), and [GiNaC::container\\_storage< C >::seq](#).

**6.24.4.35 do\_print\_python()**

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::do_print_python (
 const print_python & c,
 unsigned level) const [protected]
```

References [precedence\(\)](#), and [printseq\(\)](#).

## 6.24.4.36 do\_print\_python\_repr()

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::do_print_python_repr (
 const print_python_repr & c,
 unsigned level) const [protected]
```

References [precedence\(\)](#), [printseq\(\)](#), and [GiNaC::print\\_context::s](#).

## 6.24.4.37 subschildren()

```
template<template< class T, class=std::allocator< T > > class C>
container< C >::STLT GiNaC::container< C >::subschildren (
 const exmap & m,
 unsigned options = 0) const [protected]
```

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [end\(\)](#), [GiNaC::basic::ex](#), [GiNaC::container\\_storage< C >::reserve\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [subs\(\)](#).

## 6.24.4.38 unique\_() [2/2]

```
void GiNaC::container< std::list >::unique_ () [inline], [private]
```

Specialization of [container::unique\\_\(\)](#) for `std::list`.

The documentation for this class was generated from the following files:

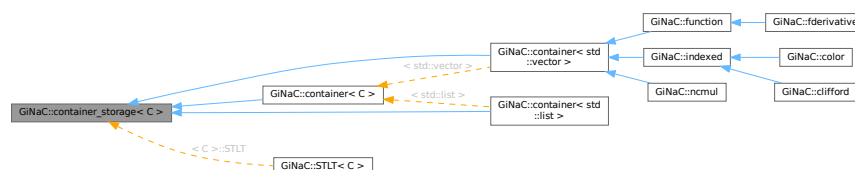
- [container.h](#)
- [lst.h](#)

## 6.25 GiNaC::container\_storage&lt; C &gt; Class Template Reference

Helper template for encapsulating the [reserve\(\)](#) mechanics of STL containers.

```
#include <container.h>
```

Inheritance diagram for `GiNaC::container_storage< C >`:



## Protected Types

- typedef C< [ex](#) > [STLT](#)

## Protected Member Functions

- [container\\_storage](#) ()
- [container\\_storage](#) (size\_t n, const [ex](#) &e)
- [container\\_storage](#) (std::initializer\_list< [ex](#) > il)
- template<class In>  
  [container\\_storage](#) (In b, In e)
- void [reserve](#) (size\_t)
- [~container\\_storage](#) ()
- void [reserve](#) (size\_t n)
- void [reserve](#) (std::vector< [ex](#) > &v, size\_t n)

## Static Protected Member Functions

- static void [reserve](#) ([STLT](#) &, size\_t)

## Protected Attributes

- [STLT seq](#)

## 6.25.1 Detailed Description

```
template<template< class T, class=std::allocator< T > > class C>
class GiNaC::container_storage< C >
```

Helper template for encapsulating the [reserve\(\)](#) mechanics of STL containers.

## 6.25.2 Member Typedef Documentation

### 6.25.2.1 STLT

```
template<template< class T, class=std::allocator< T > > class C>
typedef C<ex> GiNaC::container_storage< C >::STLT [protected]
```

## 6.25.3 Constructor & Destructor Documentation

### 6.25.3.1 container\_storage() [1/4]

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container_storage< C >::container_storage () [inline], [protected]
```

Referenced by [GiNaC::container< std::vector >::container\(\)](#), and [GiNaC::container< std::vector >::container\(\)](#).



**6.25.3.2 container\_storage() [2/4]**

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container_storage< C >::container_storage (
 size_t n,
 const ex & e) [inline], [protected]
```

**6.25.3.3 container\_storage() [3/4]**

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container_storage< C >::container_storage (
 std::initializer_list< ex > il) [inline], [protected]
```

**6.25.3.4 container\_storage() [4/4]**

```
template<template< class T, class=std::allocator< T > > class C>
template<class In>
GiNaC::container_storage< C >::container_storage (
 In b,
 In e) [inline], [protected]
```

**6.25.3.5 ~container\_storage()**

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container_storage< C >::~~container_storage () [inline], [protected]
```

**6.25.4 Member Function Documentation****6.25.4.1 reserve() [1/4]**

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container_storage< C >::reserve (
 size_t) [inline], [protected]
```

Referenced by [GiNaC::container< std::vector >::conjugate\(\)](#), [GiNaC::container< std::vector >::imag\\_part\(\)](#), [GiNaC::container< std::vector >::read\\_archive\(\)](#), [GiNaC::container< std::vector >::real\\_part\(\)](#), and [GiNaC::container< C >::subs](#)

**6.25.4.2 reserve() [2/4]**

```
template<template< class T, class=std::allocator< T > > class C>
static void GiNaC::container_storage< C >::reserve (
 STLT & ,
 size_t) [inline], [static], [protected]
```

**6.25.4.3 reserve() [3/4]**

```
void GiNaC::container_storage< std::vector >::reserve (
 size_t n) [inline], [protected]
```

#### 6.25.4.4 `reserve()` [4/4]

```
void GiNaC::container_storage< std::vector >::reserve (
 std::vector< ex > & v,
 size_t n) [inline], [protected]
```

### 6.25.5 Member Data Documentation

#### 6.25.5.1 `seq`

```
template<template< class T, class=std::allocator< T > > class C>
STLT GiNaC::container_storage< C >::seq [protected]
```

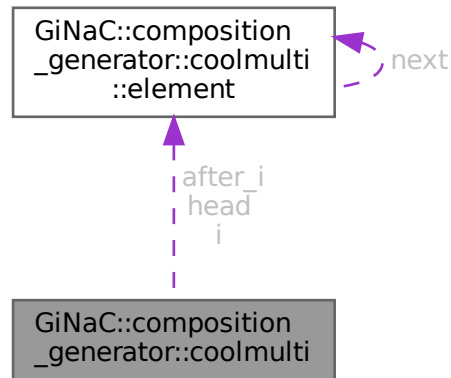
Referenced by [GiNaC::indexed::all\\_index\\_values\\_are\(\)](#), [GiNaC::container< C >::append\(\)](#), [GiNaC::container< std::vector >::archive\(\)](#), [GiNaC::container< std::vector >::begin\(\)](#), [GiNaC::ncmul::coeff\(\)](#), [GiNaC::container< std::vector >::conjugate\(\)](#), [GiNaC::function::conjugate\(\)](#), [GiNaC::container< std::vector >::container\(\)](#), [GiNaC::container< std::vector >::container\(\)](#), [GiNaC::ncmul::degree\(\)](#), [GiNaC::fderivative::derivative\(\)](#), [GiNaC::function::derivative\(\)](#), [GiNaC::ncmul::derivative\(\)](#), [GiNaC::clifford::do\\_print\\_dflt\(\)](#), [GiNaC::clifford::do\\_print\\_latex\(\)](#), [GiNaC::clifford::do\\_print\\_tree\(\)](#), [GiNaC::container< C >::do\\_print\\_tree\(\)](#), [GiNaC::fderivative::do\\_print\\_tree\(\)](#), [GiNaC::indexed::do\\_print\\_tree\(\)](#), [GiNaC::container< std::vector >::end\(\)](#), [GiNaC::fderivative::eval\(\)](#), [GiNaC::function::eval\(\)](#), [GiNaC::indexed::eval\(\)](#), [GiNaC::ncmul::eval\(\)](#), [GiNaC::function::eval\\_ncmul\(\)](#), [GiNaC::function::evalf\(\)](#), [GiNaC::ncmul::evalm\(\)](#), [GiNaC::function::expand\(\)](#), [GiNaC::indexed::expand\(\)](#), [GiNaC::ncmul::expand\(\)](#), [GiNaC::ncmul::expandchildren\(\)](#), [GiNaC::function::expl\\_derivative\(\)](#), [GiNaC::indexed::get\\_dummy\\_indices\(\)](#), [GiNaC::ncmul::get\\_factors\(\)](#), [GiNaC::indexed::get\\_free\\_indices\(\)](#), [GiNaC::indexed::get\\_indices\(\)](#), [GiNaC::indexed::has\\_dummy\\_index\(\)](#), [GiNaC::function::imag\\_part\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::function::info\(\)](#), [GiNaC::indexed::info\(\)](#), [GiNaC::remember\\_table\\_entry::is\\_equal\(\)](#), [GiNaC::container< C >::is\\_equal\\_same\\_type\(\)](#), [GiNaC::ncmul::ldegree\(\)](#), [GiNaC::container< C >::let\\_op\(\)](#), [GiNaC::container< std::vector >::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::function::pderivative\(\)](#), [GiNaC::function::power\(\)](#), [GiNaC::container< C >::prepend\(\)](#), [GiNaC::function::print\(\)](#), [GiNaC::indexed::print\\_indexed\(\)](#), [GiNaC::indexed::printindices\(\)](#), [GiNaC::container< C >::printseq\(\)](#), [GiNaC::container< std::vector >::read\\_archive\(\)](#), [GiNaC::function::read\\_archive\(\)](#), [GiNaC::indexed::read\\_archive\(\)](#), [GiNaC::function::real\\_part\(\)](#), [GiNaC::container< C >::remove\\_all\(\)](#), [GiNaC::container< C >::remove\\_first\(\)](#), [GiNaC::container< C >::remove\\_last\(\)](#), [GiNaC::container< std::vector >::rend\(\)](#), [GiNaC::indexed::reposition\\_dummy\\_indices\(\)](#), [GiNaC::function::return\\_type\(\)](#), [GiNaC::ncmul::return\\_type\(\)](#), [GiNaC::function::return\\_type\\_tinfo\(\)](#), [GiNaC::ncmul::return\\_type\\_tinfo\(\)](#), [GiNaC::function::series\(\)](#), [GiNaC::indexed::simplify\\_indexed\(\)](#), [GiNaC::container< std::vector >::sort\\_\(\)](#), [GiNaC::container< std::vector >::subschildren\(\)](#), [GiNaC::container< std::vector >::unique\\_\(\)](#), and [GiNaC::indexed::validate\(\)](#).

The documentation for this class was generated from the following file:

- [container.h](#)

## 6.26 GiNaC::composition\_generator::coolmulti Struct Reference

Collaboration diagram for GiNaC::composition\_generator::coolmulti:



### Classes

- struct [element](#)

### Public Member Functions

- [coolmulti](#) (const std::vector< unsigned > &partition)
- [~coolmulti](#) ()
- void [next\\_permutation](#) ()
- bool [finished](#) () const

### Public Attributes

- [element](#) \* [head](#)
- [element](#) \* [i](#)
- [element](#) \* [after\\_i](#)

### 6.26.1 Constructor & Destructor Documentation

#### 6.26.1.1 coolmulti()

```

GiNaC::composition_generator::coolmulti::coolmulti (
 const std::vector< unsigned > & partition) [inline], [explicit]

```

References [after\\_i](#), [head](#), and [i](#).

### 6.26.1.2 `~coolmulti()`

```
GiNaC::composition_generator::coolmulti::~~coolmulti () [inline]
```

References [head](#).

## 6.26.2 Member Function Documentation

### 6.26.2.1 `next_permutation()`

```
void GiNaC::composition_generator::coolmulti::next_permutation () [inline]
```

References [after\\_i](#), [head](#), [i](#), [GiNaC::composition\\_generator::coolmulti::element::next](#), and [GiNaC::composition\\_generator::coolmulti::e](#).

### 6.26.2.2 `finished()`

```
bool GiNaC::composition_generator::coolmulti::finished () const [inline]
```

References [after\\_i](#), and [head](#).

## 6.26.3 Member Data Documentation

### 6.26.3.1 `head`

```
element* GiNaC::composition_generator::coolmulti::head
```

Referenced by [coolmulti\(\)](#), [finished\(\)](#), [next\\_permutation\(\)](#), and [~coolmulti\(\)](#).

### 6.26.3.2 `i`

```
element * GiNaC::composition_generator::coolmulti::i
```

Referenced by [coolmulti\(\)](#), and [next\\_permutation\(\)](#).

### 6.26.3.3 `after_i`

```
element * GiNaC::composition_generator::coolmulti::after_i
```

Referenced by [coolmulti\(\)](#), [finished\(\)](#), and [next\\_permutation\(\)](#).

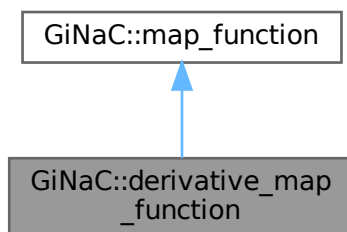
The documentation for this struct was generated from the following file:

- [utils.h](#)

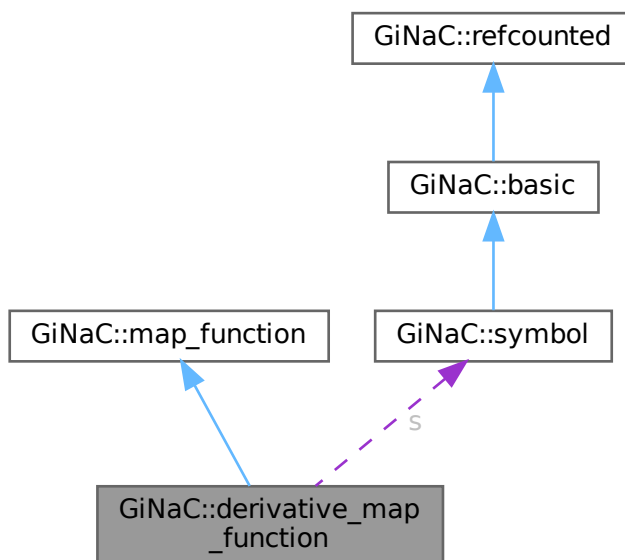
## 6.27 GiNaC::derivative\_map\_function Struct Reference

Function object to be applied by [basic::derivative\(\)](#).

Inheritance diagram for GiNaC::derivative\_map\_function:



Collaboration diagram for GiNaC::derivative\_map\_function:



### Public Member Functions

- [derivative\\_map\\_function](#) (const [symbol](#) &sym)
- [ex operator\(\)](#) (const [ex](#) &e) override

## Public Member Functions inherited from [GiNaC::map\\_function](#)

- virtual [~map\\_function\(\)](#)

## Public Attributes

- const [symbol](#) & [s](#)

## Additional Inherited Members

## Public Types inherited from [GiNaC::map\\_function](#)

- typedef const [ex](#) & [argument\\_type](#)
- typedef [ex](#) [result\\_type](#)

### 6.27.1 Detailed Description

Function object to be applied by [basic::derivative\(\)](#).

### 6.27.2 Constructor & Destructor Documentation

#### 6.27.2.1 [derivative\\_map\\_function\(\)](#)

```
GiNaC::derivative_map_function::derivative_map_function (
 const symbol & sym) [inline]
```

References [s](#).

### 6.27.3 Member Function Documentation

#### 6.27.3.1 [operator\(\)\(\)](#)

```
ex GiNaC::derivative_map_function::operator() (
 const ex & e) [inline], [override], [virtual]
```

Implements [GiNaC::map\\_function](#).

References [GiNaC::diff\(\)](#), and [s](#).

### 6.27.4 Member Data Documentation

#### 6.27.4.1 [s](#)

```
const symbol& GiNaC::derivative_map_function::s
```

Referenced by [derivative\\_map\\_function\(\)](#), and [operator\(\)\(\)](#).

The documentation for this struct was generated from the following file:

- [basic.cpp](#)

## 6.28 GiNaC::determinant\_algo Class Reference

Switch to control algorithm for determinant computation.

```
#include <flags.h>
```

### Public Types

- enum {  
    [automatic](#) , [gauss](#) , [divfree](#) , [laplace](#) ,  
    [bareiss](#) }

### 6.28.1 Detailed Description

Switch to control algorithm for determinant computation.

### 6.28.2 Member Enumeration Documentation

#### 6.28.2.1 anonymous enum

anonymous enum

#### Enumerator

|           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| automatic | Let the system choose. A heuristics is applied for automatic determination of a suitable algorithm.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| gauss     | <p>Gauss elimination. If <math>m_{i,j}^{(0)}</math> are the entries of the original matrix, then the matrix is transformed into triangular form by applying the rules</p> $m_{i,j}^{(k+1)} = m_{i,j}^{(k)} - m_{i,k}^{(k)} m_{k,j}^{(k)} / m_{k,k}^{(k)}$ <p>The determinant is then just the product of diagonal elements. Choose this algorithm only for purely numerical matrices.</p>                                                                                                                                                                                                                                                                                                                                                                                                                  |
| divfree   | <p>Division-free elimination. This is a modification of Gauss elimination where the division by the pivot element is not carried out. If <math>m_{i,j}^{(0)}</math> are the entries of the original matrix, then the matrix is transformed into triangular form by applying the rules</p> $m_{i,j}^{(k+1)} = m_{i,j}^{(k)} m_{k,k}^{(k)} - m_{i,k}^{(k)} m_{k,j}^{(k)}$ <p>The determinant can later be computed by inspecting the diagonal elements only. This algorithm is only there for the purpose of cross-checks. It is never fast.</p>                                                                                                                                                                                                                                                             |
| laplace   | Laplace elimination. This is plain recursive elimination along minors although multiple minors are avoided by the algorithm. Although the algorithm is exponential in complexity it is frequently the fastest one when the matrix is populated by complicated symbolic expressions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| bareiss   | <p>Bareiss fraction-free elimination. This is a modification of Gauss elimination where the division by the pivot element is <i>delayed</i> until it can be carried out without computing GCDs. If <math>m_{i,j}^{(0)}</math> are the entries of the original matrix, then the matrix is transformed into triangular form by applying the rules</p> $m_{i,j}^{(k+1)} = (m_{i,j}^{(k)} m_{k,k}^{(k)} - m_{i,k}^{(k)} m_{k,j}^{(k)}) / m_{k-1,k-1}^{(k-1)}$ <p>(We have set <math>m_{-1,-1}^{(-1)} = 1</math> in order to avoid a case distinction in above formula.) It can be shown that nothing more than polynomial long division is needed for carrying out the division. The determinant can then be read of from the lower right entry. This algorithm is rarely fast for computing determinants.</p> |

The documentation for this class was generated from the following file:

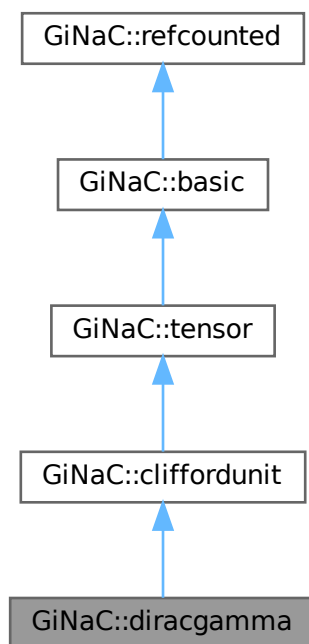
- [flags.h](#)

## 6.29 GiNaC::diracgamma Class Reference

This class represents the Dirac gamma Lorentz vector.

```
#include <clifford.h>
```

Inheritance diagram for GiNaC::diracgamma:





Collaboration diagram for GiNaC::diracgamma:



### Public Member Functions

- bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const override  
*Contraction of a gamma matrix with something else.*

### Public Member Functions inherited from `GiNaC::tensor`

- bool `replace_contr_index` (exvector::iterator self, exvector::iterator other) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).*

### Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic` \* `duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*

- virtual `ex evalf ()` const  
*Evaluate object numerically.*
- virtual `ex evalm ()` const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ ()` const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed (const basic &i)` const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print (const print_context &c, unsigned level=0)` const  
*Output to stream.*
- virtual void `dbgprint ()` const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree ()` const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence ()` const  
*Return relative operator precedence (for parenthesizing output).*
- virtual bool `info (unsigned inf)` const  
*Information about the object.*
- virtual size\_t `nops ()` const  
*Number of operands/members.*
- virtual `ex op (size_t i)` const  
*Return operand/member at position i.*
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex & let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual bool `has (const ex &other, unsigned options=0)` const  
*Test for occurrence of a pattern.*
- virtual bool `match (const ex &pattern, exmap &repls)` const  
*Check whether the expression matches a given pattern.*
- virtual `ex subs (const exmap &m, unsigned options=0)` const  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map (map_function &f)` const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept (GiNaC::visitor &v)` const
- virtual bool `is_polynomial (const ex &var)` const  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree (const ex &s)` const  
*Return degree of highest power in object s.*
- virtual int `ldegree (const ex &s)` const  
*Return degree of lowest power in object s.*
- virtual `ex coeff (const ex &s, int n=1)` const  
*Return coefficient of degree n in object s.*
- virtual `ex expand (unsigned options=0)` const  
*Expand expression, i.e.*
- virtual `ex collect (const ex &s, bool distributed=false)` const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series (const relational &r, int order, unsigned options=0)` const  
*Default implementation of `ex::series()`.*

- virtual `ex normal` (`exmap &repl`, `exmap &rev_lookup`, `lst &modifier`) const  
*Default implementation of `ex::normal()`.*
- virtual `ex to_rational` (`exmap &repl`) const  
*Default implementation of `ex::to_rational()`.*
- virtual `ex to_polynomial` (`exmap &repl`) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric &xi`) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const  
*Implementation `ex::max_coefficient()`.*
- virtual `exvector get_free_indices` () const  
*Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed` (const `ex &self`, const `ex &other`) const  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex &self`, const `numeric &other`) const  
*Multiply an indexed expression with a scalar.*
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T>  
void `print_dispatch` (const `print_context &c`, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info &ri`, const `print_context &c`, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- virtual void `archive` (`archive_node &n`) const  
*Save (serialize) the object into archive node.*
- virtual void `read_archive` (const `archive_node &n`, `lst &syms`)  
*Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap &m`, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol &s`, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic &other`) const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic &other`) const  
*Test for syntactic equality.*
- const `basic & hold` () const  
*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic & setflag` (unsigned f) const  
*Set some `status_flags`.*
- const `basic & clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

### Protected Member Functions

- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

### Protected Member Functions inherited from `GiNaC::cliffordunit`

- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

### Protected Member Functions inherited from `GiNaC::tensor`

- unsigned `return_type` () const override

### Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual `ex derivative` (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned `calchash` () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void `do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

### Additional Inherited Members

### Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`  
*of type `status_flags`*
- unsigned `hashvalue`  
*hash value*

## 6.29.1 Detailed Description

This class represents the Dirac gamma Lorentz vector.

## 6.29.2 Member Function Documentation

### 6.29.2.1 contract\_with()

```
bool GiNaC::diracgamma::contract_with (
 exvector::iterator self,
 exvector::iterator other,
 exvector & v) const [override], [virtual]
```

Contraction of a gamma matrix with something else.

Reimplemented from [GiNaC::cliffordunit](#).

References [GiNaC::\\_ex1](#), [GiNaC::\\_ex2](#), [GiNaC::\\_ex\\_2](#), [GiNaC::base\\_and\\_index\(\)](#), [GiNaC::dirac\\_ONE\(\)](#), [GiNaC::dirac\\_slash\(\)](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::lorentz\\_g\(\)](#), and [GiNaC::minimal\\_dim\(\)](#).

### 6.29.2.2 do\_print()

```
void GiNaC::diracgamma::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

### 6.29.2.3 do\_print\_latex()

```
void GiNaC::diracgamma::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

The documentation for this class was generated from the following files:

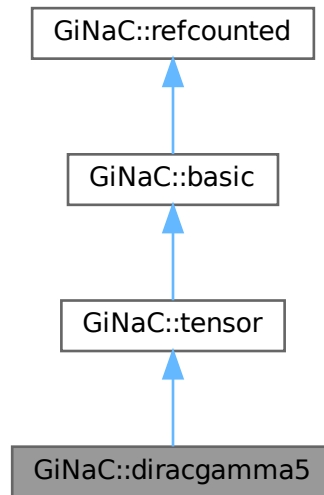
- [clifford.h](#)
- [clifford.cpp](#)

## 6.30 GiNaC::diracgamma5 Class Reference

This class represents the Dirac gamma5 object which anticommutes with all other gammas.

```
#include <clifford.h>
```

Inheritance diagram for GiNaC::diracgamma5:



Collaboration diagram for GiNaC::diracgamma5:



**Protected Member Functions**

- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

**Protected Member Functions inherited from `GiNaC::tensor`**

- unsigned `return_type` () const override

**Protected Member Functions inherited from `GiNaC::basic`**

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual `ex derivative` (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned `calchash` () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void `do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

**Private Member Functions**

- `ex conjugate` () const override

**Additional Inherited Members****Public Member Functions inherited from `GiNaC::tensor`**

- bool `replace_contr_index` (`exvector::iterator` self, `exvector::iterator` other) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).*

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic` \* `duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf` () const  
*Evaluate object numerically.*
- virtual `ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree` () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence` () const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool `info` (unsigned inf) const  
*Information about the object.*
- virtual size\_t `nops` () const  
*Number of operands/members.*
- virtual `ex op` (size\_t i) const  
*Return operand/member at position i.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex` & `let_op` (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual `ex` & `operator[]` (const `ex` &index)
- virtual `ex` & `operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const  
*Check whether the expression matches a given pattern.*
- virtual `ex subs` (const `exmap` &m, unsigned options=0) const  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map` (`map_function` &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const



- Return degree of highest power in object s.*

  - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

  - virtual `ex coeff` (const `ex` &s, int n=1) const
- Return coefficient of degree n in object s.*

  - virtual `ex expand` (unsigned options=0) const
- Expand expression, i.e.*

  - virtual `ex collect` (const `ex` &s, bool distributed=false) const
- Sort expanded expression in terms of powers of some object(s).*

  - virtual `ex series` (const `relational` &r, int order, unsigned options=0) const
- Default implementation of `ex::series()`.*

  - virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

  - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

  - virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

  - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

  - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

  - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

  - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

  - virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

  - virtual `return_type_t return_type_tinfo` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T>
- void `print_dispatch` (const `print_context` &c, unsigned level) const

*Like `print()`, but dispatch to the specified class.*

  - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const

*Like `print()`, but dispatch to the specified class.*
- virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

  - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
- Load (deserialize) the object from an archive node.*

  - `ex subs_one_level` (const `exmap` &m, unsigned options) const
- Helper function for `subs()`.*

  - `ex diff` (const `symbol` &s, unsigned nth=1) const
- Default interface of nth derivative `ex::diff(s, n)`.*

  - int `compare` (const `basic` &other) const
- Compare objects syntactically to establish canonical ordering.*

  - bool `is_equal` (const `basic` &other) const
- Test for syntactic equality.*

  - const `basic` & `hold` () const
- Stop further evaluation.*

- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const  
*Set some [status\\_flags](#).*
- const [basic](#) & [clearflag](#) (unsigned f) const  
*Clear some [status\\_flags](#).*

### Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

### Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

## 6.30.1 Detailed Description

This class represents the Dirac gamma5 object which anticommutes with all other gammas.

## 6.30.2 Member Function Documentation

### 6.30.2.1 conjugate()

```
ex GiNaC::diracgamma5::conjugate () const [override], [private], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex\\_1](#).

### 6.30.2.2 do\_print()

```
void GiNaC::diracgamma5::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

### 6.30.2.3 do\_print\_latex()

```
void GiNaC::diracgamma5::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

The documentation for this class was generated from the following files:

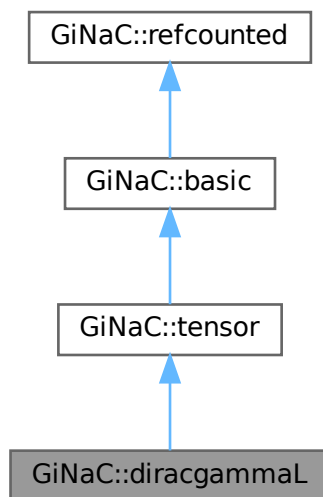
- [clifford.h](#)
- [clifford.cpp](#)

## 6.31 GiNaC::diracgammaL Class Reference

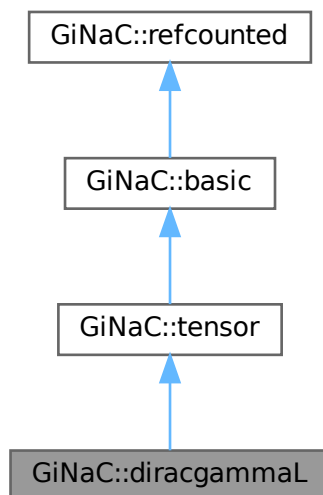
This class represents the Dirac gammaL object which behaves like  $\frac{1}{2}(1-\gamma_5)$ .

```
#include <clifford.h>
```

Inheritance diagram for GiNaC::diracgammaL:



Collaboration diagram for GiNaC::diracgammaL:



### Protected Member Functions

- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

### Protected Member Functions inherited from `GiNaC::tensor`

- unsigned `return_type` () const override

### Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual `ex derivative` (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned `calchash` () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void `do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

### Private Member Functions

- `ex conjugate` () const override

### Additional Inherited Members

### Public Member Functions inherited from `GiNaC::tensor`

- bool `replace_contr_index` (`exvector::iterator` self, `exvector::iterator` other) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).*

## Public Member Functions inherited from GiNaC::basic

- virtual `~basic ()`  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate () const`  
*Create a clone of this object on the heap.*
- virtual `ex eval () const`  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf () const`  
*Evaluate object numerically.*
- virtual `ex evalm () const`  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ () const`  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed (const basic &i) const`  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual `void print (const print_context &c, unsigned level=0) const`  
*Output to stream.*
- virtual `void dbgprint () const`  
*Little wrapper around print to be called within a debugger.*
- virtual `void dbgprinttree () const`  
*Little wrapper around printtree to be called within a debugger.*
- virtual `unsigned precedence () const`  
*Return relative operator precedence (for parenthezing output).*
- virtual `bool info (unsigned inf) const`  
*Information about the object.*
- virtual `size_t nops () const`  
*Number of operands/members.*
- virtual `ex op (size_t i) const`  
*Return operand/member at position i.*
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`
- virtual `ex & let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual `bool has (const ex &other, unsigned options=0) const`  
*Test for occurrence of a pattern.*
- virtual `bool match (const ex &pattern, exmap &repls) const`  
*Check whether the expression matches a given pattern.*
- virtual `ex subs (const exmap &m, unsigned options=0) const`  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map (map_function &f) const`  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual `void accept (GiNaC::visitor &v) const`
- virtual `bool is_polynomial (const ex &var) const`  
*Check whether this is a polynomial in the given variables.*
- virtual `int degree (const ex &s) const`

- Return degree of highest power in object s.*

  - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

  - virtual `ex coeff` (const `ex` &s, int n=1) const
- Return coefficient of degree n in object s.*

  - virtual `ex expand` (unsigned options=0) const
- Expand expression, i.e.*

  - virtual `ex collect` (const `ex` &s, bool distributed=false) const
- Sort expanded expression in terms of powers of some object(s).*

  - virtual `ex series` (const `relational` &r, int order, unsigned options=0) const
- Default implementation of `ex::series()`.*

  - virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

  - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

  - virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

  - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

  - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

  - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

  - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

  - virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

  - virtual `return_type_t return_type_tinfo` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T>
  - void `print_dispatch` (const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

  - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
- Load (deserialize) the object from an archive node.*

  - `ex subs_one_level` (const `exmap` &m, unsigned options) const
- Helper function for `subs()`.*

  - `ex diff` (const `symbol` &s, unsigned nth=1) const
- Default interface of nth derivative `ex::diff(s, n)`.*

  - int `compare` (const `basic` &other) const
- Compare objects syntactically to establish canonical ordering.*

  - bool `is_equal` (const `basic` &other) const
- Test for syntactic equality.*

  - const `basic` & `hold` () const
- Stop further evaluation.*

- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const  
*Set some [status\\_flags](#).*
- const [basic](#) & [clearflag](#) (unsigned f) const  
*Clear some [status\\_flags](#).*

### Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

### Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

## 6.31.1 Detailed Description

This class represents the Dirac gammaL object which behaves like  $1/2 (1-\gamma_5)$ .

## 6.31.2 Member Function Documentation

### 6.31.2.1 conjugate()

```
ex GiNaC::diracgammaL::conjugate () const [override], [private], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::dynallocate\(\)](#).

### 6.31.2.2 do\_print()

```
void GiNaC::diracgammaL::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

### 6.31.2.3 do\_print\_latex()

```
void GiNaC::diracgammaL::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

The documentation for this class was generated from the following files:

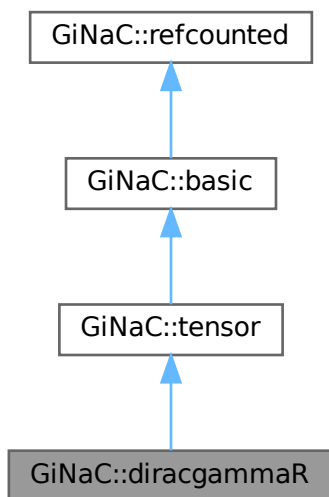
- [clifford.h](#)
- [clifford.cpp](#)

## 6.32 GiNaC::diracgammaR Class Reference

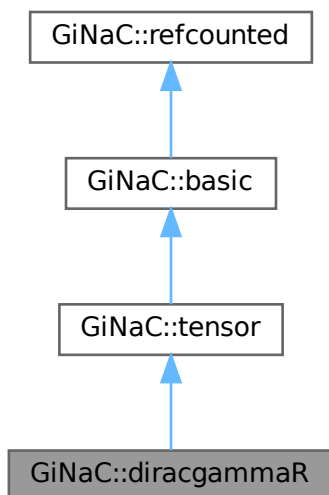
This class represents the Dirac gammaL object which behaves like  $\frac{1}{2}(1+\gamma_5)$ .

```
#include <clifford.h>
```

Inheritance diagram for GiNaC::diracgammaR:



Collaboration diagram for GiNaC::diracgammaR:





### Protected Member Functions

- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

### Protected Member Functions inherited from `GiNaC::tensor`

- unsigned `return_type` () const override

### Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual `ex derivative` (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned `calchash` () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void `do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

### Private Member Functions

- `ex conjugate` () const override

### Additional Inherited Members

### Public Member Functions inherited from `GiNaC::tensor`

- bool `replace_contr_index` (`exvector::iterator` self, `exvector::iterator` other) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).*

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic` \* `duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf` () const  
*Evaluate object numerically.*
- virtual `ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree` () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence` () const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool `info` (unsigned inf) const  
*Information about the object.*
- virtual size\_t `nops` () const  
*Number of operands/members.*
- virtual `ex op` (size\_t i) const  
*Return operand/member at position i.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex` & `let_op` (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual `ex` & `operator[]` (const `ex` &index)
- virtual `ex` & `operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const  
*Check whether the expression matches a given pattern.*
- virtual `ex subs` (const `exmap` &m, unsigned options=0) const  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map` (`map_function` &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const

- Return degree of highest power in object s.*

  - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

  - virtual `ex coeff` (const `ex` &s, int n=1) const
- Return coefficient of degree n in object s.*

  - virtual `ex expand` (unsigned options=0) const
- Expand expression, i.e.*

  - virtual `ex collect` (const `ex` &s, bool distributed=false) const
- Sort expanded expression in terms of powers of some object(s).*

  - virtual `ex series` (const `relational` &r, int order, unsigned options=0) const
- Default implementation of `ex::series()`.*

  - virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

  - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

  - virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

  - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

  - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

  - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

  - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

  - virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

  - virtual `return_type_t return_type_tinfo` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T>  
void `print_dispatch` (const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

  - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
- Load (deserialize) the object from an archive node.*

  - `ex subs_one_level` (const `exmap` &m, unsigned options) const
- Helper function for `subs()`.*

  - `ex diff` (const `symbol` &s, unsigned nth=1) const
- Default interface of nth derivative `ex::diff(s, n)`.*

  - int `compare` (const `basic` &other) const
- Compare objects syntactically to establish canonical ordering.*

  - bool `is_equal` (const `basic` &other) const
- Test for syntactic equality.*

  - const `basic` & `hold` () const
- Stop further evaluation.*

- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const  
*Set some [status\\_flags](#).*
- const [basic](#) & [clearflag](#) (unsigned f) const  
*Clear some [status\\_flags](#).*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.32.1 Detailed Description

This class represents the Dirac gammaL object which behaves like  $\frac{1}{2} (1 + \gamma_5)$ .

### 6.32.2 Member Function Documentation

#### 6.32.2.1 [conjugate\(\)](#)

```
ex GiNaC::diracgammaR::conjugate () const [override], [private], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::dynallocate\(\)](#).

#### 6.32.2.2 [do\\_print\(\)](#)

```
void GiNaC::diracgammaR::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

#### 6.32.2.3 [do\\_print\\_latex\(\)](#)

```
void GiNaC::diracgammaR::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

The documentation for this class was generated from the following files:

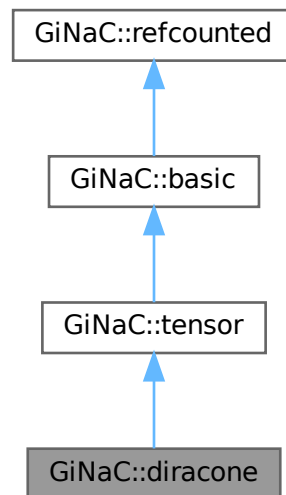
- [clifford.h](#)
- [clifford.cpp](#)

## 6.33 GiNaC::diracone Class Reference

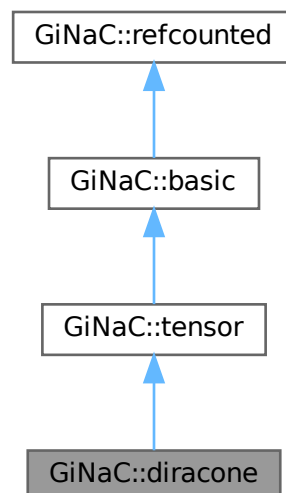
This class represents the Clifford algebra unity element.

```
#include <clifford.h>
```

Inheritance diagram for GiNaC::diracone:



Collaboration diagram for GiNaC::diracone:



### Protected Member Functions

- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

### Protected Member Functions inherited from `GiNaC::tensor`

- unsigned `return_type` () const override

### Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual `ex derivative` (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned `calchash` () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void `do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

### Additional Inherited Members

### Public Member Functions inherited from `GiNaC::tensor`

- bool `replace_contr_index` (`exvector::iterator` self, `exvector::iterator` other) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).*

## Public Member Functions inherited from GiNaC::basic

- virtual `~basic ()`  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate () const`  
*Create a clone of this object on the heap.*
- virtual `ex eval () const`  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf () const`  
*Evaluate object numerically.*
- virtual `ex evalm () const`  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ () const`  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed (const basic &i) const`  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual `void print (const print_context &c, unsigned level=0) const`  
*Output to stream.*
- virtual `void dbgprint () const`  
*Little wrapper around print to be called within a debugger.*
- virtual `void dbgprinttree () const`  
*Little wrapper around printtree to be called within a debugger.*
- virtual `unsigned precedence () const`  
*Return relative operator precedence (for parenthezing output).*
- virtual `bool info (unsigned inf) const`  
*Information about the object.*
- virtual `size_t nops () const`  
*Number of operands/members.*
- virtual `ex op (size_t i) const`  
*Return operand/member at position i.*
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`
- virtual `ex & let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual `bool has (const ex &other, unsigned options=0) const`  
*Test for occurrence of a pattern.*
- virtual `bool match (const ex &pattern, exmap &repls) const`  
*Check whether the expression matches a given pattern.*
- virtual `ex subs (const exmap &m, unsigned options=0) const`  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map (map_function &f) const`  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual `void accept (GiNaC::visitor &v) const`
- virtual `bool is_polynomial (const ex &var) const`  
*Check whether this is a polynomial in the given variables.*
- virtual `int degree (const ex &s) const`

- Return degree of highest power in object s.*

  - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

  - virtual `ex coeff` (const `ex` &s, int n=1) const
- Return coefficient of degree n in object s.*

  - virtual `ex expand` (unsigned options=0) const
- Expand expression, i.e.*

  - virtual `ex collect` (const `ex` &s, bool distributed=false) const
- Sort expanded expression in terms of powers of some object(s).*

  - virtual `ex series` (const `relational` &r, int order, unsigned options=0) const
- Default implementation of `ex::series()`.*

  - virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

  - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

  - virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

  - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

  - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

  - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

  - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

  - virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

  - virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T>
  - void `print_dispatch` (const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

  - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
- Load (deserialize) the object from an archive node.*

  - `ex subs_one_level` (const `exmap` &m, unsigned options) const
- Helper function for `subs()`.*

  - `ex diff` (const `symbol` &s, unsigned nth=1) const
- Default interface of nth derivative `ex::diff(s, n)`.*

  - int `compare` (const `basic` &other) const
- Compare objects syntactically to establish canonical ordering.*

  - bool `is_equal` (const `basic` &other) const
- Test for syntactic equality.*

  - const `basic` & `hold` () const



*Stop further evaluation.*

- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const

*Set some [status\\_flags](#).*

- const [basic](#) & [clearflag](#) (unsigned f) const

*Clear some [status\\_flags](#).*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.33.1 Detailed Description

This class represents the Clifford algebra unity element.

### 6.33.2 Member Function Documentation

#### 6.33.2.1 [do\\_print\(\)](#)

```
void GiNaC::diracone::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

#### 6.33.2.2 [do\\_print\\_latex\(\)](#)

```
void GiNaC::diracone::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

The documentation for this class was generated from the following file:

- [clifford.h](#)

## 6.34 GiNaC::do\_taylor Class Reference

Exception class thrown by classes which provide their own series expansion to signal that ordinary Taylor expansion is safe.

```
#include <function.h>
```

### 6.34.1 Detailed Description

Exception class thrown by classes which provide their own series expansion to signal that ordinary Taylor expansion is safe.

The documentation for this class was generated from the following file:

- [function.h](#)

## 6.35 GiNaC::domain Class Reference

Domain of an object.

```
#include <flags.h>
```

### Public Types

- enum { [complex](#) , [real](#) , [positive](#) }

### 6.35.1 Detailed Description

Domain of an object.

### 6.35.2 Member Enumeration Documentation

#### 6.35.2.1 anonymous enum

```
anonymous enum
```

#### Enumerator

|          |  |
|----------|--|
| complex  |  |
| real     |  |
| positive |  |

The documentation for this class was generated from the following file:

- [flags.h](#)

## 6.36 GiNaC::dunno Class Reference

Exception class thrown by functions to signal unimplemented functionality so the expression may just be .hold()

```
#include <utils.h>
```

### 6.36.1 Detailed Description

Exception class thrown by functions to signal unimplemented functionality so the expression may just be .hold()

The documentation for this class was generated from the following file:

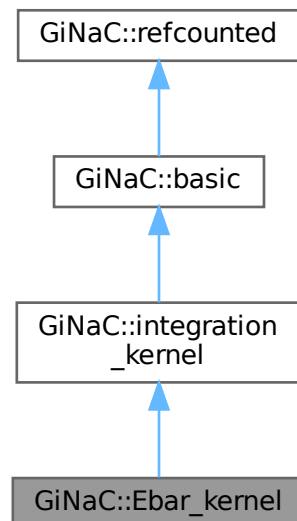
- [utils.h](#)

## 6.37 GiNaC::Ebar\_kernel Class Reference

The Ebar-kernel.

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::Ebar\_kernel:



Collaboration diagram for GiNaC::Ebar\_kernel:



## Public Member Functions

- `Ebar_kernel` (const `ex` &`n`, const `ex` &`m`, const `ex` &`x`, const `ex` &`y`)
- `size_t nops` () const override  
*Number of operands/members.*
- `ex op` (size\_t `i`) const override  
*Return operand/member at position `i`.*
- `ex & let_op` (size\_t `i`) override  
*Return modifiable operand/member at position `i`.*
- `bool is_numeric` (void) const override  
*This routine returns true, if the integration kernel can be evaluated numerically.*
- `ex get_numerical_value` (const `ex` &`qbar`, int `N_trunc`=0) const override  
*Returns the value of `Ebar_{n,m}(x,y,qbar)`*

## Public Member Functions inherited from GiNaC::integration\_kernel

- **ex series** (const relational &r, int order, unsigned options=0) const override  
*Default implementation of ex::series().*
- virtual bool **has\_trailing\_zero** (void) const  
*This routine returns true, if the integration kernel has a trailing zero.*
- virtual **ex Laurent\_series** (const ex &x, int order) const  
*Returns the Laurent series, starting possibly with the pole term.*
- size\_t **get\_cache\_size** (void) const  
*Returns the current size of the cache.*
- void **set\_cache\_step** (int cache\_steps) const  
*Sets the step size by which the cache is increased.*
- **ex get\_series\_coeff** (int i) const  
*Wrapper around series\_coeff(i), converts cl\_N to numeric.*
- cln::cl\_N **series\_coeff** (int i) const  
*Subclasses have either to implement series\_coeff\_impl or the two methods Laurent\_series and uses\_Laurent\_series.*

## Public Member Functions inherited from GiNaC::basic

- virtual **~basic** ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- **basic** (const basic &other)
- const **basic & operator=** (const basic &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual **basic \* duplicate** () const  
*Create a clone of this object on the heap.*
- virtual **ex eval** () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual **ex evalf** () const  
*Evaluate object numerically.*
- virtual **ex evalm** () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual **ex eval\_integ** () const  
*Evaluate integrals, if result is known.*
- virtual **ex eval\_indexed** (const basic &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void **print** (const print\_context &c, unsigned level=0) const  
*Output to stream.*
- virtual void **dbgprint** () const  
*Little wrapper around print to be called within a debugger.*
- virtual void **dbgprinttree** () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned **precedence** () const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool **info** (unsigned inf) const  
*Information about the object.*
- virtual **ex operator[]** (const ex &index) const
- virtual **ex operator[]** (size\_t i) const
- virtual **ex & operator[]** (const ex &index)
- virtual **ex & operator[]** (size\_t i)
- virtual bool **has** (const ex &other, unsigned options=0) const

- Test for occurrence of a pattern.*

  - virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
- Check whether the expression matches a given pattern.*

  - virtual `ex subs` (const `exmap` &m, unsigned options=0) const
- Substitute a set of objects by arbitrary expressions.*

  - virtual `ex map` (`map_function` &f) const
- Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*

  - virtual void `accept` (`GiNaC::visitor` &v) const
  - virtual bool `is_polynomial` (const `ex` &var) const
- Check whether this is a polynomial in the given variables.*

  - virtual int `degree` (const `ex` &s) const
- Return degree of highest power in object s.*

  - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

  - virtual `ex coeff` (const `ex` &s, int n=1) const
- Return coefficient of degree n in object s.*

  - virtual `ex expand` (unsigned options=0) const
- Expand expression, i.e.*

  - virtual `ex collect` (const `ex` &s, bool distributed=false) const
- Sort expanded expression in terms of powers of some object(s).*

  - virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

  - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

  - virtual `ex to_polynomial` (`exmap` &repl) const
  - virtual `numeric integer_content` () const
  - virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

  - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

  - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

  - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

  - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

  - virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

  - virtual unsigned `return_type` () const
  - virtual `return_type_t return_type_tinfo` () const
  - virtual `ex conjugate` () const
  - virtual `ex real_part` () const
  - virtual `ex imag_part` () const
- template<class T>

  - void `print_dispatch` (const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

  - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)

- *Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- `int compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- `bool is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- `const basic & hold` () const  
*Stop further evaluation.*
- `unsigned gethash` () const
- `const basic & setflag` (unsigned f) const  
*Set some `status_flags`.*
- `const basic & clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- `unsigned int add_reference` () noexcept
- `unsigned int remove_reference` () noexcept
- `unsigned int get_refcount` () const noexcept
- `void set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- `cln::cl_N series_coeff_impl` (int i) const override  
*For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.*
- `void do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::integration_kernel`

- `virtual bool uses_Laurent_series` () const  
*Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).*
- `ex get_numerical_value_impl` (const `ex` &lambda, const `ex` &pre, int shift, int N\_trunc) const  
*The actual implementation for computing a numerical value for the integrand.*
- `void do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual [ex derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Attributes

- [ex n](#)
- [ex m](#)
- [ex x](#)
- [ex y](#)

## Protected Attributes inherited from [GiNaC::integration\\_kernel](#)

- int [cache\\_step\\_size](#)
- std::vector< [cln::cl\\_N](#) > [series\\_vec](#)

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.37.1 Detailed Description

The Ebar-kernel.

This class represents the differential one-form

$$\omega_{n;m}^{\bar{E}}(x; y) = \bar{E}_{n;m}(x; y; \bar{q}) \frac{d\bar{q}}{\bar{q}}$$



## 6.37.2 Constructor & Destructor Documentation

### 6.37.2.1 Ebar\_kernel()

```
GiNaC::Ebar_kernel::Ebar_kernel (
 const ex & n,
 const ex & m,
 const ex & x,
 const ex & y)
```

References [Ebar\\_kernel\(\)](#), [m](#), [n](#), [x](#), and [y](#).

Referenced by [Ebar\\_kernel\(\)](#).

## 6.37.3 Member Function Documentation

### 6.37.3.1 nops()

```
size_t GiNaC::Ebar_kernel::nops () const \[override\], \[virtual\]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

### 6.37.3.2 op()

```
ex GiNaC::Ebar_kernel::op (
 size_t i) const \[override\], \[virtual\]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [m](#), [n](#), [x](#), and [y](#).

### 6.37.3.3 let\_op()

```
ex & GiNaC::Ebar_kernel::let_op (
 size_t i) \[override\], \[virtual\]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [m](#), [n](#), [x](#), and [y](#).

#### 6.37.3.4 is\_numeric()

```
bool GiNaC::Ebar_kernel::is_numeric (
 void) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration\\_kernel](#).

References [m](#), [n](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::info\\_flags::numeric](#), [x](#), and [y](#).

#### 6.37.3.5 get\_numerical\_value()

```
ex GiNaC::Ebar_kernel::get_numerical_value (
 const ex & qbar,
 int N_trunc = 0) const [override], [virtual]
```

Returns the value of  $Ebar_{\{n,m\}}(x,y,qbar)$

Reimplemented from [GiNaC::integration\\_kernel](#).

References [GiNaC::integration\\_kernel::get\\_numerical\\_value\\_impl\(\)](#).

Referenced by [GiNaC::Kronecker\\_dtau\\_kernel::get\\_numerical\\_value\(\)](#), and [GiNaC::Kronecker\\_dz\\_kernel::series\\_coeff\\_impl\(\)](#).

#### 6.37.3.6 series\_coeff\_impl()

```
cln::cl_N GiNaC::Ebar_kernel::series_coeff_impl (
 int i) const [override], [protected], [virtual]
```

For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.

The  $i$ -th coefficient corresponds to the power  $\lambda^{i-1}$ .

Reimplemented from [GiNaC::integration\\_kernel](#).

References [GiNaC::ex\\_to\(\)](#), [m](#), [n](#), [x](#), and [y](#).

#### 6.37.3.7 do\_print()

```
void GiNaC::Ebar_kernel::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [m](#), [n](#), [GiNaC::print\\_context::s](#), [x](#), and [y](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.37.4 Member Data Documentation

### 6.37.4.1 n

`ex` GiNaC::Ebar\_kernel::n [protected]

Referenced by [do\\_print\(\)](#), [Ebar\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

### 6.37.4.2 m

`ex` GiNaC::Ebar\_kernel::m [protected]

Referenced by [do\\_print\(\)](#), [Ebar\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

### 6.37.4.3 x

`ex` GiNaC::Ebar\_kernel::x [protected]

Referenced by [do\\_print\(\)](#), [Ebar\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

### 6.37.4.4 y

`ex` GiNaC::Ebar\_kernel::y [protected]

Referenced by [do\\_print\(\)](#), [Ebar\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

The documentation for this class was generated from the following files:

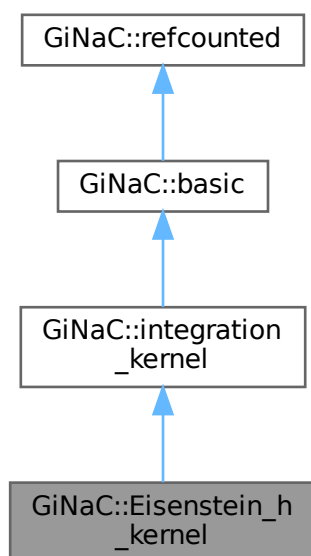
- [integration\\_kernel.h](#)
- [integration\\_kernel.cpp](#)

## 6.38 GiNaC::Eisenstein\_h\_kernel Class Reference

The kernel corresponding to the Eisenstein series  $h_{k,N,r,s}(\tau)$ .

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::Eisenstein\_h\_kernel:



Collaboration diagram for GiNaC::Eisenstein\_h\_kernel:



## Public Member Functions

- `Eisenstein_h_kernel` (const `ex` &`k`, const `ex` &`N`, const `ex` &`r`, const `ex` &`s`, const `ex` &`C_norm=numeric(1)`)
- `ex series` (const `relational` &`r`, int order, unsigned options=0) const override  
*The series method for this class returns the qbar-expansion of the modular form, without an additional factor of C\_norm/qbar.*
- `size_t nops` () const override  
*Number of operands/members.*
- `ex op` (size\_t i) const override  
*Return operand/member at position i.*
- `ex & let_op` (size\_t i) override  
*Return modifiable operand/member at position i.*
- `bool is_numeric` (void) const override  
*This routine returns true, if the integration kernel can be evaluated numerically.*
- `ex Laurent_series` (const `ex` &`x`, int order) const override

- Returns the Laurent series, starting possibly with the pole term.*

• `ex get_numerical_value` (const `ex` &qbar, int N\_trunc=0) const override

*Returns the value of the modular form.*
- `ex coefficient_a0` (const `numeric` &k, const `numeric` &r, const `numeric` &s, const `numeric` &N) const

*The constant coefficient in the Fourier expansion.*
- `ex coefficient_an` (const `numeric` &n, const `numeric` &k, const `numeric` &r, const `numeric` &s, const `numeric` &N) const

*The higher coefficients in the Fourier expansion.*
- `ex q_expansion_modular_form` (const `ex` &q, int order) const

## Public Member Functions inherited from `GiNaC::integration_kernel`

- `ex series` (const `relational` &r, int order, unsigned options=0) const override

*Default implementation of `ex::series()`.*
- virtual bool `has_trailing_zero` (void) const

*This routine returns true, if the integration kernel has a trailing zero.*
- size\_t `get_cache_size` (void) const

*Returns the current size of the cache.*
- void `set_cache_step` (int cache\_steps) const

*Sets the step size by which the cache is increased.*
- `ex get_series_coeff` (int i) const

*Wrapper around `series_coeff(i)`, converts `cl_N` to `numeric`.*
- `cln::cl_N series_coeff` (int i) const

*Subclasses have either to implement `series_coeff_impl` or the two methods `Laurent_series` and `uses_Laurent_series`.*

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()

*basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)

*basic assignment operator: the other object might be of a derived class.*
- virtual `basic` \* `duplicate` () const

*Create a clone of this object on the heap.*
- virtual `ex eval` () const

*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf` () const

*Evaluate object numerically.*
- virtual `ex evalm` () const

*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const

*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const

*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const

*Output to stream.*
- virtual void `dbgprint` () const

*Little wrapper around `print` to be called within a debugger.*
- virtual void `dbgprinttree` () const

- Little wrapper around printtree to be called within a debugger.*
- virtual unsigned [precedence](#) () const
  - Return relative operator precedence (for parenthezing output).*
- virtual bool [info](#) (unsigned inf) const
  - Information about the object.*
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size\_t i) const
- virtual [ex & operator\[\]](#) (const [ex](#) &index)
- virtual [ex & operator\[\]](#) (size\_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned options=0) const
  - Test for occurrence of a pattern.*
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
  - Check whether the expression matches a given pattern.*
- virtual [ex subs](#) (const [exmap](#) &m, unsigned options=0) const
  - Substitute a set of objects by arbitrary expressions.*
- virtual [ex map](#) ([map\\_function](#) &f) const
  - Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is\\_polynomial](#) (const [ex](#) &var) const
  - Check whether this is a polynomial in the given variables.*
- virtual int [degree](#) (const [ex](#) &s) const
  - Return degree of highest power in object s.*
- virtual int [ldegree](#) (const [ex](#) &s) const
  - Return degree of lowest power in object s.*
- virtual [ex coeff](#) (const [ex](#) &s, int n=1) const
  - Return coefficient of degree n in object s.*
- virtual [ex expand](#) (unsigned options=0) const
  - Expand expression, i.e.*
- virtual [ex collect](#) (const [ex](#) &s, bool distributed=false) const
  - Sort expanded expression in terms of powers of some object(s).*
- virtual [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev\_lookup, [lst](#) &modifier) const
  - Default implementation of [ex::normal\(\)](#).*
- virtual [ex to\\_rational](#) ([exmap](#) &repl) const
  - Default implementation of [ex::to\\_rational\(\)](#).*
- virtual [ex to\\_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer\\_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const
  - Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual [numeric max\\_coefficient](#) () const
  - Implementation [ex::max\\_coefficient\(\)](#).*
- virtual [exvector get\\_free\\_indices](#) () const
  - Return a vector containing the free indices of an expression.*
- virtual [ex add\\_indexed](#) (const [ex](#) &self, const [ex](#) &other) const
  - Add two indexed expressions.*
- virtual [ex scalar\\_mul\\_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const
  - Multiply an indexed expression with a scalar.*
- virtual bool [contract\\_with](#) ([exvector::iterator](#) self, [exvector::iterator](#) other, [exvector](#) &v) const
  - Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned [return\\_type](#) () const
- virtual [return\\_type\\_t](#) [return\\_type\\_tinfo](#) () const
- virtual [ex conjugate](#) () const

- virtual `ex real_part ()` const
- virtual `ex imag_part ()` const
- template<class T>  
void `print_dispatch` (const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- virtual void `archive` (`archive_node` &n) const  
*Save (serialize) the object into archive node.*
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)  
*Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- const `basic` & `hold` () const  
*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const  
*Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- bool `uses_Laurent_series` () const override  
*Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).*
- void `do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::integration_kernel`

- virtual `cln::cl_N series_coeff_impl` (int i) const  
*For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.*
- `ex get_numerical_value_impl` (const `ex` &lambda, const `ex` &pre, int shift, int N\_trunc) const  
*The actual implementation for computing a numerical value for the integrand.*
- void `do_print` (const `print_context` &c, unsigned level) const



## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual [ex derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Attributes

- [ex k](#)
- [ex N](#)
- [ex r](#)
- [ex s](#)
- [ex C\\_norm](#)

## Protected Attributes inherited from [GiNaC::integration\\_kernel](#)

- int [cache\\_step\\_size](#)
- std::vector< [cln::cl\\_N](#) > [series\\_vec](#)

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.38.1 Detailed Description

The kernel corresponding to the Eisenstein series  $h_{k,N,r,s}(\tau)$ .

This class represents the differential one-form

$$\omega_{k,N,r,s}^{\text{Eisenstein,h}} = C_k h_{k,N,r,s}(\tau) \frac{d\bar{q}_N}{\bar{q}_N}$$

## 6.38.2 Constructor & Destructor Documentation

### 6.38.2.1 Eisenstein\_h\_kernel()

```
GiNaC::Eisenstein_h_kernel::Eisenstein_h_kernel (
 const ex & k,
 const ex & N,
 const ex & r,
 const ex & s,
 const ex & C_norm = numeric(1))
```

References [C\\_norm](#), [Eisenstein\\_h\\_kernel\(\)](#), [k](#), [N](#), [r](#), and [s](#).

Referenced by [Eisenstein\\_h\\_kernel\(\)](#).

## 6.38.3 Member Function Documentation

### 6.38.3.1 series()

```
ex GiNaC::Eisenstein_h_kernel::series (
 const relational & r,
 int order,
 unsigned options = 0) const \[override\], \[virtual\]
```

The series method for this class returns the qbar-expansion of the modular form, without an additional factor of C\_norm/qbar.

This allows for easy use in the class [modular\\_form\\_kernel](#).

Reimplemented from [GiNaC::basic](#).

References [q\\_expansion\\_modular\\_form\(\)](#), [r](#), and [GiNaC::ex::series\(\)](#).

### 6.38.3.2 nops()

```
size_t GiNaC::Eisenstein_h_kernel::nops () const \[override\], \[virtual\]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

### 6.38.3.3 op()

```
ex GiNaC::Eisenstein_h_kernel::op (
 size_t i) const \[override\], \[virtual\]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [C\\_norm](#), [k](#), [N](#), [r](#), and [s](#).

#### 6.38.3.4 let\_op()

```
ex & GiNaC::Eisenstein_h_kernel::let_op (
 size_t i) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [C\\_norm](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [k](#), [N](#), [r](#), and [s](#).

#### 6.38.3.5 is\_numeric()

```
bool GiNaC::Eisenstein_h_kernel::is_numeric (
 void) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration\\_kernel](#).

References [C\\_norm](#), [GiNaC::info\\_flags::integer](#), [k](#), [N](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::info\\_flags::posint](#), [r](#), and [s](#).

#### 6.38.3.6 Laurent\_series()

```
ex GiNaC::Eisenstein_h_kernel::Laurent_series (
 const ex & x,
 int order) const [override], [virtual]
```

Returns the Laurent series, starting possibly with the pole term.

Neglected terms are of order  $O(x^{order})$ .

Reimplemented from [GiNaC::integration\\_kernel](#).

References [C\\_norm](#), [q\\_expansion\\_modular\\_form\(\)](#), and [GiNaC::ex::series\(\)](#).

#### 6.38.3.7 get\_numerical\_value()

```
ex GiNaC::Eisenstein_h_kernel::get_numerical_value (
 const ex & qbar,
 int N_trunc = 0) const [override], [virtual]
```

Returns the value of the modular form.

Reimplemented from [GiNaC::integration\\_kernel](#).

References [C\\_norm](#), and [GiNaC::integration\\_kernel::get\\_numerical\\_value\\_impl\(\)](#).

### 6.38.3.8 uses\_Laurent\_series()

```
bool GiNaC::Eisenstein_h_kernel::uses_Laurent_series () const [override], [protected], [virtual]
```

Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).

Returns false if this is not the case (and the class has an implementation of `series_coeff_impl`).

Reimplemented from [GiNaC::integration\\_kernel](#).

### 6.38.3.9 coefficient\_a0()

```
ex GiNaC::Eisenstein_h_kernel::coefficient_a0 (
 const numeric & k,
 const numeric & r,
 const numeric & s,
 const numeric & N) const
```

The constant coefficient in the Fourier expansion.

References [GiNaC::Bernoulli\\_polynomial\(\)](#), [GiNaC::cos\(\)](#), [GiNaC::I](#), [GiNaC::irem\(\)](#), [k](#), [GiNaC::mod\(\)](#), [N](#), [GiNaC::Pi](#), [r](#), [s](#), and [GiNaC::sin\(\)](#).

Referenced by [q\\_expansion\\_modular\\_form\(\)](#).

### 6.38.3.10 coefficient\_an()

```
ex GiNaC::Eisenstein_h_kernel::coefficient_an (
 const numeric & n,
 const numeric & k,
 const numeric & r,
 const numeric & s,
 const numeric & N) const
```

The higher coefficients in the Fourier expansion.

References [GiNaC::exp\(\)](#), [GiNaC::I](#), [GiNaC::irem\(\)](#), [k](#), [GiNaC::mod\(\)](#), [N](#), [GiNaC::Pi](#), [GiNaC::pow\(\)](#), [r](#), and [s](#).

Referenced by [q\\_expansion\\_modular\\_form\(\)](#).

### 6.38.3.11 q\_expansion\_modular\_form()

```
ex GiNaC::Eisenstein_h_kernel::q_expansion_modular_form (
 const ex & q,
 int order) const
```

References [coefficient\\_a0\(\)](#), [coefficient\\_an\(\)](#), [GiNaC::ex\\_to\(\)](#), [k](#), [N](#), [GiNaC::pow\(\)](#), [r](#), [s](#), and [GiNaC::ex::series\(\)](#).

Referenced by [Laurent\\_series\(\)](#), and [series\(\)](#).

### 6.38.3.12 do\_print()

```
void GiNaC::Eisenstein_h_kernel::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [C\\_norm](#), [k](#), [N](#), [r](#), [s](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.38.4 Member Data Documentation

### 6.38.4.1 k

```
ex GiNaC::Eisenstein_h_kernel::k [protected]
```

Referenced by [coefficient\\_a0\(\)](#), [coefficient\\_an\(\)](#), [do\\_print\(\)](#), [Eisenstein\\_h\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [q\\_expansion\\_modular\\_form\(\)](#).

### 6.38.4.2 N

```
ex GiNaC::Eisenstein_h_kernel::N [protected]
```

Referenced by [coefficient\\_a0\(\)](#), [coefficient\\_an\(\)](#), [do\\_print\(\)](#), [Eisenstein\\_h\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [q\\_expansion\\_modular\\_form\(\)](#).

### 6.38.4.3 r

```
ex GiNaC::Eisenstein_h_kernel::r [protected]
```

Referenced by [coefficient\\_a0\(\)](#), [coefficient\\_an\(\)](#), [do\\_print\(\)](#), [Eisenstein\\_h\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), [q\\_expansion\\_modular\\_form\(\)](#), and [series\(\)](#).

### 6.38.4.4 s

```
ex GiNaC::Eisenstein_h_kernel::s [protected]
```

Referenced by [coefficient\\_a0\(\)](#), [coefficient\\_an\(\)](#), [do\\_print\(\)](#), [Eisenstein\\_h\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [q\\_expansion\\_modular\\_form\(\)](#).

### 6.38.4.5 C\_norm

```
ex GiNaC::Eisenstein_h_kernel::C_norm [protected]
```

Referenced by [do\\_print\(\)](#), [Eisenstein\\_h\\_kernel\(\)](#), [get\\_numerical\\_value\(\)](#), [is\\_numeric\(\)](#), [Laurent\\_series\(\)](#), [let\\_op\(\)](#), and [op\(\)](#).

The documentation for this class was generated from the following files:

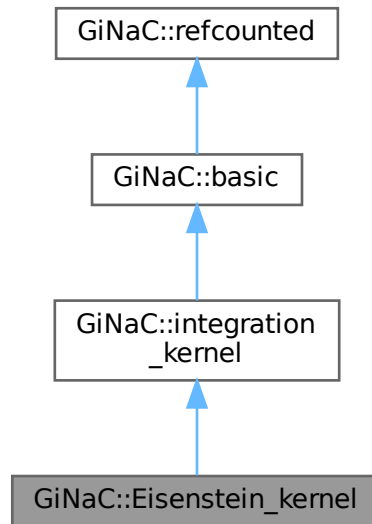
- [integration\\_kernel.h](#)
- [integration\\_kernel.cpp](#)

## 6.39 GiNaC::Eisenstein\_kernel Class Reference

The kernel corresponding to the Eisenstein series  $E_{k,N,a,b,K}(\tau)$ .

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::Eisenstein\_kernel:



Collaboration diagram for GiNaC::Eisenstein\_kernel:



## Public Member Functions

- `Eisenstein_kernel` (const `ex` &`k`, const `ex` &`N`, const `ex` &`a`, const `ex` &`b`, const `ex` &`K`, const `ex` &`C_norm`=numeric(1))
- `ex series` (const `relational` &`r`, int order, unsigned options=0) const override  
*The series method for this class returns the qbar-expansion of the modular form, without an additional factor of  $C\_norm/qbar$ .*
- `size_t nops` () const override  
*Number of operands/members.*
- `ex op` (size\_t `i`) const override  
*Return operand/member at position `i`.*
- `ex &let_op` (size\_t `i`) override  
*Return modifiable operand/member at position `i`.*
- `bool is_numeric` (void) const override  
*This routine returns true, if the integration kernel can be evaluated numerically.*

- [ex Laurent\\_series](#) (const [ex](#) &x, int order) const override  
*Returns the Laurent series, starting possibly with the pole term.*
- [ex get\\_numerical\\_value](#) (const [ex](#) &qbar, int N\_trunc=0) const override  
*Returns the value of the modular form.*
- [ex q\\_expansion\\_modular\\_form](#) (const [ex](#) &q, int order) const

## Public Member Functions inherited from [GiNaC::integration\\_kernel](#)

- [ex series](#) (const [relational](#) &r, int order, unsigned options=0) const override  
*Default implementation of [ex::series\(\)](#).*
- virtual bool [has\\_trailing\\_zero](#) (void) const  
*This routine returns true, if the integration kernel has a trailing zero.*
- [size\\_t get\\_cache\\_size](#) (void) const  
*Returns the current size of the cache.*
- void [set\\_cache\\_step](#) (int cache\_steps) const  
*Sets the step size by which the cache is increased.*
- [ex get\\_series\\_coeff](#) (int i) const  
*Wrapper around [series\\_coeff\(i\)](#), converts [cl\\_N](#) to numeric.*
- [cln::cl\\_N series\\_coeff](#) (int i) const  
*Subclasses have either to implement [series\\_coeff\\_impl](#) or the two methods [Laurent\\_series](#) and [uses\\_Laurent\\_series](#).*

## Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()  
*basic destructor, virtual because class [ex](#) will delete objects of derived classes via a [basic\\*](#).*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual [basic \\* duplicate](#) () const  
*Create a clone of this object on the heap.*
- virtual [ex eval](#) () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual [ex evalf](#) () const  
*Evaluate object numerically.*
- virtual [ex evalm](#) () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual [ex eval\\_integ](#) () const  
*Evaluate integrals, if result is known.*
- virtual [ex eval\\_indexed](#) (const [basic](#) &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void [print](#) (const [print\\_context](#) &c, unsigned level=0) const  
*Output to stream.*
- virtual void [dbgprint](#) () const  
*Little wrapper around [print](#) to be called within a debugger.*
- virtual void [dbgprinttree](#) () const  
*Little wrapper around [printtree](#) to be called within a debugger.*
- virtual unsigned [precedence](#) () const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool [info](#) (unsigned inf) const



*Information about the object.*

- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const

*Test for occurrence of a pattern.*

- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const

*Check whether the expression matches a given pattern.*

- virtual `ex subs` (const `exmap` &m, unsigned options=0) const

*Substitute a set of objects by arbitrary expressions.*

- virtual `ex map` (`map_function` &f) const

*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*

- virtual void `accept` (GiNaC::visitor &v) const
- virtual bool `is_polynomial` (const `ex` &var) const

*Check whether this is a polynomial in the given variables.*

- virtual int `degree` (const `ex` &s) const

*Return degree of highest power in object s.*

- virtual int `ldegree` (const `ex` &s) const

*Return degree of lowest power in object s.*

- virtual `ex coeff` (const `ex` &s, int n=1) const

*Return coefficient of degree n in object s.*

- virtual `ex expand` (unsigned options=0) const

*Expand expression, i.e.*

- virtual `ex collect` (const `ex` &s, bool distributed=false) const

*Sort expanded expression in terms of powers of some object(s).*

- virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const

*Default implementation of `ex::normal()`.*

- virtual `ex to_rational` (`exmap` &repl) const

*Default implementation of `ex::to_rational()`.*

- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const

*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

- virtual `numeric max_coefficient` () const

*Implementation `ex::max_coefficient()`.*

- virtual `exvector get_free_indices` () const

*Return a vector containing the free indices of an expression.*

- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const

*Add two indexed expressions.*

- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const

*Multiply an indexed expression with a scalar.*

- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const

*Try to contract two indexed expressions that appear in the same product.*

- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const

- template<class T>

void `print_dispatch` (const `print_context` &c, unsigned level) const

*Like `print()`, but dispatch to the specified class.*

- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- virtual void `archive` (`archive_node` &n) const  
*Save (serialize) the object into archive node.*
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)  
*Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- const `basic` & `hold` () const  
*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const  
*Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- bool `uses_Laurent_series` () const override  
*Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).*
- void `do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::integration_kernel`

- virtual `cln::cl_N series_coeff_impl` (int i) const  
*For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.*
- `ex get_numerical_value_impl` (const `ex` &lambda, const `ex` &pre, int shift, int N\_trunc) const  
*The actual implementation for computing a numerical value for the integrand.*
- void `do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual [ex derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Attributes

- [ex k](#)
- [ex N](#)
- [ex a](#)
- [ex b](#)
- [ex K](#)
- [ex C\\_norm](#)

## Protected Attributes inherited from [GiNaC::integration\\_kernel](#)

- int [cache\\_step\\_size](#)
- std::vector< [cln::cl\\_N](#) > [series\\_vec](#)

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.39.1 Detailed Description

The kernel corresponding to the Eisenstein series  $E_{k,N,a,b,K}(\tau)$ .

This class represents the differential one-form

$$\omega_{k,N,a,b,K}^{\text{Eisenstein}} = C_k E_{k,N,a,b,K}(\tau) \frac{d\bar{q}_N}{\bar{q}_N}$$

The integers a and b are either one or the discriminant of a quadratic number field. This class represents Eisenstein series, which can be defined by primitive Dirichlet characters from the Kronecker symbol. This implies that the characters take the values -1,0,1, i.e. no higher roots of unity occur. The

$$\bar{q}$$

-expansion has then rational coefficients.

Ref.: W. Stein, Modular Forms: A Computational Approach, Chapter 5

### 6.39.2 Constructor & Destructor Documentation

#### 6.39.2.1 Eisenstein\_kernel()

```
GiNaC::Eisenstein_kernel::Eisenstein_kernel (
 const ex & k,
 const ex & N,
 const ex & a,
 const ex & b,
 const ex & K,
 const ex & C_norm = numeric(1))
```

References [a](#), [b](#), [C\\_norm](#), [Eisenstein\\_kernel\(\)](#), [K](#), [k](#), and [N](#).

Referenced by [Eisenstein\\_kernel\(\)](#).

### 6.39.3 Member Function Documentation

#### 6.39.3.1 series()

```
ex GiNaC::Eisenstein_kernel::series (
 const relational & r,
 int order,
 unsigned options = 0) const [override], [virtual]
```

The series method for this class returns the qbar-expansion of the modular form, without an additional factor of C\_norm/qbar.

This allows for easy use in the class [modular\\_form\\_kernel](#).

Reimplemented from [GiNaC::basic](#).

References [GiNaC::relational::lhs\(\)](#), [q\\_expansion\\_modular\\_form\(\)](#), [GiNaC::relational::rhs\(\)](#), and [GiNaC::ex::series\(\)](#).

### 6.39.3.2 nops()

```
size_t GiNaC::Eisenstein_kernel::nops () const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

### 6.39.3.3 op()

```
ex GiNaC::Eisenstein_kernel::op (
 size_t i) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [C\\_norm](#), [K](#), [k](#), and [N](#).

### 6.39.3.4 let\_op()

```
ex & GiNaC::Eisenstein_kernel::let_op (
 size_t i) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [C\\_norm](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [K](#), [k](#), and [N](#).

### 6.39.3.5 is\_numeric()

```
bool GiNaC::Eisenstein_kernel::is_numeric (
 void) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration\\_kernel](#).

References [a](#), [b](#), [C\\_norm](#), [GiNaC::info\\_flags::integer](#), [K](#), [k](#), [N](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::info\\_flags::numeric](#), and [GiNaC::info\\_flags::posint](#).

### 6.39.3.6 Laurent\_series()

```
ex GiNaC::Eisenstein_kernel::Laurent_series (
 const ex & x,
 int order) const [override], [virtual]
```

Returns the Laurent series, starting possibly with the pole term.

Neglected terms are of order  $O(x^{order})$ .

Reimplemented from [GiNaC::integration\\_kernel](#).

References [C\\_norm](#), [q\\_expansion\\_modular\\_form\(\)](#), and [GiNaC::ex::series\(\)](#).

### 6.39.3.7 `get_numerical_value()`

```
ex GiNaC::Eisenstein_kernel::get_numerical_value (
 const ex & qbar,
 int N_trunc = 0) const [override], [virtual]
```

Returns the value of the modular form.

Reimplemented from [GiNaC::integration\\_kernel](#).

References [C\\_norm](#), and [GiNaC::integration\\_kernel::get\\_numerical\\_value\\_impl\(\)](#).

### 6.39.3.8 `uses_Laurent_series()`

```
bool GiNaC::Eisenstein_kernel::uses_Laurent_series () const [override], [protected], [virtual]
```

Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).

Returns false if this is not the case (and the class has an implementation of `series_coeff_impl`).

Reimplemented from [GiNaC::integration\\_kernel](#).

### 6.39.3.9 `q_expansion_modular_form()`

```
ex GiNaC::Eisenstein_kernel::q_expansion_modular_form (
 const ex & q,
 int order) const
```

References [a](#), [b](#), [GiNaC::ex\\_to\(\)](#), [K](#), [k](#), and [N](#).

Referenced by [Laurent\\_series\(\)](#), and [series\(\)](#).

### 6.39.3.10 `do_print()`

```
void GiNaC::Eisenstein_kernel::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [a](#), [b](#), [C\\_norm](#), [K](#), [k](#), [N](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.39.4 Member Data Documentation

### 6.39.4.1 `k`

```
ex GiNaC::Eisenstein_kernel::k [protected]
```

Referenced by [do\\_print\(\)](#), [Eisenstein\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [q\\_expansion\\_modular\\_form\(\)](#).

**6.39.4.2 N**

`ex GiNaC::Eisenstein_kernel::N [protected]`

Referenced by [do\\_print\(\)](#), [Eisenstein\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [q\\_expansion\\_modular\\_form\(\)](#).

**6.39.4.3 a**

`ex GiNaC::Eisenstein_kernel::a [protected]`

Referenced by [do\\_print\(\)](#), [Eisenstein\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [q\\_expansion\\_modular\\_form\(\)](#).

**6.39.4.4 b**

`ex GiNaC::Eisenstein_kernel::b [protected]`

Referenced by [do\\_print\(\)](#), [Eisenstein\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [q\\_expansion\\_modular\\_form\(\)](#).

**6.39.4.5 K**

`ex GiNaC::Eisenstein_kernel::K [protected]`

Referenced by [do\\_print\(\)](#), [Eisenstein\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [q\\_expansion\\_modular\\_form\(\)](#).

**6.39.4.6 C\_norm**

`ex GiNaC::Eisenstein_kernel::C_norm [protected]`

Referenced by [do\\_print\(\)](#), [Eisenstein\\_kernel\(\)](#), [get\\_numerical\\_value\(\)](#), [is\\_numeric\(\)](#), [Laurent\\_series\(\)](#), [let\\_op\(\)](#), and [op\(\)](#).

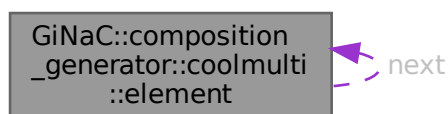
The documentation for this class was generated from the following files:

- [integration\\_kernel.h](#)
- [integration\\_kernel.cpp](#)

## 6.40 GiNaC::composition\_generator::coolmulti::element Struct Reference

```
#include <utils.h>
```

Collaboration diagram for GiNaC::composition\_generator::coolmulti::element:



## Public Member Functions

- [element](#) (unsigned val, [element](#) \*n)
- [~element](#) ()

## Public Attributes

- unsigned [value](#)
- [element](#) \* [next](#)

## 6.40.1 Constructor & Destructor Documentation

### 6.40.1.1 [element](#)()

```
GiNaC::composition_generator::coolmulti::element::element (
 unsigned val,
 element * n) [inline]
```

References [element\(\)](#), [next](#), and [value](#).

Referenced by [element\(\)](#).

### 6.40.1.2 [~element](#)()

```
GiNaC::composition_generator::coolmulti::element::~~element () [inline]
```

References [next](#).

## 6.40.2 Member Data Documentation

### 6.40.2.1 [value](#)

```
unsigned GiNaC::composition_generator::coolmulti::element::value
```

Referenced by [element\(\)](#), [GiNaC::composition\\_generator::get\(\)](#), and [GiNaC::composition\\_generator::coolmulti::next\\_permutation\(\)](#).

### 6.40.2.2 [next](#)

```
element* GiNaC::composition_generator::coolmulti::element::next
```

Referenced by [element\(\)](#), [GiNaC::composition\\_generator::get\(\)](#), [GiNaC::composition\\_generator::coolmulti::next\\_permutation\(\)](#), and [~element\(\)](#).

The documentation for this struct was generated from the following file:

- [utils.h](#)

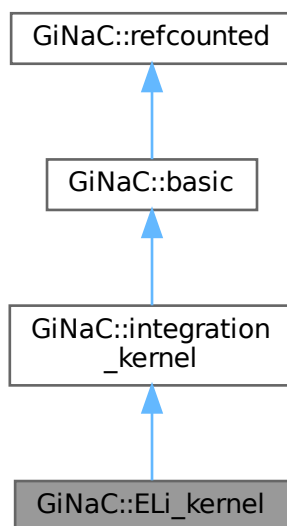


## 6.41 GiNaC::ELi\_kernel Class Reference

The ELi-kernel.

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::ELi\_kernel:



Collaboration diagram for GiNaC::ELi\_kernel:



## Public Member Functions

- `ELi_kernel` (const `ex` &`n`, const `ex` &`m`, const `ex` &`x`, const `ex` &`y`)
- `size_t nops` () const override  
*Number of operands/members.*
- `ex op` (size\_t `i`) const override  
*Return operand/member at position `i`.*
- `ex & let_op` (size\_t `i`) override  
*Return modifiable operand/member at position `i`.*
- `bool is_numeric` (void) const override  
*This routine returns true, if the integration kernel can be evaluated numerically.*
- `ex get_numerical_value` (const `ex` &`qbar`, int `N_trunc`=0) const override  
*Returns the value of  $ELi_{\{n,m\}}(x,y,qbar)$*

## Public Member Functions inherited from GiNaC::integration\_kernel

- **ex series** (const relational &r, int order, unsigned options=0) const override  
*Default implementation of ex::series().*
- virtual bool **has\_trailing\_zero** (void) const  
*This routine returns true, if the integration kernel has a trailing zero.*
- virtual **ex Laurent\_series** (const ex &x, int order) const  
*Returns the Laurent series, starting possibly with the pole term.*
- size\_t **get\_cache\_size** (void) const  
*Returns the current size of the cache.*
- void **set\_cache\_step** (int cache\_steps) const  
*Sets the step size by which the cache is increased.*
- **ex get\_series\_coeff** (int i) const  
*Wrapper around series\_coeff(i), converts cl\_N to numeric.*
- cln::cl\_N **series\_coeff** (int i) const  
*Subclasses have either to implement series\_coeff\_impl or the two methods Laurent\_series and uses\_Laurent\_series.*

## Public Member Functions inherited from GiNaC::basic

- virtual **~basic** ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- **basic** (const basic &other)
- const **basic & operator=** (const basic &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual **basic \* duplicate** () const  
*Create a clone of this object on the heap.*
- virtual **ex eval** () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual **ex evalf** () const  
*Evaluate object numerically.*
- virtual **ex evalm** () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual **ex eval\_integ** () const  
*Evaluate integrals, if result is known.*
- virtual **ex eval\_indexed** (const basic &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void **print** (const print\_context &c, unsigned level=0) const  
*Output to stream.*
- virtual void **dbgprint** () const  
*Little wrapper around print to be called within a debugger.*
- virtual void **dbgprinttree** () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned **precedence** () const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool **info** (unsigned inf) const  
*Information about the object.*
- virtual **ex operator[]** (const ex &index) const
- virtual **ex operator[]** (size\_t i) const
- virtual **ex & operator[]** (const ex &index)
- virtual **ex & operator[]** (size\_t i)
- virtual bool **has** (const ex &other, unsigned options=0) const

- Test for occurrence of a pattern.*

  - virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
- Check whether the expression matches a given pattern.*

  - virtual `ex subs` (const `exmap` &m, unsigned options=0) const
- Substitute a set of objects by arbitrary expressions.*

  - virtual `ex map` (`map_function` &f) const
- Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*

  - virtual void `accept` (`GiNaC::visitor` &v) const
  - virtual bool `is_polynomial` (const `ex` &var) const
- Check whether this is a polynomial in the given variables.*

  - virtual int `degree` (const `ex` &s) const
- Return degree of highest power in object s.*

  - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

  - virtual `ex coeff` (const `ex` &s, int n=1) const
- Return coefficient of degree n in object s.*

  - virtual `ex expand` (unsigned options=0) const
- Expand expression, i.e.*

  - virtual `ex collect` (const `ex` &s, bool distributed=false) const
- Sort expanded expression in terms of powers of some object(s).*

  - virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

  - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

  - virtual `ex to_polynomial` (`exmap` &repl) const
  - virtual `numeric integer_content` () const
  - virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

  - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

  - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

  - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

  - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

  - virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

  - virtual unsigned `return_type` () const
  - virtual `return_type_t return_type_tinfo` () const
  - virtual `ex conjugate` () const
  - virtual `ex real_part` () const
  - virtual `ex imag_part` () const
- template<class T>

  - void `print_dispatch` (const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

  - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)

- *Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- `int compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- `bool is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- `const basic & hold` () const  
*Stop further evaluation.*
- `unsigned gethash` () const
- `const basic & setflag` (unsigned f) const  
*Set some `status_flags`.*
- `const basic & clearflag` (unsigned f) const  
*Clear some `status_flags`.*

### Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- `unsigned int add_reference` () noexcept
- `unsigned int remove_reference` () noexcept
- `unsigned int get_refcount` () const noexcept
- `void set_refcount` (unsigned int r) noexcept

### Protected Member Functions

- `cln::cl_N series_coeff_impl` (int i) const override  
*For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.*
- `void do_print` (const `print_context` &c, unsigned level) const

### Protected Member Functions inherited from `GiNaC::integration_kernel`

- `virtual bool uses_Laurent_series` () const  
*Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).*
- `ex get_numerical_value_impl` (const `ex` &lambda, const `ex` &pre, int shift, int N\_trunc) const  
*The actual implementation for computing a numerical value for the integrand.*
- `void do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::basic`

- `basic ()`
- virtual `ex eval_ncmul (const exvector &v) const`
- virtual `bool match_same_type (const basic &other) const`  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual `ex derivative (const symbol &s) const`  
*Default implementation of `ex::diff()`.*
- virtual `int compare_same_type (const basic &other) const`  
*Returns order relation between two objects of same type.*
- virtual `bool is_equal_same_type (const basic &other) const`  
*Returns true if two objects of same type are equal.*
- virtual `unsigned calchash () const`  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `ensure_if_modifiable () const`  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print (const print_context &c, unsigned level) const`  
*Default output to stream.*
- void `do_print_tree (const print_tree &c, unsigned level) const`  
*Tree output to stream.*
- void `do_print_python_repr (const print_python_repr &c, unsigned level) const`  
*Python parsable output to stream.*

## Protected Attributes

- `ex n`
- `ex m`
- `ex x`
- `ex y`

## Protected Attributes inherited from `GiNaC::integration_kernel`

- `int cache_step_size`
- `std::vector< cln::cl_N > series_vec`

## Protected Attributes inherited from `GiNaC::basic`

- `unsigned flags`  
*of type `status_flags`*
- `unsigned hashvalue`  
*hash value*

### 6.41.1 Detailed Description

The ELi-kernel.

This class represents the differential one-form

$$\omega_{n;m}^{\text{ELi}}(x; y) = \text{ELi}_{n;m}(x; y; \bar{q}) \frac{d\bar{q}}{\bar{q}}$$

## 6.41.2 Constructor & Destructor Documentation

### 6.41.2.1 ELi\_kernel()

```
GiNaC::ELi_kernel::ELi_kernel (
 const ex & n,
 const ex & m,
 const ex & x,
 const ex & y)
```

References [ELi\\_kernel\(\)](#), [m](#), [n](#), [x](#), and [y](#).

Referenced by [ELi\\_kernel\(\)](#).

## 6.41.3 Member Function Documentation

### 6.41.3.1 nops()

```
size_t GiNaC::ELi_kernel::nops () const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

### 6.41.3.2 op()

```
ex GiNaC::ELi_kernel::op (
 size_t i) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [m](#), [n](#), [x](#), and [y](#).

### 6.41.3.3 let\_op()

```
ex & GiNaC::ELi_kernel::let_op (
 size_t i) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [m](#), [n](#), [x](#), and [y](#).

#### 6.41.3.4 is\_numeric()

```
bool GiNaC::ELi_kernel::is_numeric (
 void) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration\\_kernel](#).

References [m](#), [n](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::info\\_flags::numeric](#), [x](#), and [y](#).

#### 6.41.3.5 get\_numerical\_value()

```
ex GiNaC::ELi_kernel::get_numerical_value (
 const ex & qbar,
 int N_trunc = 0) const [override], [virtual]
```

Returns the value of  $\text{ELi}_{\{n,m\}}(x,y,qbar)$

Reimplemented from [GiNaC::integration\\_kernel](#).

References [GiNaC::integration\\_kernel::get\\_numerical\\_value\\_impl\(\)](#).

#### 6.41.3.6 series\_coeff\_impl()

```
cln::cl_N GiNaC::ELi_kernel::series_coeff_impl (
 int i) const [override], [protected], [virtual]
```

For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.

The  $i$ -th coefficient corresponds to the power  $\lambda^{i-1}$ .

Reimplemented from [GiNaC::integration\\_kernel](#).

References [GiNaC::ex\\_to\(\)](#), [m](#), [n](#), [x](#), and [y](#).

#### 6.41.3.7 do\_print()

```
void GiNaC::ELi_kernel::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [m](#), [n](#), [GiNaC::print\\_context::s](#), [x](#), and [y](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.41.4 Member Data Documentation

#### 6.41.4.1 n

```
ex GiNaC::ELi_kernel::n [protected]
```

Referenced by [do\\_print\(\)](#), [ELi\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).



#### 6.41.4.2 m

```
ex GiNaC::ELi_kernel::m [protected]
```

Referenced by [do\\_print\(\)](#), [ELi\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

#### 6.41.4.3 x

```
ex GiNaC::ELi_kernel::x [protected]
```

Referenced by [do\\_print\(\)](#), [ELi\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

#### 6.41.4.4 y

```
ex GiNaC::ELi_kernel::y [protected]
```

Referenced by [do\\_print\(\)](#), [ELi\\_kernel\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

The documentation for this class was generated from the following files:

- [integration\\_kernel.h](#)
- [integration\\_kernel.cpp](#)

## 6.42 std::equal\_to< GiNaC::ex > Struct Reference

Specialization of std::equal\_to() for ex objects.

```
#include <ex.h>
```

### Public Member Functions

- `bool operator() (const GiNaC::ex &e1, const GiNaC::ex &e2) const` noexcept

### 6.42.1 Detailed Description

Specialization of std::equal\_to() for ex objects.

### 6.42.2 Member Function Documentation

#### 6.42.2.1 operator()()

```
bool std::equal_to< GiNaC::ex >::operator() (
 const GiNaC::ex & e1,
 const GiNaC::ex & e2) const [inline], [noexcept]
```

The documentation for this struct was generated from the following file:

- [ex.h](#)

## 6.43 GiNaC::error\_and\_integral Struct Reference

Collaboration diagram for GiNaC::error\_and\_integral:



### Public Member Functions

- [error\\_and\\_integral](#) (const [ex](#) &err, const [ex](#) &integ)

### Public Attributes

- [ex error](#)
- [ex integral](#)

## 6.43.1 Constructor & Destructor Documentation

### 6.43.1.1 error\_and\_integral()

```

GiNaC::error_and_integral::error_and_integral (
 const ex & err,
 const ex & integ) [inline]

```

References [error](#), and [integral](#).

## 6.43.2 Member Data Documentation

### 6.43.2.1 error

`ex` `GiNaC::error_and_integral::error`

Referenced by [error\\_and\\_integral\(\)](#), and [GiNaC::error\\_and\\_integral\\_is\\_less::operator\(\)](#).

### 6.43.2.2 integral

`ex` `GiNaC::error_and_integral::integral`

Referenced by [error\\_and\\_integral\(\)](#), and [GiNaC::error\\_and\\_integral\\_is\\_less::operator\(\)](#).

The documentation for this struct was generated from the following file:

- [integral.cpp](#)

## 6.44 GiNaC::error\_and\_integral\_is\_less Struct Reference

### Public Member Functions

- `bool operator()` (`const error\_and\_integral &e1`, `const error\_and\_integral &e2`) `const`

## 6.44.1 Member Function Documentation

### 6.44.1.1 operator()

```
bool GiNaC::error_and_integral_is_less::operator() (
 const error_and_integral & e1,
 const error_and_integral & e2) const [inline]
```

References [GiNaC::ex::compare\(\)](#), [GiNaC::error\\_and\\_integral::error](#), and [GiNaC::error\\_and\\_integral::integral](#).

The documentation for this struct was generated from the following file:

- [integral.cpp](#)

## 6.45 GiNaC::eval\_integ\_map\_function Struct Reference

Function object to be applied by [basic::eval\\_integ\(\)](#).

Inheritance diagram for GiNaC::eval\_integ\_map\_function:



Collaboration diagram for GiNaC::eval\_integ\_map\_function:



### Public Member Functions

- [ex operator\(\)](#) (const [ex](#) &e) override

### Public Member Functions inherited from [GiNaC::map\\_function](#)

- virtual [~map\\_function](#) ()

### Additional Inherited Members

### Public Types inherited from [GiNaC::map\\_function](#)

- typedef const [ex](#) & [argument\\_type](#)
- typedef [ex](#) [result\\_type](#)

### 6.45.1 Detailed Description

Function object to be applied by [basic::eval\\_integ\(\)](#).

### 6.45.2 Member Function Documentation

#### 6.45.2.1 operator()

```
ex GiNaC::eval_integ_map_function::operator() (
 const ex & e) [inline], [override], [virtual]
```

Implements [GiNaC::map\\_function](#).

References [GiNaC::eval\\_integ\(\)](#).

The documentation for this struct was generated from the following file:

- [basic.cpp](#)

## 6.46 GiNaC::evalf\_map\_function Struct Reference

Function object to be applied by [basic::evalf\(\)](#).

Inheritance diagram for GiNaC::evalf\_map\_function:



Collaboration diagram for GiNaC::evalf\_map\_function:



## Public Member Functions

- [ex operator\(\)](#) (const [ex](#) &[e](#)) override

## Public Member Functions inherited from [GiNaC::map\\_function](#)

- virtual [~map\\_function](#) ()

## Additional Inherited Members

## Public Types inherited from [GiNaC::map\\_function](#)

- typedef const [ex](#) & [argument\\_type](#)
- typedef [ex](#) [result\\_type](#)

### 6.46.1 Detailed Description

Function object to be applied by [basic::evalf\(\)](#).

### 6.46.2 Member Function Documentation

#### 6.46.2.1 [operator\(\)](#)

```
ex GiNaC::evalf_map_function::operator() (
 const ex & e) [inline], [override], [virtual]
```

Implements [GiNaC::map\\_function](#).

References [GiNaC::evalf\(\)](#).

The documentation for this struct was generated from the following file:

- [basic.cpp](#)

## 6.47 GiNaC::evalm\_map\_function Struct Reference

Function object to be applied by [basic::evalm\(\)](#).

Inheritance diagram for GiNaC::evalm\_map\_function:



Collaboration diagram for GiNaC::evalm\_map\_function:



### Public Member Functions

- [ex operator\(\)](#) (const [ex](#) &[e](#)) override

### Public Member Functions inherited from [GiNaC::map\\_function](#)

- virtual [~map\\_function](#) ()

### Additional Inherited Members

### Public Types inherited from [GiNaC::map\\_function](#)

- typedef const [ex](#) & [argument\\_type](#)
- typedef [ex](#) [result\\_type](#)

### 6.47.1 Detailed Description

Function object to be applied by [basic::evalm\(\)](#).

### 6.47.2 Member Function Documentation

#### 6.47.2.1 operator>()

```
ex GiNaC::evalm_map_function::operator() (
 const ex & e) [inline], [override], [virtual]
```

Implements [GiNaC::map\\_function](#).

References [GiNaC::evalm\(\)](#).

The documentation for this struct was generated from the following file:

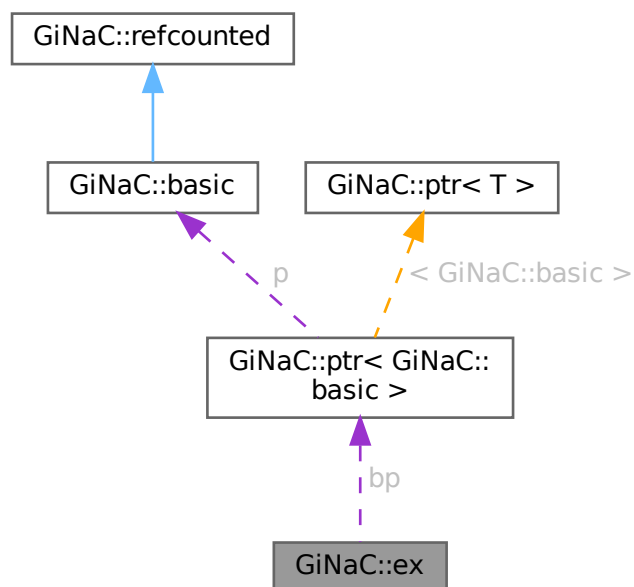
- [basic.cpp](#)

## 6.48 GiNaC::ex Class Reference

Lightweight wrapper for [GiNaC](#)'s symbolic objects.

```
#include <ex.h>
```

Collaboration diagram for GiNaC::ex:





## Public Member Functions

- `ex ()` noexcept
- `ex (const basic &other)`
- `ex (int i)`
- `ex (unsigned int i)`
- `ex (long i)`
- `ex (unsigned long i)`
- `ex (long long i)`
- `ex (unsigned long long i)`
- `ex (double const d)`
- `ex (const std::string &s, const ex &l)`  
*Construct ex from string and a list of symbols.*
- `void swap (ex &other)` noexcept  
*Efficiently swap the contents of two expressions.*
- `const_iterator begin ()` const noexcept
- `const_iterator end ()` const noexcept
- `const_preorder_iterator preorder_begin ()` const
- `const_preorder_iterator preorder_end ()` const noexcept
- `const_postorder_iterator postorder_begin ()` const
- `const_postorder_iterator postorder_end ()` const noexcept
- `ex eval ()` const
- `ex evalf ()` const
- `ex evalm ()` const
- `ex eval_ncmul (const exvector &v)` const
- `ex eval_integ ()` const
- `void print (const print_context &c, unsigned level=0)` const  
*Print expression to stream.*
- `void dbgprint ()` const  
*Little wrapper around print to be called within a debugger.*
- `void dbgprinttree ()` const  
*Little wrapper around printtree to be called within a debugger.*
- `bool info (unsigned inf)` const
- `size_t nops ()` const
- `ex op (size_t i)` const
- `ex operator[] (const ex &index)` const
- `ex operator[] (size_t i)` const
- `ex & let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- `ex & operator[] (const ex &index)`
- `ex & operator[] (size_t i)`
- `ex lhs ()` const  
*Left hand side of relational expression.*
- `ex rhs ()` const  
*Right hand side of relational expression.*
- `ex conjugate ()` const
- `ex real_part ()` const
- `ex imag_part ()` const
- `bool has (const ex &pattern, unsigned options=0)` const
- `bool find (const ex &pattern, exset &found)` const  
*Find all occurrences of a pattern.*
- `bool match (const ex &pattern)` const  
*Check whether expression matches a specified pattern.*

- `bool match` (const `ex` &pattern, `exmap` &repls) const
- `ex subs` (const `exmap` &m, unsigned options=0) const
- `ex subs` (const `lst` &ls, const `lst` &lr, unsigned options=0) const
 

*Substitute objects in an expression (syntactic substitution) and return the result as a new expression.*
- `ex subs` (const `ex` &e, unsigned options=0) const
 

*Substitute objects in an expression (syntactic substitution) and return the result as a new expression.*
- `ex map` (`map_function` &f) const
- `ex map` (`ex`(\*f)(const `ex` &e)) const
- void `accept` (`visitor` &v) const
- void `traverse_preorder` (`visitor` &v) const
 

*Traverse expression tree with given visitor, preorder traversal.*
- void `traverse_postorder` (`visitor` &v) const
 

*Traverse expression tree with given visitor, postorder traversal.*
- void `traverse` (`visitor` &v) const
- `bool is_polynomial` (const `ex` &vars) const
 

*Check whether expression is a polynomial.*
- `int degree` (const `ex` &s) const
- `int ldegree` (const `ex` &s) const
- `ex coeff` (const `ex` &s, int n=1) const
- `ex lcoeff` (const `ex` &s) const
- `ex tcoeff` (const `ex` &s) const
- `ex expand` (unsigned options=0) const
 

*Expand an expression.*
- `ex collect` (const `ex` &s, bool distributed=false) const
- `ex diff` (const `symbol` &s, unsigned nth=1) const
 

*Compute partial derivative of an expression.*
- `ex series` (const `ex` &r, int order, unsigned options=0) const
 

*Compute the truncated series expansion of an expression.*
- `ex normal` () const
 

*Normalization of rational functions.*
- `ex to_rational` (`exmap` &repl) const
 

*Rationalization of non-rational functions.*
- `ex to_polynomial` (`exmap` &repl) const
- `ex numer` () const
 

*Get numerator of an expression.*
- `ex denom` () const
 

*Get denominator of an expression.*
- `ex numer_denom` () const
 

*Get numerator and denominator of an expression.*
- `ex unit` (const `ex` &x) const
 

*Compute unit part (= sign of leading coefficient) of a multivariate polynomial in  $Q[x]$ .*
- `ex content` (const `ex` &x) const
 

*Compute content part (= unit normal GCD of all coefficients) of a multivariate polynomial in  $Q[x]$ .*
- `numeric_integer_content` () const
 

*Compute the integer content (= GCD of all numeric coefficients) of an expanded polynomial.*
- `ex primpart` (const `ex` &x) const
 

*Compute primitive part of a multivariate polynomial in  $Q[x]$ .*
- `ex primpart` (const `ex` &x, const `ex` &cont) const
 

*Compute primitive part of a multivariate polynomial in  $Q[x]$  when the content part is already known.*
- void `unitcontprim` (const `ex` &x, `ex` &u, `ex` &c, `ex` &p) const
 

*Compute unit part, content part, and primitive part of a multivariate polynomial in  $Q[x]$ .*
- `ex smod` (const `numeric` &xi) const

- [numeric max\\_coefficient](#) () const  
*Return maximum (absolute value) coefficient of a polynomial.*
- [exvector get\\_free\\_indices](#) () const
- [ex simplify\\_indexed](#) (unsigned options=0) const  
*Simplify/canonicalize expression containing indexed objects.*
- [ex simplify\\_indexed](#) (const [scalar\\_products](#) &sp, unsigned options=0) const  
*Simplify/canonicalize expression containing indexed objects.*
- int [compare](#) (const [ex](#) &other) const
- bool [is\\_equal](#) (const [ex](#) &other) const
- bool [is\\_zero](#) () const
- bool [is\\_zero\\_matrix](#) () const  
*Check whether expression is zero or zero matrix.*
- [ex symmetrize](#) () const  
*Symmetrize expression over its free indices.*
- [ex symmetrize](#) (const [lst](#) &l) const  
*Symmetrize expression over a list of objects (symbols, indices).*
- [ex antisymmetrize](#) () const  
*Antisymmetrize expression over its free indices.*
- [ex antisymmetrize](#) (const [lst](#) &l) const  
*Antisymmetrize expression over a list of objects (symbols, indices).*
- [ex symmetrize\\_cyclic](#) () const  
*Symmetrize expression by cyclic permutation over its free indices.*
- [ex symmetrize\\_cyclic](#) (const [lst](#) &l) const  
*Symmetrize expression by cyclic permutation over a list of objects (symbols, indices).*
- unsigned [return\\_type](#) () const
- [return\\_type\\_t](#) [return\\_type\\_tinfo](#) () const
- unsigned [gethash](#) () const

### Private Member Functions

- void [makewritable](#) ()  
*Make this ex writable (if more than one ex handle the same basic) by unlinking the object and creating an unshared copy of it.*
- void [share](#) (const [ex](#) &other) const  
*Share equal objects between expressions.*

### Static Private Member Functions

- static [ptr](#)< [basic](#) > [construct\\_from\\_basic](#) (const [basic](#) &other)  
*Helper function for the ex-from-basic constructor.*
- static [basic](#) & [construct\\_from\\_int](#) (int i)
- static [basic](#) & [construct\\_from\\_uint](#) (unsigned int i)
- static [basic](#) & [construct\\_from\\_long](#) (long i)
- static [basic](#) & [construct\\_from\\_ulong](#) (unsigned long i)
- static [basic](#) & [construct\\_from\\_longlong](#) (long long i)
- static [basic](#) & [construct\\_from\\_ulonglong](#) (unsigned long long i)
- static [basic](#) & [construct\\_from\\_double](#) (double d)
- static [ptr](#)< [basic](#) > [construct\\_from\\_string\\_and\\_lst](#) (const std::string &s, const [ex](#) &l)

## Private Attributes

- `ptr< basic > bp`  
*pointer to basic object managed by this*

## Friends

- class `archive_node`
- bool `are_ex_trivially_equal` (const `ex` &e1, const `ex` &e2)  
*Compare two objects of class quickly without doing a deep tree traversal.*
- template<class T>  
const T & `ex_to` (const `ex` &e)  
*Return a reference to the basic-derived class T object embedded in an expression.*
- template<class T>  
bool `is_a` (const `ex` &obj)  
*Check if ex is a handle to a T, including base classes.*
- template<class T>  
bool `is_exactly_a` (const `ex` &obj)  
*Check if ex is a handle to a T, not including base classes.*

## 6.48.1 Detailed Description

Lightweight wrapper for `GiNaC`'s symbolic objects.

It holds a pointer to the other object in order to do garbage collection by the method of reference counting. I.e., it is a smart pointer. Also, the constructor `ex::ex(const basic & other)` calls the methods that do automatic evaluation. E.g., `x-x` turns automatically into 0.

## 6.48.2 Constructor & Destructor Documentation

### 6.48.2.1 `ex()` [1/10]

```
GiNaC::ex::ex () [inline], [noexcept]
```

References `GiNaC::_num0_bp`, `bp`, `GiNaC::status_flags::dynallocated`, and `GINAC_ASSERT`.

Referenced by `antisymmetrize()`, `antisymmetrize()`, `archive_node`, `are_ex_trivially_equal`, `coeff()`, `collect()`, `compare()`, `conjugate()`, `construct_from_basic()`, `construct_from_string_and_lst()`, `content()`, `degree()`, `denom()`, `diff()`, `eval()`, `eval_integ()`, `eval_ncmul()`, `evalf()`, `evalm()`, `ex()`, `ex_to`, `expand()`, `find()`, `has()`, `imag_part()`, `is_a`, `is_equal()`, `is_exactly_a`, `is_polynomial()`, `is_zero()`, `is_zero_matrix()`, `lcoeff()`, `ldegree()`, `let_op()`, `lhs()`, `map()`, `map()`, `match()`, `match()`, `normal()`, `numer()`, `numer_denom()`, `op()`, `operator[]()`, `operator[]()`, `operator[]()`, `operator[]()`, `primpart()`, `primpart()`, `real_part()`, `rhs()`, `series()`, `share()`, `simplify_indexed()`, `simplify_indexed()`, `smod()`, `subs()`, `subs()`, `subs()`, `swap()`, `symmetrize()`, `symmetrize()`, `symmetrize_cyclic()`, `symmetrize_cyclic()`, `tcoeff()`, `to_polynomial()`, `to_rational()`, `unit()`, and `unitcontprim()`.

### 6.48.2.2 `ex()` [2/10]

```
GiNaC::ex::ex (
 const basic & other) [inline]
```

References `bp`, `construct_from_basic()`, `GiNaC::status_flags::dynallocated`, and `GINAC_ASSERT`.

**6.48.2.3 ex()** [3/10]

```
GiNaC::ex::ex (
 int i) [inline]
```

References [bp](#), [construct\\_from\\_int\(\)](#), [GiNaC::status\\_flags::dynallocated](#), and [GINAC\\_ASSERT](#).

**6.48.2.4 ex()** [4/10]

```
GiNaC::ex::ex (
 unsigned int i) [inline]
```

References [bp](#), [construct\\_from\\_uint\(\)](#), [GiNaC::status\\_flags::dynallocated](#), and [GINAC\\_ASSERT](#).

**6.48.2.5 ex()** [5/10]

```
GiNaC::ex::ex (
 long i) [inline]
```

References [bp](#), [construct\\_from\\_long\(\)](#), [GiNaC::status\\_flags::dynallocated](#), and [GINAC\\_ASSERT](#).

**6.48.2.6 ex()** [6/10]

```
GiNaC::ex::ex (
 unsigned long i) [inline]
```

References [bp](#), [construct\\_from\\_ulong\(\)](#), [GiNaC::status\\_flags::dynallocated](#), and [GINAC\\_ASSERT](#).

**6.48.2.7 ex()** [7/10]

```
GiNaC::ex::ex (
 long long i) [inline]
```

References [bp](#), [construct\\_from\\_longlong\(\)](#), [GiNaC::status\\_flags::dynallocated](#), and [GINAC\\_ASSERT](#).

**6.48.2.8 ex()** [8/10]

```
GiNaC::ex::ex (
 unsigned long long i) [inline]
```

References [bp](#), [construct\\_from\\_ulonglong\(\)](#), [GiNaC::status\\_flags::dynallocated](#), and [GINAC\\_ASSERT](#).

**6.48.2.9 ex()** [9/10]

```
GiNaC::ex::ex (
 double const d) [inline]
```

References [bp](#), [construct\\_from\\_double\(\)](#), [GiNaC::status\\_flags::dynallocated](#), and [GINAC\\_ASSERT](#).

### 6.48.2.10 `ex()` [10/10]

```
GiNaC::ex::ex (
 const std::string & s,
 const ex & l) [inline]
```

Construct `ex` from string and a list of symbols.

The input grammar is similar to the [GiNaC](#) output format. All symbols and indices to be used in the expression must be specified in a list in the second argument. Undefined symbols and other parser errors will throw an exception.

References [bp](#), [construct\\_from\\_string\\_and\\_lst\(\)](#), [GiNaC::status\\_flags::dynallocated](#), [ex\(\)](#), and [GINAC\\_ASSERT](#).

## 6.48.3 Member Function Documentation

### 6.48.3.1 `swap()`

```
void GiNaC::ex::swap (
 ex & other) [inline], [noexcept]
```

Efficiently swap the contents of two expressions.

References [bp](#), [GiNaC::status\\_flags::dynallocated](#), [ex\(\)](#), [GINAC\\_ASSERT](#), and [swap\(\)](#).

Referenced by [GiNaC::ncmul::derivative\(\)](#), [GiNaC::ex\\_swap::operator\(\)\(\)](#), [swap\(\)](#), [GiNaC::swap\(\)](#), and [std::swap\(\)](#).

### 6.48.3.2 `begin()`

```
const_iterator GiNaC::ex::begin () const [inline], [noexcept]
```

Referenced by [GiNaC::abs\\_expand\(\)](#), [GiNaC::antisymmetrize\(\)](#), [GiNaC::exp\\_expand\(\)](#), [GiNaC::log\\_expand\(\)](#), [GiNaC::rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::symmetrize\(\)](#), and [GiNaC::symmetrize\\_cyclic\(\)](#).

### 6.48.3.3 `end()`

```
const_iterator GiNaC::ex::end () const [inline], [noexcept]
```

References [nops\(\)](#).

Referenced by [GiNaC::abs\\_expand\(\)](#), [GiNaC::exp\\_expand\(\)](#), [GiNaC::log\\_expand\(\)](#), and [GiNaC::rename\\_dummy\\_indices\\_uniquely\(\)](#).

### 6.48.3.4 `preorder_begin()`

```
const_preorder_iterator GiNaC::ex::preorder_begin () const [inline]
```

References [nops\(\)](#).

**6.48.3.5 preorder\_end()**

```
const_preorder_iterator GiNaC::ex::preorder_end () const [inline], [noexcept]
```

**6.48.3.6 postorder\_begin()**

```
const_postorder_iterator GiNaC::ex::postorder_begin () const [inline]
```

References [nops\(\)](#).

**6.48.3.7 postorder\_end()**

```
const_postorder_iterator GiNaC::ex::postorder_end () const [inline], [noexcept]
```

**6.48.3.8 eval()**

```
ex GiNaC::ex::eval () const [inline]
```

References [bp](#), [eval\(\)](#), and [ex\(\)](#).

Referenced by [GiNaC::eval\(\)](#), and [eval\(\)](#).

**6.48.3.9 evalf()**

```
ex GiNaC::ex::evalf () const [inline]
```

References [bp](#), and [ex\(\)](#).

Referenced by [GiNaC::adaptivesimpson\(\)](#), [GiNaC::EllipticE\\_evalf\(\)](#), [GiNaC::EllipticK\\_evalf\(\)](#), [GiNaC::evalf\(\)](#), [GiNaC::integral::evalf\(\)](#), [GiNaC::fsolve\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::get\\_numerical\\_value\(\)](#), [GiNaC::integration\\_kernel::get\\_numerical\\_value\(\)](#), [GiNaC::H\\_evalf\(\)](#), [GiNaC::modular\\_form\\_kernel::is\\_numeric\(\)](#), [GiNaC::iterated\\_integral\\_evalf\\_impl\(\)](#), [GiNaC::Li\\_evalf\(\)](#), [GiNaC::S\\_evalf\(\)](#), [GiNaC::integration\\_kernel::series\\_coeff\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::series\\_coeff\\_impl\(\)](#), [GiNaC::Kronecker\\_dz\\_kernel::series\\_coeff\\_impl\(\)](#), and [GiNaC::subsvalue\(\)](#).

**6.48.3.10 evalm()**

```
ex GiNaC::ex::evalm () const [inline]
```

References [bp](#), and [ex\(\)](#).

Referenced by [GiNaC::add::evalm\(\)](#), [GiNaC::evalm\(\)](#), [GiNaC::mul::evalm\(\)](#), and [is\\_zero\\_matrix\(\)](#).

**6.48.3.11 eval\_ncmul()**

```
ex GiNaC::ex::eval_ncmul (
 const exvector & v) const [inline]
```

References [bp](#), and [ex\(\)](#).

### 6.48.3.12 eval\_integ()

```
ex GiNaC::ex::eval_integ () const [inline]
```

References [bp](#), and [ex\(\)](#).

Referenced by [GiNaC::eval\\_integ\(\)](#), and [GiNaC::integral::eval\\_integ\(\)](#).

### 6.48.3.13 print()

```
void GiNaC::ex::print (
 const print_context & c,
 unsigned level = 0) const
```

Print expression to stream.

The formatting of the output is determined by the kind of [print\\_context](#) object that is passed. Possible formattings include ginsh-parsable output (the default), tree-like output for debugging, and C++ source.

See also

[print\\_context](#)

References [bp](#).

Referenced by [GiNaC::abs\\_print\\_csrc\\_float\(\)](#), [GiNaC::abs\\_print\\_latex\(\)](#), [GiNaC::conjugate\\_print\\_latex\(\)](#), [GiNaC::mul::do\\_print\(\)](#), [GiNaC::add::do\\_print\\_python\\_repr\(\)](#), [GiNaC::mul::do\\_print\\_python\\_repr\(\)](#), [GiNaC::EllipticE\\_print\\_latex\(\)](#), [GiNaC::EllipticK\\_print\\_latex\(\)](#), [GiNaC::factorial\\_print\\_dflt\\_latex\(\)](#), [GiNaC::H\\_print\\_latex\(\)](#), [GiNaC::imag\\_part\\_print\\_latex\(\)](#), [GiNaC::operator<<\(\)](#), [GiNaC::expairseq::printpair\(\)](#), [GiNaC::real\\_part\\_print\\_latex\(\)](#), [GiNaC::S\\_print\\_latex\(\)](#), and [GiNaC::zeta1\\_print\\_latex\(\)](#).

### 6.48.3.14 dbgprint()

```
void GiNaC::ex::dbgprint () const
```

Little wrapper around print to be called within a debugger.

References [bp](#).

### 6.48.3.15 dbgprinttree()

```
void GiNaC::ex::dbgprinttree () const
```

Little wrapper around printtree to be called within a debugger.

References [bp](#).



### 6.48.3.16 info()

```
bool GiNaC::ex::info (
 unsigned inf) const [inline]
```

References [bp](#).

Referenced by [GiNaC::abs\\_eval\(\)](#), [GiNaC::abs\\_info\(\)](#), [GiNaC::abs\\_power\(\)](#), [GiNaC::acos\\_eval\(\)](#), [GiNaC::acosh\\_eval\(\)](#), [GiNaC::asin\\_eval\(\)](#), [GiNaC::asin\\_info\(\)](#), [GiNaC::asinh\\_conjugate\(\)](#), [GiNaC::asinh\\_eval\(\)](#), [GiNaC::atan2\\_eval\(\)](#), [GiNaC::atan2\\_info\(\)](#), [GiNaC::atan\\_conjugate\(\)](#), [GiNaC::atan\\_eval\(\)](#), [GiNaC::atan\\_info\(\)](#), [GiNaC::atanh\\_eval\(\)](#), [GiNaC::beta\\_eval\(\)](#), [GiNaC::beta\\_series\(\)](#), [GiNaC::mul::can\\_be\\_further\\_expanded\(\)](#), [GiNaC::mul::can\\_make\\_flat\(\)](#), [GiNaC::canonicalize\\_clifford\(\)](#), [GiNaC::clifford\\_moebius\\_map\(\)](#), [GiNaC::clifford\\_prime\(\)](#), [GiNaC::clifford\\_star\\_bar\(\)](#), [GiNaC::expairseq::construct\\_from\\_2\\_ex\(\)](#), [content\(\)](#), [GiNaC::cos\\_eval\(\)](#), [GiNaC::cosh\\_eval\(\)](#), [GiNaC::csgn\\_series\(\)](#), [GiNaC::matrix::determinant\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide\\_in\\_z\(\)](#), [GiNaC::EllipticE\\_eval\(\)](#), [GiNaC::EllipticE\\_evalf\(\)](#), [GiNaC::EllipticK\\_eval\(\)](#), [GiNaC::EllipticK\\_evalf\(\)](#), [GiNaC::eta\\_eval\(\)](#), [GiNaC::eta\\_evalf\(\)](#), [GiNaC::eta\\_series\(\)](#), [GiNaC::exp\\_eval\(\)](#), [GiNaC::exp\\_info\(\)](#), [GiNaC::exp\\_power\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::find\\_common\\_factor\(\)](#), [GiNaC::func\\_arg\\_info\(\)](#), [GiNaC::G2\\_eval\(\)](#), [GiNaC::G2\\_evalf\(\)](#), [GiNaC::G3\\_eval\(\)](#), [GiNaC::G3\\_evalf\(\)](#), [GiNaC::gcd\(\)](#), [GiNaC::get\\_clifford\\_comp\(\)](#), [GiNaC::get\\_dim\\_uint\(\)](#), [GiNaC::H\\_eval\(\)](#), [GiNaC::H\\_evalf\(\)](#), [GiNaC::power::has\(\)](#), [GiNaC::heur\\_gcd\(\)](#), [GiNaC::power::imag\\_part\(\)](#), [GiNaC::mul::info\(\)](#), [GiNaC::modular\\_form\\_kernel::is\\_numeric\(\)](#), [GiNaC::iterated\\_integral2\\_eval\(\)](#), [GiNaC::iterated\\_integral3\\_eval\(\)](#), [GiNaC::iterated\\_integral\\_evalf\\_impl\(\)](#), [GiNaC::lcm\(\)](#), [GiNaC::lcmcoeff\(\)](#), [GiNaC::lgamma\\_conjugate\(\)](#), [GiNaC::lgamma\\_eval\(\)](#), [GiNaC::lgamma\\_series\(\)](#), [GiNaC::Li2\\_conjugate\(\)](#), [GiNaC::Li2\\_eval\(\)](#), [GiNaC::Li2\\_series\(\)](#), [GiNaC::Li\\_eval\(\)](#), [GiNaC::Li\\_evalf\(\)](#), [GiNaC::Li\\_series\(\)](#), [GiNaC::log\\_conjugate\(\)](#), [GiNaC::log\\_eval\(\)](#), [GiNaC::log\\_expand\(\)](#), [GiNaC::log\\_imag\\_part\(\)](#), [GiNaC::log\\_info\(\)](#), [GiNaC::log\\_real\\_part\(\)](#), [GiNaC::log\\_series\(\)](#), [GiNaC::lsolve\(\)](#), [GiNaC::lst\\_to\\_clifford\(\)](#), [GiNaC::basic::normal\(\)](#), [GiNaC::power::normal\(\)](#), [GiNaC::relational::operator safe\\_bool\(\)](#), [GiNaC::Order\\_imag\\_part\(\)](#), [GiNaC::Order\\_power\(\)](#), [GiNaC::matrix::pow\(\)](#), [GiNaC::prem\(\)](#), [GiNaC::psi1\\_eval\(\)](#), [GiNaC::psi1\\_series\(\)](#), [GiNaC::psi2\\_eval\(\)](#), [GiNaC::psi2\\_series\(\)](#), [GiNaC::quo\(\)](#), [GiNaC::power::real\\_part\(\)](#), [GiNaC::rem\(\)](#), [GiNaC::remove\\_dirac\\_ONE\(\)](#), [GiNaC::resultant\(\)](#), [GiNaC::S\\_eval\(\)](#), [GiNaC::S\\_evalf\(\)](#), [GiNaC::S\\_series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::sin\\_eval\(\)](#), [GiNaC::sinh\\_eval\(\)](#), [GiNaC::sprem\(\)](#), [GiNaC::step\\_series\(\)](#), [subs\(\)](#), [GiNaC::tan\\_eval\(\)](#), [GiNaC::tanh\\_eval\(\)](#), [GiNaC::tgamma\\_eval\(\)](#), [GiNaC::tgamma\\_series\(\)](#), [GiNaC::expairseq::to\\_polynomial\(\)](#), [GiNaC::expairseq::to\\_rational\(\)](#), [GiNaC::matrix::trace\(\)](#), [GiNaC::trig\\_info\(\)](#), [GiNaC::tryfactsubs\(\)](#), [unit\(\)](#), [unitcontprim\(\)](#), [GiNaC::zeta1\\_eval\(\)](#), [GiNaC::zeta2\\_deriv\(\)](#), [GiNaC::zeta2\\_eval\(\)](#), and [GiNaC::zetaderiv\\_eval\(\)](#).

### 6.48.3.17 nops()

```
size_t GiNaC::ex::nops () const [inline]
```

References [bp](#).

Referenced by [GiNaC::abs\\_expand\(\)](#), [GiNaC::matrix::add\\_indexed\(\)](#), [GiNaC::algebraic\\_match\\_mul\\_with\\_mul\(\)](#), [GiNaC::ncmul::append\\_factors\(\)](#), [GiNaC::clifford\\_max\\_label\(\)](#), [GiNaC::clifford\\_star\\_bar\(\)](#), [GiNaC::basic::collect\(\)](#), [GiNaC::collect\\_symbols\(\)](#), [GiNaC::color\\_trace\(\)](#), [GiNaC::ncmul::count\\_factors\(\)](#), [GiNaC::csgn\\_eval\(\)](#), [GiNaC::const\\_postorder\\_iterator\(\)](#), [GiNaC::dirac\\_trace\(\)](#), [GiNaC::divide\(\)](#), [end\(\)](#), [GiNaC::indexed::eval\(\)](#), [GiNaC::exp\\_expand\(\)](#), [GiNaC::indexed::expand\(\)](#), [GiNaC::integral::expand\(\)](#), [GiNaC::mul::expand\(\)](#), [find\(\)](#), [GiNaC::find\\_common\\_factor\(\)](#), [GiNaC::gcd\\_pf\\_mul\(\)](#), [GiNaC::get\\_all\\_dummy\\_indices\\_safely\(\)](#), [GiNaC::get\\_clifford\\_comp\(\)](#), [GiNaC::get\\_first\\_symbol\(\)](#), [GiNaC::get\\_symbol\\_stats\(\)](#), [GiNaC::H\\_evalf\(\)](#), [GiNaC::hasindex\(\)](#), [GiNaC::haswild\(\)](#), [GiNaC::idx\\_symmetrization\(\)](#), [GiNaC::const\\_preorder\\_iterator::increment\(\)](#), [GiNaC::lcmcoeff\(\)](#), [GiNaC::Li2\\_series\(\)](#), [GiNaC::Li\\_deriv\(\)](#), [GiNaC::log\\_expand\(\)](#), [GiNaC::lsolve\(\)](#), [GiNaC::basic::match\(\)](#), [GiNaC::expairseq::match\(\)](#), [GiNaC::multiply\\_lcm\(\)](#), [GiNaC::nops\(\)](#), [postorder\\_begin\(\)](#), [preorder\\_begin\(\)](#), [GiNaC::product\\_to\\_exvector\(\)](#), [GiNaC::rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::indexed::reposition\\_dummy\\_indices](#), [GiNaC::matrix::scalar\\_mul\\_indexed\(\)](#), [GiNaC::integral::series\(\)](#), [GiNaC::indexed::simplify\\_indexed](#), [GiNaC::indexed::simplify\\_indexed\\_product](#), [GiNaC::step\\_eval\(\)](#), [GiNaC::symminfo::symminfo\(\)](#), [traverse\\_postorder\(\)](#), [traverse\\_preorder\(\)](#), [GiNaC::zeta1\\_eval\(\)](#), [GiNaC::zeta1\\_evalf\(\)](#), and [GiNaC::zeta2\\_evalf\(\)](#).

### 6.48.3.18 op()

```
ex GiNaC::ex::op (
 size_t i) const [inline]
```

References [bp](#), and [ex\(\)](#).

Referenced by [GiNaC::abs\\_eval\(\)](#), [GiNaC::matrix::add\\_indexed\(\)](#), [GiNaC::algebraic\\_match\\_mul\\_with\\_mul\(\)](#), [GiNaC::ncmul::append\\_factors\(\)](#), [GiNaC::atan\\_series\(\)](#), [GiNaC::atanh\\_series\(\)](#), [GiNaC::mul::can\\_be\\_further\\_expanded\(\)](#), [GiNaC::clifford\\_max\\_label\(\)](#), [GiNaC::clifford\\_moebius\\_map\(\)](#), [GiNaC::clifford\\_prime\(\)](#), [GiNaC::clifford\\_star\\_bar\(\)](#), [GiNaC::clifford\\_to\\_lst\(\)](#), [GiNaC::basic::collect\(\)](#), [GiNaC::collect\\_symbols\(\)](#), [GiNaC::color\\_trace\(\)](#), [GiNaC::cliffordunit::contract\\_with\(\)](#), [GiNaC::matrix::contract\\_with\(\)](#), [GiNaC::cos\\_eval\(\)](#), [GiNaC::cosh\\_eval\(\)](#), [GiNaC::ncmul::count\\_factors\(\)](#), [GiNaC::csgn\\_eval\(\)](#), [GiNaC::decomp\\_rational\(\)](#), [denom\(\)](#), [GiNaC::const\\_postorder\\_iterator::descend\(\)](#), [GiNaC::dirac\\_trace\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide\\_in\\_z\(\)](#), [GiNaC::epsilon\\_tensor\(\)](#), [GiNaC::epsilon\\_tensor\(\)](#), [GiNaC::indexed::eval\(\)](#), [GiNaC::clifford::eval\\_ncmul\(\)](#), [GiNaC::exp\\_eval\(\)](#), [GiNaC::indexed::expand\(\)](#), [GiNaC::integral::expand\(\)](#), [GiNaC::mul::expand\(\)](#), [find\(\)](#), [GiNaC::find\\_common\\_factor\(\)](#), [GiNaC::matrix::fraction\\_free\\_elimination\(\)](#), [GiNaC::gcd\\_pf\\_mul\(\)](#), [GiNaC::gcd\\_pf\\_pow\(\)](#), [GiNaC::gcd\\_pf\\_pow\\_pow\(\)](#), [GiNaC::get\\_all\\_dummy\\_indices\\_safely\(\)](#), [GiNaC::get\\_clifford\\_comp\(\)](#), [GiNaC::get\\_first\\_symbol\(\)](#), [GiNaC::H\\_evalf\(\)](#), [GiNaC::power::has\(\)](#), [GiNaC::hasindex\(\)](#), [GiNaC::haswild\(\)](#), [GiNaC::const\\_preorder\\_iterator::increment\(\)](#), [GiNaC::lcmcoeff\(\)](#), [GiNaC::Li2\\_series\(\)](#), [GiNaC::Li\\_deriv\(\)](#), [GiNaC::log\\_eval\(\)](#), [GiNaC::lorentz\\_eps\(\)](#), [GiNaC::lsolve\(\)](#), [GiNaC::lst\\_to\\_clifford\(\)](#), [GiNaC::basic::match\(\)](#), [GiNaC::expairseq::match\(\)](#), [GiNaC::multiply\\_lcm\(\)](#), [GiNaC::add::normal\(\)](#), [GiNaC::basic::normal\(\)](#), [normal\(\)](#), [GiNaC::mul::normal\(\)](#), [GiNaC::power::normal\(\)](#), [numer\(\)](#), [GiNaC::op\(\)](#), [GiNaC::ex\\_base\\_is\\_less::operator\(\)\(\)](#), [GiNaC::op0\\_is\\_equal::operator\(\)\(\)](#), [GiNaC::product\\_to\\_exvector\(\)](#), [GiNaC::remove\\_dirac\\_ONE\(\)](#), [GiNaC::replace\\_with\\_symbol\(\)](#), [GiNaC::indexed::reposition\\_dummy\\_indices](#), [GiNaC::clifford::same\\_metric\(\)](#), [GiNaC::matrix::scalar\\_mul\\_indexed\(\)](#), [GiNaC::indexed::simplify\\_indexed](#), [GiNaC::indexed::simplify\\_indexed\\_product](#), [GiNaC::sin\\_eval\(\)](#), [GiNaC::sinh\\_eval\(\)](#), [GiNaC::spmapkey::spmapkey\(\)](#), [GiNaC::sqrfree\\_parfrac\(\)](#), [GiNaC::step\\_eval\(\)](#), [subs\(\)](#), [GiNaC::symminfo::symminfo\(\)](#), [GiNaC::tan\\_eval\(\)](#), [GiNaC::tanh\\_eval\(\)](#), [traverse\\_postorder\(\)](#), [traverse\\_preorder\(\)](#), [GiNaC::tryfactsubs\(\)](#), [GiNaC::zeta1\\_eval\(\)](#), and [GiNaC::zeta2\\_deriv\(\)](#).

### 6.48.3.19 operator[]() [1/4]

```
ex GiNaC::ex::operator[] (
 const ex & index) const [inline]
```

References [bp](#), and [ex\(\)](#).

### 6.48.3.20 operator[]() [2/4]

```
ex GiNaC::ex::operator[] (
 size_t i) const [inline]
```

References [bp](#), and [ex\(\)](#).

### 6.48.3.21 let\_op()

```
ex & GiNaC::ex::let_op (
 size_t i)
```

Return modifiable operand/member at position i.

References [bp](#), [ex\(\)](#), and [makewritable\(\)](#).

**6.48.3.22 operator[]() [3/4]**

```
ex & GiNaC::ex::operator[] (
 const ex & index)
```

References [bp](#), [ex\(\)](#), and [makewriteable\(\)](#).

**6.48.3.23 operator[]() [4/4]**

```
ex & GiNaC::ex::operator[] (
 size_t i)
```

References [bp](#), [ex\(\)](#), and [makewriteable\(\)](#).

**6.48.3.24 lhs()**

```
ex GiNaC::ex::lhs () const
```

Left hand side of relational expression.

References [bp](#), [ex\(\)](#), and [is\\_a](#).

Referenced by [GiNaC::fsolve\(\)](#), [GiNaC::lhs\(\)](#), [GiNaC::pseries::pseries\(\)](#), and [GiNaC::pseries::pseries\(\)](#).

**6.48.3.25 rhs()**

```
ex GiNaC::ex::rhs () const
```

Right hand side of relational expression.

References [bp](#), [ex\(\)](#), and [is\\_a](#).

Referenced by [GiNaC::fsolve\(\)](#), [GiNaC::pseries::pseries\(\)](#), [GiNaC::pseries::pseries\(\)](#), and [GiNaC::rhs\(\)](#).

**6.48.3.26 conjugate()**

```
ex GiNaC::ex::conjugate () const [inline]
```

References [bp](#), and [ex\(\)](#).

Referenced by [GiNaC::abs\\_expl\\_derivative\(\)](#), [GiNaC::abs\\_power\(\)](#), [GiNaC::acos\\_conjugate\(\)](#), [GiNaC::acosh\\_conjugate\(\)](#), [GiNaC::asin\\_conjugate\(\)](#), [GiNaC::asinh\\_conjugate\(\)](#), [GiNaC::atan\\_conjugate\(\)](#), [GiNaC::atanh\\_conjugate\(\)](#), [GiNaC::add::conjugate\(\)](#), [GiNaC::conjugate\(\)](#), [GiNaC::mul::conjugate\(\)](#), [GiNaC::conjugate\\_eval\(\)](#), [GiNaC::cos\\_conjugate\(\)](#), [GiNaC::cosh\\_conjugate\(\)](#), [GiNaC::exp\\_conjugate\(\)](#), [GiNaC::lgamma\\_conjugate\(\)](#), [GiNaC::Li2\\_conjugate\(\)](#), [GiNaC::log\\_conjugate\(\)](#), [GiNaC::sin\\_conjugate\(\)](#), [GiNaC::sinh\\_conjugate\(\)](#), [GiNaC::tan\\_conjugate\(\)](#), [GiNaC::tanh\\_conjugate\(\)](#), and [GiNaC::tgamma\\_conjugate\(\)](#).

**6.48.3.27 real\_part()**

```
ex GiNaC::ex::real_part () const [inline]
```

References [bp](#), and [ex\(\)](#).

Referenced by [GiNaC::abs\\_eval\(\)](#), [GiNaC::asinh\\_conjugate\(\)](#), [GiNaC::atan\\_conjugate\(\)](#), [GiNaC::conjugate\\_real\\_part\(\)](#), [GiNaC::add::real\\_part\(\)](#), [GiNaC::real\\_part\(\)](#), and [GiNaC::real\\_part\\_eval\(\)](#).

**6.48.3.28 imag\_part()**

```
ex GiNaC::ex::imag_part () const [inline]
```

References [bp](#), and [ex\(\)](#).

Referenced by [GiNaC::acos\\_conjugate\(\)](#), [GiNaC::acosh\\_conjugate\(\)](#), [GiNaC::asin\\_conjugate\(\)](#), [GiNaC::asinh\\_conjugate\(\)](#), [GiNaC::atan\\_conjugate\(\)](#), [GiNaC::atanh\\_conjugate\(\)](#), [GiNaC::conjugate\\_imag\\_part\(\)](#), [GiNaC::add::imag\\_part\(\)](#), [GiNaC::imag\\_part\(\)](#), [GiNaC::imag\\_part\\_eval\(\)](#), [GiNaC::lgamma\\_conjugate\(\)](#), [GiNaC::Li2\\_conjugate\(\)](#), and [GiNaC::log\\_conjugate\(\)](#).

**6.48.3.29 has()**

```
bool GiNaC::ex::has (
 const ex & pattern,
 unsigned options = 0) const [inline]
```

References [bp](#), and [ex\(\)](#).

Referenced by [GiNaC::integral::expand\(\)](#), and [GiNaC::has\(\)](#).

**6.48.3.30 find()**

```
bool GiNaC::ex::find (
 const ex & pattern,
 exset & found) const
```

Find all occurrences of a pattern.

The found matches are appended to the "found" list. If the expression itself matches the pattern, the children are not further examined. This function returns true when any matches were found.

References [ex\(\)](#), [find\(\)](#), [match\(\)](#), [nops\(\)](#), and [op\(\)](#).

Referenced by [find\(\)](#), [GiNaC::find\(\)](#), [GiNaC::replace\\_with\\_symbol\(\)](#), and [GiNaC::idx::subs\(\)](#).

**6.48.3.31 match() [1/2]**

```
bool GiNaC::ex::match (
 const ex & pattern) const
```

Check whether expression matches a specified pattern.

References [bp](#), and [ex\(\)](#).

Referenced by [find\(\)](#), [GiNaC::match\(\)](#), and [GiNaC::tryfactsubs\(\)](#).

**6.48.3.32 match()** [2/2]

```
bool GiNaC::ex::match (
 const ex & pattern,
 exmap & repls) const [inline]
```

References [bp](#), and [ex\(\)](#).

**6.48.3.33 subs()** [1/3]

```
ex GiNaC::ex::subs (
 const exmap & m,
 unsigned options = 0) const [inline]
```

References [bp](#), and [ex\(\)](#).

Referenced by [GiNaC::adaptivesimpson\(\)](#), [GiNaC::mul::algebraic\\_subs\\_mul\(\)](#), [GiNaC::atan\\_series\(\)](#), [GiNaC::atanh\\_series\(\)](#), [GiNaC::beta\\_series\(\)](#), [GiNaC::canonicalize\\_clifford\(\)](#), [GiNaC::clifford\\_to\\_lst\(\)](#), [GiNaC::collect\\_common\\_factors\(\)](#), [GiNaC::csgn\\_series\(\)](#), [denom\(\)](#), [GiNaC::dirac\\_trace\(\)](#), [GiNaC::divide\\_in\\_z\(\)](#), [GiNaC::EllipticE\\_series\(\)](#), [GiNaC::EllipticK\\_series\(\)](#), [GiNaC::eta\\_series\(\)](#), [GiNaC::tensdelta::eval\\_indexed\(\)](#), [GiNaC::integral::eval\\_integ\(\)](#), [GiNaC::integral::evalf\(\)](#), [GiNaC::expand\\_dummy\\_sum\(\)](#), [GiNaC::fsolve\(\)](#), [GiNaC::gcd\(\)](#), [GiNaC::get\\_clifford\\_comp\(\)](#), [GiNaC::H\\_evalf\(\)](#), [GiNaC::heur\\_gcd\\_z\(\)](#), [GiNaC::modular\\_form\\_kernel::is\\_numeric\(\)](#), [GiNaC::lgamma\\_series\(\)](#), [GiNaC::Li2\\_series\(\)](#), [GiNaC::Li\\_series\(\)](#), [GiNaC::log\\_series\(\)](#), [GiNaC::basic::normal\(\)](#), [normal\(\)](#), [GiNaC::power::normal\(\)](#), [numer\(\)](#), [numer\\_denom\(\)](#), [GiNaC::psi1\\_series\(\)](#), [GiNaC::psi2\\_series\(\)](#), [GiNaC::rename\\_dummy\\_indices\(\)](#), [GiNaC::rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::tensor::replace\\_contr\\_index\(\)](#), [GiNaC::replace\\_with\\_symbol\(\)](#), [GiNaC::replace\\_with\\_symbol\(\)](#), [GiNaC::indexed::reposition\\_dummy\\_indices\(\)](#), [GiNaC::S\\_series\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::step\\_series\(\)](#), [GiNaC::basic::subs\(\)](#), [GiNaC::clifford::subs\(\)](#), [GiNaC::pseries::subs\(\)](#), [GiNaC::subs\(\)](#), [GiNaC::subs\(\)](#), [GiNaC::subs\(\)](#), [GiNaC::expairseq::subschildren\(\)](#), [GiNaC::subsvalue\(\)](#), [GiNaC::symm\(\)](#), [GiNaC::symmetrize\\_cyclic\(\)](#), [GiNaC::tan\\_series\(\)](#), [GiNaC::tanh\\_series\(\)](#), and [GiNaC::tgamma\\_series\(\)](#).

**6.48.3.34 subs()** [2/3]

```
ex GiNaC::ex::subs (
 const lst & ls,
 const lst & lr,
 unsigned options = 0) const
```

Substitute objects in an expression (syntactic substitution) and return the result as a new expression.

References [GiNaC::container< C >::begin\(\)](#), [bp](#), [GiNaC::container< C >::end\(\)](#), [ex\(\)](#), [GINAC\\_ASSERT](#), [is\\_exactly\\_a](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::subs\\_options::pattern\\_is\\_not\\_product](#), and [GiNaC::subs\\_options::pattern\\_is\\_p](#).

**6.48.3.35 subs()** [3/3]

```
ex GiNaC::ex::subs (
 const ex & e,
 unsigned options = 0) const
```

Substitute objects in an expression (syntactic substitution) and return the result as a new expression.

There are two valid types of replacement arguments: 1) a relational like `object==ex` and 2) a list of relationals `lst{object1==ex1,object2==ex2,...}`.

References [bp](#), [ex\(\)](#), [ex\\_to](#), [GINAC\\_ASSERT](#), [info\(\)](#), [is\\_a](#), [is\\_exactly\\_a](#), [GiNaC::info\\_flags::list](#), [op\(\)](#), [GiNaC::subs\\_options::pattern\\_is\\_not\\_product](#), [GiNaC::subs\\_options::pattern\\_is\\_product](#), and [GiNaC::info\\_flags::relation\\_equal](#).

**6.48.3.36 map() [1/2]**

```
ex GiNaC::ex::map (
 map_function & f) const [inline]
```

References [bp](#), and [ex\(\)](#).

Referenced by [GiNaC::canonicalize\\_clifford\(\)](#), [GiNaC::clifford\\_prime\(\)](#), [GiNaC::clifford\\_star\\_bar\(\)](#), [GiNaC::color\\_trace\(\)](#), [GiNaC::dirac\\_trace\(\)](#), [GiNaC::expand\\_dummy\\_sum\(\)](#), [GiNaC::get\\_clifford\\_comp\(\)](#), and [GiNaC::remove\\_dirac\\_ONE\(\)](#).

**6.48.3.37 map() [2/2]**

```
ex GiNaC::ex::map (
 ex(* f) (const ex &e)) const
```

References [ex\(\)](#).

**6.48.3.38 accept()**

```
void GiNaC::ex::accept (
 visitor & v) const [inline]
```

References [bp](#).

Referenced by [traverse\\_postorder\(\)](#), and [traverse\\_preorder\(\)](#).

**6.48.3.39 traverse\_preorder()**

```
void GiNaC::ex::traverse_preorder (
 visitor & v) const
```

Traverse expression tree with given visitor, preorder traversal.

References [accept\(\)](#), [nops\(\)](#), [op\(\)](#), and [traverse\\_preorder\(\)](#).

Referenced by [traverse\(\)](#), and [traverse\\_preorder\(\)](#).

**6.48.3.40 traverse\_postorder()**

```
void GiNaC::ex::traverse_postorder (
 visitor & v) const
```

Traverse expression tree with given visitor, postorder traversal.

References [accept\(\)](#), [nops\(\)](#), [op\(\)](#), and [traverse\\_postorder\(\)](#).

Referenced by [traverse\\_postorder\(\)](#).

**6.48.3.41 traverse()**

```
void GiNaC::ex::traverse (
 visitor & v) const [inline]
```

References [traverse\\_preorder\(\)](#).

**6.48.3.42 is\_polynomial()**

```
bool GiNaC::ex::is_polynomial (
 const ex & vars) const
```

Check whether expression is a polynomial.

References [bp](#), [ex\(\)](#), [ex\\_to](#), and [is\\_a](#).

Referenced by [GiNaC::is\\_polynomial\(\)](#).

**6.48.3.43 degree()**

```
int GiNaC::ex::degree (
 const ex & s) const [inline]
```

References [bp](#), and [ex\(\)](#).

Referenced by [GiNaC::basic::collect\(\)](#), [content\(\)](#), [GiNaC::degree\(\)](#), [GiNaC::integral::degree\(\)](#), [GiNaC::mul::degree\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide\\_in\\_z\(\)](#), [GiNaC::get\\_symbol\\_stats\(\)](#), [GiNaC::heur\\_gcd\\_z\(\)](#), [lcoeff\(\)](#), [GiNaC::prem\(\)](#), [GiNaC::quo\(\)](#), [GiNaC::rem\(\)](#), [GiNaC::resultant\(\)](#), [GiNaC::sprem\(\)](#), and [GiNaC::sr\\_gcd\(\)](#).

**6.48.3.44 ldegree()**

```
int GiNaC::ex::ldegree (
 const ex & s) const [inline]
```

References [bp](#), and [ex\(\)](#).

Referenced by [content\(\)](#), [GiNaC::gcd\\_pf\\_pow\(\)](#), [GiNaC::get\\_symbol\\_stats\(\)](#), [GiNaC::ldegree\(\)](#), [GiNaC::mul::ldegree\(\)](#), [GiNaC::Order\\_series\(\)](#), [GiNaC::resultant\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::power::series\(\)](#), and [tcoeff\(\)](#).

**6.48.3.45 coeff()**

```
ex GiNaC::ex::coeff (
 const ex & s,
 int n = 1) const [inline]
```

References [bp](#), and [ex\(\)](#).

Referenced by [GiNaC::Bernoulli\\_polynomial\(\)](#), [GiNaC::add::coeff\(\)](#), [GiNaC::coeff\(\)](#), [GiNaC::mul::coeff\(\)](#), [GiNaC::ncmul::coeff\(\)](#), [GiNaC::pseries::coeff\(\)](#), [GiNaC::basic::collect\(\)](#), [content\(\)](#), [GiNaC::pseries::derivative\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide\\_in\\_z\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::pseries::eval\\_integ\(\)](#), [GiNaC::pseries::evalm\(\)](#), [GiNaC::pseries::expand\(\)](#), [GiNaC::expairseq::expandchildren\(\)](#), [GiNaC::generalised\\_Bernoulli\\_number\(\)](#), [GiNaC::add::imag\\_part\(\)](#), [lcoeff\(\)](#), [GiNaC::lsolve\(\)](#), [GiNaC::expairseq::make\\_flat\(\)](#), [GiNaC::pseries::normal\(\)](#), [GiNaC::prem\(\)](#), [GiNaC::quo\(\)](#), [GiNaC::add::real\\_part\(\)](#), [GiNaC::rem\(\)](#), [GiNaC::resultant\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::integration\\_kernel::series\\_coeff\(\)](#), [GiNaC::sprem\(\)](#), [GiNaC::sqrfree\\_parfrac\(\)](#), [GiNaC::expairseq::subschildren\(\)](#), and [tcoeff\(\)](#).

**6.48.3.46 lcoeff()**

```
ex GiNaC::ex::lcoeff (
 const ex & s) const [inline]
```

References [coeff\(\)](#), [degree\(\)](#), and [ex\(\)](#).

Referenced by [content\(\)](#), [GiNaC::get\\_symbol\\_stats\(\)](#), [GiNaC::sr\\_gcd\(\)](#), and [unit\(\)](#).

**6.48.3.47 tcoeff()**

```
ex GiNaC::ex::tcoeff (
 const ex & s) const [inline]
```

References [coeff\(\)](#), [ex\(\)](#), and [ldegree\(\)](#).

**6.48.3.48 expand()**

```
ex GiNaC::ex::expand (
 unsigned options = 0) const
```

Expand an expression.

Parameters

|                |                                           |
|----------------|-------------------------------------------|
| <i>options</i> | see <a href="#">GiNaC::expand_options</a> |
|----------------|-------------------------------------------|

References [bp](#), [ex\(\)](#), and [GiNaC::status\\_flags::expanded](#).

Referenced by [GiNaC::abs\\_expand\(\)](#), [GiNaC::binomial\\_sym\(\)](#), [GiNaC::clifford\\_star\\_bar\(\)](#), [GiNaC::color\\_trace\(\)](#), [content\(\)](#), [GiNaC::matrix::determinant\\_minor\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide\\_in\\_z\(\)](#), [GiNaC::exp\\_expand\(\)](#), [GiNaC::expand\(\)](#), [GiNaC::indexed::expand\(\)](#), [GiNaC::integral::expand\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::expand\\_dummy\\_sum\(\)](#), [GiNaC::mul::expandchildren\(\)](#), [GiNaC::ncmul::expandchildren\(\)](#), [GiNaC::mul::find\\_real\\_imag\(\)](#), [GiNaC::frac\\_cancel\(\)](#), [GiNaC::gcd\(\)](#), [GiNaC::get\\_clifford\\_comp\(\)](#), [GiNaC::heur\\_gcd\\_z\(\)](#), [GiNaC::log\\_expand\(\)](#), [GiNaC::lsolve\(\)](#), [GiNaC::expand\\_map\\_function::operator\(\)](#), [GiNaC::prem\(\)](#), [GiNaC::quo\(\)](#), [GiNaC::rem\(\)](#), [GiNaC::resultant\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::indexed::simplify\\_indexed](#), [GiNaC::sprem\(\)](#), [GiNaC::sqfree\\_parfrac\(\)](#), [GiNaC::sr\\_gcd\(\)](#), [GiNaC::matrix::trace\(\)](#), [unit\(\)](#), and [unitcontprim\(\)](#).

**6.48.3.49 collect()**

```
ex GiNaC::ex::collect (
 const ex & s,
 bool distributed = false) const [inline]
```

References [bp](#), and [ex\(\)](#).

Referenced by [GiNaC::matrix::charpoly\(\)](#), [GiNaC::basic::collect\(\)](#), and [GiNaC::collect\(\)](#).

**6.48.3.50 diff()**

```
ex GiNaC::ex::diff (
 const symbol & s,
 unsigned nth = 1) const
```

Compute partial derivative of an expression.



## Parameters

|            |                                           |
|------------|-------------------------------------------|
| <i>s</i>   | symbol by which the expression is derived |
| <i>nth</i> | order of derivative (default 1)           |

## Returns

partial derivative as a new expression

References [bp](#), and [ex\(\)](#).

Referenced by [GiNaC::abs\\_expl\\_derivative\(\)](#), [GiNaC::conjugate\\_expl\\_derivative\(\)](#), [GiNaC::basic::diff\(\)](#), [GiNaC::diff\(\)](#), [GiNaC::fsolve\(\)](#), [GiNaC::imag\\_part\\_expl\\_derivative\(\)](#), [GiNaC::log\\_series\(\)](#), [GiNaC::Order\\_expl\\_derivative\(\)](#), [GiNaC::real\\_part\\_expl\\_derivative\(\)](#), [GiNaC::basic::series\(\)](#), and [GiNaC::sqrfree\\_yun\(\)](#).

**6.48.3.51 series()**

```
ex GiNaC::ex::series (
 const ex & r,
 int order,
 unsigned options = 0) const
```

Compute the truncated series expansion of an expression.

This function returns an expression containing an object of class `pseries` to represent the series. If the series does not terminate within the given truncation order, the last term of the series will be an order term.

## Parameters

|                |                                                            |
|----------------|------------------------------------------------------------|
| <i>r</i>       | expansion relation, lhs holds variable and rhs holds point |
| <i>order</i>   | truncation order of series calculations                    |
| <i>options</i> | of class <a href="#">series_options</a>                    |

## Returns

an expression holding a `pseries` object

References [GiNaC::\\_ex0](#), [bp](#), [ex\(\)](#), [ex\\_to](#), and [is\\_a](#).

Referenced by [GiNaC::Bernoulli\\_polynomial\(\)](#), [GiNaC::EllipticE\\_series\(\)](#), [GiNaC::EllipticK\\_series\(\)](#), [GiNaC::generalised\\_Bernoulli\\_nu](#), [GiNaC::Eisenstein\\_h\\_kernel::Laurent\\_series\(\)](#), [GiNaC::Eisenstein\\_kernel::Laurent\\_series\(\)](#), [GiNaC::integration\\_kernel::Laurent\\_seri](#), [GiNaC::modular\\_form\\_kernel::Laurent\\_series\(\)](#), [GiNaC::Li2\\_series\(\)](#), [GiNaC::Li\\_series\(\)](#), [GiNaC::log\\_series\(\)](#), [GiNaC::Eisenstein\\_h\\_kernel::q\\_expansion\\_modular\\_form\(\)](#), [GiNaC::S\\_series\(\)](#), [GiNaC::Eisenstein\\_h\\_kernel::series\(\)](#), [GiNaC::Eisenstein\\_kernel::series\(\)](#), [GiNaC::integral::series\(\)](#), [GiNaC::modular\\_form\\_kernel::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::pseries::series\(\)](#), [GiNaC::series\(\)](#), and [GiNaC::tgamma\\_series\(\)](#).

### 6.48.3.52 `normal()`

```
ex GiNaC::ex::normal () const
```

Normalization of rational functions.

This function converts an expression to its normal form "numerator/denominator", where numerator and denominator are (relatively prime) polynomials. Any subexpressions which are not rational functions (like non-rational numbers, non-integer powers or functions like `sin()`, `cos()` etc.) are replaced by temporary symbols which are re-substituted by the (normalized) subexpressions before `normal()` returns (this way, any expression can be treated as a rational function). `normal()` is applied recursively to arguments of functions etc.

#### Returns

normalized expression

References `bp`, `ex()`, `GINAC_ASSERT`, `is_a`, `GiNaC::subs_options::no_pattern`, `GiNaC::container< C >::nops()`, `GiNaC::container< C >::op()`, `op()`, and `subs()`.

Referenced by `GiNaC::matrix::determinant()`, `GiNaC::matrix::gauss_elimination()`, `GiNaC::add::normal()`, `GiNaC::mul::normal()`, `GiNaC::normal()`, and `GiNaC::matrix::trace()`.

### 6.48.3.53 `to_rational()`

```
ex GiNaC::ex::to_rational (
 exmap & repl) const
```

Rationalization of non-rational functions.

This function converts a general expression to a rational function by replacing all non-rational subexpressions (like non-rational numbers, non-integer powers or functions like `sin()`, `cos()` etc.) to temporary symbols. This makes it possible to use functions like `gcd()` and `divide()` on non-rational functions by applying `to_rational()` on the arguments, calling the desired function and re-substituting the temporary symbols in the result. To make the last step possible, all temporary symbols and their associated expressions are collected in the map specified by the `repl` parameter, ready to be passed as an argument to `ex::subs()`.

#### Parameters

|             |                                                       |
|-------------|-------------------------------------------------------|
| <i>repl</i> | collects all temporary symbols and their replacements |
|-------------|-------------------------------------------------------|

#### Returns

rationalized expression

References `bp`, and `ex()`.

Referenced by `GiNaC::canonicalize_clifford()`, and `GiNaC::to_rational()`.

### 6.48.3.54 `to_polynomial()`

```
ex GiNaC::ex::to_polynomial (
 exmap & repl) const
```

References `bp`, and `ex()`.

Referenced by `GiNaC::find_common_factor()`, `GiNaC::power::to_polynomial()`, and `GiNaC::to_polynomial()`.

### 6.48.3.55 `numer()`

```
ex GiNaC::ex::numer () const
```

Get numerator of an expression.

If the expression is not of the normal form "numerator/denominator", it is first converted to this form and then the numerator is returned.

See also

[ex::normal](#)

Returns

numerator

References [bp](#), [ex\(\)](#), [GINAC\\_ASSERT](#), [is\\_a](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [op\(\)](#), and [subs\(\)](#).

Referenced by [GiNaC::numer\(\)](#).

### 6.48.3.56 `denom()`

```
ex GiNaC::ex::denom () const
```

Get denominator of an expression.

If the expression is not of the normal form "numerator/denominator", it is first converted to this form and then the denominator is returned.

See also

[ex::normal](#)

Returns

denominator

References [bp](#), [ex\(\)](#), [GINAC\\_ASSERT](#), [is\\_a](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [op\(\)](#), and [subs\(\)](#).

Referenced by [GiNaC::denom\(\)](#).

### 6.48.3.57 numer\_denom()

```
ex GiNaC::ex::numer_denom () const
```

Get numerator and denominator of an expression.

If the expression is not of the normal form "numerator/denominator", it is first converted to this form and then a list [numerator, denominator] is returned.

See also

[ex::normal](#)

Returns

a list [numerator, denominator]

References [bp](#), [ex\(\)](#), [GINAC\\_ASSERT](#), [is\\_a](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), and [subs\(\)](#).

Referenced by [GiNaC::numer\\_denom\(\)](#).

### 6.48.3.58 unit()

```
ex GiNaC::ex::unit (
 const ex & x) const
```

Compute unit part (= sign of leading coefficient) of a multivariate polynomial in  $\mathbb{Q}[x]$ .

The product of unit part, content part, and primitive part is the polynomial itself.

Parameters

|     |               |
|-----|---------------|
| $x$ | main variable |
|-----|---------------|

Returns

unit part

See also

[ex::content](#), [ex::primpart](#), [ex::unitcontprim](#)

References [GiNaC::\\_ex1](#), [GiNaC::\\_ex\\_1](#), [ex\(\)](#), [expand\(\)](#), [GiNaC::get\\_first\\_symbol\(\)](#), [info\(\)](#), [is\\_exactly\\_a](#), [lcoeff\(\)](#), [GiNaC::info\\_flags::negative](#), and [unit\(\)](#).

Referenced by [GiNaC::frac\\_cancel\(\)](#), [primpart\(\)](#), [unit\(\)](#), and [unitcontprim\(\)](#).

### 6.48.3.59 content()

```
ex GiNaC::ex::content (
 const ex & x) const
```

Compute content part (= unit normal GCD of all coefficients) of a multivariate polynomial in  $\mathbb{Q}[x]$ .

The product of unit part, content part, and primitive part is the polynomial itself.

## Parameters

|                |               |
|----------------|---------------|
| <code>x</code> | main variable |
|----------------|---------------|

## Returns

content part

## See also

[ex::unit](#), [ex::primpart](#), [ex::unitcontprim](#)

References [GiNaC::\\_ex0](#), [coeff\(\)](#), [degree\(\)](#), [ex\(\)](#), [expand\(\)](#), [GiNaC::gcd\(\)](#), [info\(\)](#), [GiNaC::info\\_flags::integer](#), [integer\\_content\(\)](#), [is\\_exactly\\_a](#), [is\\_zero\(\)](#), [lcoeff\(\)](#), [ldegree\(\)](#), and [GiNaC::info\\_flags::negative](#).

Referenced by [GiNaC::sr\\_gcd\(\)](#), and [unitcontprim\(\)](#).

**6.48.3.60 integer\_content()**

```
numeric GiNaC::ex::integer_content () const
```

Compute the integer content (= GCD of all numeric coefficients) of an expanded polynomial.

For a polynomial with rational coefficients, this returns g/l where g is the GCD of the coefficients' numerators and l is the LCM of the coefficients' denominators.

## Returns

integer content

References [bp](#).

Referenced by [content\(\)](#), [GiNaC::gcd\(\)](#), and [GiNaC::heur\\_gcd\\_z\(\)](#).

**6.48.3.61 primpart() [1/2]**

```
ex GiNaC::ex::primpart (
 const ex & x) const
```

Compute primitive part of a multivariate polynomial in  $\mathbb{Q}[x]$ .

The result will be a unit-normal polynomial with a content part of 1. The product of unit part, content part, and primitive part is the polynomial itself.

## Parameters

|                |               |
|----------------|---------------|
| <code>x</code> | main variable |
|----------------|---------------|

## Returns

primitive part

## See also

[ex::unit](#), [ex::content](#), [ex::unitcontprim](#)

References [ex\(\)](#), and [unitcontprim\(\)](#).

Referenced by [GiNaC::sr\\_gcd\(\)](#).

**6.48.3.62 primpart()** [2/2]

```
ex GiNaC::ex::primpart (
 const ex & x,
 const ex & c) const
```

Compute primitive part of a multivariate polynomial in  $\mathbb{Q}[x]$  when the content part is already known.

This function is faster in computing the primitive part than the previous function.

**Parameters**

|          |                                  |
|----------|----------------------------------|
| <i>x</i> | main variable                    |
| <i>c</i> | previously computed content part |

**Returns**

primitive part

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [ex\(\)](#), [is\\_exactly\\_a](#), [is\\_zero\(\)](#), [GiNaC::quo\(\)](#), and [unit\(\)](#).

**6.48.3.63 unitcontprim()**

```
void GiNaC::ex::unitcontprim (
 const ex & x,
 ex & u,
 ex & c,
 ex & p) const
```

Compute unit part, content part, and primitive part of a multivariate polynomial in  $\mathbb{Q}[x]$ .

The product of the three parts is the polynomial itself.

**Parameters**

|          |                           |
|----------|---------------------------|
| <i>x</i> | main variable             |
| <i>u</i> | unit part (returned)      |
| <i>c</i> | content part (returned)   |
| <i>p</i> | primitive part (returned) |

**See also**

[ex::unit](#), [ex::content](#), [ex::primpart](#)

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [GiNaC::\\_ex\\_1](#), [GiNaC::abs\(\)](#), [content\(\)](#), [ex\(\)](#), [ex\\_to](#), [expand\(\)](#), [info\(\)](#), [is\\_exactly\\_a](#), [is\\_zero\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::quo\(\)](#), and [unit\(\)](#).

Referenced by [GiNaC::gcd\(\)](#), and [primpart\(\)](#).

**6.48.3.64 smod()**

```
ex GiNaC::ex::smod (
 const numeric & xi) const [inline]
```

References [bp](#), and [ex\(\)](#).

Referenced by [GiNaC::interpolate\(\)](#).

**6.48.3.65 max\_coefficient()**

```
numeric GiNaC::ex::max_coefficient () const
```

Return maximum (absolute value) coefficient of a polynomial.

This function is used internally by [heur\\_gcd\(\)](#).

**Returns**

maximum coefficient

**See also**

[heur\\_gcd](#)

References [bp](#).

Referenced by [GiNaC::heur\\_gcd\\_z\(\)](#).

**6.48.3.66 get\_free\_indices()**

```
exvector GiNaC::ex::get_free_indices () const [inline]
```

References [bp](#).

Referenced by [antisymmetrize\(\)](#), [GiNaC::clifford\\_unit\(\)](#), [GiNaC::get\\_all\\_dummy\\_indices\\_safely\(\)](#), [GiNaC::add::get\\_free\\_indices\(\)](#), [GiNaC::mul::get\\_free\\_indices\(\)](#), [GiNaC::ncmul::get\\_free\\_indices\(\)](#), [GiNaC::make\\_flat\\_inserter::handle\\_factor\(\)](#), [GiNaC::clifford::same\\_metric\(\)](#), [symmetrize\(\)](#), and [symmetrize\\_cyclic\(\)](#).

**6.48.3.67 simplify\_indexed() [1/2]**

```
ex GiNaC::ex::simplify_indexed (
 unsigned options = 0) const
```

Simplify/canonicalize expression containing indexed objects.

This performs contraction of dummy indices where possible and checks whether the free indices in sums are consistent.

## Parameters

|                |                                           |
|----------------|-------------------------------------------|
| <i>options</i> | Simplification options (currently unused) |
|----------------|-------------------------------------------|

## Returns

simplified expression

References [ex\(\)](#), and [GiNaC::simplify\\_indexed\(\)](#).

Referenced by [GiNaC::canonicalize\\_clifford\(\)](#), [GiNaC::tensepsilon::contract\\_with\(\)](#), [GiNaC::simplify\\_indexed\(\)](#), and [GiNaC::simplify\\_indexed\(\)](#).

**6.48.3.68 simplify\_indexed()** [2/2]

```
ex GiNaC::ex::simplify_indexed (
 const scalar_products & sp,
 unsigned options = 0) const
```

Simplify/canonicalize expression containing indexed objects.

This performs contraction of dummy indices where possible, checks whether the free indices in sums are consistent, and automatically replaces scalar products by known values if desired.

## Parameters

|                |                                              |
|----------------|----------------------------------------------|
| <i>sp</i>      | Scalar products to be replaced automatically |
| <i>options</i> | Simplification options (currently unused)    |

## Returns

simplified expression

References [ex\(\)](#), and [GiNaC::simplify\\_indexed\(\)](#).

**6.48.3.69 compare()**

```
int GiNaC::ex::compare (
 const ex & other) const [inline]
```

References [bp](#), [ex\(\)](#), and [share\(\)](#).

Referenced by [GiNaC::expairseq::construct\\_from\\_2\\_ex\(\)](#), [GiNaC::error\\_and\\_integral\\_is\\_less::operator\(\)\(\)](#), [GiNaC::ex\\_is\\_less::operator\(\)\(\)](#), [GiNaC::expair\\_rest\\_is\\_less::operator\(\)\(\)](#), [GiNaC::symminfo\\_is\\_less\\_by\\_orig::operator\(\)\(\)](#), [GiNaC::symminfo\\_is\\_less\\_by\\_symmterm::operator\(\)\(\)](#), [GiNaC::terminfo\\_is\\_less::operator\(\)\(\)](#), and [GiNaC::spmapkey::spmapkey\(\)](#).



### 6.48.3.70 is\_equal()

```
bool GiNaC::ex::is_equal (
 const ex & other) const [inline]
```

References [bp](#), [ex\(\)](#), and [share\(\)](#).

Referenced by [GiNaC::abs\\_power\(\)](#), [GiNaC::acos\\_eval\(\)](#), [GiNaC::acosh\\_eval\(\)](#), [GiNaC::matrix::add\\_indexed\(\)](#), [GiNaC::asin\\_eval\(\)](#), [GiNaC::atan2\\_eval\(\)](#), [GiNaC::atan\\_eval\(\)](#), [GiNaC::atan\\_series\(\)](#), [GiNaC::atanh\\_eval\(\)](#), [GiNaC::atanh\\_series\(\)](#), [GiNaC::beta\\_eval\(\)](#), [GiNaC::add::combine\\_ex\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::mul::combine\\_ex\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::mul::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::mul::conjugate\(\)](#), [GiNaC::diracgamma::contract\\_with\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide\\_in\\_z\(\)](#), [GiNaC::epsilon\\_tensor\(\)](#), [GiNaC::epsilon\\_tensor\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::matrix::eval\\_indexed\(\)](#), [GiNaC::tensdelta::eval\\_indexed\(\)](#), [GiNaC::tensmetric::eval\\_indexed\(\)](#), [GiNaC::clifford::eval\\_ncmul\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::power::expand\\_add\\_2\(\)](#), [GiNaC::find\\_common\\_factor\(\)](#), [GiNaC::frac\\_cancel\(\)](#), [GiNaC::gcd\(\)](#), [GiNaC::gcd\\_pf\\_pow\(\)](#), [GiNaC::gcd\\_pf\\_pow\\_pow\(\)](#), [is\\_zero\(\)](#), [GiNaC::Li2\\_eval\(\)](#), [GiNaC::Li2\\_series\(\)](#), [GiNaC::Li\\_eval\(\)](#), [GiNaC::log\\_eval\(\)](#), [GiNaC::lorentz\\_eps\(\)](#), [GiNaC::expairseq::match\(\)](#), [GiNaC::minimal\\_dim\(\)](#), [GiNaC::pseries::mul\\_series\(\)](#), [GiNaC::power::normal\(\)](#), [GiNaC::ex\\_is\\_equal::operator\(\)](#), [GiNaC::idx\\_is\\_equal\\_ignore\\_dim::operator\(\)](#), [GiNaC::op0\\_is\\_equal::operator\(\)](#), [GiNaC::product\\_to\\_exvector\(\)](#), [GiNaC::psi2\\_eval\(\)](#), [GiNaC::quo\(\)](#), [GiNaC::mul::recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::rem\(\)](#), [GiNaC::replace\\_with\\_symbol\(\)](#), [GiNaC::clifford::same\\_metric\(\)](#), [GiNaC::indexed::simplify\\_indexed\(\)](#), [GiNaC::add::split\\_ex\\_to\\_pair\(\)](#), and [GiNaC::sqrfree\\_yun\(\)](#).

### 6.48.3.71 is\_zero()

```
bool GiNaC::ex::is_zero () const [inline]
```

References [GiNaC::\\_ex0](#), [ex\(\)](#), and [is\\_equal\(\)](#).

Referenced by [GiNaC::acos\\_conjugate\(\)](#), [GiNaC::acos\\_eval\(\)](#), [GiNaC::acosh\\_conjugate\(\)](#), [GiNaC::acosh\\_eval\(\)](#), [GiNaC::pseries::add\\_series\(\)](#), [GiNaC::asin\\_conjugate\(\)](#), [GiNaC::asin\\_eval\(\)](#), [GiNaC::asinh\\_eval\(\)](#), [GiNaC::atan2\\_eval\(\)](#), [GiNaC::atan\\_eval\(\)](#), [GiNaC::atanh\\_conjugate\(\)](#), [GiNaC::atanh\\_eval\(\)](#), [GiNaC::clifford\\_inverse\(\)](#), [GiNaC::clifford\\_to\\_lst\(\)](#), [GiNaC::add::coeff\(\)](#), [GiNaC::mul::coeff\(\)](#), [GiNaC::ncmul::coeff\(\)](#), [content\(\)](#), [GiNaC::cosh\\_eval\(\)](#), [GiNaC::fderivative::derivative\(\)](#), [GiNaC::function::derivative\(\)](#), [GiNaC::pseries::derivative\(\)](#), [GiNaC::matrix::determinant\(\)](#), [GiNaC::matrix::determinant\\_minor\(\)](#), [GiNaC::basic::diff\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide\\_in\\_z\(\)](#), [GiNaC::function::eval\(\)](#), [GiNaC::indexed::eval\(\)](#), [GiNaC::pseries::evalm\(\)](#), [GiNaC::exp\\_eval\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::pseries::expand\(\)](#), [GiNaC::power::expand\\_add\(\)](#), [GiNaC::power::expand\\_add\\_2\(\)](#), [GiNaC::find\\_common\\_factor\(\)](#), [GiNaC::mul::find\\_real\\_imag\(\)](#), [GiNaC::frac\\_cancel\(\)](#), [GiNaC::gcd\(\)](#), [GiNaC::get\\_clifford\\_comp\(\)](#), [GiNaC::heur\\_gcd\\_z\(\)](#), [GiNaC::add::imag\\_part\(\)](#), [GiNaC::interpolate\(\)](#), [GiNaC::is\\_zero\(\)](#), [is\\_zero\\_matrix\(\)](#), [GiNaC::lgamma\\_conjugate\(\)](#), [GiNaC::Li2\\_conjugate\(\)](#), [GiNaC::Li2\\_eval\(\)](#), [GiNaC::Li2\\_series\(\)](#), [GiNaC::Li3\\_eval\(\)](#), [GiNaC::Li\\_series\(\)](#), [GiNaC::log\\_conjugate\(\)](#), [GiNaC::log\\_eval\(\)](#), [GiNaC::log\\_series\(\)](#), [GiNaC::matrix::markowitz\\_elimination\(\)](#), [GiNaC::pseries::mul\\_series\(\)](#), [GiNaC::pseries::normal\(\)](#), [GiNaC::relational::operator safe\\_bool\(\)](#), [GiNaC::Order\\_eval\(\)](#), [GiNaC::prem\(\)](#), [primpart\(\)](#), [GiNaC::psi2\\_eval\(\)](#), [GiNaC::quo\(\)](#), [GiNaC::add::real\\_part\(\)](#), [GiNaC::rem\(\)](#), [GiNaC::S\\_eval\(\)](#), [GiNaC::S\\_series\(\)](#), [GiNaC::clifford::same\\_metric\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::symbol::series\(\)](#), [GiNaC::indexed::simplify\\_indexed\(\)](#), [GiNaC::indexed::simplify\\_indexed\\_product\(\)](#), [GiNaC::sinh\\_eval\(\)](#), [GiNaC::sprem\(\)](#), [GiNaC::sqrfree\\_yun\(\)](#), [GiNaC::sr\\_gcd\(\)](#), [GiNaC::tanh\\_eval\(\)](#), [unitcontprim\(\)](#), and [GiNaC::zetaderiv\\_eval\(\)](#).

### 6.48.3.72 is\_zero\_matrix()

```
bool GiNaC::ex::is_zero_matrix () const
```

Check whether expression is zero or zero matrix.

References [evalm\(\)](#), [ex\(\)](#), [ex\\_to](#), [is\\_a](#), and [is\\_zero\(\)](#).

#### 6.48.3.73 `symmetrize()` [1/2]

```
ex GiNaC::ex::symmetrize () const
```

Symmetrize expression over its free indices.

References [ex\(\)](#), [get\\_free\\_indices\(\)](#), and [GiNaC::symmetrize\(\)](#).

Referenced by [GiNaC::symmetrize\(\)](#), and [GiNaC::symmetrize\(\)](#).

#### 6.48.3.74 `symmetrize()` [2/2]

```
ex GiNaC::ex::symmetrize (
 const lst & l) const
```

Symmetrize expression over a list of objects (symbols, indices).

References [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), [ex\(\)](#), and [GiNaC::symm\(\)](#).

#### 6.48.3.75 `antisymmetrize()` [1/2]

```
ex GiNaC::ex::antisymmetrize () const
```

Antisymmetrize expression over its free indices.

References [GiNaC::antisymmetrize\(\)](#), [ex\(\)](#), and [get\\_free\\_indices\(\)](#).

Referenced by [GiNaC::antisymmetrize\(\)](#), and [GiNaC::antisymmetrize\(\)](#).

#### 6.48.3.76 `antisymmetrize()` [2/2]

```
ex GiNaC::ex::antisymmetrize (
 const lst & l) const
```

Antisymmetrize expression over a list of objects (symbols, indices).

References [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), [ex\(\)](#), and [GiNaC::symm\(\)](#).

#### 6.48.3.77 `symmetrize_cyclic()` [1/2]

```
ex GiNaC::ex::symmetrize_cyclic () const
```

Symmetrize expression by cyclic permutation over its free indices.

References [ex\(\)](#), [get\\_free\\_indices\(\)](#), and [GiNaC::symmetrize\\_cyclic\(\)](#).

Referenced by [GiNaC::symmetrize\\_cyclic\(\)](#), and [GiNaC::symmetrize\\_cyclic\(\)](#).

**6.48.3.78 symmetrize\_cyclic()** [2/2]

```
ex GiNaC::ex::symmetrize_cyclic (
 const lst & l) const
```

Symmetrize expression by cyclic permutation over a list of objects (symbols, indices).

References [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), [ex\(\)](#), and [GiNaC::symmetrize\\_cyclic\(\)](#).

**6.48.3.79 return\_type()**

```
unsigned GiNaC::ex::return_type () const [inline]
```

References [bp](#).

Referenced by [GiNaC::ncmul::append\\_factors\(\)](#), [GiNaC::ncmul::count\\_factors\(\)](#), [GiNaC::exmul\(\)](#), [GiNaC::matrix::mul\\_scalar\(\)](#), and [GiNaC::indexed::return\\_type\(\)](#).

**6.48.3.80 return\_type\_tinfo()**

```
return_type_t GiNaC::ex::return_type_tinfo () const [inline]
```

References [bp](#).

Referenced by [GiNaC::color\\_trace\(\)](#), [GiNaC::dirac\\_trace\(\)](#), and [GiNaC::indexed::return\\_type\\_tinfo\(\)](#).

**6.48.3.81 gethash()**

```
unsigned GiNaC::ex::gethash () const [inline]
```

References [bp](#).

Referenced by [GiNaC::function::calchash\(\)](#).

**6.48.3.82 construct\_from\_basic()**

```
ptr< basic > GiNaC::ex::construct_from_basic (
 const basic & other) [static], [private]
```

Helper function for the ex-from-basic constructor.

This is where [GiNaC](#)'s automatic evaluator and memory management are implemented.

See also

[ex::ex\(const basic &\)](#)

References [bp](#), [GiNaC::basic::duplicate\(\)](#), [GiNaC::status\\_flags::dynallocated](#), [GiNaC::basic::eval\(\)](#), [GiNaC::status\\_flags::evaluated](#), [ex\(\)](#), [GiNaC::basic::flags](#), [GiNaC::refcounted::get\\_refcount\(\)](#), and [GINAC\\_ASSERT](#).

Referenced by [ex\(\)](#).

**6.48.3.83 construct\_from\_int()**

```
basic & GiNaC::ex::construct_from_int (
 int i) [static], [private]
```

References [GiNaC::\\_num0\\_p](#), [GiNaC::\\_num10\\_p](#), [GiNaC::\\_num11\\_p](#), [GiNaC::\\_num12\\_p](#), [GiNaC::\\_num1\\_p](#), [GiNaC::\\_num2\\_p](#), [GiNaC::\\_num3\\_p](#), [GiNaC::\\_num4\\_p](#), [GiNaC::\\_num5\\_p](#), [GiNaC::\\_num6\\_p](#), [GiNaC::\\_num7\\_p](#), [GiNaC::\\_num8\\_p](#), [GiNaC::\\_num9\\_p](#), [GiNaC::\\_num\\_10\\_p](#), [GiNaC::\\_num\\_11\\_p](#), [GiNaC::\\_num\\_12\\_p](#), [GiNaC::\\_num\\_1\\_p](#), [GiNaC::\\_num\\_2\\_p](#), [GiNaC::\\_num\\_3\\_p](#), [GiNaC::\\_num\\_4\\_p](#), [GiNaC::\\_num\\_5\\_p](#), [GiNaC::\\_num\\_6\\_p](#), [GiNaC::\\_num\\_7\\_p](#), [GiNaC::\\_num\\_8\\_p](#), [GiNaC::\\_num\\_9\\_p](#), and [GiNaC::dynallocate\(\)](#).

Referenced by [construct\\_from\\_longlong\(\)](#), and [ex\(\)](#).

**6.48.3.84 construct\_from\_uint()**

```
basic & GiNaC::ex::construct_from_uint (
 unsigned int i) [static], [private]
```

References [GiNaC::\\_num0\\_p](#), [GiNaC::\\_num10\\_p](#), [GiNaC::\\_num11\\_p](#), [GiNaC::\\_num12\\_p](#), [GiNaC::\\_num1\\_p](#), [GiNaC::\\_num2\\_p](#), [GiNaC::\\_num3\\_p](#), [GiNaC::\\_num4\\_p](#), [GiNaC::\\_num5\\_p](#), [GiNaC::\\_num6\\_p](#), [GiNaC::\\_num7\\_p](#), [GiNaC::\\_num8\\_p](#), [GiNaC::\\_num9\\_p](#), and [GiNaC::dynallocate\(\)](#).

Referenced by [construct\\_from\\_ulonglong\(\)](#), and [ex\(\)](#).

**6.48.3.85 construct\_from\_long()**

```
basic & GiNaC::ex::construct_from_long (
 long i) [static], [private]
```

References [GiNaC::\\_num0\\_p](#), [GiNaC::\\_num10\\_p](#), [GiNaC::\\_num11\\_p](#), [GiNaC::\\_num12\\_p](#), [GiNaC::\\_num1\\_p](#), [GiNaC::\\_num2\\_p](#), [GiNaC::\\_num3\\_p](#), [GiNaC::\\_num4\\_p](#), [GiNaC::\\_num5\\_p](#), [GiNaC::\\_num6\\_p](#), [GiNaC::\\_num7\\_p](#), [GiNaC::\\_num8\\_p](#), [GiNaC::\\_num9\\_p](#), [GiNaC::\\_num\\_10\\_p](#), [GiNaC::\\_num\\_11\\_p](#), [GiNaC::\\_num\\_12\\_p](#), [GiNaC::\\_num\\_1\\_p](#), [GiNaC::\\_num\\_2\\_p](#), [GiNaC::\\_num\\_3\\_p](#), [GiNaC::\\_num\\_4\\_p](#), [GiNaC::\\_num\\_5\\_p](#), [GiNaC::\\_num\\_6\\_p](#), [GiNaC::\\_num\\_7\\_p](#), [GiNaC::\\_num\\_8\\_p](#), [GiNaC::\\_num\\_9\\_p](#), and [GiNaC::dynallocate\(\)](#).

Referenced by [ex\(\)](#).

**6.48.3.86 construct\_from\_ulong()**

```
basic & GiNaC::ex::construct_from_ulong (
 unsigned long i) [static], [private]
```

References [GiNaC::\\_num0\\_p](#), [GiNaC::\\_num10\\_p](#), [GiNaC::\\_num11\\_p](#), [GiNaC::\\_num12\\_p](#), [GiNaC::\\_num1\\_p](#), [GiNaC::\\_num2\\_p](#), [GiNaC::\\_num3\\_p](#), [GiNaC::\\_num4\\_p](#), [GiNaC::\\_num5\\_p](#), [GiNaC::\\_num6\\_p](#), [GiNaC::\\_num7\\_p](#), [GiNaC::\\_num8\\_p](#), [GiNaC::\\_num9\\_p](#), and [GiNaC::dynallocate\(\)](#).

Referenced by [ex\(\)](#).

### 6.48.3.87 `construct_from_longlong()`

```
basic & GiNaC::ex::construct_from_longlong (
 long long i) [static], [private]
```

References [construct\\_from\\_int\(\)](#), and [GiNaC::dynallocate\(\)](#).

Referenced by [ex\(\)](#).

### 6.48.3.88 `construct_from_ulonglong()`

```
basic & GiNaC::ex::construct_from_ulonglong (
 unsigned long long i) [static], [private]
```

References [construct\\_from\\_uint\(\)](#), and [GiNaC::dynallocate\(\)](#).

Referenced by [ex\(\)](#).

### 6.48.3.89 `construct_from_double()`

```
basic & GiNaC::ex::construct_from_double (
 double d) [static], [private]
```

References [GiNaC::dynallocate\(\)](#).

Referenced by [ex\(\)](#).

### 6.48.3.90 `construct_from_string_and_lst()`

```
static ptr< basic > GiNaC::ex::construct_from_string_and_lst (
 const std::string & s,
 const ex & l) [static], [private]
```

References [ex\(\)](#).

Referenced by [ex\(\)](#).

### 6.48.3.91 `makewriteable()`

```
void GiNaC::ex::makewriteable () [private]
```

Make this ex writable (if more than one ex handle the same basic) by unlinking the object and creating an unshared copy of it.

References [bp](#), [GiNaC::status\\_flags::dynallocated](#), and [GINAC\\_ASSERT](#).

Referenced by [let\\_op\(\)](#), [operator\[\]\(\)](#), and [operator\[\]\(\)](#).

### 6.48.3.92 `share()`

```
void GiNaC::ex::share (
 const ex & other) const [private]
```

Share equal objects between expressions.

See also

`ex::compare(const ex &)`

References [bp](#), [ex\(\)](#), and [GiNaC::status\\_flags::not\\_shareable](#).

Referenced by [compare\(\)](#), and [is\\_equal\(\)](#).

## 6.48.4 Friends And Related Symbol Documentation

### 6.48.4.1 `archive_node`

```
friend class archive_node [friend]
```

References [archive\\_node](#), and [ex\(\)](#).

Referenced by [archive\\_node](#).

### 6.48.4.2 `are_ex_trivially_equal`

```
bool are_ex_trivially_equal (
 const ex & e1,
 const ex & e2) [friend]
```

Compare two objects of class quickly without doing a deep tree traversal.

Returns

"true" if they are equal "false" if equality cannot be established quickly (e1 and e2 may still be equal, in this case).

References [bp](#), and [ex\(\)](#).

### 6.48.4.3 `ex_to`

```
template<class T>
const T & ex_to (
 const ex & e) [friend]
```

Return a reference to the basic-derived class T object embedded in an expression.

This is fast but unsafe: the result is undefined if the expression does not contain a T object at its top level. Hence, you should generally check the type of e first. Also, you shouldn't cache the returned reference because [GiNaC](#)'s garbage collector may destroy the referenced object any time it's used in another expression.

## Parameters

|          |            |
|----------|------------|
| <i>e</i> | expression |
|----------|------------|

## Returns

reference to object of class T

## See also

[is\\_exactly\\_a<class T>\(\)](#)

References [bp](#), [ex\(\)](#), [GINAC\\_ASSERT](#), and [is\\_a](#).

Referenced by [is\\_polynomial\(\)](#), [is\\_zero\\_matrix\(\)](#), [series\(\)](#), [subs\(\)](#), and [unitcontprim\(\)](#).

## 6.48.4.4 is\_a

```
template<class T>
bool is_a (
 const ex & obj) [friend]
```

Check if *ex* is a handle to a T, including base classes.

References [bp](#), [ex\(\)](#), and [GiNaC::is\\_a\(\)](#).

Referenced by [denom\(\)](#), [ex\\_to](#), [is\\_polynomial\(\)](#), [is\\_zero\\_matrix\(\)](#), [lhs\(\)](#), [normal\(\)](#), [numer\(\)](#), [numer\\_denom\(\)](#), [rhs\(\)](#), [series\(\)](#), and [subs\(\)](#).

## 6.48.4.5 is\_exactly\_a

```
template<class T>
bool is_exactly_a (
 const ex & obj) [friend]
```

Check if *ex* is a handle to a T, not including base classes.

References [bp](#), [ex\(\)](#), and [GiNaC::is\\_exactly\\_a\(\)](#).

Referenced by [content\(\)](#), [primpart\(\)](#), [subs\(\)](#), [subs\(\)](#), [unit\(\)](#), and [unitcontprim\(\)](#).





## Public Member Functions

- `bool operator()` (const `ex` &lh, const `ex` &rh) const

## 6.50.1 Member Function Documentation

### 6.50.1.1 operator()

```
bool GiNaC::ex_is_equal::operator() (
 const ex & lh,
 const ex & rh) const [inline]
```

References [GiNaC::ex::is\\_equal\(\)](#).

The documentation for this struct was generated from the following file:

- [ex.h](#)

## 6.51 GiNaC::ex\_is\_less Struct Reference

```
#include <ex.h>
```

## Public Member Functions

- `bool operator()` (const `ex` &lh, const `ex` &rh) const

## 6.51.1 Member Function Documentation

### 6.51.1.1 operator()

```
bool GiNaC::ex_is_less::operator() (
 const ex & lh,
 const ex & rh) const [inline]
```

References [GiNaC::ex::compare\(\)](#).

The documentation for this struct was generated from the following file:

- [ex.h](#)

## 6.52 GiNaC::ex\_swap Struct Reference

```
#include <ex.h>
```

## Public Member Functions

- void [operator\(\)](#) ([ex](#) &lh, [ex](#) &rh) const

## 6.52.1 Member Function Documentation

### 6.52.1.1 [operator\(\)](#)()

```
void GiNaC::ex_swap::operator() (
 ex & lh,
 ex & rh) const [inline]
```

References [GiNaC::ex::swap\(\)](#).

The documentation for this struct was generated from the following file:

- [ex.h](#)

## 6.53 GiNaC::expair Class Reference

A pair of expressions.

```
#include <expair.h>
```

Collaboration diagram for GiNaC::expair:



## Public Member Functions

- [expair](#) ()
- [expair](#) (const [ex](#) &r, const [ex](#) &c)  
*Construct an expair from two ex.*
- bool [is\\_equal](#) (const [expair](#) &other) const  
*Member-wise check for canonical ordering equality.*
- bool [is\\_less](#) (const [expair](#) &other) const  
*Member-wise check for canonical ordering lessness.*
- int [compare](#) (const [expair](#) &other) const  
*Member-wise check for canonical ordering.*
- void [print](#) (std::ostream &os) const
- bool [is\\_canonical\\_numeric](#) () const  
*True if this is of the form (numeric,ex(1)).*
- void [swap](#) ([expair](#) &other)  
*Swap contents with other expair.*
- const [expair](#) [conjugate](#) () const

## Public Attributes

- [ex](#) [rest](#)  
*first member of pair, an arbitrary expression*
- [ex](#) [coeff](#)  
*second member of pair, must be numeric*

### 6.53.1 Detailed Description

A pair of expressions.

This is similar to STL's `pair<>`. It is slightly extended since we need to account for methods like `.compare()`. Also, since this is meant for use by class `expairseq` it must satisfy the invariance that the member `coeff` must be of type `numeric`.

### 6.53.2 Constructor & Destructor Documentation

#### 6.53.2.1 `expair()` [1/2]

```
GiNaC::expair::expair () [inline]
```

References [coeff](#), and [rest](#).

Referenced by [compare\(\)](#), [conjugate\(\)](#), [is\\_equal\(\)](#), [is\\_less\(\)](#), and [swap\(\)](#).

#### 6.53.2.2 `expair()` [2/2]

```
GiNaC::expair::expair (
 const ex & r,
 const ex & c) [inline]
```

Construct an expair from two ex.

References [coeff](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [rest](#).

### 6.53.3 Member Function Documentation

#### 6.53.3.1 `is_equal()`

```
bool GiNaC::expair::is_equal (
 const expair & other) const [inline]
```

Member-wise check for canonical ordering equality.

References [coeff](#), [expair\(\)](#), and [rest](#).

Referenced by [GiNaC::conjugateepvector\(\)](#), [GiNaC::expairseq::evalchildren\(\)](#), [GiNaC::mul::expair\\_needs\\_further\\_processing\(\)](#), and [GiNaC::expairseq::subschildren\(\)](#).

#### 6.53.3.2 `is_less()`

```
bool GiNaC::expair::is_less (
 const expair & other) const [inline]
```

Member-wise check for canonical ordering lessness.

References [coeff](#), [expair\(\)](#), and [rest](#).

Referenced by [GiNaC::expair\\_is\\_less::operator\(\)\(\)](#).

#### 6.53.3.3 `compare()`

```
int GiNaC::expair::compare (
 const expair & other) const [inline]
```

Member-wise check for canonical ordering.

References [coeff](#), [expair\(\)](#), and [rest](#).

#### 6.53.3.4 `print()`

```
void GiNaC::expair::print (
 std::ostream & os) const
```

References [coeff](#), [GiNaC::print\\_tree::delta\\_indent](#), and [rest](#).

#### 6.53.3.5 `is_canonical_numeric()`

```
bool GiNaC::expair::is_canonical_numeric () const [inline]
```

True if this is of the form (numeric,ex(1)).

References [coeff](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [rest](#).

### 6.53.3.6 swap()

```
void GiNaC::expair::swap (
 expair & other) [inline]
```

Swap contents with other expair.

References [coeff](#), [expair\(\)](#), and [rest](#).

Referenced by [GiNaC::mul::derivative\(\)](#), [GiNaC::expair\\_swap::operator\(\)](#), and [GiNaC::swap\(\)](#).

### 6.53.3.7 conjugate()

```
const expair GiNaC::expair::conjugate () const
```

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [coeff](#), [expair\(\)](#), and [rest](#).

Referenced by [GiNaC::conjugateepvector\(\)](#).

## 6.53.4 Member Data Documentation

### 6.53.4.1 rest

```
ex GiNaC::expair::rest
```

first member of pair, an arbitrary expression

Referenced by [GiNaC::add::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::expairseq::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::mul::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [compare\(\)](#), [conjugate\(\)](#), [GiNaC::expairseq::construct\\_from\\_2\\_ex\(\)](#), [GiNaC::expairseq::construct\\_from\\_expairseq\\_ex\(\)](#), [expair\(\)](#), [expair\(\)](#), [is\\_canonical\\_numeric\(\)](#), [is\\_equal\(\)](#), [is\\_less\(\)](#), [GiNaC::expair\\_rest\\_is\\_less::operator\(\)](#), [print\(\)](#), [GiNaC::expairseq::printpair\(\)](#), [GiNaC::add::recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::expairseq::recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::mul::recombine\\_pair\\_to\\_ex\(\)](#), and [swap\(\)](#).

### 6.53.4.2 coeff

```
ex GiNaC::expair::coeff
```

second member of pair, must be numeric

Referenced by [GiNaC::mul::can\\_make\\_flat\(\)](#), [GiNaC::add::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::expairseq::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::mul::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [compare\(\)](#), [conjugate\(\)](#), [GiNaC::expairseq::construct\\_from\\_2\\_ex\(\)](#), [GiNaC::expairseq::construct\\_from\\_expairseq\\_ex\(\)](#), [expair\(\)](#), [expair\(\)](#), [GiNaC::power::expand\\_mul\(\)](#), [is\\_canonical\\_numeric\(\)](#), [is\\_equal\(\)](#), [is\\_less\(\)](#), [print\(\)](#), [GiNaC::expairseq::printpair\(\)](#), [GiNaC::add::recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::expairseq::recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::mul::recombine\\_pair\\_to\\_ex\(\)](#), and [swap\(\)](#).

The documentation for this class was generated from the following files:

- [expair.h](#)
- [expair.cpp](#)

## 6.54 GiNaC::expair\_is\_less Struct Reference

Function object for insertion into third argument of STL's sort() etc.

```
#include <expair.h>
```

### Public Member Functions

- bool [operator\(\)](#) (const [expair](#) &lh, const [expair](#) &rh) const

### 6.54.1 Detailed Description

Function object for insertion into third argument of STL's sort() etc.

### 6.54.2 Member Function Documentation

#### 6.54.2.1 operator()

```
bool GiNaC::expair_is_less::operator() (
 const expair & lh,
 const expair & rh) const [inline]
```

References [GiNaC::expair::is\\_less\(\)](#).

The documentation for this struct was generated from the following file:

- [expair.h](#)

## 6.55 GiNaC::expair\_rest\_is\_less Struct Reference

Function object not caring about the numerical coefficients for insertion into third argument of STL's sort().

```
#include <expair.h>
```

### Public Member Functions

- bool [operator\(\)](#) (const [expair](#) &lh, const [expair](#) &rh) const

### 6.55.1 Detailed Description

Function object not caring about the numerical coefficients for insertion into third argument of STL's sort().

Note that this does not define a strict weak ordering since for any symbol  $x$  we have neither  $3*x < 2*x$  or  $2*x < 3*x$ . Handle with care!

## 6.55.2 Member Function Documentation

### 6.55.2.1 operator()()

```
bool GiNaC::expair_rest_is_less::operator() (
 const expair & lh,
 const expair & rh) const [inline]
```

References [GiNaC::ex::compare\(\)](#), and [GiNaC::expair::rest](#).

The documentation for this struct was generated from the following file:

- [expair.h](#)

## 6.56 GiNaC::expair\_swap Struct Reference

```
#include <expair.h>
```

### Public Member Functions

- void [operator\(\)](#) ([expair](#) &lh, [expair](#) &rh) const

## 6.56.1 Member Function Documentation

### 6.56.1.1 operator()()

```
void GiNaC::expair_swap::operator() (
 expair & lh,
 expair & rh) const [inline]
```

References [GiNaC::expair::swap\(\)](#).

The documentation for this struct was generated from the following file:

- [expair.h](#)

## 6.57 GiNaC::expairseq Class Reference

A sequence of class `expair`.

```
#include <expairseq.h>
```

Inheritance diagram for `GiNaC::expairseq`:





Collaboration diagram for GiNaC::expairseq:



## Public Member Functions

- `expairseq` (const `ex` &lh, const `ex` &rh)
- `expairseq` (const `exvector` &v)
- `expairseq` (const `epvector` &v, const `ex` &oc, bool do\_index\_renaming=false)
- `expairseq` (`epvector` &&vp, const `ex` &oc, bool do\_index\_renaming=false)
- unsigned `precedence` () const override  
Return relative operator precedence (for parenthezing output).
- bool `info` (unsigned inf) const override  
Information about the object.
- size\_t `nops` () const override  
Number of operands/members.
- `ex op` (size\_t i) const override  
Return operand/member at position i.
- `ex map` (`map_function` &f) const override  
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- `ex eval` () const override  
Perform coefficient-wise automatic term rewriting rules in this class.
- `ex to_rational` (`exmap` &repl) const override  
Implementation of `ex::to_rational()` for `expairseqs`.

- `ex to_polynomial` (`exmap` &repl) const override  
*Implementation of `ex::to_polynomial()` for `expairseqs`.*
- bool `match` (const `ex` &pattern, `exmap` &repl\_lst) const override  
*Check whether the expression matches a given pattern.*
- `ex subs` (const `exmap` &m, unsigned options=0) const override  
*Substitute a set of objects by arbitrary expressions.*
- `ex conjugate` () const override
- void `archive` (`archive_node` &n) const override  
*Save (serialize) the object into archive node.*
- void `read_archive` (const `archive_node` &n, `lst` &syms) override  
*Load (deserialize) the object from an archive node.*

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex evalf` () const  
*Evaluate object numerically.*
- virtual `ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around `print` to be called within a debugger.*
- virtual void `dbgprinttree` () const  
*Little wrapper around `printtree` to be called within a debugger.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex & let_op` (size\_t i)  
*Return modifiable operand/member at position `i`.*
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const  
*Return degree of highest power in object `s`.*
- virtual int `ldegree` (const `ex` &s) const  
*Return degree of lowest power in object `s`.*

- virtual [ex coeff](#) (const [ex](#) &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual [ex collect](#) (const [ex](#) &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual [ex series](#) (const [relational](#) &r, int order, unsigned options=0) const  
*Default implementation of [ex::series\(\)](#).*
- virtual [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev\_lookup, [lst](#) &modifier) const  
*Default implementation of [ex::normal\(\)](#).*
- virtual [numeric integer\\_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual [numeric max\\_coefficient](#) () const  
*Implementation [ex::max\\_coefficient\(\)](#).*
- virtual [exvector get\\_free\\_indices](#) () const  
*Return a vector containing the free indices of an expression.*
- virtual [ex add\\_indexed](#) (const [ex](#) &self, const [ex](#) &other) const  
*Add two indexed expressions.*
- virtual [ex scalar\\_mul\\_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool [contract\\_with](#) ([exvector::iterator](#) self, [exvector::iterator](#) other, [exvector](#) &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- virtual [return\\_type\\_t](#) [return\\_type\\_tinfo](#) () const
- virtual [ex real\\_part](#) () const
- virtual [ex imag\\_part](#) () const
- template<class T>  
void [print\\_dispatch](#) (const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- void [print\\_dispatch](#) (const [registered\\_class\\_info](#) &ri, const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- [ex subs\\_one\\_level](#) (const [exmap](#) &m, unsigned options) const  
*Helper function for [subs\(\)](#).*
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const  
*Default interface of nth derivative [ex::diff\(s, n\)](#).*
- int [compare](#) (const [basic](#) &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool [is\\_equal](#) (const [basic](#) &other) const  
*Test for syntactic equality.*
- const [basic](#) & [hold](#) () const  
*Stop further evaluation.*
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const  
*Set some [status\\_flags](#).*
- const [basic](#) & [clearflag](#) (unsigned f) const  
*Clear some [status\\_flags](#).*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Member Functions

- bool `is_equal_same_type` (const `basic` &other) const override  
*Returns true if two objects of same type are equal.*
- unsigned `return_type` () const override
- unsigned `calchash` () const override  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- `ex expand` (unsigned options=0) const override  
*Expand expression, i.e.*
- virtual `ex thisexpairseq` (const `epvector` &v, const `ex` &oc, bool do\_index\_renaming=false) const  
*Create an object of this type.*
- virtual `ex thisexpairseq` (`epvector` &&vp, const `ex` &oc, bool do\_index\_renaming=false) const
- virtual void `printseq` (const `print_context` &c, char delim, unsigned this\_precedence, unsigned upper\_precedence) const
- virtual void `printpair` (const `print_context` &c, const `expair` &p, unsigned upper\_precedence) const
- virtual `expair split_ex_to_pair` (const `ex` &e) const  
*Form an expair from an ex, using the corresponding semantics.*
- virtual `expair combine_ex_with_coeff_to_pair` (const `ex` &e, const `ex` &c) const
- virtual `expair combine_pair_with_coeff_to_pair` (const `expair` &p, const `ex` &c) const
- virtual `ex recombine_pair_to_ex` (const `expair` &p) const  
*Form an ex out of an expair, using the corresponding semantics.*
- virtual bool `expair_needs_further_processing` (`epp` it)
- virtual `ex default_overall_coeff` () const
- virtual void `combine_overall_coeff` (const `ex` &c)
- virtual void `combine_overall_coeff` (const `ex` &c1, const `ex` &c2)
- virtual bool `can_make_flat` (const `expair` &p) const
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
- void `construct_from_2_ex` (const `ex` &lh, const `ex` &rh)
- void `construct_from_2_expairseq` (const `expairseq` &s1, const `expairseq` &s2)
- void `construct_from_expairseq_ex` (const `expairseq` &s, const `ex` &e)
- void `construct_from_exvector` (const `exvector` &v)
- void `construct_from_epvector` (const `epvector` &v, bool do\_index\_renaming=false)
- void `construct_from_epvector` (`epvector` &&v, bool do\_index\_renaming=false)
- void `make_flat` (const `exvector` &v)  
*Combine this expairseq with argument exvector.*
- void `make_flat` (const `epvector` &v, bool do\_index\_renaming=false)  
*Combine this expairseq with argument epvector.*
- void `canonicalize` ()  
*Brings this expairseq into a sorted (canonical) form.*
- void `combine_same_terms_sorted_seq` ()  
*Compact a presorted expairseq by combining all matching expairs to one each.*
- bool `is_canonical` () const  
*Check if this expairseq is in sorted (canonical) form.*
- `epvector expandchildren` (unsigned options) const  
*Member-wise expand the expairs in this sequence.*
- `epvector evalchildren` () const  
*Member-wise evaluate the expairs in this sequence.*
- `epvector subschildren` (const `exmap` &m, unsigned options=0) const  
*Member-wise substitute in this sequence.*

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual [ex derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Attributes

- [epvector seq](#)
- [ex overall\\_coeff](#)

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.57.1 Detailed Description

A sequence of class `expair`.

This is used for time-critical classes like sums and products of terms since handling a list of coeff and rest is much faster than handling a list of products or powers, respectively. (Not incidentally, Maple does it the same way, maybe others too.) The semantics is (at least) twofold: one for addition and one for multiplication and several methods have to be overridden by derived classes to reflect the change in semantics. However, most functionality turns out to be shared between addition and multiplication, which is the reason why there is this base class.

### 6.57.2 Constructor & Destructor Documentation

#### 6.57.2.1 `expairseq()` [1/4]

```
GiNaC::expairseq::expairseq (
 const ex & lh,
 const ex & rh)
```

References [construct\\_from\\_2\\_ex\(\)](#), [GiNaC::basic::ex](#), [GINAC\\_ASSERT](#), and [is\\_canonical\(\)](#).

Referenced by [construct\\_from\\_2\\_expairseq\(\)](#), [construct\\_from\\_expairseq\\_ex\(\)](#), [is\\_equal\\_same\\_type\(\)](#), [make\\_flat\(\)](#), [make\\_flat\(\)](#), [thisexpairseq\(\)](#), and [thisexpairseq\(\)](#).

### 6.57.2.2 `expairseq()` [2/4]

```
GiNaC::expairseq::expairseq (
 const exvector & v)
```

References [construct\\_from\\_exvector\(\)](#), [GINAC\\_ASSERT](#), and [is\\_canonical\(\)](#).

### 6.57.2.3 `expairseq()` [3/4]

```
GiNaC::expairseq::expairseq (
 const epvector & v,
 const ex & oc,
 bool do_index_renaming = false)
```

References [construct\\_from\\_epvector\(\)](#), [GiNaC::basic::ex](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [is\\_canonical\(\)](#), and [overall\\_coeff](#).

### 6.57.2.4 `expairseq()` [4/4]

```
GiNaC::expairseq::expairseq (
 epvector && vp,
 const ex & oc,
 bool do_index_renaming = false)
```

References [construct\\_from\\_epvector\(\)](#), [GiNaC::basic::ex](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [is\\_canonical\(\)](#), and [overall\\_coeff](#).

## 6.57.3 Member Function Documentation

### 6.57.3.1 `precedence()`

```
unsigned GiNaC::expairseq::precedence () const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::mul](#).

Referenced by [do\\_print\(\)](#), and [printpair\(\)](#).

### 6.57.3.2 `info()`

```
bool GiNaC::expairseq::info (
 unsigned inf) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::mul](#).

References [GiNaC::basic::clearflag\(\)](#), [GiNaC::info\\_flags::expanded](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::basic::flags](#), [GiNaC::info\\_flags::has\\_indices](#), [GiNaC::status\\_flags::has\\_indices](#), [GiNaC::status\\_flags::has\\_no\\_indices](#), [seq](#), and [GiNaC::basic::setflag\(\)](#).

### 6.57.3.3 nops()

```
size_t GiNaC::expairseq::nops () const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

References [default\\_overall\\_coeff\(\)](#), [overall\\_coeff](#), and [seq](#).

Referenced by [GiNaC::algebraic\\_match\\_mul\\_with\\_mul\(\)](#), [GiNaC::mul::algebraic\\_subs\\_mul\(\)](#), [GiNaC::add::conjugate\(\)](#), [GiNaC::add::do\\_print\\_python\\_repr\(\)](#), [GiNaC::mul::do\\_print\\_python\\_repr\(\)](#), [do\\_print\\_tree\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::power::expand\\_add\(\)](#), [GiNaC::power::expand\\_add\\_2\(\)](#), [GiNaC::add::get\\_free\\_indices\(\)](#), [GiNaC::mul::get\\_free\\_indices\(\)](#), [GiNaC::mul::has\(\)](#), [match\(\)](#), and [GiNaC::Order\\_eval\(\)](#).

### 6.57.3.4 op()

```
ex GiNaC::expairseq::op (
 size_t i) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [default\\_overall\\_coeff\(\)](#), [GiNaC::basic::ex](#), [GINAC\\_ASSERT](#), [overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), and [seq](#).

Referenced by [GiNaC::algebraic\\_match\\_mul\\_with\\_mul\(\)](#), [GiNaC::mul::algebraic\\_subs\\_mul\(\)](#), [GiNaC::add::conjugate\(\)](#), [GiNaC::add::do\\_print\\_python\\_repr\(\)](#), [GiNaC::mul::do\\_print\\_python\\_repr\(\)](#), [GiNaC::add::get\\_free\\_indices\(\)](#), [GiNaC::mul::get\\_free\\_indices\(\)](#), [match\(\)](#), [GiNaC::Order\\_eval\(\)](#), [GiNaC::add::series\(\)](#), and [GiNaC::mul::series\(\)](#).

### 6.57.3.5 map()

```
ex GiNaC::expairseq::map (
 map_function & f) const [override], [virtual]
```

Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).

Reimplemented from [GiNaC::basic](#).

References [default\\_overall\\_coeff\(\)](#), [GiNaC::basic::ex](#), [GiNaC::is\\_a\(\)](#), [overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), [seq](#), [split\\_ex\\_to\\_pair\(\)](#), and [thisexpairseq\(\)](#).

### 6.57.3.6 eval()

```
ex GiNaC::expairseq::eval () const [override], [virtual]
```

Perform coefficient-wise automatic term rewriting rules in this class.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::mul](#).

References [GiNaC::dynallocate\(\)](#), [evalchildren\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::basic::ex](#), [GiNaC::basic::flags](#), [GiNaC::basic::hold\(\)](#), and [overall\\_coeff](#).

### 6.57.3.7 to\_rational()

```
ex GiNaC::expairseq::to_rational (
 exmap & repl) const [override], [virtual]
```

Implementation of [ex::to\\_rational\(\)](#) for expairseqs.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [default\\_overall\\_coeff\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::numeric](#), [overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), [seq](#), [split\\_ex\\_to\\_pair\(\)](#), [thisexpairseq\(\)](#), and [to\\_rational\(\)](#).

Referenced by [to\\_rational\(\)](#).

### 6.57.3.8 to\_polynomial()

```
ex GiNaC::expairseq::to_polynomial (
 exmap & repl) const [override], [virtual]
```

Implementation of [ex::to\\_polynomial\(\)](#) for expairseqs.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [default\\_overall\\_coeff\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::numeric](#), [overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), [seq](#), [split\\_ex\\_to\\_pair\(\)](#), [thisexpairseq\(\)](#), and [to\\_polynomial\(\)](#).

Referenced by [to\\_polynomial\(\)](#).

### 6.57.3.9 match()

```
bool GiNaC::expairseq::match (
 const ex & pattern,
 exmap & repl_lst) const [override], [virtual]
```

Check whether the expression matches a given pattern.

For every wildcard object in the pattern, a pair with the wildcard as a key and matching expression as a value is added to `repl_lst`.

Reimplemented from [GiNaC::basic](#).

References [default\\_overall\\_coeff\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), [nops\(\)](#), [GiNaC::ex::op\(\)](#), [op\(\)](#), [split\\_ex\\_to\\_pair\(\)](#), and [thisexpairseq\(\)](#).

### 6.57.3.10 subs()

```
ex GiNaC::expairseq::subs (
 const exmap & m,
 unsigned options = 0) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The `ex` returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::subs\\_options::algebraic](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::subs\\_options::no\\_index](#), [overall\\_coeff](#), [GiNaC::basic::subs\\_one\\_level\(\)](#), [subschildren\(\)](#), and [thisexpairseq\(\)](#).



### 6.57.3.11 conjugate()

```
ex GiNaC::expairseq::conjugate () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::mul](#).

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [GiNaC::conjugateepvector\(\)](#), [GiNaC::basic::ex](#), [overall\\_coeff](#), [seq](#), and [thisexpairseq\(\)](#).

### 6.57.3.12 archive()

```
void GiNaC::expairseq::archive (
 archive_node & n) const [override], [virtual]
```

Save (serialize) the object into archive node.

Archive the object.

Losely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::add\\_ex\(\)](#), [overall\\_coeff](#), and [seq](#).

### 6.57.3.13 read\_archive()

```
void GiNaC::expairseq::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive\\_node](#).

#### Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::basic](#).

References [canonicalize\(\)](#), [GiNaC::basic::coeff\(\)](#), [GiNaC::basic::ex](#), [GiNaC::archive\\_node::find\\_ex\(\)](#), [GiNaC::archive\\_node::find\\_ex\\_b](#), [GiNaC::archive\\_node::find\\_property\\_range\(\)](#), [GINAC\\_ASSERT](#), [is\\_canonical\(\)](#), [overall\\_coeff](#), and [seq](#).

### 6.57.3.14 `is_equal_same_type()`

```
bool GiNaC::expairseq::is_equal_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare\\_same\\_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::basic\(\)](#), [expairseq\(\)](#), [overall\\_coeff](#), and [seq](#).

### 6.57.3.15 `return_type()`

```
unsigned GiNaC::expairseq::return_type () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::mul](#).

References [GiNaC::return\\_types::noncommutative\\_composite](#).

### 6.57.3.16 `calchash()`

```
unsigned GiNaC::expairseq::calchash () const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::basic::flags](#), [GiNaC::status\\_flags::hash\\_calculated](#), [GiNaC::basic::hashvalue](#), [GiNaC::make\\_hash\\_seed\(\)](#), [overall\\_coeff](#), [GiNaC::rotate\\_left\(\)](#), [seq](#), and [GiNaC::basic::setflag\(\)](#).

### 6.57.3.17 `expand()`

```
ex GiNaC::expairseq::expand (
 unsigned options = 0) const [override], [protected], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::mul](#).

References [GiNaC::basic::ex](#), [expandchildren\(\)](#), [GiNaC::status\\_flags::expanded](#), [overall\\_coeff](#), [GiNaC::basic::setflag\(\)](#), and [thisexpairseq\(\)](#).

**6.57.3.18 thisexpairseq()** [1/2]

```
ex GiNaC::expairseq::thisexpairseq (
 const epvector & v,
 const ex & oc,
 bool do_index_renaming = false) const [protected], [virtual]
```

Create an object of this type.

This method works similar to a constructor. It is useful because expairseq has (at least) two possible different semantics but we want to inherit methods thus avoiding code duplication. Sometimes a method in expairseq has to create a new one of the same semantics, which cannot be done by a ctor because the name (add, mul,...) is unknown on the expairseq level. In order for this trick to work a derived class must of course override this definition.

Reimplemented in [GiNaC::add](#), and [GiNaC::mul](#).

References [GiNaC::basic::ex](#), and [expairseq\(\)](#).

Referenced by [conjugate\(\)](#), [expand\(\)](#), [map\(\)](#), [match\(\)](#), [subs\(\)](#), [to\\_polynomial\(\)](#), and [to\\_rational\(\)](#).

**6.57.3.19 thisexpairseq()** [2/2]

```
ex GiNaC::expairseq::thisexpairseq (
 epvector && vp,
 const ex & oc,
 bool do_index_renaming = false) const [protected], [virtual]
```

Reimplemented in [GiNaC::add](#), and [GiNaC::mul](#).

References [GiNaC::basic::ex](#), and [expairseq\(\)](#).

**6.57.3.20 printseq()**

```
void GiNaC::expairseq::printseq (
 const print_context & c,
 char delim,
 unsigned this_precedence,
 unsigned upper_precedence) const [protected], [virtual]
```

References [default\\_overall\\_coeff\(\)](#), [overall\\_coeff](#), [printpair\(\)](#), [GiNaC::print\\_context::s](#), and [seq](#).

Referenced by [do\\_print\(\)](#).

**6.57.3.21 printpair()**

```
void GiNaC::expairseq::printpair (
 const print_context & c,
 const expair & p,
 unsigned upper_precedence) const [protected], [virtual]
```

References [GiNaC::expair::coeff](#), [precedence\(\)](#), [GiNaC::ex::print\(\)](#), [GiNaC::expair::rest](#), and [GiNaC::print\\_context::s](#).

Referenced by [is\\_canonical\(\)](#), and [printseq\(\)](#).

### 6.57.3.22 split\_ex\_to\_pair()

```
expair GiNaC::expairseq::split_ex_to_pair (
 const ex & e) const [protected], [virtual]
```

Form an expair from an ex, using the corresponding semantics.

See also

[expairseq::recombine\\_pair\\_to\\_ex\(\)](#)

Reimplemented in [GiNaC::add](#), and [GiNaC::mul](#).

References [GiNaC::\\_ex1](#), and [GiNaC::basic::ex](#).

Referenced by [construct\\_from\\_2\\_ex\(\)](#), [construct\\_from\\_expairseq\\_ex\(\)](#), [make\\_flat\(\)](#), [map\(\)](#), [match\(\)](#), [subschildren\(\)](#), [to\\_polynomial\(\)](#), and [to\\_rational\(\)](#).

### 6.57.3.23 combine\_ex\_with\_coeff\_to\_pair()

```
expair GiNaC::expairseq::combine_ex_with_coeff_to_pair (
 const ex & e,
 const ex & c) const [protected], [virtual]
```

Reimplemented in [GiNaC::add](#), and [GiNaC::mul](#).

References [GiNaC::basic::ex](#), [GINAC\\_ASSERT](#), and [GiNaC::is\\_exactly\\_a\(\)](#).

Referenced by [evalchildren\(\)](#), and [subschildren\(\)](#).

### 6.57.3.24 combine\_pair\_with\_coeff\_to\_pair()

```
expair GiNaC::expairseq::combine_pair_with_coeff_to_pair (
 const expair & p,
 const ex & c) const [protected], [virtual]
```

Reimplemented in [GiNaC::add](#), and [GiNaC::mul](#).

References [GiNaC::expair::coeff](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [GiNaC::expair::rest](#).

### 6.57.3.25 recombine\_pair\_to\_ex()

```
ex GiNaC::expairseq::recombine_pair_to_ex (
 const expair & p) const [protected], [virtual]
```

Form an ex out of an expair, using the corresponding semantics.

See also

[expairseq::split\\_ex\\_to\\_pair\(\)](#)

Reimplemented in [GiNaC::add](#), and [GiNaC::mul](#).

References [GiNaC::expair::coeff](#), [GiNaC::basic::ex](#), and [GiNaC::expair::rest](#).

Referenced by [map\(\)](#), [op\(\)](#), [subschildren\(\)](#), [to\\_polynomial\(\)](#), and [to\\_rational\(\)](#).

**6.57.3.26 expair\_needs\_further\_processing()**

```
bool GiNaC::expairseq::expair_needs_further_processing (
 expair it) [protected], [virtual]
```

Reimplemented in [GiNaC::mul](#).

References [GiNaC::\\_ex1](#), and [GiNaC::is\\_exactly\\_a\(\)](#).

Referenced by [combine\\_same\\_terms\\_sorted\\_seq\(\)](#), [construct\\_from\\_2\\_expairseq\(\)](#), and [construct\\_from\\_expairseq\\_ex\(\)](#).

**6.57.3.27 default\_overall\_coeff()**

```
ex GiNaC::expairseq::default_overall_coeff () const [protected], [virtual]
```

Reimplemented in [GiNaC::mul](#).

References [GiNaC::\\_ex0](#), and [GiNaC::basic::ex](#).

Referenced by [do\\_print\\_tree\(\)](#), [map\(\)](#), [match\(\)](#), [nops\(\)](#), [op\(\)](#), [printseq\(\)](#), [to\\_polynomial\(\)](#), and [to\\_rational\(\)](#).

**6.57.3.28 combine\_overall\_coeff() [1/2]**

```
void GiNaC::expairseq::combine_overall_coeff (
 const ex & c) [protected], [virtual]
```

Reimplemented in [GiNaC::mul](#).

References [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [overall\\_coeff](#).

Referenced by [construct\\_from\\_2\\_ex\(\)](#), [construct\\_from\\_2\\_expairseq\(\)](#), [construct\\_from\\_expairseq\\_ex\(\)](#), [make\\_flat\(\)](#), and [make\\_flat\(\)](#).

**6.57.3.29 combine\_overall\_coeff() [2/2]**

```
void GiNaC::expairseq::combine_overall_coeff (
 const ex & c1,
 const ex & c2) [protected], [virtual]
```

Reimplemented in [GiNaC::mul](#).

References [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [overall\\_coeff](#).

**6.57.3.30 can\_make\_flat()**

```
bool GiNaC::expairseq::can_make_flat (
 const expair & p) const [protected], [virtual]
```

Reimplemented in [GiNaC::mul](#).

**6.57.3.31 do\_print()**

```
void GiNaC::expairseq::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [precedence\(\)](#), [printseq\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.57.3.32 do\_print\_tree()**

```
void GiNaC::expairseq::do_print_tree (
 const print_tree & c,
 unsigned level) const [protected]
```

References [default\\_overall\\_coeff\(\)](#), [GiNaC::print\\_tree::delta\\_indent](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [nops\(\)](#), [overall\\_coeff](#), [GiNaC::print\\_context::s](#), and [seq](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.57.3.33 construct\_from\_2\_ex()**

```
void GiNaC::expairseq::construct_from_2_ex (
 const ex & lh,
 const ex & rh) [protected]
```

References [GiNaC::expair::coeff](#), [combine\\_overall\\_coeff\(\)](#), [GiNaC::ex::compare\(\)](#), [construct\\_from\\_2\\_expairseq\(\)](#), [construct\\_from\\_expairseq\\_ex\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::info\\_flags::has\\_indices](#), [GiNaC::ex::info\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::expair::rest](#), [seq](#), and [split\\_ex\\_to\\_pair\(\)](#).

Referenced by [GiNaC::add::add\(\)](#), [expairseq\(\)](#), and [GiNaC::mul::mul\(\)](#).

**6.57.3.34 construct\_from\_2\_expairseq()**

```
void GiNaC::expairseq::construct_from_2_expairseq (
 const expairseq & s1,
 const expairseq & s2) [protected]
```

References [combine\\_overall\\_coeff\(\)](#), [construct\\_from\\_epvector\(\)](#), [GiNaC::ex\\_to\(\)](#), [expair\\_needs\\_further\\_processing\(\)](#), [expairseq\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [overall\\_coeff](#), and [seq](#).

Referenced by [construct\\_from\\_2\\_ex\(\)](#).

**6.57.3.35 construct\_from\_expairseq\_ex()**

```
void GiNaC::expairseq::construct_from_expairseq_ex (
 const expairseq & s,
 const ex & e) [protected]
```

References [GiNaC::class\\_info< OPT >::first](#), [GiNaC::expair::coeff](#), [combine\\_overall\\_coeff\(\)](#), [construct\\_from\\_epvector\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [expair\\_needs\\_further\\_processing\(\)](#), [expairseq\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [overall\\_coeff](#), [GiNaC::expair::rest](#), [seq](#), and [split\\_ex\\_to\\_pair\(\)](#).

Referenced by [construct\\_from\\_2\\_ex\(\)](#).

**6.57.3.36 construct\_from\_exvector()**

```
void GiNaC::expairseq::construct_from_exvector (
 const exvector & v) [protected]
```

References [canonicalize\(\)](#), [combine\\_same\\_terms\\_sorted\\_seq\(\)](#), and [make\\_flat\(\)](#).

Referenced by [GiNaC::add::add\(\)](#), [expairseq\(\)](#), [GiNaC::mul::mul\(\)](#), and [GiNaC::mul::mul\(\)](#).

**6.57.3.37 construct\_from\_epvector() [1/2]**

```
void GiNaC::expairseq::construct_from_epvector (
 const epvector & v,
 bool do_index_renaming = false) [protected]
```

References [canonicalize\(\)](#), [combine\\_same\\_terms\\_sorted\\_seq\(\)](#), and [make\\_flat\(\)](#).

Referenced by [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [combine\\_same\\_terms\\_sorted\\_seq\(\)](#), [construct\\_from\\_2\\_expairseq\(\)](#), [construct\\_from\\_expairseq\\_ex\(\)](#), [expairseq\(\)](#), [expairseq\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::mul::mul\(\)](#), and [GiNaC::mul::mul\(\)](#).

**6.57.3.38 construct\_from\_epvector() [2/2]**

```
void GiNaC::expairseq::construct_from_epvector (
 epvector && v,
 bool do_index_renaming = false) [protected]
```

References [canonicalize\(\)](#), [combine\\_same\\_terms\\_sorted\\_seq\(\)](#), and [make\\_flat\(\)](#).

**6.57.3.39 make\_flat() [1/2]**

```
void GiNaC::expairseq::make_flat (
 const exvector & v) [protected]
```

Combine this expairseq with argument exvector.

It cares for associativity as well as for special handling of numerics.

References [GiNaC::\\_ex1](#), [combine\\_overall\\_coeff\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [expairseq\(\)](#), [GiNaC::make\\_flat\\_inserter::handle\\_factor\(\)](#), [GiNaC::info\\_flags::has\\_indices](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [overall\\_coeff](#), [seq](#), and [split\\_ex\\_to\\_pair\(\)](#).

Referenced by [construct\\_from\\_epvector\(\)](#), [construct\\_from\\_epvector\(\)](#), and [construct\\_from\\_exvector\(\)](#).

**6.57.3.40 make\_flat() [2/2]**

```
void GiNaC::expairseq::make_flat (
 const epvector & v,
 bool do_index_renaming = false) [protected]
```

Combine this expairseq with argument epvector.

It cares for associativity as well as for special handling of numerics.

References [GiNaC::\\_ex1](#), [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [GiNaC::ex::coeff\(\)](#), [combine\\_overall\\_coeff\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [expairseq\(\)](#), [GiNaC::make\\_flat\\_inserter::handle\\_factor\(\)](#), [GiNaC::info\\_flags::has\\_indices](#), [GiNaC::is\\_a\(\)](#), [overall\\_coeff](#), and [seq](#).

**6.57.3.41 canonicalize()**

```
void GiNaC::expairseq::canonicalize () [protected]
```

Brings this expairseq into a sorted (canonical) form.

References [seq](#).

Referenced by [construct\\_from\\_epvector\(\)](#), [construct\\_from\\_epvector\(\)](#), [construct\\_from\\_exvector\(\)](#), and [read\\_archive\(\)](#).

**6.57.3.42 combine\_same\_terms\_sorted\_seq()**

```
void GiNaC::expairseq::combine_same_terms_sorted_seq () [protected]
```

Compact a presorted expairseq by combining all matching expairs to one each.

On an add object, this is responsible for  $2*x+3*x+y \rightarrow 5*x+y$ , for instance.

References [construct\\_from\\_epvector\(\)](#), [GiNaC::ex\\_to\(\)](#), [expair\\_needs\\_further\\_processing\(\)](#), and [seq](#).

Referenced by [construct\\_from\\_epvector\(\)](#), [construct\\_from\\_epvector\(\)](#), and [construct\\_from\\_exvector\(\)](#).

**6.57.3.43 is\_canonical()**

```
bool GiNaC::expairseq::is_canonical () const [protected]
```

Check if this expairseq is in sorted (canonical) form.

Useful mainly for debugging or in assertions since being sorted is an invariance.

References [GiNaC::is\\_exactly\\_a\(\)](#), [printpair\(\)](#), and [seq](#).

Referenced by [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [expairseq\(\)](#), [expairseq\(\)](#), [expairseq\(\)](#), [expairseq\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::mul::mul\(\)](#), and [read\\_archive\(\)](#).

**6.57.3.44 expandchildren()**

```
epvector GiNaC::expairseq::expandchildren (
 unsigned options) const [protected]
```

Member-wise expand the expairs in this sequence.

See also

[expairseq::expand\(\)](#)

Returns

epvector containing expanded pairs, empty if no members had to be changed.

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::basic::ex](#), and [seq](#).

Referenced by [GiNaC::add::expand\(\)](#), and [expand\(\)](#).



### 6.57.3.45 evalchildren()

```
epvector GiNaC::expairseq::evalchildren () const [protected]
```

Member-wise evaluate the expairs in this sequence.

See also

[expairseq::eval\(\)](#)

Returns

epvector containing evaluated pairs, empty if no members had to be changed.

References [combine\\_ex\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::expair::is\\_equal\(\)](#), [seq](#), and [unlikely](#).

Referenced by [GiNaC::add::eval\(\)](#), [eval\(\)](#), and [GiNaC::mul::eval\(\)](#).

### 6.57.3.46 subschildren()

```
epvector GiNaC::expairseq::subschildren (
 const exmap & m,
 unsigned options = 0) const [protected]
```

Member-wise substitute in this sequence.

See also

[expairseq::subs\(\)](#)

Returns

epvector containing expanded pairs, empty if no members had to be changed.

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [GiNaC::ex::coeff\(\)](#), [combine\\_ex\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::basic::ex](#), [GiNaC::expair::is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::subs\\_options::pattern\\_is\\_not\\_product](#), [GiNaC::subs\\_options::pattern\\_is\\_pr](#), [recombine\\_pair\\_to\\_ex\(\)](#), [seq](#), [split\\_ex\\_to\\_pair\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [subs\(\)](#).

## 6.57.4 Member Data Documentation

### 6.57.4.1 seq

```
epvector GiNaC::expairseq::seq [protected]
```

Referenced by [archive\(\)](#), [calchash\(\)](#), [GiNaC::mul::can\\_be\\_further\\_expanded\(\)](#), [canonicalize\(\)](#), [GiNaC::add::coeff\(\)](#), [GiNaC::mul::coeff\(\)](#), [combine\\_same\\_terms\\_sorted\\_seq\(\)](#), [conjugate\(\)](#), [GiNaC::mul::conjugate\(\)](#), [construct\\_from\\_2\\_ex\(\)](#), [construct\\_from\\_2\\_expairseq\(\)](#), [construct\\_from\\_expairseq\\_ex\(\)](#), [GiNaC::add::degree\(\)](#), [GiNaC::mul::degree\(\)](#), [GiNaC::add::derivative\(\)](#), [GiNaC::mul::derivative\(\)](#), [GiNaC::mul::do\\_print\(\)](#), [GiNaC::add::do\\_print\\_csrc\(\)](#), [GiNaC::mul::do\\_print\\_csrc\(\)](#), [GiNaC::mul::do\\_print\\_latex\(\)](#), [do\\_print\\_tree\(\)](#), [GiNaC::add::eval\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::add::eval\\_ncmul\(\)](#), [GiNaC::mul::eval\\_ncmul\(\)](#), [evalchildren\(\)](#), [GiNaC::mul::evalf\(\)](#), [GiNaC::add::evalm\(\)](#), [GiNaC::mul::evalm\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::expand\\_add\(\)](#), [GiNaC::power::expand\\_add\\_2\(\)](#), [GiNaC::power::expand\\_mul\(\)](#), [expandchildren\(\)](#), [GiNaC::mul::expandchildren\(\)](#), [GiNaC::mul::find\\_real\\_imag\(\)](#), [GiNaC::add::imag\\_part\(\)](#), [GiNaC::add::info\(\)](#), [info\(\)](#), [GiNaC::mul::info\(\)](#), [GiNaC::add::integer\\_content\(\)](#), [GiNaC::mul::integer\\_content\(\)](#), [is\\_canonical\(\)](#), [is\\_equal\\_same\\_type\(\)](#), [GiNaC::add::is\\_polynomial\(\)](#), [GiNaC::mul::is\\_polynomial\(\)](#), [GiNaC::add::ldegree\(\)](#), [GiNaC::mul::ldegree\(\)](#), [make\\_flat\(\)](#), [make\\_flat\(\)](#), [map\(\)](#), [GiNaC::add::max\\_coefficient\(\)](#), [GiNaC::mul::max\\_coefficient\(\)](#), [nops\(\)](#), [GiNaC::add::normal\(\)](#), [GiNaC::mul::normal\(\)](#), [op\(\)](#), [GiNaC::add::print\\_add\(\)](#), [printseq\(\)](#), [read\\_archive\(\)](#), [GiNaC::add::real\\_part\(\)](#), [GiNaC::add::return\\_type\(\)](#), [GiNaC::mul::return\\_type\(\)](#), [GiNaC::add::return\\_type\\_tinfo\(\)](#), [GiNaC::mul::return\\_type\\_tinfo\(\)](#), [GiNaC::add::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::add::smod\(\)](#), [GiNaC::mul::smod\(\)](#), [subschildren\(\)](#), [to\\_polynomial\(\)](#), and [to\\_rational\(\)](#).

### 6.57.4.2 overall\_coeff

`ex GiNaC::expairseq::overall_coeff [protected]`

Referenced by [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [GiNaC::add::add\(\)](#), [archive\(\)](#), [calchash\(\)](#), [GiNaC::add::coeff\(\)](#), [GiNaC::mul::coeff\(\)](#), [GiNaC::add::combine\\_ex\\_with\\_coeff\\_to\\_pair\(\)](#), [combine\\_overall\\_coeff\(\)](#), [combine\\_overall\\_coeff\(\)](#), [GiNaC::mul::combine\\_overall\\_coeff\(\)](#), [GiNaC::mul::combine\\_overall\\_coeff\(\)](#), [conjugate\(\)](#), [GiNaC::mul::conjugate\(\)](#), [construct\\_from\\_2\\_expairseq\(\)](#), [construct\\_from\\_expairseq\\_ex\(\)](#), [GiNaC::add::degree\(\)](#), [GiNaC::mul::derivative\(\)](#), [GiNaC::add::do\\_print\\_csrc\(\)](#), [GiNaC::mul::do\\_print\\_csrc\(\)](#), [do\\_print\\_tree\(\)](#), [GiNaC::add::eval\(\)](#), [eval\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::mul::evalf\(\)](#), [GiNaC::add::evalm\(\)](#), [GiNaC::mul::evalm\(\)](#), [expairseq\(\)](#), [expairseq\(\)](#), [GiNaC::add::expand\(\)](#), [expand\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::expand\\_add\(\)](#), [GiNaC::power::expand\\_add\\_2\(\)](#), [GiNaC::power::expand\\_mul\(\)](#), [GiNaC::mul::find\\_real\\_imag\(\)](#), [GiNaC::add::imag\\_part\(\)](#), [GiNaC::add::info\(\)](#), [GiNaC::mul::info\(\)](#), [GiNaC::add::integer\\_content\(\)](#), [GiNaC::mul::integer\\_content\(\)](#), [is\\_equal\\_same\\_type\(\)](#), [GiNaC::add::ldegree\(\)](#), [make\\_flat\(\)](#), [make\\_flat\(\)](#), [map\(\)](#), [GiNaC::add::max\\_coefficient\(\)](#), [GiNaC::mul::max\\_coefficient\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::mul::mul\(\)](#), [nops\(\)](#), [GiNaC::add::normal\(\)](#), [GiNaC::mul::normal\(\)](#), [op\(\)](#), [GiNaC::add::print\\_add\(\)](#), [GiNaC::mul::print\\_overall\\_coeff\(\)](#), [printseq\(\)](#), [read\\_archive\(\)](#), [GiNaC::add::real\\_part\(\)](#), [GiNaC::add::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::add::smod\(\)](#), [GiNaC::mul::smod\(\)](#), [GiNaC::add::split\\_ex\\_to\\_pair\(\)](#), [subs\(\)](#), [to\\_polynomial\(\)](#), and [to\\_rational\(\)](#).

The documentation for this class was generated from the following files:

- [expairseq.h](#)
- [expairseq.cpp](#)
- [normal.cpp](#)

## 6.58 GiNaC::expand\_map\_function Struct Reference

Function object to be applied by [basic::expand\(\)](#).

Inheritance diagram for `GiNaC::expand_map_function`:



Collaboration diagram for GiNaC::expand\_map\_function:



### Public Member Functions

- [expand\\_map\\_function](#) (unsigned o)
- [ex operator\(\)](#) (const [ex](#) &e) override

### Public Member Functions inherited from [GiNaC::map\\_function](#)

- virtual [~map\\_function](#) ()

### Public Attributes

- unsigned [options](#)

### Additional Inherited Members

### Public Types inherited from [GiNaC::map\\_function](#)

- typedef const [ex](#) & [argument\\_type](#)
- typedef [ex](#) [result\\_type](#)

## 6.58.1 Detailed Description

Function object to be applied by [basic::expand\(\)](#).

## 6.58.2 Constructor & Destructor Documentation

### 6.58.2.1 [expand\\_map\\_function\(\)](#)

```
GiNaC::expand_map_function::expand_map_function (
 unsigned o) [inline]
```

References [options](#).

### 6.58.3 Member Function Documentation

#### 6.58.3.1 operator()

```
ex GiNaC::expand_map_function::operator() (
 const ex & e) [inline], [override], [virtual]
```

Implements [GiNaC::map\\_function](#).

References [GiNaC::ex::expand\(\)](#), and [options](#).

### 6.58.4 Member Data Documentation

#### 6.58.4.1 options

```
unsigned GiNaC::expand_map_function::options
```

Referenced by [expand\\_map\\_function\(\)](#), and [operator\(\)](#).

The documentation for this struct was generated from the following file:

- [basic.cpp](#)

## 6.59 GiNaC::expand\_options Class Reference

Flags to control the behavior of [expand\(\)](#).

```
#include <flags.h>
```

### Public Types

- enum { [expand\\_indexed](#) = 0x0001 , [expand\\_function\\_args](#) = 0x0002 , [expand\\_rename\\_idx](#) = 0x0004 , [expand\\_transcendental](#) = 0x0008 }

#### 6.59.1 Detailed Description

Flags to control the behavior of [expand\(\)](#).

### 6.59.2 Member Enumeration Documentation

#### 6.59.2.1 anonymous enum

```
anonymous enum
```

**Enumerator**

|                       |                                                   |
|-----------------------|---------------------------------------------------|
| expand_indexed        | expands (a+b).i to a.i+b.i                        |
| expand_function_args  | expands the arguments of functions                |
| expand_rename_idx     | used internally by <a href="#">mul::expand()</a>  |
| expand_transcendental | expands transcendental functions like log and exp |

The documentation for this class was generated from the following file:

- [flags.h](#)

## 6.60 GiNaC::factor\_options Class Reference

Flags to control the polynomial factorization.

```
#include <flags.h>
```

**Public Types**

- enum { [polynomial](#) = 0x0000 , [all](#) = 0x0001 }

### 6.60.1 Detailed Description

Flags to control the polynomial factorization.

### 6.60.2 Member Enumeration Documentation

#### 6.60.2.1 anonymous enum

```
anonymous enum
```

**Enumerator**

|            |                                              |
|------------|----------------------------------------------|
| polynomial | factor only expressions that are polynomials |
| all        | factor all polynomial subexpressions         |

The documentation for this class was generated from the following file:

- [flags.h](#)

## 6.61 GiNaC::fail Class Reference

```
#include <fail.h>
```

Inheritance diagram for GiNaC::fail:



Collaboration diagram for GiNaC::fail:



### Protected Member Functions

- unsigned [return\\_type](#) () const override
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual [ex derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Additional Inherited Members

## Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()  
*basic destructor, virtual because class [ex](#) will delete objects of derived classes via a [basic\\*](#).*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual [basic \\* duplicate](#) () const  
*Create a clone of this object on the heap.*
- virtual [ex eval](#) () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual [ex evalf](#) () const  
*Evaluate object numerically.*
- virtual [ex evalm](#) () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual [ex eval\\_integ](#) () const  
*Evaluate integrals, if result is known.*
- virtual [ex eval\\_indexed](#) (const [basic](#) &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void [print](#) (const [print\\_context](#) &c, unsigned level=0) const  
*Output to stream.*
- virtual void [dbgprint](#) () const  
*Little wrapper around print to be called within a debugger.*
- virtual void [dbgprinttree](#) () const  
*Little wrapper around printtree to be called within a debugger.*

- virtual unsigned [precedence](#) () const  
*Return relative operator precedence (for parenthesizing output).*
- virtual bool [info](#) (unsigned inf) const  
*Information about the object.*
- virtual size\_t [nops](#) () const  
*Number of operands/members.*
- virtual [ex op](#) (size\_t i) const  
*Return operand/member at position i.*
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size\_t i) const
- virtual [ex](#) & [let\\_op](#) (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size\_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const  
*Check whether the expression matches a given pattern.*
- virtual [ex subs](#) (const [exmap](#) &m, unsigned options=0) const  
*Substitute a set of objects by arbitrary expressions.*
- virtual [ex map](#) ([map\\_function](#) &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is\\_polynomial](#) (const [ex](#) &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int [degree](#) (const [ex](#) &s) const  
*Return degree of highest power in object s.*
- virtual int [ldegree](#) (const [ex](#) &s) const  
*Return degree of lowest power in object s.*
- virtual [ex coeff](#) (const [ex](#) &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual [ex expand](#) (unsigned options=0) const  
*Expand expression, i.e.*
- virtual [ex collect](#) (const [ex](#) &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual [ex series](#) (const [relational](#) &r, int order, unsigned options=0) const  
*Default implementation of [ex::series\(\)](#).*
- virtual [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev\_lookup, [lst](#) &modifier) const  
*Default implementation of [ex::normal\(\)](#).*
- virtual [ex to\\_rational](#) ([exmap](#) &repl) const  
*Default implementation of [ex::to\\_rational\(\)](#).*
- virtual [ex to\\_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer\\_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual [numeric max\\_coefficient](#) () const  
*Implementation [ex::max\\_coefficient\(\)](#).*
- virtual [exvector get\\_free\\_indices](#) () const  
*Return a vector containing the free indices of an expression.*
- virtual [ex add\\_indexed](#) (const [ex](#) &self, const [ex](#) &other) const  
*Add two indexed expressions.*



- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T>  
void `print_dispatch` (const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- virtual void `archive` (`archive_node` &n) const  
*Save (serialize) the object into archive node.*
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)  
*Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- const `basic` & `hold` () const  
*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const  
*Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

## Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`  
*of type `status_flags`*
- unsigned `hashvalue`  
*hash value*

## 6.61.1 Member Function Documentation

### 6.61.1.1 `return_type()`

```
unsigned GiNaC::fail::return_type () const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::noncommutative\\_composite](#).

### 6.61.1.2 `do_print()`

```
void GiNaC::fail::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

The documentation for this class was generated from the following file:

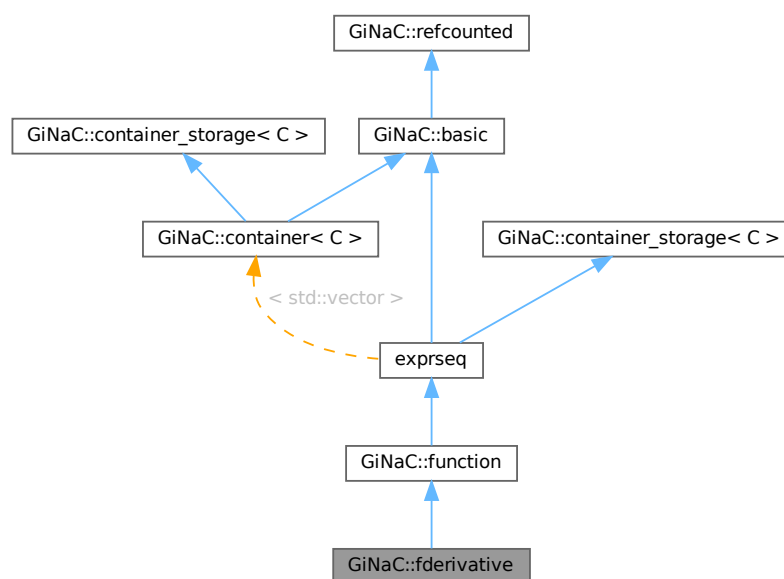
- [fail.h](#)

## 6.62 GiNaC::fderivative Class Reference

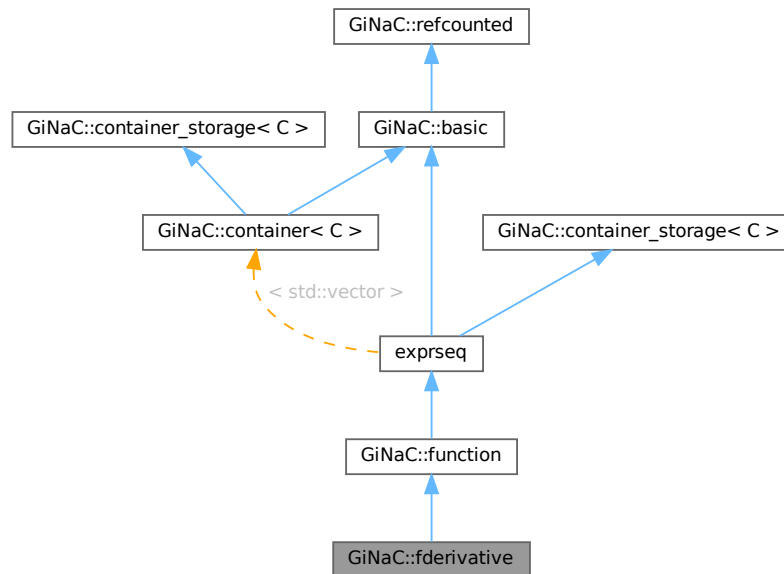
This class represents the (abstract) derivative of a symbolic function.

```
#include <fderivative.h>
```

Inheritance diagram for GiNaC::fderivative:



Collaboration diagram for GiNaC::fderivative:



## Public Member Functions

- `fderivative` (unsigned ser, unsigned param, const `exvector` &args)  
*Construct derivative with respect to one parameter.*
- `fderivative` (unsigned ser, const `paramset` &params, const `exvector` &args)  
*Construct derivative with respect to multiple parameters.*
- `fderivative` (unsigned ser, const `paramset` &params, `exvector` &&v)
- void `print` (const `print_context` &c, unsigned level=0) const override  
*Output to stream.*
- `ex eval` () const override  
*Perform automatic non-interruptive term rewriting rules.*
- `ex series` (const `relational` &r, int order, unsigned options=0) const override  
*The series expansion of derivatives falls back to Taylor expansion.*
- `ex thiscontainer` (const `exvector` &v) const override  
*Similar to `duplicate()`, but with a preset sequence.*
- `ex thiscontainer` (`exvector` &&v) const override  
*Similar to `duplicate()`, but with a preset sequence (which gets pilfered).*
- void `archive` (`archive_node` &n) const override  
*Archive the object.*
- void `read_archive` (const `archive_node` &n, `lst` &syms) override  
*Load (deserialize) the object from an archive node.*
- const `paramset` & `derivatives` () const  
*Expose this object's derivative structure.*

## Public Member Functions inherited from `GiNaC::function`

- `function` (unsigned ser)
- `function` (unsigned ser, const `ex` &param1)
- `function` (unsigned ser, const `ex` &param1, const `ex` &param2)
- `function` (unsigned ser, const `ex` &param1, const `ex` &param2, const `ex` &param3)
- `function` (unsigned ser, const `ex` &param1, const `ex` &param2, const `ex` &param3, const `ex` &param4)
- `function` (unsigned ser, const `ex` &param1, const `ex` &param2, const `ex` &param3, const `ex` &param4, const `ex` &param5)
- `function` (unsigned ser, const `ex` &param1, const `ex` &param2, const `ex` &param3, const `ex` &param4, const `ex` &param5, const `ex` &param6)
- `function` (unsigned ser, const `ex` &param1, const `ex` &param2, const `ex` &param3, const `ex` &param4, const `ex` &param5, const `ex` &param6, const `ex` &param7)
- `function` (unsigned ser, const `ex` &param1, const `ex` &param2, const `ex` &param3, const `ex` &param4, const `ex` &param5, const `ex` &param6, const `ex` &param7, const `ex` &param8)
- `function` (unsigned ser, const `ex` &param1, const `ex` &param2, const `ex` &param3, const `ex` &param4, const `ex` &param5, const `ex` &param6, const `ex` &param7, const `ex` &param8, const `ex` &param9)
- `function` (unsigned ser, const `ex` &param1, const `ex` &param2, const `ex` &param3, const `ex` &param4, const `ex` &param5, const `ex` &param6, const `ex` &param7, const `ex` &param8, const `ex` &param9, const `ex` &param10)
- `function` (unsigned ser, const `ex` &param1, const `ex` &param2, const `ex` &param3, const `ex` &param4, const `ex` &param5, const `ex` &param6, const `ex` &param7, const `ex` &param8, const `ex` &param9, const `ex` &param10, const `ex` &param11)
- `function` (unsigned ser, const `ex` &param1, const `ex` &param2, const `ex` &param3, const `ex` &param4, const `ex` &param5, const `ex` &param6, const `ex` &param7, const `ex` &param8, const `ex` &param9, const `ex` &param10, const `ex` &param11, const `ex` &param12)
- `function` (unsigned ser, const `ex` &param1, const `ex` &param2, const `ex` &param3, const `ex` &param4, const `ex` &param5, const `ex` &param6, const `ex` &param7, const `ex` &param8, const `ex` &param9, const `ex` &param10, const `ex` &param11, const `ex` &param12, const `ex` &param13)
- `function` (unsigned ser, const `ex` &param1, const `ex` &param2, const `ex` &param3, const `ex` &param4, const `ex` &param5, const `ex` &param6, const `ex` &param7, const `ex` &param8, const `ex` &param9, const `ex` &param10, const `ex` &param11, const `ex` &param12, const `ex` &param13, const `ex` &param14)
- `function` (unsigned ser, const `exprseq` &es)
- `function` (unsigned ser, const `exvector` &v)
- `function` (unsigned ser, `exvector` &&v)
- void `print` (const `print_context` &c, unsigned level=0) const override  
*Output to stream.*
- unsigned `precedence` () const override  
*Return relative operator precedence (for parenthezing output).*
- `ex expand` (unsigned options=0) const override  
*Expand expression, i.e.*
- `ex eval` () const override  
*Perform automatic non-interruptive term rewriting rules.*
- `ex evalf` () const override  
*Evaluate object numerically.*
- `ex eval_ncmul` (const `exvector` &v) const override  
*This method is defined to be in line with behavior of `function::return_type()`*
- unsigned `calchash` () const override  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- `ex series` (const `relational` &r, int order, unsigned options=0) const override  
*Implementation of `ex::series` for functions.*
- `ex thiscontainer` (const `exvector` &v) const override  
*Similar to `duplicate()`, but with a preset sequence.*
- `ex thiscontainer` (`exvector` &&v) const override  
*Similar to `duplicate()`, but with a preset sequence (which gets pilfered).*

- `ex conjugate ()` const override  
*Implementation of `ex::conjugate` for functions.*
- `ex real_part ()` const override  
*Implementation of `ex::real_part` for functions.*
- `ex imag_part ()` const override  
*Implementation of `ex::imag_part` for functions.*
- `void archive (archive_node &n)` const override  
*Archive the object.*
- `void read_archive (const archive_node &n, lst &syms)` override  
*Construct object from `archive_node`.*
- `bool info (unsigned inf)` const override  
*Implementation of `ex::info` for functions.*
- `ex power (const ex &exp)` const
- `unsigned get_serial ()` const
- `std::string get_name ()` const  
*Return the print name of the function.*

## Public Member Functions inherited from `GiNaC::container< std::vector >`

- `container (STLT const &s)`
- `container (STLT &&v)`
- `container (exvector::const_iterator b, exvector::const_iterator e)`
- `container (std::initializer_list< ex > il)`
- `size_t nops ()` const override  
*Number of operands/members.*
- `ex op (size_t i)` const override  
*Return operand/member at position *i*.*
- `ex & let_op (size_t i)` override  
*Return modifiable operand/member at position *i*.*
- `ex subs (const exmap &m, unsigned options=0)` const override  
*Substitute a set of objects by arbitrary expressions.*
- `container & prepend (const ex &b)`  
*Add element at front.*
- `container & append (const ex &b)`  
*Add element at back.*
- `container & remove_first ()`  
*Remove first element.*
- `container & remove_last ()`  
*Remove last element.*
- `container & remove_all ()`  
*Remove all elements.*
- `container & sort ()`  
*Sort elements.*
- `container & unique ()`  
*Remove adjacent duplicate elements.*
- `const_iterator begin ()` const
- `const_iterator end ()` const
- `const_reverse_iterator rbegin ()` const
- `const_reverse_iterator rend ()` const
- `container (STLT const &s)`
- `container (STLT &&v)`

- `container` (`exvector::const_iterator b, exvector::const_iterator e`)
- `container` (`std::initializer_list< ex > il`)
- `size_t nops ()` const override  
*Number of operands/members.*
- `ex op (size_t i)` const override  
*Return operand/member at position i.*
- `ex & let_op (size_t i)` override  
*Return modifiable operand/member at position i.*
- `ex subs (const exmap &m, unsigned options=0)` const override  
*Substitute a set of objects by arbitrary expressions.*
- `container & prepend (const ex &b)`  
*Add element at front.*
- `container & append (const ex &b)`  
*Add element at back.*
- `container & remove_first ()`  
*Remove first element.*
- `container & remove_last ()`  
*Remove last element.*
- `container & remove_all ()`  
*Remove all elements.*
- `container & sort ()`  
*Sort elements.*
- `container & unique ()`  
*Remove adjacent duplicate elements.*
- `const_iterator begin ()` const
- `const_iterator end ()` const
- `const_reverse_iterator rbegin ()` const
- `const_reverse_iterator rend ()` const

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic ()`  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate ()` const  
*Create a clone of this object on the heap.*
- virtual `ex evalm ()` const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ ()` const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed (const basic &i)` const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `dbgprint ()` const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree ()` const  
*Little wrapper around printtree to be called within a debugger.*
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex & operator[] (const ex &index)`

- virtual [ex](#) & [operator\[\]](#) (size\_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const  
*Check whether the expression matches a given pattern.*
- virtual [ex](#) [map](#) ([map\\_function](#) &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is\\_polynomial](#) (const [ex](#) &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int [degree](#) (const [ex](#) &s) const  
*Return degree of highest power in object s.*
- virtual int [ldegree](#) (const [ex](#) &s) const  
*Return degree of lowest power in object s.*
- virtual [ex](#) [coeff](#) (const [ex](#) &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual [ex](#) [collect](#) (const [ex](#) &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual [ex](#) [normal](#) ([exmap](#) &repl, [exmap](#) &rev\_lookup, [lst](#) &modifier) const  
*Default implementation of [ex::normal\(\)](#).*
- virtual [ex](#) [to\\_rational](#) ([exmap](#) &repl) const  
*Default implementation of [ex::to\\_rational\(\)](#).*
- virtual [ex](#) [to\\_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer\\_content](#) () const
- virtual [ex](#) [smod](#) (const [numeric](#) &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual [numeric max\\_coefficient](#) () const  
*Implementation [ex::max\\_coefficient\(\)](#).*
- virtual [exvector](#) [get\\_free\\_indices](#) () const  
*Return a vector containing the free indices of an expression.*
- virtual [ex](#) [add\\_indexed](#) (const [ex](#) &self, const [ex](#) &other) const  
*Add two indexed expressions.*
- virtual [ex](#) [scalar\\_mul\\_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool [contract\\_with](#) ([exvector::iterator](#) self, [exvector::iterator](#) other, [exvector](#) &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- template<class T>  
void [print\\_dispatch](#) (const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- void [print\\_dispatch](#) (const [registered\\_class\\_info](#) &ri, const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- [ex](#) [subs\\_one\\_level](#) (const [exmap](#) &m, unsigned options) const  
*Helper function for [subs\(\)](#).*
- [ex](#) [diff](#) (const [symbol](#) &s, unsigned nth=1) const  
*Default interface of nth derivative [ex::diff\(s, n\)](#).*
- int [compare](#) (const [basic](#) &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool [is\\_equal](#) (const [basic](#) &other) const  
*Test for syntactic equality.*
- const [basic](#) & [hold](#) () const  
*Stop further evaluation.*

- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const  
*Set some [status\\_flags](#).*
- const [basic](#) & [clearflag](#) (unsigned f) const  
*Clear some [status\\_flags](#).*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Member Functions

- [ex\\_derivative](#) (const [symbol](#) &s) const override  
*Implementation of [ex::diff\(\)](#) for derivatives.*
- bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if two objects of same type are equal.*
- bool [match\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if the attributes of two objects are similar enough for a match.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_latex](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_csrc](#) (const [print\\_csrc](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::function](#)

- [ex\\_derivative](#) (const [symbol](#) &s) const override  
*Implementation of [ex::diff\(\)](#) for functions.*
- bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if two objects of same type are equal.*
- bool [match\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if the attributes of two objects are similar enough for a match.*
- unsigned [return\\_type](#) () const override
- [return\\_type\\_t](#) [return\\_type\\_tinfo](#) () const override
- [ex\\_pderivative](#) (unsigned diff\_param) const
- [ex\\_expl\\_derivative](#) (const [symbol](#) &s) const
- bool [lookup\\_remember\\_table](#) ([ex](#) &result) const
- void [store\\_remember\\_table](#) ([ex](#) const &result) const



## Protected Member Functions inherited from [GiNaC::container< std::vector >](#)

- virtual void [printseq](#) (const [print\\_context](#) &c, char openbracket, char delim, char closebracket, unsigned this←\_precedence, unsigned upper\_precedence=0) const  
*Print sequence of contained elements.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const
- void [do\\_print\\_python](#) (const [print\\_python](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const
- [STLT](#) [subchildren](#) (const [exmap](#) &m, unsigned options=0) const
- virtual void [printseq](#) (const [print\\_context](#) &c, char openbracket, char delim, char closebracket, unsigned this←\_precedence, unsigned upper\_precedence=0) const  
*Print sequence of contained elements.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const
- void [do\\_print\\_python](#) (const [print\\_python](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const
- [STLT](#) [subchildren](#) (const [exmap](#) &m, unsigned options=0) const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Member Functions inherited from [GiNaC::container\\_storage< C >](#)

- [container\\_storage](#) ()
- [container\\_storage](#) (size\_t n, const [ex](#) &e)
- [container\\_storage](#) (std::initializer\_list< [ex](#) > il)
- template<class In>  
[container\\_storage](#) (In b, In e)
- void [reserve](#) (size\_t)
- [~container\\_storage](#) ()
- void [reserve](#) (size\_t n)
- void [reserve](#) (std::vector< [ex](#) > &v, size\_t n)

## Protected Attributes

- [paramset](#) [parameter\\_set](#)  
*Set of parameter numbers with respect to which to take the derivative.*

### Protected Attributes inherited from [GiNaC::function](#)

- unsigned [serial](#)

### Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
of type [status\\_flags](#)
- unsigned [hashvalue](#)  
hash value

### Protected Attributes inherited from [GiNaC::container\\_storage< C >](#)

- [STLT seq](#)

### Additional Inherited Members

### Public Types inherited from [GiNaC::container< std::vector >](#)

- typedef [STLT::const\\_iterator](#) [const\\_iterator](#)
- typedef [STLT::const\\_reverse\\_iterator](#) [const\\_reverse\\_iterator](#)

### Static Public Member Functions inherited from [GiNaC::function](#)

- static unsigned [register\\_new](#) ([function\\_options](#) const &opt)
- static unsigned [find\\_function](#) (const std::string &name, unsigned nparams)  
*Find serial number of function by name and number of parameters.*
- static std::vector< [function\\_options](#) > [get\\_registered\\_functions](#) ()

### Static Public Attributes inherited from [GiNaC::function](#)

- static unsigned [current\\_serial](#) = 0  
*This can be used as a hook for external applications.*

### Protected Types inherited from [GiNaC::container< std::vector >](#)

- typedef [container\\_storage< std::vector >::STLT](#) [STLT](#)

### Protected Types inherited from [GiNaC::container\\_storage< C >](#)

- typedef C< [ex](#) > [STLT](#)

### Static Protected Member Functions inherited from [GiNaC::function](#)

- static std::vector< [function\\_options](#) > & [registered\\_functions](#) ()

## Static Protected Member Functions inherited from [GiNaC::container< std::vector >](#)

- static unsigned [get\\_default\\_flags](#) ()
- static char [get\\_open\\_delim](#) ()
- static char [get\\_close\\_delim](#) ()
- static unsigned [get\\_default\\_flags](#) ()
- static char [get\\_open\\_delim](#) ()
- static char [get\\_close\\_delim](#) ()

## Static Protected Member Functions inherited from [GiNaC::container\\_storage< C >](#)

- static void [reserve](#) (STLT &, size\_t)

### 6.62.1 Detailed Description

This class represents the (abstract) derivative of a symbolic function.

It is used to represent the derivatives of functions that do not have a derivative or series expansion procedure defined.

### 6.62.2 Constructor & Destructor Documentation

#### 6.62.2.1 fderivative() [1/3]

```
GiNaC::fderivative::fderivative (
 unsigned ser,
 unsigned param,
 const exvector & args)
```

Construct derivative with respect to one parameter.

##### Parameters

|              |                                                                  |
|--------------|------------------------------------------------------------------|
| <i>ser</i>   | Serial number of function                                        |
| <i>param</i> | Number of parameter with respect to which to take the derivative |
| <i>args</i>  | Arguments of derivative function                                 |

References [GiNaC::function::function\(\)](#), and [parameter\\_set](#).

Referenced by [derivative\(\)](#), [is\\_equal\\_same\\_type\(\)](#), [match\\_same\\_type\(\)](#), [thiscontainer\(\)](#), and [thiscontainer\(\)](#).

#### 6.62.2.2 fderivative() [2/3]

```
GiNaC::fderivative::fderivative (
 unsigned ser,
 const paramset & params,
 const exvector & args)
```

Construct derivative with respect to multiple parameters.

## Parameters

|               |                                                                           |
|---------------|---------------------------------------------------------------------------|
| <i>ser</i>    | Serial number of function                                                 |
| <i>params</i> | Set of numbers of parameters with respect to which to take the derivative |
| <i>args</i>   | Arguments of derivative function                                          |

References [GiNaC::function::function\(\)](#), and [parameter\\_set](#).

**6.62.2.3 fderivative() [3/3]**

```
GiNaC::fderivative::fderivative (
 unsigned ser,
 const paramset & params,
 exvector && v)
```

References [GiNaC::function::function\(\)](#), and [parameter\\_set](#).

**6.62.3 Member Function Documentation****6.62.3.1 print()**

```
void GiNaC::fderivative::print (
 const print_context & c,
 unsigned level = 0) const [override], [virtual]
```

Output to stream.

This performs double dispatch on the dynamic type of \*this and the dynamic type of the supplied print context.

## Parameters

|              |                                                                                                           |
|--------------|-----------------------------------------------------------------------------------------------------------|
| <i>c</i>     | print context object that describes the output formatting                                                 |
| <i>level</i> | value that is used to identify the precedence or indentation level for placing parentheses and formatting |

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::print\(\)](#).

**6.62.3.2 eval()**

```
ex GiNaC::fderivative::eval () const [override], [virtual]
```

Perform automatic non-interruptive term rewriting rules.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::function::function\(\)](#), [GiNaC::basic::hold\(\)](#), [parameter\\_set](#), [GiNaC::function::pderivative\(\)](#), [GiNaC::function::registered\\_functions\(\)](#), [GiNaC::container\\_storage< C >::seq](#), and [GiNaC::function::serial](#).

### 6.62.3.3 series()

```
ex GiNaC::fderivative::series (
 const relational & r,
 int order,
 unsigned options = 0) const [override], [virtual]
```

The series expansion of derivatives falls back to Taylor expansion.

See also

[basic::series](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::series\(\)](#).

### 6.62.3.4 thiscontainer() [1/2]

```
ex GiNaC::fderivative::thiscontainer (
 const exvector & v) const [override], [virtual]
```

Similar to [duplicate\(\)](#), but with a preset sequence.

Must be overridden by derived classes.

Reimplemented from [GiNaC::container< std::vector >](#).

References [fderivative\(\)](#), [parameter\\_set](#), and [GiNaC::function::serial](#).

### 6.62.3.5 thiscontainer() [2/2]

```
ex GiNaC::fderivative::thiscontainer (
 exvector && v) const [override], [virtual]
```

Similar to [duplicate\(\)](#), but with a preset sequence (which gets pilfered).

Must be overridden by derived classes.

Reimplemented from [GiNaC::container< std::vector >](#).

References [fderivative\(\)](#), [parameter\\_set](#), and [GiNaC::function::serial](#).

### 6.62.3.6 archive()

```
void GiNaC::fderivative::archive (
 archive_node & n) const [override], [virtual]
```

Archive the object.

Reimplemented from [GiNaC::container< std::vector >](#).

References [GiNaC::archive\\_node::add\\_unsigned\(\)](#), [GiNaC::container< std::vector >::end\(\)](#), and [parameter\\_set](#).

### 6.62.3.7 read\_archive()

```
void GiNaC::fderivative::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive\\_node](#).

#### Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::container< std::vector >](#).

References [GiNaC::archive\\_node::find\\_unsigned\(\)](#), and [parameter\\_set](#).

### 6.62.3.8 derivative()

```
ex GiNaC::fderivative::derivative (
 const symbol & s) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for derivatives.

It applies the chain rule.

#### See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [fderivative\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [parameter\\_set](#), [GiNaC::container\\_storage< C >::seq](#), and [GiNaC::function::serial](#).

### 6.62.3.9 is\_equal\_same\_type()

```
bool GiNaC::fderivative::is_equal_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare\\_same\\_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::container< std::vector >](#).

References [fderivative\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), and [parameter\\_set](#).

### 6.62.3.10 match\_same\_type()

```
bool GiNaC::fderivative::match_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is\\_equal\\_same\\_type\(\)](#) is automatically used instead of [match\\_same\\_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

References [fderivative\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), and [parameter\\_set](#).

### 6.62.3.11 derivatives()

```
const paramset & GiNaC::fderivative::derivatives () const
```

Expose this object's derivative structure.

Parameter numbers occurring more than once stand for repeated differentiation with respect to that parameter. If a symbolic function  $f(x,y)$  is differentiated with respect to  $x$ , this method will return  $\{0\}$ . If  $f(x,y)$  is differentiated twice with respect to  $y$ , it will return  $\{1,1\}$ . (This corresponds to the way this object is printed.)

Returns

multiset of function's parameter numbers that are abstractly differentiated.

References [parameter\\_set](#).

### 6.62.3.12 do\_print()

```
void GiNaC::fderivative::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [GiNaC::container< std::vector >::end\(\)](#), [parameter\\_set](#), [GiNaC::container< std::vector >::precedence\(\)](#), [GiNaC::function::precedence\(\)](#), [GiNaC::container< std::vector >::printseq\(\)](#), [GiNaC::function::registered\\_functions\(\)](#), [GiNaC::print\\_context::s](#), and [GiNaC::function::serial](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.62.3.13 do\_print\_latex()

```
void GiNaC::fderivative::do_print_latex (
 const print_context & c,
 unsigned level) const [protected]
```

References [GiNaC::container< std::vector >::end\(\)](#), [parameter\\_set](#), [GiNaC::container< std::vector >::precedence\(\)](#), [GiNaC::function::precedence\(\)](#), [GiNaC::container< std::vector >::printseq\(\)](#), [GiNaC::function::registered\\_functions\(\)](#), [GiNaC::print\\_context::s](#), and [GiNaC::function::serial](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.62.3.14 do\_print\_csrc()

```
void GiNaC::fderivative::do_print_csrc (
 const print_csrc & c,
 unsigned level) const [protected]
```

References [GiNaC::container< std::vector >::end\(\)](#), [parameter\\_set](#), [GiNaC::container< std::vector >::precedence\(\)](#), [GiNaC::function::precedence\(\)](#), [GiNaC::container< std::vector >::printseq\(\)](#), [GiNaC::function::registered\\_functions\(\)](#), [GiNaC::print\\_context::s](#), and [GiNaC::function::serial](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.62.3.15 do\_print\_tree()

```
void GiNaC::fderivative::do_print_tree (
 const print_tree & c,
 unsigned level) const [protected]
```

References [GiNaC::print\\_tree::delta\\_indent](#), [GiNaC::container< std::vector >::end\(\)](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [GiNaC::container< std::vector >::nops\(\)](#), [parameter\\_set](#), [GiNaC::function::registered\\_functions\(\)](#), [GiNaC::print\\_context::s](#), [GiNaC::container\\_storage< C >::seq](#), and [GiNaC::function::serial](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.62.4 Member Data Documentation

### 6.62.4.1 parameter\_set

```
paramset GiNaC::fderivative::parameter_set [protected]
```

Set of parameter numbers with respect to which to take the derivative.

Referenced by [archive\(\)](#), [derivative\(\)](#), [derivatives\(\)](#), [do\\_print\(\)](#), [do\\_print\\_csrc\(\)](#), [do\\_print\\_latex\(\)](#), [do\\_print\\_tree\(\)](#), [eval\(\)](#), [fderivative\(\)](#), [fderivative\(\)](#), [fderivative\(\)](#), [is\\_equal\\_same\\_type\(\)](#), [match\\_same\\_type\(\)](#), [read\\_archive\(\)](#), [thiscontainer\(\)](#), and [thiscontainer\(\)](#).

The documentation for this class was generated from the following files:

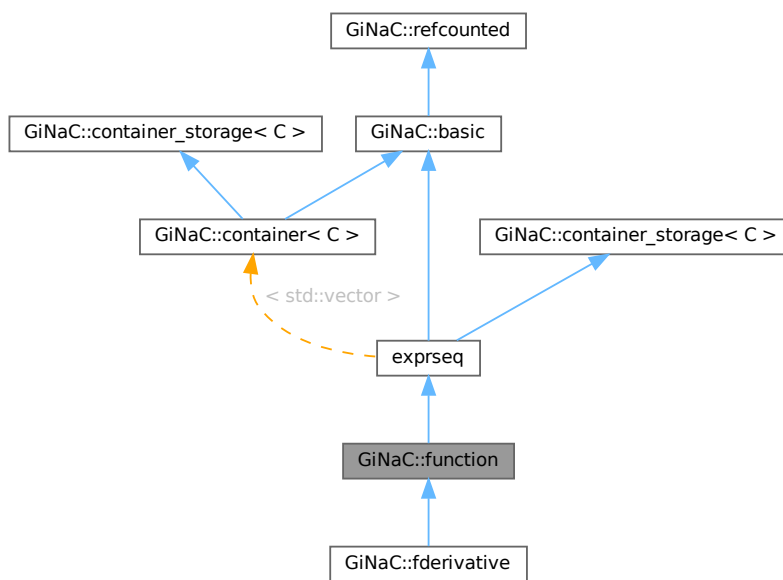
- [fderivative.h](#)
- [fderivative.cpp](#)



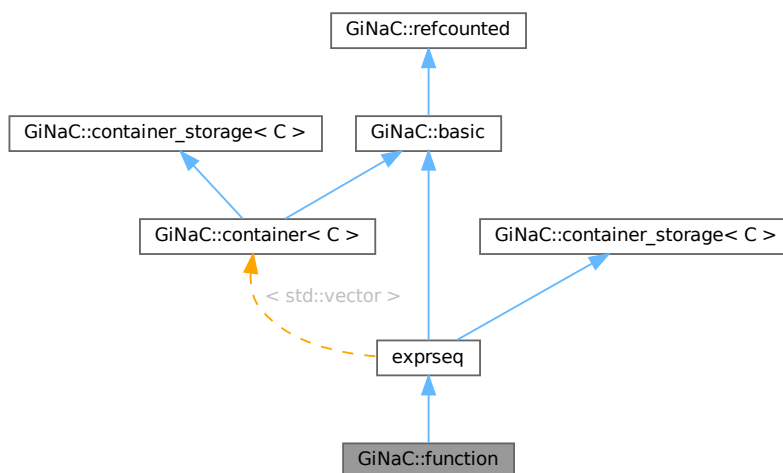
The class function is used to implement builtin functions like sin, cos... and user defined functions.

```
#include <function.h>
```

Inheritance diagram for GiNaC::function:



Collaboration diagram for GiNaC::function:



## Public Member Functions

- [function](#) (unsigned ser)
- [function](#) (unsigned ser, const [ex](#) &param1)
- [function](#) (unsigned ser, const [ex](#) &param1, const [ex](#) &param2)
- [function](#) (unsigned ser, const [ex](#) &param1, const [ex](#) &param2, const [ex](#) &param3)
- [function](#) (unsigned ser, const [ex](#) &param1, const [ex](#) &param2, const [ex](#) &param3, const [ex](#) &param4)
- [function](#) (unsigned ser, const [ex](#) &param1, const [ex](#) &param2, const [ex](#) &param3, const [ex](#) &param4, const [ex](#) &param5)
- [function](#) (unsigned ser, const [ex](#) &param1, const [ex](#) &param2, const [ex](#) &param3, const [ex](#) &param4, const [ex](#) &param5, const [ex](#) &param6)
- [function](#) (unsigned ser, const [ex](#) &param1, const [ex](#) &param2, const [ex](#) &param3, const [ex](#) &param4, const [ex](#) &param5, const [ex](#) &param6, const [ex](#) &param7)
- [function](#) (unsigned ser, const [ex](#) &param1, const [ex](#) &param2, const [ex](#) &param3, const [ex](#) &param4, const [ex](#) &param5, const [ex](#) &param6, const [ex](#) &param7, const [ex](#) &param8)
- [function](#) (unsigned ser, const [ex](#) &param1, const [ex](#) &param2, const [ex](#) &param3, const [ex](#) &param4, const [ex](#) &param5, const [ex](#) &param6, const [ex](#) &param7, const [ex](#) &param8, const [ex](#) &param9)
- [function](#) (unsigned ser, const [ex](#) &param1, const [ex](#) &param2, const [ex](#) &param3, const [ex](#) &param4, const [ex](#) &param5, const [ex](#) &param6, const [ex](#) &param7, const [ex](#) &param8, const [ex](#) &param9, const [ex](#) &param10)
- [function](#) (unsigned ser, const [ex](#) &param1, const [ex](#) &param2, const [ex](#) &param3, const [ex](#) &param4, const [ex](#) &param5, const [ex](#) &param6, const [ex](#) &param7, const [ex](#) &param8, const [ex](#) &param9, const [ex](#) &param10, const [ex](#) &param11)
- [function](#) (unsigned ser, const [ex](#) &param1, const [ex](#) &param2, const [ex](#) &param3, const [ex](#) &param4, const [ex](#) &param5, const [ex](#) &param6, const [ex](#) &param7, const [ex](#) &param8, const [ex](#) &param9, const [ex](#) &param10, const [ex](#) &param11, const [ex](#) &param12)
- [function](#) (unsigned ser, const [ex](#) &param1, const [ex](#) &param2, const [ex](#) &param3, const [ex](#) &param4, const [ex](#) &param5, const [ex](#) &param6, const [ex](#) &param7, const [ex](#) &param8, const [ex](#) &param9, const [ex](#) &param10, const [ex](#) &param11, const [ex](#) &param12, const [ex](#) &param13)
- [function](#) (unsigned ser, const [ex](#) &param1, const [ex](#) &param2, const [ex](#) &param3, const [ex](#) &param4, const [ex](#) &param5, const [ex](#) &param6, const [ex](#) &param7, const [ex](#) &param8, const [ex](#) &param9, const [ex](#) &param10, const [ex](#) &param11, const [ex](#) &param12, const [ex](#) &param13, const [ex](#) &param14)
- [function](#) (unsigned ser, const [exprseq](#) &es)
- [function](#) (unsigned ser, const [exvector](#) &v)
- [function](#) (unsigned ser, [exvector](#) &&v)
- void [print](#) (const [print\\_context](#) &c, unsigned level=0) const override  
*Output to stream.*
- unsigned [precedence](#) () const override  
*Return relative operator precedence (for parenthezing output).*
- [ex expand](#) (unsigned options=0) const override  
*Expand expression, i.e.*
- [ex eval](#) () const override  
*Perform automatic non-interruptive term rewriting rules.*
- [ex evalf](#) () const override  
*Evaluate object numerically.*
- [ex eval\\_ncmul](#) (const [exvector](#) &v) const override  
*This method is defined to be in line with behavior of [function::return\\_type\(\)](#)*
- unsigned [calchash](#) () const override  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- [ex series](#) (const [relational](#) &r, int order, unsigned options=0) const override  
*Implementation of [ex::series](#) for functions.*
- [ex thiscontainer](#) (const [exvector](#) &v) const override  
*Similar to [duplicate\(\)](#), but with a preset sequence.*
- [ex thiscontainer](#) ([exvector](#) &&v) const override  
*Similar to [duplicate\(\)](#), but with a preset sequence (which gets pilfered).*

- `ex conjugate ()` const override  
*Implementation of `ex::conjugate` for functions.*
- `ex real_part ()` const override  
*Implementation of `ex::real_part` for functions.*
- `ex imag_part ()` const override  
*Implementation of `ex::imag_part` for functions.*
- `void archive (archive_node &n)` const override  
*Archive the object.*
- `void read_archive (const archive_node &n, lst &syms)` override  
*Construct object from `archive_node`.*
- `bool info (unsigned inf)` const override  
*Implementation of `ex::info` for functions.*
- `ex power (const ex &exp)` const
- `unsigned get_serial ()` const
- `std::string get_name ()` const  
*Return the print name of the function.*

## Public Member Functions inherited from `GiNaC::container< std::vector >`

- `container (STLT const &s)`
- `container (STLT &&v)`
- `container (exvector::const_iterator b, exvector::const_iterator e)`
- `container (std::initializer_list< ex > il)`
- `size_t nops ()` const override  
*Number of operands/members.*
- `ex op (size_t i)` const override  
*Return operand/member at position *i*.*
- `ex & let_op (size_t i)` override  
*Return modifiable operand/member at position *i*.*
- `ex subs (const exmap &m, unsigned options=0)` const override  
*Substitute a set of objects by arbitrary expressions.*
- `container & prepend (const ex &b)`  
*Add element at front.*
- `container & append (const ex &b)`  
*Add element at back.*
- `container & remove_first ()`  
*Remove first element.*
- `container & remove_last ()`  
*Remove last element.*
- `container & remove_all ()`  
*Remove all elements.*
- `container & sort ()`  
*Sort elements.*
- `container & unique ()`  
*Remove adjacent duplicate elements.*
- `const_iterator begin ()` const
- `const_iterator end ()` const
- `const_reverse_iterator rbegin ()` const
- `const_reverse_iterator rend ()` const
- `container (STLT const &s)`
- `container (STLT &&v)`

- `container` (`exvector::const_iterator b, exvector::const_iterator e`)
- `container` (`std::initializer_list< ex > il`)
- `size_t nops ()` const override  
*Number of operands/members.*
- `ex op (size_t i)` const override  
*Return operand/member at position i.*
- `ex & let_op (size_t i)` override  
*Return modifiable operand/member at position i.*
- `ex subs (const exmap &m, unsigned options=0)` const override  
*Substitute a set of objects by arbitrary expressions.*
- `container & prepend (const ex &b)`  
*Add element at front.*
- `container & append (const ex &b)`  
*Add element at back.*
- `container & remove_first ()`  
*Remove first element.*
- `container & remove_last ()`  
*Remove last element.*
- `container & remove_all ()`  
*Remove all elements.*
- `container & sort ()`  
*Sort elements.*
- `container & unique ()`  
*Remove adjacent duplicate elements.*
- `const_iterator begin ()` const
- `const_iterator end ()` const
- `const_reverse_iterator rbegin ()` const
- `const_reverse_iterator rend ()` const

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic ()`  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate ()` const  
*Create a clone of this object on the heap.*
- virtual `ex evalm ()` const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ ()` const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed (const basic &i)` const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `dbgprint ()` const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree ()` const  
*Little wrapper around printtree to be called within a debugger.*
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex & operator[] (const ex &index)`

- virtual `ex & operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const  
*Check whether the expression matches a given pattern.*
- virtual `ex map` (map\_function &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept` (GiNaC::visitor &v) const
- virtual bool `is_polynomial` (const `ex` &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const  
*Return degree of highest power in object s.*
- virtual int `ldegree` (const `ex` &s) const  
*Return degree of lowest power in object s.*
- virtual `ex coeff` (const `ex` &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual `ex collect` (const `ex` &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const  
*Default implementation of `ex::normal()`.*
- virtual `ex to_rational` (`exmap` &repl) const  
*Default implementation of `ex::to_rational()`.*
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const  
*Implementation `ex::max_coefficient()`.*
- virtual `exvector get_free_indices` () const  
*Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- template<class T>  
void `print_dispatch` (const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- const `basic` & `hold` () const  
*Stop further evaluation.*

- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const  
*Set some [status\\_flags](#).*
- const [basic](#) & [clearflag](#) (unsigned f) const  
*Clear some [status\\_flags](#).*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Static Public Member Functions

- static unsigned [register\\_new](#) ([function\\_options](#) const &opt)
- static unsigned [find\\_function](#) (const std::string &name, unsigned nparams)  
*Find serial number of function by name and number of parameters.*
- static std::vector< [function\\_options](#) > [get\\_registered\\_functions](#) ()

## Static Public Attributes

- static unsigned [current\\_serial](#) = 0  
*This can be used as a hook for external applications.*

## Protected Member Functions

- [ex\\_derivative](#) (const [symbol](#) &s) const override  
*Implementation of [ex::diff\(\)](#) for functions.*
- bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if two objects of same type are equal.*
- bool [match\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if the attributes of two objects are similar enough for a match.*
- unsigned [return\\_type](#) () const override
- [return\\_type\\_t](#) [return\\_type\\_tinfo](#) () const override
- [ex](#) [pderivative](#) (unsigned diff\_param) const
- [ex](#) [expl\\_derivative](#) (const [symbol](#) &s) const
- bool [lookup\\_remember\\_table](#) ([ex](#) &result) const
- void [store\\_remember\\_table](#) ([ex](#) const &result) const

### Protected Member Functions inherited from [GiNaC::container< std::vector >](#)

- virtual void [printseq](#) (const [print\\_context](#) &c, char openbracket, char delim, char closebracket, unsigned this←\_precedence, unsigned upper\_precedence=0) const  
*Print sequence of contained elements.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const
- void [do\\_print\\_python](#) (const [print\\_python](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const
- [STLT](#) [subchildren](#) (const [exmap](#) &m, unsigned options=0) const
- virtual void [printseq](#) (const [print\\_context](#) &c, char openbracket, char delim, char closebracket, unsigned this←\_precedence, unsigned upper\_precedence=0) const  
*Print sequence of contained elements.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const
- void [do\\_print\\_python](#) (const [print\\_python](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const
- [STLT](#) [subchildren](#) (const [exmap](#) &m, unsigned options=0) const

### Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

### Protected Member Functions inherited from [GiNaC::container\\_storage< C >](#)

- [container\\_storage](#) ()
- [container\\_storage](#) (size\_t n, const [ex](#) &e)
- [container\\_storage](#) (std::initializer\_list< [ex](#) > il)
- template<class In>  
[container\\_storage](#) (In b, In e)
- void [reserve](#) (size\_t)
- [~container\\_storage](#) ()
- void [reserve](#) (size\_t n)
- void [reserve](#) (std::vector< [ex](#) > &v, size\_t n)

### Static Protected Member Functions

- static std::vector< [function\\_options](#) > & [registered\\_functions](#) ()

### Static Protected Member Functions inherited from [GiNaC::container< std::vector >](#)

- static unsigned [get\\_default\\_flags](#) ()
- static char [get\\_open\\_delim](#) ()
- static char [get\\_close\\_delim](#) ()
- static unsigned [get\\_default\\_flags](#) ()
- static char [get\\_open\\_delim](#) ()
- static char [get\\_close\\_delim](#) ()

### Static Protected Member Functions inherited from [GiNaC::container\\_storage< C >](#)

- static void [reserve](#) (STLT &, size\_t)

### Protected Attributes

- unsigned [serial](#)

### Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
of type [status\\_flags](#)
- unsigned [hashvalue](#)  
hash value

### Protected Attributes inherited from [GiNaC::container\\_storage< C >](#)

- [STLT seq](#)

### Friends

- class [remember\\_table\\_entry](#)

### Additional Inherited Members

### Public Types inherited from [GiNaC::container< std::vector >](#)

- typedef STLT::const\_iterator [const\\_iterator](#)
- typedef STLT::const\_reverse\_iterator [const\\_reverse\\_iterator](#)

### Protected Types inherited from [GiNaC::container< std::vector >](#)

- typedef [container\\_storage< std::vector >::STLT](#) STLT

### Protected Types inherited from [GiNaC::container\\_storage< C >](#)

- typedef C< [ex](#) > STLT



### 6.63.1 Detailed Description

The class function is used to implement builtin functions like sin, cos... and user defined functions.

### 6.63.2 Constructor & Destructor Documentation

#### 6.63.2.1 function() [1/18]

```
GiNaC::function::function (
 unsigned ser)
```

References [serial](#).

Referenced by [GiNaC::fderivative::eval\(\)](#), [evalf\(\)](#), [GiNaC::fderivative::fderivative\(\)](#), [GiNaC::fderivative::fderivative\(\)](#), [GiNaC::fderivative::fderivative\(\)](#), [is\\_equal\\_same\\_type\(\)](#), [match\\_same\\_type\(\)](#), [remember\\_table\\_entry](#), [thiscontainer\(\)](#), and [thiscontainer\(\)](#).

#### 6.63.2.2 function() [2/18]

```
GiNaC::function::function (
 unsigned ser,
 const ex & param1)
```

References [serial](#).

#### 6.63.2.3 function() [3/18]

```
GiNaC::function::function (
 unsigned ser,
 const ex & param1,
 const ex & param2)
```

References [serial](#).

#### 6.63.2.4 function() [4/18]

```
GiNaC::function::function (
 unsigned ser,
 const ex & param1,
 const ex & param2,
 const ex & param3)
```

References [serial](#).

#### 6.63.2.5 function() [5/18]

```
GiNaC::function::function (
 unsigned ser,
 const ex & param1,
 const ex & param2,
 const ex & param3,
 const ex & param4)
```

References [serial](#).

#### 6.63.2.6 function() [6/18]

```
GiNaC::function::function (
 unsigned ser,
 const ex & param1,
 const ex & param2,
 const ex & param3,
 const ex & param4,
 const ex & param5)
```

References [serial](#).

#### 6.63.2.7 function() [7/18]

```
GiNaC::function::function (
 unsigned ser,
 const ex & param1,
 const ex & param2,
 const ex & param3,
 const ex & param4,
 const ex & param5,
 const ex & param6)
```

References [serial](#).

#### 6.63.2.8 function() [8/18]

```
GiNaC::function::function (
 unsigned ser,
 const ex & param1,
 const ex & param2,
 const ex & param3,
 const ex & param4,
 const ex & param5,
 const ex & param6,
 const ex & param7)
```

References [serial](#).

### 6.63.2.9 function() [9/18]

```
GiNaC::function::function (
 unsigned ser,
 const ex & param1,
 const ex & param2,
 const ex & param3,
 const ex & param4,
 const ex & param5,
 const ex & param6,
 const ex & param7,
 const ex & param8)
```

References [serial](#).

### 6.63.2.10 function() [10/18]

```
GiNaC::function::function (
 unsigned ser,
 const ex & param1,
 const ex & param2,
 const ex & param3,
 const ex & param4,
 const ex & param5,
 const ex & param6,
 const ex & param7,
 const ex & param8,
 const ex & param9)
```

References [serial](#).

### 6.63.2.11 function() [11/18]

```
GiNaC::function::function (
 unsigned ser,
 const ex & param1,
 const ex & param2,
 const ex & param3,
 const ex & param4,
 const ex & param5,
 const ex & param6,
 const ex & param7,
 const ex & param8,
 const ex & param9,
 const ex & param10)
```

References [serial](#).

#### 6.63.2.12 function() [12/18]

```
GiNaC::function::function (
 unsigned ser,
 const ex & param1,
 const ex & param2,
 const ex & param3,
 const ex & param4,
 const ex & param5,
 const ex & param6,
 const ex & param7,
 const ex & param8,
 const ex & param9,
 const ex & param10,
 const ex & param11)
```

References [serial](#).

#### 6.63.2.13 function() [13/18]

```
GiNaC::function::function (
 unsigned ser,
 const ex & param1,
 const ex & param2,
 const ex & param3,
 const ex & param4,
 const ex & param5,
 const ex & param6,
 const ex & param7,
 const ex & param8,
 const ex & param9,
 const ex & param10,
 const ex & param11,
 const ex & param12)
```

References [serial](#).

#### 6.63.2.14 function() [14/18]

```
GiNaC::function::function (
 unsigned ser,
 const ex & param1,
 const ex & param2,
 const ex & param3,
 const ex & param4,
 const ex & param5,
 const ex & param6,
 const ex & param7,
 const ex & param8,
 const ex & param9,
 const ex & param10,
 const ex & param11,
 const ex & param12,
 const ex & param13)
```

References [serial](#).

**6.63.2.15 function() [15/18]**

```
GiNaC::function::function (
 unsigned ser,
 const ex & param1,
 const ex & param2,
 const ex & param3,
 const ex & param4,
 const ex & param5,
 const ex & param6,
 const ex & param7,
 const ex & param8,
 const ex & param9,
 const ex & param10,
 const ex & param11,
 const ex & param12,
 const ex & param13,
 const ex & param14)
```

References [serial](#).

**6.63.2.16 function() [16/18]**

```
GiNaC::function::function (
 unsigned ser,
 const exprseq & es)
```

References [GiNaC::basic::clearflag\(\)](#), [GiNaC::status\\_flags::evaluated](#), and [serial](#).

**6.63.2.17 function() [17/18]**

```
GiNaC::function::function (
 unsigned ser,
 const exvector & v)
```

References [serial](#).

**6.63.2.18 function() [18/18]**

```
GiNaC::function::function (
 unsigned ser,
 exvector && v)
```

References [serial](#).

**6.63.3 Member Function Documentation****6.63.3.1 print()**

```
void GiNaC::function::print (
 const print_context & c,
 unsigned level = 0) const [override], [virtual]
```

Output to stream.

This performs double dispatch on the dynamic type of \*this and the dynamic type of the supplied print context.

## Parameters

|              |                                                                                                           |
|--------------|-----------------------------------------------------------------------------------------------------------|
| <i>c</i>     | print context object that describes the output formatting                                                 |
| <i>level</i> | value that is used to identify the precedence or indentation level for placing parentheses and formatting |

Reimplemented from [GiNaC::basic](#).

References [current\\_serial](#), [GiNaC::basic::flags](#), [GiNaC::print\\_context\\_options::get\\_id\(\)](#), [GiNaC::class\\_info< OPT >::get\\_parent\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::basic::hashvalue](#), [GiNaC::is\\_a\(\)](#), [GiNaC::function\\_options::name](#), [GiNaC::container< std::vector >::nops\(\)](#), [GiNaC::function\\_options::nparams](#), [GiNaC::class\\_info< OPT >::options](#), [GiNaC::container< std::vector >::precedence\(\)](#), [precedence\(\)](#), [print\(\)](#), [GiNaC::function\\_options::print\\_dispatch\\_table](#), [GiNaC::function\\_options::print\\_use\\_exvector\\_args](#), [GiNaC::container< std::vector >::printseq\(\)](#), [registered\\_functions\(\)](#), [GiNaC::print\\_context::s](#), [GiNaC::container\\_storage< C >::seq](#), [serial](#), and [GiNaC::function\\_options::TeX\\_name](#).

Referenced by [print\(\)](#), and [remember\\_table\\_entry](#).

### 6.63.3.2 precedence()

```
unsigned GiNaC::function::precedence () const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::container< std::vector >](#).

References [precedence\(\)](#).

Referenced by [GiNaC::fderivative::do\\_print\(\)](#), [GiNaC::fderivative::do\\_print\\_csrc\(\)](#), [GiNaC::fderivative::do\\_print\\_latex\(\)](#), [precedence\(\)](#), and [print\(\)](#).

### 6.63.3.3 expand()

```
ex GiNaC::function::expand (
 unsigned options = 0) const [override], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

References [current\\_serial](#), [GiNaC::function\\_options::expand\\_f](#), [GiNaC::expand\\_options::expand\\_function\\_args](#), [GiNaC::function\\_options::expand\\_use\\_exvector\\_args](#), [GiNaC::status\\_flags::expanded](#), [GINAC\\_ASSERT](#), [GiNaC::function\\_options::nparams](#), [registered\\_functions\(\)](#), [GiNaC::container\\_storage< C >::seq](#), [serial](#), and [GiNaC::basic::setflag\(\)](#).

### 6.63.3.4 eval()

```
ex GiNaC::function::eval () const [override], [virtual]
```

Perform automatic non-interruptive term rewriting rules.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::canonicalize\(\)](#), [current\\_serial](#), [GiNaC::function\\_options::eval\\_f](#), [GiNaC::function\\_options::eval\\_use\\_exvector\\_args](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::basic::flags](#), [GINAC\\_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [lookup\\_remember\\_table\(\)](#), [GiNaC::function\\_options::nparams](#), [registered\\_functions\(\)](#), [GiNaC::container\\_storage< C >::seq](#), [serial](#), [store\\_remember\\_table\(\)](#), [GiNaC::function\\_options::symtree](#), [thiscontainer\(\)](#), and [GiNaC::function\\_options::use\\_remember](#).

### 6.63.3.5 evalf()

```
ex GiNaC::function::evalf () const [override], [virtual]
```

Evaluate object numerically.

Reimplemented from [GiNaC::basic](#).

References [current\\_serial](#), [GiNaC::function\\_options::evalf\\_f](#), [GiNaC::function\\_options::evalf\\_params\\_first](#), [GiNaC::function\\_options::evalf\\_use\\_exvector\\_args](#), [function\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::function\\_options::nparams](#), [registered\\_functions\(\)](#), [GiNaC::container\\_storage< C >::seq](#), and [serial](#).

Referenced by [GiNaC::iterated\\_integral2\\_eval\(\)](#), and [GiNaC::iterated\\_integral3\\_eval\(\)](#).

### 6.63.3.6 eval\_ncmul()

```
ex GiNaC::function::eval_ncmul (
 const exvector & v) const [override], [virtual]
```

This method is defined to be in line with behavior of [function::return\\_type\(\)](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::container\\_storage< C >::seq](#).

### 6.63.3.7 calchash()

```
unsigned GiNaC::function::calchash () const [override], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::basic::flags](#), [GiNaC::ex::gethash\(\)](#), [GiNaC::golden\\_ratio\\_hash\(\)](#), [GiNaC::status\\_flags::hash\\_calculated](#), [GiNaC::basic::hashvalue](#), [GiNaC::make\\_hash\\_seed\(\)](#), [GiNaC::container< std::vector >::nops](#), [GiNaC::container< std::vector >::op\(\)](#), [GiNaC::rotate\\_left\(\)](#), [serial](#), and [GiNaC::basic::setflag\(\)](#).

### 6.63.3.8 series()

```
ex GiNaC::function::series (
 const relational & r,
 int order,
 unsigned options = 0) const [override], [virtual]
```

Implementation of [ex::series](#) for functions.

@see [ex::series](#)

Reimplemented from [GiNaC::basic](#).

References [current\\_serial](#), [GINAC\\_ASSERT](#), [GiNaC::function\\_options::nparams](#), [registered\\_functions\(\)](#), [GiNaC::container\\_storage< C >::seq](#), [serial](#), [GiNaC::basic::series\(\)](#), [GiNaC::function\\_options::series\\_f](#), and [GiNaC::function\\_options::series\\_use\\_exvector\\_args](#).

**6.63.3.9 thiscontainer() [1/2]**

```
ex GiNaC::function::thiscontainer (
 const exvector & v) const \[override\], \[virtual\]
```

Similar to [duplicate\(\)](#), but with a preset sequence.

Must be overridden by derived classes.

Reimplemented from [GiNaC::container< std::vector >](#).

References [function\(\)](#), and [serial](#).

Referenced by [eval\(\)](#).

**6.63.3.10 thiscontainer() [2/2]**

```
ex GiNaC::function::thiscontainer (
 exvector && v) const \[override\], \[virtual\]
```

Similar to [duplicate\(\)](#), but with a preset sequence (which gets pilfered).

Must be overridden by derived classes.

Reimplemented from [GiNaC::container< std::vector >](#).

References [function\(\)](#), and [serial](#).

**6.63.3.11 conjugate()**

```
ex GiNaC::function::conjugate () const \[override\], \[virtual\]
```

Implementation of [ex::conjugate](#) for functions.

Reimplemented from [GiNaC::container< std::vector >](#).

References [GiNaC::function\\_options::conjugate\\_f](#), [GiNaC::function\\_options::conjugate\\_use\\_exvector\\_args](#), [GINAC\\_ASSERT](#), [GiNaC::function\\_options::nparams](#), [registered\\_functions\(\)](#), [GiNaC::container\\_storage< C >::seq](#), and [serial](#).

**6.63.3.12 real\_part()**

```
ex GiNaC::function::real_part () const \[override\], \[virtual\]
```

Implementation of [ex::real\\_part](#) for functions.

Reimplemented from [GiNaC::container< std::vector >](#).

References [GINAC\\_ASSERT](#), [GiNaC::function\\_options::nparams](#), [GiNaC::basic::real\\_part\(\)](#), [GiNaC::function\\_options::real\\_part\\_f](#), [GiNaC::function\\_options::real\\_part\\_use\\_exvector\\_args](#), [registered\\_functions\(\)](#), [GiNaC::container\\_storage< C >::seq](#), and [serial](#).



### 6.63.3.13 `imag_part()`

```
ex GiNaC::function::imag_part () const [override], [virtual]
```

Implementation of [ex::imag\\_part](#) for functions.

Reimplemented from [GiNaC::container< std::vector >](#).

References [GINAC\\_ASSERT](#), [GiNaC::basic::imag\\_part\(\)](#), [GiNaC::function\\_options::imag\\_part\\_f](#), [GiNaC::function\\_options::imag\\_part](#), [GiNaC::function\\_options::nparams](#), [registered\\_functions\(\)](#), [GiNaC::container\\_storage< C >::seq](#), and [serial](#).

### 6.63.3.14 `archive()`

```
void GiNaC::function::archive (
 archive_node & n) const [override], [virtual]
```

Archive the object.

Reimplemented from [GiNaC::container< std::vector >](#).

References [GiNaC::archive\\_node::add\\_string\(\)](#), [GINAC\\_ASSERT](#), [registered\\_functions\(\)](#), and [serial](#).

### 6.63.3.15 `read_archive()`

```
void GiNaC::function::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Construct object from [archive\\_node](#).

Reimplemented from [GiNaC::container< std::vector >](#).

References [GiNaC::archive\\_node::find\\_string\(\)](#), [registered\\_functions\(\)](#), [GiNaC::container\\_storage< C >::seq](#), and [serial](#).

### 6.63.3.16 `info()`

```
bool GiNaC::function::info (
 unsigned inf) const [override], [virtual]
```

Implementation of [ex::info](#) for functions.

Reimplemented from [GiNaC::container< std::vector >](#).

References [GINAC\\_ASSERT](#), [GiNaC::basic::info\(\)](#), [GiNaC::function\\_options::info\\_f](#), [GiNaC::function\\_options::info\\_use\\_exvector\\_arg](#), [GiNaC::function\\_options::nparams](#), [registered\\_functions\(\)](#), [GiNaC::container\\_storage< C >::seq](#), and [serial](#).

### 6.63.3.17 derivative()

```
ex GiNaC::function::derivative (
 const symbol & s) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for functions.

It applies the chain rule, except for the Order term function. @see [ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [expl\\_derivative\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [pderivative\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).

### 6.63.3.18 is\_equal\_same\_type()

```
bool GiNaC::function::is_equal_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare\\_same\\_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::container< std::vector >](#).

References [function\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [GiNaC::container< std::vector >::is\\_equal\\_same\\_type\(\)](#), and [serial](#).

### 6.63.3.19 match\_same\_type()

```
bool GiNaC::function::match_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is\\_equal\\_same\\_type\(\)](#) is automatically used instead of [match\\_same\\_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

References [function\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), and [serial](#).

**6.63.3.20 return\_type()**

```
unsigned GiNaC::function::return_type () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::commutative](#), [GINAC\\_ASSERT](#), [registered\\_functions\(\)](#), [GiNaC::function\\_options::return\\_type](#), [GiNaC::container\\_storage< C >::seq](#), [serial](#), and [GiNaC::function\\_options::use\\_return\\_type](#).

**6.63.3.21 return\_type\_tinfo()**

```
return_type_t GiNaC::function::return_type_tinfo () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GINAC\\_ASSERT](#), [GiNaC::make\\_return\\_type\\_t\(\)](#), [registered\\_functions\(\)](#), [GiNaC::function\\_options::return\\_type\\_tinfo](#), [GiNaC::container\\_storage< C >::seq](#), [serial](#), and [GiNaC::function\\_options::use\\_return\\_type](#).

**6.63.3.22 pderivative()**

```
ex GiNaC::function::pderivative (
 unsigned diff_param) const [protected]
```

References [current\\_serial](#), [GiNaC::function\\_options::derivative\\_f](#), [GiNaC::function\\_options::derivative\\_use\\_exvector\\_args](#), [GINAC\\_ASSERT](#), [GiNaC::function\\_options::nparams](#), [registered\\_functions\(\)](#), [GiNaC::container\\_storage< C >::seq](#), and [serial](#).

Referenced by [derivative\(\)](#), and [GiNaC::fderivative::eval\(\)](#).

**6.63.3.23 expl\_derivative()**

```
ex GiNaC::function::expl_derivative (
 const symbol & s) const [protected]
```

References [current\\_serial](#), [GiNaC::function\\_options::expl\\_derivative\\_f](#), [GiNaC::function\\_options::expl\\_derivative\\_use\\_exvector\\_args](#), [GINAC\\_ASSERT](#), [GiNaC::function\\_options::nparams](#), [registered\\_functions\(\)](#), [GiNaC::container\\_storage< C >::seq](#), and [serial](#).

Referenced by [derivative\(\)](#).

**6.63.3.24 registered\_functions()**

```
std::vector< function_options > & GiNaC::function::registered_functions () [static], [protected]
```

Referenced by [archive\(\)](#), [conjugate\(\)](#), [GiNaC::fderivative::do\\_print\(\)](#), [GiNaC::fderivative::do\\_print\\_csrc\(\)](#), [GiNaC::fderivative::do\\_print\\_latex\(\)](#), [GiNaC::fderivative::do\\_print\\_tree\(\)](#), [GiNaC::fderivative::eval\(\)](#), [eval\(\)](#), [evalf\(\)](#), [expand\(\)](#), [expl\\_derivative\(\)](#), [find\\_function\(\)](#), [get\\_name\(\)](#), [get\\_registered\\_functions\(\)](#), [imag\\_part\(\)](#), [info\(\)](#), [pderivative\(\)](#), [power\(\)](#), [print\(\)](#), [read\\_archive\(\)](#), [real\\_part\(\)](#), [register\\_new\(\)](#), [return\\_type\(\)](#), [return\\_type\\_tinfo\(\)](#), and [series\(\)](#).

**6.63.3.25 lookup\_remember\_table()**

```
bool GiNaC::function::lookup_remember_table (
 ex & result) const [protected]
```

References [GiNaC::remember\\_table::remember\\_tables\(\)](#), and [serial](#).

Referenced by [eval\(\)](#).

**6.63.3.26 store\_remember\_table()**

```
void GiNaC::function::store_remember_table (
 ex const & result) const [protected]
```

References [GiNaC::remember\\_table::remember\\_tables\(\)](#), and [serial](#).

Referenced by [eval\(\)](#).

**6.63.3.27 power()**

```
ex GiNaC::function::power (
 const ex & exp) const
```

References [current\\_serial](#), [GiNaC::dynallocate\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GINAC\\_ASSERT](#), [GiNaC::function\\_options::nparams](#), [GiNaC::function\\_options::power\\_f](#), [GiNaC::function\\_options::power\\_use\\_exvector\\_args](#), [registered\\_functions\(\)](#), [GiNaC::container\\_storage< C >::seq](#), and [serial](#).

**6.63.3.28 register\_new()**

```
unsigned GiNaC::function::register_new (
 function_options const & opt) [static]
```

References [GiNaC::function\\_options::functions\\_with\\_same\\_name](#), [GiNaC::function\\_options::name](#), [registered\\_functions\(\)](#), [GiNaC::function\\_options::remember\\_assoc\\_size](#), [GiNaC::function\\_options::remember\\_size](#), [GiNaC::function\\_options::remember\\_str](#), [GiNaC::remember\\_table::remember\\_tables\(\)](#), and [GiNaC::function\\_options::use\\_remember](#).

**6.63.3.29 find\_function()**

```
unsigned GiNaC::function::find_function (
 const std::string & name,
 unsigned nparams) [static]
```

Find serial number of function by name and number of parameters.

Throws exception if function was not found.

References [registered\\_functions\(\)](#), and [serial](#).

### 6.63.3.30 `get_registered_functions()`

```
static std::vector< function_options > GiNaC::function::get_registered_functions () \[inline\],
\[static\]
```

References [registered\\_functions\(\)](#).

### 6.63.3.31 `get_serial()`

```
unsigned GiNaC::function::get_serial () const \[inline\]
```

References [serial](#).

### 6.63.3.32 `get_name()`

```
std::string GiNaC::function::get_name () const
```

Return the print name of the function.

References [GINAC\\_ASSERT](#), [registered\\_functions\(\)](#), and [serial](#).

## 6.63.4 Friends And Related Symbol Documentation

### 6.63.4.1 `remember_table_entry`

```
friend class remember_table_entry \[friend\]
```

References [function\(\)](#), [print\(\)](#), and [remember\\_table\\_entry](#).

Referenced by [remember\\_table\\_entry](#).

## 6.63.5 Member Data Documentation

### 6.63.5.1 `current_serial`

```
unsigned GiNaC::function::current_serial = 0 \[static\]
```

This can be used as a hook for external applications.

Referenced by [eval\(\)](#), [evalf\(\)](#), [expand\(\)](#), [expl\\_derivative\(\)](#), [pderivative\(\)](#), [power\(\)](#), [print\(\)](#), and [series\(\)](#).



Collaboration diagram for GiNaC::function\_options:



## Public Member Functions

- `function_options` ()
- `function_options` (std::string const &n, std::string const &tn=std::string())
- `function_options` (std::string const &n, unsigned np)
- `~function_options` ()
- void `initialize` ()
- `function_options` & `dummy` ()
- `function_options` & `set_name` (std::string const &n, std::string const &tn=std::string())
- `function_options` & `latex_name` (std::string const &tn)
- `function_options` & `eval_func` (eval\_funcp\_1 e)
- `function_options` & `eval_func` (eval\_funcp\_2 e)
- `function_options` & `eval_func` (eval\_funcp\_3 e)
- `function_options` & `eval_func` (eval\_funcp\_4 e)
- `function_options` & `eval_func` (eval\_funcp\_5 e)





- Generated by Doxygen

- [function\\_options](#) & [power\\_func](#) ([power\\_funcp\\_4](#) e)
- [function\\_options](#) & [power\\_func](#) ([power\\_funcp\\_5](#) e)
- [function\\_options](#) & [power\\_func](#) ([power\\_funcp\\_6](#) e)
- [function\\_options](#) & [power\\_func](#) ([power\\_funcp\\_7](#) e)
- [function\\_options](#) & [power\\_func](#) ([power\\_funcp\\_8](#) e)
- [function\\_options](#) & [power\\_func](#) ([power\\_funcp\\_9](#) e)
- [function\\_options](#) & [power\\_func](#) ([power\\_funcp\\_10](#) e)
- [function\\_options](#) & [power\\_func](#) ([power\\_funcp\\_11](#) e)
- [function\\_options](#) & [power\\_func](#) ([power\\_funcp\\_12](#) e)
- [function\\_options](#) & [power\\_func](#) ([power\\_funcp\\_13](#) e)
- [function\\_options](#) & [power\\_func](#) ([power\\_funcp\\_14](#) e)
- [function\\_options](#) & [series\\_func](#) ([series\\_funcp\\_1](#) e)
- [function\\_options](#) & [series\\_func](#) ([series\\_funcp\\_2](#) e)
- [function\\_options](#) & [series\\_func](#) ([series\\_funcp\\_3](#) e)
- [function\\_options](#) & [series\\_func](#) ([series\\_funcp\\_4](#) e)
- [function\\_options](#) & [series\\_func](#) ([series\\_funcp\\_5](#) e)
- [function\\_options](#) & [series\\_func](#) ([series\\_funcp\\_6](#) e)
- [function\\_options](#) & [series\\_func](#) ([series\\_funcp\\_7](#) e)
- [function\\_options](#) & [series\\_func](#) ([series\\_funcp\\_8](#) e)
- [function\\_options](#) & [series\\_func](#) ([series\\_funcp\\_9](#) e)
- [function\\_options](#) & [series\\_func](#) ([series\\_funcp\\_10](#) e)
- [function\\_options](#) & [series\\_func](#) ([series\\_funcp\\_11](#) e)
- [function\\_options](#) & [series\\_func](#) ([series\\_funcp\\_12](#) e)
- [function\\_options](#) & [series\\_func](#) ([series\\_funcp\\_13](#) e)
- [function\\_options](#) & [series\\_func](#) ([series\\_funcp\\_14](#) e)
- [function\\_options](#) & [info\\_func](#) ([info\\_funcp\\_1](#) e)
- [function\\_options](#) & [info\\_func](#) ([info\\_funcp\\_2](#) e)
- [function\\_options](#) & [info\\_func](#) ([info\\_funcp\\_3](#) e)
- [function\\_options](#) & [info\\_func](#) ([info\\_funcp\\_4](#) e)
- [function\\_options](#) & [info\\_func](#) ([info\\_funcp\\_5](#) e)
- [function\\_options](#) & [info\\_func](#) ([info\\_funcp\\_6](#) e)
- [function\\_options](#) & [info\\_func](#) ([info\\_funcp\\_7](#) e)
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- [function\\_options](#) & [info\\_func](#) ([info\\_funcp\\_10](#) e)
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- [function\\_options](#) & [info\\_func](#) ([info\\_funcp\\_12](#) e)
- [function\\_options](#) & [info\\_func](#) ([info\\_funcp\\_13](#) e)
- [function\\_options](#) & [info\\_func](#) ([info\\_funcp\\_14](#) e)
- [function\\_options](#) & [eval\\_func](#) ([eval\\_funcp\\_exvector](#) e)
- [function\\_options](#) & [evalf\\_func](#) ([evalf\\_funcp\\_exvector](#) e)
- [function\\_options](#) & [conjugate\\_func](#) ([conjugate\\_funcp\\_exvector](#) e)
- [function\\_options](#) & [real\\_part\\_func](#) ([real\\_part\\_funcp\\_exvector](#) e)
- [function\\_options](#) & [imag\\_part\\_func](#) ([imag\\_part\\_funcp\\_exvector](#) e)
- [function\\_options](#) & [expand\\_func](#) ([expand\\_funcp\\_exvector](#) e)
- [function\\_options](#) & [derivative\\_func](#) ([derivative\\_funcp\\_exvector](#) e)
- [function\\_options](#) & [expl\\_derivative\\_func](#) ([expl\\_derivative\\_funcp\\_exvector](#) e)
- [function\\_options](#) & [power\\_func](#) ([power\\_funcp\\_exvector](#) e)
- [function\\_options](#) & [series\\_func](#) ([series\\_funcp\\_exvector](#) e)
- [function\\_options](#) & [info\\_func](#) ([info\\_funcp\\_exvector](#) e)
- [template<class Ctx>](#)  
[function\\_options](#) & [print\\_func](#) ([print\\_funcp\\_1](#) p)
- [template<class Ctx>](#)  
[function\\_options](#) & [print\\_func](#) ([print\\_funcp\\_2](#) p)

- `template<class Ctx>`  
`function_options` & `print_func` (`print_funcp_3` p)
- `template<class Ctx>`  
`function_options` & `print_func` (`print_funcp_4` p)
- `template<class Ctx>`  
`function_options` & `print_func` (`print_funcp_5` p)
- `template<class Ctx>`  
`function_options` & `print_func` (`print_funcp_6` p)
- `template<class Ctx>`  
`function_options` & `print_func` (`print_funcp_7` p)
- `template<class Ctx>`  
`function_options` & `print_func` (`print_funcp_8` p)
- `template<class Ctx>`  
`function_options` & `print_func` (`print_funcp_9` p)
- `template<class Ctx>`  
`function_options` & `print_func` (`print_funcp_10` p)
- `template<class Ctx>`  
`function_options` & `print_func` (`print_funcp_11` p)
- `template<class Ctx>`  
`function_options` & `print_func` (`print_funcp_12` p)
- `template<class Ctx>`  
`function_options` & `print_func` (`print_funcp_13` p)
- `template<class Ctx>`  
`function_options` & `print_func` (`print_funcp_14` p)
- `template<class Ctx>`  
`function_options` & `print_func` (`print_funcp_exvector` p)
- `function_options` & `set_return_type` (unsigned rt, const `return_type_t` \*rtt=nullptr)
- `function_options` & `do_not_evalf_params` ()
- `function_options` & `remember` (unsigned size, unsigned assoc\_size=0, unsigned strategy=`remember_strategies::delete_never`)
- `function_options` & `overloaded` (unsigned o)
- `function_options` & `set_symmetry` (const `symmetry` &s)
- `std::string` `get_name` () const
- unsigned `get_nparams` () const

### Protected Member Functions

- bool `has_derivative` () const
- bool `has_power` () const
- void `test_and_set_nparams` (unsigned n)
- void `set_print_func` (unsigned id, `print_funcp` f)

### Protected Attributes

- `std::string` `name`
- `std::string` `TeX_name`
- unsigned `nparams`
- `eval_funcp` `eval_f`
- `evalf_funcp` `evalf_f`
- `conjugate_funcp` `conjugate_f`
- `real_part_funcp` `real_part_f`
- `imag_part_funcp` `imag_part_f`
- `expand_funcp` `expand_f`
- `derivative_funcp` `derivative_f`
- `expl_derivative_funcp` `expl_derivative_f`



### 6.64.1.2 function options() [2/3]

References `initialize()`, and `set name()`.

References [initialize\(\)](#), [nparams](#), and [set\\_name\(\)](#).

### 6.64.2 Member Function Documentation

Referenced by [function options\(\)](#), [function options\(\)](#), and [function options\(\)](#).

### 6.64.2.2 dummy()

```
function_options & GiNaC::function_options::dummy () [inline]
```

References [function\\_options\(\)](#).

### 6.64.2.3 set\_name()

```
function_options & GiNaC::function_options::set_name (
 std::string const & n,
 std::string const & tn = std::string())
```

References [function\\_options\(\)](#), [name](#), and [TeX\\_name](#).

Referenced by [function\\_options\(\)](#), [function\\_options\(\)](#), and [initialize\(\)](#).

### 6.64.2.4 latex\_name()

```
function_options & GiNaC::function_options::latex_name (
 std::string const & tn)
```

References [function\\_options\(\)](#), and [TeX\\_name](#).

### 6.64.2.5 eval\_func() [1/15]

```
function_options & GiNaC::function_options::eval_func (
 eval_funcp_1 e)
```

References [eval\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

### 6.64.2.6 eval\_func() [2/15]

```
function_options & GiNaC::function_options::eval_func (
 eval_funcp_2 e)
```

References [eval\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

### 6.64.2.7 eval\_func() [3/15]

```
function_options & GiNaC::function_options::eval_func (
 eval_funcp_3 e)
```

References [eval\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.8 eval\_func()** [4/15]

```
function_options & GiNaC::function_options::eval_func (
 eval_funcp_4 e)
```

References [eval\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.9 eval\_func()** [5/15]

```
function_options & GiNaC::function_options::eval_func (
 eval_funcp_5 e)
```

References [eval\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.10 eval\_func()** [6/15]

```
function_options & GiNaC::function_options::eval_func (
 eval_funcp_6 e)
```

References [eval\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.11 eval\_func()** [7/15]

```
function_options & GiNaC::function_options::eval_func (
 eval_funcp_7 e)
```

References [eval\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.12 eval\_func()** [8/15]

```
function_options & GiNaC::function_options::eval_func (
 eval_funcp_8 e)
```

References [eval\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.13 eval\_func()** [9/15]

```
function_options & GiNaC::function_options::eval_func (
 eval_funcp_9 e)
```

References [eval\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.14 eval\_func()** [10/15]

```
function_options & GiNaC::function_options::eval_func (
 eval_funcp_10 e)
```

References [eval\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.15 eval\_func()** [11/15]

```
function_options & GiNaC::function_options::eval_func (
 eval_funcp_11 e)
```

References [eval\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.16 eval\_func()** [12/15]

```
function_options & GiNaC::function_options::eval_func (
 eval_funcp_12 e)
```

References [eval\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.17 eval\_func()** [13/15]

```
function_options & GiNaC::function_options::eval_func (
 eval_funcp_13 e)
```

References [eval\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.18 eval\_func()** [14/15]

```
function_options & GiNaC::function_options::eval_func (
 eval_funcp_14 e)
```

References [eval\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.19 evalf\_func()** [1/15]

```
function_options & GiNaC::function_options::evalf_func (
 evalf_funcp_1 e)
```

References [evalf\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.20 evalf\_func()** [2/15]

```
function_options & GiNaC::function_options::evalf_func (
 evalf_funcp_2 e)
```

References [evalf\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.21 evalf\_func()** [3/15]

```
function_options & GiNaC::function_options::evalf_func (
 evalf_funcp_3 e)
```

References [evalf\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).



**6.64.2.22 evalf\_func()** [4/15]

```
function_options & GiNaC::function_options::evalf_func (
 evalf_funcp_4 e)
```

References [evalf\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.23 evalf\_func()** [5/15]

```
function_options & GiNaC::function_options::evalf_func (
 evalf_funcp_5 e)
```

References [evalf\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.24 evalf\_func()** [6/15]

```
function_options & GiNaC::function_options::evalf_func (
 evalf_funcp_6 e)
```

References [evalf\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.25 evalf\_func()** [7/15]

```
function_options & GiNaC::function_options::evalf_func (
 evalf_funcp_7 e)
```

References [evalf\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.26 evalf\_func()** [8/15]

```
function_options & GiNaC::function_options::evalf_func (
 evalf_funcp_8 e)
```

References [evalf\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.27 evalf\_func()** [9/15]

```
function_options & GiNaC::function_options::evalf_func (
 evalf_funcp_9 e)
```

References [evalf\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.28 evalf\_func()** [10/15]

```
function_options & GiNaC::function_options::evalf_func (
 evalf_funcp_10 e)
```

References [evalf\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.29 evalf\_func()** [11/15]

```
function_options & GiNaC::function_options::evalf_func (
 evalf_funcp_11 e)
```

References [evalf\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.30 evalf\_func()** [12/15]

```
function_options & GiNaC::function_options::evalf_func (
 evalf_funcp_12 e)
```

References [evalf\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.31 evalf\_func()** [13/15]

```
function_options & GiNaC::function_options::evalf_func (
 evalf_funcp_13 e)
```

References [evalf\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.32 evalf\_func()** [14/15]

```
function_options & GiNaC::function_options::evalf_func (
 evalf_funcp_14 e)
```

References [evalf\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.33 conjugate\_func()** [1/15]

```
function_options & GiNaC::function_options::conjugate_func (
 conjugate_funcp_1 e)
```

References [conjugate\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.34 conjugate\_func()** [2/15]

```
function_options & GiNaC::function_options::conjugate_func (
 conjugate_funcp_2 e)
```

References [conjugate\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.35 conjugate\_func()** [3/15]

```
function_options & GiNaC::function_options::conjugate_func (
 conjugate_funcp_3 e)
```

References [conjugate\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.36 conjugate\_func()** [4/15]

```
function_options & GiNaC::function_options::conjugate_func (
 conjugate_funcp_4 e)
```

References [conjugate\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.37 conjugate\_func()** [5/15]

```
function_options & GiNaC::function_options::conjugate_func (
 conjugate_funcp_5 e)
```

References [conjugate\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.38 conjugate\_func()** [6/15]

```
function_options & GiNaC::function_options::conjugate_func (
 conjugate_funcp_6 e)
```

References [conjugate\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.39 conjugate\_func()** [7/15]

```
function_options & GiNaC::function_options::conjugate_func (
 conjugate_funcp_7 e)
```

References [conjugate\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.40 conjugate\_func()** [8/15]

```
function_options & GiNaC::function_options::conjugate_func (
 conjugate_funcp_8 e)
```

References [conjugate\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.41 conjugate\_func()** [9/15]

```
function_options & GiNaC::function_options::conjugate_func (
 conjugate_funcp_9 e)
```

References [conjugate\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.42 conjugate\_func()** [10/15]

```
function_options & GiNaC::function_options::conjugate_func (
 conjugate_funcp_10 e)
```

References [conjugate\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.43 conjugate\_func()** [11/15]

```
function_options & GiNaC::function_options::conjugate_func (
 conjugate_funcp_11 e)
```

References [conjugate\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.44 conjugate\_func()** [12/15]

```
function_options & GiNaC::function_options::conjugate_func (
 conjugate_funcp_12 e)
```

References [conjugate\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.45 conjugate\_func()** [13/15]

```
function_options & GiNaC::function_options::conjugate_func (
 conjugate_funcp_13 e)
```

References [conjugate\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.46 conjugate\_func()** [14/15]

```
function_options & GiNaC::function_options::conjugate_func (
 conjugate_funcp_14 e)
```

References [conjugate\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.47 real\_part\_func()** [1/15]

```
function_options & GiNaC::function_options::real_part_func (
 real_part_funcp_1 e)
```

References [function\\_options\(\)](#), [real\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.48 real\_part\_func()** [2/15]

```
function_options & GiNaC::function_options::real_part_func (
 real_part_funcp_2 e)
```

References [function\\_options\(\)](#), [real\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.49 real\_part\_func()** [3/15]

```
function_options & GiNaC::function_options::real_part_func (
 real_part_funcp_3 e)
```

References [function\\_options\(\)](#), [real\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.50 real\_part\_func()** [4/15]

```
function_options & GiNaC::function_options::real_part_func (
 real_part_funcp_4 e)
```

References [function\\_options\(\)](#), [real\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.51 real\_part\_func()** [5/15]

```
function_options & GiNaC::function_options::real_part_func (
 real_part_funcp_5 e)
```

References [function\\_options\(\)](#), [real\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.52 real\_part\_func()** [6/15]

```
function_options & GiNaC::function_options::real_part_func (
 real_part_funcp_6 e)
```

References [function\\_options\(\)](#), [real\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.53 real\_part\_func()** [7/15]

```
function_options & GiNaC::function_options::real_part_func (
 real_part_funcp_7 e)
```

References [function\\_options\(\)](#), [real\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.54 real\_part\_func()** [8/15]

```
function_options & GiNaC::function_options::real_part_func (
 real_part_funcp_8 e)
```

References [function\\_options\(\)](#), [real\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.55 real\_part\_func()** [9/15]

```
function_options & GiNaC::function_options::real_part_func (
 real_part_funcp_9 e)
```

References [function\\_options\(\)](#), [real\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.56 real\_part\_func()** [10/15]

```
function_options & GiNaC::function_options::real_part_func (
 real_part_funcp_10 e)
```

References [function\\_options\(\)](#), [real\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.57 real\_part\_func()** [11/15]

```
function_options & GiNaC::function_options::real_part_func (
 real_part_funcp_11 e)
```

References [function\\_options\(\)](#), [real\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.58 real\_part\_func()** [12/15]

```
function_options & GiNaC::function_options::real_part_func (
 real_part_funcp_12 e)
```

References [function\\_options\(\)](#), [real\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.59 real\_part\_func()** [13/15]

```
function_options & GiNaC::function_options::real_part_func (
 real_part_funcp_13 e)
```

References [function\\_options\(\)](#), [real\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.60 real\_part\_func()** [14/15]

```
function_options & GiNaC::function_options::real_part_func (
 real_part_funcp_14 e)
```

References [function\\_options\(\)](#), [real\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.61 imag\_part\_func()** [1/15]

```
function_options & GiNaC::function_options::imag_part_func (
 imag_part_funcp_1 e)
```

References [function\\_options\(\)](#), [imag\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.62 imag\_part\_func()** [2/15]

```
function_options & GiNaC::function_options::imag_part_func (
 imag_part_funcp_2 e)
```

References [function\\_options\(\)](#), [imag\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.63 imag\_part\_func()** [3/15]

```
function_options & GiNaC::function_options::imag_part_func (
 imag_part_funcp_3 e)
```

References [function\\_options\(\)](#), [imag\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.64 imag\_part\_func()** [4/15]

```
function_options & GiNaC::function_options::imag_part_func (
 imag_part_funcp_4 e)
```

References [function\\_options\(\)](#), [imag\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.65 imag\_part\_func()** [5/15]

```
function_options & GiNaC::function_options::imag_part_func (
 imag_part_funcp_5 e)
```

References [function\\_options\(\)](#), [imag\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.66 imag\_part\_func()** [6/15]

```
function_options & GiNaC::function_options::imag_part_func (
 imag_part_funcp_6 e)
```

References [function\\_options\(\)](#), [imag\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.67 imag\_part\_func()** [7/15]

```
function_options & GiNaC::function_options::imag_part_func (
 imag_part_funcp_7 e)
```

References [function\\_options\(\)](#), [imag\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.68 imag\_part\_func()** [8/15]

```
function_options & GiNaC::function_options::imag_part_func (
 imag_part_funcp_8 e)
```

References [function\\_options\(\)](#), [imag\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.69 imag\_part\_func()** [9/15]

```
function_options & GiNaC::function_options::imag_part_func (
 imag_part_funcp_9 e)
```

References [function\\_options\(\)](#), [imag\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.70 imag\_part\_func()** [10/15]

```
function_options & GiNaC::function_options::imag_part_func (
 imag_part_funcp_10 e)
```

References [function\\_options\(\)](#), [imag\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.71 imag\_part\_func()** [11/15]

```
function_options & GiNaC::function_options::imag_part_func (
 imag_part_funcp_11 e)
```

References [function\\_options\(\)](#), [imag\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.72 imag\_part\_func()** [12/15]

```
function_options & GiNaC::function_options::imag_part_func (
 imag_part_funcp_12 e)
```

References [function\\_options\(\)](#), [imag\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.73 imag\_part\_func()** [13/15]

```
function_options & GiNaC::function_options::imag_part_func (
 imag_part_funcp_13 e)
```

References [function\\_options\(\)](#), [imag\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.74 imag\_part\_func()** [14/15]

```
function_options & GiNaC::function_options::imag_part_func (
 imag_part_funcp_14 e)
```

References [function\\_options\(\)](#), [imag\\_part\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.75 expand\_func()** [1/15]

```
function_options & GiNaC::function_options::expand_func (
 expand_funcp_1 e)
```

References [expand\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.76 expand\_func()** [2/15]

```
function_options & GiNaC::function_options::expand_func (
 expand_funcp_2 e)
```

References [expand\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.77 expand\_func()** [3/15]

```
function_options & GiNaC::function_options::expand_func (
 expand_funcp_3 e)
```

References [expand\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).



**6.64.2.78 expand\_func()** [4/15]

```
function_options & GiNaC::function_options::expand_func (
 expand_funcp_4 e)
```

References [expand\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.79 expand\_func()** [5/15]

```
function_options & GiNaC::function_options::expand_func (
 expand_funcp_5 e)
```

References [expand\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.80 expand\_func()** [6/15]

```
function_options & GiNaC::function_options::expand_func (
 expand_funcp_6 e)
```

References [expand\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.81 expand\_func()** [7/15]

```
function_options & GiNaC::function_options::expand_func (
 expand_funcp_7 e)
```

References [expand\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.82 expand\_func()** [8/15]

```
function_options & GiNaC::function_options::expand_func (
 expand_funcp_8 e)
```

References [expand\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.83 expand\_func()** [9/15]

```
function_options & GiNaC::function_options::expand_func (
 expand_funcp_9 e)
```

References [expand\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.84 expand\_func()** [10/15]

```
function_options & GiNaC::function_options::expand_func (
 expand_funcp_10 e)
```

References [expand\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.85 expand\_func()** [11/15]

```
function_options & GiNaC::function_options::expand_func (
 expand_funcp_11 e)
```

References [expand\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.86 expand\_func()** [12/15]

```
function_options & GiNaC::function_options::expand_func (
 expand_funcp_12 e)
```

References [expand\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.87 expand\_func()** [13/15]

```
function_options & GiNaC::function_options::expand_func (
 expand_funcp_13 e)
```

References [expand\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.88 expand\_func()** [14/15]

```
function_options & GiNaC::function_options::expand_func (
 expand_funcp_14 e)
```

References [expand\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.89 derivative\_func()** [1/15]

```
function_options & GiNaC::function_options::derivative_func (
 derivative_funcp_1 e)
```

References [derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.90 derivative\_func()** [2/15]

```
function_options & GiNaC::function_options::derivative_func (
 derivative_funcp_2 e)
```

References [derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.91 derivative\_func()** [3/15]

```
function_options & GiNaC::function_options::derivative_func (
 derivative_funcp_3 e)
```

References [derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.92 derivative\_func()** [4/15]

```
function_options & GiNaC::function_options::derivative_func (
 derivative_funcp_4 e)
```

References [derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.93 derivative\_func()** [5/15]

```
function_options & GiNaC::function_options::derivative_func (
 derivative_funcp_5 e)
```

References [derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.94 derivative\_func()** [6/15]

```
function_options & GiNaC::function_options::derivative_func (
 derivative_funcp_6 e)
```

References [derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.95 derivative\_func()** [7/15]

```
function_options & GiNaC::function_options::derivative_func (
 derivative_funcp_7 e)
```

References [derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.96 derivative\_func()** [8/15]

```
function_options & GiNaC::function_options::derivative_func (
 derivative_funcp_8 e)
```

References [derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.97 derivative\_func()** [9/15]

```
function_options & GiNaC::function_options::derivative_func (
 derivative_funcp_9 e)
```

References [derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.98 derivative\_func()** [10/15]

```
function_options & GiNaC::function_options::derivative_func (
 derivative_funcp_10 e)
```

References [derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.99 derivative\_func()** [11/15]

```
function_options & GiNaC::function_options::derivative_func (
 derivative_funcp_11 e)
```

References [derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.100 derivative\_func()** [12/15]

```
function_options & GiNaC::function_options::derivative_func (
 derivative_funcp_12 e)
```

References [derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.101 derivative\_func()** [13/15]

```
function_options & GiNaC::function_options::derivative_func (
 derivative_funcp_13 e)
```

References [derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.102 derivative\_func()** [14/15]

```
function_options & GiNaC::function_options::derivative_func (
 derivative_funcp_14 e)
```

References [derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.103 expl\_derivative\_func()** [1/15]

```
function_options & GiNaC::function_options::expl_derivative_func (
 expl_derivative_funcp_1 e)
```

References [expl\\_derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.104 expl\_derivative\_func()** [2/15]

```
function_options & GiNaC::function_options::expl_derivative_func (
 expl_derivative_funcp_2 e)
```

References [expl\\_derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.105 expl\_derivative\_func()** [3/15]

```
function_options & GiNaC::function_options::expl_derivative_func (
 expl_derivative_funcp_3 e)
```

References [expl\\_derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.106 expl\_derivative\_func() [4/15]**

```
function_options & GiNaC::function_options::expl_derivative_func (
 expl_derivative_funcp_4 e)
```

References [expl\\_derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.107 expl\_derivative\_func() [5/15]**

```
function_options & GiNaC::function_options::expl_derivative_func (
 expl_derivative_funcp_5 e)
```

References [expl\\_derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.108 expl\_derivative\_func() [6/15]**

```
function_options & GiNaC::function_options::expl_derivative_func (
 expl_derivative_funcp_6 e)
```

References [expl\\_derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.109 expl\_derivative\_func() [7/15]**

```
function_options & GiNaC::function_options::expl_derivative_func (
 expl_derivative_funcp_7 e)
```

References [expl\\_derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.110 expl\_derivative\_func() [8/15]**

```
function_options & GiNaC::function_options::expl_derivative_func (
 expl_derivative_funcp_8 e)
```

References [expl\\_derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.111 expl\_derivative\_func() [9/15]**

```
function_options & GiNaC::function_options::expl_derivative_func (
 expl_derivative_funcp_9 e)
```

References [expl\\_derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.112 expl\_derivative\_func() [10/15]**

```
function_options & GiNaC::function_options::expl_derivative_func (
 expl_derivative_funcp_10 e)
```

References [expl\\_derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.113 expl\_derivative\_func() [11/15]**

```
function_options & GiNaC::function_options::expl_derivative_func (
 expl_derivative_funcp_11 e)
```

References [expl\\_derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.114 expl\_derivative\_func() [12/15]**

```
function_options & GiNaC::function_options::expl_derivative_func (
 expl_derivative_funcp_12 e)
```

References [expl\\_derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.115 expl\_derivative\_func() [13/15]**

```
function_options & GiNaC::function_options::expl_derivative_func (
 expl_derivative_funcp_13 e)
```

References [expl\\_derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.116 expl\_derivative\_func() [14/15]**

```
function_options & GiNaC::function_options::expl_derivative_func (
 expl_derivative_funcp_14 e)
```

References [expl\\_derivative\\_f](#), [function\\_options\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.117 power\_func() [1/15]**

```
function_options & GiNaC::function_options::power_func (
 power_funcp_1 e)
```

References [function\\_options\(\)](#), [power\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.118 power\_func() [2/15]**

```
function_options & GiNaC::function_options::power_func (
 power_funcp_2 e)
```

References [function\\_options\(\)](#), [power\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.119 power\_func() [3/15]**

```
function_options & GiNaC::function_options::power_func (
 power_funcp_3 e)
```

References [function\\_options\(\)](#), [power\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.120 power\_func()** [4/15]

```
function_options & GiNaC::function_options::power_func (
 power_funcp_4 e)
```

References [function\\_options\(\)](#), [power\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.121 power\_func()** [5/15]

```
function_options & GiNaC::function_options::power_func (
 power_funcp_5 e)
```

References [function\\_options\(\)](#), [power\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.122 power\_func()** [6/15]

```
function_options & GiNaC::function_options::power_func (
 power_funcp_6 e)
```

References [function\\_options\(\)](#), [power\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.123 power\_func()** [7/15]

```
function_options & GiNaC::function_options::power_func (
 power_funcp_7 e)
```

References [function\\_options\(\)](#), [power\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.124 power\_func()** [8/15]

```
function_options & GiNaC::function_options::power_func (
 power_funcp_8 e)
```

References [function\\_options\(\)](#), [power\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.125 power\_func()** [9/15]

```
function_options & GiNaC::function_options::power_func (
 power_funcp_9 e)
```

References [function\\_options\(\)](#), [power\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.126 power\_func()** [10/15]

```
function_options & GiNaC::function_options::power_func (
 power_funcp_10 e)
```

References [function\\_options\(\)](#), [power\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.127 power\_func()** [11/15]

```
function_options & GiNaC::function_options::power_func (
 power_funcp_11 e)
```

References [function\\_options\(\)](#), [power\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.128 power\_func()** [12/15]

```
function_options & GiNaC::function_options::power_func (
 power_funcp_12 e)
```

References [function\\_options\(\)](#), [power\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.129 power\_func()** [13/15]

```
function_options & GiNaC::function_options::power_func (
 power_funcp_13 e)
```

References [function\\_options\(\)](#), [power\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.130 power\_func()** [14/15]

```
function_options & GiNaC::function_options::power_func (
 power_funcp_14 e)
```

References [function\\_options\(\)](#), [power\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.131 series\_func()** [1/15]

```
function_options & GiNaC::function_options::series_func (
 series_funcp_1 e)
```

References [function\\_options\(\)](#), [series\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.132 series\_func()** [2/15]

```
function_options & GiNaC::function_options::series_func (
 series_funcp_2 e)
```

References [function\\_options\(\)](#), [series\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.133 series\_func()** [3/15]

```
function_options & GiNaC::function_options::series_func (
 series_funcp_3 e)
```

References [function\\_options\(\)](#), [series\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).



**6.64.2.134 series\_func()** [4/15]

```
function_options & GiNaC::function_options::series_func (
 series_funcp_4 e)
```

References [function\\_options\(\)](#), [series\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.135 series\_func()** [5/15]

```
function_options & GiNaC::function_options::series_func (
 series_funcp_5 e)
```

References [function\\_options\(\)](#), [series\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.136 series\_func()** [6/15]

```
function_options & GiNaC::function_options::series_func (
 series_funcp_6 e)
```

References [function\\_options\(\)](#), [series\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.137 series\_func()** [7/15]

```
function_options & GiNaC::function_options::series_func (
 series_funcp_7 e)
```

References [function\\_options\(\)](#), [series\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.138 series\_func()** [8/15]

```
function_options & GiNaC::function_options::series_func (
 series_funcp_8 e)
```

References [function\\_options\(\)](#), [series\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.139 series\_func()** [9/15]

```
function_options & GiNaC::function_options::series_func (
 series_funcp_9 e)
```

References [function\\_options\(\)](#), [series\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.140 series\_func()** [10/15]

```
function_options & GiNaC::function_options::series_func (
 series_funcp_10 e)
```

References [function\\_options\(\)](#), [series\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.141 series\_func()** [11/15]

```
function_options & GiNaC::function_options::series_func (
 series_funcp_11 e)
```

References [function\\_options\(\)](#), [series\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.142 series\_func()** [12/15]

```
function_options & GiNaC::function_options::series_func (
 series_funcp_12 e)
```

References [function\\_options\(\)](#), [series\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.143 series\_func()** [13/15]

```
function_options & GiNaC::function_options::series_func (
 series_funcp_13 e)
```

References [function\\_options\(\)](#), [series\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.144 series\_func()** [14/15]

```
function_options & GiNaC::function_options::series_func (
 series_funcp_14 e)
```

References [function\\_options\(\)](#), [series\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.145 info\_func()** [1/15]

```
function_options & GiNaC::function_options::info_func (
 info_funcp_1 e)
```

References [function\\_options\(\)](#), [info\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.146 info\_func()** [2/15]

```
function_options & GiNaC::function_options::info_func (
 info_funcp_2 e)
```

References [function\\_options\(\)](#), [info\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.147 info\_func()** [3/15]

```
function_options & GiNaC::function_options::info_func (
 info_funcp_3 e)
```

References [function\\_options\(\)](#), [info\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.148 info\_func()** [4/15]

```
function_options & GiNaC::function_options::info_func (
 info_funcp_4 e)
```

References [function\\_options\(\)](#), [info\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.149 info\_func()** [5/15]

```
function_options & GiNaC::function_options::info_func (
 info_funcp_5 e)
```

References [function\\_options\(\)](#), [info\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.150 info\_func()** [6/15]

```
function_options & GiNaC::function_options::info_func (
 info_funcp_6 e)
```

References [function\\_options\(\)](#), [info\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.151 info\_func()** [7/15]

```
function_options & GiNaC::function_options::info_func (
 info_funcp_7 e)
```

References [function\\_options\(\)](#), [info\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.152 info\_func()** [8/15]

```
function_options & GiNaC::function_options::info_func (
 info_funcp_8 e)
```

References [function\\_options\(\)](#), [info\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.153 info\_func()** [9/15]

```
function_options & GiNaC::function_options::info_func (
 info_funcp_9 e)
```

References [function\\_options\(\)](#), [info\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.154 info\_func()** [10/15]

```
function_options & GiNaC::function_options::info_func (
 info_funcp_10 e)
```

References [function\\_options\(\)](#), [info\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.155 info\_func()** [11/15]

```
function_options & GiNaC::function_options::info_func (
 info_funcp_11 e)
```

References [function\\_options\(\)](#), [info\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.156 info\_func()** [12/15]

```
function_options & GiNaC::function_options::info_func (
 info_funcp_12 e)
```

References [function\\_options\(\)](#), [info\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.157 info\_func()** [13/15]

```
function_options & GiNaC::function_options::info_func (
 info_funcp_13 e)
```

References [function\\_options\(\)](#), [info\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.158 info\_func()** [14/15]

```
function_options & GiNaC::function_options::info_func (
 info_funcp_14 e)
```

References [function\\_options\(\)](#), [info\\_f](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.159 eval\_func()** [15/15]

```
function_options & GiNaC::function_options::eval_func (
 eval_funcp_exvector e)
```

References [eval\\_f](#), [eval\\_use\\_exvector\\_args](#), and [function\\_options\(\)](#).

**6.64.2.160 evalf\_func()** [15/15]

```
function_options & GiNaC::function_options::evalf_func (
 evalf_funcp_exvector e)
```

References [evalf\\_f](#), [evalf\\_use\\_exvector\\_args](#), and [function\\_options\(\)](#).

**6.64.2.161 conjugate\_func()** [15/15]

```
function_options & GiNaC::function_options::conjugate_func (
 conjugate_funcp_exvector e)
```

References [conjugate\\_f](#), [conjugate\\_use\\_exvector\\_args](#), and [function\\_options\(\)](#).

**6.64.2.162 real\_part\_func()** [15/15]

```
function_options & GiNaC::function_options::real_part_func (
 real_part_funcp_exvector e)
```

References [function\\_options\(\)](#), [real\\_part\\_f](#), and [real\\_part\\_use\\_exvector\\_args](#).

**6.64.2.163 imag\_part\_func()** [15/15]

```
function_options & GiNaC::function_options::imag_part_func (
 imag_part_funcp_exvector e)
```

References [function\\_options\(\)](#), [imag\\_part\\_f](#), and [imag\\_part\\_use\\_exvector\\_args](#).

**6.64.2.164 expand\_func()** [15/15]

```
function_options & GiNaC::function_options::expand_func (
 expand_funcp_exvector e)
```

References [expand\\_f](#), [expand\\_use\\_exvector\\_args](#), and [function\\_options\(\)](#).

**6.64.2.165 derivative\_func()** [15/15]

```
function_options & GiNaC::function_options::derivative_func (
 derivative_funcp_exvector e)
```

References [derivative\\_f](#), [derivative\\_use\\_exvector\\_args](#), and [function\\_options\(\)](#).

**6.64.2.166 expl\_derivative\_func()** [15/15]

```
function_options & GiNaC::function_options::expl_derivative_func (
 expl_derivative_funcp_exvector e)
```

References [expl\\_derivative\\_f](#), [expl\\_derivative\\_use\\_exvector\\_args](#), and [function\\_options\(\)](#).

**6.64.2.167 power\_func()** [15/15]

```
function_options & GiNaC::function_options::power_func (
 power_funcp_exvector e)
```

References [function\\_options\(\)](#), [power\\_f](#), and [power\\_use\\_exvector\\_args](#).

**6.64.2.168 series\_func()** [15/15]

```
function_options & GiNaC::function_options::series_func (
 series_funcp_exvector e)
```

References [function\\_options\(\)](#), [series\\_f](#), and [series\\_use\\_exvector\\_args](#).

**6.64.2.169 info\_func()** [15/15]

```
function_options & GiNaC::function_options::info_func (
 info_funcp_exvector e)
```

References [function\\_options\(\)](#), [info\\_f](#), and [info\\_use\\_exvector\\_args](#).

**6.64.2.170 print\_func()** [1/15]

```
template<class Ctx>
function_options & GiNaC::function_options::print_func (
 print_funcp_1 p) [inline]
```

References [function\\_options\(\)](#), [set\\_print\\_func\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.171 print\_func()** [2/15]

```
template<class Ctx>
function_options & GiNaC::function_options::print_func (
 print_funcp_2 p) [inline]
```

References [function\\_options\(\)](#), [set\\_print\\_func\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.172 print\_func()** [3/15]

```
template<class Ctx>
function_options & GiNaC::function_options::print_func (
 print_funcp_3 p) [inline]
```

References [function\\_options\(\)](#), [set\\_print\\_func\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.173 print\_func()** [4/15]

```
template<class Ctx>
function_options & GiNaC::function_options::print_func (
 print_funcp_4 p) [inline]
```

References [function\\_options\(\)](#), [set\\_print\\_func\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.174 print\_func()** [5/15]

```
template<class Ctx>
function_options & GiNaC::function_options::print_func (
 print_funcp_5 p) [inline]
```

References [function\\_options\(\)](#), [set\\_print\\_func\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.175 print\_func()** [6/15]

```
template<class Ctx>
function_options & GiNaC::function_options::print_func (
 print_funcp_6 p) [inline]
```

References [function\\_options\(\)](#), [set\\_print\\_func\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.176 print\_func()** [7/15]

```
template<class Ctx>
function_options & GiNaC::function_options::print_func (
 print_funcp_7 p) [inline]
```

References [function\\_options\(\)](#), [set\\_print\\_func\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.177 print\_func()** [8/15]

```
template<class Ctx>
function_options & GiNaC::function_options::print_func (
 print_funcp_8 p) [inline]
```

References [function\\_options\(\)](#), [set\\_print\\_func\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.178 print\_func()** [9/15]

```
template<class Ctx>
function_options & GiNaC::function_options::print_func (
 print_funcp_9 p) [inline]
```

References [function\\_options\(\)](#), [set\\_print\\_func\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.179 print\_func()** [10/15]

```
template<class Ctx>
function_options & GiNaC::function_options::print_func (
 print_funcp_10 p) [inline]
```

References [function\\_options\(\)](#), [set\\_print\\_func\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.180 print\_func()** [11/15]

```
template<class Ctx>
function_options & GiNaC::function_options::print_func (
 print_funcp_11 p) [inline]
```

References [function\\_options\(\)](#), [set\\_print\\_func\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.181 print\_func() [12/15]**

```
template<class Ctx>
function_options & GiNaC::function_options::print_func (
 print_funcp_12 p) [inline]
```

References [function\\_options\(\)](#), [set\\_print\\_func\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.182 print\_func() [13/15]**

```
template<class Ctx>
function_options & GiNaC::function_options::print_func (
 print_funcp_13 p) [inline]
```

References [function\\_options\(\)](#), [set\\_print\\_func\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.183 print\_func() [14/15]**

```
template<class Ctx>
function_options & GiNaC::function_options::print_func (
 print_funcp_14 p) [inline]
```

References [function\\_options\(\)](#), [set\\_print\\_func\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

**6.64.2.184 print\_func() [15/15]**

```
template<class Ctx>
function_options & GiNaC::function_options::print_func (
 print_funcp_exvector p) [inline]
```

References [function\\_options\(\)](#), [print\\_use\\_exvector\\_args](#), and [set\\_print\\_func\(\)](#).

**6.64.2.185 set\_return\_type()**

```
function_options & GiNaC::function_options::set_return_type (
 unsigned rt,
 const return_type_t * rtt = nullptr)
```

References [function\\_options\(\)](#), [GiNaC::make\\_return\\_type\\_t\(\)](#), [return\\_type](#), [return\\_type\\_tinfo](#), and [use\\_return\\_type](#).

**6.64.2.186 do\_not\_evalf\_params()**

```
function_options & GiNaC::function_options::do_not_evalf_params ()
```

References [evalf\\_params\\_first](#), and [function\\_options\(\)](#).



**6.64.2.187 remember()**

```
function_options & GiNaC::function_options::remember (
 unsigned size,
 unsigned assoc_size = 0,
 unsigned strategy = remember_strategies::delete_never)
```

References [function\\_options\(\)](#), [remember\\_assoc\\_size](#), [remember\\_size](#), [remember\\_strategy](#), and [use\\_remember](#).

**6.64.2.188 overloaded()**

```
function_options & GiNaC::function_options::overloaded (
 unsigned o)
```

References [function\\_options\(\)](#), and [functions\\_with\\_same\\_name](#).

**6.64.2.189 set\_symmetry()**

```
function_options & GiNaC::function_options::set_symmetry (
 const symmetry & s)
```

References [function\\_options\(\)](#), and [symtree](#).

**6.64.2.190 get\_name()**

```
std::string GiNaC::function_options::get_name () const [inline]
```

References [name](#).

**6.64.2.191 get\_nparams()**

```
unsigned GiNaC::function_options::get_nparams () const [inline]
```

References [nparams](#).

**6.64.2.192 has\_derivative()**

```
bool GiNaC::function_options::has_derivative () const [inline], [protected]
```

References [derivative\\_f](#).

**6.64.2.193 has\_power()**

```
bool GiNaC::function_options::has_power () const [inline], [protected]
```

References [power\\_f](#).



### 6.64.3.2 fderivative

friend class `fderivative` [friend]

References [fderivative](#).

Referenced by [fderivative](#).

## 6.64.4 Member Data Documentation

### 6.64.4.1 name

std::string `GiNaC::function_options::name` [protected]

Referenced by [get\\_name\(\)](#), [GiNaC::function::print\(\)](#), [GiNaC::function::register\\_new\(\)](#), [set\\_name\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

### 6.64.4.2 TeX\_name

std::string `GiNaC::function_options::TeX_name` [protected]

Referenced by [latex\\_name\(\)](#), [GiNaC::function::print\(\)](#), and [set\\_name\(\)](#).

### 6.64.4.3 nparams

unsigned `GiNaC::function_options::nparams` [protected]

Referenced by [GiNaC::function::conjugate\(\)](#), [GiNaC::function::eval\(\)](#), [GiNaC::function::evalf\(\)](#), [GiNaC::function::expand\(\)](#), [GiNaC::function::expl\\_derivative\(\)](#), [function\\_options\(\)](#), [get\\_nparams\(\)](#), [GiNaC::function::imag\\_part\(\)](#), [GiNaC::function::info\(\)](#), [initialize\(\)](#), [GiNaC::function::pderivative\(\)](#), [GiNaC::function::power\(\)](#), [GiNaC::function::print\(\)](#), [GiNaC::function::real\\_part\(\)](#), [GiNaC::function::series\(\)](#), and [test\\_and\\_set\\_nparams\(\)](#).

### 6.64.4.4 eval\_f

`eval_funcp` `GiNaC::function_options::eval_f` [protected]

Referenced by [GiNaC::function::eval\(\)](#), [eval\\_func\(\)](#), [eval\\_func\(\)](#), [eval\\_func\(\)](#), [eval\\_func\(\)](#), [eval\\_func\(\)](#), [eval\\_func\(\)](#), [eval\\_func\(\)](#), [eval\\_func\(\)](#), [eval\\_func\(\)](#), [eval\\_func\(\)](#), [eval\\_func\(\)](#), [eval\\_func\(\)](#), and [initialize\(\)](#).

### 6.64.4.5 evalf\_f

`evalf_funcp` `GiNaC::function_options::evalf_f` [protected]

Referenced by [GiNaC::function::evalf\(\)](#), [evalf\\_func\(\)](#), [evalf\\_func\(\)](#), [evalf\\_func\(\)](#), [evalf\\_func\(\)](#), [evalf\\_func\(\)](#), [evalf\\_func\(\)](#), [evalf\\_func\(\)](#), [evalf\\_func\(\)](#), [evalf\\_func\(\)](#), [evalf\\_func\(\)](#), [evalf\\_func\(\)](#), [evalf\\_func\(\)](#), and [initialize\(\)](#).

#### 6.64.4.6 conjugate\_f

`conjugate_funcp` `GiNaC::function_options::conjugate_f` [protected]

Referenced by `GiNaC::function::conjugate()`, `conjugate_func()`, `conjugate_func()`, `conjugate_func()`, `conjugate_func()`, `conjugate_func()`, `conjugate_func()`, `conjugate_func()`, `conjugate_func()`, `conjugate_func()`, `conjugate_func()`, `conjugate_func()`, `conjugate_func()`, and `initialize()`.

#### 6.64.4.7 real\_part\_f

`real_part_funcp` `GiNaC::function_options::real_part_f` [protected]

Referenced by `initialize()`, `GiNaC::function::real_part()`, `real_part_func()`, `real_part_func()`, `real_part_func()`, `real_part_func()`, `real_part_func()`, `real_part_func()`, `real_part_func()`, `real_part_func()`, `real_part_func()`, `real_part_func()`, `real_part_func()`, and `real_part_func()`.

#### 6.64.4.8 imag\_part\_f

`imag_part_funcp` `GiNaC::function_options::imag_part_f` [protected]

Referenced by `GiNaC::function::imag_part()`, `imag_part_func()`, `imag_part_func()`, `imag_part_func()`, `imag_part_func()`, `imag_part_func()`, `imag_part_func()`, `imag_part_func()`, `imag_part_func()`, `imag_part_func()`, `imag_part_func()`, `imag_part_func()`, `imag_part_func()`, and `initialize()`.

#### 6.64.4.9 expand\_f

`expand_funcp` `GiNaC::function_options::expand_f` [protected]

Referenced by `GiNaC::function::expand()`, `expand_func()`, `expand_func()`, `expand_func()`, `expand_func()`, `expand_func()`, `expand_func()`, `expand_func()`, `expand_func()`, `expand_func()`, `expand_func()`, `expand_func()`, `expand_func()`, and `initialize()`.

#### 6.64.4.10 derivative\_f

`derivative_funcp` `GiNaC::function_options::derivative_f` [protected]

Referenced by `derivative_func()`, `derivative_func()`, `derivative_func()`, `derivative_func()`, `derivative_func()`, `derivative_func()`, `derivative_func()`, `derivative_func()`, `derivative_func()`, `derivative_func()`, `derivative_func()`, `derivative_func()`, `derivative_func()`, `derivative_func()`, `has_derivative()`, `initialize()`, and `GiNaC::function::pderivative()`.

#### 6.64.4.11 expl\_derivative\_f

`expl_derivative_funcp` `GiNaC::function_options::expl_derivative_f` [protected]

Referenced by `GiNaC::function::expl_derivative()`, `expl_derivative_func()`, `expl_derivative_func()`, `expl_derivative_func()`, `expl_derivative_func()`, `expl_derivative_func()`, `expl_derivative_func()`, `expl_derivative_func()`, `expl_derivative_func()`, `expl_derivative_func()`, `expl_derivative_func()`, `expl_derivative_func()`, `expl_derivative_func()`, `expl_derivative_func()`, and `initialize()`.

#### 6.64.4.12 power\_f

`power_funcp` GiNaC::function\_options::power\_f [protected]

Referenced by [has\\_power\(\)](#), [initialize\(\)](#), [GiNaC::function::power\(\)](#), [power\\_func\(\)](#), [power\\_func\(\)](#), [power\\_func\(\)](#), [power\\_func\(\)](#), [power\\_func\(\)](#), [power\\_func\(\)](#), [power\\_func\(\)](#), [power\\_func\(\)](#), [power\\_func\(\)](#), [power\\_func\(\)](#), [power\\_func\(\)](#), [power\\_func\(\)](#), and [power\\_func\(\)](#).

#### 6.64.4.13 series\_f

`series_funcp` GiNaC::function\_options::series\_f [protected]

Referenced by [initialize\(\)](#), [GiNaC::function::series\(\)](#), [series\\_func\(\)](#), [series\\_func\(\)](#), [series\\_func\(\)](#), [series\\_func\(\)](#), [series\\_func\(\)](#), [series\\_func\(\)](#), [series\\_func\(\)](#), [series\\_func\(\)](#), [series\\_func\(\)](#), [series\\_func\(\)](#), [series\\_func\(\)](#), [series\\_func\(\)](#), [series\\_func\(\)](#), and [series\\_func\(\)](#).

#### 6.64.4.14 print\_dispatch\_table

`std::vector<print_funcp>` GiNaC::function\_options::print\_dispatch\_table [protected]

Referenced by [GiNaC::function::print\(\)](#), and [set\\_print\\_func\(\)](#).

#### 6.64.4.15 info\_f

`info_funcp` GiNaC::function\_options::info\_f [protected]

Referenced by [GiNaC::function::info\(\)](#), [info\\_func\(\)](#), [info\\_func\(\)](#), [info\\_func\(\)](#), [info\\_func\(\)](#), [info\\_func\(\)](#), [info\\_func\(\)](#), [info\\_func\(\)](#), [info\\_func\(\)](#), [info\\_func\(\)](#), [info\\_func\(\)](#), [info\\_func\(\)](#), [info\\_func\(\)](#), [info\\_func\(\)](#), [info\\_func\(\)](#), and [initialize\(\)](#).

#### 6.64.4.16 evalf\_params\_first

`bool` GiNaC::function\_options::evalf\_params\_first [protected]

Referenced by [do\\_not\\_evalf\\_params\(\)](#), [GiNaC::function::evalf\(\)](#), and [initialize\(\)](#).

#### 6.64.4.17 use\_return\_type

`bool` GiNaC::function\_options::use\_return\_type [protected]

Referenced by [initialize\(\)](#), [GiNaC::function::return\\_type\(\)](#), [GiNaC::function::return\\_type\\_tinfo\(\)](#), and [set\\_return\\_type\(\)](#).

#### 6.64.4.18 return\_type

`unsigned` GiNaC::function\_options::return\_type [protected]

Referenced by [GiNaC::function::return\\_type\(\)](#), and [set\\_return\\_type\(\)](#).

#### 6.64.4.19 return\_type\_tinfo

`return_type_t` `GiNaC::function_options::return_type_tinfo` [protected]

Referenced by [GiNaC::function::return\\_type\\_tinfo\(\)](#), and [set\\_return\\_type\(\)](#).

#### 6.64.4.20 use\_remember

`bool` `GiNaC::function_options::use_remember` [protected]

Referenced by [GiNaC::function::eval\(\)](#), [initialize\(\)](#), [GiNaC::function::register\\_new\(\)](#), and [remember\(\)](#).

#### 6.64.4.21 remember\_size

`unsigned` `GiNaC::function_options::remember_size` [protected]

Referenced by [GiNaC::function::register\\_new\(\)](#), and [remember\(\)](#).

#### 6.64.4.22 remember\_assoc\_size

`unsigned` `GiNaC::function_options::remember_assoc_size` [protected]

Referenced by [GiNaC::function::register\\_new\(\)](#), and [remember\(\)](#).

#### 6.64.4.23 remember\_strategy

`unsigned` `GiNaC::function_options::remember_strategy` [protected]

Referenced by [GiNaC::function::register\\_new\(\)](#), and [remember\(\)](#).

#### 6.64.4.24 eval\_use\_exvector\_args

`bool` `GiNaC::function_options::eval_use_exvector_args` [protected]

Referenced by [GiNaC::function::eval\(\)](#), [eval\\_func\(\)](#), and [initialize\(\)](#).

#### 6.64.4.25 evalf\_use\_exvector\_args

`bool` `GiNaC::function_options::evalf_use_exvector_args` [protected]

Referenced by [GiNaC::function::evalf\(\)](#), [evalf\\_func\(\)](#), and [initialize\(\)](#).

#### 6.64.4.26 conjugate\_use\_exvector\_args

`bool` `GiNaC::function_options::conjugate_use_exvector_args` [protected]

Referenced by [GiNaC::function::conjugate\(\)](#), [conjugate\\_func\(\)](#), and [initialize\(\)](#).

#### 6.64.4.27 real\_part\_use\_exvector\_args

```
bool GiNaC::function_options::real_part_use_exvector_args [protected]
```

Referenced by [initialize\(\)](#), [GiNaC::function::real\\_part\(\)](#), and [real\\_part\\_func\(\)](#).

#### 6.64.4.28 imag\_part\_use\_exvector\_args

```
bool GiNaC::function_options::imag_part_use_exvector_args [protected]
```

Referenced by [GiNaC::function::imag\\_part\(\)](#), [imag\\_part\\_func\(\)](#), and [initialize\(\)](#).

#### 6.64.4.29 expand\_use\_exvector\_args

```
bool GiNaC::function_options::expand_use_exvector_args [protected]
```

Referenced by [GiNaC::function::expand\(\)](#), [expand\\_func\(\)](#), and [initialize\(\)](#).

#### 6.64.4.30 derivative\_use\_exvector\_args

```
bool GiNaC::function_options::derivative_use_exvector_args [protected]
```

Referenced by [derivative\\_func\(\)](#), [initialize\(\)](#), and [GiNaC::function::pderivative\(\)](#).

#### 6.64.4.31 expl\_derivative\_use\_exvector\_args

```
bool GiNaC::function_options::expl_derivative_use_exvector_args [protected]
```

Referenced by [GiNaC::function::expl\\_derivative\(\)](#), [expl\\_derivative\\_func\(\)](#), and [initialize\(\)](#).

#### 6.64.4.32 power\_use\_exvector\_args

```
bool GiNaC::function_options::power_use_exvector_args [protected]
```

Referenced by [initialize\(\)](#), [GiNaC::function::power\(\)](#), and [power\\_func\(\)](#).

#### 6.64.4.33 series\_use\_exvector\_args

```
bool GiNaC::function_options::series_use_exvector_args [protected]
```

Referenced by [initialize\(\)](#), [GiNaC::function::series\(\)](#), and [series\\_func\(\)](#).

#### 6.64.4.34 print\_use\_exvector\_args

```
bool GiNaC::function_options::print_use_exvector_args [protected]
```

Referenced by [initialize\(\)](#), [GiNaC::function::print\(\)](#), and [print\\_func\(\)](#).

#### 6.64.4.35 info\_use\_exvector\_args

`bool GiNaC::function_options::info_use_exvector_args [protected]`

Referenced by [GiNaC::function::info\(\)](#), [info\\_func\(\)](#), and [initialize\(\)](#).

#### 6.64.4.36 functions\_with\_same\_name

`unsigned GiNaC::function_options::functions_with_same_name [protected]`

Referenced by [initialize\(\)](#), [overloaded\(\)](#), and [GiNaC::function::register\\_new\(\)](#).

#### 6.64.4.37 symtree

`ex GiNaC::function_options::symtree [protected]`

Referenced by [GiNaC::function::eval\(\)](#), [initialize\(\)](#), and [set\\_symmetry\(\)](#).

The documentation for this class was generated from the following files:

- [function.h](#)
- [function.cpp](#)

## 6.65 GiNaC::G2\_SERIAL Class Reference

Generalized multiple polylogarithm.

```
#include <inifcns.h>
```

### Static Public Attributes

- static unsigned [serial](#)

### 6.65.1 Detailed Description

Generalized multiple polylogarithm.

### 6.65.2 Member Data Documentation

#### 6.65.2.1 serial

`unsigned GiNaC::G2_SERIAL::serial [static]`

#### Initial value:

```
= function::register_new(function_options("G", 2).
 evalf_func(G2_evalf).
 eval_func(G2_eval).
 overloaded(2))
```

Referenced by [GiNaC::G\(\)](#).

The documentation for this class was generated from the following files:

- [inifcns.h](#)
- [inifcns\\_nstdsums.cpp](#)



## 6.66 GiNaC::G3\_SERIAL Class Reference

Generalized multiple polylogarithm with explicit imaginary parts.

```
#include <inifcns.h>
```

### Static Public Attributes

- static unsigned [serial](#)

### 6.66.1 Detailed Description

Generalized multiple polylogarithm with explicit imaginary parts.

### 6.66.2 Member Data Documentation

#### 6.66.2.1 serial

```
unsigned GiNaC::G3_SERIAL::serial [static]
```

#### Initial value:

```
= function::register_new(function_options("G", 3).
 evalf_func(G3_evalf).
 eval_func(G3_eval).
 overloaded(2))
```

Referenced by [GiNaC::G\(\)](#).

The documentation for this class was generated from the following files:

- [inifcns.h](#)
- [inifcns\\_nstdsums.cpp](#)

## 6.67 GiNaC::gcd\_options Struct Reference

Flags to control the behavior of [gcd\(\)](#) and friends.

```
#include <normal.h>
```

### Public Types

- enum { [no\\_heur\\_gcd](#) = 2 , [no\\_part\\_factored](#) = 4 , [use\\_sr\\_gcd](#) = 8 }

### 6.67.1 Detailed Description

Flags to control the behavior of [gcd\(\)](#) and friends.

### 6.67.2 Member Enumeration Documentation

#### 6.67.2.1 anonymous enum

```
anonymous enum
```

## Enumerator

|                  |                                                                                                                                                                                                                                                                                                                                                              |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| no_heur_gcd      | Usually <a href="#">GiNaC</a> tries heuristic GCD first, because typically it's much faster than anything else. Even if heuristic algorithm fails, the overhead is negligible w.r.t. cost of computing the GCD by some other method. However, some people dislike it, so here's a flag which tells <a href="#">GiNaC</a> to NOT use the heuristic algorithm. |
| no_part_factored | <a href="#">GiNaC</a> tries to avoid expanding expressions when computing GCDs. This is a good idea, but some people dislike it. Hence the flag to disable special handling of partially factored polynomials. DON'T SET THIS unless you <i>really</i> know what are you doing!                                                                              |
| use_sr_gcd       | By default <a href="#">GiNaC</a> uses modular GCD algorithm. Typically it's much faster than PRS (pseudo remainder sequence) algorithm. This flag forces <a href="#">GiNaC</a> to use PRS algorithm                                                                                                                                                          |

The documentation for this struct was generated from the following file:

- [normal.h](#)

## 6.68 GiNaC::gcdheu\_failed Class Reference

Exception thrown by [heur\\_gcd\(\)](#) to signal failure.

### 6.68.1 Detailed Description

Exception thrown by [heur\\_gcd\(\)](#) to signal failure.

The documentation for this class was generated from the following file:

- [normal.cpp](#)

## 6.69 GiNaC::has\_distance< T > Class Template Reference

SFINAE test for distance.

```
#include <utils_multi_iterator.h>
```

### Public Types

- enum { [value](#) = sizeof(test<T>(0)) == sizeof(yes\_type) }

### Private Types

- typedef char [yes\\_type](#)[1]
- typedef char [no\\_type](#)[2]

## Static Private Member Functions

- `template<typename C>`  
static `yes_type` & `test` (`decltype(std::distance< C >)`)
- `template<typename C>`  
static `no_type` & `test` (...)

### 6.69.1 Detailed Description

`template<typename T>`  
`class GiNaC::has_distance< T >`

SFINAE test for distance.

### 6.69.2 Member Typedef Documentation

#### 6.69.2.1 yes\_type

```
template<typename T>
typedef char GiNaC::has_distance< T >::yes_type[1] [private]
```

#### 6.69.2.2 no\_type

```
template<typename T>
typedef char GiNaC::has_distance< T >::no_type[2] [private]
```

### 6.69.3 Member Enumeration Documentation

#### 6.69.3.1 anonymous enum

```
template<typename T>
anonymous enum
```

Enumerator

|       |  |
|-------|--|
| value |  |
|-------|--|

### 6.69.4 Member Function Documentation

#### 6.69.4.1 test() [1/2]

```
template<typename T>
template<typename C>
static yes_type & GiNaC::has_distance< T >::test (
 decltype(std::distance< C >)) [static], [private]
```

#### 6.69.4.2 test() [2/2]

```
template<typename T>
template<typename C>
static no_type & GiNaC::has_distance< T >::test (
 ...) [static], [private]
```

The documentation for this class was generated from the following file:

- [utils\\_multi\\_iterator.h](#)

## 6.70 GiNaC::has\_options Class Reference

Flags to control the behavior of [has\(\)](#).

```
#include <flags.h>
```

### Public Types

- enum { [algebraic](#) = 0x0001 }

#### 6.70.1 Detailed Description

Flags to control the behavior of [has\(\)](#).

#### 6.70.2 Member Enumeration Documentation

##### 6.70.2.1 anonymous enum

```
anonymous enum
```

### Enumerator

|                           |                           |
|---------------------------|---------------------------|
| <a href="#">algebraic</a> | enable algebraic matching |
|---------------------------|---------------------------|

The documentation for this class was generated from the following file:

- [flags.h](#)

## 6.71 std::hash< GiNaC::ex > Struct Reference

Specialization of `std::hash()` for `ex` objects.

```
#include <ex.h>
```

## Public Member Functions

- `std::size_t operator() (const GiNaC::ex &e) const` noexcept

### 6.71.1 Detailed Description

Specialization of `std::hash()` for `ex` objects.

### 6.71.2 Member Function Documentation

#### 6.71.2.1 operator()

```
std::size_t std::hash< GiNaC::ex >::operator() (
 const GiNaC::ex & e) const [inline], [noexcept]
```

The documentation for this struct was generated from the following file:

- [ex.h](#)

## 6.72 GiNaC::idx Class Reference

This class holds one index of an indexed object.

```
#include <idx.h>
```

Inheritance diagram for `GiNaC::idx`:



Collaboration diagram for `GiNaC::idx`:



## Public Member Functions

- `idx` (const `ex` &`v`, const `ex` &`dim`)  
Construct index with given value and dimension.
- bool `info` (unsigned `inf`) const override  
Information about the object.
- `size_t nops` () const override  
Number of operands/members.
- `ex op` (`size_t i`) const override  
Return operand/member at position *i*.
- `ex map` (`map_function` &`f`) const override  
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- `ex evalf` () const override  
By default, `basic::evalf` would evaluate the index value but we don't want `a.1` to become `a`.
- `ex subs` (const `exmap` &`m`, unsigned `options=0`) const override  
Substitute a set of objects by arbitrary expressions.
- void `archive` (`archive_node` &`n`) const override  
Save (serialize) the object into archive node.
- void `read_archive` (const `archive_node` &`n`, `lst` &`syms`) override

- Load (deserialize) the object from an archive node.*
- virtual bool `is_dummy_pair_same_type` (const `basic` &other) const  
*Check whether the index forms a dummy index pair with another index of the same type.*
- `ex get_value` () const  
*Get value of index.*
- bool `is_numeric` () const  
*Check whether the index is numeric.*
- bool `is_symbolic` () const  
*Check whether the index is symbolic.*
- `ex get_dim` () const  
*Get dimension of index space.*
- bool `is_dim_numeric` () const  
*Check whether the dimension is numeric.*
- bool `is_dim_symbolic` () const  
*Check whether the dimension is symbolic.*
- `ex replace_dim` (const `ex` &new\_dim) const  
*Make a new index with the same value but a different dimension.*
- `ex minimal_dim` (const `idx` &other) const  
*Return the minimum of the dimensions of this and another index.*

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree` () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence` () const  
*Return relative operator precedence (for parenthezing output).*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex & let_op` (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[]` (const `ex` &index)

- virtual `ex & operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const  
*Check whether the expression matches a given pattern.*
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const  
*Return degree of highest power in object s.*
- virtual int `ldegree` (const `ex` &s) const  
*Return degree of lowest power in object s.*
- virtual `ex` `coeff` (const `ex` &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual `ex` `expand` (unsigned options=0) const  
*Expand expression, i.e.*
- virtual `ex` `collect` (const `ex` &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex` `series` (const `relational` &r, int order, unsigned options=0) const  
*Default implementation of `ex::series()`.*
- virtual `ex` `normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const  
*Default implementation of `ex::normal()`.*
- virtual `ex` `to_rational` (`exmap` &repl) const  
*Default implementation of `ex::to_rational()`.*
- virtual `ex` `to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex` `smod` (const `numeric` &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const  
*Implementation `ex::max_coefficient()`.*
- virtual `exvector` `get_free_indices` () const  
*Return a vector containing the free indices of an expression.*
- virtual `ex` `add_indexed` (const `ex` &self, const `ex` &other) const  
*Add two indexed expressions.*
- virtual `ex` `scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned `return_type` () const
- virtual `return_type_t` `return_type_tinfo` () const
- virtual `ex` `conjugate` () const
- virtual `ex` `real_part` () const
- virtual `ex` `imag_part` () const
- template<class T>  
void `print_dispatch` (const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- `ex` `subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex` `diff` (const `symbol` &s, unsigned nth=1) const



*Default interface of nth derivative `ex::diff(s, n)`.*

- int `compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- const `basic` & `hold` () const  
*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const  
*Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- `ex_derivative` (const `symbol` &s) const override  
*Implementation of `ex::diff()` for an index always returns 0.*
- bool `match_same_type` (const `basic` &other) const override  
*Returns true if the attributes of two objects are similar enough for a match.*
- unsigned `calchash` () const override  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `print_index` (const `print_context` &c, unsigned level) const
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_csrc` (const `print_csrc` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const
- void `do_print_tree` (const `print_tree` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- void `ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void `do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Attributes

- [ex value](#)  
*Expression that constitutes the index (numeric or symbolic name)*
- [ex dim](#)  
*Dimension of space (can be symbolic or numeric)*

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.72.1 Detailed Description

This class holds one index of an indexed object.

Indices can theoretically consist of any symbolic expression but they are usually only just a symbol (e.g. "mu", "i") or numeric (integer). Indices belong to a space with a certain numeric or symbolic dimension.

### 6.72.2 Constructor & Destructor Documentation

#### 6.72.2.1 `idx()`

```
GiNaC::idx::idx (
 const ex & v,
 const ex & dim) [explicit]
```

Construct index with given value and dimension.

#### Parameters

|            |                                                |
|------------|------------------------------------------------|
| <i>v</i>   | Value of index (numeric or symbolic)           |
| <i>dim</i> | Dimension of index space (numeric or symbolic) |

References [dim](#), [GiNaC::basic::ex](#), [is\\_dim\\_numeric\(\)](#), [GiNaC::info\\_flags::posint](#), and [value](#).

Referenced by [is\\_dummy\\_pair\\_same\\_type\(\)](#), [map\(\)](#), [match\\_same\\_type\(\)](#), [minimal\\_dim\(\)](#), [replace\\_dim\(\)](#), and [subs\(\)](#).

### 6.72.3 Member Function Documentation

#### 6.72.3.1 `info()`

```
bool GiNaC::idx::info (
 unsigned inf) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info\\_flags::has\\_indices](#), and [GiNaC::info\\_flags::idx](#).

### 6.72.3.2 nops()

```
size_t GiNaC::idx::nops () const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

### 6.72.3.3 op()

```
ex GiNaC::idx::op (
 size_t i) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), [GINAC\\_ASSERT](#), and [value](#).

### 6.72.3.4 map()

```
ex GiNaC::idx::map (
 map_function & f) const [override], [virtual]
```

Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [GiNaC::basic::clearflag\(\)](#), [GiNaC::basic::duplicate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::status\\_flags::hash\\_calculated](#), [idx\(\)](#), and [value](#).

### 6.72.3.5 evalf()

```
ex GiNaC::idx::evalf () const [override], [virtual]
```

By default, [basic::evalf](#) would evaluate the index value but we don't want a.1 to become a.

(1.0).

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

### 6.72.3.6 subs()

```
ex GiNaC::idx::subs (
 const exmap & m,
 unsigned options = 0) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [GiNaC::basic::clearflag\(\)](#), [GiNaC::basic::duplicate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex::find\(\)](#), [GiNaC::status\\_flags::hash\\_calculated](#), [idx\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::subs\\_options::really\\_subs\\_idx](#), and [value](#).

### 6.72.3.7 archive()

```
void GiNaC::idx::archive (
 archive_node & n) const [override], [virtual]
```

Save (serialize) the object into archive node.

Archive the object.

Losely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::spinidx](#), and [GiNaC::varidx](#).

References [GiNaC::archive\\_node::add\\_ex\(\)](#), [dim](#), and [value](#).

### 6.72.3.8 read\_archive()

```
void GiNaC::idx::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive\\_node](#).

#### Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::spinidx](#), and [GiNaC::varidx](#).

References [dim](#), [GiNaC::archive\\_node::find\\_ex\(\)](#), and [value](#).

### 6.72.3.9 derivative()

```
ex GiNaC::idx::derivative (
 const symbol & s) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for an index always returns 0.

#### See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), and [GiNaC::basic::ex](#).

### 6.72.3.10 match\_same\_type()

```
bool GiNaC::idx::match_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is\\_equal\\_same\\_type\(\)](#) is automatically used instead of [match\\_same\\_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::spinidx](#), and [GiNaC::varidx](#).

References [GiNaC::basic::basic\(\)](#), [dim](#), [GINAC\\_ASSERT](#), [idx\(\)](#), and [GiNaC::is\\_a\(\)](#).

### 6.72.3.11 calchash()

```
unsigned GiNaC::idx::calchash () const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::basic::flags](#), [GiNaC::status\\_flags::hash\\_calculated](#), [GiNaC::basic::hashvalue](#), [GiNaC::make\\_hash\\_seed\(\)](#), [GiNaC::rotate\\_left\(\)](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

### 6.72.3.12 is\_dummy\_pair\_same\_type()

```
bool GiNaC::idx::is_dummy_pair_same_type (
 const basic & other) const [virtual]
```

Check whether the index forms a dummy index pair with another index of the same type.

Reimplemented in [GiNaC::spinidx](#), and [GiNaC::varidx](#).

References [GiNaC::basic::basic\(\)](#), [dim](#), [idx\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [value](#).

Referenced by [GiNaC::is\\_dummy\\_pair\(\)](#).

**6.72.3.13 get\_value()**

```
ex GiNaC::idx::get_value () const [inline]
```

Get value of index.

References [GiNaC::basic::ex](#), and [value](#).

Referenced by [GiNaC::matrix::eval\\_indexed\(\)](#), [GiNaC::minkmetric::eval\\_indexed\(\)](#), [GiNaC::spinmetric::eval\\_indexed\(\)](#), and [GiNaC::tensdelta::eval\\_indexed\(\)](#).

**6.72.3.14 is\_numeric()**

```
bool GiNaC::idx::is_numeric () const [inline]
```

Check whether the index is numeric.

References [GiNaC::is\\_exactly\\_a\(\)](#), and [value](#).

**6.72.3.15 is\_symbolic()**

```
bool GiNaC::idx::is_symbolic () const [inline]
```

Check whether the index is symbolic.

References [GiNaC::is\\_exactly\\_a\(\)](#), and [value](#).

Referenced by [GiNaC::spinmetric::contract\\_with\(\)](#), and [GiNaC::tensor::replace\\_contr\\_index\(\)](#).

**6.72.3.16 get\_dim()**

```
ex GiNaC::idx::get_dim () const [inline]
```

Get dimension of index space.

References [dim](#), and [GiNaC::basic::ex](#).

Referenced by [GiNaC::matrix::eval\\_indexed\(\)](#), [GiNaC::tensdelta::eval\\_indexed\(\)](#), and [GiNaC::tensmetric::eval\\_indexed\(\)](#).

**6.72.3.17 is\_dim\_numeric()**

```
bool GiNaC::idx::is_dim_numeric () const [inline]
```

Check whether the dimension is numeric.

References [dim](#), and [GiNaC::is\\_exactly\\_a\(\)](#).

Referenced by [idx\(\)](#).

**6.72.3.18 is\_dim\_symbolic()**

```
bool GiNaC::idx::is_dim_symbolic () const [inline]
```

Check whether the dimension is symbolic.

References [dim](#), and [GiNaC::is\\_exactly\\_a\(\)](#).

**6.72.3.19 replace\_dim()**

```
ex GiNaC::idx::replace_dim (
 const ex & new_dim) const
```

Make a new index with the same value but a different dimension.

References [GiNaC::basic::clearflag\(\)](#), [dim](#), [GiNaC::basic::duplicate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::status\\_flags::hash\\_calculated](#), and [idx\(\)](#).

Referenced by [GiNaC::tensdelta::eval\\_indexed\(\)](#), [GiNaC::tensmetric::eval\\_indexed\(\)](#), and [GiNaC::tensor::replace\\_contr\\_index\(\)](#).

**6.72.3.20 minimal\_dim()**

```
ex GiNaC::idx::minimal_dim (
 const idx & other) const
```

Return the minimum of the dimensions of this and another index.

If this is undecidable, throw an exception.

References [dim](#), [GiNaC::basic::ex](#), [idx\(\)](#), and [GiNaC::minimal\\_dim\(\)](#).

Referenced by [GiNaC::tensdelta::eval\\_indexed\(\)](#), [GiNaC::tensmetric::eval\\_indexed\(\)](#), and [GiNaC::tensor::replace\\_contr\\_index\(\)](#).

**6.72.3.21 print\_index()**

```
void GiNaC::idx::print_index (
 const print_context & c,
 unsigned level) const [protected]
```

References [dim](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::print\\_context::options](#), [GiNaC::print\\_options::print\\_index\\_dimensions](#), [GiNaC::print\\_context::s](#), and [value](#).

Referenced by [do\\_print\(\)](#), [GiNaC::spinidx::do\\_print\(\)](#), [GiNaC::varidx::do\\_print\(\)](#), [do\\_print\\_latex\(\)](#), and [GiNaC::spinidx::do\\_print\\_latex\(\)](#).

**6.72.3.22 do\_print()**

```
void GiNaC::idx::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [print\\_index\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.72.3.23 do\_print\_csrc()

```
void GiNaC::idx::do_print_csrc (
 const print_csrc & c,
 unsigned level) const [protected]
```

References [GiNaC::ex\\_to\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::print\\_context::s](#), and [value](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.72.3.24 do\_print\_latex()

```
void GiNaC::idx::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

References [print\\_index\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.72.3.25 do\_print\_tree()

```
void GiNaC::idx::do_print_tree (
 const print_tree & c,
 unsigned level) const [protected]
```

References [GiNaC::print\\_tree::delta\\_indent](#), [dim](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [GiNaC::print\\_context::s](#), and [value](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.72.4 Member Data Documentation

### 6.72.4.1 value

```
ex GiNaC::idx::value [protected]
```

Expression that constitutes the index (numeric or symbolic name)

Referenced by [archive\(\)](#), [calchash\(\)](#), [do\\_print\\_csrc\(\)](#), [do\\_print\\_tree\(\)](#), [GiNaC::spinidx::do\\_print\\_tree\(\)](#), [GiNaC::varidx::do\\_print\\_tree\(\)](#), [get\\_value\(\)](#), [idx\(\)](#), [is\\_dummy\\_pair\\_same\\_type\(\)](#), [is\\_numeric\(\)](#), [is\\_symbolic\(\)](#), [map\(\)](#), [op\(\)](#), [print\\_index\(\)](#), [read\\_archive\(\)](#), and [subs\(\)](#).

### 6.72.4.2 dim

```
ex GiNaC::idx::dim [protected]
```

Dimension of space (can be symbolic or numeric)

Referenced by [archive\(\)](#), [do\\_print\\_tree\(\)](#), [GiNaC::spinidx::do\\_print\\_tree\(\)](#), [GiNaC::varidx::do\\_print\\_tree\(\)](#), [get\\_dim\(\)](#), [idx\(\)](#), [is\\_dim\\_numeric\(\)](#), [is\\_dim\\_symbolic\(\)](#), [is\\_dummy\\_pair\\_same\\_type\(\)](#), [match\\_same\\_type\(\)](#), [minimal\\_dim\(\)](#), [print\\_index\(\)](#), [read\\_archive\(\)](#), and [replace\\_dim\(\)](#).

The documentation for this class was generated from the following files:

- [idx.h](#)
- [idx.cpp](#)



## 6.73 GiNaC::idx\_is\_equal\_ignore\_dim Struct Reference

### Public Member Functions

- bool [operator\(\)](#) (const [ex](#) &lh, const [ex](#) &rh) const

### 6.73.1 Member Function Documentation

#### 6.73.1.1 operator()

```
bool GiNaC::idx_is_equal_ignore_dim::operator() (
 const ex & lh,
 const ex & rh) const [inline]
```

References [GiNaC::ex\\_to\(\)](#), and [GiNaC::ex::is\\_equal\(\)](#).

The documentation for this struct was generated from the following file:

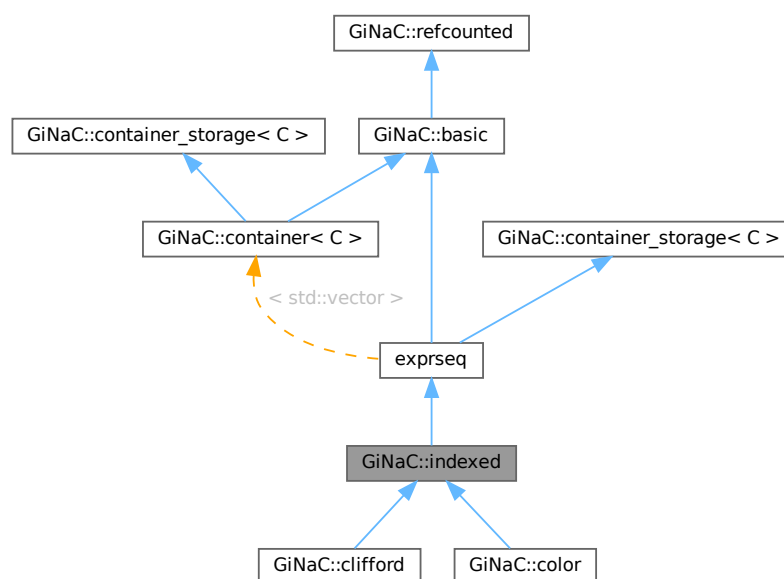
- [indexed.cpp](#)

## 6.74 GiNaC::indexed Class Reference

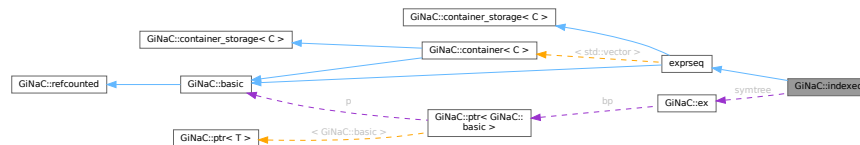
This class holds an indexed expression.

```
#include <indexed.h>
```

Inheritance diagram for GiNaC::indexed:



Collaboration diagram for `GiNaC::indexed`:



## Public Member Functions

- `indexed` (const `ex` &b)  
Construct indexed object with no index.
- `indexed` (const `ex` &b, const `ex` &i1)  
Construct indexed object with one index.
- `indexed` (const `ex` &b, const `ex` &i1, const `ex` &i2)  
Construct indexed object with two indices.
- `indexed` (const `ex` &b, const `ex` &i1, const `ex` &i2, const `ex` &i3)  
Construct indexed object with three indices.
- `indexed` (const `ex` &b, const `ex` &i1, const `ex` &i2, const `ex` &i3, const `ex` &i4)  
Construct indexed object with four indices.
- `indexed` (const `ex` &b, const `symmetry` &symm, const `ex` &i1, const `ex` &i2)  
Construct indexed object with two indices and a specified symmetry.
- `indexed` (const `ex` &b, const `symmetry` &symm, const `ex` &i1, const `ex` &i2, const `ex` &i3)  
Construct indexed object with three indices and a specified symmetry.
- `indexed` (const `ex` &b, const `symmetry` &symm, const `ex` &i1, const `ex` &i2, const `ex` &i3, const `ex` &i4)  
Construct indexed object with four indices and a specified symmetry.
- `indexed` (const `ex` &b, const `exvector` &iv)  
Construct indexed object with a specified vector of indices.
- `indexed` (const `ex` &b, const `symmetry` &symm, const `exvector` &iv)  
Construct indexed object with a specified vector of indices and symmetry.
- `indexed` (const `symmetry` &symm, const `exprseq` &es)
- `indexed` (const `symmetry` &symm, const `exvector` &v)
- `indexed` (const `symmetry` &symm, `exvector` &&v)
- unsigned `precedence` () const override  
Return relative operator precedence (for parenthesizing output).
- bool `info` (unsigned inf) const override  
Information about the object.
- `ex eval` () const override  
Perform automatic non-interruptive term rewriting rules.
- `ex real_part` () const override
- `ex imag_part` () const override
- `exvector get_free_indices` () const override  
Return a vector containing the free indices of an expression.
- void `archive` (`archive_node` &n) const override  
Save (a.k.a.
- void `read_archive` (const `archive_node` &n, `lst` &syms) override  
Read (a.k.a.
- bool `all_index_values_are` (unsigned inf) const  
Check whether all index values have a certain property.

- [exvector get\\_indices \(\)](#) const  
*Return a vector containing the object's indices.*
- [exvector get\\_dummy\\_indices \(\)](#) const  
*Return a vector containing the dummy indices of the object, if any.*
- [exvector get\\_dummy\\_indices \(const indexed &other\)](#) const  
*Return a vector containing the dummy indices in the contraction with another indexed object.*
- [bool has\\_dummy\\_index\\_for \(const ex &i\)](#) const  
*Check whether the object has an index that forms a dummy index pair with a given index.*
- [ex get\\_symmetry \(\)](#) const  
*Return symmetry properties.*

## Public Member Functions inherited from [GiNaC::container< std::vector >](#)

- [container \(STLT const &s\)](#)
- [container \(STLT &&v\)](#)
- [container \(exvector::const\\_iterator b, exvector::const\\_iterator e\)](#)
- [container \(std::initializer\\_list< ex > il\)](#)
- [size\\_t nops \(\)](#) const override  
*Number of operands/members.*
- [ex op \(size\\_t i\)](#) const override  
*Return operand/member at position i.*
- [ex & let\\_op \(size\\_t i\)](#) override  
*Return modifiable operand/member at position i.*
- [ex subs \(const exmap &m, unsigned options=0\)](#) const override  
*Substitute a set of objects by arbitrary expressions.*
- [container & prepend \(const ex &b\)](#)  
*Add element at front.*
- [container & append \(const ex &b\)](#)  
*Add element at back.*
- [container & remove\\_first \(\)](#)  
*Remove first element.*
- [container & remove\\_last \(\)](#)  
*Remove last element.*
- [container & remove\\_all \(\)](#)  
*Remove all elements.*
- [container & sort \(\)](#)  
*Sort elements.*
- [container & unique \(\)](#)  
*Remove adjacent duplicate elements.*
- [const\\_iterator begin \(\)](#) const
- [const\\_iterator end \(\)](#) const
- [const\\_reverse\\_iterator rbegin \(\)](#) const
- [const\\_reverse\\_iterator rend \(\)](#) const
- [container \(STLT const &s\)](#)
- [container \(STLT &&v\)](#)
- [container \(exvector::const\\_iterator b, exvector::const\\_iterator e\)](#)
- [container \(std::initializer\\_list< ex > il\)](#)
- [size\\_t nops \(\)](#) const override  
*Number of operands/members.*
- [ex op \(size\\_t i\)](#) const override  
*Return operand/member at position i.*

- `ex & let_op` (size\_t i) override  
*Return modifiable operand/member at position i.*
- `ex subs` (const `exmap` &m, unsigned options=0) const override  
*Substitute a set of objects by arbitrary expressions.*
- `container & prepend` (const `ex` &b)  
*Add element at front.*
- `container & append` (const `ex` &b)  
*Add element at back.*
- `container & remove_first` ()  
*Remove first element.*
- `container & remove_last` ()  
*Remove last element.*
- `container & remove_all` ()  
*Remove all elements.*
- `container & sort` ()  
*Sort elements.*
- `container & unique` ()  
*Remove adjacent duplicate elements.*
- `const_iterator begin` () const
- `const_iterator end` () const
- `const_reverse_iterator rbegin` () const
- `const_reverse_iterator rend` () const

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic` (const `basic` &other)
- const `basic & operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex evalf` () const  
*Evaluate object numerically.*
- virtual `ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree` () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const

- *Test for occurrence of a pattern.*  
virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
- *Check whether the expression matches a given pattern.*  
virtual `ex map` (`map_function` &f) const
- *Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*  
virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
- *Check whether this is a polynomial in the given variables.*  
virtual int `degree` (const `ex` &s) const
- *Return degree of highest power in object s.*  
virtual int `ldegree` (const `ex` &s) const
- *Return degree of lowest power in object s.*  
virtual `ex coeff` (const `ex` &s, int n=1) const
- *Return coefficient of degree n in object s.*  
virtual `ex collect` (const `ex` &s, bool distributed=false) const
- *Sort expanded expression in terms of powers of some object(s).*  
virtual `ex series` (const `relational` &r, int order, unsigned options=0) const
- *Default implementation of `ex::series()`.*  
virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const
- *Default implementation of `ex::normal()`.*  
virtual `ex to_rational` (`exmap` &repl) const
- *Default implementation of `ex::to_rational()`.*  
virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
- *Apply symmetric modular homomorphism to an expanded multivariate polynomial.*  
virtual `numeric max_coefficient` () const
- *Implementation `ex::max_coefficient()`.*  
virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- *Add two indexed expressions.*  
virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- *Multiply an indexed expression with a scalar.*  
virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const
- *Try to contract two indexed expressions that appear in the same product.*  
template<class T>  
void `print_dispatch` (const `print_context` &c, unsigned level) const
- *Like `print()`, but dispatch to the specified class.*  
void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
- *Like `print()`, but dispatch to the specified class.*  
• `ex subs_one_level` (const `exmap` &m, unsigned options) const
- *Helper function for `subs()`.*  
• `ex diff` (const `symbol` &s, unsigned nth=1) const
- *Default interface of nth derivative `ex::diff(s, n)`.*  
int `compare` (const `basic` &other) const
- *Compare objects syntactically to establish canonical ordering.*  
bool `is_equal` (const `basic` &other) const
- *Test for syntactic equality.*  
const `basic` & `hold` () const
- *Stop further evaluation.*  
unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
- *Set some `status_flags`.*  
const `basic` & `clearflag` (unsigned f) const
- *Clear some `status_flags`.*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Member Functions

- [ex\\_derivative](#) (const [symbol](#) &s) const override  
*Implementation of [ex::diff\(\)](#) for an indexed object always returns 0.*
- [ex\\_thiscontainer](#) (const [exvector](#) &v) const override  
*Similar to [duplicate\(\)](#), but with a preset sequence.*
- [ex\\_thiscontainer](#) ([exvector](#) &&v) const override  
*Similar to [duplicate\(\)](#), but with a preset sequence (which gets pilfered).*
- unsigned [return\\_type](#) () const override
- [return\\_type\\_t](#) [return\\_type\\_tinfo](#) () const override
- [ex\\_expand](#) (unsigned options=0) const override  
*Expand expression, i.e.*
- void [printindices](#) (const [print\\_context](#) &c, unsigned level) const
- void [print\\_indexed](#) (const [print\\_context](#) &c, const char \*openbrace, const char \*closebrace, unsigned level) const
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_latex](#) (const [print\\_latex](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const
- void [validate](#) () const  
*Check whether all indices are of class idx and validate the symmetry tree.*

## Protected Member Functions inherited from [GiNaC::container< \[std::vector\]\(#\) >](#)

- [ex\\_conjugate](#) () const override
- bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if two objects of same type are equal.*
- virtual void [printseq](#) (const [print\\_context](#) &c, char openbracket, char delim, char closebracket, unsigned this←\_precedence, unsigned upper\_precedence=0) const  
*Print sequence of contained elements.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const
- void [do\\_print\\_python](#) (const [print\\_python](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const
- [STLT\\_subchildren](#) (const [exmap](#) &m, unsigned options=0) const
- [ex\\_conjugate](#) () const override
- bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if two objects of same type are equal.*
- virtual void [printseq](#) (const [print\\_context](#) &c, char openbracket, char delim, char closebracket, unsigned this←\_precedence, unsigned upper\_precedence=0) const  
*Print sequence of contained elements.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const
- void [do\\_print\\_python](#) (const [print\\_python](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const
- [STLT\\_subchildren](#) (const [exmap](#) &m, unsigned options=0) const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Member Functions inherited from [GiNaC::container\\_storage< C >](#)

- [container\\_storage](#) ()
- [container\\_storage](#) (size\_t n, const [ex](#) &e)
- [container\\_storage](#) (std::initializer\_list< [ex](#) > il)
- template<class In>  
  [container\\_storage](#) (In b, In e)
- void [reserve](#) (size\_t)
- [~container\\_storage](#) ()
- void [reserve](#) (size\_t n)
- void [reserve](#) (std::vector< [ex](#) > &v, size\_t n)

## Protected Attributes

- [ex symtree](#)  
*Index symmetry (tree of symmetry objects)*

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

## Protected Attributes inherited from [GiNaC::container\\_storage< C >](#)

- [STLT seq](#)

## Friends

- [ex simplify\\_indexed](#) (const [ex](#) &e, [exvector](#) &free\_indices, [exvector](#) &dummy\_indices, const [scalar\\_products](#) &sp)  
*Simplify indexed expression, return list of free indices.*
- [ex simplify\\_indexed\\_product](#) (const [ex](#) &e, [exvector](#) &free\_indices, [exvector](#) &dummy\_indices, const [scalar\\_products](#) &sp)  
*Simplify product of indexed expressions (commutative, noncommutative and simple squares), return list of free indices.*
- bool [reposition\\_dummy\\_indices](#) ([ex](#) &e, [exvector](#) &variant\_dummy\_indices, [exvector](#) &moved\_indices)  
*Raise/lower dummy indices in a single indexed objects to canonicalize their variance.*

## Additional Inherited Members

### Public Types inherited from [GiNaC::container< std::vector >](#)

- typedef STL::const\_iterator [const\\_iterator](#)
- typedef STL::const\_reverse\_iterator [const\\_reverse\\_iterator](#)

### Protected Types inherited from [GiNaC::container< std::vector >](#)

- typedef [container\\_storage](#)< std::vector >::STLT [STLT](#)

### Protected Types inherited from [GiNaC::container\\_storage< C >](#)

- typedef C< [ex](#) > [STLT](#)

### Static Protected Member Functions inherited from [GiNaC::container< std::vector >](#)

- static unsigned [get\\_default\\_flags](#) ()
- static char [get\\_open\\_delim](#) ()
- static char [get\\_close\\_delim](#) ()
- static unsigned [get\\_default\\_flags](#) ()
- static char [get\\_open\\_delim](#) ()
- static char [get\\_close\\_delim](#) ()

### Static Protected Member Functions inherited from [GiNaC::container\\_storage< C >](#)

- static void [reserve](#) ([STLT](#) &, size\_t)

## 6.74.1 Detailed Description

This class holds an indexed expression.

It consists of a 'base' expression (the expression being indexed) which can be accessed as op(0), and n (n >= 0) indices (all of class [idx](#)), accessible as op(1)..op(n).

## 6.74.2 Constructor & Destructor Documentation

### 6.74.2.1 indexed() [1/13]

```
GiNaC::indexed::indexed (
 const ex & b)
```

Construct indexed object with no index.



## Parameters

|          |                 |
|----------|-----------------|
| <i>b</i> | Base expression |
|----------|-----------------|

References [indexed\(\)](#), [GiNaC::not\\_symmetric\(\)](#), [symtree](#), and [validate\(\)](#).

Referenced by [eval\(\)](#), [GiNaC::clifford::eval\\_ncmul\(\)](#), [get\\_dummy\\_indices\(\)](#), [GiNaC::clifford::get\\_metric\(\)](#), [indexed\(\)](#), [simplify\\_indexed\(\)](#), [thiscontainer\(\)](#), and [thiscontainer\(\)](#).

**6.74.2.2 indexed()** [2/13]

```
GiNaC::indexed::indexed (
 const ex & b,
 const ex & i1)
```

Construct indexed object with one index.

The index must be of class idx.

## Parameters

|           |                 |
|-----------|-----------------|
| <i>b</i>  | Base expression |
| <i>i1</i> | The index       |

References [GiNaC::not\\_symmetric\(\)](#), [symtree](#), and [validate\(\)](#).

**6.74.2.3 indexed()** [3/13]

```
GiNaC::indexed::indexed (
 const ex & b,
 const ex & i1,
 const ex & i2)
```

Construct indexed object with two indices.

The indices must be of class idx.

## Parameters

|           |                 |
|-----------|-----------------|
| <i>b</i>  | Base expression |
| <i>i1</i> | First index     |
| <i>i2</i> | Second index    |

References [GiNaC::not\\_symmetric\(\)](#), [symtree](#), and [validate\(\)](#).

**6.74.2.4 indexed()** [4/13]

```
GiNaC::indexed::indexed (
 const ex & b,
 const ex & i1,
 const ex & i2,
 const ex & i3)
```

Construct indexed object with three indices.

The indices must be of class idx.

## Parameters

|           |                 |
|-----------|-----------------|
| <i>b</i>  | Base expression |
| <i>i1</i> | First index     |
| <i>i2</i> | Second index    |
| <i>i3</i> | Third index     |

References [GiNaC::not\\_symmetric\(\)](#), [symtree](#), and [validate\(\)](#).

**6.74.2.5 indexed()** [5/13]

```
GiNaC::indexed::indexed (
 const ex & b,
 const ex & i1,
 const ex & i2,
 const ex & i3,
 const ex & i4)
```

Construct indexed object with four indices.

The indices must be of class idx.

## Parameters

|           |                 |
|-----------|-----------------|
| <i>b</i>  | Base expression |
| <i>i1</i> | First index     |
| <i>i2</i> | Second index    |
| <i>i3</i> | Third index     |
| <i>i4</i> | Fourth index    |

References [GiNaC::not\\_symmetric\(\)](#), [symtree](#), and [validate\(\)](#).

**6.74.2.6 indexed()** [6/13]

```
GiNaC::indexed::indexed (
 const ex & b,
 const symmetry & symm,
 const ex & i1,
 const ex & i2)
```

Construct indexed object with two indices and a specified symmetry.

The indices must be of class idx.

## Parameters

|             |                     |
|-------------|---------------------|
| <i>b</i>    | Base expression     |
| <i>symm</i> | Symmetry of indices |
| <i>i1</i>   | First index         |
| <i>i2</i>   | Second index        |

References [GiNaC::symm\(\)](#), [symtree](#), and [validate\(\)](#).

**6.74.2.7 indexed()** [7/13]

```
GiNaC::indexed::indexed (
 const ex & b,
 const symmetry & symm,
 const ex & i1,
 const ex & i2,
 const ex & i3)
```

Construct indexed object with three indices and a specified symmetry.

The indices must be of class `idx`.

**Parameters**

|             |                     |
|-------------|---------------------|
| <i>b</i>    | Base expression     |
| <i>symm</i> | Symmetry of indices |
| <i>i1</i>   | First index         |
| <i>i2</i>   | Second index        |
| <i>i3</i>   | Third index         |

References [GiNaC::symm\(\)](#), [symtree](#), and [validate\(\)](#).

**6.74.2.8 indexed()** [8/13]

```
GiNaC::indexed::indexed (
 const ex & b,
 const symmetry & symm,
 const ex & i1,
 const ex & i2,
 const ex & i3,
 const ex & i4)
```

Construct indexed object with four indices and a specified symmetry.

The indices must be of class `idx`.

**Parameters**

|             |                     |
|-------------|---------------------|
| <i>b</i>    | Base expression     |
| <i>symm</i> | Symmetry of indices |
| <i>i1</i>   | First index         |
| <i>i2</i>   | Second index        |
| <i>i3</i>   | Third index         |
| <i>i4</i>   | Fourth index        |

References [GiNaC::symm\(\)](#), [symtree](#), and [validate\(\)](#).

**6.74.2.9 indexed()** [9/13]

```
GiNaC::indexed::indexed (
 const ex & b,
 const exvector & iv)
```

Construct indexed object with a specified vector of indices.

The indices must be of class `idx`.

## Parameters

|           |                   |
|-----------|-------------------|
| <i>b</i>  | Base expression   |
| <i>iv</i> | Vector of indices |

References [GiNaC::not\\_symmetric\(\)](#), [GiNaC::container\\_storage< C >::seq](#), [symtree](#), and [validate\(\)](#).

**6.74.2.10 indexed()** [10/13]

```
GiNaC::indexed::indexed (
 const ex & b,
 const symmetry & symm,
 const exvector & iv)
```

Construct indexed object with a specified vector of indices and symmetry.

The indices must be of class `idx`.

## Parameters

|             |                     |
|-------------|---------------------|
| <i>b</i>    | Base expression     |
| <i>symm</i> | Symmetry of indices |
| <i>iv</i>   | Vector of indices   |

References [GiNaC::container\\_storage< C >::seq](#), [GiNaC::symm\(\)](#), [symtree](#), and [validate\(\)](#).

**6.74.2.11 indexed()** [11/13]

```
GiNaC::indexed::indexed (
 const symmetry & symm,
 const exprseq & es)
```

References [GiNaC::symm\(\)](#), and [symtree](#).

**6.74.2.12 indexed()** [12/13]

```
GiNaC::indexed::indexed (
 const symmetry & symm,
 const exvector & v)
```

References [GiNaC::symm\(\)](#), and [symtree](#).

**6.74.2.13 indexed()** [13/13]

```
GiNaC::indexed::indexed (
 const symmetry & symm,
 exvector && v)
```

References [GiNaC::symm\(\)](#), and [symtree](#).

### 6.74.3 Member Function Documentation

#### 6.74.3.1 precedence()

```
unsigned GiNaC::indexed::precedence () const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::container< std::vector >](#).

Referenced by [print\\_indexed\(\)](#).

#### 6.74.3.2 info()

```
bool GiNaC::indexed::info (
 unsigned inf) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::container< std::vector >](#).

References [GiNaC::info\\_flags::has\\_indices](#), [GiNaC::info\\_flags::indexed](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [imag\\_part\(\)](#), and [real\\_part\(\)](#).

#### 6.74.3.3 eval()

```
ex GiNaC::indexed::eval () const [override], [virtual]
```

Perform automatic non-interruptive term rewriting rules.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::canonicalize\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [indexed\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::container\\_storage< C >::seq](#), [syntree](#), and [thiscontainer\(\)](#).

#### 6.74.3.4 real\_part()

```
ex GiNaC::indexed::real_part () const [override], [virtual]
```

Reimplemented from [GiNaC::container< std::vector >](#).

References [info\(\)](#), [GiNaC::container< std::vector >::op\(\)](#), and [GiNaC::info\\_flags::real](#).

### 6.74.3.5 `imag_part()`

```
ex GiNaC::indexed::imag_part () const [override], [virtual]
```

Reimplemented from [GiNaC::container< std::vector >](#).

References [info\(\)](#), [GiNaC::container< std::vector >::op\(\)](#), and [GiNaC::info\\_flags::real](#).

### 6.74.3.6 `get_free_indices()`

```
exvector GiNaC::indexed::get_free_indices () const [override], [virtual]
```

Return a vector containing the free indices of an expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::find\\_free\\_and\\_dummy\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [get\\_dummy\\_indices\(\)](#).

### 6.74.3.7 `archive()`

```
void GiNaC::indexed::archive (
 archive_node & n) const [override], [virtual]
```

Save (a.k.a.

serialize) indexed object into archive.

Reimplemented from [GiNaC::container< std::vector >](#).

References [GiNaC::archive\\_node::add\\_ex\(\)](#), and [symtree](#).

### 6.74.3.8 `read_archive()`

```
void GiNaC::indexed::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Read (a.k.a.

deserialize) indexed object from archive.

Reimplemented from [GiNaC::container< std::vector >](#).

References [GiNaC::ex\\_to\(\)](#), [GiNaC::archive\\_node::find\\_ex\(\)](#), [GiNaC::archive\\_node::find\\_unsigned\(\)](#), [GiNaC::not\\_symmetric\(\)](#), [GiNaC::container\\_storage< C >::seq](#), [GiNaC::sy\\_anti\(\)](#), [GiNaC::sy\\_symm\(\)](#), [GiNaC::symm\(\)](#), [symtree](#), and [validate\(\)](#).

### 6.74.3.9 derivative()

```
ex GiNaC::indexed::derivative (
 const symbol & s) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for an indexed object always returns 0.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#).

### 6.74.3.10 thiscontainer() [1/2]

```
ex GiNaC::indexed::thiscontainer (
 const exvector & v) const [override], [protected], [virtual]
```

Similar to [duplicate\(\)](#), but with a preset sequence.

Must be overridden by derived classes.

Reimplemented from [GiNaC::container< std::vector >](#).

References [GiNaC::ex\\_to\(\)](#), [indexed\(\)](#), and [symtree](#).

Referenced by [eval\(\)](#), and [expand\(\)](#).

### 6.74.3.11 thiscontainer() [2/2]

```
ex GiNaC::indexed::thiscontainer (
 exvector && v) const [override], [protected], [virtual]
```

Similar to [duplicate\(\)](#), but with a preset sequence (which gets pilfered).

Must be overridden by derived classes.

Reimplemented from [GiNaC::container< std::vector >](#).

References [GiNaC::ex\\_to\(\)](#), [indexed\(\)](#), and [symtree](#).

### 6.74.3.12 return\_type()

```
unsigned GiNaC::indexed::return_type () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::commutative](#), [GiNaC::is\\_a\(\)](#), [GiNaC::container< std::vector >::op\(\)](#), and [GiNaC::ex::return\\_type\(\)](#).

### 6.74.3.13 `return_type_tinfo()`

```
return_type_t GiNaC::indexed::return_type_tinfo () const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::container< std::vector >::op\(\)](#), and [GiNaC::ex::return\\_type\\_tinfo\(\)](#).

### 6.74.3.14 `expand()`

```
ex GiNaC::indexed::expand (
 unsigned options = 0) const [override], [protected], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::expand\\_options::expand\\_in](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::container\\_storage< C >::seq](#), and [thiscontainer\(\)](#).

### 6.74.3.15 `all_index_values_are()`

```
bool GiNaC::indexed::all_index_values_are (
 unsigned inf) const
```

Check whether all index values have a certain property.

See also

class [info\\_flags](#)

References [GiNaC::container\\_storage< C >::seq](#).

### 6.74.3.16 `get_indices()`

```
exvector GiNaC::indexed::get_indices () const
```

Return a vector containing the object's indices.

References [GINAC\\_ASSERT](#), and [GiNaC::container\\_storage< C >::seq](#).

### 6.74.3.17 `get_dummy_indices()` [1/2]

```
exvector GiNaC::indexed::get_dummy_indices () const
```

Return a vector containing the dummy indices of the object, if any.

References [GiNaC::find\\_free\\_and\\_dummy\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).



**6.74.3.18 get\_dummy\_indices()** [2/2]

```
exvector GiNaC::indexed::get_dummy_indices (
 const indexed & other) const
```

Return a vector containing the dummy indices in the contraction with another indexed object.

This is symmetric: `a.get_dummy_indices(b) == b.get_dummy_indices(a)`

References [GiNaC::find\\_dummy\\_indices\(\)](#), [get\\_free\\_indices\(\)](#), and [indexed\(\)](#).

**6.74.3.19 has\_dummy\_index\_for()**

```
bool GiNaC::indexed::has_dummy_index_for (
 const ex & i) const
```

Check whether the object has an index that forms a dummy index pair with a given index.

References [GiNaC::is\\_dummy\\_pair\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).

**6.74.3.20 get\_symmetry()**

```
ex GiNaC::indexed::get_symmetry () const [inline]
```

Return symmetry properties.

References [symtree](#).

Referenced by [GiNaC::clifford::get\\_metric\(\)](#).

**6.74.3.21 printindices()**

```
void GiNaC::indexed::printindices (
 const print_context & c,
 unsigned level) const [protected]
```

References [GiNaC::class\\_info< OPT >::first](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::print\\_context::s](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [GiNaC::clifford::do\\_print\\_dflt\(\)](#), [GiNaC::clifford::do\\_print\\_tree\(\)](#), [do\\_print\\_tree\(\)](#), and [print\\_indexed\(\)](#).

**6.74.3.22 print\_indexed()**

```
void GiNaC::indexed::print_indexed (
 const print_context & c,
 const char * openbrace,
 const char * closebrace,
 unsigned level) const [protected]
```

References [precedence\(\)](#), [printindices\(\)](#), [GiNaC::print\\_context::s](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [do\\_print\(\)](#), and [do\\_print\\_latex\(\)](#).

**6.74.3.23 do\_print()**

```
void GiNaC::indexed::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [print\\_indexed\(\)](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.74.3.24 do\_print\_latex()**

```
void GiNaC::indexed::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

References [print\\_indexed\(\)](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.74.3.25 do\_print\_tree()**

```
void GiNaC::indexed::do_print_tree (
 const print_tree & c,
 unsigned level) const [protected]
```

References [GiNaC::print\\_tree::delta\\_indent](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [printindices\(\)](#), [GiNaC::print\\_context::s](#), [GiNaC::container\\_storage< C >::seq](#), and [symtree](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.74.3.26 validate()**

```
void GiNaC::indexed::validate () const [protected]
```

Check whether all indices are of class `idx` and validate the symmetry tree.

This function is used internally to make sure that all constructed indexed objects really carry indices and not some other classes.

References [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::container\\_storage< C >::seq](#), [symtree](#), and [validate\(\)](#).

Referenced by [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [read\\_archive\(\)](#), and [validate\(\)](#).

## 6.74.4 Friends And Related Symbol Documentation

### 6.74.4.1 simplify\_indexed

```
ex simplify_indexed (
 const ex & e,
 exvector & free_indices,
 exvector & dummy_indices,
 const scalar_products & sp) [friend]
```

Simplify indexed expression, return list of free indices.

References [GiNaC::\\_ex2](#), [GiNaC::class\\_info< OPT >::first](#), [GiNaC::basic::coeff\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::find\\_free\\_and\\_dummy\(\)](#), [GiNaC::find\\_variant\\_indices\(\)](#), [GiNaC::hasindex\(\)](#), [GiNaC::idx\\_symmetrization\(\)](#), [indexed\(\)](#), [GiNaC::indices\\_consistent\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::rename\\_dummy\\_indices\(\)](#), [GiNaC::reposition\\_dummy\\_indices\(\)](#), [GiNaC::container\\_storage< C >::seq](#), [GiNaC::simplify\\_indexed\(\)](#), and [GiNaC::simplify\\_indexed\\_product\(\)](#).

Referenced by [GiNaC::clifford::get\\_metric\(\)](#), and [GiNaC::clifford::same\\_metric\(\)](#).

### 6.74.4.2 simplify\_indexed\_product

```
ex simplify_indexed_product (
 const ex & e,
 exvector & free_indices,
 exvector & dummy_indices,
 const scalar_products & sp) [friend]
```

Simplify product of indexed expressions (commutative, noncommutative and simple squares), return list of free indices.

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [GiNaC::return\\_types::commutative](#), [GiNaC::scalar\\_products::evaluate\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::find\\_free\\_and\\_dummy\(\)](#), [GiNaC::find\\_variant\\_indices\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::idx\\_symmetrization\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::scalar\\_products::is\\_defined\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::minimal\\_dim\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::product\\_to\\_exvector\(\)](#), [GiNaC::rename\\_dummy\\_indices\(\)](#), [GiNaC::reposition\\_dummy\\_indices\(\)](#), [GiNaC::simplify\\_indexed\(\)](#), and [GiNaC::simplify\\_indexed\\_product\(\)](#).

### 6.74.4.3 reposition\_dummy\_indices

```
bool reposition_dummy_indices (
 ex & e,
 exvector & variant_dummy_indices,
 exvector & moved_indices) [friend]
```

Raise/lower dummy indices in a single indexed objects to canonicalize their variance.

#### Parameters

|                              |                                                                                     |
|------------------------------|-------------------------------------------------------------------------------------|
| <i>e</i>                     | Object to work on                                                                   |
| <i>variant_dummy_indices</i> | The set of indices that might need repositioning (will be changed by this function) |
| <i>moved_indices</i>         | The set of indices that have been repositioned (will be changed by this function)   |

#### Returns

true if 'e' was changed

References [GiNaC::ex\\_to\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_dummy\\_pair\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::container\\_storage< C >::seq](#), and [GiNaC::ex::subs\(\)](#).

## 6.74.5 Member Data Documentation

### 6.74.5.1 symtree

`ex GiNaC::indexed::symtree [protected]`

Index symmetry (tree of symmetry objects)

Referenced by [archive\(\)](#), [GiNaC::clifford::do\\_print\\_tree\(\)](#), [do\\_print\\_tree\(\)](#), [eval\(\)](#), [get\\_symmetry\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [indexed\(\)](#), [read\\_archive\(\)](#), [thiscontainer\(\)](#), [thiscontainer\(\)](#), and [validate\(\)](#).

The documentation for this class was generated from the following files:

- [indexed.h](#)
- [indexed.cpp](#)

## 6.75 GiNaC::info\_flags Class Reference

Possible attributes an object can have.

```
#include <flags.h>
```

### Public Types

- enum {  
[numeric](#) , [real](#) , [rational](#) , [integer](#) ,  
[crational](#) , [cinteger](#) , [positive](#) , [negative](#) ,  
[nonnegative](#) , [posint](#) , [negint](#) , [nonnegint](#) ,  
[even](#) , [odd](#) , [prime](#) , [relation](#) ,  
[relation\\_equal](#) , [relation\\_not\\_equal](#) , [relation\\_less](#) , [relation\\_less\\_or\\_equal](#) ,  
[relation\\_greater](#) , [relation\\_greater\\_or\\_equal](#) , [symbol](#) , [list](#) ,  
[exprseq](#) , [polynomial](#) , [integer\\_polynomial](#) , [cinteger\\_polynomial](#) ,  
[rational\\_polynomial](#) , [crational\\_polynomial](#) , [rational\\_function](#) , [indexed](#) ,  
[has\\_indices](#) , [idx](#) , [expanded](#) , [indefinite](#) }

### 6.75.1 Detailed Description

Possible attributes an object can have.

## 6.75.2 Member Enumeration Documentation

### 6.75.2.1 anonymous enum

```
anonymous enum
```

## Enumerator

|                           |  |
|---------------------------|--|
| numeric                   |  |
| real                      |  |
| rational                  |  |
| integer                   |  |
| crational                 |  |
| cinteger                  |  |
| positive                  |  |
| negative                  |  |
| nonnegative               |  |
| posint                    |  |
| negint                    |  |
| nonnegint                 |  |
| even                      |  |
| odd                       |  |
| prime                     |  |
| relation                  |  |
| relation_equal            |  |
| relation_not_equal        |  |
| relation_less             |  |
| relation_less_or_equal    |  |
| relation_greater          |  |
| relation_greater_or_equal |  |
| symbol                    |  |
| list                      |  |
| exprseq                   |  |
| polynomial                |  |
| integer_polynomial        |  |
| cinteger_polynomial       |  |
| rational_polynomial       |  |
| crational_polynomial      |  |
| rational_function         |  |
| indexed                   |  |
| has_indices               |  |
| idx                       |  |
| expanded                  |  |
| indefinite                |  |

The documentation for this class was generated from the following file:

- [flags.h](#)

## 6.76 GiNaC::integral Class Reference

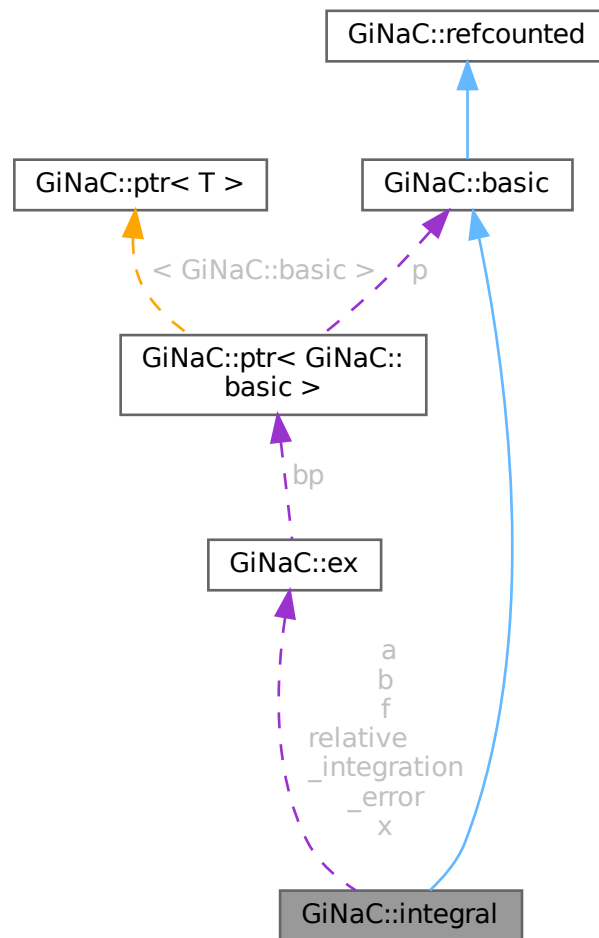
Symbolic integral.

```
#include <integral.h>
```

Inheritance diagram for GiNaC::integral:



Collaboration diagram for GiNaC::integral:



## Public Member Functions

- `integral` (const `ex` &`x_`, const `ex` &`a_`, const `ex` &`b_`, const `ex` &`f_`)
- unsigned `precedence` () const override  
Return relative operator precedence (for parenthesizing output).
- `ex eval` () const override  
Perform automatic non-interruptive term rewriting rules.
- `ex evalf` () const override  
Evaluate object numerically.
- int `degree` (const `ex` &`s`) const override  
Return degree of highest power in object `s`.
- int `ldegree` (const `ex` &`s`) const override  
Return degree of lowest power in object `s`.
- `ex eval_ncmul` (const `exvector` &`v`) const override
- size\_t `nops` () const override

- *Number of operands/members.*
- `ex op` (`size_t i`) `const` override  
*Return operand/member at position  $i$ .*
- `ex & let_op` (`size_t i`) override  
*Return modifiable operand/member at position  $i$ .*
- `ex expand` (`unsigned options=0`) `const` override  
*Expand expression, i.e.*
- `exvector get_free_indices` () `const` override  
*Return a vector containing the free indices of an expression.*
- `unsigned return_type` () `const` override
- `return_type_t return_type_tinfo` () `const` override
- `ex conjugate` () `const` override
- `ex eval_integ` () `const` override  
*Evaluate integrals, if result is known.*
- `void archive` (`archive_node &n`) `const` override  
*Save (a.k.a.*
- `void read_archive` (`const archive_node &n`, `lst &syms`) override  
*Read (a.k.a.*

## Public Member Functions inherited from `GiNaC::basic`

- `virtual ~basic` ()  
*basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic` (`const basic &other`)
- `const basic & operator=` (`const basic &other`)  
*basic assignment operator: the other object might be of a derived class.*
- `virtual basic * duplicate` () `const`  
*Create a clone of this object on the heap.*
- `virtual ex evalm` () `const`  
*Evaluate sums, products and integer powers of matrices.*
- `virtual ex eval_indexed` (`const basic &i`) `const`  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- `virtual void print` (`const print_context &c`, `unsigned level=0`) `const`  
*Output to stream.*
- `virtual void dbgprint` () `const`  
*Little wrapper around `print` to be called within a debugger.*
- `virtual void dbgprinttree` () `const`  
*Little wrapper around `printtree` to be called within a debugger.*
- `virtual bool info` (`unsigned inf`) `const`  
*Information about the object.*
- `virtual ex operator[]` (`const ex &index`) `const`
- `virtual ex operator[]` (`size_t i`) `const`
- `virtual ex & operator[]` (`const ex &index`)
- `virtual ex & operator[]` (`size_t i`)
- `virtual bool has` (`const ex &other`, `unsigned options=0`) `const`  
*Test for occurrence of a pattern.*
- `virtual bool match` (`const ex &pattern`, `exmap &repls`) `const`  
*Check whether the expression matches a given pattern.*
- `virtual ex subs` (`const exmap &m`, `unsigned options=0`) `const`  
*Substitute a set of objects by arbitrary expressions.*
- `virtual ex map` (`map_function &f`) `const`



- Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (`GiNaC::visitor &v`) const
- virtual bool `is_polynomial` (const `ex &var`) const
  - Check whether this is a polynomial in the given variables.
- virtual `ex coeff` (const `ex &s`, int `n=1`) const
  - Return coefficient of degree `n` in object `s`.
- virtual `ex collect` (const `ex &s`, bool `distributed=false`) const
  - Sort expanded expression in terms of powers of some object(s).
- virtual `ex normal` (`exmap &repl`, `exmap &rev_lookup`, `lst &modifier`) const
  - Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap &repl`) const
  - Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap &repl`) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric &xi`) const
  - Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
  - Implementation `ex::max_coefficient()`.
- virtual `ex add_indexed` (const `ex &self`, const `ex &other`) const
  - Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex &self`, const `numeric &other`) const
  - Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (`exvector::iterator self`, `exvector::iterator other`, `exvector &v`) const
  - Try to contract two indexed expressions that appear in the same product.
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T>
  - void `print_dispatch` (const `print_context &c`, unsigned level) const
    - Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info &ri`, const `print_context &c`, unsigned level) const
  - Like `print()`, but dispatch to the specified class.
- `ex subs_one_level` (const `exmap &m`, unsigned options) const
  - Helper function for `subs()`.
- `ex diff` (const `symbol &s`, unsigned `nth=1`) const
  - Default interface of `nth` derivative `ex::diff(s, n)`.
- int `compare` (const `basic &other`) const
  - Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic &other`) const
  - Test for syntactic equality.
- const `basic & hold` () const
  - Stop further evaluation.
- unsigned `gethash` () const
- const `basic & setflag` (unsigned `f`) const
  - Set some `status_flags`.
- const `basic & clearflag` (unsigned `f`) const
  - Clear some `status_flags`.

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int `r`) noexcept

### Static Public Attributes

- static int `max_integration_level` = 15
- static `ex` `relative_integration_error` = 1e-8

### Protected Member Functions

- `ex` `derivative` (const `symbol` &s) const override  
*Default implementation of `ex::diff()`.*
- `ex` `series` (const `relational` &r, int order, unsigned options=0) const override  
*Default implementation of `ex::series()`.*
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

### Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned `calchash` () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void `do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

### Private Attributes

- `ex` x
- `ex` a
- `ex` b
- `ex` f

### Additional Inherited Members

### Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`  
*of type `status_flags`*
- unsigned `hashvalue`  
*hash value*

## 6.76.1 Detailed Description

Symbolic integral.

## 6.76.2 Constructor & Destructor Documentation

### 6.76.2.1 integral()

```
GiNaC::integral::integral (
 const ex & x_,
 const ex & a_,
 const ex & b_,
 const ex & f_)
```

References [a](#), [b](#), [GiNaC::basic::ex](#), [f](#), [integral\(\)](#), [GiNaC::is\\_a\(\)](#), and [x](#).

Referenced by [derivative\(\)](#), [expand\(\)](#), [integral\(\)](#), and [series\(\)](#).

## 6.76.3 Member Function Documentation

### 6.76.3.1 precedence()

```
unsigned GiNaC::integral::precedence () const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Referenced by [do\\_print\\_latex\(\)](#).

### 6.76.3.2 eval()

```
ex GiNaC::integral::eval () const [override], [virtual]
```

Perform automatic non-interruptive term rewriting rules.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [a](#), [b](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::basic::ex](#), [f](#), [GiNaC::basic::flags](#), [GiNaC::haswild\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

### 6.76.3.3 evalf()

```
ex GiNaC::integral::evalf () const [override], [virtual]
```

Evaluate object numerically.

Reimplemented from [GiNaC::basic](#).

References [a](#), [GiNaC::adaptivesimpson\(\)](#), [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [b](#), [GiNaC::dynallocate\(\)](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::basic::ex](#), [f](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::ex::subs\(\)](#), and [x](#).

#### 6.76.3.4 degree()

```
int GiNaC::integral::degree (
 const ex & s) const [override], [virtual]
```

Return degree of highest power in object s.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [GiNaC::ex::degree\(\)](#), [GiNaC::basic::ex](#), and [f](#).

#### 6.76.3.5 ldegree()

```
int GiNaC::integral::ldegree (
 const ex & s) const [override], [virtual]
```

Return degree of lowest power in object s.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [GiNaC::basic::ex](#), and [f](#).

#### 6.76.3.6 eval\_ncmul()

```
ex GiNaC::integral::eval_ncmul (
 const exvector & v) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), and [f](#).

#### 6.76.3.7 nops()

```
size_t GiNaC::integral::nops () const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

#### 6.76.3.8 op()

```
ex GiNaC::integral::op (
 size_t i) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [GiNaC::basic::ex](#), [f](#), [GINAC\\_ASSERT](#), and [x](#).

**6.76.3.9 let\_op()**

```
ex & GiNaC::integral::let_op (
 size_t i) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [GiNaC::basic::ex](#), [f](#), and [x](#).

**6.76.3.10 expand()**

```
ex GiNaC::integral::expand (
 unsigned options = 0) const [override], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

References [a](#), [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [b](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex::expand\(\)](#), [GiNaC::status\\_flags::expanded](#), [f](#), [GiNaC::basic::flags](#), [GiNaC::ex::has\(\)](#), [integral\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::basic::setflag\(\)](#), and [x](#).

Referenced by [eval\\_integ\(\)](#).

**6.76.3.11 get\_free\_indices()**

```
exvector GiNaC::integral::get_free_indices () const [override], [virtual]
```

Return a vector containing the free indices of an expression.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), and [f](#).

**6.76.3.12 return\_type()**

```
unsigned GiNaC::integral::return_type () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [f](#).

**6.76.3.13 return\_type\_tinfo()**

```
return_type_t GiNaC::integral::return_type_tinfo () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [f](#).

#### 6.76.3.14 conjugate()

```
ex GiNaC::integral::conjugate () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [a](#), [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [b](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [f](#), and [x](#).

#### 6.76.3.15 eval\_integ()

```
ex GiNaC::integral::eval_integ () const [override], [virtual]
```

Evaluate integrals, if result is known.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [GiNaC::ex::eval\\_integ\(\)](#), [GiNaC::basic::ex](#), [expand\(\)](#), [GiNaC::status\\_flags::expanded](#), [f](#), [GiNaC::basic::flags](#), [GiNaC::is\\_a\(\)](#), [GiNaC::log\(\)](#), [GiNaC::ex::subs\(\)](#), and [x](#).

#### 6.76.3.16 archive()

```
void GiNaC::integral::archive (
 archive_node & n) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [a](#), [GiNaC::archive\\_node::add\\_ex\(\)](#), [b](#), [f](#), and [x](#).

#### 6.76.3.17 read\_archive()

```
void GiNaC::integral::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [f](#), [GiNaC::archive\\_node::find\\_ex\(\)](#), and [x](#).

### 6.76.3.18 derivative()

```
ex GiNaC::integral::derivative (
 const symbol & s) const [override], [protected], [virtual]
```

Default implementation of [ex::diff\(\)](#).

It maps the operation on the operands (or returns 0 when the object has no operands).

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [GiNaC::basic::ex](#), [f](#), [integral\(\)](#), and [x](#).

### 6.76.3.19 series()

```
ex GiNaC::integral::series (
 const relational & r,
 int order,
 unsigned options = 0) const [override], [protected], [virtual]
```

Default implementation of [ex::series\(\)](#).

This performs Taylor expansion.

See also

[ex::series](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [a](#), [b](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [f](#), [integral\(\)](#), [GiNaC::is\\_order\\_function\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::series\(\)](#), and [x](#).

### 6.76.3.20 do\_print()

```
void GiNaC::integral::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [a](#), [b](#), [f](#), [GiNaC::print\\_context::s](#), and [x](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.76.3.21 do\_print\_latex()

```
void GiNaC::integral::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

References [a](#), [b](#), [GiNaC::ex\\_to\(\)](#), [f](#), [precedence\(\)](#), [GiNaC::print\\_context::s](#), and [x](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.76.4 Member Data Documentation

### 6.76.4.1 max\_integration\_level

```
int GiNaC::integral::max_integration_level = 15 [static]
```

Referenced by [GiNaC::adaptivesimpson\(\)](#).

### 6.76.4.2 relative\_integration\_error

```
ex GiNaC::integral::relative_integration_error = 1e-8 [static]
```

Referenced by [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER\(\)](#).

### 6.76.4.3 x

```
ex GiNaC::integral::x [private]
```

Referenced by [archive\(\)](#), [conjugate\(\)](#), [derivative\(\)](#), [do\\_print\(\)](#), [do\\_print\\_latex\(\)](#), [eval\(\)](#), [eval\\_integ\(\)](#), [evalf\(\)](#), [expand\(\)](#), [integral\(\)](#), [let\\_op\(\)](#), [op\(\)](#), [read\\_archive\(\)](#), and [series\(\)](#).

### 6.76.4.4 a

```
ex GiNaC::integral::a [private]
```

Referenced by [archive\(\)](#), [conjugate\(\)](#), [degree\(\)](#), [derivative\(\)](#), [do\\_print\(\)](#), [do\\_print\\_latex\(\)](#), [eval\(\)](#), [eval\\_integ\(\)](#), [evalf\(\)](#), [expand\(\)](#), [get\\_free\\_indices\(\)](#), [integral\(\)](#), [ldegree\(\)](#), [let\\_op\(\)](#), [op\(\)](#), [read\\_archive\(\)](#), and [series\(\)](#).

### 6.76.4.5 b

```
ex GiNaC::integral::b [private]
```

Referenced by [archive\(\)](#), [conjugate\(\)](#), [degree\(\)](#), [derivative\(\)](#), [do\\_print\(\)](#), [do\\_print\\_latex\(\)](#), [eval\(\)](#), [eval\\_integ\(\)](#), [evalf\(\)](#), [expand\(\)](#), [get\\_free\\_indices\(\)](#), [integral\(\)](#), [ldegree\(\)](#), [let\\_op\(\)](#), [op\(\)](#), [read\\_archive\(\)](#), and [series\(\)](#).



## 6.76.4.6 f

```
ex GiNaC::integral::f [private]
```

Referenced by [archive\(\)](#), [conjugate\(\)](#), [degree\(\)](#), [derivative\(\)](#), [do\\_print\(\)](#), [do\\_print\\_latex\(\)](#), [eval\(\)](#), [eval\\_integ\(\)](#), [eval\\_ncmul\(\)](#), [evalf\(\)](#), [expand\(\)](#), [get\\_free\\_indices\(\)](#), [integral\(\)](#), [ldegree\(\)](#), [let\\_op\(\)](#), [op\(\)](#), [read\\_archive\(\)](#), [return\\_type\(\)](#), [return\\_type\\_tinfo\(\)](#), and [series\(\)](#).

The documentation for this class was generated from the following files:

- [integral.h](#)
- [indexed.cpp](#)
- [integral.cpp](#)
- [pseries.cpp](#)

## 6.77 GiNaC::integration\_kernel Class Reference

The base class for integration kernels for iterated integrals.

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::integration\_kernel:



Collaboration diagram for `GiNaC::integration_kernel`:



## Public Member Functions

- `ex series` (const `relational` &r, int order, unsigned options=0) const override  
*Default implementation of `ex::series()`.*
- virtual bool `has_trailing_zero` (void) const  
*This routine returns true, if the integration kernel has a trailing zero.*
- virtual bool `is_numeric` (void) const  
*This routine returns true, if the integration kernel can be evaluated numerically.*
- virtual `ex Laurent_series` (const `ex` &x, int order) const  
*Returns the Laurent series, starting possibly with the pole term.*
- virtual `ex get_numerical_value` (const `ex` &lambda, int N\_trunc=0) const  
*Evaluates the integrand at lambda.*
- `size_t get_cache_size` (void) const  
*Returns the current size of the cache.*
- void `set_cache_step` (int cache\_steps) const  
*Sets the step size by which the cache is increased.*
- `ex get_series_coeff` (int i) const  
*Wrapper around `series_coeff(i)`, converts `cl_N` to numeric.*
- `cln::cl_N series_coeff` (int i) const  
*Subclasses have either to implement `series_coeff_impl` or the two methods `Laurent_series` and `uses_Laurent_series`.*

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate` () const  
*Create a clone of this object on the heap.*

- virtual `ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf` () const  
*Evaluate object numerically.*
- virtual `ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree` () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence` () const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool `info` (unsigned inf) const  
*Information about the object.*
- virtual size\_t `nops` () const  
*Number of operands/members.*
- virtual `ex op` (size\_t i) const  
*Return operand/member at position i.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex & let_op` (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const  
*Check whether the expression matches a given pattern.*
- virtual `ex subs` (const `exmap` &m, unsigned options=0) const  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map` (`map_function` &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const  
*Return degree of highest power in object s.*
- virtual int `ldegree` (const `ex` &s) const  
*Return degree of lowest power in object s.*
- virtual `ex coeff` (const `ex` &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual `ex expand` (unsigned options=0) const  
*Expand expression, i.e.*
- virtual `ex collect` (const `ex` &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*

- virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const  
*Default implementation of `ex::normal()`.*
- virtual `ex to_rational` (`exmap` &repl) const  
*Default implementation of `ex::to_rational()`.*
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const  
*Implementation `ex::max_coefficient()`.*
- virtual `exvector get_free_indices` () const  
*Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T>  
 void `print_dispatch` (const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- virtual void `archive` (`archive_node` &n) const  
*Save (serialize) the object into archive node.*
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)  
*Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of `nth` derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- const `basic` & `hold` () const  
*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const  
*Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from GiNaC::refcounted

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Member Functions

- virtual bool [uses\\_Laurent\\_series](#) () const  
*Returns true, if the coefficients are computed from the Laurent series (in which case the method Laurent\_series needs to be implemented).*
- virtual `cln::cl_N` [series\\_coeff\\_impl](#) (int i) const  
*For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.*
- `ex` [get\\_numerical\\_value\\_impl](#) (const `ex` &lambda, const `ex` &pre, int shift, int N\_trunc) const  
*The actual implementation for computing a numerical value for the integrand.*
- void [do\\_print](#) (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from GiNaC::basic

- [basic](#) ()
- virtual `ex` [eval\\_ncmul](#) (const `exvector` &v) const
- virtual bool [match\\_same\\_type](#) (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual `ex` [derivative](#) (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- virtual int [compare\\_same\\_type](#) (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Attributes

- int [cache\\_step\\_size](#)
- `std::vector< cln::cl_N >` [series\\_vec](#)

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
of type [status\\_flags](#)
- unsigned [hashvalue](#)  
hash value

### 6.77.1 Detailed Description

The base class for integration kernels for iterated integrals.

This class represents the differential one-form

$$\omega = d\lambda$$

The integration variable is a dummy variable and does not need to be specified.

### 6.77.2 Member Function Documentation

#### 6.77.2.1 [series\(\)](#)

```
ex GiNaC::integration_kernel::series (
 const relational & r,
 int order,
 unsigned options = 0) const [override], [virtual]
```

Default implementation of [ex::series\(\)](#).

This performs Taylor expansion.

See also

[ex::series](#)

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::modular\\_form\\_kernel](#).

References [GiNaC::basic::ex](#), [Laurent\\_series\(\)](#), [GiNaC::relational::lhs\(\)](#), [GiNaC::relational::rhs\(\)](#), and [series\(\)](#).

Referenced by [series\(\)](#).

#### 6.77.2.2 [has\\_trailing\\_zero\(\)](#)

```
bool GiNaC::integration_kernel::has_trailing_zero (
 void) const [virtual]
```

This routine returns true, if the integration kernel has a trailing zero.

References [has\\_trailing\\_zero\(\)](#), and [series\\_coeff\(\)](#).

Referenced by [has\\_trailing\\_zero\(\)](#).

### 6.77.2.3 is\_numeric()

```
bool GiNaC::integration_kernel::is_numeric (
 void) const [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented in [GiNaC::Ebar\\_kernel](#), [GiNaC::Eisenstein\\_h\\_kernel](#), [GiNaC::Eisenstein\\_kernel](#), [GiNaC::ELi\\_kernel](#), [GiNaC::Kronecker\\_dtau\\_kernel](#), [GiNaC::Kronecker\\_dz\\_kernel](#), [GiNaC::modular\\_form\\_kernel](#), [GiNaC::multiple\\_polylog\\_kernel](#), and [GiNaC::user\\_defined\\_kernel](#).

References [is\\_numeric\(\)](#).

Referenced by [is\\_numeric\(\)](#).

### 6.77.2.4 Laurent\_series()

```
ex GiNaC::integration_kernel::Laurent_series (
 const ex & x,
 int order) const [virtual]
```

Returns the Laurent series, starting possibly with the pole term.

Neglected terms are of order  $O(x^{order})$ .

Reimplemented in [GiNaC::Eisenstein\\_h\\_kernel](#), [GiNaC::Eisenstein\\_kernel](#), [GiNaC::modular\\_form\\_kernel](#), and [GiNaC::user\\_defined\\_kernel](#).

References [GiNaC::basic::ex](#), [Laurent\\_series\(\)](#), [GiNaC::pow\(\)](#), [GiNaC::ex::series\(\)](#), and [series\\_coeff\(\)](#).

Referenced by [Laurent\\_series\(\)](#), [series\(\)](#), and [series\\_coeff\(\)](#).

### 6.77.2.5 get\_numerical\_value()

```
ex GiNaC::integration_kernel::get_numerical_value (
 const ex & lambda,
 int N_trunc = 0) const [virtual]
```

Evaluates the integrand at lambda.

Reimplemented in [GiNaC::Ebar\\_kernel](#), [GiNaC::Eisenstein\\_h\\_kernel](#), [GiNaC::Eisenstein\\_kernel](#), [GiNaC::ELi\\_kernel](#), [GiNaC::Kronecker\\_dtau\\_kernel](#), [GiNaC::Kronecker\\_dz\\_kernel](#), and [GiNaC::modular\\_form\\_kernel](#).

References [GiNaC::basic::ex](#), [get\\_numerical\\_value\(\)](#), and [get\\_numerical\\_value\\_impl\(\)](#).

Referenced by [get\\_numerical\\_value\(\)](#).

### 6.77.2.6 uses\_Laurent\_series()

```
bool GiNaC::integration_kernel::uses_Laurent_series () const [protected], [virtual]
```

Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).

Returns false if this is not the case (and the class has an implementation of `series_coeff_impl`).

Reimplemented in [GiNaC::Eisenstein\\_h\\_kernel](#), [GiNaC::Eisenstein\\_kernel](#), [GiNaC::modular\\_form\\_kernel](#), and [GiNaC::user\\_defined\\_kernel](#).

References [uses\\_Laurent\\_series\(\)](#).

Referenced by [series\\_coeff\(\)](#), and [uses\\_Laurent\\_series\(\)](#).

### 6.77.2.7 series\_coeff\_impl()

```
cln::cl_N GiNaC::integration_kernel::series_coeff_impl (
 int i) const [protected], [virtual]
```

For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.

The  $i$ -th coefficient corresponds to the power  $\lambda^{i-1}$ .

Reimplemented in [GiNaC::basic\\_log\\_kernel](#), [GiNaC::Ebar\\_kernel](#), [GiNaC::ELi\\_kernel](#), [GiNaC::Kronecker\\_dtau\\_kernel](#), [GiNaC::Kronecker\\_dz\\_kernel](#), and [GiNaC::multiple\\_polylog\\_kernel](#).

References [series\\_coeff\\_impl\(\)](#).

Referenced by [series\\_coeff\(\)](#), and [series\\_coeff\\_impl\(\)](#).

### 6.77.2.8 get\_cache\_size()

```
size_t GiNaC::integration_kernel::get_cache_size (
 void) const
```

Returns the current size of the cache.

References [get\\_cache\\_size\(\)](#), and [series\\_vec](#).

Referenced by [get\\_cache\\_size\(\)](#).

### 6.77.2.9 set\_cache\_step()

```
void GiNaC::integration_kernel::set_cache_step (
 int cache_steps) const
```

Sets the step size by which the cache is increased.

References [cache\\_step\\_size](#), and [set\\_cache\\_step\(\)](#).

Referenced by [set\\_cache\\_step\(\)](#).



**6.77.2.10 get\_series\_coeff()**

```
ex GiNaC::integration_kernel::get_series_coeff (
 int i) const
```

Wrapper around `series_coeff(i)`, converts `cl_N` to numeric.

References [GiNaC::basic::ex](#), [get\\_series\\_coeff\(\)](#), and [series\\_coeff\(\)](#).

Referenced by [get\\_series\\_coeff\(\)](#).

**6.77.2.11 series\_coeff()**

```
cln::cl_N GiNaC::integration_kernel::series_coeff (
 int i) const
```

Subclasses have either to implement `series_coeff_impl` or the two methods `Laurent_series` and `uses_Laurent_series`.

The method `series_coeff_impl` can be used, if a single coefficient can be computed independently of the others.

The method `Laurent_series` can be used, if it is more efficient to compute a Laurent series in one shot and to determine a range of coefficients from this Laurent series.

References [cache\\_step\\_size](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [Laurent\\_series\(\)](#), [series\\_coeff\(\)](#), [series\\_coeff\\_impl\(\)](#), [series\\_vec](#), and [uses\\_Laurent\\_series\(\)](#).

Referenced by [get\\_numerical\\_value\\_impl\(\)](#), [get\\_series\\_coeff\(\)](#), [has\\_trailing\\_zero\(\)](#), [Laurent\\_series\(\)](#), and [series\\_coeff\(\)](#).

**6.77.2.12 get\_numerical\_value\_impl()**

```
ex GiNaC::integration_kernel::get_numerical_value_impl (
 const ex & lambda,
 const ex & pre,
 int shift,
 int N_trunc) const [protected]
```

The actual implementation for computing a numerical value for the integrand.

References [GiNaC::Digits](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [get\\_numerical\\_value\\_impl\(\)](#), and [series\\_coeff\(\)](#).

Referenced by [GiNaC::Ebar\\_kernel::get\\_numerical\\_value\(\)](#), [GiNaC::Eisenstein\\_h\\_kernel::get\\_numerical\\_value\(\)](#), [GiNaC::Eisenstein\\_kernel::get\\_numerical\\_value\(\)](#), [GiNaC::ELi\\_kernel::get\\_numerical\\_value\(\)](#), [get\\_numerical\\_value\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::get\\_numerical\\_value\(\)](#), [GiNaC::Kronecker\\_dz\\_kernel::get\\_numerical\\_value\(\)](#), [GiNaC::modular\\_form\\_kernel::get\\_numerical\\_value\(\)](#), and [get\\_numerical\\_value\\_impl\(\)](#).

**6.77.2.13 do\_print()**

```
void GiNaC::integration_kernel::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [do\\_print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [do\\_print\(\)](#), and [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.77.3 Member Data Documentation

#### 6.77.3.1 `cache_step_size`

```
int GiNaC::integration_kernel::cache_step_size [mutable], [protected]
```

Referenced by [series\\_coeff\(\)](#), and [set\\_cache\\_step\(\)](#).

#### 6.77.3.2 `series_vec`

```
std::vector<cln::cl_N> GiNaC::integration_kernel::series_vec [mutable], [protected]
```

Referenced by [get\\_cache\\_size\(\)](#), and [series\\_coeff\(\)](#).

The documentation for this class was generated from the following files:

- [integration\\_kernel.h](#)
- [integration\\_kernel.cpp](#)

## 6.78 `GiNaC::is_not_a_clifford` Struct Reference

Predicate for finding non-clifford objects.

### Public Member Functions

- bool [operator\(\)](#) (const [ex](#) &e)

#### 6.78.1 Detailed Description

Predicate for finding non-clifford objects.

### 6.78.2 Member Function Documentation

#### 6.78.2.1 `operator()`

```
bool GiNaC::is_not_a_clifford::operator() (
 const ex & e) [inline]
```

References [GiNaC::is\\_a\(\)](#).

The documentation for this struct was generated from the following file:

- [clifford.cpp](#)

## 6.79 GiNaC::is\_summation\_idx Struct Reference

### Public Member Functions

- bool [operator\(\)](#) (const [ex](#) &e)

### 6.79.1 Member Function Documentation

#### 6.79.1.1 operator()

```
bool GiNaC::is_summation_idx::operator() (
 const ex & e) [inline]
```

References [GiNaC::is\\_dummy\\_pair\(\)](#).

The documentation for this struct was generated from the following file:

- [indexed.cpp](#)

## 6.80 GiNaC::iterated\_integral2\_SERIAL Class Reference

Complete elliptic integral of the first kind.

```
#include <inifcns.h>
```

### Static Public Attributes

- static unsigned [serial](#)

### 6.80.1 Detailed Description

Complete elliptic integral of the first kind.

Complete elliptic integral of the second kind. Iterated integral.

### 6.80.2 Member Data Documentation

#### 6.80.2.1 serial

```
unsigned GiNaC::iterated_integral2_SERIAL::serial [static]
```

#### Initial value:

```
=
 function::register_new(function_options("iterated_integral", 2).
 eval_func(iterated_integral2_eval).
 evalf_func(iterated_integral2_evalf).
 do_not_evalf_params().
 overloaded(2))
```

Referenced by [GiNaC::iterated\\_integral\(\)](#).

The documentation for this class was generated from the following files:

- [inifcns.h](#)
- [inifcns\\_elliptic.cpp](#)

## 6.81 GiNaC::iterated\_integral3\_SERIAL Class Reference

Iterated integral with explicit truncation.

```
#include <inifcns.h>
```

### Static Public Attributes

- static unsigned [serial](#)

### 6.81.1 Detailed Description

Iterated integral with explicit truncation.

### 6.81.2 Member Data Documentation

#### 6.81.2.1 serial

```
unsigned GiNaC::iterated_integral3_SERIAL::serial [static]
```

#### Initial value:

```
=
 function::register_new(function_options("iterated_integral", 3).
 eval_func(iterated_integral3_eval).
 evalf_func(iterated_integral3_evalf).
 do_not_evalf_params().
 overloaded(2))
```

Referenced by [GiNaC::iterated\\_integral\(\)](#).

The documentation for this class was generated from the following files:

- [inifcns.h](#)
- [inifcns\\_elliptic.cpp](#)

## 6.82 GiNaC::Kronecker\_dtau\_kernel Class Reference

The kernel corresponding to integrating the Kronecker coefficient function  $g^{(n)}(z_j, K\tau)$  in  $\tau$  (or equivalently in  $\bar{q}$ ).

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::Kronecker\_dtau\_kernel:



Collaboration diagram for GiNaC::Kronecker\_dtau\_kernel:



## Public Member Functions

- `Kronecker_dtau_kernel` (const `ex` &`n`, const `ex` &`z`, const `ex` &`K=numeric(1)`, const `ex` &`C_norm=numeric(1)`)
- `size_t nops` () const override  
*Number of operands/members.*
- `ex op` (size\_t `i`) const override  
*Return operand/member at position `i`.*
- `ex &let_op` (size\_t `i`) override  
*Return modifiable operand/member at position `i`.*
- `bool is_numeric` (void) const override  
*This routine returns true, if the integration kernel can be evaluated numerically.*
- `ex get_numerical_value` (const `ex` &`qbar`, int `N_trunc=0`) const override  
*Returns the value of the  $g^{\wedge}(n)(z, K \cdot \tau)$ , where  $\tau$  is given by `qbar`.*

## Public Member Functions inherited from GiNaC::integration\_kernel

- **ex series** (const relational &r, int order, unsigned options=0) const override  
*Default implementation of ex::series().*
- virtual bool **has\_trailing\_zero** (void) const  
*This routine returns true, if the integration kernel has a trailing zero.*
- virtual **ex Laurent\_series** (const ex &x, int order) const  
*Returns the Laurent series, starting possibly with the pole term.*
- size\_t **get\_cache\_size** (void) const  
*Returns the current size of the cache.*
- void **set\_cache\_step** (int cache\_steps) const  
*Sets the step size by which the cache is increased.*
- **ex get\_series\_coeff** (int i) const  
*Wrapper around series\_coeff(i), converts cl\_N to numeric.*
- cln::cl\_N **series\_coeff** (int i) const  
*Subclasses have either to implement series\_coeff\_impl or the two methods Laurent\_series and uses\_Laurent\_series.*

## Public Member Functions inherited from GiNaC::basic

- virtual **~basic** ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- **basic** (const basic &other)
- const **basic & operator=** (const basic &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual **basic \* duplicate** () const  
*Create a clone of this object on the heap.*
- virtual **ex eval** () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual **ex evalf** () const  
*Evaluate object numerically.*
- virtual **ex evalm** () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual **ex eval\_integ** () const  
*Evaluate integrals, if result is known.*
- virtual **ex eval\_indexed** (const basic &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void **print** (const print\_context &c, unsigned level=0) const  
*Output to stream.*
- virtual void **dbgprint** () const  
*Little wrapper around print to be called within a debugger.*
- virtual void **dbgprinttree** () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned **precedence** () const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool **info** (unsigned inf) const  
*Information about the object.*
- virtual **ex operator[]** (const ex &index) const
- virtual **ex operator[]** (size\_t i) const
- virtual **ex & operator[]** (const ex &index)
- virtual **ex & operator[]** (size\_t i)
- virtual bool **has** (const ex &other, unsigned options=0) const

- Test for occurrence of a pattern.*

  - virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
- Check whether the expression matches a given pattern.*

  - virtual `ex subs` (const `exmap` &m, unsigned options=0) const
- Substitute a set of objects by arbitrary expressions.*

  - virtual `ex map` (`map_function` &f) const
- Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*

  - virtual void `accept` (`GiNaC::visitor` &v) const
  - virtual bool `is_polynomial` (const `ex` &var) const
- Check whether this is a polynomial in the given variables.*

  - virtual int `degree` (const `ex` &s) const
- Return degree of highest power in object s.*

  - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

  - virtual `ex coeff` (const `ex` &s, int n=1) const
- Return coefficient of degree n in object s.*

  - virtual `ex expand` (unsigned options=0) const
- Expand expression, i.e.*

  - virtual `ex collect` (const `ex` &s, bool distributed=false) const
- Sort expanded expression in terms of powers of some object(s).*

  - virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

  - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

  - virtual `ex to_polynomial` (`exmap` &repl) const
  - virtual `numeric integer_content` () const
  - virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

  - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

  - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

  - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

  - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

  - virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

  - virtual unsigned `return_type` () const
  - virtual `return_type_t return_type_tinfo` () const
  - virtual `ex conjugate` () const
  - virtual `ex real_part` () const
  - virtual `ex imag_part` () const
- template<class T>

  - void `print_dispatch` (const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

  - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)



- *Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- `int compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- `bool is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- `const basic & hold` () const  
*Stop further evaluation.*
- `unsigned gethash` () const
- `const basic & setflag` (unsigned f) const  
*Set some `status_flags`.*
- `const basic & clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- `unsigned int add_reference` () noexcept
- `unsigned int remove_reference` () noexcept
- `unsigned int get_refcount` () const noexcept
- `void set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- `cln::cl_N series_coeff_impl` (int i) const override  
*For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.*
- `void do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::integration_kernel`

- `virtual bool uses_Laurent_series` () const  
*Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).*
- `ex get_numerical_value_impl` (const `ex` &lambda, const `ex` &pre, int shift, int N\_trunc) const  
*The actual implementation for computing a numerical value for the integrand.*
- `void do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual [ex derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Attributes

- [ex n](#)
- [ex z](#)
- [ex K](#)
- [ex C\\_norm](#)

## Protected Attributes inherited from [GiNaC::integration\\_kernel](#)

- int [cache\\_step\\_size](#)
- `std::vector< cln::cl\_N >` [series\\_vec](#)

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.82.1 Detailed Description

The kernel corresponding to integrating the Kronecker coefficient function  $g^{(n)}(z_j, K\tau)$  in  $\tau$  (or equivalently in  $\bar{q}$ ).

This class represents the differential one-form

$$\omega_{n,K}^{\text{Kronecker},\tau}(z_j) = \frac{C_n K(n-1)}{(2\pi i)^n} g^{(n)}(z_j, K\tau) \frac{d\bar{q}}{\bar{q}}$$

## 6.82.2 Constructor & Destructor Documentation

### 6.82.2.1 Kronecker\_dtau\_kernel()

```
GiNaC::Kronecker_dtau_kernel::Kronecker_dtau_kernel (
 const ex & n,
 const ex & z,
 const ex & K = numeric(1),
 const ex & C_norm = numeric(1))
```

References [C\\_norm](#), [K](#), [Kronecker\\_dtau\\_kernel\(\)](#), [n](#), and [z](#).

Referenced by [Kronecker\\_dtau\\_kernel\(\)](#).

## 6.82.3 Member Function Documentation

### 6.82.3.1 nops()

```
size_t GiNaC::Kronecker_dtau_kernel::nops () const \[override\], \[virtual\]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

### 6.82.3.2 op()

```
ex GiNaC::Kronecker_dtau_kernel::op (
 size_t i) const \[override\], \[virtual\]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [C\\_norm](#), [K](#), [n](#), and [z](#).

### 6.82.3.3 let\_op()

```
ex & GiNaC::Kronecker_dtau_kernel::let_op (
 size_t i) \[override\], \[virtual\]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [C\\_norm](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [K](#), [n](#), and [z](#).

#### 6.82.3.4 is\_numeric()

```
bool GiNaC::Kronecker_dtau_kernel::is_numeric (
 void) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration\\_kernel](#).

References [C\\_norm](#), [K](#), [n](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::info\\_flags::posint](#), and [z](#).

#### 6.82.3.5 get\_numerical\_value()

```
ex GiNaC::Kronecker_dtau_kernel::get_numerical_value (
 const ex & qbar,
 int N_trunc = 0) const [override], [virtual]
```

Returns the value of the  $g^{(n)}(z, K \cdot \tau)$ , where  $\tau$  is given by  $qbar$ .

Reimplemented from [GiNaC::integration\\_kernel](#).

References [C\\_norm](#), [GiNaC::basic::evalf\(\)](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::exp\(\)](#), [GiNaC::Ebar\\_kernel::get\\_numerical\\_val](#), [GiNaC::integration\\_kernel::get\\_numerical\\_value\\_impl\(\)](#), [GiNaC::l](#), [K](#), [n](#), [GiNaC::Pi](#), [GiNaC::pow\(\)](#), and [z](#).

#### 6.82.3.6 series\_coeff\_impl()

```
cln::cl_N GiNaC::Kronecker_dtau_kernel::series_coeff_impl (
 int i) const [override], [protected], [virtual]
```

For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.

The  $i$ -th coefficient corresponds to the power  $\lambda^{i-1}$ .

Reimplemented from [GiNaC::integration\\_kernel](#).

References [GiNaC::bernoulli\(\)](#), [C\\_norm](#), [GiNaC::basic::evalf\(\)](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::exp\(\)](#), [GiNaC::factorial\(\)](#), [GiNaC::l](#), [K](#), [n](#), [GiNaC::Pi](#), [GiNaC::numeric::to\\_cl\\_N\(\)](#), [GiNaC::numeric::to\\_int\(\)](#), and [z](#).

#### 6.82.3.7 do\_print()

```
void GiNaC::Kronecker_dtau_kernel::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [C\\_norm](#), [K](#), [n](#), [GiNaC::print\\_context::s](#), and [z](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.82.4 Member Data Documentation

### 6.82.4.1 n

`ex` GiNaC::Kronecker\_dtau\_kernel::n [protected]

Referenced by [do\\_print\(\)](#), [get\\_numerical\\_value\(\)](#), [is\\_numeric\(\)](#), [Kronecker\\_dtau\\_kernel\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

### 6.82.4.2 z

`ex` GiNaC::Kronecker\_dtau\_kernel::z [protected]

Referenced by [do\\_print\(\)](#), [get\\_numerical\\_value\(\)](#), [is\\_numeric\(\)](#), [Kronecker\\_dtau\\_kernel\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

### 6.82.4.3 K

`ex` GiNaC::Kronecker\_dtau\_kernel::K [protected]

Referenced by [do\\_print\(\)](#), [get\\_numerical\\_value\(\)](#), [is\\_numeric\(\)](#), [Kronecker\\_dtau\\_kernel\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

### 6.82.4.4 C\_norm

`ex` GiNaC::Kronecker\_dtau\_kernel::C\_norm [protected]

Referenced by [do\\_print\(\)](#), [get\\_numerical\\_value\(\)](#), [is\\_numeric\(\)](#), [Kronecker\\_dtau\\_kernel\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

The documentation for this class was generated from the following files:

- [integration\\_kernel.h](#)
- [integration\\_kernel.cpp](#)

## 6.83 GiNaC::Kronecker\_dz\_kernel Class Reference

The kernel corresponding to integrating the Kronecker coefficient function  $g^{(n-1)}(z - z_j, K\tau)$  in  $z$ .

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::Kronecker\_dz\_kernel:



Collaboration diagram for GiNaC::Kronecker\_dz\_kernel:



## Public Member Functions

- `Kronecker_dz_kernel` (const `ex` &`n`, const `ex` &`z_j`, const `ex` &`tau`, const `ex` &`K=numeric(1)`, const `ex` &`C_norm=numeric(1)`)
- `size_t nops` () const override  
*Number of operands/members.*
- `ex op` (size\_t `i`) const override  
*Return operand/member at position i.*
- `ex & let_op` (size\_t `i`) override  
*Return modifiable operand/member at position i.*
- `bool is_numeric` (void) const override  
*This routine returns true, if the integration kernel can be evaluated numerically.*
- `ex get_numerical_value` (const `ex` &`z`, int `N_trunc=0`) const override  
*Returns the value of the  $g^{(n-1)}(z-z_j, K*\tau)$ .*

## Public Member Functions inherited from `GiNaC::integration_kernel`

- `ex series` (const `relational` &r, int order, unsigned options=0) const override  
*Default implementation of `ex::series()`.*
- virtual bool `has_trailing_zero` (void) const  
*This routine returns true, if the integration kernel has a trailing zero.*
- virtual `ex Laurent_series` (const `ex` &x, int order) const  
*Returns the Laurent series, starting possibly with the pole term.*
- `size_t get_cache_size` (void) const  
*Returns the current size of the cache.*
- void `set_cache_step` (int cache\_steps) const  
*Sets the step size by which the cache is increased.*
- `ex get_series_coeff` (int i) const  
*Wrapper around `series_coeff(i)`, converts `cl_N` to numeric.*
- `cln::cl_N series_coeff` (int i) const  
*Subclasses have either to implement `series_coeff_impl` or the two methods `Laurent_series` and `uses_Laurent_series`.*

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf` () const  
*Evaluate object numerically.*
- virtual `ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around `print` to be called within a debugger.*
- virtual void `dbgprinttree` () const  
*Little wrapper around `printtree` to be called within a debugger.*
- virtual unsigned `precedence` () const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool `info` (unsigned inf) const  
*Information about the object.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const



- Test for occurrence of a pattern.*

  - virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
- Check whether the expression matches a given pattern.*

  - virtual `ex subs` (const `exmap` &m, unsigned options=0) const
- Substitute a set of objects by arbitrary expressions.*

  - virtual `ex map` (`map_function` &f) const
- Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*

  - virtual void `accept` (`GiNaC::visitor` &v) const
  - virtual bool `is_polynomial` (const `ex` &var) const
- Check whether this is a polynomial in the given variables.*

  - virtual int `degree` (const `ex` &s) const
- Return degree of highest power in object s.*

  - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

  - virtual `ex coeff` (const `ex` &s, int n=1) const
- Return coefficient of degree n in object s.*

  - virtual `ex expand` (unsigned options=0) const
- Expand expression, i.e.*

  - virtual `ex collect` (const `ex` &s, bool distributed=false) const
- Sort expanded expression in terms of powers of some object(s).*

  - virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

  - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

  - virtual `ex to_polynomial` (`exmap` &repl) const
  - virtual `numeric integer_content` () const
  - virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

  - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

  - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

  - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

  - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

  - virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

  - virtual unsigned `return_type` () const
  - virtual `return_type_t return_type_tinfo` () const
  - virtual `ex conjugate` () const
  - virtual `ex real_part` () const
  - virtual `ex imag_part` () const
- template<class T>

  - void `print_dispatch` (const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

  - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)

- *Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- `int compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- `bool is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- `const basic & hold` () const  
*Stop further evaluation.*
- `unsigned gethash` () const
- `const basic & setflag` (unsigned f) const  
*Set some `status_flags`.*
- `const basic & clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- `unsigned int add_reference` () noexcept
- `unsigned int remove_reference` () noexcept
- `unsigned int get_refcount` () const noexcept
- `void set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- `cl::cl_N series_coeff_impl` (int i) const override  
*For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.*
- `void do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::integration_kernel`

- `virtual bool uses_Laurent_series` () const  
*Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).*
- `ex get_numerical_value_impl` (const `ex` &lambda, const `ex` &pre, int shift, int N\_trunc) const  
*The actual implementation for computing a numerical value for the integrand.*
- `void do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual [ex derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Attributes

- [ex n](#)
- [ex z\\_j](#)
- [ex tau](#)
- [ex K](#)
- [ex C\\_norm](#)

## Protected Attributes inherited from [GiNaC::integration\\_kernel](#)

- int [cache\\_step\\_size](#)
- `std::vector< cln::cl\_N >` [series\\_vec](#)

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.83.1 Detailed Description

The kernel corresponding to integrating the Kronecker coefficient function  $g^{(n-1)}(z - z_j, K\tau)$  in  $z$ .

This class represents the differential one-form

$$\omega_{n,K}^{\text{Kronecker},z}(z_j, \tau) = C_n (2\pi i)^{2-n} g^{(n-1)}(z - z_j, K\tau) dz$$

## 6.83.2 Constructor & Destructor Documentation

### 6.83.2.1 Kronecker\_dz\_kernel()

```
GiNaC::Kronecker_dz_kernel::Kronecker_dz_kernel (
 const ex & n,
 const ex & z_j,
 const ex & tau,
 const ex & K = numeric(1),
 const ex & C_norm = numeric(1))
```

References [C\\_norm](#), [K](#), [Kronecker\\_dz\\_kernel\(\)](#), [n](#), [tau](#), and [z\\_j](#).

Referenced by [Kronecker\\_dz\\_kernel\(\)](#).

## 6.83.3 Member Function Documentation

### 6.83.3.1 nops()

```
size_t GiNaC::Kronecker_dz_kernel::nops () const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

### 6.83.3.2 op()

```
ex GiNaC::Kronecker_dz_kernel::op (
 size_t i) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [C\\_norm](#), [K](#), [n](#), [tau](#), and [z\\_j](#).

### 6.83.3.3 let\_op()

```
ex & GiNaC::Kronecker_dz_kernel::let_op (
 size_t i) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [C\\_norm](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [K](#), [n](#), [tau](#), and [z\\_j](#).

#### 6.83.3.4 is\_numeric()

```
bool GiNaC::Kronecker_dz_kernel::is_numeric (
 void) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration\\_kernel](#).

References [C\\_norm](#), [K](#), [n](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::info\\_flags::posint](#), [tau](#), and [z\\_j](#).

#### 6.83.3.5 get\_numerical\_value()

```
ex GiNaC::Kronecker_dz_kernel::get_numerical_value (
 const ex & z,
 int N_trunc = 0) const [override], [virtual]
```

Returns the value of the  $g^{(n-1)}(z-z_j, K \cdot \tau)$ .

Reimplemented from [GiNaC::integration\\_kernel](#).

References [C\\_norm](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::integration\\_kernel::get\\_numerical\\_value\\_impl\(\)](#), [GiNaC::l](#), [n](#), [GiNaC::Pi](#), and [GiNaC::pow\(\)](#).

#### 6.83.3.6 series\_coeff\_impl()

```
cln::cl_N GiNaC::Kronecker_dz_kernel::series_coeff_impl (
 int i) const [override], [protected], [virtual]
```

For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.

The  $i$ -th coefficient corresponds to the power  $\lambda^{i-1}$ .

Reimplemented from [GiNaC::integration\\_kernel](#).

References [GiNaC::bernoulli\(\)](#), [C\\_norm](#), [GiNaC::basic::evalf\(\)](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::exp\(\)](#), [GiNaC::factorial\(\)](#), [GiNaC::Ebar\\_kernel::get\\_numerical\\_value\(\)](#), [GiNaC::l](#), [GiNaC::is\\_even\(\)](#), [K](#), [n](#), [GiNaC::Pi](#), [GiNaC::pow\(\)](#), [tau](#), [GiNaC::numeric::to\\_int\(\)](#), and [z\\_j](#).

#### 6.83.3.7 do\_print()

```
void GiNaC::Kronecker_dz_kernel::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [C\\_norm](#), [K](#), [n](#), [GiNaC::print\\_context::s](#), [tau](#), and [z\\_j](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.83.4 Member Data Documentation

#### 6.83.4.1 `n`

`ex GiNaC::Kronecker_dz_kernel::n` [protected]

Referenced by [do\\_print\(\)](#), [get\\_numerical\\_value\(\)](#), [is\\_numeric\(\)](#), [Kronecker\\_dz\\_kernel\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

#### 6.83.4.2 `z_j`

`ex GiNaC::Kronecker_dz_kernel::z_j` [protected]

Referenced by [do\\_print\(\)](#), [is\\_numeric\(\)](#), [Kronecker\\_dz\\_kernel\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

#### 6.83.4.3 `tau`

`ex GiNaC::Kronecker_dz_kernel::tau` [protected]

Referenced by [do\\_print\(\)](#), [is\\_numeric\(\)](#), [Kronecker\\_dz\\_kernel\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

#### 6.83.4.4 `K`

`ex GiNaC::Kronecker_dz_kernel::K` [protected]

Referenced by [do\\_print\(\)](#), [is\\_numeric\(\)](#), [Kronecker\\_dz\\_kernel\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

#### 6.83.4.5 `C_norm`

`ex GiNaC::Kronecker_dz_kernel::C_norm` [protected]

Referenced by [do\\_print\(\)](#), [get\\_numerical\\_value\(\)](#), [is\\_numeric\(\)](#), [Kronecker\\_dz\\_kernel\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

The documentation for this class was generated from the following files:

- [integration\\_kernel.h](#)
- [integration\\_kernel.cpp](#)

## 6.84 GiNaC::lanczos\_coeffs Class Reference

### Public Member Functions

- [lanczos\\_coeffs](#) ()
- bool [sufficiently\\_accurate](#) (int digits)
- int [get\\_order](#) () const
- cln::cl\_N [calc\\_lanczos\\_A](#) (const cln::cl\_N &) const

### Private Attributes

- `std::vector< cln::cl_N > * current\_vector`

### Static Private Attributes

- `static std::vector< cln::cl_N > * coeffs = nullptr`

## 6.84.1 Constructor & Destructor Documentation

### 6.84.1.1 `lanczos_coeffs()`

```
GiNaC::lanczos_coeffs::lanczos_coeffs ()
```

References [coeffs](#).

## 6.84.2 Member Function Documentation

### 6.84.2.1 `sufficiently_accurate()`

```
bool GiNaC::lanczos_coeffs::sufficiently_accurate (
 int digits)
```

References [coeffs](#), and [current\\_vector](#).

Referenced by [GiNaC::lgamma\(\)](#), and [GiNaC::tgamma\(\)](#).

### 6.84.2.2 `get_order()`

```
int GiNaC::lanczos_coeffs::get_order () const [inline]
```

References [current\\_vector](#).

Referenced by [GiNaC::lgamma\(\)](#), and [GiNaC::tgamma\(\)](#).

### 6.84.2.3 `calc_lanczos_A()`

```
cln::cl_N GiNaC::lanczos_coeffs::calc_lanczos_A (
 const cln::cl_N & x) const
```

References [current\\_vector](#).

Referenced by [GiNaC::lgamma\(\)](#), and [GiNaC::tgamma\(\)](#).

### 6.84.3 Member Data Documentation

#### 6.84.3.1 coeffs

```
std::vector< cln::cl_N > * GiNaC::lanczos_coeffs::coeffs = nullptr [static], [private]
```

Referenced by [lanczos\\_coeffs\(\)](#), and [sufficiently\\_accurate\(\)](#).

#### 6.84.3.2 current\_vector

```
std::vector<cln::cl_N>* GiNaC::lanczos_coeffs::current_vector [private]
```

Referenced by [calc\\_lanczos\\_A\(\)](#), [get\\_order\(\)](#), and [sufficiently\\_accurate\(\)](#).

The documentation for this class was generated from the following file:

- [numeric.cpp](#)

## 6.85 std::less< GiNaC::ptr< T > > Struct Template Reference

Specialization of std::less for ptr<T> to enable ordering of ptr<T> objects (e.g.

```
#include <ptr.h>
```

### Public Member Functions

- bool [operator\(\)](#) (const [GiNaC::ptr< T >](#) &lhs, const [GiNaC::ptr< T >](#) &rhs) const

#### 6.85.1 Detailed Description

```
template<class T>
struct std::less< GiNaC::ptr< T > >
```

Specialization of std::less for ptr<T> to enable ordering of ptr<T> objects (e.g.

for the use as std::map keys).

### 6.85.2 Member Function Documentation

#### 6.85.2.1 operator()()

```
template<class T>
bool std::less< GiNaC::ptr< T > >::operator() (
 const GiNaC::ptr< T > & lhs,
 const GiNaC::ptr< T > & rhs) const [inline]
```

The documentation for this struct was generated from the following file:

- [ptr.h](#)



## 6.86 GiNaC::library\_init Class Reference

Helper class to initialize the library.

```
#include <ex.h>
```

### Public Member Functions

- [library\\_init\(\)](#)  
*Ctor of static initialization helpers.*
- [~library\\_init\(\)](#)  
*Dtor of static initialization helpers.*

### Static Private Member Functions

- static void [init\\_unarchivers\(\)](#)

### Static Private Attributes

- static int [count](#) = 0  
*How many static objects were created?*

### 6.86.1 Detailed Description

Helper class to initialize the library.

There must be one static object of this class in every object file that makes use of our flyweights in order to guarantee proper initialization. Hence we put it into this file which is included by every relevant file anyways. This is modeled after section [ios::Init] of the C++ standard, where cout and friends are set up.

See also

[utils.cpp](#)

### 6.86.2 Constructor & Destructor Documentation

#### 6.86.2.1 library\_init()

```
GiNaC::library_init::library_init ()
```

Ctor of static initialization helpers.

The fist call to this is going to initialize the library, the others do nothing.

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [GiNaC::\\_ex10](#), [GiNaC::\\_ex11](#), [GiNaC::\\_ex12](#), [GiNaC::\\_ex120](#), [GiNaC::\\_ex15](#), [GiNaC::\\_ex18](#), [GiNaC::\\_ex1\\_2](#), [GiNaC::\\_ex1\\_3](#), [GiNaC::\\_ex1\\_4](#), [GiNaC::\\_ex2](#), [GiNaC::\\_ex20](#), [GiNaC::\\_ex24](#), [GiNaC::\\_ex25](#), [GiNaC::\\_ex3](#), [GiNaC::\\_ex30](#), [GiNaC::\\_ex4](#), [GiNaC::\\_ex48](#), [GiNaC::\\_ex5](#), [GiNaC::\\_ex6](#), [GiNaC::\\_ex60](#), [GiNaC::\\_ex7](#), [GiNaC::\\_ex8](#), [GiNaC::\\_ex9](#), [GiNaC::\\_ex\\_1](#), [GiNaC::\\_ex\\_10](#), [GiNaC::\\_ex\\_11](#), [GiNaC::\\_ex\\_12](#), [GiNaC::\\_ex\\_120](#), [GiNaC::\\_ex\\_15](#), [GiNaC::\\_ex\\_18](#), [GiNaC::\\_ex\\_1\\_2](#), [GiNaC::\\_ex\\_1\\_3](#), [GiNaC::\\_ex\\_1\\_4](#), [GiNaC::\\_ex\\_2](#), [GiNaC::\\_ex\\_20](#), [GiNaC::\\_ex\\_24](#), [GiNaC::\\_ex\\_25](#), [GiNaC::\\_ex\\_3](#), [GiNaC::\\_ex\\_30](#), [GiNaC::\\_ex\\_4](#), [GiNaC::\\_ex\\_48](#), [GiNaC::\\_ex\\_5](#), [GiNaC::\\_ex\\_6](#), [GiNaC::\\_ex\\_60](#), [GiNaC::\\_ex\\_7](#), [GiNaC::\\_ex\\_8](#), [GiNaC::\\_ex\\_9](#), [GiNaC::\\_num0\\_bp](#), [GiNaC::\\_num0\\_p](#), [GiNaC::\\_num10\\_p](#), [GiNaC::\\_num11\\_p](#), [GiNaC::\\_num120\\_p](#), [GiNaC::\\_num12\\_p](#), [GiNaC::\\_num15\\_p](#), [GiNaC::\\_num18\\_p](#), [GiNaC::\\_num1\\_2\\_p](#), [GiNaC::\\_num1\\_3\\_p](#), [GiNaC::\\_num1\\_4\\_p](#), [GiNaC::\\_num1\\_p](#), [GiNaC::\\_num20\\_p](#), [GiNaC::\\_num24\\_p](#), [GiNaC::\\_num25\\_p](#), [GiNaC::\\_num2\\_p](#), [GiNaC::\\_num30\\_p](#), [GiNaC::\\_num3\\_p](#), [GiNaC::\\_num48\\_p](#), [GiNaC::\\_num4\\_p](#), [GiNaC::\\_num5\\_p](#), [GiNaC::\\_num60\\_p](#), [GiNaC::\\_num6\\_p](#), [GiNaC::\\_num7\\_p](#), [GiNaC::\\_num8\\_p](#), [GiNaC::\\_num9\\_p](#), [GiNaC::\\_num\\_10\\_p](#), [GiNaC::\\_num\\_11\\_p](#), [GiNaC::\\_num\\_120\\_p](#), [GiNaC::\\_num\\_12\\_p](#), [GiNaC::\\_num\\_15\\_p](#), [GiNaC::\\_num\\_18\\_p](#), [GiNaC::\\_num\\_1\\_2\\_p](#), [GiNaC::\\_num\\_1\\_3\\_p](#), [GiNaC::\\_num\\_1\\_4\\_p](#), [GiNaC::\\_num\\_1\\_p](#), [GiNaC::\\_num\\_20\\_p](#), [GiNaC::\\_num\\_24\\_p](#), [GiNaC::\\_num\\_25\\_p](#), [GiNaC::\\_num\\_2\\_p](#), [GiNaC::\\_num\\_30\\_p](#), [GiNaC::\\_num\\_3\\_p](#), [GiNaC::\\_num\\_48\\_p](#), [GiNaC::\\_num\\_4\\_p](#), [GiNaC::\\_num\\_5\\_p](#), [GiNaC::\\_num\\_60\\_p](#), [GiNaC::\\_num\\_6\\_p](#), [GiNaC::\\_num\\_7\\_p](#), [GiNaC::\\_num\\_8\\_p](#), [GiNaC::\\_num\\_9\\_p](#), [count](#), and [GiNaC::dynallocate\(\)](#).

### 6.86.2.2 ~library\_init()

```
GiNaC::library_init::~~library_init ()
```

Dtor of static initialization helpers.

The last call to this is going to shut down the library, the others do nothing.

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [GiNaC::\\_ex10](#), [GiNaC::\\_ex11](#), [GiNaC::\\_ex12](#), [GiNaC::\\_ex120](#), [GiNaC::\\_ex15](#), [GiNaC::\\_ex18](#), [GiNaC::\\_ex1\\_2](#), [GiNaC::\\_ex1\\_3](#), [GiNaC::\\_ex1\\_4](#), [GiNaC::\\_ex2](#), [GiNaC::\\_ex20](#), [GiNaC::\\_ex24](#), [GiNaC::\\_ex25](#), [GiNaC::\\_ex3](#), [GiNaC::\\_ex30](#), [GiNaC::\\_ex4](#), [GiNaC::\\_ex48](#), [GiNaC::\\_ex5](#), [GiNaC::\\_ex6](#), [GiNaC::\\_ex60](#), [GiNaC::\\_ex7](#), [GiNaC::\\_ex8](#), [GiNaC::\\_ex9](#), [GiNaC::\\_ex\\_1](#), [GiNaC::\\_ex\\_10](#), [GiNaC::\\_ex\\_11](#), [GiNaC::\\_ex\\_12](#), [GiNaC::\\_ex\\_120](#), [GiNaC::\\_ex\\_15](#), [GiNaC::\\_ex\\_18](#), [GiNaC::\\_ex\\_1\\_2](#), [GiNaC::\\_ex\\_1\\_3](#), [GiNaC::\\_ex\\_1\\_4](#), [GiNaC::\\_ex\\_2](#), [GiNaC::\\_ex\\_20](#), [GiNaC::\\_ex\\_24](#), [GiNaC::\\_ex\\_25](#), [GiNaC::\\_ex\\_3](#), [GiNaC::\\_ex\\_30](#), [GiNaC::\\_ex\\_4](#), [GiNaC::\\_ex\\_48](#), [GiNaC::\\_ex\\_5](#), [GiNaC::\\_ex\\_6](#), [GiNaC::\\_ex\\_60](#), [GiNaC::\\_ex\\_7](#), [GiNaC::\\_ex\\_8](#), [GiNaC::\\_ex\\_9](#), and [count](#).

## 6.86.3 Member Function Documentation

### 6.86.3.1 init\_unarchivers()

```
void GiNaC::library_init::init_unarchivers () [static], [private]
```

## 6.86.4 Member Data Documentation

### 6.86.4.1 count

```
int GiNaC::library_init::count = 0 [static], [private]
```

How many static objects were created?

Only the first one must create the static flyweights on the heap.

Referenced by [library\\_init\(\)](#), and [~library\\_init\(\)](#).

The documentation for this class was generated from the following files:

- [ex.h](#)
- [utils.cpp](#)

## 6.87 GiNaC::make\_flat\_inserter Class Reference

Class to handle the renaming of dummy indices.

```
#include <expairseq.h>
```

## Public Member Functions

- [make\\_flat\\_inserter](#) (const [epvector](#) &epv, bool b)
- [make\\_flat\\_inserter](#) (const [exvector](#) &v, bool b)
- [ex\\_handle\\_factor](#) (const [ex](#) &x, const [ex](#) &coeff)

## Private Member Functions

- void [combine\\_indices](#) (const [exvector](#) &dummies\_of\_factor)

## Private Attributes

- bool [do\\_renaming](#)
- [exvector](#) [used\\_indices](#)

## 6.87.1 Detailed Description

Class to handle the renaming of dummy indices.

It holds a vector of indices that are being used in the expression so far. If the same index occurs again as a dummy index in a factor, it is to be renamed. Unless dummy index renaming was switched off, of course ;-)

## 6.87.2 Constructor & Destructor Documentation

### 6.87.2.1 [make\\_flat\\_inserter\(\)](#) [1/2]

```
GiNaC::make_flat_inserter::make_flat_inserter (
 const epvector & epv,
 bool b) [inline]
```

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [combine\\_indices\(\)](#), and [do\\_renaming](#).

### 6.87.2.2 [make\\_flat\\_inserter\(\)](#) [2/2]

```
GiNaC::make_flat_inserter::make_flat_inserter (
 const exvector & v,
 bool b) [inline]
```

References [combine\\_indices\(\)](#), and [do\\_renaming](#).

## 6.87.3 Member Function Documentation

### 6.87.3.1 [handle\\_factor\(\)](#)

```
ex GiNaC::make_flat_inserter::handle_factor (
 const ex & x,
 const ex & coeff) [inline]
```

References [GiNaC::coeff\(\)](#), [combine\\_indices\(\)](#), [do\\_renaming](#), [GiNaC::get\\_all\\_dummy\\_indices\\_safely\(\)](#), [GiNaC::ex::get\\_free\\_indices\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::rename\\_dummy\\_indices\\_uniquely\(\)](#), and [used\\_indices](#).

Referenced by [GiNaC::ncmul::eval\(\)](#), [GiNaC::expairseq::make\\_flat\(\)](#), and [GiNaC::expairseq::make\\_flat\(\)](#).

### 6.87.3.2 combine\_indices()

```
void GiNaC::make_flat_inserter::combine_indices (
 const exvector & dummies_of_factor) [inline], [private]
```

References [used\\_indices](#).

Referenced by [handle\\_factor\(\)](#), [make\\_flat\\_inserter\(\)](#), and [make\\_flat\\_inserter\(\)](#).

## 6.87.4 Member Data Documentation

### 6.87.4.1 do\_renaming

```
bool GiNaC::make_flat_inserter::do_renaming [private]
```

Referenced by [handle\\_factor\(\)](#), [make\\_flat\\_inserter\(\)](#), and [make\\_flat\\_inserter\(\)](#).

### 6.87.4.2 used\_indices

```
exvector GiNaC::make_flat_inserter::used_indices [private]
```

Referenced by [combine\\_indices\(\)](#), and [handle\\_factor\(\)](#).

The documentation for this class was generated from the following file:

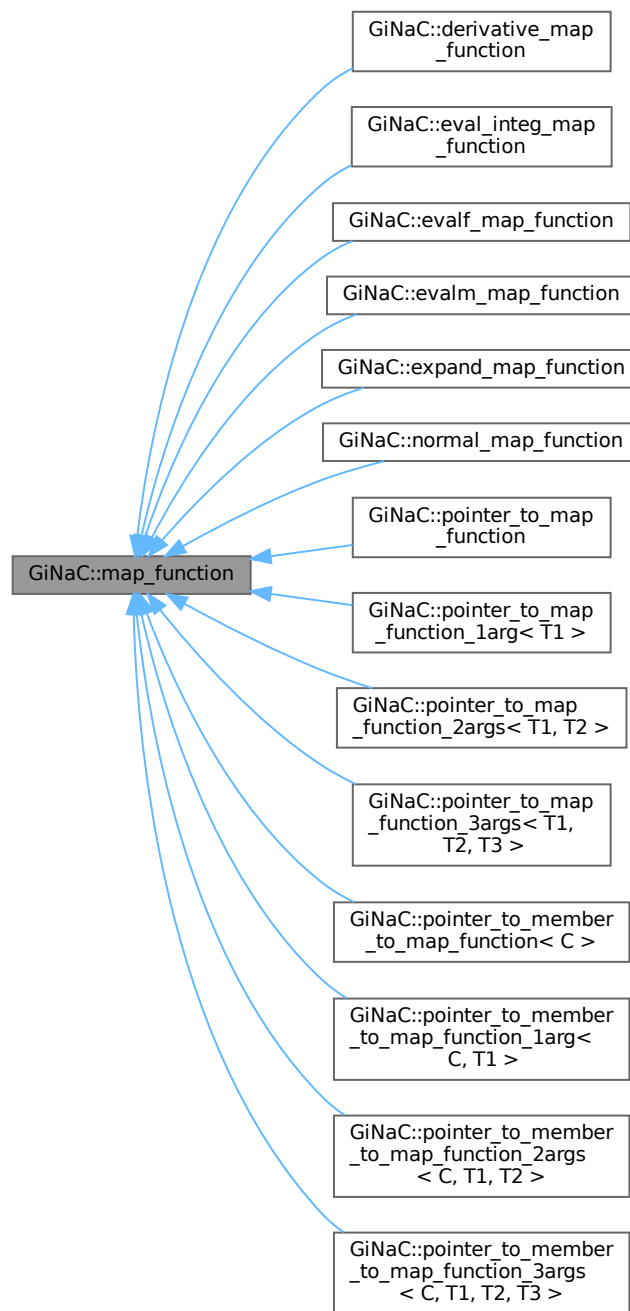
- [expairseq.h](#)

## 6.88 GiNaC::map\_function Struct Reference

Function object for map().

```
#include <basic.h>
```

Inheritance diagram for GiNaC::map\_function:



### Public Types

- typedef const [ex](#) & [argument\\_type](#)
- typedef [ex](#) [result\\_type](#)

### Public Member Functions

- virtual [~map\\_function](#) ()
- virtual [ex operator\(\)](#) (const [ex](#) &e)=0

### 6.88.1 Detailed Description

Function object for map().

### 6.88.2 Member Typedef Documentation

#### 6.88.2.1 argument\_type

```
typedef const ex& GiNaC::map_function::argument_type
```

#### 6.88.2.2 result\_type

```
typedef ex GiNaC::map_function::result_type
```

### 6.88.3 Constructor & Destructor Documentation

#### 6.88.3.1 ~map\_function()

```
virtual GiNaC::map_function::~~map_function () [inline], [virtual]
```

### 6.88.4 Member Function Documentation

#### 6.88.4.1 operator>()

```
virtual ex GiNaC::map_function::operator() (
 const ex & e) [pure virtual]
```

Implemented in [GiNaC::derivative\\_map\\_function](#), [GiNaC::eval\\_integ\\_map\\_function](#), [GiNaC::evalf\\_map\\_function](#), [GiNaC::evalm\\_map\\_function](#), [GiNaC::expand\\_map\\_function](#), [GiNaC::normal\\_map\\_function](#), [GiNaC::pointer\\_to\\_map\\_function](#), [GiNaC::pointer\\_to\\_map\\_function\\_1arg< T1 >](#), [GiNaC::pointer\\_to\\_map\\_function\\_2args< T1, T2 >](#), [GiNaC::pointer\\_to\\_map\\_function\\_3args< T1, T2, T3 >](#), [GiNaC::pointer\\_to\\_member\\_to\\_map\\_function< C >](#), [GiNaC::pointer\\_to\\_member\\_to\\_map\\_function\\_1arg< C, T1 >](#), [GiNaC::pointer\\_to\\_member\\_to\\_map\\_function\\_2args< C, T1, T2 >](#), and [GiNaC::pointer\\_to\\_member\\_to\\_map\\_function\\_3args< C, T1, T2, T3 >](#).

The documentation for this struct was generated from the following file:

- [basic.h](#)

## 6.89 GiNaC::matrix Class Reference

Symbolic matrices.

```
#include <matrix.h>
```

Inheritance diagram for GiNaC::matrix:



Collaboration diagram for GiNaC::matrix:



### Public Member Functions

- [matrix](#) (unsigned r, unsigned c)  
*Very common ctor.*
- [matrix](#) (unsigned r, unsigned c, const [lst](#) &l)  
*Construct matrix from (flat) list of elements.*

- **matrix** (std::initializer\_list< std::initializer\_list< **ex** > > l)  
*Construct a matrix from an 2 dimensional initializer list.*
- **size\_t nops** () const override  
*nops is defined to be rows x columns.*
- **ex op** (size\_t i) const override  
*returns matrix entry at position (i/col, icol).*
- **ex & let\_op** (size\_t i) override  
*returns writable matrix entry at position (i/col, icol).*
- **ex evalm** () const override  
*Evaluate sums, products and integer powers of matrices.*
- **ex subs** (const **exmap** &m, unsigned options=0) const override  
*Substitute a set of objects by arbitrary expressions.*
- **ex eval\_indexed** (const **basic** &i) const override  
*Automatic symbolic evaluation of an indexed matrix.*
- **ex add\_indexed** (const **ex** &self, const **ex** &other) const override  
*Sum of two indexed matrices.*
- **ex scalar\_mul\_indexed** (const **ex** &self, const **numeric** &other) const override  
*Product of an indexed matrix with a number.*
- **bool contract\_with** (exvector::iterator self, exvector::iterator other, **exvector** &v) const override  
*Contraction of an indexed matrix with something else.*
- **ex conjugate** () const override  
*Complex conjugate every matrix entry.*
- **ex real\_part** () const override
- **ex imag\_part** () const override
- **void archive** (**archive\_node** &n) const override  
*Save (a.k.a.*
- **void read\_archive** (const **archive\_node** &n, **lst** &syms) override  
*Read (a.k.a.*
- **unsigned rows** () const  
*Get number of rows.*
- **unsigned cols** () const  
*Get number of columns.*
- **matrix add** (const **matrix** &other) const  
*Sum of matrices.*
- **matrix sub** (const **matrix** &other) const  
*Difference of matrices.*
- **matrix mul** (const **matrix** &other) const  
*Product of matrices.*
- **matrix mul** (const **numeric** &other) const  
*Product of matrix and scalar.*
- **matrix mul\_scalar** (const **ex** &other) const  
*Product of matrix and scalar expression.*
- **matrix pow** (const **ex** &expn) const  
*Power of a matrix.*
- **const ex & operator()** (unsigned ro, unsigned co) const  
*operator() to access elements for reading.*
- **ex & operator()** (unsigned ro, unsigned co)  
*operator() to access elements for writing.*
- **matrix & set** (unsigned ro, unsigned co, const **ex** &value)
- **matrix transpose** () const  
*Transposed of an m x n matrix, producing a new n x m matrix object that represents the transposed.*



- `ex determinant` (unsigned algo=`determinant_algo::automatic`) const  
*Determinant of square matrix.*
- `ex trace` () const  
*Trace of a matrix.*
- `ex charpoly` (const `ex` &lambda) const  
*Characteristic Polynomial.*
- `matrix inverse` () const  
*Inverse of this matrix, with automatic algorithm selection.*
- `matrix inverse` (unsigned algo) const  
*Inverse of this matrix.*
- `matrix solve` (const `matrix` &vars, const `matrix` &rhs, unsigned algo=`solve_algo::automatic`) const  
*Solve a linear system consisting of a  $m \times n$  matrix and a  $m \times p$  right hand side by applying an elimination scheme to the augmented matrix.*
- unsigned `rank` () const  
*Compute the rank of this matrix.*
- unsigned `rank` (unsigned `solve_algo`) const  
*Compute the rank of this matrix using the given algorithm, which should be a member of enum `solve_algo`.*
- bool `is_zero_matrix` () const  
*Function to check that all elements of the matrix are zero.*

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic` \* `duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf` () const  
*Evaluate object numerically.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree` () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence` () const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool `info` (unsigned inf) const  
*Information about the object.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex` & `operator[]` (const `ex` &index)
- virtual `ex` & `operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const

- Test for occurrence of a pattern.*

  - virtual bool `match` (const `ex` &pattern, `exmap` &repls) const

*Check whether the expression matches a given pattern.*
- virtual `ex map` (`map_function` &f) const

*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const

*Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const

*Return degree of highest power in object s.*
- virtual int `ldegree` (const `ex` &s) const

*Return degree of lowest power in object s.*
- virtual `ex coeff` (const `ex` &s, int n=1) const

*Return coefficient of degree n in object s.*
- virtual `ex expand` (unsigned options=0) const

*Expand expression, i.e.*
- virtual `ex collect` (const `ex` &s, bool distributed=false) const

*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series` (const `relational` &r, int order, unsigned options=0) const

*Default implementation of `ex::series()`.*
- virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const

*Default implementation of `ex::normal()`.*
- virtual `ex to_rational` (`exmap` &repl) const

*Default implementation of `ex::to_rational()`.*
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const

*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const

*Implementation `ex::max_coefficient()`.*
- virtual `exvector get_free_indices` () const

*Return a vector containing the free indices of an expression.*
- virtual `return_type_t return_type_tinfo` () const
- template<class T>
  - void `print_dispatch` (const `print_context` &c, unsigned level) const

*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const

*Like `print()`, but dispatch to the specified class.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const

*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const

*Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const

*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const

*Test for syntactic equality.*
- const `basic` & `hold` () const

*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const

*Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const

*Clear some `status_flags`.*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Member Functions

- [matrix](#) (unsigned r, unsigned c, const [exvector](#) &m2)  
*Ctor from representation, for internal use only.*
- [matrix](#) (unsigned r, unsigned c, [exvector](#) &&m2)
- bool [match\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if the attributes of two objects are similar enough for a match.*
- unsigned [return\\_type](#) () const override
- [ex\\_determinant\\_minor](#) () const  
*Recursive determinant for small matrices having at least one symbolic entry.*
- std::vector< unsigned > [echelon\\_form](#) (unsigned algo, int n)
- int [gauss\\_elimination](#) (const bool det=false)  
*Perform the steps of an ordinary Gaussian elimination to bring the m x n matrix into an upper echelon form.*
- int [division\\_free\\_elimination](#) (const bool det=false)  
*Perform the steps of division free elimination to bring the m x n matrix into an upper echelon form.*
- int [fraction\\_free\\_elimination](#) (const bool det=false)  
*Perform the steps of Bareiss' one-step fraction free elimination to bring the matrix into an upper echelon form.*
- std::vector< unsigned > [markowitz\\_elimination](#) (unsigned n)
- int [pivot](#) (unsigned ro, unsigned co, bool symbolic=true)  
*Partial pivoting method for matrix elimination schemes.*
- void [print\\_elements](#) (const [print\\_context](#) &c, const char \*row\_start, const char \*row\_end, const char \*row↵\_sep, const char \*col\_sep) const
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_latex](#) (const [print\\_latex](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex\\_eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual [ex\\_derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Attributes

- unsigned [row](#)  
*number of rows*
- unsigned [col](#)  
*number of columns*
- [exvector m](#)  
*representation (cols indexed first)*

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

## 6.89.1 Detailed Description

Symbolic matrices.

## 6.89.2 Constructor & Destructor Documentation

### 6.89.2.1 [matrix\(\)](#) [1/5]

```
GiNaC::matrix::matrix (
 unsigned r,
 unsigned c)
```

Very common ctor.

Initializes to r x c-dimensional zero-matrix.

#### Parameters

|          |                |
|----------|----------------|
| <i>r</i> | number of rows |
| <i>c</i> | number of cols |

References [GiNaC::\\_ex0](#), [col](#), [m](#), [matrix\(\)](#), [GiNaC::status\\_flags::not\\_shareable](#), [row](#), and [GiNaC::basic::setflag\(\)](#).

Referenced by [add\(\)](#), [add\\_indexed\(\)](#), [charpoly\(\)](#), [conjugate\(\)](#), [contract\\_with\(\)](#), [determinant\(\)](#), [fraction\\_free\\_elimination\(\)](#), [imag\\_part\(\)](#), [inverse\(\)](#), [inverse\(\)](#), [match\\_same\\_type\(\)](#), [matrix\(\)](#), [mul\(\)](#), [mul\(\)](#), [mul\\_scalar\(\)](#), [pow\(\)](#), [rank\(\)](#), [real\\_part\(\)](#), [scalar\\_mul\\_indexed\(\)](#), [set\(\)](#), [solve\(\)](#), [sub\(\)](#), [subs\(\)](#), and [transpose\(\)](#).

### 6.89.2.2 matrix() [2/5]

```
GiNaC::matrix::matrix (
 unsigned r,
 unsigned c,
 const lst & l)
```

Construct matrix from (flat) list of elements.

If the list has fewer elements than the matrix, the remaining matrix elements are set to zero. If the list has more elements than the matrix, the excessive elements are thrown away.

References [GiNaC::\\_ex0](#), [col](#), [m](#), [GiNaC::status\\_flags::not\\_shareable](#), [row](#), and [GiNaC::basic::setflag\(\)](#).

### 6.89.2.3 matrix() [3/5]

```
GiNaC::matrix::matrix (
 std::initializer_list< std::initializer_list< ex > > l)
```

Construct a matrix from an 2 dimensional initializer list.

Throws an exception if some row has a different length than all the others.

References [col](#), [m](#), [GiNaC::status\\_flags::not\\_shareable](#), [row](#), and [GiNaC::basic::setflag\(\)](#).

### 6.89.2.4 matrix() [4/5]

```
GiNaC::matrix::matrix (
 unsigned r,
 unsigned c,
 const exvector & m2) [protected]
```

Ctor from representation, for internal use only.

References [col](#), [m](#), [GiNaC::status\\_flags::not\\_shareable](#), [row](#), and [GiNaC::basic::setflag\(\)](#).

### 6.89.2.5 matrix() [5/5]

```
GiNaC::matrix::matrix (
 unsigned r,
 unsigned c,
 exvector && m2) [protected]
```

References [col](#), [m](#), [GiNaC::status\\_flags::not\\_shareable](#), [row](#), and [GiNaC::basic::setflag\(\)](#).

## 6.89.3 Member Function Documentation

### 6.89.3.1 nops()

```
size_t GiNaC::matrix::nops () const [override], [virtual]
```

nops is defined to be rows x columns.

Reimplemented from [GiNaC::basic](#).

References [col](#), and [row](#).

Referenced by [let\\_op\(\)](#), [GiNaC::nops\(\)](#), and [op\(\)](#).

### 6.89.3.2 op()

```
ex GiNaC::matrix::op (
 size_t i) const [override], [virtual]
```

returns matrix entry at position (i/col, icol).

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), [GINAC\\_ASSERT](#), [m](#), and [nops\(\)](#).

Referenced by [contract\\_with\(\)](#).

### 6.89.3.3 let\_op()

```
ex & GiNaC::matrix::let_op (
 size_t i) [override], [virtual]
```

returns writable matrix entry at position (i/col, icol).

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [GiNaC::basic::ex](#), [GINAC\\_ASSERT](#), [m](#), and [nops\(\)](#).

### 6.89.3.4 evalm()

```
ex GiNaC::matrix::evalm () const [inline], [override], [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

### 6.89.3.5 subs()

```
ex GiNaC::matrix::subs (
 const exmap & m,
 unsigned options = 0) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [col](#), [GiNaC::basic::ex](#), [m](#), [matrix\(\)](#), [row](#), and [subs\(\)](#).

Referenced by [fraction\\_free\\_elimination\(\)](#), and [subs\(\)](#).

### 6.89.3.6 eval\_indexed()

```
ex GiNaC::matrix::eval_indexed (
 const basic & i) const [override], [virtual]
```

Automatic symbolic evaluation of an indexed matrix.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::basic\(\)](#), [col](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::idx::get\\_dim\(\)](#), [GiNaC::idx::get\\_value\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_dummy\\_pair\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::basic::nops\(\)](#), [GiNaC::basic::op\(\)](#), [row](#), and [trace\(\)](#).

### 6.89.3.7 add\_indexed()

```
ex GiNaC::matrix::add_indexed (
 const ex & self,
 const ex & other) const [override], [virtual]
```

Sum of two indexed matrices.

Reimplemented from [GiNaC::basic](#).

References [add\(\)](#), [col](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [matrix\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [row](#), and [transpose\(\)](#).

### 6.89.3.8 scalar\_mul\_indexed()

```
ex GiNaC::matrix::scalar_mul_indexed (
 const ex & self,
 const numeric & other) const [override], [virtual]
```

Product of an indexed matrix with a number.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [matrix\(\)](#), [mul\(\)](#), [GiNaC::ex::nops\(\)](#), and [GiNaC::ex::op\(\)](#).

**6.89.3.9 contract\_with()**

```
bool GiNaC::matrix::contract_with (
 exvector::iterator self,
 exvector::iterator other,
 exvector & v) const [override], [virtual]
```

Contraction of an indexed matrix with something else.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [col](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_dummy\\_pair\(\)](#), [matrix\(\)](#), [mul\(\)](#), [GiNaC::ex::op\(\)](#), [op\(\)](#), [row](#), and [transpose\(\)](#).

**6.89.3.10 conjugate()**

```
ex GiNaC::matrix::conjugate () const [override], [virtual]
```

Complex conjugate every matrix entry.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [col](#), [GiNaC::basic::ex](#), [m](#), [matrix\(\)](#), and [row](#).

**6.89.3.11 real\_part()**

```
ex GiNaC::matrix::real_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [col](#), [GiNaC::basic::ex](#), [m](#), [matrix\(\)](#), and [row](#).

**6.89.3.12 imag\_part()**

```
ex GiNaC::matrix::imag_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [col](#), [GiNaC::basic::ex](#), [m](#), [matrix\(\)](#), and [row](#).

**6.89.3.13 archive()**

```
void GiNaC::matrix::archive (
 archive_node & n) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::add\\_ex\(\)](#), [GiNaC::archive\\_node::add\\_unsigned\(\)](#), [col](#), [m](#), and [row](#).



**6.89.3.14 read\_archive()**

```
void GiNaC::matrix::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [col](#), [GiNaC::basic::ex](#), [GiNaC::archive\\_node::find\\_ex\\_by\\_loc\(\)](#), [GiNaC::archive\\_node::find\\_property\\_range\(\)](#), [GiNaC::archive\\_node::find\\_unsigned\(\)](#), [m](#), and [row](#).

**6.89.3.15 match\_same\_type()**

```
bool GiNaC::matrix::match_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is\\_equal\\_same\\_type\(\)](#) is automatically used instead of [match\\_same\\_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::basic\(\)](#), [col](#), [cols\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), [matrix\(\)](#), [row](#), and [rows\(\)](#).

**6.89.3.16 return\_type()**

```
unsigned GiNaC::matrix::return_type() const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::noncommutative](#).

**6.89.3.17 rows()**

```
unsigned GiNaC::matrix::rows () const [inline]
```

Get number of rows.

References [row](#).

Referenced by [GiNaC::clifford\\_unit\(\)](#), [division\\_free\\_elimination\(\)](#), [fraction\\_free\\_elimination\(\)](#), [gauss\\_elimination\(\)](#), [GiNaC::lsolve\(\)](#), [match\\_same\\_type\(\)](#), [mul\(\)](#), [GiNaC::reduced\\_matrix\(\)](#), [GiNaC::rows\(\)](#), [solve\(\)](#), [GiNaC::sub\\_matrix\(\)](#), and [transpose\(\)](#).

**6.89.3.18 cols()**

```
unsigned GiNaC::matrix::cols () const [inline]
```

Get number of columns.

References [col](#).

Referenced by [GiNaC::clifford\\_unit\(\)](#), [GiNaC::cols\(\)](#), [determinant\\_minor\(\)](#), [division\\_free\\_elimination\(\)](#), [fraction\\_free\\_elimination\(\)](#), [gauss\\_elimination\(\)](#), [GiNaC::lsolve\(\)](#), [match\\_same\\_type\(\)](#), [mul\(\)](#), [GiNaC::reduced\\_matrix\(\)](#), [solve\(\)](#), [GiNaC::sub\\_matrix\(\)](#), and [transpose\(\)](#).

**6.89.3.19 add()**

```
matrix GiNaC::matrix::add (
 const matrix & other) const
```

Sum of matrices.

**Exceptions**

|                    |                         |
|--------------------|-------------------------|
| <i>logic_error</i> | (incompatible matrices) |
|--------------------|-------------------------|

References [col](#), [m](#), [matrix\(\)](#), and [row](#).

Referenced by [add\\_indexed\(\)](#), and [GiNaC::add::evalm\(\)](#).

**6.89.3.20 sub()**

```
matrix GiNaC::matrix::sub (
 const matrix & other) const
```

Difference of matrices.

**Exceptions**

|                    |                         |
|--------------------|-------------------------|
| <i>logic_error</i> | (incompatible matrices) |
|--------------------|-------------------------|

References [col](#), [m](#), [matrix\(\)](#), and [row](#).

**6.89.3.21 mul() [1/2]**

```
matrix GiNaC::matrix::mul (
 const matrix & other) const
```

Product of matrices.

## Exceptions

|                    |                         |
|--------------------|-------------------------|
| <i>logic_error</i> | (incompatible matrices) |
|--------------------|-------------------------|

References [col](#), [cols\(\)](#), [GiNaC::is\\_zero\(\)](#), [m](#), [matrix\(\)](#), [row](#), and [rows\(\)](#).

Referenced by [charpoly\(\)](#), [contract\\_with\(\)](#), [GiNaC::ncmul::evalm\(\)](#), [pow\(\)](#), and [scalar\\_mul\\_indexed\(\)](#).

**6.89.3.22 mul()** [2/2]

```
matrix GiNaC::matrix::mul (
 const numeric & other) const
```

Product of matrix and scalar.

References [col](#), [m](#), [matrix\(\)](#), and [row](#).

**6.89.3.23 mul\_scalar()**

```
matrix GiNaC::matrix::mul_scalar (
 const ex & other) const
```

Product of matrix and scalar expression.

References [col](#), [GiNaC::return\\_types::commutative](#), [GiNaC::basic::ex](#), [m](#), [matrix\(\)](#), [GiNaC::ex::return\\_type\(\)](#), and [row](#).

Referenced by [GiNaC::mul::evalm\(\)](#).

**6.89.3.24 pow()**

```
matrix GiNaC::matrix::pow (
 const ex & expn) const
```

Power of a matrix.

Currently handles integer exponents only.

References [GiNaC::\\_ex1](#), [GiNaC::\\_num1\\_p](#), [GiNaC::\\_num2\\_p](#), [col](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [inverse\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::numeric::is\\_odd\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [matrix\(\)](#), [mul\(\)](#), [GiNaC::info\\_flags::negative](#), and [row](#).

**6.89.3.25 operator>()** [1/2]

```
const ex & GiNaC::matrix::operator() (
 unsigned ro,
 unsigned co) const
```

[operator\(\)](#) to access elements for reading.

## Parameters

|           |                   |
|-----------|-------------------|
| <i>ro</i> | row of element    |
| <i>co</i> | column of element |

## Exceptions

|                    |                      |
|--------------------|----------------------|
| <i>range_error</i> | (index out of range) |
|--------------------|----------------------|

References [col](#), [GiNaC::basic::ex](#), [m](#), and [row](#).

**6.89.3.26 operator>() [2/2]**

```
ex & GiNaC::matrix::operator() (
 unsigned ro,
 unsigned co)
```

`operator()` to access elements for writing.

## Parameters

|           |                   |
|-----------|-------------------|
| <i>ro</i> | row of element    |
| <i>co</i> | column of element |

## Exceptions

|                    |                      |
|--------------------|----------------------|
| <i>range_error</i> | (index out of range) |
|--------------------|----------------------|

References [col](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [GiNaC::basic::ex](#), [m](#), and [row](#).

**6.89.3.27 set()**

```
matrix & GiNaC::matrix::set (
 unsigned ro,
 unsigned co,
 const ex & value) [inline]
```

References [GiNaC::basic::ex](#), and [matrix\(\)](#).

**6.89.3.28 transpose()**

```
matrix GiNaC::matrix::transpose () const
```

Transposed of an  $m \times n$  matrix, producing a new  $n \times m$  matrix object that represents the transposed.

References [cols\(\)](#), [m](#), [matrix\(\)](#), and [rows\(\)](#).

Referenced by [add\\_indexed\(\)](#), [contract\\_with\(\)](#), and [GiNaC::transpose\(\)](#).

### 6.89.3.29 determinant()

```
ex GiNaC::matrix::determinant (
 unsigned algo = determinant_algo::automatic) const
```

Determinant of square matrix.

This routine doesn't actually calculate the determinant, it only implements some heuristics about which algorithm to run. If all the elements of the matrix are elements of an integral domain the determinant is also in that integral domain and the result is expanded only. If one or more elements are from a quotient field the determinant is usually also in that quotient field and the result is normalized before it is returned. This implies that the determinant of the symbolic 2x2 matrix  $\begin{bmatrix} a/(a-b) & 1 \\ b/(a-b) & 1 \end{bmatrix}$  is returned as unity. (In this respect, it behaves like MapleV and unlike Mathematica.)

#### Parameters

|             |                              |
|-------------|------------------------------|
| <i>algo</i> | allows to chose an algorithm |
|-------------|------------------------------|

#### Returns

the determinant as a new expression

#### Exceptions

|                    |                     |
|--------------------|---------------------|
| <i>logic_error</i> | (matrix not square) |
|--------------------|---------------------|

#### See also

[determinant\\_algo](#)

References [GiNaC::ex0](#), [GiNaC::determinant\\_algo::automatic](#), [GiNaC::determinant\\_algo::bareiss](#), [col](#), [GiNaC::info\\_flags::crational\\_p](#), [determinant\\_minor\(\)](#), [GiNaC::determinant\\_algo::divfree](#), [division\\_free\\_elimination\(\)](#), [GiNaC::basic::ex](#), [fraction\\_free\\_elimination\(\)](#), [GiNaC::determinant\\_algo::gauss](#), [gauss\\_elimination\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::is\\_zero\(\)](#), [GiNaC::determinant\\_algo::laplace](#), [m](#), [matrix\(\)](#), [GiNaC::ex::normal\(\)](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::permutation\\_sign\(\)](#), [GiNaC::info\\_flags::rational\\_function](#), and [row](#).

Referenced by [charpoly\(\)](#), [GiNaC::tensepsilon::contract\\_with\(\)](#), [GiNaC::determinant\(\)](#), and [GiNaC::resultant\(\)](#).

### 6.89.3.30 trace()

```
ex GiNaC::matrix::trace () const
```

Trace of a matrix.

The result is normalized if it is in some quotient field and expanded only otherwise. This implies that the trace of the symbolic 2x2 matrix  $\begin{bmatrix} a/(a-b) & x \\ y & b/(b-a) \end{bmatrix}$  is recognized to be unity.

#### Returns

the sum of diagonal elements

## Exceptions

|                    |                     |
|--------------------|---------------------|
| <i>logic_error</i> | (matrix not square) |
|--------------------|---------------------|

References [col](#), [GiNaC::info\\_flags::crational\\_polynomial](#), [GiNaC::basic::ex](#), [GiNaC::ex::expand\(\)](#), [GiNaC::ex::info\(\)](#), [m](#), [GiNaC::ex::normal\(\)](#), [GiNaC::info\\_flags::rational\\_function](#), and [row](#).

Referenced by [charpoly\(\)](#), [eval\\_indexed\(\)](#), and [GiNaC::trace\(\)](#).

**6.89.3.31 charpoly()**

```
ex GiNaC::matrix::charpoly (
 const ex & lambda) const
```

Characteristic Polynomial.

Following mathematica notation the characteristic polynomial of a matrix M is defined as the determinant of (M - lambda \* 1) where 1 stands for the unit matrix of the same dimension as M. Note that some CASs define it with a sign inside the determinant which gives rise to an overall sign if the dimension is odd. This method returns the characteristic polynomial collected in powers of lambda as a new expression.

## Returns

characteristic polynomial as new expression

## Exceptions

|                    |                     |
|--------------------|---------------------|
| <i>logic_error</i> | (matrix not square) |
|--------------------|---------------------|

## See also

[matrix::determinant\(\)](#)

References [col](#), [GiNaC::ex::collect\(\)](#), [determinant\(\)](#), [GiNaC::basic::ex](#), [m](#), [matrix\(\)](#), [mul\(\)](#), [GiNaC::info\\_flags::numeric](#), [row](#), and [trace\(\)](#).

Referenced by [GiNaC::charpoly\(\)](#).

**6.89.3.32 inverse() [1/2]**

```
matrix GiNaC::matrix::inverse () const
```

Inverse of this matrix, with automatic algorithm selection.

References [GiNaC::solve\\_algo::automatic](#), [inverse\(\)](#), and [matrix\(\)](#).

Referenced by [GiNaC::inverse\(\)](#), [GiNaC::inverse\(\)](#), [inverse\(\)](#), and [pow\(\)](#).

**6.89.3.33 inverse() [2/2]**

```
matrix GiNaC::matrix::inverse (
 unsigned algo) const
```

Inverse of this matrix.

## Parameters

|             |                                                            |
|-------------|------------------------------------------------------------|
| <i>algo</i> | selects the algorithm (one of <a href="#">solve_algo</a> ) |
|-------------|------------------------------------------------------------|

## Returns

the inverted matrix

## Exceptions

|                      |                     |
|----------------------|---------------------|
| <i>logic_error</i>   | (matrix not square) |
| <i>runtime_error</i> | (singular matrix)   |

References [GiNaC::\\_ex1](#), [col](#), [matrix\(\)](#), [row](#), and [solve\(\)](#).

**6.89.3.34 solve()**

```
matrix GiNaC::matrix::solve (
 const matrix & vars,
 const matrix & rhs,
 unsigned algo = solve_algo::automatic) const
```

Solve a linear system consisting of a m x n matrix and a m x p right hand side by applying an elimination scheme to the augmented matrix.

## Parameters

|             |                                            |
|-------------|--------------------------------------------|
| <i>vars</i> | n x p matrix, all elements must be symbols |
| <i>rhs</i>  | m x p matrix                               |
| <i>algo</i> | selects the solving algorithm              |

## Returns

n x p solution matrix

## Exceptions

|                         |                                          |
|-------------------------|------------------------------------------|
| <i>logic_error</i>      | (incompatible matrices)                  |
| <i>invalid_argument</i> | (1st argument must be matrix of symbols) |
| <i>runtime_error</i>    | (inconsistent linear system)             |

## See also

[solve\\_algo](#)

References [cols\(\)](#), [echelon\\_form\(\)](#), [GiNaC::basic::ex](#), [GiNaC::basic::info\(\)](#), [m](#), [matrix\(\)](#), [GiNaC::basic::normal\(\)](#), [GiNaC::rhs\(\)](#), [rows\(\)](#), and [GiNaC::info\\_flags::symbol](#).

Referenced by [inverse\(\)](#), [GiNaC::lsolve\(\)](#), and [GiNaC::sqrfree\\_pfrac\(\)](#).

**6.89.3.35 rank()** [1/2]

```
unsigned GiNaC::matrix::rank () const
```

Compute the rank of this matrix.

References [GiNaC::solve\\_algo::automatic](#), and [rank\(\)](#).

Referenced by [rank\(\)](#), [GiNaC::rank\(\)](#), and [GiNaC::rank\(\)](#).

**6.89.3.36 rank()** [2/2]

```
unsigned GiNaC::matrix::rank (
 unsigned solve_algo) const
```

Compute the rank of this matrix using the given algorithm, which should be a member of enum [solve\\_algo](#).

References [col](#), [echelon\\_form\(\)](#), [GINAC\\_ASSERT](#), [m](#), [matrix\(\)](#), and [row](#).

**6.89.3.37 is\_zero\_matrix()**

```
bool GiNaC::matrix::is_zero_matrix () const
```

Function to check that all elements of the matrix are zero.

References [m](#).

**6.89.3.38 determinant\_minor()**

```
ex GiNaC::matrix::determinant_minor () const [protected]
```

Recursive determinant for small matrices having at least one symbolic entry.

The basic algorithm, known as Laplace-expansion, is enhanced by some bookkeeping to avoid calculation of the same submatrices ("minors") more than once. According to W.M.Gentleman and S.C.Johnson this algorithm is better than elimination schemes for matrices of sparse multivariate polynomials and also for matrices of dense univariate polynomials if the matrix' dimension is larger than 7.

**Returns**

the determinant as a new expression (in expanded form)

**See also**

[matrix::determinant\(\)](#)

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [cols\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex::expand\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::is\\_zero\(\)](#), and [m](#).

Referenced by [determinant\(\)](#).



**6.89.3.39 echelon\_form()**

```
std::vector< unsigned > GiNaC::matrix::echelon_form (
 unsigned algo,
 int n) [protected]
```

References [GiNaC::solve\\_algo::automatic](#), [GiNaC::solve\\_algo::bareiss](#), [col](#), [GiNaC::solve\\_algo::divfree](#), [division\\_free\\_elimination\(\)](#), [fraction\\_free\\_elimination\(\)](#), [GiNaC::solve\\_algo::gauss](#), [gauss\\_elimination\(\)](#), [m](#), [GiNaC::solve\\_algo::markowitz](#), [markowitz\\_elimination\(\)](#), [GiNaC::info\\_flags::numeric](#), and [row](#).

Referenced by [rank\(\)](#), and [solve\(\)](#).

**6.89.3.40 gauss\_elimination()**

```
int GiNaC::matrix::gauss_elimination (
 const bool det = false) [protected]
```

Perform the steps of an ordinary Gaussian elimination to bring the m x n matrix into an upper echelon form.

The algorithm is ok for matrices with numeric coefficients but quite unsuited for symbolic matrices.

**Parameters**

|            |                                                                                                                                                                            |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>det</i> | may be set to true to save a lot of space if one is only interested in the diagonal elements (i.e. for calculating determinants). The others are set to zero in this case. |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Returns**

sign is 1 if an even number of rows was swapped, -1 if an odd number of rows was swapped and 0 if the matrix is singular.

References [GiNaC::\\_ex0](#), [cols\(\)](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [GiNaC::basic::ex](#), [GINAC\\_ASSERT](#), [GiNaC::basic::info\(\)](#), [GiNaC::is\\_zero\(\)](#), [m](#), [GiNaC::ex::normal\(\)](#), [GiNaC::info\\_flags::numeric](#), [pivot\(\)](#), and [rows\(\)](#).

Referenced by [determinant\(\)](#), and [echelon\\_form\(\)](#).

**6.89.3.41 division\_free\_elimination()**

```
int GiNaC::matrix::division_free_elimination (
 const bool det = false) [protected]
```

Perform the steps of division free elimination to bring the m x n matrix into an upper echelon form.

**Parameters**

|            |                                                                                                                                                                            |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>det</i> | may be set to true to save a lot of space if one is only interested in the diagonal elements (i.e. for calculating determinants). The others are set to zero in this case. |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Returns**

sign is 1 if an even number of rows was swapped, -1 if an odd number of rows was swapped and 0 if the matrix is singular.

References [GiNaC::\\_ex0](#), [cols\(\)](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [GINAC\\_ASSERT](#), [m](#), [pivot\(\)](#), and [rows\(\)](#).

Referenced by [determinant\(\)](#), and [echelon\\_form\(\)](#).

### 6.89.3.42 fraction\_free\_elimination()

```
int GiNaC::matrix::fraction_free_elimination (
 const bool det = false) [protected]
```

Perform the steps of Bareiss' one-step fraction free elimination to bring the matrix into an upper echelon form.

Fraction free elimination means that divide is used straightforwardly, without computing GCDs first. This is possible, since we know the divisor at each step.

#### Parameters

|            |                                                                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>det</i> | may be set to true to save a lot of space if one is only interested in the last element (i.e. for calculating determinants). The others are set to zero in this case. |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|

#### Returns

sign is 1 if an even number of rows was swapped, -1 if an odd number of rows was swapped and 0 if the matrix is singular.

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [cols\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [GiNaC::basic::ex](#), [GiNaC::basic::expand\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_zero\(\)](#), [m](#), [matrix\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::ex::op\(\)](#), [rows\(\)](#), and [subs\(\)](#).

Referenced by [determinant\(\)](#), and [echelon\\_form\(\)](#).

### 6.89.3.43 markowitz\_elimination()

```
std::vector< unsigned > GiNaC::matrix::markowitz_elimination (
 unsigned n) [protected]
```

References [GiNaC::\\_ex0](#), [col](#), [GiNaC::basic::ex](#), [GINAC\\_ASSERT](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::is\\_zero\(\)](#), [m](#), [GiNaC::basic::normal\(\)](#), [row](#), and [std::swap\(\)](#).

Referenced by [echelon\\_form\(\)](#).

### 6.89.3.44 pivot()

```
int GiNaC::matrix::pivot (
 unsigned ro,
 unsigned co,
 bool symbolic = true) [protected]
```

Partial pivoting method for matrix elimination schemes.

Usual pivoting (symbolic==false) returns the index to the element with the largest absolute value in column ro and swaps the current row with the one where the element was found. With (symbolic==true) it does the same thing with the first non-zero element.

#### Parameters

|                 |                                                                                                                       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------|
| <i>ro</i>       | is the row from where to begin                                                                                        |
| <i>co</i>       | is the column to be inspected                                                                                         |
| <i>symbolic</i> | signal if we want the first non-zero element to be pivoted (true) or the one with the largest absolute value (false). |

**Returns**

0 if no interchange occurred, -1 if all are zero (usually signaling a degeneracy) and positive integer k means that rows ro and k were swapped.

References [GiNaC::abs\(\)](#), [col](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::basic::expand\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::is\\_zero\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [m](#), [row](#), and [GiNaC::swap\(\)](#).

Referenced by [division\\_free\\_elimination\(\)](#), and [gauss\\_elimination\(\)](#).

**6.89.3.45 print\_elements()**

```
void GiNaC::matrix::print_elements (
 const print_context & c,
 const char * row_start,
 const char * row_end,
 const char * row_sep,
 const char * col_sep) const [protected]
```

References [col](#), [m](#), [row](#), and [GiNaC::print\\_context::s](#).

Referenced by [do\\_print\(\)](#), [do\\_print\\_latex\(\)](#), and [do\\_print\\_python\\_repr\(\)](#).

**6.89.3.46 do\_print()**

```
void GiNaC::matrix::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [print\\_elements\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.89.3.47 do\_print\_latex()**

```
void GiNaC::matrix::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

References [col](#), [print\\_elements\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.89.3.48 do\_print\_python\_repr()**

```
void GiNaC::matrix::do_print_python_repr (
 const print_python_repr & c,
 unsigned level) const [protected]
```

References [print\\_elements\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.89.4 Member Data Documentation

### 6.89.4.1 row

`unsigned GiNaC::matrix::row` [protected]

number of rows

Referenced by [add\(\)](#), [add\\_indexed\(\)](#), [archive\(\)](#), [charpoly\(\)](#), [conjugate\(\)](#), [contract\\_with\(\)](#), [determinant\(\)](#), [echelon\\_form\(\)](#), [eval\\_indexed\(\)](#), [imag\\_part\(\)](#), [inverse\(\)](#), [markowitz\\_elimination\(\)](#), [match\\_same\\_type\(\)](#), [matrix\(\)](#), [matrix\(\)](#), [matrix\(\)](#), [matrix\(\)](#), [mul\(\)](#), [mul\(\)](#), [mul\\_scalar\(\)](#), [nops\(\)](#), [operator\(\)\(\)](#), [operator\(\)\(\)](#), [pivot\(\)](#), [pow\(\)](#), [print\\_elements\(\)](#), [rank\(\)](#), [read\\_archive\(\)](#), [real\\_part\(\)](#), [rows\(\)](#), [sub\(\)](#), [subs\(\)](#), and [trace\(\)](#).

### 6.89.4.2 col

`unsigned GiNaC::matrix::col` [protected]

number of columns

Referenced by [add\(\)](#), [add\\_indexed\(\)](#), [archive\(\)](#), [charpoly\(\)](#), [cols\(\)](#), [conjugate\(\)](#), [contract\\_with\(\)](#), [determinant\(\)](#), [do\\_print\\_latex\(\)](#), [echelon\\_form\(\)](#), [eval\\_indexed\(\)](#), [imag\\_part\(\)](#), [inverse\(\)](#), [markowitz\\_elimination\(\)](#), [match\\_same\\_type\(\)](#), [matrix\(\)](#), [matrix\(\)](#), [matrix\(\)](#), [matrix\(\)](#), [matrix\(\)](#), [mul\(\)](#), [mul\(\)](#), [mul\\_scalar\(\)](#), [nops\(\)](#), [operator\(\)\(\)](#), [operator\(\)\(\)](#), [pivot\(\)](#), [pow\(\)](#), [print\\_elements\(\)](#), [rank\(\)](#), [read\\_archive\(\)](#), [real\\_part\(\)](#), [sub\(\)](#), [subs\(\)](#), and [trace\(\)](#).

### 6.89.4.3 m

`exvector GiNaC::matrix::m` [protected]

representation (cols indexed first)

Referenced by [add\(\)](#), [archive\(\)](#), [charpoly\(\)](#), [conjugate\(\)](#), [determinant\(\)](#), [determinant\\_minor\(\)](#), [division\\_free\\_elimination\(\)](#), [echelon\\_form\(\)](#), [fraction\\_free\\_elimination\(\)](#), [gauss\\_elimination\(\)](#), [imag\\_part\(\)](#), [is\\_zero\\_matrix\(\)](#), [let\\_op\(\)](#), [markowitz\\_elimination\(\)](#), [matrix\(\)](#), [matrix\(\)](#), [matrix\(\)](#), [matrix\(\)](#), [matrix\(\)](#), [mul\(\)](#), [mul\(\)](#), [mul\\_scalar\(\)](#), [op\(\)](#), [operator\(\)\(\)](#), [operator\(\)\(\)](#), [pivot\(\)](#), [print\\_elements\(\)](#), [rank\(\)](#), [read\\_archive\(\)](#), [real\\_part\(\)](#), [solve\(\)](#), [sub\(\)](#), [subs\(\)](#), [trace\(\)](#), and [transpose\(\)](#).

The documentation for this class was generated from the following files:

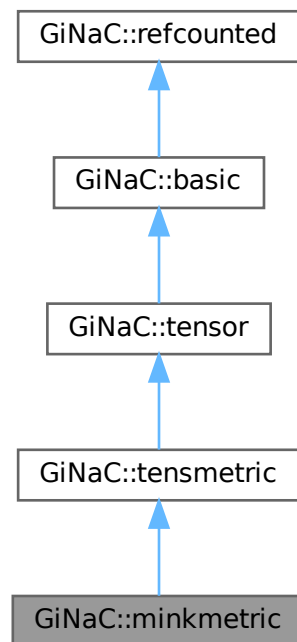
- [matrix.h](#)
- [matrix.cpp](#)

## 6.90 GiNaC::minkmetric Class Reference

This class represents a Minkowski metric tensor.

```
#include <tensor.h>
```

Inheritance diagram for GiNaC::minkmetric:



Collaboration diagram for `GiNaC::minkmetric`:



## Public Member Functions

- `minkmetric` (bool `pos_sig`)  
*Construct Lorentz metric tensor with given signature.*
- bool `info` (unsigned int) const override  
*Information about the object.*
- `ex eval_indexed` (const `basic` &i) const override  
*Automatic symbolic evaluation of an indexed Lorentz metric tensor.*
- void `archive` (`archive_node` &n) const override  
*Save (a.k.a.*
- void `read_archive` (const `archive_node` &n, `lst` &syms) override  
*Read (a.k.a.*

## Public Member Functions inherited from `GiNaC::tensmetric`

- bool `info` (unsigned int) const override  
*Information about the object.*
- `ex eval_indexed` (const `basic` &i) const override  
*Automatic symbolic evaluation of an indexed metric tensor.*
- bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const override  
*Contraction of an indexed metric tensor with something else.*

## Public Member Functions inherited from [GiNaC::tensor](#)

- bool [replace\\_contr\\_index](#) (exvector::iterator self, exvector::iterator other) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).*

## Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual [basic](#) \* [duplicate](#) () const  
*Create a clone of this object on the heap.*
- virtual [ex eval](#) () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual [ex evalf](#) () const  
*Evaluate object numerically.*
- virtual [ex evalm](#) () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual [ex eval\\_integ](#) () const  
*Evaluate integrals, if result is known.*
- virtual void [print](#) (const [print\\_context](#) &c, unsigned level=0) const  
*Output to stream.*
- virtual void [dbgprint](#) () const  
*Little wrapper around print to be called within a debugger.*
- virtual void [dbgprinttree](#) () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned [precedence](#) () const  
*Return relative operator precedence (for parenthezing output).*
- virtual size\_t [nops](#) () const  
*Number of operands/members.*
- virtual [ex op](#) (size\_t i) const  
*Return operand/member at position i.*
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size\_t i) const
- virtual [ex](#) & [let\\_op](#) (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size\_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const  
*Check whether the expression matches a given pattern.*
- virtual [ex subs](#) (const [exmap](#) &m, unsigned options=0) const  
*Substitute a set of objects by arbitrary expressions.*
- virtual [ex map](#) ([map\\_function](#) &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is\\_polynomial](#) (const [ex](#) &var) const

- Check whether this is a polynomial in the given variables.*

  - virtual int `degree` (const `ex` &s) const  
*Return degree of highest power in object s.*
  - virtual int `ldegree` (const `ex` &s) const  
*Return degree of lowest power in object s.*
  - virtual `ex` `coeff` (const `ex` &s, int n=1) const  
*Return coefficient of degree n in object s.*
  - virtual `ex` `expand` (unsigned options=0) const  
*Expand expression, i.e.*
  - virtual `ex` `collect` (const `ex` &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
  - virtual `ex` `series` (const `relational` &r, int order, unsigned options=0) const  
*Default implementation of `ex::series()`.*
  - virtual `ex` `normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const  
*Default implementation of `ex::normal()`.*
  - virtual `ex` `to_rational` (`exmap` &repl) const  
*Default implementation of `ex::to_rational()`.*
  - virtual `ex` `to_polynomial` (`exmap` &repl) const
  - virtual `numeric` `integer_content` () const
  - virtual `ex` `smod` (const `numeric` &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
  - virtual `numeric` `max_coefficient` () const  
*Implementation `ex::max_coefficient()`.*
  - virtual `exvector` `get_free_indices` () const  
*Return a vector containing the free indices of an expression.*
  - virtual `ex` `add_indexed` (const `ex` &self, const `ex` &other) const  
*Add two indexed expressions.*
  - virtual `ex` `scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const  
*Multiply an indexed expression with a scalar.*
  - virtual `return_type_t` `return_type_tinfo` () const
  - virtual `ex` `conjugate` () const
  - virtual `ex` `real_part` () const
  - virtual `ex` `imag_part` () const
  - template<class T>  
void `print_dispatch` (const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
  - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
  - `ex` `subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
  - `ex` `diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
  - int `compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
  - bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
  - const `basic` & `hold` () const  
*Stop further evaluation.*
  - unsigned `gethash` () const
  - const `basic` & `setflag` (unsigned f) const  
*Set some `status_flags`.*
  - const `basic` & `clearflag` (unsigned f) const  
*Clear some `status_flags`.*



## Public Member Functions inherited from GiNaC::refcounted

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- unsigned `return_type` () const override
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

## Protected Member Functions inherited from GiNaC::tensmetric

- unsigned `return_type` () const override
- void `do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from GiNaC::tensor

- unsigned `return_type` () const override

## Protected Member Functions inherited from GiNaC::basic

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual `ex derivative` (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned `calchash` () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void `do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

## Private Attributes

- bool `pos_sig`  
*If true, the metric is  $\text{diag}(-1, 1, 1, \dots)$ .*

## Additional Inherited Members

### Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
of type [status\\_flags](#)
- unsigned [hashvalue](#)  
hash value

## 6.90.1 Detailed Description

This class represents a Minkowski metric tensor.

It has all the properties of a metric tensor and is (as a matrix) equal to  $\text{diag}(1,-1,-1,\dots)$  or  $\text{diag}(-1,1,1,\dots)$ .

## 6.90.2 Constructor & Destructor Documentation

### 6.90.2.1 `minkmetric()`

```
GiNaC::minkmetric::minkmetric (
 bool pos_sig)
```

Construct Lorentz metric tensor with given signature.

References [minkmetric\(\)](#), and [pos\\_sig](#).

Referenced by [minkmetric\(\)](#).

## 6.90.3 Member Function Documentation

### 6.90.3.1 `info()`

```
bool GiNaC::minkmetric::info (
 unsigned inf) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info\\_flags::real](#).

### 6.90.3.2 eval\_indexed()

```
ex GiNaC::minkmetric::eval_indexed (
 const basic & i) const [override], [virtual]
```

Automatic symbolic evaluation of an indexed Lorentz metric tensor.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [GiNaC::\\_ex\\_1](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::idx::get\\_value\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::basic::nops\(\)](#), [GiNaC::basic::op\(\)](#), and [pos\\_sig](#).

### 6.90.3.3 archive()

```
void GiNaC::minkmetric::archive (
 archive_node & n) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::add\\_bool\(\)](#), and [pos\\_sig](#).

### 6.90.3.4 read\_archive()

```
void GiNaC::minkmetric::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::find\\_bool\(\)](#), and [pos\\_sig](#).

### 6.90.3.5 return\_type()

```
unsigned GiNaC::minkmetric::return_type () const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::commutative](#).

### 6.90.3.6 do\_print()

```
void GiNaC::minkmetric::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

### 6.90.3.7 do\_print\_latex()

```
void GiNaC::minkmetric::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

## 6.90.4 Member Data Documentation

### 6.90.4.1 pos\_sig

```
bool GiNaC::minkmetric::pos_sig [private]
```

If true, the metric is  $\text{diag}(-1, 1, 1, \dots)$ .

Otherwise it is  $\text{diag}(1, -1, -1, \dots)$ .

Referenced by [archive\(\)](#), [eval\\_indexed\(\)](#), [minkmetric\(\)](#), and [read\\_archive\(\)](#).

The documentation for this class was generated from the following files:

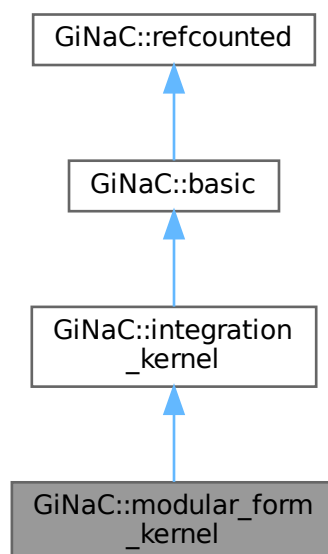
- [tensor.h](#)
- [tensor.cpp](#)

## 6.91 GiNaC::modular\_form\_kernel Class Reference

A kernel corresponding to a polynomial in Eisenstein series.

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::modular\_form\_kernel:



Collaboration diagram for GiNaC::modular\_form\_kernel:



## Public Member Functions

- `modular_form_kernel` (const `ex` &`k`, const `ex` &`P`, const `ex` &`C_norm=numeric(1)`)
- `ex series` (const `relational` &`r`, int order, unsigned options=0) const override  
The series method for this class returns the `qbar`-expansion of the modular form, without an additional factor of `C_norm/qbar`.
- `size_t nops` () const override  
Number of operands/members.
- `ex op` (size\_t `i`) const override  
Return operand/member at position `i`.
- `ex & let_op` (size\_t `i`) override  
Return modifiable operand/member at position `i`.
- `bool is_numeric` (void) const override  
This routine returns true, if the integration kernel can be evaluated numerically.
- `ex Laurent_series` (const `ex` &`qbar`, int order) const override  
Returns the Laurent series, starting possibly with the pole term.
- `ex get_numerical_value` (const `ex` &`qbar`, int `N_trunc=0`) const override  
Returns the value of the modular form.
- `ex q_expansion_modular_form` (const `ex` &`q`, int order) const

## Public Member Functions inherited from [GiNaC::integration\\_kernel](#)

- virtual bool [has\\_trailing\\_zero](#) (void) const  
*This routine returns true, if the integration kernel has a trailing zero.*
- size\_t [get\\_cache\\_size](#) (void) const  
*Returns the current size of the cache.*
- void [set\\_cache\\_step](#) (int cache\_steps) const  
*Sets the step size by which the cache is increased.*
- [ex](#) [get\\_series\\_coeff](#) (int i) const  
*Wrapper around series\_coeff(i), converts cl\_N to numeric.*
- cln::cl\_N [series\\_coeff](#) (int i) const  
*Subclasses have either to implement series\_coeff\_impl or the two methods Laurent\_series and uses\_Laurent\_series.*

## Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual [basic](#) \* [duplicate](#) () const  
*Create a clone of this object on the heap.*
- virtual [ex](#) [eval](#) () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual [ex](#) [evalf](#) () const  
*Evaluate object numerically.*
- virtual [ex](#) [evalm](#) () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual [ex](#) [eval\\_integ](#) () const  
*Evaluate integrals, if result is known.*
- virtual [ex](#) [eval\\_indexed](#) (const [basic](#) &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void [print](#) (const [print\\_context](#) &c, unsigned level=0) const  
*Output to stream.*
- virtual void [dbgprint](#) () const  
*Little wrapper around print to be called within a debugger.*
- virtual void [dbgprinttree](#) () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned [precedence](#) () const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool [info](#) (unsigned inf) const  
*Information about the object.*
- virtual [ex](#) [operator\[\]](#) (const [ex](#) &index) const
- virtual [ex](#) [operator\[\]](#) (size\_t i) const
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size\_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const  
*Check whether the expression matches a given pattern.*
- virtual [ex](#) [subs](#) (const [exmap](#) &m, unsigned options=0) const

- virtual `ex map` (`map_function` &f) const  
*Substitute a set of objects by arbitrary expressions.*
- virtual void `accept` (GiNaC::visitor &v) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual bool `is_polynomial` (const `ex` &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const  
*Return degree of highest power in object s.*
- virtual int `ldegree` (const `ex` &s) const  
*Return degree of lowest power in object s.*
- virtual `ex coeff` (const `ex` &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual `ex expand` (unsigned options=0) const  
*Expand expression, i.e.*
- virtual `ex collect` (const `ex` &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex normal` (exmap &repl, exmap &rev\_lookup, lst &modifier) const  
*Default implementation of `ex::normal()`.*
- virtual `ex to_rational` (exmap &repl) const  
*Default implementation of `ex::to_rational()`.*
- virtual `ex to_polynomial` (exmap &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const  
*Implementation `ex::max_coefficient()`.*
- virtual `exvector get_free_indices` () const  
*Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T>  
void `print_dispatch` (const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- virtual void `archive` (`archive_node` &n) const  
*Save (serialize) the object into archive node.*
- virtual void `read_archive` (const `archive_node` &n, lst &syms)  
*Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const exmap &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const

*Default interface of nth derivative `ex::diff(s, n)`.*

- int `compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- const `basic` & `hold` () const  
*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const  
*Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- bool `uses_Laurent_series` () const override  
*Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).*
- void `do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::integration_kernel`

- virtual `cln::cl_N series_coeff_impl` (int i) const  
*For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.*
- `ex get_numerical_value_impl` (const `ex` &lambda, const `ex` &pre, int shift, int N\_trunc) const  
*The actual implementation for computing a numerical value for the integrand.*
- void `do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual `ex derivative` (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned `calchash` () const



- Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.
- void [ensure\\_if\\_modifiable](#) () const  
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
Default output to stream.
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
Tree output to stream.
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
Python parsable output to stream.

### Protected Attributes

- [ex](#) k
- [ex](#) P
- [ex](#) C\_norm

### Protected Attributes inherited from [GiNaC::integration\\_kernel](#)

- int [cache\\_step\\_size](#)
- std::vector< cln::cl\_N > [series\\_vec](#)

### Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
of type [status\\_flags](#)
- unsigned [hashvalue](#)  
hash value

## 6.91.1 Detailed Description

A kernel corresponding to a polynomial in Eisenstein series.

This class represents the differential one-form

$$\omega^{\text{modular}}(P_k(\eta_{k_1}^{(1)}, \dots, \eta_{k_r}^{(r)})) = C_k P_k(\eta_{k_1}^{(1)}, \dots, \eta_{k_r}^{(r)}) \frac{d\bar{q}_N}{\bar{q}_N}.$$

## 6.91.2 Constructor & Destructor Documentation

### 6.91.2.1 modular\_form\_kernel()

```
GiNaC::modular_form_kernel::modular_form_kernel (
 const ex & k,
 const ex & P,
 const ex & C_norm = numeric(1))
```

References [C\\_norm](#), [k](#), [modular\\_form\\_kernel\(\)](#), and [P](#).

Referenced by [modular\\_form\\_kernel\(\)](#).

### 6.91.3 Member Function Documentation

#### 6.91.3.1 `series()`

```
ex GiNaC::modular_form_kernel::series (
 const relational & r,
 int order,
 unsigned options = 0) const [override], [virtual]
```

The `series` method for this class returns the  $q$ -bar-expansion of the modular form, without an additional factor of  $C\_norm/qbar$ .

Reimplemented from [GiNaC::integration\\_kernel](#).

References [GiNaC::relational::lhs\(\)](#), [P](#), [GiNaC::pow\(\)](#), [GiNaC::relational::rhs\(\)](#), and [GiNaC::ex::series\(\)](#).

Referenced by [q\\_expansion\\_modular\\_form\(\)](#).

#### 6.91.3.2 `nops()`

```
size_t GiNaC::modular_form_kernel::nops () const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

#### 6.91.3.3 `op()`

```
ex GiNaC::modular_form_kernel::op (
 size_t i) const [override], [virtual]
```

Return operand/member at position  $i$ .

Reimplemented from [GiNaC::basic](#).

References [C\\_norm](#), [k](#), and [P](#).

#### 6.91.3.4 `let_op()`

```
ex & GiNaC::modular_form_kernel::let_op (
 size_t i) [override], [virtual]
```

Return modifiable operand/member at position  $i$ .

Reimplemented from [GiNaC::basic](#).

References [C\\_norm](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [k](#), and [P](#).

### 6.91.3.5 is\_numeric()

```
bool GiNaC::modular_form_kernel::is_numeric (
 void) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration\\_kernel](#).

References [C\\_norm](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::ex::info\(\)](#), [k](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::info\\_flags::numeric](#), [q\\_expansion\\_modular\\_form\(\)](#), [GiNaC::series\\_to\\_poly\(\)](#), and [GiNaC::ex::subs\(\)](#).

### 6.91.3.6 Laurent\_series()

```
ex GiNaC::modular_form_kernel::Laurent_series (
 const ex & x,
 int order) const [override], [virtual]
```

Returns the Laurent series, starting possibly with the pole term.

Neglected terms are of order  $O(x^{order})$ .

Reimplemented from [GiNaC::integration\\_kernel](#).

References [C\\_norm](#), [q\\_expansion\\_modular\\_form\(\)](#), [GiNaC::ex::series\(\)](#), and [GiNaC::series\\_to\\_poly\(\)](#).

### 6.91.3.7 get\_numerical\_value()

```
ex GiNaC::modular_form_kernel::get_numerical_value (
 const ex & qbar,
 int N_trunc = 0) const [override], [virtual]
```

Returns the value of the modular form.

Reimplemented from [GiNaC::integration\\_kernel](#).

References [C\\_norm](#), and [GiNaC::integration\\_kernel::get\\_numerical\\_value\\_impl\(\)](#).

### 6.91.3.8 uses\_Laurent\_series()

```
bool GiNaC::modular_form_kernel::uses_Laurent_series () const [override], [protected], [virtual]
```

Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).

Returns false if this is not the case (and the class has an implementation of `series_coeff_impl`).

Reimplemented from [GiNaC::integration\\_kernel](#).

### 6.91.3.9 q\_expansion\_modular\_form()

```
ex GiNaC::modular_form_kernel::q_expansion_modular_form (
 const ex & q,
 int order) const
```

References [series\(\)](#).

Referenced by [is\\_numeric\(\)](#), and [Laurent\\_series\(\)](#).

### 6.91.3.10 do\_print()

```
void GiNaC::modular_form_kernel::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [C\\_norm](#), [k](#), [P](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.91.4 Member Data Documentation

### 6.91.4.1 k

```
ex GiNaC::modular_form_kernel::k [protected]
```

Referenced by [do\\_print\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [modular\\_form\\_kernel\(\)](#), and [op\(\)](#).

### 6.91.4.2 P

```
ex GiNaC::modular_form_kernel::P [protected]
```

Referenced by [do\\_print\(\)](#), [let\\_op\(\)](#), [modular\\_form\\_kernel\(\)](#), [op\(\)](#), and [series\(\)](#).

### 6.91.4.3 C\_norm

```
ex GiNaC::modular_form_kernel::C_norm [protected]
```

Referenced by [do\\_print\(\)](#), [get\\_numerical\\_value\(\)](#), [is\\_numeric\(\)](#), [Laurent\\_series\(\)](#), [let\\_op\(\)](#), [modular\\_form\\_kernel\(\)](#), and [op\(\)](#).

The documentation for this class was generated from the following files:

- [integration\\_kernel.h](#)
- [integration\\_kernel.cpp](#)

## 6.92 GiNaC::basic\_partition\_generator::mpartition2 Struct Reference

```
#include <utils.h>
```

### Public Member Functions

- [mpartition2](#) (unsigned n\_, unsigned m\_)
- bool [next\\_partition](#) ()

### Public Attributes

- std::vector< unsigned > [x](#)
- unsigned [n](#)
- unsigned [m](#)

### 6.92.1 Constructor & Destructor Documentation

#### 6.92.1.1 mpartition2()

```
GiNaC::basic_partition_generator::mpartition2::mpartition2 (
 unsigned n_,
 unsigned m_) [inline]
```

References [m](#), [n](#), and [x](#).

### 6.92.2 Member Function Documentation

#### 6.92.2.1 next\_partition()

```
bool GiNaC::basic_partition_generator::mpartition2::next_partition () [inline]
```

References [m](#), and [x](#).

### 6.92.3 Member Data Documentation

#### 6.92.3.1 x

```
std::vector<unsigned> GiNaC::basic_partition_generator::mpartition2::x
```

Referenced by [mpartition2\(\)](#), and [next\\_partition\(\)](#).

#### 6.92.3.2 n

```
unsigned GiNaC::basic_partition_generator::mpartition2::n
```

Referenced by [mpartition2\(\)](#).

### 6.92.3.3 m

unsigned GiNaC::basic\_partition\_generator::mpartition2::m

Referenced by [mpartition2\(\)](#), and [next\\_partition\(\)](#).

The documentation for this struct was generated from the following file:

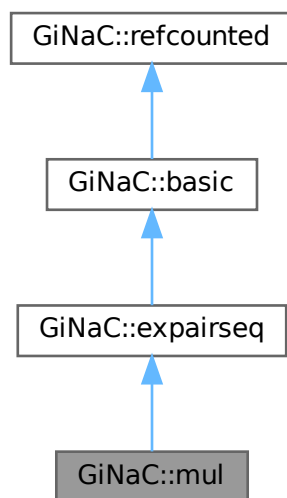
- [utils.h](#)

## 6.93 GiNaC::mul Class Reference

Product of expressions.

```
#include <mul.h>
```

Inheritance diagram for GiNaC::mul:



Collaboration diagram for GiNaC::mul:



## Public Member Functions

- `mul` (const `ex` &lh, const `ex` &rh)
- `mul` (const `exvector` &v)
- `mul` (const `epvector` &v)
- `mul` (const `epvector` &v, const `ex` &oc, bool do\_index\_renaming=false)
- `mul` (`epvector` &&vp)
- `mul` (`epvector` &&vp, const `ex` &oc, bool do\_index\_renaming=false)
- `mul` (const `ex` &lh, const `ex` &mh, const `ex` &rh)
- unsigned `precedence` () const override  
*Return relative operator precedence (for parenthezing output).*
- bool `info` (unsigned inf) const override  
*Information about the object.*
- bool `is_polynomial` (const `ex` &var) const override  
*Check whether this is a polynomial in the given variables.*
- int `degree` (const `ex` &s) const override

- *Return degree of highest power in object s.*
- `int ldegree` (const `ex` &s) const override
- *Return degree of lowest power in object s.*
- `ex coeff` (const `ex` &s, int n=1) const override
- *Return coefficient of degree n in object s.*
- `bool has` (const `ex` &other, unsigned options=0) const override
- *Test for occurrence of a pattern.*
- `ex eval` () const override
- *Perform automatic term rewriting rules in this class.*
- `ex evalf` () const override
- *Evaluate object numerically.*
- `ex real_part` () const override
- `ex imag_part` () const override
- `ex evalm` () const override
- *Evaluate sums, products and integer powers of matrices.*
- `ex series` (const `relational` &s, int order, unsigned options=0) const override
- *Implementation of `ex::series()` for product.*
- `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const override
- *Implementation of `ex::normal()` for a product.*
- `numeric integer_content` () const override
- `ex smod` (const `numeric` &xi) const override
- *Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- `numeric max_coefficient` () const override
- *Implementation `ex::max_coefficient()`.*
- `exvector get_free_indices` () const override
- *Return a vector containing the free indices of an expression.*
- `ex conjugate` () const override
- `ex algebraic_subs_mul` (const `exmap` &m, unsigned options) const

## Public Member Functions inherited from `GiNaC::expairseq`

- `expairseq` (const `ex` &lh, const `ex` &rh)
- `expairseq` (const `exvector` &v)
- `expairseq` (const `epvector` &v, const `ex` &oc, bool do\_index\_renaming=false)
- `expairseq` (`epvector` &&vp, const `ex` &oc, bool do\_index\_renaming=false)
- `size_t nops` () const override
- *Number of operands/members.*
- `ex op` (size\_t i) const override
- *Return operand/member at position i.*
- `ex map` (`map_function` &f) const override
- *Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- `ex to_rational` (`exmap` &repl) const override
- *Implementation of `ex::to_rational()` for expairseqs.*
- `ex to_polynomial` (`exmap` &repl) const override
- *Implementation of `ex::to_polynomial()` for expairseqs.*
- `bool match` (const `ex` &pattern, `exmap` &repl\_lst) const override
- *Check whether the expression matches a given pattern.*
- `ex subs` (const `exmap` &m, unsigned options=0) const override
- *Substitute a set of objects by arbitrary expressions.*
- `void archive` (`archive_node` &n) const override
- *Save (serialize) the object into archive node.*
- `void read_archive` (const `archive_node` &n, `lst` &syms) override
- *Load (deserialize) the object from an archive node.*



## Public Member Functions inherited from GiNaC::basic

- virtual `~basic` ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic` \* `duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree` () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex` & `let_op` (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual `ex` & `operator[]` (const `ex` &index)
- virtual `ex` & `operator[]` (size\_t i)
- virtual void `accept` (GiNaC::visitor &v) const
- virtual `ex collect` (const `ex` &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- template<class T>  
void `print_dispatch` (const `print_context` &c, unsigned level) const  
*Like print(), but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like print(), but dispatch to the specified class.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for subs().*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative ex::diff(s, n).*
- int `compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- const `basic` & `hold` () const  
*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const  
*Set some status\_flags.*
- const `basic` & `clearflag` (unsigned f) const  
*Clear some status\_flags.*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Member Functions

- [ex derivative](#) (const [symbol](#) &s) const override  
*Implementation of [ex::diff\(\)](#) for a product.*
- [ex eval\\_ncmul](#) (const [exvector](#) &v) const override
- unsigned [return\\_type](#) () const override
- [return\\_type\\_t return\\_type\\_tinfo](#) () const override
- [ex thisexpairseq](#) (const [epvector](#) &v, const [ex](#) &oc, bool do\_index\_renaming=false) const override  
*Create an object of this type.*
- [ex thisexpairseq](#) ([epvector](#) &&vp, const [ex](#) &oc, bool do\_index\_renaming=false) const override
- [expair split\\_ex\\_to\\_pair](#) (const [ex](#) &e) const override  
*Form an expair from an ex, using the corresponding semantics.*
- [expair combine\\_ex\\_with\\_coeff\\_to\\_pair](#) (const [ex](#) &e, const [ex](#) &c) const override
- [expair combine\\_pair\\_with\\_coeff\\_to\\_pair](#) (const [expair](#) &p, const [ex](#) &c) const override
- [ex recombine\\_pair\\_to\\_ex](#) (const [expair](#) &p) const override  
*Form an ex out of an expair, using the corresponding semantics.*
- bool [expair\\_needs\\_further\\_processing](#) ([ep](#) it) override
- [ex default\\_overall\\_coeff](#) () const override
- void [combine\\_overall\\_coeff](#) (const [ex](#) &c) override
- void [combine\\_overall\\_coeff](#) (const [ex](#) &c1, const [ex](#) &c2) override
- bool [can\\_make\\_flat](#) (const [expair](#) &p) const override
- [ex expand](#) (unsigned options=0) const override  
*Expand expression, i.e.*
- void [find\\_real\\_imag](#) ([ex](#) &, [ex](#) &) const
- void [print\\_overall\\_coeff](#) (const [print\\_context](#) &c, const char \*mul\_sym) const
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_latex](#) (const [print\\_latex](#) &c, unsigned level) const
- void [do\\_print\\_csrc](#) (const [print\\_csrc](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const
- [epvector expandchildren](#) (unsigned options) const  
*Member-wise expand the expairs representing this sequence.*

## Protected Member Functions inherited from [GiNaC::expairseq](#)

- bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if two objects of same type are equal.*
- unsigned [calchash](#) () const override  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- virtual void [printseq](#) (const [print\\_context](#) &c, char delim, unsigned this\_precedence, unsigned upper\_precedence) const
- virtual void [printpair](#) (const [print\\_context](#) &c, const [expair](#) &p, unsigned upper\_precedence) const
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const
- void [construct\\_from\\_2\\_ex](#) (const [ex](#) &lh, const [ex](#) &rh)

- void [construct\\_from\\_2\\_expireseq](#) (const [expireseq](#) &s1, const [expireseq](#) &s2)
- void [construct\\_from\\_expireseq\\_ex](#) (const [expireseq](#) &s, const [ex](#) &e)
- void [construct\\_from\\_exvector](#) (const [exvector](#) &v)
- void [construct\\_from\\_epvector](#) (const [epvector](#) &v, bool do\_index\_renaming=false)
- void [construct\\_from\\_epvector](#) ([epvector](#) &&v, bool do\_index\_renaming=false)
- void [make\\_flat](#) (const [exvector](#) &v)  
Combine this [expireseq](#) with argument [exvector](#).
- void [make\\_flat](#) (const [epvector](#) &v, bool do\_index\_renaming=false)  
Combine this [expireseq](#) with argument [epvector](#).
- void [canonicalize](#) ()  
Brings this [expireseq](#) into a sorted (canonical) form.
- void [combine\\_same\\_terms\\_sorted\\_seq](#) ()  
Compact a presorted [expireseq](#) by combining all matching [expires](#) to one each.
- bool [is\\_canonical](#) () const  
Check if this [expireseq](#) is in sorted (canonical) form.
- [epvector](#) [expandchildren](#) (unsigned options) const  
Member-wise expand the [expires](#) in this sequence.
- [epvector](#) [evalchildren](#) () const  
Member-wise evaluate the [expires](#) in this sequence.
- [epvector](#) [subschildren](#) (const [exmap](#) &m, unsigned options=0) const  
Member-wise substitute in this sequence.

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
Returns true if the attributes of two objects are similar enough for a match.
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
Returns order relation between two objects of same type.
- void [ensure\\_if\\_modifiable](#) () const  
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
Default output to stream.
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
Tree output to stream.
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
Python parsable output to stream.

## Static Protected Member Functions

- static bool [can\\_be\\_further\\_expanded](#) (const [ex](#) &e)

## Friends

- class [add](#)
- class [ncmul](#)
- class [power](#)

## Additional Inherited Members

### Protected Attributes inherited from [GiNaC::expairseq](#)

- [epvector seq](#)
- [ex overall\\_coeff](#)

### Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
of type [status\\_flags](#)
- unsigned [hashvalue](#)  
hash value

## 6.93.1 Detailed Description

Product of expressions.

## 6.93.2 Constructor & Destructor Documentation

### 6.93.2.1 [mul\(\)](#) [1/7]

```
GiNaC::mul::mul (
 const ex & lh,
 const ex & rh)
```

References [GiNaC::\\_ex1](#), [GiNaC::expairseq::construct\\_from\\_2\\_ex\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::expairseq::is\\_canonical\(\)](#), and [GiNaC::expairseq::overall\\_coeff](#).

Referenced by [do\\_print\\_latex\(\)](#), [expand\(\)](#), [power](#), and [smod\(\)](#).

### 6.93.2.2 [mul\(\)](#) [2/7]

```
GiNaC::mul::mul (
 const exvector & v)
```

References [GiNaC::\\_ex1](#), [GiNaC::expairseq::construct\\_from\\_exvector\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::expairseq::is\\_canonical\(\)](#), and [GiNaC::expairseq::overall\\_coeff](#).

### 6.93.2.3 [mul\(\)](#) [3/7]

```
GiNaC::mul::mul (
 const epvector & v)
```

References [GiNaC::\\_ex1](#), [GiNaC::expairseq::construct\\_from\\_epvector\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::expairseq::is\\_canonical\(\)](#), and [GiNaC::expairseq::overall\\_coeff](#).

**6.93.2.4 mul()** [4/7]

```
GiNaC::mul::mul (
 const epvector & v,
 const ex & oc,
 bool do_index_renaming = false)
```

References [GiNaC::expairseq::construct\\_from\\_epvector\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::expairseq::is\\_canonical\(\)](#), and [GiNaC::expairseq::overall\\_coeff](#).

**6.93.2.5 mul()** [5/7]

```
GiNaC::mul::mul (
 epvector && vp)
```

References [GiNaC::\\_ex1](#), [GiNaC::expairseq::construct\\_from\\_epvector\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::expairseq::is\\_canonical\(\)](#), and [GiNaC::expairseq::overall\\_coeff](#).

**6.93.2.6 mul()** [6/7]

```
GiNaC::mul::mul (
 epvector && vp,
 const ex & oc,
 bool do_index_renaming = false)
```

References [GiNaC::expairseq::construct\\_from\\_epvector\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::expairseq::is\\_canonical\(\)](#), and [GiNaC::expairseq::overall\\_coeff](#).

**6.93.2.7 mul()** [7/7]

```
GiNaC::mul::mul (
 const ex & lh,
 const ex & mh,
 const ex & rh)
```

References [GiNaC::\\_ex1](#), [GiNaC::expairseq::construct\\_from\\_exvector\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::expairseq::is\\_canonical\(\)](#), and [GiNaC::expairseq::overall\\_coeff](#).

**6.93.3 Member Function Documentation****6.93.3.1 precedence()**

```
unsigned GiNaC::mul::precedence () const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::expairseq](#).

References [precedence\(\)](#).

Referenced by [do\\_print\(\)](#), [do\\_print\\_csrc\(\)](#), [do\\_print\\_latex\(\)](#), [precedence\(\)](#), and [print\\_overall\\_coeff\(\)](#).

### 6.93.3.2 info()

```
bool GiNaC::mul::info (
 unsigned int) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::\\_num1\\_p](#), [GiNaC::info\\_flags::integer](#), [GiNaC::info\\_flags::integer\\_polynomial](#), [GiNaC::info\\_flags::crational](#), [GiNaC::info\\_flags::crational\\_polynomial](#), [GiNaC::info\\_flags::even](#), [GiNaC::factor\(\)](#), [GiNaC::basic::flags](#), [GiNaC::info\\_flags::indefinite](#), [GiNaC::ex::info\(\)](#), [info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::info\\_flags::integer\\_polynomial](#), [GiNaC::status\\_flags::is\\_negative](#), [GiNaC::status\\_flags::is\\_positive](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::negint](#), [GiNaC::info\\_flags::nonnegative](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::expairseq::overall\\_coeff](#), [GiNaC::info\\_flags::polynomial](#), [GiNaC::info\\_flags::posint](#), [GiNaC::info\\_flags::positive](#), [GiNaC::status\\_flags::purely\\_indefinite](#), [GiNaC::info\\_flags::rational](#), [GiNaC::info\\_flags::rational\\_function](#), [GiNaC::info\\_flags::rational\\_polynomial](#), [GiNaC::info\\_flags::real](#), [recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::expairseq::seq](#), and [GiNaC::basic::setflag\(\)](#).

Referenced by [expand\(\)](#), [GiNaC::power::expand\\_mul\(\)](#), and [info\(\)](#).

### 6.93.3.3 is\_polynomial()

```
bool GiNaC::mul::is_polynomial (
 const ex & var) const [override], [virtual]
```

Check whether this is a polynomial in the given variables.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info\\_flags::nonnegint](#), and [GiNaC::expairseq::seq](#).

### 6.93.3.4 degree()

```
int GiNaC::mul::degree (
 const ex & s) const [override], [virtual]
```

Return degree of highest power in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::degree\(\)](#), [GiNaC::ex\\_to\(\)](#), [recombine\\_pair\\_to\\_ex\(\)](#), and [GiNaC::expairseq::seq](#).

### 6.93.3.5 ldegree()

```
int GiNaC::mul::ldegree (
 const ex & s) const [override], [virtual]
```

Return degree of lowest power in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex\\_to\(\)](#), [GiNaC::ex::ldegree\(\)](#), [recombine\\_pair\\_to\\_ex\(\)](#), and [GiNaC::expairseq::seq](#).

### 6.93.3.6 coeff()

```
ex GiNaC::mul::coeff (
 const ex & s,
 int n = 1) const [override], [virtual]
```

Return coefficient of degree n in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::ex::coeff\(\)](#), [coeff\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), and [GiNaC::expairseq::seq](#).

Referenced by [coeff\(\)](#), and [print\\_overall\\_coeff\(\)](#).

### 6.93.3.7 has()

```
bool GiNaC::mul::has (
 const ex & pattern,
 unsigned options = 0) const [override], [virtual]
```

Test for occurrence of a pattern.

An object 'has' a pattern if it matches the pattern itself or one of the children 'has' it. As a consequence (according to the definition of children) given  $e=x+y+z$ ,  $e.has(x)$  is true but  $e.has(x+y)$  is false.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::has\\_options::algebraic](#), [GiNaC::algebraic\\_match\\_mul\\_with\\_mul\(\)](#), [GiNaC::basic::has\(\)](#), [GiNaC::is\\_a\(\)](#), and [GiNaC::expairseq::nops\(\)](#).

### 6.93.3.8 eval()

```
ex GiNaC::mul::eval () const [override], [virtual]
```

Perform automatic term rewriting rules in this class.

In the following  $x$ ,  $x_1$ ,  $x_2$ ,... stand for a symbolic variables of type `ex` and  $c$ ,  $c_1$ ,  $c_2$ ... stand for such expressions that contain a plain number.

- $(...,x;0) \rightarrow 0$
- $*(+(x_1,x_2,...);c) \rightarrow *(+(* (x_1,c),(x_2,c),...))$
- $*(x;1) \rightarrow x$
- $*(;c) \rightarrow c$

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [GiNaC::\\_num1\\_p](#), [GiNaC::\\_num\\_1\\_p](#), [add](#), [GiNaC::basic::clearflag\(\)](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::add::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::numeric::div\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::expairseq::evalchildren\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::basic::flags](#), [GINAC\\_ASSERT](#), [GiNaC::status\\_flags::hash\\_calculated](#), [GiNaC::basic::hold\(\)](#), [GiNaC::numeric::integer\\_content](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::is\\_pos\\_integer\(\)](#), [likely](#), [GiNaC::numeric::mul\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::expairseq::seq](#), and [unlikely](#).

### 6.93.3.9 evalf()

```
ex GiNaC::mul::evalf () const [override], [virtual]
```

Evaluate object numerically.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::dynallocate\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), and [GiNaC::expairseq::seq](#).

### 6.93.3.10 real\_part()

```
ex GiNaC::mul::real_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [find\\_real\\_imag\(\)](#).

### 6.93.3.11 imag\_part()

```
ex GiNaC::mul::imag_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [find\\_real\\_imag\(\)](#).

### 6.93.3.12 evalm()

```
ex GiNaC::mul::evalm () const [override], [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [GiNaC::dynallocate\(\)](#), [GiNaC::ex::evalm\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::matrix::mul\\_scalar\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::expairseq::seq](#), and [split\\_ex\\_to\\_pair\(\)](#).

### 6.93.3.13 series()

```
ex GiNaC::mul::series (
 const relational & r,
 int order,
 unsigned options = 0) const [override], [virtual]
```

Implementation of [ex::series\(\)](#) for product.

This performs series multiplication when multiplying series.

See also

[ex::series](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::factor\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::is\\_a\(\)](#), [GiNaC::ex::lddegree\(\)](#), [GiNaC::relational::lhs\(\)](#), [GiNaC::pseries::mul\\_const\(\)](#), [GiNaC::pseries::mul\\_series\(\)](#), [GiNaC::expairseq::op\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::relational::rhs\(\)](#), [GiNaC::expairseq::seq](#), and [GiNaC::ex::series\(\)](#).



### 6.93.3.14 normal()

```
ex GiNaC::mul::normal (
 exmap & repl,
 exmap & rev_lookup,
 lst & modifier) const [override], [virtual]
```

Implementation of [ex::normal\(\)](#) for a product.

It cancels common factors from fractions.

See also

[ex::normal\(\)](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::dynallocate\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::frac\\_cancel\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::ex::normal\(\)](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), and [GiNaC::expairseq::seq](#).

### 6.93.3.15 integer\_content()

```
numeric GiNaC::mul::integer_content () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::abs\(\)](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), and [GiNaC::expairseq::seq](#).

### 6.93.3.16 smod()

```
ex GiNaC::mul::smod (
 const numeric & xi) const [override], [virtual]
```

Apply symmetric modular homomorphism to an expanded multivariate polynomial.

This function is usually used internally by [heur\\_gcd\(\)](#).

Parameters

|      |         |
|------|---------|
| $xi$ | modulus |
|------|---------|

Returns

mapped polynomial

See also

[heur\\_gcd](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::clearflag\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::status\\_flags::hash\\_calculated](#), [GiNaC::is\\_exactly\\_a\(\)](#), [mul\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::expairseq::seq](#), and [GiNaC::smod\(\)](#).

**6.93.3.17 max\_coefficient()**

```
numeric GiNaC::mul::max_coefficient () const [override], [virtual]
```

Implementation [ex::max\\_coefficient\(\)](#).

See also

[heur\\_gcd](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::abs\(\)](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), and [GiNaC::expairseq::seq](#).

**6.93.3.18 get\_free\_indices()**

```
exvector GiNaC::mul::get_free_indices () const [override], [virtual]
```

Return a vector containing the free indices of an expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::find\\_free\\_and\\_dummy\(\)](#), [GiNaC::ex::get\\_free\\_indices\(\)](#), [GiNaC::expairseq::nops\(\)](#), and [GiNaC::expairseq::op\(\)](#).

**6.93.3.19 conjugate()**

```
ex GiNaC::mul::conjugate () const [override], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::expairseq::seq](#), [split\\_ex\\_to\\_pair\(\)](#), and [thisexpairseq\(\)](#).

**6.93.3.20 derivative()**

```
ex GiNaC::mul::derivative (
 const symbol & s) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for a product.

It applies the product rule.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [GiNaC::basic::diff\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [GiNaC::pow\(\)](#), [GiNaC::expairseq::seq](#), [split\\_ex\\_to\\_pair\(\)](#), and [GiNaC::expair::swap\(\)](#).

**6.93.3.21 eval\_ncmul()**

```
ex GiNaC::mul::eval_ncmul (
 const exvector & v) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::noncommutative](#), and [GiNaC::expairseq::seq](#).

**6.93.3.22 return\_type()**

```
unsigned GiNaC::mul::return_type () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::return\\_types::commutative](#), [GiNaC::return\\_types::noncommutative](#), [GiNaC::return\\_types::noncommutative\\_com](#) and [GiNaC::expairseq::seq](#).

**6.93.3.23 return\_type\_tinfo()**

```
return_type_t GiNaC::mul::return_type_tinfo () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::make\\_return\\_type\\_t\(\)](#), [GiNaC::return\\_types::noncommutative](#), and [GiNaC::expairseq::seq](#).

**6.93.3.24 thisexpairseq() [1/2]**

```
ex GiNaC::mul::thisexpairseq (
 const epvector & v,
 const ex & oc,
 bool do_index_renaming = false) const [override], [protected], [virtual]
```

Create an object of this type.

This method works similar to a constructor. It is useful because expairseq has (at least) two possible different semantics but we want to inherit methods thus avoiding code duplication. Sometimes a method in expairseq has to create a new one of the same semantics, which cannot be done by a ctor because the name (add, mul,...) is unknown on the expairseq level. In order for this trick to work a derived class must of course override this definition.

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::dynallocate\(\)](#).

Referenced by [conjugate\(\)](#).

**6.93.3.25 thisexpairseq() [2/2]**

```
ex GiNaC::mul::thisexpairseq (
 epvector && vp,
 const ex & oc,
 bool do_index_renaming = false) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::dynallocate\(\)](#).

### 6.93.3.26 split\_ex\_to\_pair()

```
expair GiNaC::mul::split_ex_to_pair (
 const ex & e) const [override], [protected], [virtual]
```

Form an expair from an ex, using the corresponding semantics.

See also

[expairseq::recombine\\_pair\\_to\\_ex\(\)](#)

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::\\_ex1](#), [GiNaC::power::basis](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::power::exponent](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [power](#).

Referenced by [combine\\_ex\\_with\\_coeff\\_to\\_pair\(\)](#), [combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [conjugate\(\)](#), [derivative\(\)](#), [evalm\(\)](#), [expair\\_needs\\_further\\_processing\(\)](#), [expand\(\)](#), and [expandchildren\(\)](#).

### 6.93.3.27 combine\_ex\_with\_coeff\_to\_pair()

```
expair GiNaC::mul::combine_ex_with_coeff_to_pair (
 const ex & e,
 const ex & c) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::\\_ex1](#), [GINAC\\_ASSERT](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::pow\(\)](#), and [split\\_ex\\_to\\_pair\(\)](#).

### 6.93.3.28 combine\_pair\_with\_coeff\_to\_pair()

```
expair GiNaC::mul::combine_pair_with_coeff_to_pair (
 const expair & p,
 const ex & c) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::\\_ex1](#), [GiNaC::expair::coeff](#), [GINAC\\_ASSERT](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::pow\(\)](#), [recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::expair::rest](#), and [split\\_ex\\_to\\_pair\(\)](#).

Referenced by [GiNaC::power::expand\\_mul\(\)](#).

### 6.93.3.29 recombine\_pair\_to\_ex()

```
ex GiNaC::mul::recombine_pair_to_ex (
 const expair & p) const [override], [protected], [virtual]
```

Form an ex out of an expair, using the corresponding semantics.

See also

[expairseq::split\\_ex\\_to\\_pair\(\)](#)

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::\\_ex1](#), [GiNaC::expair::coeff](#), [GiNaC::dynallocate\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), and [GiNaC::expair::rest](#).

Referenced by [coeff\(\)](#), [combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [conjugate\(\)](#), [degree\(\)](#), [do\\_print\(\)](#), [do\\_print\\_latex\(\)](#), [eval\(\)](#), [evalm\(\)](#), [expair\\_needs\\_further\\_processing\(\)](#), [GiNaC::power::expand\(\)](#), [expandchildren\(\)](#), [find\\_real\\_imag\(\)](#), [info\(\)](#), [integer\\_content\(\)](#), [ldegree\(\)](#), [max\\_coefficient\(\)](#), [normal\(\)](#), [series\(\)](#), and [smod\(\)](#).

**6.93.3.30 `expair_needs_further_processing()`**

```
bool GiNaC::mul::expair_needs_further_processing (
 exp it) [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::\\_ex1](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::expair::is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [recombine\\_pair\\_to\\_ex\(\)](#), and [split\\_ex\\_to\\_pair\(\)](#).

**6.93.3.31 `default_overall_coeff()`**

```
ex GiNaC::mul::default_overall_coeff () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::\\_ex1](#).

**6.93.3.32 `combine_overall_coeff()` [1/2]**

```
void GiNaC::mul::combine_overall_coeff (
 const ex & c) [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [GiNaC::expairseq::overall\\_coeff](#).

**6.93.3.33 `combine_overall_coeff()` [2/2]**

```
void GiNaC::mul::combine_overall_coeff (
 const ex & c1,
 const ex & c2) [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), and [power](#).

**6.93.3.34 `can_make_flat()`**

```
bool GiNaC::mul::can_make_flat (
 const expair & p) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::expair::coeff](#), [GINAC\\_ASSERT](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), and [GiNaC::is\\_exactly\\_a\(\)](#).

### 6.93.3.35 expand()

```
ex GiNaC::mul::expand (
 unsigned options = 0) const [override], [protected], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::\\_ex1](#), [GiNaC::\\_num0\\_p](#), [add](#), [can\\_be\\_further\\_expanded\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::expand\\_options::expand\\_rename\\_idx](#), [expandchildren\(\)](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::get\\_all\\_dummy\\_indices\\_safely\(\)](#), [GiNaC::info\\_flags::has\\_indices](#), [info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::is\\_a\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [mul\(\)](#), [GiNaC::numeric::mul\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::ex::nops\(\)](#), [GiNaC::expairseq::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [GiNaC::rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::expairseq::seq](#), [GiNaC::basic::setflag\(\)](#), and [split\\_ex\\_to\\_pair\(\)](#).

### 6.93.3.36 algebraic\_subs\_mul()

```
ex GiNaC::mul::algebraic_subs_mul (
 const exmap & m,
 unsigned options) const
```

References [GiNaC::subs\\_options::algebraic](#), [GiNaC::algebraic\\_match\\_mul\\_with\\_mul\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::expairseq::nops\(\)](#), [GiNaC::expairseq::op\(\)](#), [GiNaC::pow\(\)](#), [GiNaC::ex::subs\(\)](#), [GiNaC::basic::subs\\_one\\_level\(\)](#), and [GiNaC::tryfactsubs\(\)](#).

### 6.93.3.37 find\_real\_imag()

```
void GiNaC::mul::find_real_imag (
 ex & rp,
 ex & ip) const [protected]
```

References [GiNaC::ex::expand\(\)](#), [GiNaC::factor\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [recombine\\_pair\\_to\\_ex\(\)](#), and [GiNaC::expairseq::seq](#).

Referenced by [imag\\_part\(\)](#), and [real\\_part\(\)](#).

### 6.93.3.38 print\_overall\_coeff()

```
void GiNaC::mul::print_overall_coeff (
 const print_context & c,
 const char * mul_sym) const [protected]
```

References [GiNaC::\\_num1\\_p](#), [GiNaC::\\_num\\_1\\_p](#), [coeff\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [precedence\(\)](#), [GiNaC::basic::print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [do\\_print\(\)](#), and [do\\_print\\_latex\(\)](#).

**6.93.3.39 do\_print()**

```
void GiNaC::mul::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [GiNaC::class\\_info< OPT >::first](#), [precedence\(\)](#), [GiNaC::ex::print\(\)](#), [print\\_overall\\_coeff\(\)](#), [recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::print\\_context::s](#), and [GiNaC::expairseq::seq](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.93.3.40 do\_print\_latex()**

```
void GiNaC::mul::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

References [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), [mul\(\)](#), [precedence\(\)](#), [print\\_overall\\_coeff\(\)](#), [recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::print\\_context::s](#), and [GiNaC::expairseq::seq](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.93.3.41 do\_print\_csrc()**

```
void GiNaC::mul::do_print_csrc (
 const print_csrc & c,
 unsigned level) const [protected]
```

References [GiNaC::\\_ex1](#), [GiNaC::\\_ex\\_1](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::info\\_flags::negint](#), [GiNaC::expairseq::overall\\_coeff](#), [power](#), [precedence\(\)](#), [GiNaC::print\\_context::s](#), and [GiNaC::expairseq::seq](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.93.3.42 do\_print\_python\_repr()**

```
void GiNaC::mul::do_print_python_repr (
 const print_python_repr & c,
 unsigned level) const [protected]
```

References [GiNaC::expairseq::nops\(\)](#), [GiNaC::expairseq::op\(\)](#), [GiNaC::ex::print\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.93.3.43 can\_be\_further\_expanded()**

```
bool GiNaC::mul::can_be_further_expanded (
 const ex & e) [static], [protected]
```

References [GiNaC::ex\\_to\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::info\\_flags::posint](#), and [GiNaC::expairseq::seq](#).

Referenced by [expand\(\)](#).

### 6.93.3.44 `expandchildren()`

```
epvector GiNaC::mul::expandchildren (
 unsigned options) const [protected]
```

Member-wise expand the expairs representing this sequence.

This must be overridden from `expairseq::expandchildren()` and done iteratively in order to allow for early cancellations and thus safe memory.

See also

[mul::expand\(\)](#)

Returns

epvector containing expanded pairs, empty if no members had to be changed.

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::factor\(\)](#), [recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::expairseq::seq](#), and [split\\_ex\\_to\\_pair\(\)](#).

Referenced by [expand\(\)](#).

## 6.93.4 Friends And Related Symbol Documentation

### 6.93.4.1 `add`

```
friend class add [friend]
```

References [add](#).

Referenced by [add](#), [eval\(\)](#), and [expand\(\)](#).

### 6.93.4.2 `ncmul`

```
friend class ncmul [friend]
```

References [ncmul](#).

Referenced by [ncmul](#).

### 6.93.4.3 `power`

```
friend class power [friend]
```

References [mul\(\)](#), and [power](#).

Referenced by [combine\\_overall\\_coeff\(\)](#), [do\\_print\\_csrc\(\)](#), [power](#), and [split\\_ex\\_to\\_pair\(\)](#).

The documentation for this class was generated from the following files:

- [mul.h](#)
- [indexed.cpp](#)
- [mul.cpp](#)
- [normal.cpp](#)
- [pseries.cpp](#)



## 6.94 GiNaC::multi\_iterator\_counter< T > Class Template Reference

The class `multi_iterator_counter` defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , such that.

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for GiNaC::multi\_iterator\_counter< T >:



Collaboration diagram for GiNaC::multi\_iterator\_counter< T >:



### Public Member Functions

- `multi_iterator_counter` (void)  
*Default constructor.*
- `multi_iterator_counter` (T B, T N, size\_t k)  
*Construct a multi\_iterator with upper limit N and size k.*
- `multi_iterator_counter` (T B, T N, const std::vector< T > &vv)  
*Construct from a vector.*
- `basic_multi_iterator< T > &init` (void)  
*Initialize the multi-index to.*
- `basic_multi_iterator< T > &operator++` (int)  
*The postfix increment operator allows to write for a multi-index n++, which will update n to the next configuration.*

## Public Member Functions inherited from [GiNaC::basic\\_multi\\_iterator< T >](#)

- [basic\\_multi\\_iterator](#) (void)  
*Default constructor.*
- [basic\\_multi\\_iterator](#) (T [B](#), T [N](#), size\_t [k](#))  
*Construct a multi\_iterator with upper limit  $N$ , lower limit  $B$  and size  $k$ .*
- [basic\\_multi\\_iterator](#) (T [B](#), T [N](#), const std::vector< T > &[vv](#))  
*Construct from a vector.*
- virtual [~basic\\_multi\\_iterator](#) ()  
*Destructor.*
- size\_t [size](#) (void) const  
*Returns the size of a multi\_iterator.*
- bool [overflow](#) (void) const  
*Return the overflow flag.*
- const std::vector< T > &[get\\_vector](#) (void) const  
*Returns a reference to the vector  $v$ .*
- T [operator\[\]](#) (size\_t [i](#)) const  
*Subscription via [].*
- T & [operator\[\]](#) (size\_t [i](#))  
*Subscription via [].*
- T [operator\(\)](#) (size\_t [i](#)) const  
*Subscription via ()*
- T & [operator\(\)](#) (size\_t [i](#))  
*Subscription via ()*

## Friends

- template<class TT>  
std::ostream & [operator<<](#) (std::ostream &[os](#), const [multi\\_iterator\\_counter](#)< TT > &[v](#))

## Additional Inherited Members

## Protected Attributes inherited from [GiNaC::basic\\_multi\\_iterator< T >](#)

- T [N](#)
- T [B](#)
- std::vector< T > [v](#)
- bool [flag\\_overflow](#)

### 6.94.1 Detailed Description

```
template<class T>
class GiNaC::multi_iterator_counter< T >
```

The class [multi\\_iterator\\_counter](#) defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , such that.

$$B \leq i_j < N$$

## 6.94.2 Constructor & Destructor Documentation

### 6.94.2.1 multi\_iterator\_counter() [1/3]

```
template<class T>
GiNaC::multi_iterator_counter< T >::multi_iterator_counter (
 void) [inline]
```

Default constructor.

References [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#).

Referenced by [operator<<](#).

### 6.94.2.2 multi\_iterator\_counter() [2/3]

```
template<class T>
GiNaC::multi_iterator_counter< T >::multi_iterator_counter (
 T B,
 T N,
 size_t k) [inline], [explicit]
```

Construct a multi\_iterator with upper limit N and size k .

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::N](#).

### 6.94.2.3 multi\_iterator\_counter() [3/3]

```
template<class T>
GiNaC::multi_iterator_counter< T >::multi_iterator_counter (
 T B,
 T N,
 const std::vector< T > & vv) [inline], [explicit]
```

Construct from a vector.

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::N](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

## 6.94.3 Member Function Documentation

### 6.94.3.1 init()

```
template<class T>
basic_multi_iterator< T > & GiNaC::multi_iterator_counter< T >::init (
 void) [inline], [virtual]
```

Initialize the multi-index to.

$$(n_1, n_2, n_3, \dots, n_k) = (B, B, \dots, B)$$

Reimplemented from [GiNaC::basic\\_multi\\_iterator< T >](#).

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::flag\\_overflow](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

### 6.94.3.2 operator++()

```
template<class T>
basic_multi_iterator< T > & GiNaC::multi_iterator_counter< T >::operator++ (
 int) [inline], [virtual]
```

The postfix increment operator allows to write for a multi-index  $n++$ , which will update  $n$  to the next configuration.

If  $n$  is in the last configuration and the increment operator  $++$  is applied to  $n$ , the overflow flag will be raised.

Reimplemented from [GiNaC::basic\\_multi\\_iterator< T >](#).

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::flag\\_overflow](#), [GiNaC::basic\\_multi\\_iterator< T >::N](#), [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

## 6.94.4 Friends And Related Symbol Documentation

### 6.94.4.1 operator<<

```
template<class T>
template<class TT>
std::ostream & operator<< (
 std::ostream & os,
 const multi_iterator_counter< TT > & v) [friend]
```

References [multi\\_iterator\\_counter\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

The documentation for this class was generated from the following file:

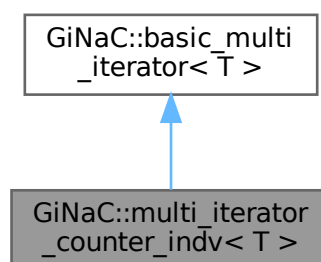
- [utils\\_multi\\_iterator.h](#)

## 6.95 GiNaC::multi\_iterator\_counter\_indv< T > Class Template Reference

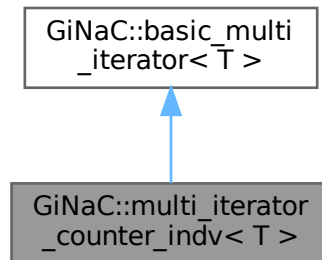
The class [multi\\_iterator\\_counter\\_indv](#) defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , such that.

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for [GiNaC::multi\\_iterator\\_counter\\_indv< T >](#):



Collaboration diagram for GiNaC::multi\_iterator\_counter\_indv< T >:



### Public Member Functions

- [multi\\_iterator\\_counter\\_indv](#) (void)  
*Default constructor.*
- [multi\\_iterator\\_counter\\_indv](#) (T B, const std::vector< T > &Nv, size\_t k)  
*Construct a multi\_iterator with upper limit N and size k .*
- [multi\\_iterator\\_counter\\_indv](#) (T B, const std::vector< T > &Nv, const std::vector< T > &vv)  
*Construct from a vector.*
- [basic\\_multi\\_iterator](#)< T > &init (void)  
*Initialize the multi-index to.*
- [basic\\_multi\\_iterator](#)< T > &operator++ (int)  
*The postfix increment operator allows to write for a multi-index n++, which will update n to the next configuration.*

### Public Member Functions inherited from [GiNaC::basic\\_multi\\_iterator< T >](#)

- [basic\\_multi\\_iterator](#) (void)  
*Default constructor.*
- [basic\\_multi\\_iterator](#) (T B, T N, size\_t k)  
*Construct a multi\_iterator with upper limit N, lower limit B and size k .*
- [basic\\_multi\\_iterator](#) (T B, T N, const std::vector< T > &vv)  
*Construct from a vector.*
- virtual [~basic\\_multi\\_iterator](#) ()  
*Destructor.*
- size\_t [size](#) (void) const  
*Returns the size of a multi\_iterator.*
- bool [overflow](#) (void) const  
*Return the overflow flag.*
- const std::vector< T > &[get\\_vector](#) (void) const  
*Returns a reference to the vector v.*
- T [operator\[\]](#) (size\_t i) const  
*Subscription via [].*
- T &[operator\[\]](#) (size\_t i)  
*Subscription via [].*
- T [operator\(\)](#) (size\_t i) const  
*Subscription via ().*
- T &[operator\(\)](#) (size\_t i)  
*Subscription via ().*

**Protected Attributes**

- `std::vector< T >` [Nv](#)

**Protected Attributes inherited from [GiNaC::basic\\_multi\\_iterator< T >](#)**

- `T` [N](#)
- `T` [B](#)
- `std::vector< T >` [v](#)
- `bool` [flag\\_overflow](#)

**Friends**

- `template<class TT>`  
`std::ostream &` [operator<<](#) (`std::ostream &os`, `const` [multi\\_iterator\\_counter\\_indv< TT >](#) `&v`)

**6.95.1 Detailed Description**

```
template<class T>
class GiNaC::multi_iterator_counter_indv< T >
```

The class [multi\\_iterator\\_counter\\_indv](#) defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , such that.

$$B \leq i_j < N_j$$

**6.95.2 Constructor & Destructor Documentation****6.95.2.1 [multi\\_iterator\\_counter\\_indv\(\)](#) [1/3]**

```
template<class T>
GiNaC::multi_iterator_counter_indv< T >::multi_iterator_counter_indv (
 void) [inline]
```

Default constructor.

References [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), and [Nv](#).

Referenced by [operator<<](#).

**6.95.2.2 [multi\\_iterator\\_counter\\_indv\(\)](#) [2/3]**

```
template<class T>
GiNaC::multi_iterator_counter_indv< T >::multi_iterator_counter_indv (
 T B,
 const std::vector< T > & Nv,
 size_t k) [inline], [explicit]
```

Construct a multi\_iterator with upper limit N and size k .

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), and [Nv](#).

### 6.95.2.3 multi\_iterator\_counter\_indv() [3/3]

```
template<class T>
GiNaC::multi_iterator_counter_indv< T >::multi_iterator_counter_indv (
 T B,
 const std::vector< T > & Nv,
 const std::vector< T > & vv) [inline], [explicit]
```

Construct from a vector.

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [Nv](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

## 6.95.3 Member Function Documentation

### 6.95.3.1 init()

```
template<class T>
basic_multi_iterator< T > & GiNaC::multi_iterator_counter_indv< T >::init (
 void) [inline], [virtual]
```

Initialize the multi-index to.

$$(n_1, n_2, n_3, \dots, n_k) = (B, B, \dots, B)$$

Reimplemented from [GiNaC::basic\\_multi\\_iterator< T >](#).

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::flag\\_overflow](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

### 6.95.3.2 operator++()

```
template<class T>
basic_multi_iterator< T > & GiNaC::multi_iterator_counter_indv< T >::operator++ (
 int) [inline], [virtual]
```

The postfix increment operator allows to write for a multi-index `n++`, which will update `n` to the next configuration.

If `n` is in the last configuration and the increment operator `++` is applied to `n`, the overflow flag will be raised.

Reimplemented from [GiNaC::basic\\_multi\\_iterator< T >](#).

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::flag\\_overflow](#), [Nv](#), [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >](#)

## 6.95.4 Friends And Related Symbol Documentation

### 6.95.4.1 operator<<

```
template<class T>
template<class TT>
std::ostream & operator<< (
 std::ostream & os,
 const multi_iterator_counter_indv< TT > & v) [friend]
```

References [multi\\_iterator\\_counter\\_indv\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

## 6.95.5 Member Data Documentation

### 6.95.5.1 Nv

```
template<class T>
std::vector<T> GiNaC::multi_iterator_counter_indv< T >::Nv [protected]
```

Referenced by [multi\\_iterator\\_counter\\_indv\(\)](#), [multi\\_iterator\\_counter\\_indv\(\)](#), [multi\\_iterator\\_counter\\_indv\(\)](#), and [operator++\(\)](#).

The documentation for this class was generated from the following file:

- [utils\\_multi\\_iterator.h](#)

## 6.96 GiNaC::multi\_iterator\_ordered< T > Class Template Reference

The class [multi\\_iterator\\_ordered](#) defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , such that.

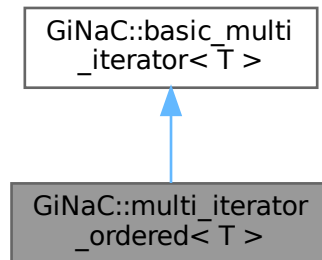
```
#include <utils_multi_iterator.h>
```

Inheritance diagram for [GiNaC::multi\\_iterator\\_ordered< T >](#):





Collaboration diagram for GiNaC::multi\_iterator\_ordered< T >:



### Public Member Functions

- `multi_iterator_ordered` (void)  
*Default constructor.*
- `multi_iterator_ordered` (T B, T N, size\_t k)  
*Construct a multi\_iterator with upper limit N and size k .*
- `multi_iterator_ordered` (T B, T N, const std::vector< T > &vv)  
*Construct from a vector.*
- `basic_multi_iterator< T > &init` (void)  
*Initialize the multi-index to.*
- `basic_multi_iterator< T > &operator++` (int)  
*The postfix increment operator allows to write for a multi-index n++, which will update n to the next configuration.*

### Public Member Functions inherited from `GiNaC::basic_multi_iterator< T >`

- `basic_multi_iterator` (void)  
*Default constructor.*
- `basic_multi_iterator` (T B, T N, size\_t k)  
*Construct a multi\_iterator with upper limit N, lower limit B and size k .*
- `basic_multi_iterator` (T B, T N, const std::vector< T > &vv)  
*Construct from a vector.*
- virtual `~basic_multi_iterator` ()  
*Destructor.*
- size\_t `size` (void) const  
*Returns the size of a multi\_iterator.*
- bool `overflow` (void) const  
*Return the overflow flag.*
- const std::vector< T > &`get_vector` (void) const  
*Returns a reference to the vector v.*
- T `operator[]` (size\_t i) const  
*Subscription via [].*
- T &`operator[]` (size\_t i)  
*Subscription via [].*
- T `operator()` (size\_t i) const  
*Subscription via ().*
- T &`operator()` (size\_t i)  
*Subscription via ().*

## Friends

- `template<class TT>`  
`std::ostream & operator<< (std::ostream &os, const multi_iterator_ordered< TT > &v)`

## Additional Inherited Members

### Protected Attributes inherited from `GiNaC::basic_multi_iterator< T >`

- `T N`
- `T B`
- `std::vector< T > v`
- `bool flag_overflow`

## 6.96.1 Detailed Description

`template<class T>`  
`class GiNaC::multi_iterator_ordered< T >`

The class `multi_iterator_ordered` defines a `multi_iterator`  $(i_1, i_2, \dots, i_k)$ , such that.

$$B \leq i_j < N$$

and

$$i_j < i_{j+1}.$$

It is assumed that  $k > 0$  and  $N - B \geq k$ .

## 6.96.2 Constructor & Destructor Documentation

### 6.96.2.1 `multi_iterator_ordered()` [1/3]

```
template<class T>
GiNaC::multi_iterator_ordered< T >::multi_iterator_ordered (
 void) [inline]
```

Default constructor.

References `GiNaC::basic_multi_iterator< T >::basic_multi_iterator()`.

Referenced by `operator<<`.

### 6.96.2.2 `multi_iterator_ordered()` [2/3]

```
template<class T>
GiNaC::multi_iterator_ordered< T >::multi_iterator_ordered (
 T B,
 T N,
 size_t k) [inline], [explicit]
```

Construct a `multi_iterator` with upper limit `N` and size `k`.

References `GiNaC::basic_multi_iterator< T >::B`, `GiNaC::basic_multi_iterator< T >::basic_multi_iterator()`, and `GiNaC::basic_multi_iterator< T >::N`.

### 6.96.2.3 multi\_iterator\_ordered() [3/3]

```
template<class T>
GiNaC::multi_iterator_ordered< T >::multi_iterator_ordered (
 T B,
 T N,
 const std::vector< T > & vv) [inline], [explicit]
```

Construct from a vector.

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::N](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

## 6.96.3 Member Function Documentation

### 6.96.3.1 init()

```
template<class T>
basic_multi_iterator< T > & GiNaC::multi_iterator_ordered< T >::init (
 void) [inline], [virtual]
```

Initialize the multi-index to.

$$(n_1, n_2, n_3, \dots, n_k) = (B + 0, B + 1, B + 2, \dots, B + k - 1)$$

Reimplemented from [GiNaC::basic\\_multi\\_iterator< T >](#).

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::flag\\_overflow](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

### 6.96.3.2 operator++()

```
template<class T>
basic_multi_iterator< T > & GiNaC::multi_iterator_ordered< T >::operator++ (
 int) [inline], [virtual]
```

The postfix increment operator allows to write for a multi-index `n++`, which will update `n` to the next configuration.

If `n` is in the last configuration and the increment operator `++` is applied to `n`, the overflow flag will be raised.

Reimplemented from [GiNaC::basic\\_multi\\_iterator< T >](#).

References [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::flag\\_overflow](#), [GiNaC::basic\\_multi\\_iterator< T >::N](#), [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

## 6.96.4 Friends And Related Symbol Documentation

### 6.96.4.1 `operator<<`

```
template<class T>
template<class TT>
std::ostream & operator<< (
 std::ostream & os,
 const multi_iterator_ordered< TT > & v) [friend]
```

References [multi\\_iterator\\_ordered\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

The documentation for this class was generated from the following file:

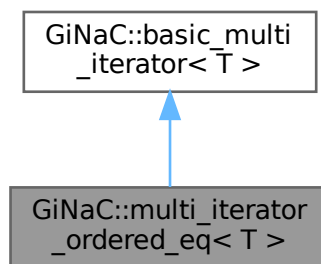
- [utils\\_multi\\_iterator.h](#)

## 6.97 GiNaC::multi\_iterator\_ordered\_eq< T > Class Template Reference

The class [multi\\_iterator\\_ordered\\_eq](#) defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , such that.

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for GiNaC::multi\_iterator\_ordered\_eq< T >:



Collaboration diagram for GiNaC::multi\_iterator\_ordered\_eq< T >:



**Public Member Functions**

- [multi\\_iterator\\_ordered\\_eq](#) (void)  
*Default constructor.*
- [multi\\_iterator\\_ordered\\_eq](#) (T B, T N, size\_t k)  
*Construct a multi\_iterator with upper limit N and size k .*
- [multi\\_iterator\\_ordered\\_eq](#) (T B, T N, const std::vector< T > &vv)  
*Construct from a vector.*
- [basic\\_multi\\_iterator](#)< T > & [init](#) (void)  
*Initialize the multi-index to.*
- [basic\\_multi\\_iterator](#)< T > & [operator++](#) (int)  
*The postfix increment operator allows to write for a multi-index n++, which will update n to the next configuration.*

**Public Member Functions inherited from [GiNaC::basic\\_multi\\_iterator< T >](#)**

- [basic\\_multi\\_iterator](#) (void)  
*Default constructor.*
- [basic\\_multi\\_iterator](#) (T B, T N, size\_t k)  
*Construct a multi\_iterator with upper limit N, lower limit B and size k .*
- [basic\\_multi\\_iterator](#) (T B, T N, const std::vector< T > &vv)  
*Construct from a vector.*
- virtual [~basic\\_multi\\_iterator](#) ()  
*Destructor.*
- size\_t [size](#) (void) const  
*Returns the size of a multi\_iterator.*
- bool [overflow](#) (void) const  
*Return the overflow flag.*
- const std::vector< T > & [get\\_vector](#) (void) const  
*Returns a reference to the vector v.*
- T [operator\[\]](#) (size\_t i) const  
*Subscription via [].*
- T & [operator\[\]](#) (size\_t i)  
*Subscription via [].*
- T [operator\(\)](#) (size\_t i) const  
*Subscription via ().*
- T & [operator\(\)](#) (size\_t i)  
*Subscription via ().*

**Friends**

- template<class TT>  
std::ostream & [operator<<](#) (std::ostream &os, const [multi\\_iterator\\_ordered\\_eq](#)< TT > &v)

**Additional Inherited Members****Protected Attributes inherited from [GiNaC::basic\\_multi\\_iterator< T >](#)**

- T N
- T B
- std::vector< T > v
- bool [flag\\_overflow](#)

### 6.97.1 Detailed Description

```
template<class T>
class GiNaC::multi_iterator_ordered_eq< T >
```

The class [multi\\_iterator\\_ordered\\_eq](#) defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , such that.

$$B \leq i_j < N$$

and

$$i_j \leq i_{j+1}.$$

It is assumed that  $k > 0$ .

### 6.97.2 Constructor & Destructor Documentation

#### 6.97.2.1 multi\_iterator\_ordered\_eq() [1/3]

```
template<class T>
GiNaC::multi_iterator_ordered_eq< T >::multi_iterator_ordered_eq (
 void) [inline]
```

Default constructor.

References [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#).

Referenced by [operator<<](#).

#### 6.97.2.2 multi\_iterator\_ordered\_eq() [2/3]

```
template<class T>
GiNaC::multi_iterator_ordered_eq< T >::multi_iterator_ordered_eq (
 T B,
 T N,
 size_t k) [inline], [explicit]
```

Construct a multi\_iterator with upper limit N and size k .

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::N](#).

#### 6.97.2.3 multi\_iterator\_ordered\_eq() [3/3]

```
template<class T>
GiNaC::multi_iterator_ordered_eq< T >::multi_iterator_ordered_eq (
 T B,
 T N,
 const std::vector< T > & vv) [inline], [explicit]
```

Construct from a vector.

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::N](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

## 6.97.3 Member Function Documentation

### 6.97.3.1 init()

```
template<class T>
basic_multi_iterator< T > & GiNaC::multi_iterator_ordered_eq< T >::init (
 void) [inline], [virtual]
```

Initialize the multi-index to.

$$(n_1, n_2, \dots, n_k) = (B, B, \dots, B)$$

Reimplemented from [GiNaC::basic\\_multi\\_iterator< T >](#).

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::flag\\_overflow](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

### 6.97.3.2 operator++()

```
template<class T>
basic_multi_iterator< T > & GiNaC::multi_iterator_ordered_eq< T >::operator++ (
 int) [inline], [virtual]
```

The postfix increment operator allows to write for a multi-index  $n++$ , which will update  $n$  to the next configuration.

If  $n$  is in the last configuration and the increment operator  $++$  is applied to  $n$ , the overflow flag will be raised.

Reimplemented from [GiNaC::basic\\_multi\\_iterator< T >](#).

References [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::flag\\_overflow](#), [GiNaC::basic\\_multi\\_iterator< T >::N](#), [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

## 6.97.4 Friends And Related Symbol Documentation

### 6.97.4.1 operator<<

```
template<class T>
template<class TT>
std::ostream & operator<< (
 std::ostream & os,
 const multi_iterator_ordered_eq< TT > & v) [friend]
```

References [multi\\_iterator\\_ordered\\_eq\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

The documentation for this class was generated from the following file:

- [utils\\_multi\\_iterator.h](#)

## 6.98 GiNaC::multi\_iterator\_ordered\_eq\_indv< T > Class Template Reference

The class [multi\\_iterator\\_ordered\\_eq\\_indv](#) defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , such that.

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for GiNaC::multi\_iterator\_ordered\_eq\_indv< T >:



Collaboration diagram for GiNaC::multi\_iterator\_ordered\_eq\_indv< T >:



### Public Member Functions

- [multi\\_iterator\\_ordered\\_eq\\_indv](#) (void)  
*Default constructor.*
- [multi\\_iterator\\_ordered\\_eq\\_indv](#) (T B, const std::vector< T > &Nv, size\_t k)  
*Construct a multi\_iterator with upper limit N and size k.*
- [multi\\_iterator\\_ordered\\_eq\\_indv](#) (T B, const std::vector< T > &Nv, const std::vector< T > &vv)  
*Construct from a vector.*
- [basic\\_multi\\_iterator](#)< T > & [init](#) (void)  
*Initialize the multi-index to.*
- [basic\\_multi\\_iterator](#)< T > & [operator++](#) (int)  
*The postfix increment operator allows to write for a multi-index n++, which will update n to the next configuration.*



**Public Member Functions inherited from [GiNaC::basic\\_multi\\_iterator< T >](#)**

- [basic\\_multi\\_iterator](#) (void)  
*Default constructor.*
- [basic\\_multi\\_iterator](#) (T [B](#), T [N](#), size\_t k)  
*Construct a multi\_iterator with upper limit N, lower limit B and size k.*
- [basic\\_multi\\_iterator](#) (T [B](#), T [N](#), const std::vector< T > &vv)  
*Construct from a vector.*
- virtual [~basic\\_multi\\_iterator](#) ()  
*Destructor.*
- size\_t [size](#) (void) const  
*Returns the size of a multi\_iterator.*
- bool [overflow](#) (void) const  
*Return the overflow flag.*
- const std::vector< T > & [get\\_vector](#) (void) const  
*Returns a reference to the vector v.*
- T [operator\[\]](#) (size\_t i) const  
*Subscription via [].*
- T & [operator\[\]](#) (size\_t i)  
*Subscription via [].*
- T [operator\(\)](#) (size\_t i) const  
*Subscription via ().*
- T & [operator\(\)](#) (size\_t i)  
*Subscription via ().*

**Protected Attributes**

- std::vector< T > [Nv](#)

**Protected Attributes inherited from [GiNaC::basic\\_multi\\_iterator< T >](#)**

- T [N](#)
- T [B](#)
- std::vector< T > [v](#)
- bool [flag\\_overflow](#)

**Friends**

- template<class TT>  
std::ostream & [operator<<](#) (std::ostream &os, const [multi\\_iterator\\_ordered\\_eq\\_indv](#)< TT > &v)

**6.98.1 Detailed Description**

**template<class T>**  
**class [GiNaC::multi\\_iterator\\_ordered\\_eq\\_indv](#)< T >**

The class [multi\\_iterator\\_ordered\\_eq\\_indv](#) defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , such that.

$$B \leq i_j < N_j$$

and

$$i_j \leq i_{j+1}.$$

## 6.98.2 Constructor & Destructor Documentation

### 6.98.2.1 multi\_iterator\_ordered\_eq\_indv() [1/3]

```
template<class T>
GiNaC::multi_iterator_ordered_eq_indv< T >::multi_iterator_ordered_eq_indv (
 void) [inline]
```

Default constructor.

References [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), and [Nv](#).

Referenced by [operator<<](#).

### 6.98.2.2 multi\_iterator\_ordered\_eq\_indv() [2/3]

```
template<class T>
GiNaC::multi_iterator_ordered_eq_indv< T >::multi_iterator_ordered_eq_indv (
 T B,
 const std::vector< T > & Nv,
 size_t k) [inline], [explicit]
```

Construct a multi\_iterator with upper limit N and size k .

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), and [Nv](#).

### 6.98.2.3 multi\_iterator\_ordered\_eq\_indv() [3/3]

```
template<class T>
GiNaC::multi_iterator_ordered_eq_indv< T >::multi_iterator_ordered_eq_indv (
 T B,
 const std::vector< T > & Nv,
 const std::vector< T > & vv) [inline], [explicit]
```

Construct from a vector.

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [Nv](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

## 6.98.3 Member Function Documentation

### 6.98.3.1 init()

```
template<class T>
basic_multi_iterator< T > & GiNaC::multi_iterator_ordered_eq_indv< T >::init (
 void) [inline], [virtual]
```

Initialize the multi-index to.

$$(n_1, n_2, n_3, \dots, n_k) = (B, B, B, \dots, B)$$

Reimplemented from [GiNaC::basic\\_multi\\_iterator< T >](#).

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::flag\\_overflow](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

### 6.98.3.2 operator++()

```
template<class T>
basic_multi_iterator< T > & GiNaC::multi_iterator_ordered_eq_indv< T >::operator++ (
 int) [inline], [virtual]
```

The postfix increment operator allows to write for a multi-index  $n++$ , which will update  $n$  to the next configuration.

If  $n$  is in the last configuration and the increment operator  $++$  is applied to  $n$ , the overflow flag will be raised.

Reimplemented from [GiNaC::basic\\_multi\\_iterator< T >](#).

References [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::flag\\_overflow](#), [Nv](#), [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

## 6.98.4 Friends And Related Symbol Documentation

### 6.98.4.1 operator<<

```
template<class T>
template<class TT>
std::ostream & operator<< (
 std::ostream & os,
 const multi_iterator_ordered_eq_indv< TT > & v) [friend]
```

References [multi\\_iterator\\_ordered\\_eq\\_indv\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

## 6.98.5 Member Data Documentation

### 6.98.5.1 Nv

```
template<class T>
std::vector<T> GiNaC::multi_iterator_ordered_eq_indv< T >::Nv [protected]
```

Referenced by [multi\\_iterator\\_ordered\\_eq\\_indv\(\)](#), [multi\\_iterator\\_ordered\\_eq\\_indv\(\)](#), [multi\\_iterator\\_ordered\\_eq\\_indv\(\)](#), and [operator++\(\)](#).

The documentation for this class was generated from the following file:

- [utils\\_multi\\_iterator.h](#)

## 6.99 GiNaC::multi\_iterator\_permutation< T > Class Template Reference

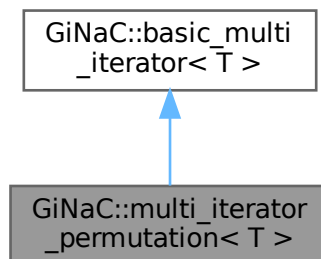
The class `multi_iterator_permutation` defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , for which.

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for GiNaC::multi\_iterator\_permutation< T >:



Collaboration diagram for GiNaC::multi\_iterator\_permutation< T >:



### Public Member Functions

- `multi_iterator_permutation` (void)  
*Default constructor.*
- `multi_iterator_permutation` (T B, T N, size\_t k)  
*Construct a multi\_iterator with upper limit N and size k.*
- `multi_iterator_permutation` (T B, T N, const std::vector< T > &vv)  
*Construct from a vector.*
- `basic_multi_iterator< T > & init` (void)  
*Initialize the multi-index to.*
- `basic_multi_iterator< T > & operator++` (int)  
*The postfix increment operator allows to write for a multi-index n++, which will update n to the next configuration.*
- `int get_sign` (void) const  
*Returns the sign of the permutation, defined by.*

**Public Member Functions inherited from [GiNaC::basic\\_multi\\_iterator< T >](#)**

- [basic\\_multi\\_iterator](#) (void)  
*Default constructor.*
- [basic\\_multi\\_iterator](#) (T B, T N, size\_t k)  
*Construct a multi\_iterator with upper limit N, lower limit B and size k .*
- [basic\\_multi\\_iterator](#) (T B, T N, const std::vector< T > &vv)  
*Construct from a vector.*
- virtual [~basic\\_multi\\_iterator](#) ()  
*Destructor.*
- size\_t [size](#) (void) const  
*Returns the size of a multi\_iterator.*
- bool [overflow](#) (void) const  
*Return the overflow flag.*
- const std::vector< T > & [get\\_vector](#) (void) const  
*Returns a reference to the vector v.*
- T [operator\[\]](#) (size\_t i) const  
*Subscription via [].*
- T & [operator\[\]](#) (size\_t i)  
*Subscription via [].*
- T [operator\(\)](#) (size\_t i) const  
*Subscription via ().*
- T & [operator\(\)](#) (size\_t i)  
*Subscription via ().*

**Friends**

- template<class TT>  
std::ostream & [operator<<](#) (std::ostream &os, const [multi\\_iterator\\_permutation](#)< TT > &v)

**Additional Inherited Members****Protected Attributes inherited from [GiNaC::basic\\_multi\\_iterator< T >](#)**

- T N
- T B
- std::vector< T > v
- bool [flag\\_overflow](#)

**6.99.1 Detailed Description**

template<class T>  
class [GiNaC::multi\\_iterator\\_permutation](#)< T >

The class [multi\\_iterator\\_permutation](#) defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , for which.

$$B \leq i_j < N$$

and

$$i_i \neq i_j$$

In particular, if  $N - B = k$ , [multi\\_iterator\\_permutation](#) loops over all permutations of  $k$  elements.

## 6.99.2 Constructor & Destructor Documentation

### 6.99.2.1 multi\_iterator\_permutation() [1/3]

```
template<class T>
GiNaC::multi_iterator_permutation< T >::multi_iterator_permutation (
 void) [inline]
```

Default constructor.

References [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#).

Referenced by [operator<<](#).

### 6.99.2.2 multi\_iterator\_permutation() [2/3]

```
template<class T>
GiNaC::multi_iterator_permutation< T >::multi_iterator_permutation (
 T B,
 T N,
 size_t k) [inline], [explicit]
```

Construct a multi\_iterator with upper limit N and size k .

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::N](#).

### 6.99.2.3 multi\_iterator\_permutation() [3/3]

```
template<class T>
GiNaC::multi_iterator_permutation< T >::multi_iterator_permutation (
 T B,
 T N,
 const std::vector< T > & vv) [inline], [explicit]
```

Construct from a vector.

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::N](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

## 6.99.3 Member Function Documentation

### 6.99.3.1 init()

```
template<class T>
basic_multi_iterator< T > & GiNaC::multi_iterator_permutation< T >::init (
 void) [inline], [virtual]
```

Initialize the multi-index to.

$$(n_1, n_2, n_3, \dots, n_k) = (B + 0, B + 1, B + 2, \dots, B + k - 1)$$

Reimplemented from [GiNaC::basic\\_multi\\_iterator< T >](#).

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::flag\\_overflow](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

### 6.99.3.2 operator++()

```
template<class T>
basic_multi_iterator< T > & GiNaC::multi_iterator_permutation< T >::operator++ (
 int) [inline], [virtual]
```

The postfix increment operator allows to write for a multi-index  $n++$ , which will update  $n$  to the next configuration.

If  $n$  is in the last configuration and the increment operator  $++$  is applied to  $n$ , the overflow flag will be raised.

Reimplemented from [GiNaC::basic\\_multi\\_iterator< T >](#).

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::flag\\_overflow](#), [GiNaC::basic\\_multi\\_iterator< T >::N](#), [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

### 6.99.3.3 get\_sign()

```
template<class T>
int GiNaC::multi_iterator_permutation< T >::get_sign (
 void) const [inline]
```

Returns the sign of the permutation, defined by.

$$(-1)^{n_{inv}},$$

where  $n_{inv}$  is the number of inversions, e.g. the number of pairs  $i < j$  for which

$$n_i > n_j.$$

References [GiNaC::basic\\_multi\\_iterator< T >::size\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

## 6.99.4 Friends And Related Symbol Documentation

### 6.99.4.1 operator<<

```
template<class T>
template<class TT>
std::ostream & operator<< (
 std::ostream & os,
 const multi_iterator_permutation< TT > & v) [friend]
```

References [multi\\_iterator\\_permutation\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

The documentation for this class was generated from the following file:

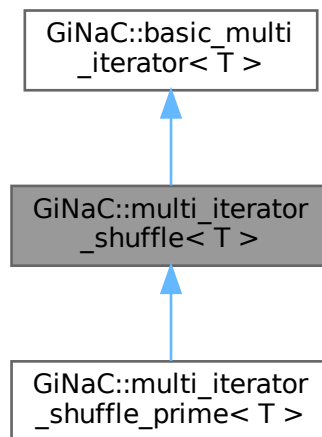
- [utils\\_multi\\_iterator.h](#)

## 6.100 GiNaC::multi\_iterator\_shuffle< T > Class Template Reference

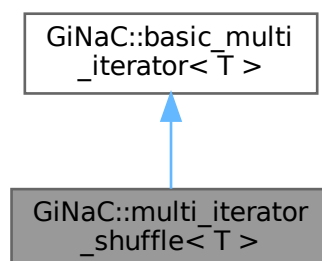
The class `multi_iterator_shuffle` defines a `multi_iterator`, which runs over all shuffles of `a` and `b`.

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for `GiNaC::multi_iterator_shuffle< T >`:



Collaboration diagram for `GiNaC::multi_iterator_shuffle< T >`:



### Public Member Functions

- `multi_iterator_shuffle` (void)  
*Default constructor.*
- `multi_iterator_shuffle` (const std::vector< T > &a, const std::vector< T > &b)  
*Construct from a vector.*
- `basic_multi_iterator< T > &init` (void)  
*Initialize the multi-index to the first shuffle.*
- `basic_multi_iterator< T > &operator++` (int)  
*The postfix increment operator allows to write for a multi-index `n++`, which will update `n` to the next configuration.*



**Public Member Functions inherited from [GiNaC::basic\\_multi\\_iterator< T >](#)**

- [basic\\_multi\\_iterator](#) (void)  
*Default constructor.*
- [basic\\_multi\\_iterator](#) (T [B](#), T [N](#), size\_t k)  
*Construct a multi\_iterator with upper limit N, lower limit B and size k .*
- [basic\\_multi\\_iterator](#) (T [B](#), T [N](#), const std::vector< T > &vv)  
*Construct from a vector.*
- virtual [~basic\\_multi\\_iterator](#) ()  
*Destructor.*
- size\_t [size](#) (void) const  
*Returns the size of a multi\_iterator.*
- bool [overflow](#) (void) const  
*Return the overflow flag.*
- const std::vector< T > & [get\\_vector](#) (void) const  
*Returns a reference to the vector v.*
- T [operator\[\]](#) (size\_t i) const  
*Subscription via [].*
- T & [operator\[\]](#) (size\_t i)  
*Subscription via [].*
- T [operator\(\)](#) (size\_t i) const  
*Subscription via ().*
- T & [operator\(\)](#) (size\_t i)  
*Subscription via ().*

**Protected Attributes**

- size\_t [N\\_internal](#)
- std::vector< size\_t > [v\\_internal](#)
- std::vector< T > [v\\_orig](#)

**Protected Attributes inherited from [GiNaC::basic\\_multi\\_iterator< T >](#)**

- T [N](#)
- T [B](#)
- std::vector< T > [v](#)
- bool [flag\\_overflow](#)

**Friends**

- template<class TT>  
std::ostream & [operator<<](#) (std::ostream &os, const [multi\\_iterator\\_shuffle](#)< TT > &v)

**6.100.1 Detailed Description**

```
template<class T>
class GiNaC::multi_iterator_shuffle< T >
```

The class [multi\\_iterator\\_shuffle](#) defines a multi\_iterator, which runs over all shuffles of a and b.

## 6.100.2 Constructor & Destructor Documentation

### 6.100.2.1 multi\_iterator\_shuffle() [1/2]

```
template<class T>
GiNaC::multi_iterator_shuffle< T >::multi_iterator_shuffle (
 void) [inline]
```

Default constructor.

References [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [N\\_internal](#), [v\\_internal](#), and [v\\_orig](#).

Referenced by [GiNaC::multi\\_iterator\\_shuffle\\_prime< T >::multi\\_iterator\\_shuffle\\_prime\(\)](#), [GiNaC::multi\\_iterator\\_shuffle\\_prime< T >::operator<<](#).

### 6.100.2.2 multi\_iterator\_shuffle() [2/2]

```
template<class T>
GiNaC::multi_iterator_shuffle< T >::multi_iterator_shuffle (
 const std::vector< T > & a,
 const std::vector< T > & b) [inline], [explicit]
```

Construct from a vector.

References [GiNaC::basic\\_multi\\_iterator< T >::B](#), [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [N\\_internal](#), [GiNaC::basic\\_multi\\_iterator< T >::v](#), [v\\_internal](#), and [v\\_orig](#).

## 6.100.3 Member Function Documentation

### 6.100.3.1 init()

```
template<class T>
basic_multi_iterator< T > & GiNaC::multi_iterator_shuffle< T >::init (
 void) [inline], [virtual]
```

Initialize the multi-index to the first shuffle.

Reimplemented from [GiNaC::basic\\_multi\\_iterator< T >](#).

Reimplemented in [GiNaC::multi\\_iterator\\_shuffle\\_prime< T >](#).

References [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::flag\\_overflow](#), [GiNaC::basic\\_multi\\_iterator< T >::v](#), [v\\_internal](#), and [v\\_orig](#).

### 6.100.3.2 operator++()

```
template<class T>
basic_multi_iterator< T > & GiNaC::multi_iterator_shuffle< T >::operator++ (
 int) [inline], [virtual]
```

The postfix increment operator allows to write for a multi-index  $n++$ , which will update  $n$  to the next configuration.

If  $n$  is in the last configuration and the increment operator  $++$  is applied to  $n$ , the overflow flag will be raised.

Reimplemented from [GiNaC::basic\\_multi\\_iterator< T >](#).

References [GiNaC::basic\\_multi\\_iterator< T >::basic\\_multi\\_iterator\(\)](#), [GiNaC::basic\\_multi\\_iterator< T >::flag\\_overflow](#), [N\\_internal](#), [GiNaC::basic\\_multi\\_iterator< T >::v](#), [v\\_internal](#), and [v\\_orig](#).

## 6.100.4 Friends And Related Symbol Documentation

### 6.100.4.1 operator<<

```
template<class T>
template<class TT>
std::ostream & operator<< (
 std::ostream & os,
 const multi_iterator_shuffle< TT > & v) [friend]
```

References [multi\\_iterator\\_shuffle\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

## 6.100.5 Member Data Documentation

### 6.100.5.1 N\_internal

```
template<class T>
size_t GiNaC::multi_iterator_shuffle< T >::N_internal [protected]
```

Referenced by [multi\\_iterator\\_shuffle\(\)](#), [multi\\_iterator\\_shuffle\(\)](#), and [operator++\(\)](#).

### 6.100.5.2 v\_internal

```
template<class T>
std::vector<size_t> GiNaC::multi_iterator_shuffle< T >::v_internal [protected]
```

Referenced by [init\(\)](#), [GiNaC::multi\\_iterator\\_shuffle\\_prime< T >::init\(\)](#), [multi\\_iterator\\_shuffle\(\)](#), [multi\\_iterator\\_shuffle\(\)](#), and [operator++\(\)](#).

### 6.100.5.3 v\_orig

```
template<class T>
std::vector<T> GiNaC::multi_iterator_shuffle< T >::v_orig [protected]
```

Referenced by [init\(\)](#), [GiNaC::multi\\_iterator\\_shuffle\\_prime< T >::init\(\)](#), [multi\\_iterator\\_shuffle\(\)](#), [multi\\_iterator\\_shuffle\(\)](#), and [operator++\(\)](#).

The documentation for this class was generated from the following file:

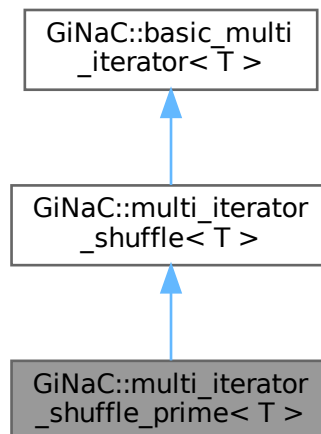
- [utils\\_multi\\_iterator.h](#)

## 6.101 GiNaC::multi\_iterator\_shuffle\_prime< T > Class Template Reference

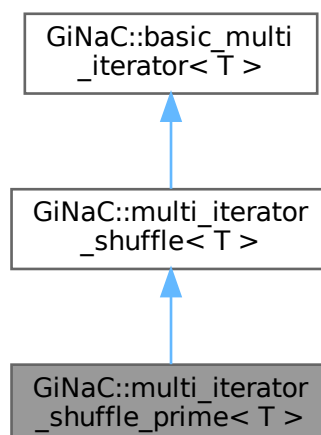
The class [multi\\_iterator\\_shuffle\\_prime](#) defines a multi\_iterator, which runs over all shuffles of a and b, excluding the first one (a,b).

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for GiNaC::multi\_iterator\_shuffle\_prime< T >:



Collaboration diagram for GiNaC::multi\_iterator\_shuffle\_prime< T >:



## Public Member Functions

- [multi\\_iterator\\_shuffle\\_prime](#) (void)  
*Default constructor.*
- [multi\\_iterator\\_shuffle\\_prime](#) (const std::vector< T > &a, const std::vector< T > &b)  
*Construct from a vector.*
- [basic\\_multi\\_iterator](#)< T > & [init](#) (void)  
*Initialize the multi-index to the first shuffle.*

## Public Member Functions inherited from [GiNaC::multi\\_iterator\\_shuffle< T >](#)

- [multi\\_iterator\\_shuffle](#) (void)  
*Default constructor.*
- [multi\\_iterator\\_shuffle](#) (const std::vector< T > &a, const std::vector< T > &b)  
*Construct from a vector.*
- [basic\\_multi\\_iterator](#)< T > & [operator++](#) (int)  
*The postfix increment operator allows to write for a multi-index n++, which will update n to the next configuration.*

## Public Member Functions inherited from [GiNaC::basic\\_multi\\_iterator< T >](#)

- [basic\\_multi\\_iterator](#) (void)  
*Default constructor.*
- [basic\\_multi\\_iterator](#) (T B, T N, size\_t k)  
*Construct a multi\_iterator with upper limit N, lower limit B and size k .*
- [basic\\_multi\\_iterator](#) (T B, T N, const std::vector< T > &vv)  
*Construct from a vector.*
- virtual [~basic\\_multi\\_iterator](#) ()  
*Destructor.*
- size\_t [size](#) (void) const  
*Returns the size of a multi\_iterator.*
- bool [overflow](#) (void) const  
*Return the overflow flag.*
- const std::vector< T > & [get\\_vector](#) (void) const  
*Returns a reference to the vector v.*
- T [operator\[\]](#) (size\_t i) const  
*Subscription via [].*
- T & [operator\[\]](#) (size\_t i)  
*Subscription via [].*
- T [operator\(\)](#) (size\_t i) const  
*Subscription via ().*
- T & [operator\(\)](#) (size\_t i)  
*Subscription via ().*

## Friends

- template<class TT>  
std::ostream & [operator<<](#) (std::ostream &os, const [multi\\_iterator\\_shuffle\\_prime](#)< TT > &v)

## Additional Inherited Members

### Protected Attributes inherited from [GiNaC::multi\\_iterator\\_shuffle< T >](#)

- `size_t` [N\\_internal](#)
- `std::vector< size_t >` [v\\_internal](#)
- `std::vector< T >` [v\\_orig](#)

### Protected Attributes inherited from [GiNaC::basic\\_multi\\_iterator< T >](#)

- `T` [N](#)
- `T` [B](#)
- `std::vector< T >` [v](#)
- `bool` [flag\\_overflow](#)

## 6.101.1 Detailed Description

```
template<class T>
class GiNaC::multi_iterator_shuffle_prime< T >
```

The class [multi\\_iterator\\_shuffle\\_prime](#) defines a multi\_iterator, which runs over all shuffles of a and b, excluding the first one (a,b).

## 6.101.2 Constructor & Destructor Documentation

### 6.101.2.1 multi\_iterator\_shuffle\_prime() [1/2]

```
template<class T>
GiNaC::multi_iterator_shuffle_prime< T >::multi_iterator_shuffle_prime (
 void) [inline]
```

Default constructor.

References [GiNaC::multi\\_iterator\\_shuffle< T >::multi\\_iterator\\_shuffle\(\)](#).

Referenced by [operator<<](#).

### 6.101.2.2 multi\_iterator\_shuffle\_prime() [2/2]

```
template<class T>
GiNaC::multi_iterator_shuffle_prime< T >::multi_iterator_shuffle_prime (
 const std::vector< T > & a,
 const std::vector< T > & b) [inline], [explicit]
```

Construct from a vector.

References [GiNaC::multi\\_iterator\\_shuffle< T >::multi\\_iterator\\_shuffle\(\)](#).

### 6.101.3 Member Function Documentation

#### 6.101.3.1 init()

```
template<class T>
basic_multi_iterator< T > & GiNaC::multi_iterator_shuffle_prime< T >::init (
 void) [inline], [virtual]
```

Initialize the multi-index to the first shuffle.

Reimplemented from [GiNaC::multi\\_iterator\\_shuffle< T >](#).

References [GiNaC::basic\\_multi\\_iterator< T >::flag\\_overflow](#), [GiNaC::basic\\_multi\\_iterator< T >::v](#), [GiNaC::multi\\_iterator\\_shuffle< T >](#) and [GiNaC::multi\\_iterator\\_shuffle< T >::v\\_orig](#).

### 6.101.4 Friends And Related Symbol Documentation

#### 6.101.4.1 operator<<

```
template<class T>
template<class TT>
std::ostream & operator<< (
 std::ostream & os,
 const multi_iterator_shuffle_prime< TT > & v) [friend]
```

References [multi\\_iterator\\_shuffle\\_prime\(\)](#), and [GiNaC::basic\\_multi\\_iterator< T >::v](#).

The documentation for this class was generated from the following file:

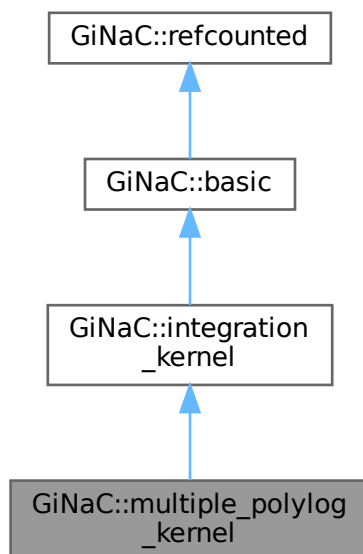
- [utils\\_multi\\_iterator.h](#)

## 6.102 GiNaC::multiple\_polylog\_kernel Class Reference

The integration kernel for multiple polylogarithms.

```
#include <integration_kernel.h>
```

Inheritance diagram for `GiNaC::multiple_polylog_kernel`:





Collaboration diagram for GiNaC::multiple\_polylog\_kernel:



### Public Member Functions

- `multiple_polylog_kernel` (const `ex` &`z`)
- `size_t nops` () const override  
*Number of operands/members.*
- `ex op` (size\_t `i`) const override  
*Return operand/member at position `i`.*
- `ex & let_op` (size\_t `i`) override  
*Return modifiable operand/member at position `i`.*
- `bool is_numeric` (void) const override  
*This routine returns true, if the integration kernel can be evaluated numerically.*

### Public Member Functions inherited from `GiNaC::integration_kernel`

- `ex series` (const `relational` &`r`, int `order`, unsigned `options=0`) const override  
*Default implementation of `ex::series()`.*
- virtual `bool has_trailing_zero` (void) const

- *This routine returns true, if the integration kernel has a trailing zero.*
- virtual `ex Laurent_series` (const `ex` &x, int order) const  
*Returns the Laurent series, starting possibly with the pole term.*
- virtual `ex get_numerical_value` (const `ex` &lambda, int N\_trunc=0) const  
*Evaluates the integrand at lambda.*
- `size_t get_cache_size` (void) const  
*Returns the current size of the cache.*
- void `set_cache_step` (int cache\_steps) const  
*Sets the step size by which the cache is increased.*
- `ex get_series_coeff` (int i) const  
*Wrapper around series\_coeff(i), converts cl\_N to numeric.*
- `cln::cl_N series_coeff` (int i) const  
*Subclasses have either to implement series\_coeff\_impl or the two methods Laurent\_series and uses\_Laurent\_series.*

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf` () const  
*Evaluate object numerically.*
- virtual `ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree` () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence` () const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool `info` (unsigned inf) const  
*Information about the object.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const

- Check whether the expression matches a given pattern.*

  - virtual `ex subs` (const `exmap` &m, unsigned options=0) const

*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map` (`map_function` &f) const

*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept` (GiNaC::visitor &v) const
- virtual bool `is_polynomial` (const `ex` &var) const

*Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const

*Return degree of highest power in object s.*
- virtual int `ldegree` (const `ex` &s) const

*Return degree of lowest power in object s.*
- virtual `ex coeff` (const `ex` &s, int n=1) const

*Return coefficient of degree n in object s.*
- virtual `ex expand` (unsigned options=0) const

*Expand expression, i.e.*
- virtual `ex collect` (const `ex` &s, bool distributed=false) const

*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const

*Default implementation of `ex::normal()`.*
- virtual `ex to_rational` (`exmap` &repl) const

*Default implementation of `ex::to_rational()`.*
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const

*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const

*Implementation `ex::max_coefficient()`.*
- virtual `exvector get_free_indices` () const

*Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const

*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const

*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const

*Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T>
  - void `print_dispatch` (const `print_context` &c, unsigned level) const

*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const

*Like `print()`, but dispatch to the specified class.*
- virtual void `archive` (`archive_node` &n) const

*Save (serialize) the object into archive node.*
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)

*Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const

- *Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- const `basic` & `hold` () const  
*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const  
*Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- `cln::cl_N series_coeff_impl` (int i) const override  
*For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.*
- void `do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::integration_kernel`

- virtual bool `uses_Laurent_series` () const  
*Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).*
- `ex get_numerical_value_impl` (const `ex` &lambda, const `ex` &pre, int shift, int N\_trunc) const  
*The actual implementation for computing a numerical value for the integrand.*
- void `do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual `ex derivative` (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const

- Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

### Protected Attributes

- [ex](#) [z](#)

### Protected Attributes inherited from [GiNaC::integration\\_kernel](#)

- int [cache\\_step\\_size](#)
- std::vector< [cln::cl\\_N](#) > [series\\_vec](#)

### Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

## 6.102.1 Detailed Description

The integration kernel for multiple polylogarithms.

This class represents the differential one-form

$$\omega^{\text{mpl}}(z) = \frac{d\lambda}{\lambda - z}$$

For the case  $z = 0$  the class [basic\\_log\\_kernel](#) should be used.

## 6.102.2 Constructor & Destructor Documentation

### 6.102.2.1 [multiple\\_polylog\\_kernel](#)()

```
GiNaC::multiple_polylog_kernel::multiple_polylog_kernel (
 const ex & z)
```

References [multiple\\_polylog\\_kernel\(\)](#), and [z](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#), and [multiple\\_polylog\\_kernel\(\)](#).

### 6.102.3 Member Function Documentation

#### 6.102.3.1 nops()

```
size_t GiNaC::multiple_polylog_kernel::nops () const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

#### 6.102.3.2 op()

```
ex GiNaC::multiple_polylog_kernel::op (
 size_t i) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [z](#).

#### 6.102.3.3 let\_op()

```
ex & GiNaC::multiple_polylog_kernel::let_op (
 size_t i) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), and [z](#).

#### 6.102.3.4 is\_numeric()

```
bool GiNaC::multiple_polylog_kernel::is_numeric (
 void) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration\\_kernel](#).

References [GiNaC::info\\_flags::numeric](#), and [z](#).

#### 6.102.3.5 series\_coeff\_impl()

```
cln::cl_N GiNaC::multiple_polylog_kernel::series_coeff_impl (
 int i) const [override], [protected], [virtual]
```

For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.

The i-th coefficient corresponds to the power  $\lambda^{i-1}$ .

Reimplemented from [GiNaC::integration\\_kernel](#).

References [GiNaC::ex\\_to\(\)](#), and [z](#).

### 6.102.3.6 do\_print()

```
void GiNaC::multiple_polylog_kernel::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [GiNaC::print\\_context::s](#), and [z](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.102.4 Member Data Documentation

### 6.102.4.1 z

```
ex GiNaC::multiple_polylog_kernel::z [protected]
```

Referenced by [do\\_print\(\)](#), [is\\_numeric\(\)](#), [let\\_op\(\)](#), [multiple\\_polylog\\_kernel\(\)](#), [op\(\)](#), and [series\\_coeff\\_impl\(\)](#).

The documentation for this class was generated from the following files:

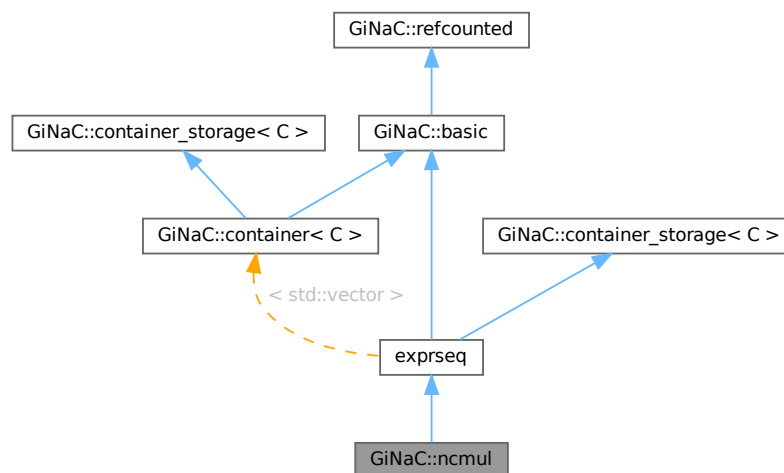
- [integration\\_kernel.h](#)
- [integration\\_kernel.cpp](#)

## 6.103 GiNaC::ncmul Class Reference

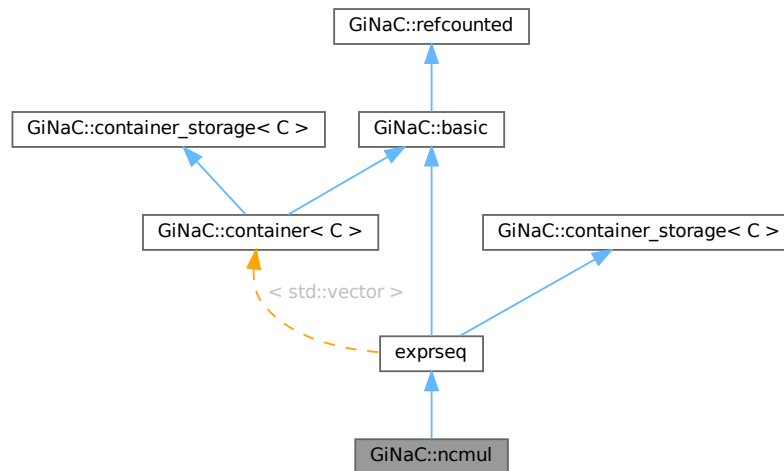
Non-commutative product of expressions.

```
#include <ncmul.h>
```

Inheritance diagram for GiNaC::ncmul:



Collaboration diagram for GiNaC::ncmul:



## Public Member Functions

- `ncmul` (const `ex` &lh, const `ex` &rh)
- `ncmul` (const `ex` &f1, const `ex` &f2, const `ex` &f3)
- `ncmul` (const `ex` &f1, const `ex` &f2, const `ex` &f3, const `ex` &f4)
- `ncmul` (const `ex` &f1, const `ex` &f2, const `ex` &f3, const `ex` &f4, const `ex` &f5)
- `ncmul` (const `ex` &f1, const `ex` &f2, const `ex` &f3, const `ex` &f4, const `ex` &f5, const `ex` &f6)
- `ncmul` (const `exvector` &v)
- `ncmul` (`exvector` &&v)
- unsigned `precedence` () const override  
*Return relative operator precedence (for parenthezing output).*
- bool `info` (unsigned inf) const override  
*Information about the object.*
- int `degree` (const `ex` &s) const override  
*Return degree of highest power in object s.*
- int `ldegree` (const `ex` &s) const override  
*Return degree of lowest power in object s.*
- `ex` `expand` (unsigned options=0) const override  
*Expand expression, i.e.*
- `ex` `coeff` (const `ex` &s, int n=1) const override  
*Return coefficient of degree n in object s.*
- `ex` `eval` () const override  
*Perform automatic term rewriting rules in this class.*
- `ex` `evalm` () const override  
*Evaluate sums, products and integer powers of matrices.*
- `exvector` `get_free_indices` () const override  
*Return a vector containing the free indices of an expression.*
- `ex` `thiscontainer` (const `exvector` &v) const override  
*Similar to `duplicate()`, but with a preset sequence.*
- `ex` `thiscontainer` (`exvector` &&v) const override



Similar to [duplicate\(\)](#), but with a preset sequence (which gets pilfered).

- [ex conjugate](#) () const override
- [ex real\\_part](#) () const override
- [ex imag\\_part](#) () const override
- const [exvector](#) & [get\\_factors](#) () const

## Public Member Functions inherited from [GiNaC::container](#)< [std::vector](#) >

- [container](#) (STLT const &s)
- [container](#) (STLT &&v)
- [container](#) (exvector::const\_iterator b, exvector::const\_iterator e)
- [container](#) (std::initializer\_list< [ex](#) > il)
- size\_t [nops](#) () const override
- *Number of operands/members.*
- [ex op](#) (size\_t i) const override
- *Return operand/member at position i.*
- [ex](#) & [let\\_op](#) (size\_t i) override
- *Return modifiable operand/member at position i.*
- [ex subs](#) (const [exmap](#) &m, unsigned options=0) const override
- *Substitute a set of objects by arbitrary expressions.*
- void [read\\_archive](#) (const [archive\\_node](#) &n, [lst](#) &sym\_lst) override
- *Load (deserialize) the object from an archive node.*
- void [archive](#) ([archive\\_node](#) &n) const override
- *Archive the object.*
- [container](#) & [prepend](#) (const [ex](#) &b)
- *Add element at front.*
- [container](#) & [append](#) (const [ex](#) &b)
- *Add element at back.*
- [container](#) & [remove\\_first](#) ()
- *Remove first element.*
- [container](#) & [remove\\_last](#) ()
- *Remove last element.*
- [container](#) & [remove\\_all](#) ()
- *Remove all elements.*
- [container](#) & [sort](#) ()
- *Sort elements.*
- [container](#) & [unique](#) ()
- *Remove adjacent duplicate elements.*
- [const\\_iterator begin](#) () const
- [const\\_iterator end](#) () const
- [const\\_reverse\\_iterator rbegin](#) () const
- [const\\_reverse\\_iterator rend](#) () const
- [container](#) (STLT const &s)
- [container](#) (STLT &&v)
- [container](#) (exvector::const\_iterator b, exvector::const\_iterator e)
- [container](#) (std::initializer\_list< [ex](#) > il)
- size\_t [nops](#) () const override
- *Number of operands/members.*
- [ex op](#) (size\_t i) const override
- *Return operand/member at position i.*
- [ex](#) & [let\\_op](#) (size\_t i) override

- Return modifiable operand/member at position i.*

  - `ex subs` (const `exmap` &m, unsigned options=0) const override

*Substitute a set of objects by arbitrary expressions.*
- void `read_archive` (const `archive_node` &n, `lst` &sym\_lst) override

*Load (deserialize) the object from an archive node.*
- void `archive` (`archive_node` &n) const override

*Archive the object.*
- `container` & `prepend` (const `ex` &b)

*Add element at front.*
- `container` & `append` (const `ex` &b)

*Add element at back.*
- `container` & `remove_first` ()

*Remove first element.*
- `container` & `remove_last` ()

*Remove last element.*
- `container` & `remove_all` ()

*Remove all elements.*
- `container` & `sort` ()

*Sort elements.*
- `container` & `unique` ()

*Remove adjacent duplicate elements.*
- `const_iterator begin` () const
- `const_iterator end` () const
- `const_reverse_iterator rbegin` () const
- `const_reverse_iterator rend` () const

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
- basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)
- basic assignment operator: the other object might be of a derived class.*
- virtual `basic` \* `duplicate` () const
- Create a clone of this object on the heap.*
- virtual `ex evalf` () const
- Evaluate object numerically.*
- virtual `ex eval_integ` () const
- Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const
- Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const
- Output to stream.*
- virtual void `dbgprint` () const
- Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree` () const
- Little wrapper around printtree to be called within a debugger.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex` & `operator[]` (const `ex` &index)
- virtual `ex` & `operator[]` (size\_t i)

- virtual bool **has** (const **ex** &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool **match** (const **ex** &pattern, **exmap** &repls) const  
*Check whether the expression matches a given pattern.*
- virtual **ex map** (**map\_function** &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void **accept** (GiNaC::visitor &v) const
- virtual bool **is\_polynomial** (const **ex** &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual **ex collect** (const **ex** &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual **ex series** (const **relational** &r, int order, unsigned options=0) const  
*Default implementation of **ex::series()**.*
- virtual **ex normal** (**exmap** &repl, **exmap** &rev\_lookup, **lst** &modifier) const  
*Default implementation of **ex::normal()**.*
- virtual **ex to\_rational** (**exmap** &repl) const  
*Default implementation of **ex::to\_rational()**.*
- virtual **ex to\_polynomial** (**exmap** &repl) const
- virtual **numeric integer\_content** () const
- virtual **ex smod** (const **numeric** &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual **numeric max\_coefficient** () const  
*Implementation **ex::max\_coefficient()**.*
- virtual **ex add\_indexed** (const **ex** &self, const **ex** &other) const  
*Add two indexed expressions.*
- virtual **ex scalar\_mul\_indexed** (const **ex** &self, const **numeric** &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool **contract\_with** (exvector::iterator self, exvector::iterator other, **exvector** &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- template<class T>  
void **print\_dispatch** (const **print\_context** &c, unsigned level) const  
*Like **print()**, but dispatch to the specified class.*
- void **print\_dispatch** (const **registered\_class\_info** &ri, const **print\_context** &c, unsigned level) const  
*Like **print()**, but dispatch to the specified class.*
- **ex subs\_one\_level** (const **exmap** &m, unsigned options) const  
*Helper function for **subs()**.*
- **ex diff** (const **symbol** &s, unsigned nth=1) const  
*Default interface of **nth** derivative **ex::diff(s, n)**.*
- int **compare** (const **basic** &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool **is\_equal** (const **basic** &other) const  
*Test for syntactic equality.*
- const **basic** & **hold** () const  
*Stop further evaluation.*
- unsigned **gethash** () const
- const **basic** & **setflag** (unsigned f) const  
*Set some **status\_flags**.*
- const **basic** & **clearflag** (unsigned f) const  
*Clear some **status\_flags**.*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Member Functions

- [ex\\_derivative](#) (const [symbol](#) &s) const override  
*Implementation of [ex::diff\(\)](#) for a non-commutative product.*
- unsigned [return\\_type](#) () const override
- [return\\_type\\_t](#) [return\\_type\\_tinfo](#) () const override
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_csrc](#) (const [print\\_context](#) &c, unsigned level) const
- size\_t [count\\_factors](#) (const [ex](#) &e) const
- void [append\\_factors](#) ([exvector](#) &v, const [ex](#) &e) const
- [exvector](#) [expandchildren](#) (unsigned options) const

## Protected Member Functions inherited from [GiNaC::container](#)< [std::vector](#) >

- bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if two objects of same type are equal.*
- virtual void [printseq](#) (const [print\\_context](#) &c, char openbracket, char delim, char closebracket, unsigned this↵\_precedence, unsigned upper\_precedence=0) const  
*Print sequence of contained elements.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const
- void [do\\_print\\_python](#) (const [print\\_python](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const
- [STLT](#) [subschildren](#) (const [exmap](#) &m, unsigned options=0) const
- bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if two objects of same type are equal.*
- virtual void [printseq](#) (const [print\\_context](#) &c, char openbracket, char delim, char closebracket, unsigned this↵\_precedence, unsigned upper\_precedence=0) const  
*Print sequence of contained elements.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const
- void [do\\_print\\_python](#) (const [print\\_python](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const
- [STLT](#) [subschildren](#) (const [exmap](#) &m, unsigned options=0) const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Member Functions inherited from [GiNaC::container\\_storage< C >](#)

- [container\\_storage](#) ()
- [container\\_storage](#) (size\_t n, const [ex](#) &e)
- [container\\_storage](#) (std::initializer\_list< [ex](#) > il)
- template<class In>  
  [container\\_storage](#) (In b, In e)
- void [reserve](#) (size\_t)
- [~container\\_storage](#) ()
- void [reserve](#) (size\_t n)
- void [reserve](#) (std::vector< [ex](#) > &v, size\_t n)

## Friends

- class [power](#)
- [ex reeval\\_ncmul](#) (const [exvector](#) &v)
- [ex hold\\_ncmul](#) (const [exvector](#) &v)

## Additional Inherited Members

## Public Types inherited from [GiNaC::container< std::vector >](#)

- typedef STLT::const\_iterator [const\\_iterator](#)
- typedef STLT::const\_reverse\_iterator [const\\_reverse\\_iterator](#)

## Protected Types inherited from [GiNaC::container< std::vector >](#)

- typedef [container\\_storage](#)< std::vector >::STLT [STLT](#)

## Protected Types inherited from [GiNaC::container\\_storage< C >](#)

- typedef C< [ex](#) > [STLT](#)

## Static Protected Member Functions inherited from [GiNaC::container< std::vector >](#)

- static unsigned [get\\_default\\_flags](#) ()
- static char [get\\_open\\_delim](#) ()
- static char [get\\_close\\_delim](#) ()
- static unsigned [get\\_default\\_flags](#) ()
- static char [get\\_open\\_delim](#) ()
- static char [get\\_close\\_delim](#) ()

## Static Protected Member Functions inherited from [GiNaC::container\\_storage< C >](#)

- static void [reserve](#) ([STLT](#) &, size\_t)

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
of type [status\\_flags](#)
- unsigned [hashvalue](#)  
hash value

## Protected Attributes inherited from [GiNaC::container\\_storage< C >](#)

- [STLT seq](#)

### 6.103.1 Detailed Description

Non-commutative product of expressions.

### 6.103.2 Constructor & Destructor Documentation

#### 6.103.2.1 [ncmul\(\)](#) [1/7]

```
GiNaC::ncmul::ncmul (
 const ex & lh,
 const ex & rh)
```

Referenced by [power](#).

#### 6.103.2.2 [ncmul\(\)](#) [2/7]

```
GiNaC::ncmul::ncmul (
 const ex & f1,
 const ex & f2,
 const ex & f3)
```

**6.103.2.3 ncmul()** [3/7]

```
GiNaC::ncmul::ncmul (
 const ex & f1,
 const ex & f2,
 const ex & f3,
 const ex & f4)
```

**6.103.2.4 ncmul()** [4/7]

```
GiNaC::ncmul::ncmul (
 const ex & f1,
 const ex & f2,
 const ex & f3,
 const ex & f4,
 const ex & f5)
```

**6.103.2.5 ncmul()** [5/7]

```
GiNaC::ncmul::ncmul (
 const ex & f1,
 const ex & f2,
 const ex & f3,
 const ex & f4,
 const ex & f5,
 const ex & f6)
```

**6.103.2.6 ncmul()** [6/7]

```
GiNaC::ncmul::ncmul (
 const exvector & v)
```

**6.103.2.7 ncmul()** [7/7]

```
GiNaC::ncmul::ncmul (
 exvector && v)
```

**6.103.3 Member Function Documentation****6.103.3.1 precedence()**

```
unsigned GiNaC::ncmul::precedence () const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::container< std::vector >](#).

References [precedence\(\)](#).

Referenced by [do\\_print\(\)](#), [do\\_print\\_csrc\(\)](#), and [precedence\(\)](#).

### 6.103.3.2 info()

```
bool GiNaC::ncmul::info (
 unsigned inf) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::container< std::vector >](#).

### 6.103.3.3 degree()

```
int GiNaC::ncmul::degree (
 const ex & s) const [override], [virtual]
```

Return degree of highest power in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex\\_to\(\)](#), [GiNaC::basic::is\\_equal\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).

### 6.103.3.4 ldegree()

```
int GiNaC::ncmul::ldegree (
 const ex & s) const [override], [virtual]
```

Return degree of lowest power in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex\\_to\(\)](#), [GiNaC::basic::is\\_equal\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).

### 6.103.3.5 expand()

```
ex GiNaC::ncmul::expand (
 unsigned options = 0) const [override], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [GiNaC::dynallocate\(\)](#), [expandchildren\(\)](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::container< std::vector >::op\(\)](#), [GiNaC::rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::container\\_storage< C >::seq](#), and [GiNaC::basic::setflag\(\)](#).



### 6.103.3.6 coeff()

```
ex GiNaC::ncmul::coeff (
 const ex & s,
 int n = 1) const [override], [virtual]
```

Return coefficient of degree n in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::basic::is\\_equal\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [GiNaC::add::coeff\(\)](#).

### 6.103.3.7 eval()

```
ex GiNaC::ncmul::eval () const [override], [virtual]
```

Perform automatic term rewriting rules in this class.

In the following x, x1, x2,... stand for a symbolic variables of type ex and c, c1, c2... stand for such expressions that contain a plain number.

- $\text{ncmul}(\dots, *(x1, x2), \dots, \text{ncmul}(x3, x4), \dots) \rightarrow \text{ncmul}(\dots, x1, x2, \dots, x3, x4, \dots)$  (associativity)
- $\text{ncmul}(x) \rightarrow x$
- [ncmul\(\)](#)  $\rightarrow 1$
- $\text{ncmul}(\dots, c1, \dots, c2, \dots) \rightarrow *(c1, c2, \text{ncmul}(\dots))$  (pull out commutative elements)
- $\text{ncmul}(x1, y1, x2, y2) \rightarrow *(\text{ncmul}(x1, x2), \text{ncmul}(y1, y2))$  (collect elements of same type)
- $\text{ncmul}(x1, x2, x3, \dots) \rightarrow x::\text{eval\_ncmul}(x1, x2, x3, \dots)$

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [append\\_factors\(\)](#), [GiNaC::return\\_types::commutative](#), [count\\_factors\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::factor\(\)](#), [GiNaC::basic::flags](#), [GINAC\\_ASSERT](#), [GiNaC::make\\_flat\\_inserter::handle\\_factor\(\)](#), [GiNaC::return\\_types::noncommutative](#), [GiNaC::return\\_types::noncommutative\\_composite](#), and [GiNaC::container\\_storage< C >::seq](#).

### 6.103.3.8 evalm()

```
ex GiNaC::ncmul::evalm () const [override], [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::dynallocate\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::matrix::mul\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).

**6.103.3.9 get\_free\_indices()**

```
exvector GiNaC::ncmul::get_free_indices () const [override], [virtual]
```

Return a vector containing the free indices of an expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::find\\_free\\_and\\_dummy\(\)](#), [GiNaC::ex::get\\_free\\_indices\(\)](#), [GiNaC::container< std::vector >::nops\(\)](#), and [GiNaC::container< std::vector >::op\(\)](#).

**6.103.3.10 thiscontainer() [1/2]**

```
ex GiNaC::ncmul::thiscontainer (
 const exvector & v) const [override], [virtual]
```

Similar to [duplicate\(\)](#), but with a preset sequence.

Must be overridden by derived classes.

Reimplemented from [GiNaC::container< std::vector >](#).

References [GiNaC::dynallocate\(\)](#).

**6.103.3.11 thiscontainer() [2/2]**

```
ex GiNaC::ncmul::thiscontainer (
 exvector && v) const [override], [virtual]
```

Similar to [duplicate\(\)](#), but with a preset sequence (which gets pilfered).

Must be overridden by derived classes.

Reimplemented from [GiNaC::container< std::vector >](#).

References [GiNaC::dynallocate\(\)](#).

**6.103.3.12 conjugate()**

```
ex GiNaC::ncmul::conjugate () const [override], [virtual]
```

Reimplemented from [GiNaC::container< std::vector >](#).

References [GiNaC::container< std::vector >::begin\(\)](#), [GiNaC::container< std::vector >::conjugate\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::container< std::vector >::end\(\)](#), [GiNaC::is\\_clifford\\_tinfo\(\)](#), [GiNaC::return\\_types::noncommutative](#), [GiNaC::container< std::vector >::nops\(\)](#), [return\\_type\(\)](#), and [return\\_type\\_tinfo\(\)](#).

**6.103.3.13 real\_part()**

```
ex GiNaC::ncmul::real_part () const [override], [virtual]
```

Reimplemented from [GiNaC::container< std::vector >](#).

References [GiNaC::basic::real\\_part\(\)](#).

**6.103.3.14 imag\_part()**

```
ex GiNaC::ncmul::imag_part () const [override], [virtual]
```

Reimplemented from [GiNaC::container< std::vector >](#).

References [GiNaC::basic::imag\\_part\(\)](#).

**6.103.3.15 derivative()**

```
ex GiNaC::ncmul::derivative (
 const symbol & s) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for a non-commutative product.

It applies the product rule.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::dynallocate\(\)](#), [GiNaC::container\\_storage< C >::seq](#), and [GiNaC::ex::swap\(\)](#).

**6.103.3.16 return\_type()**

```
unsigned GiNaC::ncmul::return_type () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::commutative](#), [GiNaC::container< std::vector >::end\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::return\\_types::noncommutative](#), [GiNaC::return\\_types::noncommutative\\_composite](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [conjugate\(\)](#).

**6.103.3.17 return\_type\_tinfo()**

```
return_type_t GiNaC::ncmul::return_type_tinfo () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::make\\_return\\_type\\_t\(\)](#), [GiNaC::return\\_types::noncommutative](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [conjugate\(\)](#).

**6.103.3.18 do\_print()**

```
void GiNaC::ncmul::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [precedence\(\)](#), and [GiNaC::container< std::vector >::printseq\(\)](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.103.3.19 do\_print\_csrc()**

```
void GiNaC::ncmul::do_print_csrc (
 const print_context & c,
 unsigned level) const [protected]
```

References [precedence\(\)](#), [GiNaC::container< std::vector >::printseq\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.103.3.20 count\_factors()**

```
size_t GiNaC::ncmul::count_factors (
 const ex & e) const [protected]
```

References [GiNaC::return\\_types::commutative](#), [count\\_factors\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [GiNaC::ex::return\\_type\(\)](#).

Referenced by [count\\_factors\(\)](#), and [eval\(\)](#).

**6.103.3.21 append\_factors()**

```
void GiNaC::ncmul::append_factors (
 exvector & v,
 const ex & e) const [protected]
```

References [append\\_factors\(\)](#), [GiNaC::return\\_types::commutative](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [GiNaC::ex::return\\_type\(\)](#).

Referenced by [append\\_factors\(\)](#), and [eval\(\)](#).

**6.103.3.22 expandchildren()**

```
exvector GiNaC::ncmul::expandchildren (
 unsigned options) const [protected]
```

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [GiNaC::container< std::vector >::end\(\)](#), [GiNaC::ex::expand\(\)](#), and [GiNaC::container\\_storage< C >::seq](#).

Referenced by [expand\(\)](#).

### 6.103.3.23 get\_factors()

```
const exvector & GiNaC::ncmul::get_factors () const
```

References [GiNaC::container\\_storage< C >::seq](#).

## 6.103.4 Friends And Related Symbol Documentation

### 6.103.4.1 power

```
friend class power [friend]
```

References [hold\\_ncmul](#), [ncmul\(\)](#), [power](#), and [reeval\\_ncmul](#).

Referenced by [power](#).

### 6.103.4.2 reeval\_ncmul

```
ex reeval_ncmul (
 const exvector & v) [friend]
```

References [GiNaC::dynallocate\(\)](#).

Referenced by [power](#).

### 6.103.4.3 hold\_ncmul

```
ex hold_ncmul (
 const exvector & v) [friend]
```

References [GiNaC::\\_ex1](#), [GiNaC::dynallocate\(\)](#), and [GiNaC::status\\_flags::evaluated](#).

Referenced by [power](#).

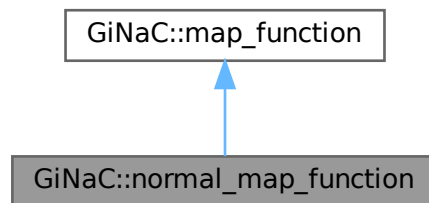
The documentation for this class was generated from the following files:

- [ncmul.h](#)
- [indexed.cpp](#)
- [ncmul.cpp](#)

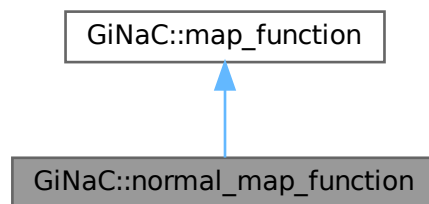
## 6.104 GiNaC::normal\_map\_function Struct Reference

Function object to be applied by [basic::normal\(\)](#).

Inheritance diagram for GiNaC::normal\_map\_function:



Collaboration diagram for GiNaC::normal\_map\_function:



### Public Member Functions

- [ex operator\(\)](#) (const [ex](#) &e) override

### Public Member Functions inherited from [GiNaC::map\\_function](#)

- virtual [~map\\_function](#) ()

### Additional Inherited Members

### Public Types inherited from [GiNaC::map\\_function](#)

- typedef const [ex](#) & [argument\\_type](#)
- typedef [ex](#) [result\\_type](#)

### 6.104.1 Detailed Description

Function object to be applied by [basic::normal\(\)](#).

### 6.104.2 Member Function Documentation

#### 6.104.2.1 operator>()()

```
ex GiNaC::normal_map_function::operator() (
 const ex & e) [inline], [override], [virtual]
```

Implements [GiNaC::map\\_function](#).

References [GiNaC::normal\(\)](#).

The documentation for this struct was generated from the following file:

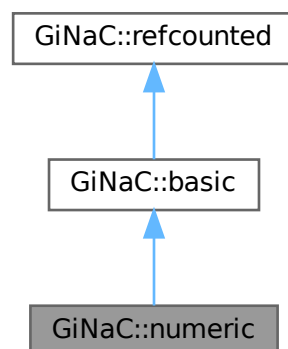
- [normal.cpp](#)

## 6.105 GiNaC::numeric Class Reference

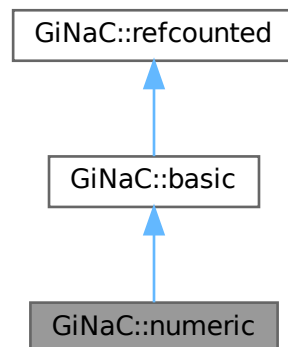
This class is a wrapper around CLN-numbers within the [GiNaC](#) class hierarchy.

```
#include <numeric.h>
```

Inheritance diagram for GiNaC::numeric:



Collaboration diagram for GiNaC::numeric:



## Public Member Functions

- [numeric](#) (int i)
- [numeric](#) (unsigned int i)
- [numeric](#) (long i)
- [numeric](#) (unsigned long i)
- [numeric](#) (long long i)
- [numeric](#) (unsigned long long i)
- [numeric](#) (long [numer](#), long [denom](#))  
*Constructor for rational numerics a/b.*
- [numeric](#) (double d)
- [numeric](#) (const char \*)  
*ctor from C-style string.*
- unsigned [precedence](#) () const override  
*Return relative operator precedence (for parenthezing output).*
- bool [info](#) (unsigned inf) const override  
*Information about the object.*
- bool [is\\_polynomial](#) (const [ex](#) &var) const override  
*Check whether this is a polynomial in the given variables.*
- int [degree](#) (const [ex](#) &s) const override  
*Return degree of highest power in object s.*
- int [ldegree](#) (const [ex](#) &s) const override  
*Return degree of lowest power in object s.*
- [ex](#) [coeff](#) (const [ex](#) &s, int n=1) const override  
*Return coefficient of degree n in object s.*
- bool [has](#) (const [ex](#) &other, unsigned options=0) const override  
*Disassemble real part and imaginary part to scan for the occurrence of a single number.*
- [ex](#) [eval](#) () const override  
*Evaluation of numbers doesn't do anything at all.*
- [ex](#) [evalf](#) () const override  
*Cast numeric into a floating-point object.*
- [ex](#) [subs](#) (const [exmap](#) &m, unsigned options=0) const override



- Substitute a set of objects by arbitrary expressions.*

  - `ex normal` (`exmap &repl`, `exmap &rev_lookup`, `lst &modifier`) const override

*Implementation of `ex::normal()` for a numeric.*
- `ex to_rational` (`exmap &repl`) const override

*Implementation of `ex::to_rational()` for a numeric.*
- `ex to_polynomial` (`exmap &repl`) const override

*Implementation of `ex::to_polynomial()` for a numeric.*
- `numeric integer_content` () const override
- `ex smod` (const `numeric &xi`) const override
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

  - `numeric max_coefficient` () const override

*Implementation `ex::max_coefficient()`.*
- `ex conjugate` () const override
- `ex real_part` () const override
- `ex imag_part` () const override
- void `archive` (`archive_node &n`) const override
- Save (a.k.a.*

  - void `read_archive` (const `archive_node &n`, `lst &syms`) override

*Read (a.k.a.*
- const `numeric add` (const `numeric &other`) const
- Numerical addition method.*
- const `numeric sub` (const `numeric &other`) const
- Numerical subtraction method.*
- const `numeric mul` (const `numeric &other`) const
- Numerical multiplication method.*
- const `numeric div` (const `numeric &other`) const
- Numerical division method.*
- const `numeric power` (const `numeric &other`) const
- Numerical exponentiation.*
- const `numeric & add_dyn` (const `numeric &other`) const
- Numerical addition method.*
- const `numeric & sub_dyn` (const `numeric &other`) const
- Numerical subtraction method.*
- const `numeric & mul_dyn` (const `numeric &other`) const
- Numerical multiplication method.*
- const `numeric & div_dyn` (const `numeric &other`) const
- Numerical division method.*
- const `numeric & power_dyn` (const `numeric &other`) const
- Numerical exponentiation.*
- const `numeric & operator=` (int i)
- const `numeric & operator=` (unsigned int i)
- const `numeric & operator=` (long i)
- const `numeric & operator=` (unsigned long i)
- const `numeric & operator=` (double d)
- const `numeric & operator=` (const char \*s)
- const `numeric inverse` () const
- Inverse of a number.*
- `numeric step` () const
- Return the step function of a numeric.*
- int `csgn` () const
- Return the complex half-plane (left or right) in which the number lies.*

- int `compare` (const `numeric` &other) const  
*This method establishes a canonical order on all numbers.*
- bool `is_equal` (const `numeric` &other) const
- bool `is_zero` () const  
*True if object is zero.*
- bool `is_positive` () const  
*True if object is not complex and greater than zero.*
- bool `is_negative` () const  
*True if object is not complex and less than zero.*
- bool `is_integer` () const  
*True if object is a non-complex integer.*
- bool `is_pos_integer` () const  
*True if object is an exact integer greater than zero.*
- bool `is_nonneg_integer` () const  
*True if object is an exact integer greater or equal zero.*
- bool `is_even` () const  
*True if object is an exact even integer.*
- bool `is_odd` () const  
*True if object is an exact odd integer.*
- bool `is_prime` () const  
*Probabilistic primality test.*
- bool `is_rational` () const  
*True if object is an exact rational number, may even be complex (denominator may be unity).*
- bool `is_real` () const  
*True if object is a real integer, rational or float (but not complex).*
- bool `is_cinteger` () const  
*True if object is element of the domain of integers extended by I, i.e.*
- bool `is_crational` () const  
*True if object is an exact rational number, may even be complex (denominator may be unity).*
- bool `operator==` (const `numeric` &other) const
- bool `operator!=` (const `numeric` &other) const
- bool `operator<` (const `numeric` &other) const  
*Numerical comparison: less.*
- bool `operator<=` (const `numeric` &other) const  
*Numerical comparison: less or equal.*
- bool `operator>` (const `numeric` &other) const  
*Numerical comparison: greater.*
- bool `operator>=` (const `numeric` &other) const  
*Numerical comparison: greater or equal.*
- int `to_int` () const  
*Converts numeric types to machine's int.*
- long `to_long` () const  
*Converts numeric types to machine's long.*
- double `to_double` () const  
*Converts numeric types to machine's double.*
- `cln::cl_N` `to_cl_N` () const  
*Returns a new CLN object of type `cl_N`, representing the value of `*this`.*
- const `numeric` `real` () const  
*Real part of a number.*
- const `numeric` `imag` () const  
*Imaginary part of a number.*

- const `numeric numer ()` const  
*Numerator.*
- const `numeric denom ()` const  
*Denominator.*
- int `int_length ()` const  
*Size in binary notation.*
- `numeric (const cln::cl_N &z)`  
*Ctor from CLN types.*

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic ()`  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic (const basic &other)`
- const `basic & operator= (const basic &other)`  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate ()` const  
*Create a clone of this object on the heap.*
- virtual `ex evalm ()` const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ ()` const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed (const basic &i)` const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print (const print_context &c, unsigned level=0)` const  
*Output to stream.*
- virtual void `dbgprint ()` const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree ()` const  
*Little wrapper around printtree to be called within a debugger.*
- virtual size\_t `nops ()` const  
*Number of operands/members.*
- virtual `ex op (size_t i)` const  
*Return operand/member at position i.*
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex & let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual bool `match (const ex &pattern, exmap &repls)` const  
*Check whether the expression matches a given pattern.*
- virtual `ex map (map_function &f)` const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept (GiNaC::visitor &v)` const
- virtual `ex expand (unsigned options=0)` const  
*Expand expression, i.e.*
- virtual `ex collect (const ex &s, bool distributed=false)` const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series (const relational &r, int order, unsigned options=0)` const

- *Default implementation of `ex::series()`.*
- virtual `exvector get_free_indices ()` const  
*Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed (const ex &self, const ex &other)` const  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed (const ex &self, const numeric &other)` const  
*Multiply an indexed expression with a scalar.*
- virtual `bool contract_with (exvector::iterator self, exvector::iterator other, exvector &v)` const  
*Try to contract two indexed expressions that appear in the same product.*
- virtual `unsigned return_type ()` const
- virtual `return_type_t return_type_tinfo ()` const
- `template<class T>`  
void `print_dispatch (const print_context &c, unsigned level)` const  
*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch (const registered_class_info &ri, const print_context &c, unsigned level)` const  
*Like `print()`, but dispatch to the specified class.*
- `ex subs_one_level (const exmap &m, unsigned options)` const  
*Helper function for `subs()`.*
- `ex diff (const symbol &s, unsigned nth=1)` const  
*Default interface of `nth` derivative `ex::diff(s, n)`.*
- `int compare (const basic &other)` const  
*Compare objects syntactically to establish canonical ordering.*
- `bool is_equal (const basic &other)` const  
*Test for syntactic equality.*
- `const basic & hold ()` const  
*Stop further evaluation.*
- `unsigned gethash ()` const
- `const basic & setflag (unsigned f)` const  
*Set some `status_flags`.*
- `const basic & clearflag (unsigned f)` const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted ()` noexcept
- `unsigned int add_reference ()` noexcept
- `unsigned int remove_reference ()` noexcept
- `unsigned int get_refcount ()` const noexcept
- `void set_refcount (unsigned int r)` noexcept

## Protected Member Functions

- `ex derivative (const symbol &s)` const override  
*Implementation of `ex::diff` for a numeric always returns 0.*
- `bool is_equal_same_type (const basic &other)` const override  
*Returns true if two objects of same type are equal.*
- `unsigned calchash ()` const override  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `print_numeric (const print_context &c, const char *par_open, const char *par_close, const char *imag←_sym, const char *mul_sym, unsigned level)` const
- void `do_print (const print_context &c, unsigned level)` const
- void `do_print_latex (const print_latex &c, unsigned level)` const
- void `do_print_csrc (const print_csrc &c, unsigned level)` const
- void `do_print_csrc_cl_N (const print_csrc_cl_N &c, unsigned level)` const
- void `do_print_tree (const print_tree &c, unsigned level)` const
- void `do_print_python_repr (const print_python_repr &c, unsigned level)` const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Attributes

- `cln::cl_N` [value](#)

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.105.1 Detailed Description

This class is a wrapper around CLN-numbers within the [GiNaC](#) class hierarchy.

Objects of this type may directly be created by the user.

### 6.105.2 Constructor & Destructor Documentation

#### 6.105.2.1 [numeric](#)() [1/10]

```
GiNaC::numeric::numeric (
 int i)
```

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

Referenced by [add\(\)](#), [add\\_dyn\(\)](#), [compare\(\)](#), [conjugate\(\)](#), [denom\(\)](#), [div\(\)](#), [div\\_dyn\(\)](#), [evalf\(\)](#), [has\(\)](#), [imag\(\)](#), [imag\\_part\(\)](#), [integer\\_content\(\)](#), [inverse\(\)](#), [is\\_equal\(\)](#), [is\\_equal\\_same\\_type\(\)](#), [max\\_coefficient\(\)](#), [mul\(\)](#), [mul\\_dyn\(\)](#), [normal\(\)](#), [numer\(\)](#), [operator!=\(\)](#), [operator<\(\)](#), [operator<=\(\)](#), [operator=\(\)](#), [operator=\(\)](#), [operator=\(\)](#), [operator=\(\)](#), [operator=\(\)](#), [operator=\(\)](#), [operator==\(\)](#), [operator>\(\)](#), [operator>=\(\)](#), [power\(\)](#), [power\\_dyn\(\)](#), [real\(\)](#), [real\\_part\(\)](#), [smod\(\)](#), [step\(\)](#), [sub\(\)](#), [sub\\_dyn\(\)](#), [to\\_polynomial\(\)](#), and [to\\_rational\(\)](#).

**6.105.2.2 numeric() [2/10]**

```
GiNaC::numeric::numeric (
 unsigned int i)
```

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

**6.105.2.3 numeric() [3/10]**

```
GiNaC::numeric::numeric (
 long i)
```

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

**6.105.2.4 numeric() [4/10]**

```
GiNaC::numeric::numeric (
 unsigned long i)
```

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

**6.105.2.5 numeric() [5/10]**

```
GiNaC::numeric::numeric (
 long long i)
```

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

**6.105.2.6 numeric() [6/10]**

```
GiNaC::numeric::numeric (
 unsigned long long i)
```

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

**6.105.2.7 numeric() [7/10]**

```
GiNaC::numeric::numeric (
 long numer,
 long denom)
```

Constructor for rational numerics a/b.

**Exceptions**

|                       |                    |
|-----------------------|--------------------|
| <i>overflow_error</i> | (division by zero) |
|-----------------------|--------------------|

References [denom\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [numer\(\)](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

### 6.105.2.8 numeric() [8/10]

```
GiNaC::numeric::numeric (
 double d)
```

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

### 6.105.2.9 numeric() [9/10]

```
GiNaC::numeric::numeric (
 const char * s)
```

ctor from C-style string.

It also accepts complex numbers in [GiNaC](#) notation like "2+5\*I".

References [GiNaC::Digits](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

### 6.105.2.10 numeric() [10/10]

```
GiNaC::numeric::numeric (
 const cln::cl_N & z) [explicit]
```

Ctor from CLN types.

This is for the initiated user or internal use only.

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

## 6.105.3 Member Function Documentation

### 6.105.3.1 precedence()

```
unsigned GiNaC::numeric::precedence () const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Referenced by [print\\_numeric\(\)](#).

### 6.105.3.2 info()

```
bool GiNaC::numeric::info (
 unsigned int) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info\\_flags::cinteger](#), [GiNaC::info\\_flags::cinteger\\_polynomial](#), [GiNaC::info\\_flags::crational](#), [GiNaC::info\\_flags::crational\\_polynomial](#), [GiNaC::info\\_flags::even](#), [GiNaC::info\\_flags::expanded](#), [GiNaC::info\\_flags::integer](#), [GiNaC::info\\_flags::integer\\_polynomial](#), [is\\_cinteger\(\)](#), [is\\_crational\(\)](#), [is\\_even\(\)](#), [is\\_integer\(\)](#), [is\\_negative\(\)](#), [is\\_nonneg\\_integer\(\)](#), [is\\_odd\(\)](#), [is\\_pos\\_integer\(\)](#), [is\\_positive\(\)](#), [is\\_prime\(\)](#), [is\\_rational\(\)](#), [is\\_real\(\)](#), [is\\_zero\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::negint](#), [GiNaC::info\\_flags::nonnegative](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::info\\_flags::numeric](#), [GiNaC::info\\_flags::odd](#), [GiNaC::info\\_flags::polynomial](#), [GiNaC::info\\_flags::posint](#), [GiNaC::info\\_flags::positive](#), [GiNaC::info\\_flags::prime](#), [GiNaC::info\\_flags::rational](#), [GiNaC::info\\_flags::rational\\_function](#), [GiNaC::info\\_flags::rational\\_polynomial](#), and [GiNaC::info\\_flags::real](#).

Referenced by [GiNaC::zeta1\\_eval\(\)](#).

### 6.105.3.3 is\_polynomial()

```
bool GiNaC::numeric::is_polynomial (
 const ex & var) const [override], [virtual]
```

Check whether this is a polynomial in the given variables.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

### 6.105.3.4 degree()

```
int GiNaC::numeric::degree (
 const ex & s) const [override], [virtual]
```

Return degree of highest power in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

### 6.105.3.5 ldegree()

```
int GiNaC::numeric::ldegree (
 const ex & s) const [override], [virtual]
```

Return degree of lowest power in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).



### 6.105.3.6 `coeff()`

```
ex GiNaC::numeric::coeff (
 const ex & s,
 int n = 1) const [override], [virtual]
```

Return coefficient of degree  $n$  in object  $s$ .

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), and [GiNaC::basic::ex](#).

Referenced by [GiNaC::pseries::mul\\_const\(\)](#).

### 6.105.3.7 has()

```
bool GiNaC::numeric::has (
 const ex & other,
 unsigned options = 0) const [override], [virtual]
```

Disassemble real part and imaginary part to scan for the occurrence of a single number.

Also handles the imaginary unit. It ignores the sign on both this and the argument, which may lead to what might appear as funny results:  $(2+i).has(-2) \rightarrow true$ . But this is consistent, since we also would like to have  $(-2+i).has(2) \rightarrow true$  and we want to think about the sign as a multiplicative factor.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::num0\\_p](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::l](#), [imag\(\)](#), [is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [is\\_real\(\)](#), [is\\_zero\(\)](#), [numeric\(\)](#), and [real\(\)](#).

### 6.105.3.8 eval()

```
ex GiNaC::numeric::eval () const [override], [virtual]
```

Evaluation of numbers doesn't do anything at all.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), and [GiNaC::basic::hold\(\)](#).

### 6.105.3.9 evalf()

```
ex GiNaC::numeric::evalf () const [override], [virtual]
```

Cast numeric into a floating-point object.

For example `exact numeric(1)` is returned as a `1.00000000000000000000` and so on according to how Digits is currently set. In case the object already was a floating point number the precision is trimmed to match the currently set default.

## Returns

an ex-handle to a numeric.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), [numeric\(\)](#), and [value](#).

**6.105.3.10 subs()**

```
ex GiNaC::numeric::subs (
 const exmap & m,
 unsigned options = 0) const [inline], [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), and [GiNaC::basic::subs\\_one\\_level\(\)](#).

**6.105.3.11 normal()**

```
ex GiNaC::numeric::normal (
 exmap & repl,
 exmap & rev_lookup,
 lst & modifier) const [override], [virtual]
```

Implementation of [ex::normal\(\)](#) for a numeric.

It splits complex numbers into  $re+I*im$  and replaces  $I$  and non-rational real numbers with a temporary symbol.

See also

[ex::normal](#)

Reimplemented from [GiNaC::basic](#).

References [denom\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::I](#), [imag\(\)](#), [is\\_integer\(\)](#), [is\\_rational\(\)](#), [is\\_real\(\)](#), [numer\(\)](#), [numeric\(\)](#), [real\(\)](#), and [GiNaC::replace\\_with\\_symbol\(\)](#).

**6.105.3.12 to\_rational()**

```
ex GiNaC::numeric::to_rational (
 exmap & repl) const [override], [virtual]
```

Implementation of [ex::to\\_rational\(\)](#) for a numeric.

It splits complex numbers into  $re+I*im$  and replaces  $I$  and non-rational real numbers with a temporary symbol.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), [GiNaC::I](#), [imag\(\)](#), [is\\_rational\(\)](#), [is\\_real\(\)](#), [numeric\(\)](#), [real\(\)](#), and [GiNaC::replace\\_with\\_symbol\(\)](#).

**6.105.3.13 to\_polynomial()**

```
ex GiNaC::numeric::to_polynomial (
 exmap & repl) const [override], [virtual]
```

Implementation of [ex::to\\_polynomial\(\)](#) for a numeric.

It splits complex numbers into re+I\*im and replaces I and non-integer real numbers with a temporary symbol.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), [GiNaC::I](#), [imag\(\)](#), [is\\_integer\(\)](#), [is\\_real\(\)](#), [numeric\(\)](#), [real\(\)](#), and [GiNaC::replace\\_with\\_symbol\(\)](#).

**6.105.3.14 integer\_content()**

```
numeric GiNaC::numeric::integer_content () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::abs\(\)](#), and [numeric\(\)](#).

Referenced by [GiNaC::mul::eval\(\)](#).

**6.105.3.15 smod()**

```
ex GiNaC::numeric::smod (
 const numeric & xi) const [override], [virtual]
```

Apply symmetric modular homomorphism to an expanded multivariate polynomial.

This function is usually used internally by [heur\\_gcd\(\)](#).

**Parameters**

|      |         |
|------|---------|
| $xi$ | modulus |
|------|---------|

**Returns**

mapped polynomial

**See also**

[heur\\_gcd](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), [numeric\(\)](#), and [GiNaC::smod\(\)](#).

#### 6.105.3.16 max\_coefficient()

```
numeric GiNaC::numeric::max_coefficient () const [override], [virtual]
```

Implementation [ex::max\\_coefficient\(\)](#).

See also

[heur\\_gcd](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::abs\(\)](#), and [numeric\(\)](#).

#### 6.105.3.17 conjugate()

```
ex GiNaC::numeric::conjugate () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), [is\\_real\(\)](#), [numeric\(\)](#), and [value](#).

#### 6.105.3.18 real\_part()

```
ex GiNaC::numeric::real_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), [numeric\(\)](#), and [value](#).

#### 6.105.3.19 imag\_part()

```
ex GiNaC::numeric::imag_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), [numeric\(\)](#), and [value](#).

#### 6.105.3.20 archive()

```
void GiNaC::numeric::archive (
 archive_node & n) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::add\\_string\(\)](#), [value](#), and [GiNaC::write\\_real\\_float\(\)](#).

**6.105.3.21 read\_archive()**

```
void GiNaC::numeric::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::archive\\_node::find\\_string\(\)](#), [GiNaC::read\\_real\\_float\(\)](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

**6.105.3.22 derivative()**

```
ex GiNaC::numeric::derivative (
 const symbol & s) const [inline], [override], [protected], [virtual]
```

Implementation of [ex::diff](#) for a numeric always returns 0.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.105.3.23 is\_equal\_same\_type()**

```
bool GiNaC::numeric::is_equal_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare\\_same\\_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::basic\(\)](#), [GINAC\\_ASSERT](#), [is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [numeric\(\)](#).

**6.105.3.24 calchash()**

```
unsigned GiNaC::numeric::calchash () const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::golden\\_ratio\\_hash\(\)](#), [GiNaC::status\\_flags::hash\\_calculated](#), [GiNaC::basic::hashvalue](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

#### 6.105.3.25 add()

```
const numeric GiNaC::numeric::add (
 const numeric & other) const
```

Numerical addition method.

Adds argument to \*this and returns result as a numeric object.

References [numeric\(\)](#), and [value](#).

Referenced by [GiNaC::multinomial\\_coefficient\(\)](#), [GiNaC::operator+\(\)](#), [GiNaC::operator++\(\)](#), [GiNaC::operator++\(\)](#), [GiNaC::operator+=\(\)](#), [GiNaC::operator--\(\)](#), and [GiNaC::operator--\(\)](#).

#### 6.105.3.26 sub()

```
const numeric GiNaC::numeric::sub (
 const numeric & other) const
```

Numerical subtraction method.

Subtracts argument from \*this and returns result as a numeric object.

References [numeric\(\)](#), and [value](#).

Referenced by [GiNaC::operator-\(\)](#), [GiNaC::operator-=\(\)](#), and [GiNaC::tgamma\\_eval\(\)](#).

#### 6.105.3.27 mul()

```
const numeric GiNaC::numeric::mul (
 const numeric & other) const
```

Numerical multiplication method.

Multiplies \*this and argument and returns result as a numeric object.

References [numeric\(\)](#), and [value](#).

Referenced by [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::lcm\(\)](#), [GiNaC::multinomial\\_coefficient\(\)](#), [GiNaC::operator\\*\(\)](#), [GiNaC::operator\\*=\(\)](#), and [GiNaC::tgamma\\_eval\(\)](#).

#### 6.105.3.28 div()

```
const numeric GiNaC::numeric::div (
 const numeric & other) const
```

Numerical division method.

Divides \*this by argument and returns result as a numeric object.

## Exceptions

|                             |                    |
|-----------------------------|--------------------|
| <code>overflow_error</code> | (division by zero) |
|-----------------------------|--------------------|

References [numeric\(\)](#), and [value](#).

Referenced by [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::multinomial\\_coefficient\(\)](#), [GiNaC::operator/\(\)](#), [GiNaC::operator/=\(\(\)\)](#), [GiNaC::basic::series\(\)](#), and [GiNaC::tgamma\\_eval\(\)](#).

**6.105.3.29 power()**

```
const numeric GiNaC::numeric::power (
 const numeric & other) const
```

Numerical exponentiation.

Raises \*this to the power given as argument and returns result as a numeric object.

References [GiNaC::\\_num0\\_p](#), [GiNaC::\\_num1\\_p](#), [numeric\(\)](#), and [value](#).

Referenced by [GiNaC::power::eval\(\)](#), [GiNaC::power::expand\\_add\(\)](#), and [GiNaC::pow\(\)](#).

**6.105.3.30 add\_dyn()**

```
const numeric & GiNaC::numeric::add_dyn (
 const numeric & other) const
```

Numerical addition method.

Adds argument to \*this and returns result as a numeric object on the heap. Use internally only for direct wrapping into an ex object, where the result would end up on the heap anyways.

References [GiNaC::\\_num0\\_p](#), [GiNaC::dynallocate\(\)](#), [numeric\(\)](#), and [value](#).

**6.105.3.31 sub\_dyn()**

```
const numeric & GiNaC::numeric::sub_dyn (
 const numeric & other) const
```

Numerical subtraction method.

Subtracts argument from \*this and returns result as a numeric object on the heap. Use internally only for direct wrapping into an ex object, where the result would end up on the heap anyways.

References [GiNaC::\\_num0\\_p](#), [GiNaC::dynallocate\(\)](#), [numeric\(\)](#), and [value](#).

**6.105.3.32 mul\_dyn()**

```
const numeric & GiNaC::numeric::mul_dyn (
 const numeric & other) const
```

Numerical multiplication method.

Multiplies *\*this* and argument and returns result as a numeric object on the heap. Use internally only for direct wrapping into an ex object, where the result would end up on the heap anyways.

References [GiNaC::\\_num1\\_p](#), [GiNaC::dynallocate\(\)](#), [numeric\(\)](#), and [value](#).

**6.105.3.33 div\_dyn()**

```
const numeric & GiNaC::numeric::div_dyn (
 const numeric & other) const
```

Numerical division method.

Divides *\*this* by argument and returns result as a numeric object on the heap. Use internally only for direct wrapping into an ex object, where the result would end up on the heap anyways.

**Exceptions**

|                       |                    |
|-----------------------|--------------------|
| <i>overflow_error</i> | (division by zero) |
|-----------------------|--------------------|

References [GiNaC::\\_num1\\_p](#), [GiNaC::dynallocate\(\)](#), [numeric\(\)](#), and [value](#).

**6.105.3.34 power\_dyn()**

```
const numeric & GiNaC::numeric::power_dyn (
 const numeric & other) const
```

Numerical exponentiation.

Raises *\*this* to the power given as argument and returns result as a numeric object on the heap. Use internally only for direct wrapping into an ex object, where the result would end up on the heap anyways.

References [GiNaC::\\_num0\\_p](#), [GiNaC::\\_num1\\_p](#), [GiNaC::dynallocate\(\)](#), [numeric\(\)](#), and [value](#).

**6.105.3.35 operator=() [1/6]**

```
const numeric & GiNaC::numeric::operator= (
 int i)
```

References [numeric\(\)](#), and [operator=\(\)](#).

Referenced by [operator=\(\)](#), [operator=\(\)](#), [operator=\(\)](#), [operator=\(\)](#), [operator=\(\)](#), and [operator=\(\)](#).



**6.105.3.36 operator=()** [2/6]

```
const numeric & GiNaC::numeric::operator= (
 unsigned int i)
```

References [numeric\(\)](#), and [operator=\(\)](#).

**6.105.3.37 operator=()** [3/6]

```
const numeric & GiNaC::numeric::operator= (
 long i)
```

References [numeric\(\)](#), and [operator=\(\)](#).

**6.105.3.38 operator=()** [4/6]

```
const numeric & GiNaC::numeric::operator= (
 unsigned long i)
```

References [numeric\(\)](#), and [operator=\(\)](#).

**6.105.3.39 operator=()** [5/6]

```
const numeric & GiNaC::numeric::operator= (
 double d)
```

References [numeric\(\)](#), and [operator=\(\)](#).

**6.105.3.40 operator=()** [6/6]

```
const numeric & GiNaC::numeric::operator= (
 const char * s)
```

References [numeric\(\)](#), and [operator=\(\)](#).

**6.105.3.41 inverse()**

```
const numeric GiNaC::numeric::inverse () const
```

Inverse of a number.

References [numeric\(\)](#), and [value](#).

Referenced by [GiNaC::divide\\_in\\_z\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::heur\\_gcd\\_z\(\)](#), [GiNaC::interpolate\(\)](#), [GiNaC::inverse\(\)](#), and [GiNaC::psi1\\_eval\(\)](#).

**6.105.3.42 step()**

```
numeric GiNaC::numeric::step () const
```

Return the step function of a numeric.

The imaginary part of it is ignored because the step function is generally considered real but a numeric may develop a small imaginary part due to rounding errors.

References [numeric\(\)](#), and [value](#).

Referenced by [GiNaC::step\(\)](#).

**6.105.3.43 csgn()**

```
int GiNaC::numeric::csgn () const
```

Return the complex half-plane (left or right) in which the number lies.

$\text{csgn}(x) == 0$  for  $x == 0$ ,  $\text{csgn}(x) == 1$  for  $\text{Re}(x) > 0$  or  $\text{Re}(x) = 0$  and  $\text{Im}(x) > 0$ ,  $\text{csgn}(x) == -1$  for  $\text{Re}(x) < 0$  or  $\text{Re}(x) = 0$  and  $\text{Im}(x) < 0$ .

See also

```
numeric::compare(const numeric &other)
```

References [value](#).

Referenced by [GiNaC::csgn\(\)](#).

**6.105.3.44 compare()**

```
int GiNaC::numeric::compare (
 const numeric & other) const
```

This method establishes a canonical order on all numbers.

For complex numbers this is not possible in a mathematically consistent way but we need to establish some order and it ought to be fast. So we simply define it to be compatible with our method `csgn`.

Returns

```
csgn(*this-other)
```

See also

```
numeric::csgn()
```

References [numeric\(\)](#), and [value](#).

Referenced by [GiNaC::binomial\(\)](#), and [GiNaC::power::eval\(\)](#).

### 6.105.3.45 is\_equal()

```
bool GiNaC::numeric::is_equal (
 const numeric & other) const
```

References [numeric\(\)](#), and [value](#).

Referenced by [GiNaC::cos\\_eval\(\)](#), [GiNaC::doublefactorial\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::exp\\_eval\(\)](#), [has\(\)](#), [is\\_equal\\_same\\_type\(\)](#), [GiNaC::psi2\\_eval\(\)](#), [GiNaC::sin\\_eval\(\)](#), [GiNaC::tan\\_eval\(\)](#), and [GiNaC::zeta1\\_eval\(\)](#).

### 6.105.3.46 is\_zero()

```
bool GiNaC::numeric::is_zero () const
```

True if object is zero.

References [value](#).

Referenced by [GiNaC::asinh\\_conjugate\(\)](#), [GiNaC::atan\(\)](#), [GiNaC::atan\(\)](#), [GiNaC::atan\\_conjugate\(\)](#), [GiNaC::clifford\\_to\\_1st\(\)](#), [GiNaC::expairseq::construct\\_from\\_2\\_expairseq\(\)](#), [GiNaC::expairseq::construct\\_from\\_expairseq\\_ex\(\)](#), [GiNaC::csgn\\_eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::power::expand\\_mul\(\)](#), [GiNaC::fibonacci\(\)](#), [GiNaC::fsolve\(\)](#), [GiNaC::gcd\(\)](#), [has\(\)](#), [info\(\)](#), [GiNaC::iquo\(\)](#), [GiNaC::iquo\(\)](#), [GiNaC::irem\(\)](#), [GiNaC::irem\(\)](#), [GiNaC::is\\_zero\(\)](#), [GiNaC::log\(\)](#), [GiNaC::matrix::pivot\(\)](#), [GiNaC::matrix::pow\(\)](#), [GiNaC::pseries::power\\_const\(\)](#), [GiNaC::step\\_eval\(\)](#), and [GiNaC::zeta1\\_eval\(\)](#).

### 6.105.3.47 is\_positive()

```
bool GiNaC::numeric::is_positive () const
```

True if object is not complex and greater than zero.

References [value](#).

Referenced by [GiNaC::power::eval\(\)](#), [GiNaC::power::expand\\_mul\(\)](#), [info\(\)](#), [GiNaC::is\\_positive\(\)](#), [GiNaC::psi1\\_eval\(\)](#), [GiNaC::psi2\\_eval\(\)](#), and [GiNaC::tgamma\\_eval\(\)](#).

### 6.105.3.48 is\_negative()

```
bool GiNaC::numeric::is_negative () const
```

True if object is not complex and less than zero.

References [value](#).

Referenced by [GiNaC::bernoulli\(\)](#), [GiNaC::beta\\_eval\(\)](#), [GiNaC::eta\\_eval\(\)](#), [GiNaC::eta\\_evalf\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::fibonacci\(\)](#), [info\(\)](#), [GiNaC::is\\_negative\(\)](#), and [GiNaC::pseries::power\\_const\(\)](#).

**6.105.3.49 is\_integer()**

```
bool GiNaC::numeric::is_integer () const
```

True if object is a non-complex integer.

References [value](#).

Referenced by [GiNaC::bernoulli\(\)](#), [GiNaC::beta\\_eval\(\)](#), [GiNaC::binomial\(\)](#), [GiNaC::binomial\\_sym\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::power::expand\\_mul\(\)](#), [GiNaC::fibonacci\(\)](#), [GiNaC::gcd\(\)](#), [info\(\)](#), [GiNaC::iquo\(\)](#), [GiNaC::iquo\(\)](#), [GiNaC::irem\(\)](#), [GiNaC::irem\(\)](#), [GiNaC::is\\_integer\(\)](#), [GiNaC::isqrt\(\)](#), [GiNaC::lcm\(\)](#), [GiNaC::mod\(\)](#), [normal\(\)](#), [GiNaC::psi1\\_eval\(\)](#), [GiNaC::psi2\\_eval\(\)](#), [GiNaC::smod\(\)](#), [GiNaC::tgamma\\_eval\(\)](#), [to\\_int\(\)](#), [to\\_long\(\)](#), [to\\_polynomial\(\)](#), and [GiNaC::zeta1\\_eval\(\)](#).

**6.105.3.50 is\_pos\_integer()**

```
bool GiNaC::numeric::is_pos_integer () const
```

True if object is an exact integer greater than zero.

References [value](#).

Referenced by [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::ifactor\(\)](#), [info\(\)](#), [GiNaC::is\\_pos\\_integer\(\)](#), and [GiNaC::pseries::power\\_const\(\)](#).

**6.105.3.51 is\_nonneg\_integer()**

```
bool GiNaC::numeric::is_nonneg_integer () const
```

True if object is an exact integer greater or equal zero.

References [value](#).

Referenced by [GiNaC::binomial\(\)](#), [GiNaC::binomial\\_sym\(\)](#), [GiNaC::doublefactorial\(\)](#), [GiNaC::factorial\(\)](#), [info\(\)](#), [GiNaC::is\\_nonneg\\_integer\(\)](#), and [print\\_numeric\(\)](#).

**6.105.3.52 is\_even()**

```
bool GiNaC::numeric::is_even () const
```

True if object is an exact even integer.

References [value](#).

Referenced by [GiNaC::fibonacci\(\)](#), [info\(\)](#), [GiNaC::is\\_even\(\)](#), [GiNaC::kronecker\\_symbol\(\)](#), and [GiNaC::tgamma\\_eval\(\)](#).

**6.105.3.53 is\_odd()**

```
bool GiNaC::numeric::is_odd () const
```

True if object is an exact odd integer.

References [value](#).

Referenced by [info\(\)](#), [GiNaC::is\\_discriminant\\_of\\_quadratic\\_number\\_field\(\)](#), [GiNaC::is\\_odd\(\)](#), and [GiNaC::matrix::pow\(\)](#).

**6.105.3.54 is\_prime()**

```
bool GiNaC::numeric::is_prime () const
```

Probabilistic primality test.

**Returns**

true if object is exact integer and prime.

References [value](#).

Referenced by [info\(\)](#), and [GiNaC::is\\_prime\(\)](#).

**6.105.3.55 is\_rational()**

```
bool GiNaC::numeric::is_rational () const
```

True if object is an exact rational number, may even be complex (denominator may be unity).

References [value](#).

Referenced by [GiNaC::power::eval\(\)](#), [info\(\)](#), [GiNaC::is\\_rational\(\)](#), [GiNaC::multiply\\_lcm\(\)](#), [normal\(\)](#), and [to\\_rational\(\)](#).

**6.105.3.56 is\_real()**

```
bool GiNaC::numeric::is_real () const
```

True if object is a real integer, rational or float (but not complex).

References [value](#).

Referenced by [GiNaC::atan\(\)](#), [GiNaC::atan\(\)](#), [GiNaC::beta\\_eval\(\)](#), [conjugate\(\)](#), [GiNaC::csgn\\_eval\(\)](#), [denom\(\)](#), [do\\_print\\_csrc\(\)](#), [do\\_print\\_csrc\\_cl\\_N\(\)](#), [GiNaC::eta\\_eval\(\)](#), [GiNaC::eta\\_evalf\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::fsolve\(\)](#), [has\(\)](#), [info\(\)](#), [is\\_cinteger\(\)](#), [is\\_crational\(\)](#), [GiNaC::is\\_real\(\)](#), [normal\(\)](#), [numer\(\)](#), [operator<\(\)](#), [operator<=\(\)](#), [operator>\(\)](#), [operator>=\(\)](#), [GiNaC::step\\_eval\(\)](#), [to\\_double\(\)](#), [to\\_polynomial\(\)](#), [to\\_rational\(\)](#), and [GiNaC::zeta\(\)](#).

**6.105.3.57 is\_cinteger()**

```
bool GiNaC::numeric::is_cinteger () const
```

True if object is element of the domain of integers extended by  $i$ , i.e.

is of the form  $a+bi$ , where  $a$  and  $b$  are integers.

References [is\\_real\(\)](#), and [value](#).

Referenced by [info\(\)](#), and [GiNaC::is\\_cinteger\(\)](#).

**6.105.3.58 is\_crational()**

```
bool GiNaC::numeric::is_crational () const
```

True if object is an exact rational number, may even be complex (denominator may be unity).

References [is\\_real\(\)](#), and [value](#).

Referenced by [GiNaC::power::eval\(\)](#), [info\(\)](#), and [GiNaC::is\\_crational\(\)](#).

**6.105.3.59 operator==(())**

```
bool GiNaC::numeric::operator== (
 const numeric & other) const
```

References [numeric\(\)](#), and [value](#).

**6.105.3.60 operator"!=()**

```
bool GiNaC::numeric::operator!= (
 const numeric & other) const
```

References [numeric\(\)](#), and [value](#).

**6.105.3.61 operator<()**

```
bool GiNaC::numeric::operator< (
 const numeric & other) const
```

Numerical comparison: less.

**Exceptions**

|                         |                      |
|-------------------------|----------------------|
| <i>invalid_argument</i> | (complex inequality) |
|-------------------------|----------------------|

References [is\\_real\(\)](#), [numeric\(\)](#), and [value](#).

**6.105.3.62 operator<=()**

```
bool GiNaC::numeric::operator<= (
 const numeric & other) const
```

Numerical comparison: less or equal.

**Exceptions**

|                         |                      |
|-------------------------|----------------------|
| <i>invalid_argument</i> | (complex inequality) |
|-------------------------|----------------------|

References [is\\_real\(\)](#), [numeric\(\)](#), and [value](#).

**6.105.3.63 operator>()**

```
bool GiNaC::numeric::operator> (
 const numeric & other) const
```

Numerical comparison: greater.

## Exceptions

|                         |                      |
|-------------------------|----------------------|
| <i>invalid_argument</i> | (complex inequality) |
|-------------------------|----------------------|

References [is\\_real\(\)](#), [numeric\(\)](#), and [value](#).

**6.105.3.64 operator>=()**

```
bool GiNaC::numeric::operator>= (
 const numeric & other) const
```

Numerical comparison: greater or equal.

## Exceptions

|                         |                      |
|-------------------------|----------------------|
| <i>invalid_argument</i> | (complex inequality) |
|-------------------------|----------------------|

References [is\\_real\(\)](#), [numeric\(\)](#), and [value](#).

**6.105.3.65 to\_int()**

```
int GiNaC::numeric::to_int () const
```

Converts numeric types to machine's int.

You should check with [is\\_integer\(\)](#) if the number is really an integer before calling this method. You may also consider checking the range first.

References [GINAC\\_ASSERT](#), [is\\_integer\(\)](#), and [value](#).

Referenced by [GiNaC::bernoulli\(\)](#), [GiNaC::Bernoulli\\_polynomial\(\)](#), [GiNaC::binomial\(\)](#), [GiNaC::binomial\\_sym\(\)](#), [GiNaC::doublefactorial\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::expand\\_mul\(\)](#), [GiNaC::factorial\(\)](#), [GiNaC::generalised\\_Bernoulli\\_number\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::series\\_coeff\\_impl\(\)](#), [GiNaC::Kronecker\\_dz\\_kernel::series\\_](#) and [GiNaC::to\\_int\(\)](#).

**6.105.3.66 to\_long()**

```
long GiNaC::numeric::to_long () const
```

Converts numeric types to machine's long.

You should check with [is\\_integer\(\)](#) if the number is really an integer before calling this method. You may also consider checking the range first.

References [GINAC\\_ASSERT](#), [is\\_integer\(\)](#), and [value](#).

Referenced by [GiNaC::power::expand\(\)](#), [GiNaC::power::expand\\_add\(\)](#), and [GiNaC::to\\_long\(\)](#).

**6.105.3.67 to\_double()**

```
double GiNaC::numeric::to_double () const
```

Converts numeric types to machine's double.

You should check with [is\\_real\(\)](#) if the number is really not complex before calling this method.

References [GINAC\\_ASSERT](#), [is\\_real\(\)](#), and [value](#).

Referenced by [GiNaC::to\\_double\(\)](#).

**6.105.3.68 to\_cl\_N()**

```
cln::cl_N GiNaC::numeric::to_cl_N () const
```

Returns a new CLN object of type `cl_N`, representing the value of `*this`.

This method may be used when mixing [GiNaC](#) and CLN in one project.

References [value](#).

Referenced by [GiNaC::abs\(\)](#), [GiNaC::acos\(\)](#), [GiNaC::acosh\(\)](#), [GiNaC::asin\(\)](#), [GiNaC::asinh\(\)](#), [GiNaC::atan\(\)](#), [GiNaC::atanh\(\)](#), [GiNaC::cos\(\)](#), [GiNaC::cosh\(\)](#), [GiNaC::exp\(\)](#), [GiNaC::fibonacci\(\)](#), [GiNaC::gcd\(\)](#), [GiNaC::iquo\(\)](#), [GiNaC::lcm\(\)](#), [GiNaC::lgamma\(\)](#), [GiNaC::li2\(\)](#), [GiNaC::log\(\)](#), [GiNaC::mod\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::series\\_coeff\\_impl\(\)](#), [GiNaC::sin\(\)](#), [GiNaC::sinh\(\)](#), [GiNaC::smod\(\)](#), [GiNaC::sqrt\(\)](#), [GiNaC::tan\(\)](#), [GiNaC::tanh\(\)](#), [GiNaC::tgamma\(\)](#), and [GiNaC::zeta\(\)](#).

**6.105.3.69 real()**

```
const numeric GiNaC::numeric::real () const
```

Real part of a number.

References [numeric\(\)](#), and [value](#).

Referenced by [GiNaC::atan\(\)](#), [GiNaC::csgn\\_eval\(\)](#), [GiNaC::power::eval\(\)](#), [has\(\)](#), [normal\(\)](#), [GiNaC::pseries::power\\_const\(\)](#), [GiNaC::real\(\)](#), [GiNaC::step\\_eval\(\)](#), [to\\_polynomial\(\)](#), and [to\\_rational\(\)](#).

**6.105.3.70 imag()**

```
const numeric GiNaC::numeric::imag () const
```

Imaginary part of a number.

References [numeric\(\)](#), and [value](#).

Referenced by [GiNaC::atan\(\)](#), [GiNaC::csgn\\_eval\(\)](#), [has\(\)](#), [GiNaC::imag\(\)](#), [normal\(\)](#), [GiNaC::step\\_eval\(\)](#), [to\\_polynomial\(\)](#), and [to\\_rational\(\)](#).



**6.105.3.71 numer()**

```
const numeric GiNaC::numeric::numer () const
```

Numerator.

Computes the numerator of rational numbers, rationalized numerator of complex if real and imaginary part are both rational numbers (i.e  $\text{numer}(4/3+5/6*i) == 8+5*i$ ), the number carrying the sign in all other cases.

References [is\\_real\(\)](#), [numeric\(\)](#), and [value](#).

Referenced by [GiNaC::power::eval\(\)](#), [GiNaC::frac\\_cancel\(\)](#), [normal\(\)](#), [GiNaC::numer\(\)](#), and [numeric\(\)](#).

**6.105.3.72 denom()**

```
const numeric GiNaC::numeric::denom () const
```

Denominator.

Computes the denominator of rational numbers, common integer denominator of complex if real and imaginary part are both rational numbers (i.e  $\text{denom}(4/3+5/6*i) == 6$ ), one in all other cases.

References [GiNaC::\\_num1\\_p](#), [is\\_real\(\)](#), [numeric\(\)](#), and [value](#).

Referenced by [GiNaC::denom\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::frac\\_cancel\(\)](#), [normal\(\)](#), and [numeric\(\)](#).

**6.105.3.73 int\_length()**

```
int GiNaC::numeric::int_length () const
```

Size in binary notation.

For integers, this is the smallest  $n \geq 0$  such that  $-2^n \leq x < 2^n$ . If  $x > 0$ , this is the unique  $n > 0$  such that  $2^{(n-1)} \leq x < 2^n$ .

**Returns**

number of bits (excluding sign) needed to represent that number in two's complement if it is an integer, 0 otherwise.

References [value](#).

Referenced by [GiNaC::heur\\_gcd\\_z\(\)](#).

**6.105.3.74 print\_numeric()**

```
void GiNaC::numeric::print_numeric (
 const print_context & c,
 const char * par_open,
 const char * par_close,
 const char * imag_sym,
 const char * mul_sym,
 unsigned level) const [protected]
```

References [is\\_nonneg\\_integer\(\)](#), [precedence\(\)](#), [GiNaC::print\\_real\\_number\(\)](#), [GiNaC::print\\_context::s](#), and [value](#).

Referenced by [do\\_print\(\)](#), [do\\_print\\_latex\(\)](#), and [do\\_print\\_python\\_repr\(\)](#).

**6.105.3.75 do\_print()**

```
void GiNaC::numeric::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [print\\_numeric\(\)](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.105.3.76 do\_print\_latex()**

```
void GiNaC::numeric::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

References [print\\_numeric\(\)](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.105.3.77 do\_print\_csrc()**

```
void GiNaC::numeric::do_print_csrc (
 const print_csrc & c,
 unsigned level) const [protected]
```

References [GiNaC::is\\_a\(\)](#), [is\\_real\(\)](#), [GiNaC::print\\_real\\_csrc\(\)](#), [GiNaC::print\\_context::s](#), and [value](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.105.3.78 do\_print\_csrc\_cl\_N()**

```
void GiNaC::numeric::do_print_csrc_cl_N (
 const print_csrc_cl_N & c,
 unsigned level) const [protected]
```

References [is\\_real\(\)](#), [GiNaC::print\\_real\\_cl\\_N\(\)](#), [GiNaC::print\\_context::s](#), and [value](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.105.3.79 do\_print\_tree()**

```
void GiNaC::numeric::do_print_tree (
 const print_tree & c,
 unsigned level) const [protected]
```

References [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [GiNaC::print\\_context::s](#), and [value](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.105.3.80 do\_print\_python\_repr()

```
void GiNaC::numeric::do_print_python_repr (
 const print_python_repr & c,
 unsigned level) const [protected]
```

References [print\\_numeric\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.105.4 Member Data Documentation

### 6.105.4.1 value

```
cln::cl_N GiNaC::numeric::value [protected]
```

Referenced by [add\(\)](#), [add\\_dyn\(\)](#), [archive\(\)](#), [calchash\(\)](#), [compare\(\)](#), [conjugate\(\)](#), [csgn\(\)](#), [denom\(\)](#), [div\(\)](#), [div\\_dyn\(\)](#), [do\\_print\\_csrc\(\)](#), [do\\_print\\_csrc\\_cl\\_N\(\)](#), [do\\_print\\_tree\(\)](#), [evalf\(\)](#), [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#), [imag\(\)](#), [imag\\_part\(\)](#), [int\\_length\(\)](#), [inverse\(\)](#), [is\\_cinteger\(\)](#), [is\\_crational\(\)](#), [is\\_equal\(\)](#), [is\\_even\(\)](#), [is\\_integer\(\)](#), [is\\_negative\(\)](#), [is\\_nonneg\\_integer\(\)](#), [is\\_odd\(\)](#), [is\\_pos\\_integer\(\)](#), [is\\_positive\(\)](#), [is\\_prime\(\)](#), [is\\_rational\(\)](#), [is\\_real\(\)](#), [is\\_zero\(\)](#), [mul\(\)](#), [mul\\_dyn\(\)](#), [numer\(\)](#), [numeric\(\)](#), [numeric\(\)](#), [numeric\(\)](#), [numeric\(\)](#), [numeric\(\)](#), [numeric\(\)](#), [numeric\(\)](#), [numeric\(\)](#), [numeric\(\)](#), [operator!=\(\)](#), [operator<\(\)](#), [operator<=\(\)](#), [operator==\(\)](#), [operator>\(\)](#), [operator>=\(\)](#), [power\(\)](#), [power\\_dyn\(\)](#), [print\\_numeric\(\)](#), [read\\_archive\(\)](#), [real\(\)](#), [real\\_part\(\)](#), [step\(\)](#), [sub\(\)](#), [sub\\_dyn\(\)](#), [to\\_cl\\_N\(\)](#), [to\\_double\(\)](#), [to\\_int\(\)](#), and [to\\_long\(\)](#).

The documentation for this class was generated from the following files:

- [numeric.h](#)
- [normal.cpp](#)
- [numeric.cpp](#)

## 6.106 GiNaC::op0\_is\_equal Struct Reference

```
#include <ex.h>
```

### Public Member Functions

- [bool operator\(\)](#) (const [ex](#) &lh, const [ex](#) &rh) const

## 6.106.1 Member Function Documentation

### 6.106.1.1 operator>()()

```
bool GiNaC::op0_is_equal::operator() (
 const ex & lh,
 const ex & rh) const [inline]
```

References [GiNaC::ex::is\\_equal\(\)](#), and [GiNaC::ex::op\(\)](#).

The documentation for this struct was generated from the following file:

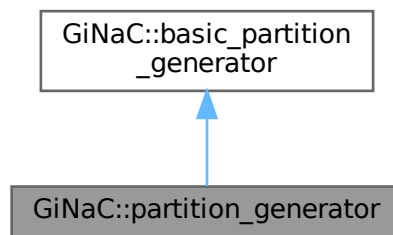
- [ex.h](#)

## 6.107 GiNaC::partition\_generator Class Reference

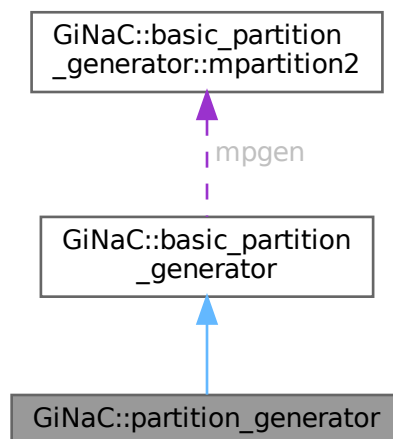
Generate all bounded combinatorial partitions of an integer  $n$  with exactly  $m$  parts (not including zero parts) in non-decreasing order.

```
#include <utils.h>
```

Inheritance diagram for GiNaC::partition\_generator:



Collaboration diagram for GiNaC::partition\_generator:



### Public Member Functions

- [partition\\_generator](#) (unsigned  $n$ , unsigned  $m$ )
- const std::vector< unsigned > & [get](#) () const
- bool [next](#) ()

### Private Attributes

- `std::vector< unsigned > partition`
- `bool current_updated`

### Additional Inherited Members

### Protected Member Functions inherited from [GiNaC::basic\\_partition\\_generator](#)

- [basic\\_partition\\_generator](#) (unsigned n\_, unsigned m\_)

### Protected Attributes inherited from [GiNaC::basic\\_partition\\_generator](#)

- `mpartition2 mpgen`

## 6.107.1 Detailed Description

Generate all bounded combinatorial partitions of an integer n with exactly m parts (not including zero parts) in non-decreasing order.

## 6.107.2 Constructor & Destructor Documentation

### 6.107.2.1 partition\_generator()

```
GiNaC::partition_generator::partition_generator (
 unsigned n_,
 unsigned m_) [inline]
```

References [GiNaC::basic\\_partition\\_generator::basic\\_partition\\_generator\(\)](#), [current\\_updated](#), and [partition](#).

## 6.107.3 Member Function Documentation

### 6.107.3.1 get()

```
const std::vector< unsigned > & GiNaC::partition_generator::get () const [inline]
```

References [current\\_updated](#), [GiNaC::basic\\_partition\\_generator::mpgen](#), and [partition](#).

### 6.107.3.2 next()

```
bool GiNaC::partition_generator::next () [inline]
```

References [current\\_updated](#), and [GiNaC::basic\\_partition\\_generator::mpgen](#).

## 6.107.4 Member Data Documentation

### 6.107.4.1 `partition`

```
std::vector<unsigned> GiNaC::partition_generator::partition [mutable], [private]
```

Referenced by [get\(\)](#), and [partition\\_generator\(\)](#).

### 6.107.4.2 `current_updated`

```
bool GiNaC::partition_generator::current_updated [mutable], [private]
```

Referenced by [get\(\)](#), [next\(\)](#), and [partition\\_generator\(\)](#).

The documentation for this class was generated from the following file:

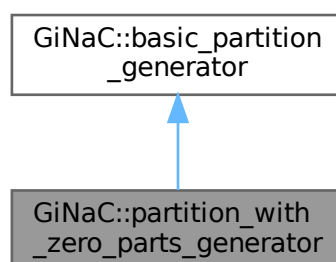
- [utils.h](#)

## 6.108 `GiNaC::partition_with_zero_parts_generator` Class Reference

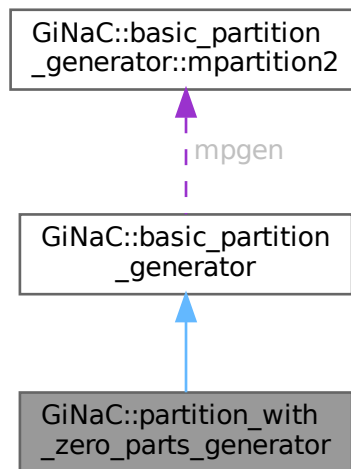
Generate all bounded combinatorial partitions of an integer  $n$  with exactly  $m$  parts (including zero parts) in non-decreasing order.

```
#include <utils.h>
```

Inheritance diagram for `GiNaC::partition_with_zero_parts_generator`:



Collaboration diagram for GiNaC::partition\_with\_zero\_parts\_generator:



### Public Member Functions

- [partition\\_with\\_zero\\_parts\\_generator](#) (unsigned n\_, unsigned m\_)
- const std::vector< unsigned > & [get](#) () const
- bool [next](#) ()

### Private Attributes

- unsigned [m](#)
- std::vector< unsigned > [partition](#)
- bool [current\\_updated](#)

### Additional Inherited Members

### Protected Member Functions inherited from [GiNaC::basic\\_partition\\_generator](#)

- [basic\\_partition\\_generator](#) (unsigned n\_, unsigned m\_)

### Protected Attributes inherited from [GiNaC::basic\\_partition\\_generator](#)

- [mpartition2](#) [mpgen](#)

## 6.108.1 Detailed Description

Generate all bounded combinatorial partitions of an integer n with exactly m parts (including zero parts) in non-decreasing order.

## 6.108.2 Constructor & Destructor Documentation

### 6.108.2.1 `partition_with_zero_parts_generator()`

```
GiNaC::partition_with_zero_parts_generator::partition_with_zero_parts_generator (
 unsigned n_,
 unsigned m_) [inline]
```

References [GiNaC::basic\\_partition\\_generator::basic\\_partition\\_generator\(\)](#), [current\\_updated](#), [m](#), and [partition](#).

## 6.108.3 Member Function Documentation

### 6.108.3.1 `get()`

```
const std::vector< unsigned > & GiNaC::partition_with_zero_parts_generator::get () const
[inline]
```

References [current\\_updated](#), [m](#), [GiNaC::basic\\_partition\\_generator::mpgen](#), and [partition](#).

Referenced by [GiNaC::power::expand\\_add\(\)](#).

### 6.108.3.2 `next()`

```
bool GiNaC::partition_with_zero_parts_generator::next () [inline]
```

References [current\\_updated](#), [m](#), and [GiNaC::basic\\_partition\\_generator::mpgen](#).

Referenced by [GiNaC::power::expand\\_add\(\)](#).

## 6.108.4 Member Data Documentation

### 6.108.4.1 `m`

```
unsigned GiNaC::partition_with_zero_parts_generator::m [private]
```

Referenced by [get\(\)](#), [next\(\)](#), and [partition\\_with\\_zero\\_parts\\_generator\(\)](#).

### 6.108.4.2 `partition`

```
std::vector<unsigned> GiNaC::partition_with_zero_parts_generator::partition [mutable], [private]
```

Referenced by [get\(\)](#), and [partition\\_with\\_zero\\_parts\\_generator\(\)](#).



#### 6.108.4.3 current\_updated

```
bool GiNaC::partition_with_zero_parts_generator::current_updated [mutable], [private]
```

Referenced by [get\(\)](#), [next\(\)](#), and [partition\\_with\\_zero\\_parts\\_generator\(\)](#).

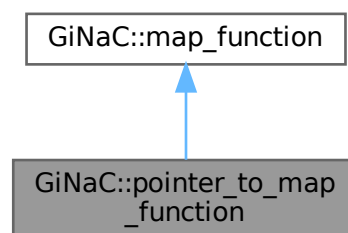
The documentation for this class was generated from the following file:

- [utils.h](#)

## 6.109 GiNaC::pointer\_to\_map\_function Class Reference

```
#include <ex.h>
```

Inheritance diagram for GiNaC::pointer\_to\_map\_function:



Collaboration diagram for `GiNaC::pointer_to_map_function`:



### Public Member Functions

- `pointer_to_map_function` (`ex` x(const `ex` &))
- `ex operator()` (const `ex` &e) override

### Public Member Functions inherited from `GiNaC::map_function`

- virtual `~map_function` ()

### Protected Attributes

- `ex(* ptr)`(const `ex` &)

### Additional Inherited Members

### Public Types inherited from `GiNaC::map_function`

- typedef const `ex` & `argument_type`
- typedef `ex` `result_type`

## 6.109.1 Constructor & Destructor Documentation

### 6.109.1.1 pointer\_to\_map\_function()

```
GiNaC::pointer_to_map_function::pointer_to_map_function (
 ex xconst ex &) [inline], [explicit]
```

References [ptr](#).

## 6.109.2 Member Function Documentation

### 6.109.2.1 operator>()()

```
ex GiNaC::pointer_to_map_function::operator() (
 const ex & e) [inline], [override], [virtual]
```

Implements [GiNaC::map\\_function](#).

References [ptr](#).

## 6.109.3 Member Data Documentation

### 6.109.3.1 ptr

```
ex(* GiNaC::pointer_to_map_function::ptr) (const ex &) [protected]
```

Referenced by [operator>\(\)\(\)](#), and [pointer\\_to\\_map\\_function\(\)](#).

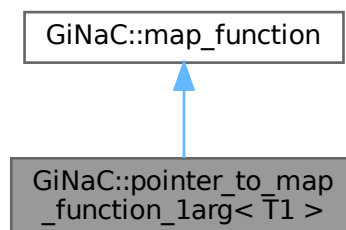
The documentation for this class was generated from the following file:

- [ex.h](#)

## 6.110 GiNaC::pointer\_to\_map\_function\_1arg< T1 > Class Template Reference

```
#include <ex.h>
```

Inheritance diagram for GiNaC::pointer\_to\_map\_function\_1arg< T1 >:



Collaboration diagram for `GiNaC::pointer_to_map_function_1arg< T1 >`:



### Public Member Functions

- `pointer_to_map_function_1arg` (`ex` x(const `ex` &, T1), T1 a1)
- `ex operator()` (const `ex` &e) override

### Public Member Functions inherited from `GiNaC::map_function`

- virtual `~map_function` ()

### Protected Attributes

- `ex(* ptr)`(const `ex` &, T1)
- T1 `arg1`

### Additional Inherited Members

### Public Types inherited from `GiNaC::map_function`

- typedef const `ex` & `argument_type`
- typedef `ex` `result_type`

## 6.110.1 Constructor & Destructor Documentation

### 6.110.1.1 pointer\_to\_map\_function\_1arg()

```
template<class T1>
GiNaC::pointer_to_map_function_1arg< T1 >::pointer_to_map_function_1arg (
 ex xconst ex &, T1,
 T1 a1) [inline], [explicit]
```

References [arg1](#), and [ptr](#).

## 6.110.2 Member Function Documentation

### 6.110.2.1 operator>()

```
template<class T1>
ex GiNaC::pointer_to_map_function_1arg< T1 >::operator() (
 const ex & e) [inline], [override], [virtual]
```

Implements [GiNaC::map\\_function](#).

References [arg1](#), and [ptr](#).

## 6.110.3 Member Data Documentation

### 6.110.3.1 ptr

```
template<class T1>
ex(* GiNaC::pointer_to_map_function_1arg< T1 >::ptr) (const ex &, T1) [protected]
```

Referenced by [operator>\(\)](#), and [pointer\\_to\\_map\\_function\\_1arg\(\)](#).

### 6.110.3.2 arg1

```
template<class T1>
T1 GiNaC::pointer_to_map_function_1arg< T1 >::arg1 [protected]
```

Referenced by [operator>\(\)](#), and [pointer\\_to\\_map\\_function\\_1arg\(\)](#).

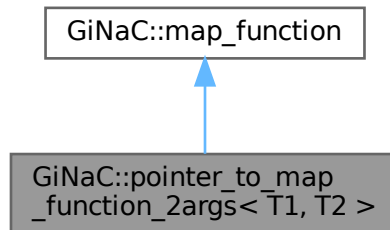
The documentation for this class was generated from the following file:

- [ex.h](#)

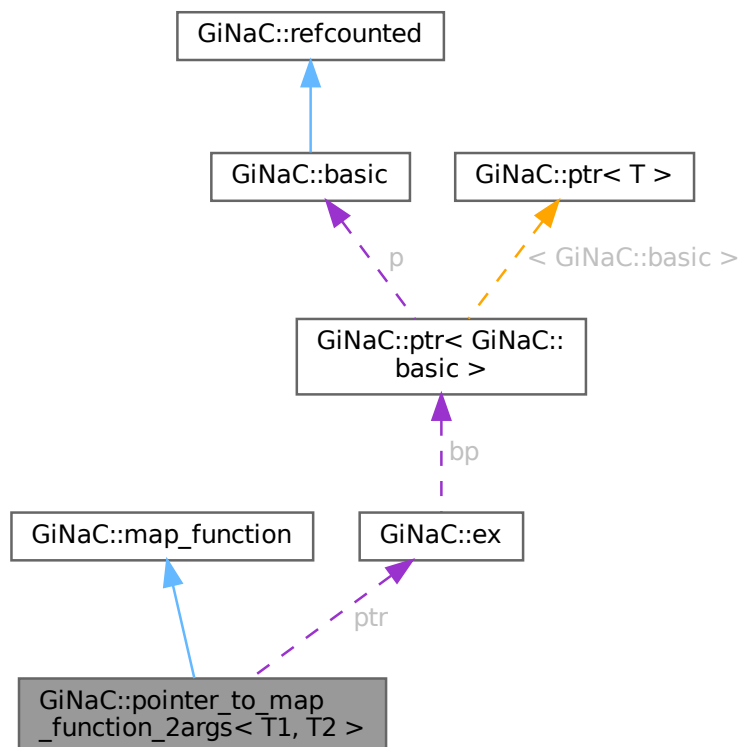
## 6.111 GiNaC::pointer\_to\_map\_function\_2args< T1, T2 > Class Template Reference

```
#include <ex.h>
```

Inheritance diagram for GiNaC::pointer\_to\_map\_function\_2args< T1, T2 >:



Collaboration diagram for GiNaC::pointer\_to\_map\_function\_2args< T1, T2 >:



## Public Member Functions

- [pointer\\_to\\_map\\_function\\_2args](#) ([ex](#) x(const [ex](#) &, T1, T2), T1 a1, T2 a2)
- [ex operator\(\)](#) (const [ex](#) &e) override

## Public Member Functions inherited from [GiNaC::map\\_function](#)

- virtual [~map\\_function](#) ()

## Protected Attributes

- [ex](#)(\* [ptr](#) )(const [ex](#) &, T1, T2)
- T1 [arg1](#)
- T2 [arg2](#)

## Additional Inherited Members

## Public Types inherited from [GiNaC::map\\_function](#)

- typedef const [ex](#) & [argument\\_type](#)
- typedef [ex](#) [result\\_type](#)

## 6.111.1 Constructor & Destructor Documentation

### 6.111.1.1 [pointer\\_to\\_map\\_function\\_2args](#)()

```
template<class T1, class T2>
GiNaC::pointer_to_map_function_2args< T1, T2 >::pointer_to_map_function_2args (
 ex xconst ex &, T1, T2,
 T1 a1,
 T2 a2) [inline], [explicit]
```

References [arg1](#), [arg2](#), and [ptr](#).

## 6.111.2 Member Function Documentation

### 6.111.2.1 [operator](#)()()

```
template<class T1, class T2>
ex GiNaC::pointer_to_map_function_2args< T1, T2 >::operator() (
 const ex & e) [inline], [override], [virtual]
```

Implements [GiNaC::map\\_function](#).

References [arg1](#), [arg2](#), and [ptr](#).

### 6.111.3 Member Data Documentation

#### 6.111.3.1 ptr

```
template<class T1, class T2>
ex(* GiNaC::pointer_to_map_function_2args< T1, T2 >::ptr) (const ex &, T1, T2) [protected]
```

Referenced by [operator\(\)\(\)](#), and [pointer\\_to\\_map\\_function\\_2args\(\)](#).

#### 6.111.3.2 arg1

```
template<class T1, class T2>
T1 GiNaC::pointer_to_map_function_2args< T1, T2 >::arg1 [protected]
```

Referenced by [operator\(\)\(\)](#), and [pointer\\_to\\_map\\_function\\_2args\(\)](#).

#### 6.111.3.3 arg2

```
template<class T1, class T2>
T2 GiNaC::pointer_to_map_function_2args< T1, T2 >::arg2 [protected]
```

Referenced by [operator\(\)\(\)](#), and [pointer\\_to\\_map\\_function\\_2args\(\)](#).

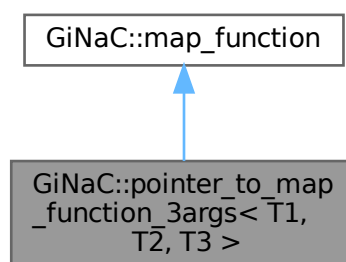
The documentation for this class was generated from the following file:

- [ex.h](#)

## 6.112 GiNaC::pointer\_to\_map\_function\_3args< T1, T2, T3 > Class Template Reference

```
#include <ex.h>
```

Inheritance diagram for GiNaC::pointer\_to\_map\_function\_3args< T1, T2, T3 >:





Collaboration diagram for GiNaC::pointer\_to\_map\_function\_3args< T1, T2, T3 >:



### Public Member Functions

- [pointer\\_to\\_map\\_function\\_3args](#) ([ex](#) x(const [ex](#) &, T1, T2, T3), T1 a1, T2 a2, T3 a3)
- [ex operator\(\)](#) (const [ex](#) &e) override

### Public Member Functions inherited from [GiNaC::map\\_function](#)

- virtual [~map\\_function](#) ()

### Protected Attributes

- [ex](#)(\* [ptr](#))(const [ex](#) &, T1, T2, T3)
- T1 [arg1](#)
- T2 [arg2](#)
- T3 [arg3](#)

### Additional Inherited Members

### Public Types inherited from [GiNaC::map\\_function](#)

- typedef const [ex](#) & [argument\\_type](#)
- typedef [ex](#) [result\\_type](#)

## 6.112.1 Constructor & Destructor Documentation

### 6.112.1.1 `pointer_to_map_function_3args()`

```
template<class T1, class T2, class T3>
GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::pointer_to_map_function_3args (
 ex xconst ex &, T1, T2, T3,
 T1 a1,
 T2 a2,
 T3 a3) [inline], [explicit]
```

References [arg1](#), [arg2](#), [arg3](#), and [ptr](#).

## 6.112.2 Member Function Documentation

### 6.112.2.1 `operator>()`

```
template<class T1, class T2, class T3>
ex GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::operator() (
 const ex & e) [inline], [override], [virtual]
```

Implements [GiNaC::map\\_function](#).

References [arg1](#), [arg2](#), [arg3](#), and [ptr](#).

## 6.112.3 Member Data Documentation

### 6.112.3.1 `ptr`

```
template<class T1, class T2, class T3>
ex(* GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::ptr) (const ex &, T1, T2, T3) [protected]
```

Referenced by [operator>\(\)](#), and [pointer\\_to\\_map\\_function\\_3args\(\)](#).

### 6.112.3.2 `arg1`

```
template<class T1, class T2, class T3>
T1 GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::arg1 [protected]
```

Referenced by [operator>\(\)](#), and [pointer\\_to\\_map\\_function\\_3args\(\)](#).

### 6.112.3.3 `arg2`

```
template<class T1, class T2, class T3>
T2 GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::arg2 [protected]
```

Referenced by [operator>\(\)](#), and [pointer\\_to\\_map\\_function\\_3args\(\)](#).

#### 6.112.3.4 arg3

```
template<class T1, class T2, class T3>
T3 GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::arg3 [protected]
```

Referenced by [operator\(\)\(\)](#), and [pointer\\_to\\_map\\_function\\_3args\(\)](#).

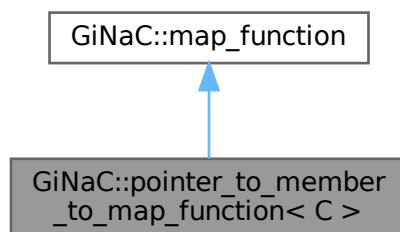
The documentation for this class was generated from the following file:

- [ex.h](#)

### 6.113 GiNaC::pointer\_to\_member\_to\_map\_function< C > Class Template Reference

```
#include <ex.h>
```

Inheritance diagram for GiNaC::pointer\_to\_member\_to\_map\_function< C >:



Collaboration diagram for `GiNaC::pointer_to_member_to_map_function< C >`:



### Public Member Functions

- `pointer_to_member_to_map_function` (`ex(C::*member)(const ex &), C &obj`)
- `ex operator()` (`const ex &e`) override

### Public Member Functions inherited from `GiNaC::map_function`

- virtual `~map_function()`

### Protected Attributes

- `ex(C::* ptr)` (`const ex &`)
- `C & c`

### Additional Inherited Members

### Public Types inherited from `GiNaC::map_function`

- typedef `const ex & argument_type`
- typedef `ex result_type`

## 6.113.1 Constructor & Destructor Documentation

### 6.113.1.1 pointer\_to\_member\_to\_map\_function()

```
template<class C>
GiNaC::pointer_to_member_to_map_function< C >::pointer_to_member_to_map_function (
 ex(C::* member) (const ex &),
 C & obj) [inline], [explicit]
```

References [c](#), and [ptr](#).

## 6.113.2 Member Function Documentation

### 6.113.2.1 operator>()()

```
template<class C>
ex GiNaC::pointer_to_member_to_map_function< C >::operator() (
 const ex & e) [inline], [override], [virtual]
```

Implements [GiNaC::map\\_function](#).

References [c](#), and [ptr](#).

## 6.113.3 Member Data Documentation

### 6.113.3.1 ptr

```
template<class C>
ex(C::* GiNaC::pointer_to_member_to_map_function< C >::ptr) (const ex &) [protected]
```

Referenced by [operator>\(\)\(\)](#), and [pointer\\_to\\_member\\_to\\_map\\_function\(\)](#).

### 6.113.3.2 c

```
template<class C>
C& GiNaC::pointer_to_member_to_map_function< C >::c [protected]
```

Referenced by [operator>\(\)\(\)](#), and [pointer\\_to\\_member\\_to\\_map\\_function\(\)](#).

The documentation for this class was generated from the following file:

- [ex.h](#)

## 6.114 GiNaC::pointer\_to\_member\_to\_map\_function\_1arg< C, T1 > Class Template Reference

```
#include <ex.h>
```

Inheritance diagram for GiNaC::pointer\_to\_member\_to\_map\_function\_1arg< C, T1 >:



Collaboration diagram for GiNaC::pointer\_to\_member\_to\_map\_function\_1arg< C, T1 >:



## Public Member Functions

- [pointer\\_to\\_member\\_to\\_map\\_function\\_1arg](#) ([ex](#)(C::\*member)(const [ex](#) &, T1), C &obj, T1 a1)
- [ex operator\(\)](#) (const [ex](#) &e) override

## Public Member Functions inherited from [GiNaC::map\\_function](#)

- virtual [~map\\_function](#) ()

## Protected Attributes

- [ex](#)(C::\* [ptr](#) )(const [ex](#) &, T1)
- C & [c](#)
- T1 [arg1](#)

## Additional Inherited Members

## Public Types inherited from [GiNaC::map\\_function](#)

- typedef const [ex](#) & [argument\\_type](#)
- typedef [ex](#) [result\\_type](#)

## 6.114.1 Constructor & Destructor Documentation

### 6.114.1.1 [pointer\\_to\\_member\\_to\\_map\\_function\\_1arg\(\)](#)

```
template<class C, class T1>
GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >::pointer_to_member_to_map_function_1arg
(
 ex(C::* member) (const ex &, T1),
 C & obj,
 T1 a1) [inline], [explicit]
```

References [arg1](#), [c](#), and [ptr](#).

## 6.114.2 Member Function Documentation

### 6.114.2.1 [operator>\(\)\(\)](#)

```
template<class C, class T1>
ex GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >::operator() (
 const ex & e) [inline], [override], [virtual]
```

Implements [GiNaC::map\\_function](#).

References [arg1](#), [c](#), and [ptr](#).

### 6.114.3 Member Data Documentation

#### 6.114.3.1 ptr

```
template<class C, class T1>
ex(C::* GiNaC::pointer_to_member_to_map_function_larg< C, T1 >::ptr) (const ex &, T1) [protected]
```

Referenced by [operator\(\)\(\)](#), and [pointer\\_to\\_member\\_to\\_map\\_function\\_1arg\(\)](#).

#### 6.114.3.2 c

```
template<class C, class T1>
C& GiNaC::pointer_to_member_to_map_function_larg< C, T1 >::c [protected]
```

Referenced by [operator\(\)\(\)](#), and [pointer\\_to\\_member\\_to\\_map\\_function\\_1arg\(\)](#).

#### 6.114.3.3 arg1

```
template<class C, class T1>
T1 GiNaC::pointer_to_member_to_map_function_larg< C, T1 >::arg1 [protected]
```

Referenced by [operator\(\)\(\)](#), and [pointer\\_to\\_member\\_to\\_map\\_function\\_1arg\(\)](#).

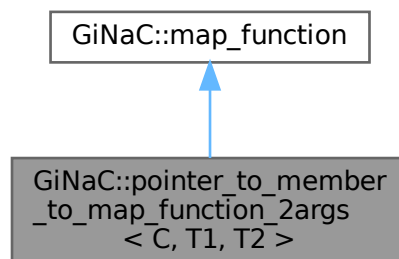
The documentation for this class was generated from the following file:

- [ex.h](#)

## 6.115 GiNaC::pointer\_to\_member\_to\_map\_function\_2args< C, T1, T2 > Class Template Reference

```
#include <ex.h>
```

Inheritance diagram for GiNaC::pointer\_to\_member\_to\_map\_function\_2args< C, T1, T2 >:





Collaboration diagram for GiNaC::pointer\_to\_member\_to\_map\_function\_2args< C, T1, T2 >:



### Public Member Functions

- [pointer\\_to\\_member\\_to\\_map\\_function\\_2args](#) ([ex](#)(C::\*[member](#))(const [ex](#) &, T1, T2), C &obj, T1 a1, T2 a2)
- [ex operator\(\)](#) (const [ex](#) &e) override

### Public Member Functions inherited from [GiNaC::map\\_function](#)

- virtual [~map\\_function](#) ()

### Protected Attributes

- [ex](#)(C::\* [ptr](#) )(const [ex](#) &, T1, T2)
- C & [c](#)
- T1 [arg1](#)
- T2 [arg2](#)

### Additional Inherited Members

### Public Types inherited from [GiNaC::map\\_function](#)

- typedef const [ex](#) & [argument\\_type](#)
- typedef [ex](#) [result\\_type](#)

## 6.115.1 Constructor & Destructor Documentation

### 6.115.1.1 `pointer_to_member_to_map_function_2args()`

```
template<class C, class T1, class T2>
GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >::pointer_to_member_to_map_function←
_2args (
 ex(C::* member) (const ex &, T1, T2),
 C & obj,
 T1 a1,
 T2 a2) [inline], [explicit]
```

References [arg1](#), [arg2](#), [c](#), and [ptr](#).

## 6.115.2 Member Function Documentation

### 6.115.2.1 `operator>()()`

```
template<class C, class T1, class T2>
ex GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >::operator() (
 const ex & e) [inline], [override], [virtual]
```

Implements [GiNaC::map\\_function](#).

References [arg1](#), [arg2](#), [c](#), and [ptr](#).

## 6.115.3 Member Data Documentation

### 6.115.3.1 `ptr`

```
template<class C, class T1, class T2>
ex(C::* GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >::ptr) (const ex &, T1, T2)
[protected]
```

Referenced by [operator>\(\)\(\)](#), and [pointer\\_to\\_member\\_to\\_map\\_function\\_2args\(\)](#).

### 6.115.3.2 `c`

```
template<class C, class T1, class T2>
C& GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >::c [protected]
```

Referenced by [operator>\(\)\(\)](#), and [pointer\\_to\\_member\\_to\\_map\\_function\\_2args\(\)](#).

### 6.115.3.3 `arg1`

```
template<class C, class T1, class T2>
T1 GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >::arg1 [protected]
```

Referenced by [operator>\(\)\(\)](#), and [pointer\\_to\\_member\\_to\\_map\\_function\\_2args\(\)](#).

## 6.115.3.4 arg2

```
template<class C, class T1, class T2>
T2 GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >::arg2 [protected]
```

Referenced by [operator\(\)\(\)](#), and [pointer\\_to\\_member\\_to\\_map\\_function\\_2args\(\)](#).

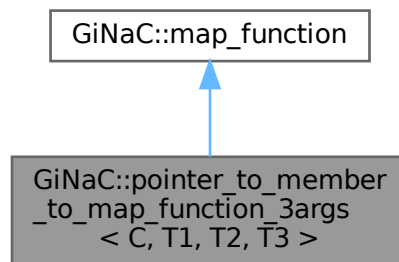
The documentation for this class was generated from the following file:

- [ex.h](#)

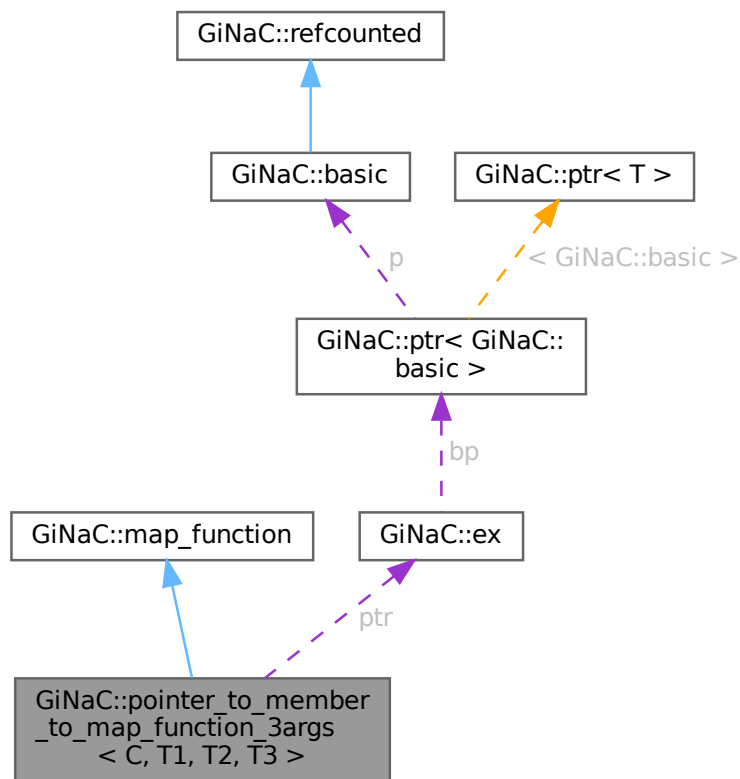
## 6.116 GiNaC::pointer\_to\_member\_to\_map\_function\_3args< C, T1, T2, T3 > Class Template Reference

```
#include <ex.h>
```

Inheritance diagram for GiNaC::pointer\_to\_member\_to\_map\_function\_3args< C, T1, T2, T3 >:



Collaboration diagram for `GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >`:



### Public Member Functions

- [pointer\\_to\\_member\\_to\\_map\\_function\\_3args](#) (`ex(C::*member)(const ex &, T1, T2, T3), C &obj, T1 a1, T2 a2, T3 a3)`)
- `ex operator()` (`const ex &e`) override

### Public Member Functions inherited from [GiNaC::map\\_function](#)

- virtual `~map_function()`

### Protected Attributes

- `ex(C::* ptr)` (`const ex &, T1, T2, T3`)
- `C & c`
- `T1 arg1`
- `T2 arg2`
- `T3 arg3`

## Additional Inherited Members

## Public Types inherited from [GiNaC::map\\_function](#)

- typedef const [ex](#) & [argument\\_type](#)
- typedef [ex](#) [result\\_type](#)

## 6.116.1 Constructor & Destructor Documentation

### 6.116.1.1 [pointer\\_to\\_member\\_to\\_map\\_function\\_3args\(\)](#)

```
template<class C, class T1, class T2, class T3>
GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::pointer_to_member_to_map_↵
function_3args (
 ex(C::* member)(const ex &, T1, T2, T3),
 C & obj,
 T1 a1,
 T2 a2,
 T3 a3) [inline], [explicit]
```

References [arg1](#), [arg2](#), [arg3](#), [c](#), and [ptr](#).

## 6.116.2 Member Function Documentation

### 6.116.2.1 [operator>\(\)\(\)](#)

```
template<class C, class T1, class T2, class T3>
ex GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::operator() (
 const ex & e) [inline], [override], [virtual]
```

Implements [GiNaC::map\\_function](#).

References [arg1](#), [arg2](#), [arg3](#), [c](#), and [ptr](#).

## 6.116.3 Member Data Documentation

### 6.116.3.1 [ptr](#)

```
template<class C, class T1, class T2, class T3>
ex(C::* GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::ptr) (const ex &, T1,
T2, T3) [protected]
```

Referenced by [operator>\(\)\(\)](#), and [pointer\\_to\\_member\\_to\\_map\\_function\\_3args\(\)](#).

### 6.116.3.2 [c](#)

```
template<class C, class T1, class T2, class T3>
C& GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::c [protected]
```

Referenced by [operator>\(\)\(\)](#), and [pointer\\_to\\_member\\_to\\_map\\_function\\_3args\(\)](#).

### 6.116.3.3 `arg1`

```
template<class C, class T1, class T2, class T3>
T1 GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::arg1 [protected]
```

Referenced by [operator\(\)\(\)](#), and [pointer\\_to\\_member\\_to\\_map\\_function\\_3args\(\)](#).

### 6.116.3.4 `arg2`

```
template<class C, class T1, class T2, class T3>
T2 GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::arg2 [protected]
```

Referenced by [operator\(\)\(\)](#), and [pointer\\_to\\_member\\_to\\_map\\_function\\_3args\(\)](#).

### 6.116.3.5 `arg3`

```
template<class C, class T1, class T2, class T3>
T3 GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::arg3 [protected]
```

Referenced by [operator\(\)\(\)](#), and [pointer\\_to\\_member\\_to\\_map\\_function\\_3args\(\)](#).

The documentation for this class was generated from the following file:

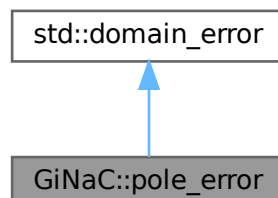
- [ex.h](#)

## 6.117 `GiNaC::pole_error` Class Reference

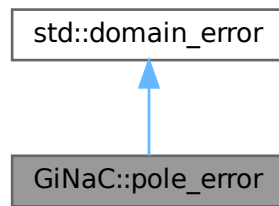
Exception class thrown when a singularity is encountered.

```
#include <numeric.h>
```

Inheritance diagram for `GiNaC::pole_error`:



Collaboration diagram for GiNaC::pole\_error:



### Public Member Functions

- `pole_error` (const std::string &what\_arg, int degree)  
*ctor for `pole_error` exception class.*
- int `degree` () const  
*Return the degree of the `pole_error` exception class.*

### Private Attributes

- int `deg`

## 6.117.1 Detailed Description

Exception class thrown when a singularity is encountered.

## 6.117.2 Constructor & Destructor Documentation

### 6.117.2.1 pole\_error()

```
GiNaC::pole_error::pole_error (
 const std::string & what_arg,
 int degree) [explicit]
```

ctor for `pole_error` exception class.

References `deg`, and `degree()`.

## 6.117.3 Member Function Documentation

### 6.117.3.1 degree()

```
int GiNaC::pole_error::degree () const
```

Return the degree of the `pole_error` exception class.

References `deg`.

Referenced by `pole_error()`.

## 6.117.4 Member Data Documentation

### 6.117.4.1 deg

```
int GiNaC::pole_error::deg [private]
```

Referenced by [degree\(\)](#), and [pole\\_error\(\)](#).

The documentation for this class was generated from the following files:

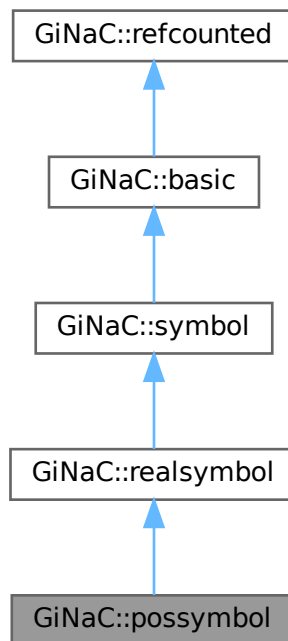
- [numeric.h](#)
- [utils.cpp](#)

## 6.118 GiNaC::possymbol Class Reference

Specialization of symbol to real positive domain.

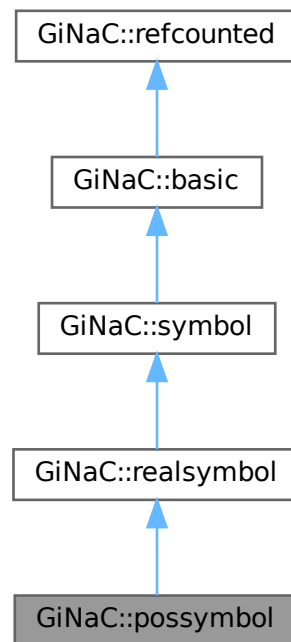
```
#include <symbol.h>
```

Inheritance diagram for GiNaC::possymbol:





Collaboration diagram for GiNaC::possymbol:



### Public Member Functions

- [possymbol](#) ()
- [possymbol](#) (const std::string &initname)
- [possymbol](#) (const std::string &initname, const std::string &texname)
- unsigned [get\\_domain](#) () const override
- [possymbol](#) \* [duplicate](#) () const override

*Create a clone of this object on the heap.*

### Public Member Functions inherited from [GiNaC::realsymbol](#)

- [realsymbol](#) ()
- [realsymbol](#) (const std::string &initname)
- [realsymbol](#) (const std::string &initname, const std::string &texname)
- unsigned [get\\_domain](#) () const override
- [ex conjugate](#) () const override
- [ex real\\_part](#) () const override
- [ex imag\\_part](#) () const override
- [realsymbol](#) \* [duplicate](#) () const override

*Create a clone of this object on the heap.*

## Public Member Functions inherited from `GiNaC::symbol`

- `symbol` (const std::string &initname)
- `symbol` (const std::string &initname, const std::string &texname)
- bool `info` (unsigned inf) const override  
*Information about the object.*
- `ex eval` () const override  
*Perform automatic non-interruptive term rewriting rules.*
- `ex evalf` () const override  
*Evaluate object numerically.*
- `ex series` (const `relational` &s, int order, unsigned options=0) const override  
*Implementation of `ex::series()` for symbols.*
- `ex subs` (const `exmap` &m, unsigned options=0) const override  
*Substitute a set of objects by arbitrary expressions.*
- `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const override  
*Implementation of `ex::normal()` for symbols.*
- `ex to_rational` (`exmap` &repl) const override  
*Implementation of `ex::to_rational()` for symbols.*
- `ex to_polynomial` (`exmap` &repl) const override  
*Implementation of `ex::to_polynomial()` for symbols.*
- `ex conjugate` () const override
- `ex real_part` () const override
- `ex imag_part` () const override
- bool `is_polynomial` (const `ex` &var) const override  
*Check whether this is a polynomial in the given variables.*
- void `archive` (`archive_node` &n) const override  
*Save (a.k.a.*
- void `read_archive` (const `archive_node` &n, `lst` &syms) override  
*Read (a.k.a.*
- void `set_name` (const std::string &n)
- void `set_TeX_name` (const std::string &n)
- std::string `get_name` () const
- std::string `get_TeX_name` () const

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*

- virtual void `dbgprinttree` () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence` () const  
*Return relative operator precedence (for parenthezing output).*
- virtual size\_t `nops` () const  
*Number of operands/members.*
- virtual `ex op` (size\_t i) const  
*Return operand/member at position i.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex & let_op` (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const  
*Check whether the expression matches a given pattern.*
- virtual `ex map` (`map_function` &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept` (GiNaC::visitor &v) const
- virtual int `degree` (const `ex` &s) const  
*Return degree of highest power in object s.*
- virtual int `ldegree` (const `ex` &s) const  
*Return degree of lowest power in object s.*
- virtual `ex coeff` (const `ex` &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual `ex expand` (unsigned options=0) const  
*Expand expression, i.e.*
- virtual `ex collect` (const `ex` &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const  
*Implementation ex::max\_coefficient().*
- virtual `exvector get_free_indices` () const  
*Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- template<class T>  
void `print_dispatch` (const `print_context` &c, unsigned level) const  
*Like print(), but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like print(), but dispatch to the specified class.*

- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- `int compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- `bool is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- `const basic & hold` () const  
*Stop further evaluation.*
- `unsigned gethash` () const
- `const basic & setflag` (unsigned f) const  
*Set some `status_flags`.*
- `const basic & clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- `unsigned int add_reference` () noexcept
- `unsigned int remove_reference` () noexcept
- `unsigned int get_refcount` () const noexcept
- `void set_refcount` (unsigned int r) noexcept

## Additional Inherited Members

## Protected Member Functions inherited from `GiNaC::symbol`

- `ex derivative` (const `symbol` &s) const override  
*Implementation of `ex::diff()` for single differentiation of a symbol.*
- `bool is_equal_same_type` (const `basic` &other) const override  
*Returns true if two objects of same type are equal.*
- `unsigned calchash` () const override  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- `void do_print` (const `print_context` &c, unsigned level) const
- `void do_print_latex` (const `print_latex` &c, unsigned level) const
- `void do_print_tree` (const `print_tree` &c, unsigned level) const
- `void do_print_python_repr` (const `print_python_repr` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- `virtual ex eval_ncmul` (const `exvector` &v) const
- `virtual bool match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- `virtual int compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- `void ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- `void do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- `void do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- `void do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Attributes inherited from [GiNaC::symbol](#)

- unsigned [serial](#)  
*unique serial number for comparison*
- std::string [name](#)  
*printrname of this symbol*
- std::string [TeX\\_name](#)  
*LaTeX name of this symbol.*

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.118.1 Detailed Description

Specialization of symbol to real positive domain.

### 6.118.2 Constructor & Destructor Documentation

#### 6.118.2.1 `possymbol()` [1/3]

```
GiNaC::possymbol::possymbol ()
```

References [GiNaC::realsymbol::realsymbol\(\)](#).

Referenced by [duplicate\(\)](#).

#### 6.118.2.2 `possymbol()` [2/3]

```
GiNaC::possymbol::possymbol (
 const std::string & initname) [explicit]
```

References [GiNaC::realsymbol::realsymbol\(\)](#).

#### 6.118.2.3 `possymbol()` [3/3]

```
GiNaC::possymbol::possymbol (
 const std::string & initname,
 const std::string & texname)
```

References [GiNaC::realsymbol::realsymbol\(\)](#).

### 6.118.3 Member Function Documentation

#### 6.118.3.1 `get_domain()`

```
unsigned GiNaC::possymbol::get_domain () const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::symbol](#).

References [GiNaC::domain::positive](#).

#### 6.118.3.2 `duplicate()`

```
possymbol * GiNaC::possymbol::duplicate () const [inline], [override], [virtual]
```

Create a clone of this object on the heap.

One can think of this as simulating a virtual copy constructor which is needed for instance by the refcounted construction of an ex from a basic.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::status\\_flags::dynallocated](#), [possymbol\(\)](#), and [GiNaC::basic::setflag\(\)](#).

The documentation for this class was generated from the following files:

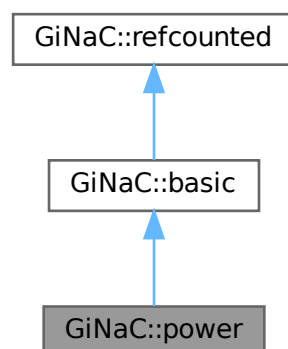
- [symbol.h](#)
- [symbol.cpp](#)

## 6.119 GiNaC::power Class Reference

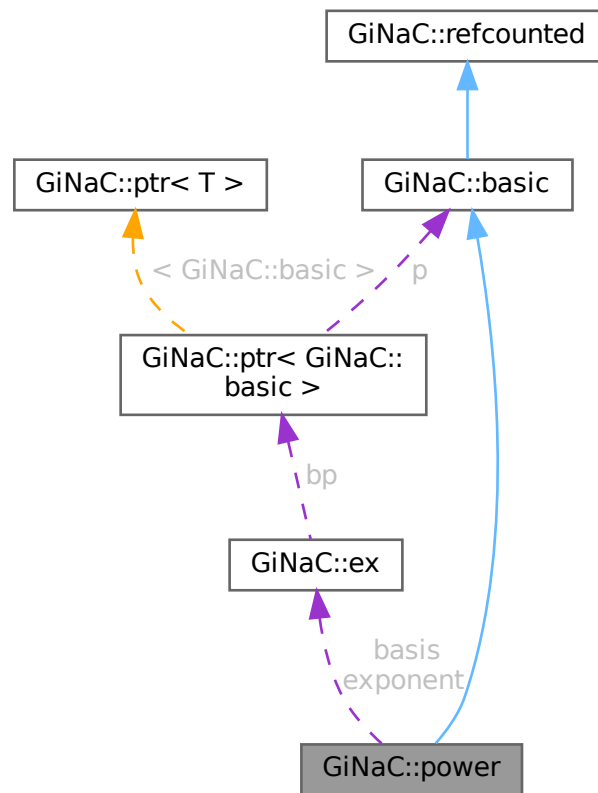
This class holds a two-component object, a basis and an exponent representing exponentiation.

```
#include <power.h>
```

Inheritance diagram for GiNaC::power:



Collaboration diagram for GiNaC::power:



## Public Member Functions

- `power` (const `ex` &lh, const `ex` &rh)
- `template<typename T>`  
`power` (const `ex` &lh, const T &rh)
- unsigned `precedence` () const override  
*Return relative operator precedence (for parenthezing output).*
- bool `info` (unsigned inf) const override  
*Information about the object.*
- `size_t nops` () const override  
*Number of operands/members.*
- `ex op` (size\_t i) const override  
*Return operand/member at position i.*
- `ex map` (`map_function` &f) const override  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- bool `is_polynomial` (const `ex` &var) const override  
*Check whether this is a polynomial in the given variables.*
- int `degree` (const `ex` &s) const override  
*Return degree of highest power in object s.*

- `int ldegree (const ex &s) const` override  
*Return degree of lowest power in object s.*
- `ex coeff (const ex &s, int n=1) const` override  
*Return coefficient of degree n in object s.*
- `ex eval ()` const override  
*Perform automatic term rewriting rules in this class.*
- `ex evalf ()` const override  
*Evaluate object numerically.*
- `ex evalm ()` const override  
*Evaluate sums, products and integer powers of matrices.*
- `ex series (const relational &s, int order, unsigned options=0) const` override  
*Implementation of [ex::series\(\)](#) for powers.*
- `ex subs (const exmap &m, unsigned options=0) const` override  
*Substitute a set of objects by arbitrary expressions.*
- `bool has (const ex &other, unsigned options=0) const` override  
*Test for occurrence of a pattern.*
- `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier) const` override  
*Implementation of [ex::normal\(\)](#) for powers.*
- `ex to_rational (exmap &repl) const` override  
*Implementation of [ex::to\\_rational\(\)](#) for powers.*
- `ex to_polynomial (exmap &repl) const` override  
*Implementation of [ex::to\\_polynomial\(\)](#) for powers.*
- `ex conjugate ()` const override
- `ex real_part ()` const override
- `ex imag_part ()` const override
- `void archive (archive\_node &n) const` override  
*Save (a.k.a.*
- `void read_archive (const archive\_node &n, lst &syms) const` override  
*Read (a.k.a.*

## Public Member Functions inherited from [GiNaC::basic](#)

- `virtual ~basic ()`  
*basic destructor, virtual because class [ex](#) will delete objects of derived classes via a [basic\\*](#).*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`  
*basic assignment operator: the other object might be of a derived class.*
- `virtual basic * duplicate () const`  
*Create a clone of this object on the heap.*
- `virtual ex eval_integ () const`  
*Evaluate integrals, if result is known.*
- `virtual ex eval_indexed (const basic &i) const`  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- `virtual void print (const print\_context &c, unsigned level=0) const`  
*Output to stream.*
- `virtual void dbgprint () const`  
*Little wrapper around print to be called within a debugger.*
- `virtual void dbgprinttree () const`  
*Little wrapper around printtree to be called within a debugger.*
- `virtual ex operator[] (const ex &index) const`



- virtual [ex operator\[\]](#) (size\_t i) const
- virtual [ex & let\\_op](#) (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual [ex & operator\[\]](#) (const [ex](#) &index)
- virtual [ex & operator\[\]](#) (size\_t i)
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const  
*Check whether the expression matches a given pattern.*
- virtual void [accept](#) (GiNaC::visitor &v) const
- virtual [ex collect](#) (const [ex](#) &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual [numeric integer\\_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual [numeric max\\_coefficient](#) () const  
*Implementation [ex::max\\_coefficient\(\)](#).*
- virtual [exvector get\\_free\\_indices](#) () const  
*Return a vector containing the free indices of an expression.*
- virtual [ex add\\_indexed](#) (const [ex](#) &self, const [ex](#) &other) const  
*Add two indexed expressions.*
- virtual [ex scalar\\_mul\\_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool [contract\\_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- template<class T>  
 void [print\\_dispatch](#) (const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- void [print\\_dispatch](#) (const [registered\\_class\\_info](#) &ri, const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- [ex subs\\_one\\_level](#) (const [exmap](#) &m, unsigned options) const  
*Helper function for [subs\(\)](#).*
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const  
*Default interface of nth derivative [ex::diff\(s, n\)](#).*
- int [compare](#) (const [basic](#) &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool [is\\_equal](#) (const [basic](#) &other) const  
*Test for syntactic equality.*
- const [basic & hold](#) () const  
*Stop further evaluation.*
- unsigned [gethash](#) () const
- const [basic & setflag](#) (unsigned f) const  
*Set some [status\\_flags](#).*
- const [basic & clearflag](#) (unsigned f) const  
*Clear some [status\\_flags](#).*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Member Functions

- `ex derivative` (const `symbol` &s) const override  
*Implementation of `ex::diff()` for a power.*
- `ex eval_ncmul` (const `exvector` &v) const override
- unsigned `return_type` () const override
- `return_type_t return_type_tinfo` () const override
- `ex expand` (unsigned options=0) const override  
*Expand expression, i.e.*
- void `print_power` (const `print_context` &c, const char \*powersymbol, const char \*openbrace, const char \*closebrace, unsigned level) const
- void `do_print_dflt` (const `print_dflt` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const
- void `do_print_csrc` (const `print_csrc` &c, unsigned level) const
- void `do_print_python` (const `print_python` &c, unsigned level) const
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
- void `do_print_csrc_cl_N` (const `print_csrc_cl_N` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned `calchash` () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void `do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

## Static Protected Member Functions

- static `ex expand_add` (const `add` &a, long n, unsigned options)  
*expand  $a^n$  where  $a$  is an add and  $n$  is a positive integer.*
- static `ex expand_add_2` (const `add` &a, unsigned options)  
*Special case of `power::expand_add`.*
- static `ex expand_mul` (const `mul` &m, const `numeric` &n, unsigned options, bool from\_expand=false)  
*Expand factors of  $m$  in  $m^n$  where  $m$  is a mul and  $n$  is an integer.*

## Protected Attributes

- `ex basis`
- `ex exponent`

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
of type [status\\_flags](#)
- unsigned [hashvalue](#)  
hash value

## Friends

- class [mul](#)

## 6.119.1 Detailed Description

This class holds a two-component object, a basis and and exponent representing exponentiation.

## 6.119.2 Constructor & Destructor Documentation

### 6.119.2.1 [power\(\)](#) [1/2]

```
GiNaC::power::power (
 const ex & lh,
 const ex & rh) [inline]
```

References [basis](#), [GiNaC::basic::ex](#), [exponent](#), and [power\(\)](#).

Referenced by [do\\_print\\_latex\(\)](#), [eval\(\)](#), and [power\(\)](#).

### 6.119.2.2 [power\(\)](#) [2/2]

```
template<typename T>
GiNaC::power::power (
 const ex & lh,
 const T & rh) [inline]
```

References [basis](#), [GiNaC::basic::ex](#), and [exponent](#).

## 6.119.3 Member Function Documentation

### 6.119.3.1 [precedence\(\)](#)

```
unsigned GiNaC::power::precedence () const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Referenced by [print\\_power\(\)](#).

### 6.119.3.2 info()

```
bool GiNaC::power::info (
 unsigned inf) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::basic](#).

References [basis](#), [GiNaC::info\\_flags::cinteger\\_polynomial](#), [GiNaC::basic::clearflag\(\)](#), [GiNaC::info\\_flags::crational\\_polynomial](#), [GiNaC::info\\_flags::even](#), [GiNaC::info\\_flags::expanded](#), [GiNaC::status\\_flags::expanded](#), [exponent](#), [GiNaC::basic::flags](#), [GiNaC::info\\_flags::has\\_indices](#), [GiNaC::status\\_flags::has\\_indices](#), [GiNaC::status\\_flags::has\\_no\\_indices](#), [GiNaC::info\\_flags::integer](#), [GiNaC::info\\_flags::integer\\_polynomial](#), [GiNaC::info\\_flags::nonnegative](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::info\\_flags::polynomial](#), [GiNaC::info\\_flags::positive](#), [GiNaC::info\\_flags::rational\\_function](#), [GiNaC::info\\_flags::rational\\_polynomial](#), [GiNaC::info\\_flags::real](#), and [GiNaC::basic::setflag\(\)](#).

### 6.119.3.3 nops()

```
size_t GiNaC::power::nops () const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

### 6.119.3.4 op()

```
ex GiNaC::power::op (
 size_t i) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [GiNaC::basic::ex](#), [exponent](#), and [GINAC\\_ASSERT](#).

### 6.119.3.5 map()

```
ex GiNaC::power::map (
 map_function & f) const [override], [virtual]
```

Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [basis](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), and [exponent](#).

### 6.119.3.6 is\_polynomial()

```
bool GiNaC::power::is_polynomial (
 const ex & var) const [override], [virtual]
```

Check whether this is a polynomial in the given variables.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [GiNaC::basic::ex](#), [exponent](#), and [GiNaC::info\\_flags::nonnegint](#).

### 6.119.3.7 degree()

```
int GiNaC::power::degree (
 const ex & s) const [override], [virtual]
```

Return degree of highest power in object s.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [exponent](#), [GiNaC::basic::is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [GiNaC::is\\_integer\(\)](#).

### 6.119.3.8 ldegree()

```
int GiNaC::power::ldegree (
 const ex & s) const [override], [virtual]
```

Return degree of lowest power in object s.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [exponent](#), [GiNaC::basic::is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [GiNaC::is\\_integer\(\)](#).

### 6.119.3.9 coeff()

```
ex GiNaC::power::coeff (
 const ex & s,
 int n = 1) const [override], [virtual]
```

Return coefficient of degree n in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [basis](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [exponent](#), [GiNaC::basic::is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [GiNaC::is\\_integer\(\)](#).

Referenced by [expand\(\)](#), and [expand\\_add\(\)](#).

**6.119.3.10 eval()**

```
ex GiNaC::power::eval () const [override], [virtual]
```

Perform automatic term rewriting rules in this class.

In the following  $x, x_1, x_2, \dots$  stand for a symbolic variables of type `ex` and  $c, c_1, c_2, \dots$  stand for such expressions that contain a plain number.

- $x^0 \rightarrow 1$  (also handles  $0^0$ )
- $x^1 \rightarrow x$
- $0^c \rightarrow 0$  or exception (depending on the real part of  $c$ )
- $1^x \rightarrow 1$
- $c_1^{c_2} \rightarrow c_1^n c_1^{c_2-n}$  (so that  $0 < c_2-n < 1$ , try to evaluate roots, possibly in numerator and denominator of  $c_1$ )
- $x^{(x, c_1), c_2} \rightarrow x^{x, c_1 c_2}$  if  $x$  is positive and  $c_1$  is real.
- $x^{(x, c_1), c_2} \rightarrow x^{x, c_1 c_2}$  ( $c_2$  integer or  $-1 < c_1 \leq 1$  or ( $c_1 = -1$  and  $c_2 > 0$ ), case  $c_1 = 1$  should not happen, see below!)
- $x^{(x, y, z), c} \rightarrow x^c y^c z^c$  (if  $c$  integer)
- $x^{(x, c_1), c_2} \rightarrow x^{x, c_2} c_1^{c_2}$  ( $c_1 > 0$ )
- $x^{(x, c_1), c_2} \rightarrow x^{-x, c_2} c_1^{c_2}$  ( $c_1 < 0$ )

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex0](#), [GiNaC::ex1](#), [GiNaC::ex\\_1](#), [GiNaC::num0\\_p](#), [GiNaC::num1\\_p](#), [GiNaC::num\\_1\\_p](#), [GiNaC::abs\(\)](#), [basis](#), [GiNaC::basic::clearflag\(\)](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::return\\_types::commutative](#), [GiNaC::numeric::compare\(\)](#), [GiNaC::numeric::denom\(\)](#), [GiNaC::numeric::div\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [expand\\_mul\(\)](#), [exponent](#), [GiNaC::basic::flags](#), [GINAC\\_ASSERT](#), [GiNaC::status\\_flags::hash\\_calculated](#), [GiNaC::basic::hold\(\)](#), [GiNaC::numeric::inverse\(\)](#), [GiNaC::iquo\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::numeric::is\\_crational\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::numeric::is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::is\\_negative\(\)](#), [GiNaC::numeric::is\\_negative\(\)](#), [GiNaC::numeric::is\\_pos\\_integer\(\)](#), [GiNaC::numeric::is\\_positive\(\)](#), [GiNaC::numeric::is\\_rational\(\)](#), [GiNaC::numeric::is\\_real\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [likely](#), [GiNaC::numeric::mul\(\)](#), [mul](#), [GiNaC::numeric::numer\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [GiNaC::info\\_flags::positive](#), [GiNaC::pow\(\)](#), [GiNaC::numeric::power\(\)](#), [power\(\)](#), [GiNaC::info\\_flags::real](#), [GiNaC::numeric::real\(\)](#), [GiNaC::expairseq::seq](#), [GiNaC::basic::setflag\(\)](#), and [GiNaC::numeric::to\\_int\(\)](#).

**6.119.3.11 evalf()**

```
ex GiNaC::power::evalf () const [override], [virtual]
```

Evaluate object numerically.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [exponent](#), and [GiNaC::is\\_exactly\\_a\(\)](#).

**6.119.3.12 evalm()**

```
ex GiNaC::power::evalm () const [override], [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [exponent](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [GiNaC::pow\(\)](#).

**6.119.3.13 series()**

```
ex GiNaC::power::series (
 const relational & r,
 int order,
 unsigned options = 0) const [override], [virtual]
```

Implementation of [ex::series\(\)](#) for powers.

This performs Laurent expansion of reciprocals of series at singularities.

See also

[ex::series](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [basis](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::exp\(\)](#), [exponent](#), [GiNaC::ex::info\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::is\\_integer\(\)](#), [GiNaC::ex::ldegree\(\)](#), [GiNaC::relational::lhs\(\)](#), [GiNaC::log\(\)](#), [GiNaC::info\\_flags::negint](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::info\\_flags::rational\\_function](#), [GiNaC::relational::rhs\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::ex::series\(\)](#), and [GiNaC::to\\_int\(\)](#).

Referenced by [GiNaC::psi1\\_series\(\)](#).

**6.119.3.14 subs()**

```
ex GiNaC::power::subs (
 const exmap & m,
 unsigned options = 0) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::subs\\_options::algebraic](#), [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [basis](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [exponent](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::pow\(\)](#), [GiNaC::basic::subs\\_one\\_level\(\)](#), and [GiNaC::tryfactsubs\(\)](#).

**6.119.3.15 has()**

```
bool GiNaC::power::has (
 const ex & pattern,
 unsigned options = 0) const \[override\], \[virtual\]
```

Test for occurrence of a pattern.

An object 'has' a pattern if it matches the pattern itself or one of the children 'has' it. As a consequence (according to the definition of children) given  $e=x+y+z$ ,  $e.has(x)$  is true but  $e.has(x+y)$  is false.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::has\\_options::algebraic](#), [basis](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [exponent](#), [GiNaC::basic::has\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::is\\_a\(\)](#), [GiNaC::info\\_flags::negint](#), [GiNaC::ex::op\(\)](#), and [GiNaC::info\\_flags::posint](#).

**6.119.3.16 normal()**

```
ex GiNaC::power::normal (
 exmap & repl,
 exmap & rev_lookup,
 lst & modifier) const \[override\], \[virtual\]
```

Implementation of [ex::normal\(\)](#) for powers.

It normalizes the basis, distributes integer exponents to numerator and denominator, and replaces non-integer powers by temporary symbols.

See also

[ex::normal](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [basis](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [exponent](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::info\\_flags::positive](#), [GiNaC::pow\(\)](#), [GiNaC::replace\\_with\\_symbol\(\)](#), and [GiNaC::ex::subs\(\)](#).

**6.119.3.17 to\_rational()**

```
ex GiNaC::power::to_rational (
 exmap & repl) const \[override\], \[virtual\]
```

Implementation of [ex::to\\_rational\(\)](#) for powers.

It replaces non-integer powers by temporary symbols.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [GiNaC::basic::ex](#), [exponent](#), [GiNaC::info\\_flags::integer](#), [GiNaC::pow\(\)](#), and [GiNaC::replace\\_with\\_symbol\(\)](#).



**6.119.3.18 to\_polynomial()**

```
ex GiNaC::power::to_polynomial (
 exmap & repl) const [override], [virtual]
```

Implementation of [ex::to\\_polynomial\(\)](#) for powers.

It replaces non-posint powers by temporary symbols.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex\\_1](#), [basis](#), [GiNaC::collect\\_common\\_factors\(\)](#), [GiNaC::basic::ex](#), [exponent](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::info\\_flags::negint](#), [GiNaC::info\\_flags::posint](#), [GiNaC::pow\(\)](#), [GiNaC::replace\\_with\\_symbol\(\)](#), and [GiNaC::ex::to\\_polynomial\(\)](#).

**6.119.3.19 conjugate()**

```
ex GiNaC::power::conjugate () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [basis](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [exponent](#), [GiNaC::info\\_flags::integer](#), and [GiNaC::info\\_flags::positive](#).

**6.119.3.20 real\_part()**

```
ex GiNaC::power::real_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [GiNaC::abs\(\)](#), [basis](#), [GiNaC::binomial\(\)](#), [GiNaC::cos\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::exp\(\)](#), [exponent](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::log\(\)](#), [GiNaC::info\\_flags::nonnegative](#), [GiNaC::numer\(\)](#), and [GiNaC::pow\(\)](#).

**6.119.3.21 imag\_part()**

```
ex GiNaC::power::imag_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [GiNaC::abs\(\)](#), [basis](#), [GiNaC::binomial\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::exp\(\)](#), [exponent](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::log\(\)](#), [GiNaC::info\\_flags::nonnegative](#), [GiNaC::numer\(\)](#), [GiNaC::pow\(\)](#), and [GiNaC::sin\(\)](#).

**6.119.3.22 archive()**

```
void GiNaC::power::archive (
 archive_node & n) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::add\\_ex\(\)](#), [basis](#), and [exponent](#).

**6.119.3.23 read\_archive()**

```
void GiNaC::power::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [exponent](#), and [GiNaC::archive\\_node::find\\_ex\(\)](#).

**6.119.3.24 derivative()**

```
ex GiNaC::power::derivative (
 const symbol & s) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for a power.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [GiNaC::\\_ex\\_1](#), [basis](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [exponent](#), [GiNaC::is\\_a\(\)](#), [GiNaC::log\(\)](#), and [GiNaC::pow\(\)](#).

**6.119.3.25 eval\_ncmul()**

```
ex GiNaC::power::eval_ncmul (
 const exvector & v) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.119.3.26 return\_type()**

```
unsigned GiNaC::power::return_type () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [basis](#).

**6.119.3.27 return\_type\_tinfo()**

```
return_type_t GiNaC::power::return_type_tinfo () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [basis](#).

**6.119.3.28 expand()**

```
ex GiNaC::power::expand (
 unsigned options = 0) const [override], [protected], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [GiNaC::\\_ex\\_1](#), [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [basis](#), [coeff\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::ex::expand\(\)](#), [expand\(\)](#), [expand\\_add\(\)](#), [expand\\_mul\(\)](#), [GiNaC::status\\_flags::expanded](#), [exponent](#), [GiNaC::basic::hold\(\)](#), [GiNaC::info\\_flags::indefinite](#), [GiNaC::ex::info\(\)](#), [GiNaC::info\\_flags::integer](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::is\\_integer\(\)](#), [mul](#), [GiNaC::info\\_flags::negative](#), [GiNaC::expairseq::overall\\_coeff](#), [GiNaC::info\\_flags::positive](#), [GiNaC::pow\(\)](#), [GiNaC::status\\_flags::purely\\_indefinite](#), [GiNaC::add::recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::mul::recombine\\_pair\\_to\\_ex\(\)](#), [GiNaC::expairseq::seq](#), [GiNaC::basic::setflag\(\)](#), [GiNaC::numeric::to\\_int\(\)](#), and [GiNaC::numeric::to\\_long\(\)](#).

Referenced by [expand\(\)](#), [expand\\_add\(\)](#), and [expand\\_add\\_2\(\)](#).

**6.119.3.29 print\_power()**

```
void GiNaC::power::print_power (
 const print_context & c,
 const char * powersymbol,
 const char * openbrace,
 const char * closebrace,
 unsigned level) const [protected]
```

References [basis](#), [exponent](#), [precedence\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [do\\_print\\_dflt\(\)](#), [do\\_print\\_latex\(\)](#), and [do\\_print\\_python\(\)](#).

**6.119.3.30 do\_print\_dflt()**

```
void GiNaC::power::do_print_dflt (
 const print_dflt & c,
 unsigned level) const [protected]
```

References [GiNaC::\\_ex1\\_2](#), [basis](#), [exponent](#), [print\\_power\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.119.3.31 do\_print\_latex()**

```
void GiNaC::power::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

References [GiNaC::\\_ex1\\_2](#), [basis](#), [GiNaC::ex\\_to\(\)](#), [exponent](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::is\\_negative\(\)](#), [power\(\)](#), [print\\_power\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.119.3.32 do\_print\_csrc()**

```
void GiNaC::power::do_print_csrc (
 const print_csrc & c,
 unsigned level) const [protected]
```

References [GiNaC::\\_ex\\_1](#), [basis](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::exp\(\)](#), [exponent](#), [GiNaC::info\\_flags::integer](#), [GiNaC::is\\_a\(\)](#), [GiNaC::print\\_sym\\_pow\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.119.3.33 do\_print\_python()**

```
void GiNaC::power::do_print_python (
 const print_python & c,
 unsigned level) const [protected]
```

References [print\\_power\(\)](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.119.3.34 do\_print\_python\_repr()**

```
void GiNaC::power::do_print_python_repr (
 const print_python_repr & c,
 unsigned level) const [protected]
```

References [basis](#), [exponent](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.119.3.35 do\_print\_csrc\_cl\_N()**

```
void GiNaC::power::do_print_csrc_cl_N (
 const print_csrc_cl_N & c,
 unsigned level) const [protected]
```

References [GiNaC::\\_ex\\_1](#), [basis](#), [exponent](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.119.3.36 expand\_add()**

```
ex GiNaC::power::expand_add (
 const add & a,
 long n,
 unsigned options) [static], [protected]
```

expand  $a^n$  where  $a$  is an add and  $n$  is a positive integer.

See also

[power::expand](#)

References [GiNaC::\\_ex1](#), [GiNaC::\\_num1\\_p](#), [basis](#), [GiNaC::binomial\(\)](#), [coeff\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [expand\(\)](#), [expand\\_add\\_2\(\)](#), [GiNaC::status\\_flags::expanded](#), [exponent](#), [GiNaC::factor\(\)](#), [GiNaC::composition\\_generator::get\(\)](#), [GiNaC::partition\\_with\\_zero\\_parts\\_generator::get\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::is\\_pos\\_integer\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [mul](#), [GiNaC::multinomial\\_coefficient\(\)](#), [GiNaC::composition\\_generator::next\(\)](#), [GiNaC::partition\\_with\\_zero\\_parts\\_generator::next\(\)](#), [GiNaC::expairseq::nops\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), [GiNaC::pow\(\)](#), [GiNaC::numeric::power\(\)](#), [GiNaC::expairseq::seq](#), and [GiNaC::numeric::to\\_long\(\)](#).

Referenced by [expand\(\)](#).

**6.119.3.37 expand\_add\_2()**

```
ex GiNaC::power::expand_add_2 (
 const add & a,
 unsigned options) [static], [protected]
```

Special case of [power::expand\\_add](#).

Expands  $a^2$  where  $a$  is an add.

See also

[power::expand\\_add](#)

References [GiNaC::\\_ex1](#), [GiNaC::\\_ex2](#), [GiNaC::\\_num2\\_p](#), [basis](#), [GiNaC::add::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [expand\(\)](#), [expand\\_mul\(\)](#), [GiNaC::status\\_flags::expanded](#), [exponent](#), [GINAC\\_ASSERT](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::is\\_pos\\_integer\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [mul](#), [GiNaC::expairseq::nops\(\)](#), [GiNaC::expairseq::overall\\_coeff](#), and [GiNaC::expairseq::seq](#).

Referenced by [expand\\_add\(\)](#).

**6.119.3.38 expand\_mul()**

```
ex GiNaC::power::expand_mul (
 const mul & m,
 const numeric & n,
 unsigned options,
 bool from_expand = false) [static], [protected]
```

Expand factors of  $m$  in  $m^n$  where  $m$  is a mul and  $n$  is an integer.

See also

[power::expand](#)

References [GiNaC::\\_ex1](#), [GiNaC::expair::coeff](#), [GiNaC::mul::combine\\_pair\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::expand\\_options::expand\\_rename\\_idx](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::get\\_all\\_dummy\\_indices\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::info\\_flags::has\\_indices](#), [GiNaC::mul::info\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::numeric::is\\_integer\(\)](#), [GiNaC::numeric::is\\_positive\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [mul](#), [GiNaC::expairseq::overall\\_coeff](#), [GiNaC::rename\\_dummy\\_indices\\_uniquely\(\)](#), [GiNaC::expairseq::seq](#), [GiNaC::basic::setflag\(\)](#), and [GiNaC::numeric::to\\_int\(\)](#).

Referenced by [eval\(\)](#), [expand\(\)](#), and [expand\\_add\\_2\(\)](#).

## 6.119.4 Friends And Related Symbol Documentation

### 6.119.4.1 mul

```
friend class mul [friend]
```

References [mul](#).

Referenced by [eval\(\)](#), [expand\(\)](#), [expand\\_add\(\)](#), [expand\\_add\\_2\(\)](#), [expand\\_mul\(\)](#), and [mul](#).

## 6.119.5 Member Data Documentation

### 6.119.5.1 basis

```
ex GiNaC::power::basis [protected]
```

Referenced by [archive\(\)](#), [coeff\(\)](#), [conjugate\(\)](#), [degree\(\)](#), [derivative\(\)](#), [do\\_print\\_csrc\(\)](#), [do\\_print\\_csrc\\_cl\\_N\(\)](#), [do\\_print\\_dflt\(\)](#), [do\\_print\\_latex\(\)](#), [do\\_print\\_python\\_repr\(\)](#), [eval\(\)](#), [evalf\(\)](#), [evalm\(\)](#), [expand\(\)](#), [expand\\_add\(\)](#), [expand\\_add\\_2\(\)](#), [has\(\)](#), [imag\\_part\(\)](#), [info\(\)](#), [is\\_polynomial\(\)](#), [ldegree\(\)](#), [map\(\)](#), [normal\(\)](#), [op\(\)](#), [power\(\)](#), [power\(\)](#), [print\\_power\(\)](#), [read\\_archive\(\)](#), [real\\_part\(\)](#), [return\\_type\(\)](#), [return\\_type\\_tinfo\(\)](#), [series\(\)](#), [GiNaC::mul::split\\_ex\\_to\\_pair\(\)](#), [subs\(\)](#), [to\\_polynomial\(\)](#), and [to\\_rational\(\)](#).

### 6.119.5.2 exponent

```
ex GiNaC::power::exponent [protected]
```

Referenced by [archive\(\)](#), [coeff\(\)](#), [conjugate\(\)](#), [degree\(\)](#), [derivative\(\)](#), [do\\_print\\_csrc\(\)](#), [do\\_print\\_csrc\\_cl\\_N\(\)](#), [do\\_print\\_dflt\(\)](#), [do\\_print\\_latex\(\)](#), [do\\_print\\_python\\_repr\(\)](#), [eval\(\)](#), [evalf\(\)](#), [evalm\(\)](#), [expand\(\)](#), [expand\\_add\(\)](#), [expand\\_add\\_2\(\)](#), [has\(\)](#), [imag\\_part\(\)](#), [info\(\)](#), [is\\_polynomial\(\)](#), [ldegree\(\)](#), [map\(\)](#), [normal\(\)](#), [op\(\)](#), [power\(\)](#), [power\(\)](#), [print\\_power\(\)](#), [read\\_archive\(\)](#), [real\\_part\(\)](#), [series\(\)](#), [GiNaC::mul::split\\_ex\\_to\\_pair\(\)](#), [subs\(\)](#), [to\\_polynomial\(\)](#), and [to\\_rational\(\)](#).

The documentation for this class was generated from the following files:

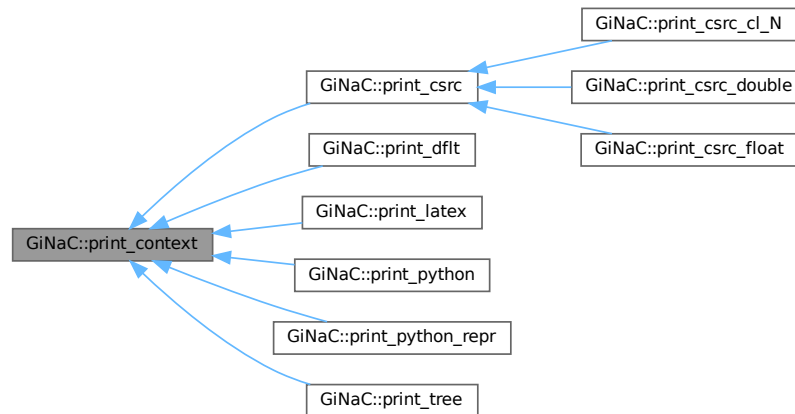
- [power.h](#)
- [normal.cpp](#)
- [power.cpp](#)
- [pseries.cpp](#)

## 6.120 GiNaC::print\_context Class Reference

Base class for print\_contexts.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print\_context:



### Public Member Functions

- [print\\_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print\\_context](#) ()

### Public Attributes

- std::ostream & [s](#)  
*stream to output to*
- unsigned [options](#)  
*option flags*

### 6.120.1 Detailed Description

Base class for print\_contexts.

### 6.120.2 Constructor & Destructor Documentation

#### 6.120.2.1 print\_context()

```
GiNaC::print_context::print_context (
 std::ostream & os,
 unsigned options = 0)
```

References [options](#), [print\\_context\(\)](#), and [s](#).

Referenced by [print\\_context\(\)](#), [GiNaC::print\\_csrc::print\\_csrc\(\)](#), [GiNaC::print\\_dflt::print\\_dflt\(\)](#), [GiNaC::print\\_latex::print\\_latex\(\)](#), [GiNaC::print\\_python::print\\_python\(\)](#), [GiNaC::print\\_python\\_repr::print\\_python\\_repr\(\)](#), [GiNaC::print\\_tree::print\\_tree\(\)](#), and [GiNaC::print\\_tree::print\\_tree\(\)](#).

### 6.120.2.2 ~print\_context()

```
virtual GiNaC::print_context::~~print_context () [inline], [virtual]
```

## 6.120.3 Member Data Documentation

### 6.120.3.1 s

```
std::ostream& GiNaC::print_context::s
```

stream to output to

Referenced by [GiNaC::abs\\_print\\_csrc\\_float\(\)](#), [GiNaC::abs\\_print\\_latex\(\)](#), [GiNaC::conjugate\\_print\\_latex\(\)](#), [GiNaC::basic::do\\_print\(\)](#), [GiNaC::basic\\_log\\_kernel::do\\_print\(\)](#), [GiNaC::constant::do\\_print\(\)](#), [GiNaC::Ebar\\_kernel::do\\_print\(\)](#), [GiNaC::Eisenstein\\_h\\_kernel::do\\_print\(\)](#), [GiNaC::Eisenstein\\_kernel::do\\_print\(\)](#), [GiNaC::ELi\\_kernel::do\\_print\(\)](#), [GiNaC::expairseq::do\\_print\(\)](#), [GiNaC::fderivative::do\\_print\(\)](#), [GiNaC::idx::do\\_print\(\)](#), [GiNaC::integral::do\\_print\(\)](#), [GiNaC::integration\\_kernel::do\\_print\(\)](#), [GiNaC::Kronecker\\_dtau\\_kernel::do\\_print\(\)](#), [GiNaC::Kronecker\\_dz\\_kernel::do\\_print\(\)](#), [GiNaC::matrix::do\\_print\(\)](#), [GiNaC::modular\\_form\\_kernel::do\\_print\(\)](#), [GiNaC::mul::do\\_print\(\)](#), [GiNaC::multiple\\_polylog\\_kernel::do\\_print\(\)](#), [GiNaC::relational::do\\_print\(\)](#), [GiNaC::spinidx::do\\_print\(\)](#), [GiNaC::symbol::do\\_print\(\)](#), [GiNaC::symmetry::do\\_print\(\)](#), [GiNaC::user\\_defined\\_kernel::do\\_print\(\)](#), [GiNaC::varidx::do\\_print\(\)](#), [GiNaC::wildcard::do\\_print\(\)](#), [GiNaC::add::do\\_print\\_csrc\(\)](#), [GiNaC::fderivative::do\\_print\\_csrc\(\)](#), [GiNaC::idx::do\\_print\\_csrc\(\)](#), [GiNaC::mul::do\\_print\\_csrc\(\)](#), [GiNaC::ncmul::do\\_print\\_csrc\(\)](#), [GiNaC::numeric::do\\_print\\_csrc\(\)](#), [GiNaC::power::do\\_print\\_csrc\(\)](#), [GiNaC::numeric::do\\_print\\_csrc\\_cl\\_N\(\)](#), [GiNaC::power::do\\_print\\_csrc\\_cl\\_N\(\)](#), [GiNaC::clifford::do\\_print\\_dflt\(\)](#), [GiNaC::power::do\\_print\\_dflt\(\)](#), [GiNaC::clifford::do\\_print\\_latex\(\)](#), [GiNaC::constant::do\\_print\\_latex\(\)](#), [GiNaC::fderivative::do\\_print\\_latex\(\)](#), [GiNaC::idx::do\\_print\\_latex\(\)](#), [GiNaC::integral::do\\_print\\_latex\(\)](#), [GiNaC::matrix::do\\_print\\_latex\(\)](#), [GiNaC::mul::do\\_print\\_latex\(\)](#), [GiNaC::power::do\\_print\\_latex\(\)](#), [GiNaC::spinidx::do\\_print\\_latex\(\)](#), [GiNaC::symbol::do\\_print\\_latex\(\)](#), [GiNaC::add::do\\_print\\_python\\_repr\(\)](#), [GiNaC::basic::do\\_print\\_python\\_repr\(\)](#), [GiNaC::constant::do\\_print\\_python\\_repr\(\)](#), [GiNaC::container< C >::do\\_print\\_python\\_repr\(\)](#), [GiNaC::matrix::do\\_print\\_python\\_repr\(\)](#), [GiNaC::mul::do\\_print\\_python\\_repr\(\)](#), [GiNaC::numeric::do\\_print\\_python\\_repr\(\)](#), [GiNaC::power::do\\_print\\_python\\_repr\(\)](#), [GiNaC::pseries::do\\_print\\_python\\_repr\(\)](#), [GiNaC::relational::do\\_print\\_python\\_repr\(\)](#), [GiNaC::symbol::do\\_print\\_python\\_repr\(\)](#), [GiNaC::wildcard::do\\_print\\_python\\_repr\(\)](#), [GiNaC::basic::do\\_print\\_tree\(\)](#), [GiNaC::clifford::do\\_print\\_tree\(\)](#), [GiNaC::constant::do\\_print\\_tree\(\)](#), [GiNaC::container< C >::do\\_print\\_tree\(\)](#), [GiNaC::expairseq::do\\_print\\_tree\(\)](#), [GiNaC::fderivative::do\\_print\\_tree\(\)](#), [GiNaC::idx::do\\_print\\_tree\(\)](#), [GiNaC::indexed::do\\_print\\_tree\(\)](#), [GiNaC::numeric::do\\_print\\_tree\(\)](#), [GiNaC::pseries::do\\_print\\_tree\(\)](#), [GiNaC::spinidx::do\\_print\\_tree\(\)](#), [GiNaC::symbol::do\\_print\\_tree\(\)](#), [GiNaC::symmetry::do\\_print\\_tree\(\)](#), [GiNaC::varidx::do\\_print\\_tree\(\)](#), [GiNaC::wildcard::do\\_print\\_tree\(\)](#), [GiNaC::EllipticE\\_print\\_latex\(\)](#), [GiNaC::EllipticK\\_print\\_latex\(\)](#), [GiNaC::factorial\\_print\\_dflt\\_latex\(\)](#), [GiNaC::H\\_print\\_latex\(\)](#), [GiNaC::imag\\_part\\_print\\_latex\(\)](#), [GiNaC::Li\\_print\\_latex\(\)](#), [GiNaC::function::print\(\)](#), [GiNaC::add::print\\_add\(\)](#), [print\\_context\(\)](#), [GiNaC::matrix::print\\_elements\(\)](#), [GiNaC::idx::print\\_index\(\)](#), [GiNaC::indexed::print\\_indexed\(\)](#), [GiNaC::print\\_integer\\_csrc\(\)](#), [GiNaC::numeric::print\\_numeric\(\)](#), [GiNaC::print\\_operator\(\)](#), [GiNaC::mul::print\\_overall\\_coeff\(\)](#), [GiNaC::power::print\\_power\(\)](#), [GiNaC::print\\_real\\_cl\\_N\(\)](#), [GiNaC::print\\_real\\_csrc\(\)](#), [GiNaC::print\\_real\\_number\(\)](#), [GiNaC::pseries::print\\_series\(\)](#), [GiNaC::print\\_sym\\_pow\(\)](#), [GiNaC::indexed::printindices\(\)](#), [GiNaC::expairseq::printpair\(\)](#), [GiNaC::container< C >::printseq\(\)](#), [GiNaC::expairseq::printseq\(\)](#), [GiNaC::real\\_part\\_print\\_latex\(\)](#), [GiNaC::S\\_print\\_latex\(\)](#), [GiNaC::zeta1\\_print\\_latex\(\)](#), and [GiNaC::zeta2\\_print\\_latex\(\)](#).

### 6.120.3.2 options

```
unsigned GiNaC::print_context::options
```

option flags

Referenced by [GiNaC::get\\_print\\_options\(\)](#), [print\\_context\(\)](#), [GiNaC::idx::print\\_index\(\)](#), [GiNaC::set\\_print\\_context\(\)](#), and [GiNaC::set\\_print\\_options\(\)](#).

The documentation for this class was generated from the following files:

- [print.h](#)
- [print.cpp](#)



## 6.121 GiNaC::print\_context\_options Class Reference

This class stores information about a registered [print\\_context](#) class.

```
#include <print.h>
```

### Public Member Functions

- [print\\_context\\_options](#) (const char \*n, const char \*p, unsigned i)
- const char \* [get\\_name](#) () const
- const char \* [get\\_parent\\_name](#) () const
- unsigned [get\\_id](#) () const

### Private Attributes

- const char \* [name](#)  
*Class name.*
- const char \* [parent\\_name](#)  
*Name of superclass.*
- unsigned [id](#)  
*ID number (assigned automatically).*

### 6.121.1 Detailed Description

This class stores information about a registered [print\\_context](#) class.

### 6.121.2 Constructor & Destructor Documentation

#### 6.121.2.1 print\_context\_options()

```
GiNaC::print_context_options::print_context_options (
 const char * n,
 const char * p,
 unsigned i) [inline]
```

References [id](#), [name](#), and [parent\\_name](#).

### 6.121.3 Member Function Documentation

#### 6.121.3.1 get\_name()

```
const char * GiNaC::print_context_options::get_name () const [inline]
```

References [name](#).

### 6.121.3.2 `get_parent_name()`

```
const char * GiNaC::print_context_options::get_parent_name () const [inline]
```

References [parent\\_name](#).

### 6.121.3.3 `get_id()`

```
unsigned GiNaC::print_context_options::get_id () const [inline]
```

References [id](#).

Referenced by [GiNaC::function::print\(\)](#), and [GiNaC::basic::print\\_dispatch\(\)](#).

## 6.121.4 Member Data Documentation

### 6.121.4.1 `name`

```
const char* GiNaC::print_context_options::name [private]
```

Class name.

Referenced by [get\\_name\(\)](#), and [print\\_context\\_options\(\)](#).

### 6.121.4.2 `parent_name`

```
const char* GiNaC::print_context_options::parent_name [private]
```

Name of superclass.

Referenced by [get\\_parent\\_name\(\)](#), and [print\\_context\\_options\(\)](#).

### 6.121.4.3 `id`

```
unsigned GiNaC::print_context_options::id [private]
```

ID number (assigned automatically).

Referenced by [get\\_id\(\)](#), and [print\\_context\\_options\(\)](#).

The documentation for this class was generated from the following file:

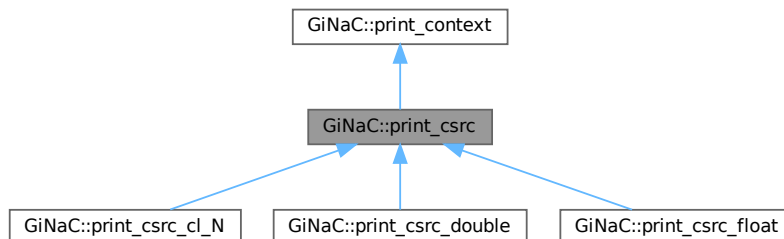
- [print.h](#)

## 6.122 GiNaC::print\_csrc Class Reference

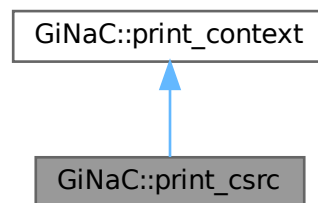
Base context for C source output.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print\_csrc:



Collaboration diagram for GiNaC::print\_csrc:



### Public Member Functions

- `print_csrc` (`std::ostream &`, unsigned `options=0`)

### Public Member Functions inherited from `GiNaC::print_context`

- `print_context` (`std::ostream &`, unsigned `options=0`)
- virtual `~print_context` ()

### Additional Inherited Members

### Public Attributes inherited from `GiNaC::print_context`

- `std::ostream & s`  
*stream to output to*
- unsigned `options`  
*option flags*

### 6.122.1 Detailed Description

Base context for C source output.

### 6.122.2 Constructor & Destructor Documentation

#### 6.122.2.1 `print_csrc()`

```
GiNaC::print_csrc::print_csrc (
 std::ostream & os,
 unsigned options = 0)
```

References [GiNaC::print\\_context::print\\_context\(\)](#).

Referenced by [GiNaC::print\\_csrc\\_cl\\_N::print\\_csrc\\_cl\\_N\(\)](#), [GiNaC::print\\_csrc\\_double::print\\_csrc\\_double\(\)](#), and [GiNaC::print\\_csrc\\_float::print\\_csrc\\_float\(\)](#).

The documentation for this class was generated from the following files:

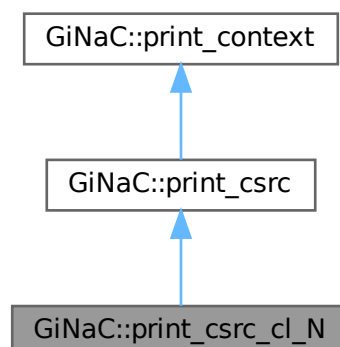
- [print.h](#)
- [print.cpp](#)

## 6.123 GiNaC::print\_csrc\_cl\_N Class Reference

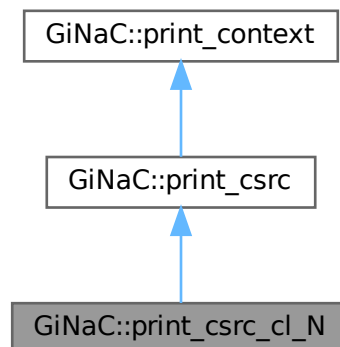
Context for C source output using CLN numbers.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print\_csrc\_cl\_N:



Collaboration diagram for GiNaC::print\_csrc\_cl\_N:



#### Public Member Functions

- [print\\_csrc\\_cl\\_N](#) (std::ostream &, unsigned [options](#)=0)

#### Public Member Functions inherited from [GiNaC::print\\_csrc](#)

- [print\\_csrc](#) (std::ostream &, unsigned [options](#)=0)

#### Public Member Functions inherited from [GiNaC::print\\_context](#)

- [print\\_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print\\_context](#) ()

#### Additional Inherited Members

#### Public Attributes inherited from [GiNaC::print\\_context](#)

- std::ostream & [s](#)  
*stream to output to*
- unsigned [options](#)  
*option flags*

### 6.123.1 Detailed Description

Context for C source output using CLN numbers.

## 6.123.2 Constructor & Destructor Documentation

### 6.123.2.1 `print_csrc_cl_N()`

```
GiNaC::print_csrc_cl_N::print_csrc_cl_N (
 std::ostream & os,
 unsigned options = 0)
```

References [GiNaC::print\\_csrc::print\\_csrc\(\)](#).

The documentation for this class was generated from the following files:

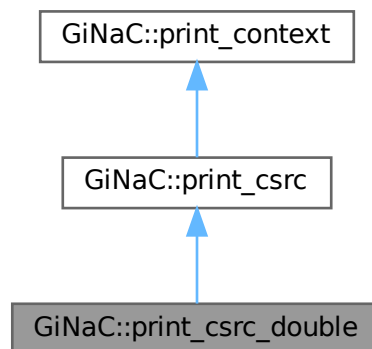
- [print.h](#)
- [print.cpp](#)

## 6.124 GiNaC::print\_csrc\_double Class Reference

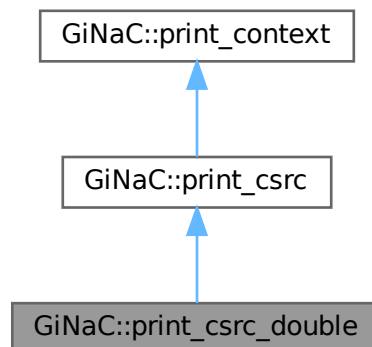
Context for C source output using double precision.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print\_csrc\_double:



Collaboration diagram for GiNaC::print\_csrc\_double:



### Public Member Functions

- [print\\_csrc\\_double](#) (std::ostream &, unsigned [options](#)=0)

### Public Member Functions inherited from [GiNaC::print\\_csrc](#)

- [print\\_csrc](#) (std::ostream &, unsigned [options](#)=0)

### Public Member Functions inherited from [GiNaC::print\\_context](#)

- [print\\_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print\\_context](#) ()

### Additional Inherited Members

### Public Attributes inherited from [GiNaC::print\\_context](#)

- std::ostream & [s](#)  
*stream to output to*
- unsigned [options](#)  
*option flags*

## 6.124.1 Detailed Description

Context for C source output using double precision.

## 6.124.2 Constructor & Destructor Documentation

### 6.124.2.1 `print_csrc_double()`

```
GiNaC::print_csrc_double::print_csrc_double (
 std::ostream & os,
 unsigned options = 0)
```

References [GiNaC::print\\_csrc::print\\_csrc\(\)](#).

The documentation for this class was generated from the following files:

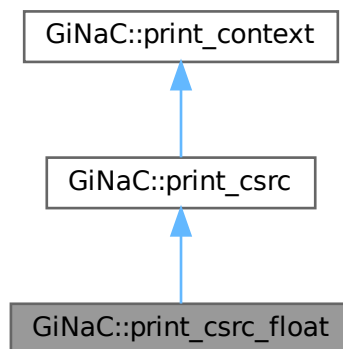
- [print.h](#)
- [print.cpp](#)

## 6.125 GiNaC::print\_csrc\_float Class Reference

Context for C source output using float precision.

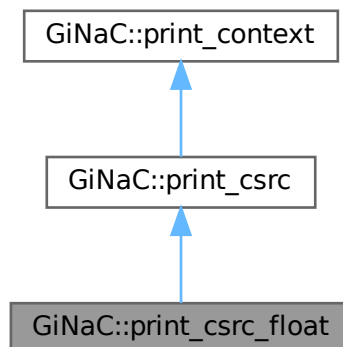
```
#include <print.h>
```

Inheritance diagram for GiNaC::print\_csrc\_float:





Collaboration diagram for GiNaC::print\_csrc\_float:



#### Public Member Functions

- [print\\_csrc\\_float](#) (std::ostream &, unsigned [options](#)=0)

#### Public Member Functions inherited from [GiNaC::print\\_csrc](#)

- [print\\_csrc](#) (std::ostream &, unsigned [options](#)=0)

#### Public Member Functions inherited from [GiNaC::print\\_context](#)

- [print\\_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print\\_context](#) ()

#### Additional Inherited Members

#### Public Attributes inherited from [GiNaC::print\\_context](#)

- std::ostream & [s](#)  
*stream to output to*
- unsigned [options](#)  
*option flags*

### 6.125.1 Detailed Description

Context for C source output using float precision.

## 6.125.2 Constructor & Destructor Documentation

### 6.125.2.1 `print_csrc_float()`

```
GiNaC::print_csrc_float::print_csrc_float (
 std::ostream & os,
 unsigned options = 0)
```

References [GiNaC::print\\_csrc::print\\_csrc\(\)](#).

The documentation for this class was generated from the following files:

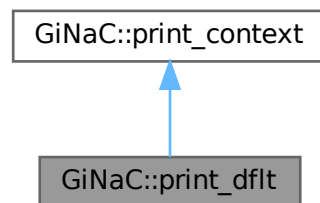
- [print.h](#)
- [print.cpp](#)

## 6.126 GiNaC::print\_dflt Class Reference

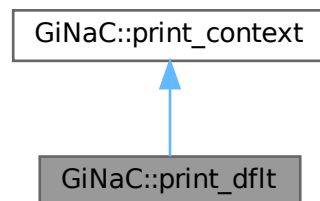
Context for default (ginsh-parsable) output.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print\_dflt:



Collaboration diagram for GiNaC::print\_dflt:



## Public Member Functions

- [print\\_dflt](#) (std::ostream &, unsigned [options](#)=0)

## Public Member Functions inherited from [GiNaC::print\\_context](#)

- [print\\_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print\\_context](#) ()

## Additional Inherited Members

## Public Attributes inherited from [GiNaC::print\\_context](#)

- std::ostream & [s](#)  
*stream to output to*
- unsigned [options](#)  
*option flags*

### 6.126.1 Detailed Description

Context for default (ginsh-parsable) output.

### 6.126.2 Constructor & Destructor Documentation

#### 6.126.2.1 [print\\_dflt\(\)](#)

```
GiNaC::print_dflt::print_dflt (
 std::ostream & os,
 unsigned options = 0)
```

References [GiNaC::print\\_context::print\\_context\(\)](#).

The documentation for this class was generated from the following files:

- [print.h](#)
- [print.cpp](#)

## 6.127 GiNaC::print\_functor Class Reference

This class represents a print method for a certain algebraic class and [print\\_context](#) type.

```
#include <print.h>
```

## Public Member Functions

- [print\\_functor](#) ()
- [print\\_functor](#) (const [print\\_functor](#) &other)
- [print\\_functor](#) (std::unique\_ptr< [print\\_functor\\_impl](#) > impl\_)
- template<class T, class C>  
  [print\\_functor](#) (void f(const T &, const C &, unsigned))
- template<class T, class C>  
  [print\\_functor](#) (void(T::\*f)(const C &, unsigned) const)
- [print\\_functor](#) & [operator=](#) (const [print\\_functor](#) &other)
- void [operator\(\)](#) (const [basic](#) &obj, const [print\\_context](#) &c, unsigned level) const
- bool [is\\_valid](#) () const

## Private Attributes

- std::unique\_ptr< [print\\_functor\\_impl](#) > [impl](#)

### 6.127.1 Detailed Description

This class represents a print method for a certain algebraic class and [print\\_context](#) type.

Its main purpose is to hide the difference between member functions and nonmember functions behind one unified [operator\(\)](#) interface. [print\\_functor](#) has value semantics and acts as a smart pointer (with deep copy) to a class derived from [print\\_functor\\_impl](#) which implements the actual function call.

### 6.127.2 Constructor & Destructor Documentation

#### 6.127.2.1 [print\\_functor](#)() [1/5]

```
GiNaC::print_functor::print_functor () [inline]
```

References [impl](#).

Referenced by [operator=\(\)](#), and [print\\_functor\(\)](#).

#### 6.127.2.2 [print\\_functor](#)() [2/5]

```
GiNaC::print_functor::print_functor (
 const print_functor & other) [inline]
```

References [impl](#), and [print\\_functor\(\)](#).

#### 6.127.2.3 [print\\_functor](#)() [3/5]

```
GiNaC::print_functor::print_functor (
 std::unique_ptr< print_functor_impl > impl_) [inline]
```

References [impl](#).

**6.127.2.4 print\_functor()** [4/5]

```
template<class T, class C>
GiNaC::print_functor::print_functor (
 void fconst T &, const C &, unsigned) [inline]
```

References [impl](#).

**6.127.2.5 print\_functor()** [5/5]

```
template<class T, class C>
GiNaC::print_functor::print_functor (
 void(T::* f) (const C &, unsigned) const) [inline]
```

References [impl](#).

**6.127.3 Member Function Documentation****6.127.3.1 operator=()**

```
print_functor & GiNaC::print_functor::operator= (
 const print_functor & other) [inline]
```

References [impl](#), and [print\\_functor\(\)](#).

**6.127.3.2 operator>()()**

```
void GiNaC::print_functor::operator() (
 const basic & obj,
 const print_context & c,
 unsigned level) const [inline]
```

**6.127.3.3 is\_valid()**

```
bool GiNaC::print_functor::is_valid () const [inline]
```

References [impl](#).

**6.127.4 Member Data Documentation****6.127.4.1 impl**

```
std::unique_ptr<print_functor_impl> GiNaC::print_functor::impl [private]
```

Referenced by [is\\_valid\(\)](#), [operator=\(\)](#), [print\\_functor\(\)](#), [print\\_functor\(\)](#), [print\\_functor\(\)](#), [print\\_functor\(\)](#), and [print\\_functor\(\)](#).

The documentation for this class was generated from the following file:

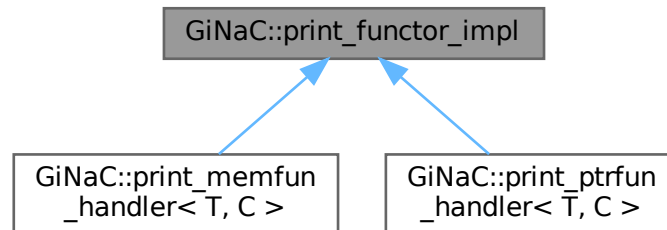
- [print.h](#)

## 6.128 GiNaC::print\_functor\_impl Class Reference

Base class for [print\\_functor](#) handlers.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print\_functor\_impl:



### Public Member Functions

- virtual [~print\\_functor\\_impl](#) ()
- virtual [print\\_functor\\_impl](#) \* [duplicate](#) () const =0
- virtual void [operator\(\)](#) (const [basic](#) &obj, const [print\\_context](#) &c, unsigned level) const =0

### 6.128.1 Detailed Description

Base class for [print\\_functor](#) handlers.

### 6.128.2 Constructor & Destructor Documentation

#### 6.128.2.1 ~print\_functor\_impl()

```
virtual GiNaC::print_functor_impl::~~print_functor_impl () [inline], [virtual]
```

### 6.128.3 Member Function Documentation

#### 6.128.3.1 duplicate()

```
virtual print_functor_impl * GiNaC::print_functor_impl::duplicate () const [pure virtual]
```

Implemented in [GiNaC::print\\_memfun\\_handler< T, C >](#), and [GiNaC::print\\_ptrfun\\_handler< T, C >](#).

### 6.128.3.2 operator>()

```
virtual void GiNaC::print_functor_impl::operator() (
 const basic & obj,
 const print_context & c,
 unsigned level) const [pure virtual]
```

Implemented in [GiNaC::print\\_memfun\\_handler< T, C >](#), and [GiNaC::print\\_ptrfun\\_handler< T, C >](#).

The documentation for this class was generated from the following file:

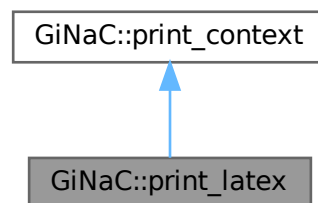
- [print.h](#)

## 6.129 GiNaC::print\_latex Class Reference

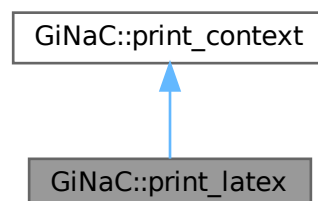
Context for latex-parsable output.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print\_latex:



Collaboration diagram for GiNaC::print\_latex:



## Public Member Functions

- [print\\_latex](#) (std::ostream &, unsigned [options](#)=0)

## Public Member Functions inherited from [GiNaC::print\\_context](#)

- [print\\_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print\\_context](#) ()

## Additional Inherited Members

## Public Attributes inherited from [GiNaC::print\\_context](#)

- std::ostream & [s](#)  
*stream to output to*
- unsigned [options](#)  
*option flags*

### 6.129.1 Detailed Description

Context for latex-parsable output.

### 6.129.2 Constructor & Destructor Documentation

#### 6.129.2.1 [print\\_latex\(\)](#)

```
GiNaC::print_latex::print_latex (
 std::ostream & os,
 unsigned options = 0)
```

References [GiNaC::print\\_context::print\\_context\(\)](#).

The documentation for this class was generated from the following files:

- [print.h](#)
- [print.cpp](#)

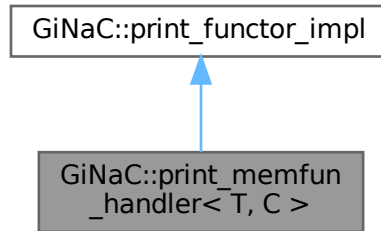


## 6.130 GiNaC::print\_memfun\_handler< T, C > Class Template Reference

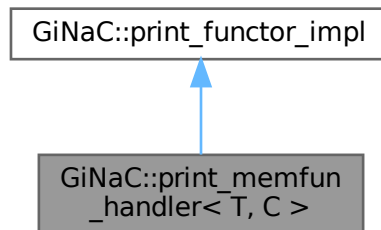
[print\\_functor](#) handler for member functions of class T, context type C

```
#include <print.h>
```

Inheritance diagram for GiNaC::print\_memfun\_handler< T, C >:



Collaboration diagram for GiNaC::print\_memfun\_handler< T, C >:



### Public Types

- typedef void(T::\* [F](#)) (const C &c, unsigned level) const

### Public Member Functions

- [print\\_memfun\\_handler](#) ([F](#) f\_)
- [print\\_memfun\\_handler](#) \* [duplicate](#) () const override
- void [operator](#)() (const [basic](#) &obj, const [print\\_context](#) &c, unsigned level) const override

### Public Member Functions inherited from [GiNaC::print\\_functor\\_impl](#)

- virtual [~print\\_functor\\_impl](#) ()

## Private Attributes

- [F f](#)

## 6.130.1 Detailed Description

```
template<class T, class C>
class GiNaC::print_memfun_handler< T, C >
```

[print\\_functor](#) handler for member functions of class T, context type C

## 6.130.2 Member Typedef Documentation

### 6.130.2.1 F

```
template<class T, class C>
typedef void(T::* GiNaC::print_memfun_handler< T, C >::F) (const C &c, unsigned level) const
```

## 6.130.3 Constructor & Destructor Documentation

### 6.130.3.1 print\_memfun\_handler()

```
template<class T, class C>
GiNaC::print_memfun_handler< T, C >::print_memfun_handler (
 F f_) [inline]
```

References [f](#).

Referenced by [duplicate\(\)](#).

## 6.130.4 Member Function Documentation

### 6.130.4.1 duplicate()

```
template<class T, class C>
print_memfun_handler * GiNaC::print_memfun_handler< T, C >::duplicate () const [inline],
[override], [virtual]
```

Implements [GiNaC::print\\_functor\\_impl](#).

References [print\\_memfun\\_handler\(\)](#).

#### 6.130.4.2 operator>()()

```
template<class T, class C>
void GiNaC::print_memfun_handler< T, C >::operator() (
 const basic & obj,
 const print_context & c,
 unsigned level) const [inline], [override], [virtual]
```

Implements [GiNaC::print\\_functor\\_impl](#).

References [f](#).

### 6.130.5 Member Data Documentation

#### 6.130.5.1 f

```
template<class T, class C>
F GiNaC::print_memfun_handler< T, C >::f [private]
```

Referenced by [operator>\(\)\(\)](#), and [print\\_memfun\\_handler\(\)](#).

The documentation for this class was generated from the following file:

- [print.h](#)

## 6.131 GiNaC::print\_options Class Reference

Flags to control the behavior of a [print\\_context](#).

```
#include <print.h>
```

### Public Types

- enum { [print\\_index\\_dimensions](#) = 0x0001 }

#### 6.131.1 Detailed Description

Flags to control the behavior of a [print\\_context](#).

### 6.131.2 Member Enumeration Documentation

#### 6.131.2.1 anonymous enum

```
anonymous enum
```

## Enumerator

|                        |                                 |
|------------------------|---------------------------------|
| print_index_dimensions | print the dimensions of indices |
|------------------------|---------------------------------|

The documentation for this class was generated from the following file:

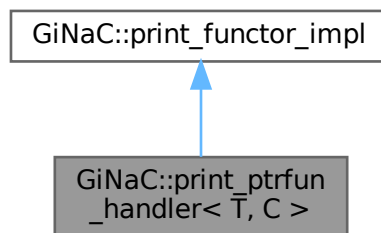
- [print.h](#)

## 6.132 GiNaC::print\_ptrfun\_handler< T, C > Class Template Reference

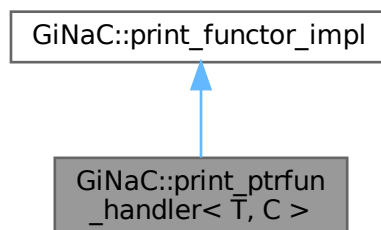
[print\\_functor](#) handler for pointer-to-functions of class T, context type C

```
#include <print.h>
```

Inheritance diagram for GiNaC::print\_ptrfun\_handler< T, C >:



Collaboration diagram for GiNaC::print\_ptrfun\_handler< T, C >:



### Public Types

- typedef void(\* [F](#)) (const T &, const C &, unsigned)

## Public Member Functions

- [print\\_ptrfun\\_handler](#) (F f\_)
- [print\\_ptrfun\\_handler](#) \* [duplicate](#) () const override
- void [operator](#)() (const [basic](#) &obj, const [print\\_context](#) &c, unsigned level) const override

## Public Member Functions inherited from [GiNaC::print\\_funcutor\\_impl](#)

- virtual [~print\\_funcutor\\_impl](#) ()

## Private Attributes

- F f

### 6.132.1 Detailed Description

```
template<class T, class C>
class GiNaC::print_ptrfun_handler< T, C >
```

[print\\_funcutor](#) handler for pointer-to-functions of class T, context type C

### 6.132.2 Member Typedef Documentation

#### 6.132.2.1 F

```
template<class T, class C>
typedef void(* GiNaC::print_ptrfun_handler< T, C >::F) (const T &, const C &, unsigned)
```

### 6.132.3 Constructor & Destructor Documentation

#### 6.132.3.1 [print\\_ptrfun\\_handler](#)()

```
template<class T, class C>
GiNaC::print_ptrfun_handler< T, C >::print_ptrfun_handler (
 F f_) [inline]
```

References [f](#).

Referenced by [duplicate](#)().

### 6.132.4 Member Function Documentation

#### 6.132.4.1 [duplicate](#)()

```
template<class T, class C>
print_ptrfun_handler * GiNaC::print_ptrfun_handler< T, C >::duplicate () const [inline],
[override], [virtual]
```

Implements [GiNaC::print\\_funcutor\\_impl](#).

References [print\\_ptrfun\\_handler](#)().

#### 6.132.4.2 `operator()()`

```
template<class T, class C>
void GiNaC::print_ptrfun_handler< T, C >::operator() (
 const basic & obj,
 const print_context & c,
 unsigned level) const [inline], [override], [virtual]
```

Implements [GiNaC::print\\_functor\\_impl](#).

References [f](#).

### 6.132.5 Member Data Documentation

#### 6.132.5.1 `f`

```
template<class T, class C>
F GiNaC::print_ptrfun_handler< T, C >::f [private]
```

Referenced by [operator\(\)\(\)](#), and [print\\_ptrfun\\_handler\(\)](#).

The documentation for this class was generated from the following file:

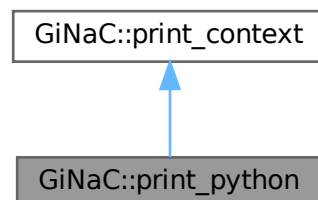
- [print.h](#)

## 6.133 GiNaC::print\_python Class Reference

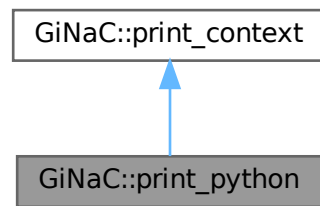
Context for python pretty-print output.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print\_python:



Collaboration diagram for GiNaC::print\_python:



### Public Member Functions

- [print\\_python](#) (std::ostream &, unsigned [options](#)=0)

### Public Member Functions inherited from [GiNaC::print\\_context](#)

- [print\\_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print\\_context](#) ()

### Additional Inherited Members

### Public Attributes inherited from [GiNaC::print\\_context](#)

- std::ostream & [s](#)  
*stream to output to*
- unsigned [options](#)  
*option flags*

## 6.133.1 Detailed Description

Context for python pretty-print output.

## 6.133.2 Constructor & Destructor Documentation

### 6.133.2.1 print\_python()

```

GiNaC::print_python::print_python (
 std::ostream & os,
 unsigned options = 0)

```

References [GiNaC::print\\_context::print\\_context\(\)](#).

The documentation for this class was generated from the following files:

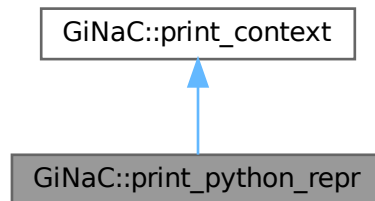
- [print.h](#)
- [print.cpp](#)

## 6.134 GiNaC::print\_python\_repr Class Reference

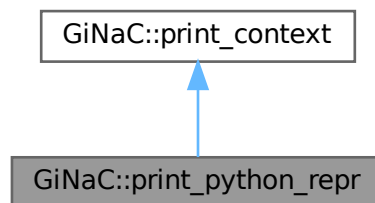
Context for python-parsable output.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print\_python\_repr:



Collaboration diagram for GiNaC::print\_python\_repr:



### Public Member Functions

- [print\\_python\\_repr](#) (std::ostream &, unsigned [options](#)=0)

### Public Member Functions inherited from [GiNaC::print\\_context](#)

- [print\\_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print\\_context](#) ()

### Additional Inherited Members

### Public Attributes inherited from [GiNaC::print\\_context](#)

- std::ostream & [s](#)  
*stream to output to*
- unsigned [options](#)  
*option flags*



### 6.134.1 Detailed Description

Context for python-parsable output.

### 6.134.2 Constructor & Destructor Documentation

#### 6.134.2.1 print\_python\_repr()

```
GiNaC::print_python_repr::print_python_repr (
 std::ostream & os,
 unsigned options = 0)
```

References [GiNaC::print\\_context::print\\_context\(\)](#).

The documentation for this class was generated from the following files:

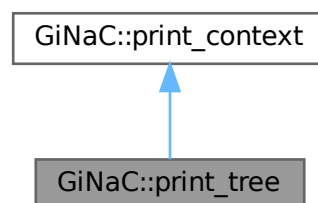
- [print.h](#)
- [print.cpp](#)

## 6.135 GiNaC::print\_tree Class Reference

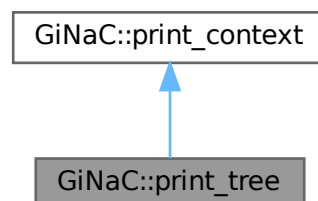
Context for tree-like output for debugging.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print\_tree:



Collaboration diagram for GiNaC::print\_tree:



## Public Member Functions

- [print\\_tree](#) (unsigned d)
- [print\\_tree](#) (std::ostream &, unsigned [options](#)=0, unsigned d=4)

## Public Member Functions inherited from [GiNaC::print\\_context](#)

- [print\\_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print\\_context](#) ()

## Public Attributes

- const unsigned [delta\\_indent](#)  
*size of indentation step*

## Public Attributes inherited from [GiNaC::print\\_context](#)

- std::ostream & [s](#)  
*stream to output to*
- unsigned [options](#)  
*option flags*

### 6.135.1 Detailed Description

Context for tree-like output for debugging.

### 6.135.2 Constructor & Destructor Documentation

#### 6.135.2.1 [print\\_tree\(\)](#) [1/2]

```
GiNaC::print_tree::print_tree (
 unsigned d)
```

References [delta\\_indent](#), and [GiNaC::print\\_context::print\\_context\(\)](#).

#### 6.135.2.2 [print\\_tree\(\)](#) [2/2]

```
GiNaC::print_tree::print_tree (
 std::ostream & os,
 unsigned options = 0,
 unsigned d = 4)
```

References [delta\\_indent](#), and [GiNaC::print\\_context::print\\_context\(\)](#).

## 6.135.3 Member Data Documentation

### 6.135.3.1 delta\_indent

```
const unsigned GiNaC::print_tree::delta_indent
```

size of indentation step

Referenced by [GiNaC::basic::do\\_print\\_tree\(\)](#), [GiNaC::clifford::do\\_print\\_tree\(\)](#), [GiNaC::container< C >::do\\_print\\_tree\(\)](#), [GiNaC::expairseq::do\\_print\\_tree\(\)](#), [GiNaC::fderivative::do\\_print\\_tree\(\)](#), [GiNaC::idx::do\\_print\\_tree\(\)](#), [GiNaC::indexed::do\\_print\\_tree\(\)](#), [GiNaC::pseries::do\\_print\\_tree\(\)](#), [GiNaC::spinidx::do\\_print\\_tree\(\)](#), [GiNaC::symmetry::do\\_print\\_tree\(\)](#), [GiNaC::varidx::do\\_print\\_tree\(\)](#), [GiNaC::expair::print\(\)](#), [print\\_tree\(\)](#), and [print\\_tree\(\)](#).

The documentation for this class was generated from the following files:

- [print.h](#)
- [print.cpp](#)

## 6.136 GiNaC::archive\_node::property Struct Reference

Archived property (data type, name and associated data)

```
#include <archive.h>
```

### Public Member Functions

- [property](#) ()
- [property](#) ([archive\\_atom](#) n, [property\\_type](#) t, unsigned v)

### Public Attributes

- [property\\_type](#) type  
*Data type of property.*
- [archive\\_atom](#) name  
*Name of property.*
- unsigned [value](#)  
*Stored value.*

### 6.136.1 Detailed Description

Archived property (data type, name and associated data)

## 6.136.2 Constructor & Destructor Documentation

### 6.136.2.1 property() [1/2]

```
GiNaC::archive_node::property::property () [inline]
```

### 6.136.2.2 `property()` [2/2]

```
GiNaC::archive_node::property::property (
 archive_atom n,
 property_type t,
 unsigned v) [inline]
```

References [name](#), [type](#), and [value](#).

## 6.136.3 Member Data Documentation

### 6.136.3.1 `type`

[property\\_type](#) GiNaC::archive\_node::property::type

Data type of property.

Referenced by [property\(\)](#).

### 6.136.3.2 `name`

[archive\\_atom](#) GiNaC::archive\_node::property::name

Name of property.

Referenced by [property\(\)](#).

### 6.136.3.3 `value`

`unsigned` GiNaC::archive\_node::property::value

Stored value.

Referenced by [property\(\)](#).

The documentation for this struct was generated from the following file:

- [archive.h](#)

## 6.137 GiNaC::archive\_node::property\_info Struct Reference

Information about a stored property.

```
#include <archive.h>
```

## Public Member Functions

- [property\\_info](#) ()
- [property\\_info](#) ([property\\_type](#) t, const std::string &n, unsigned c=1)

## Public Attributes

- [property\\_type](#) *type*  
*Data type of property.*
- std::string [name](#)  
*Name of property.*
- unsigned [count](#)  
*Number of occurrences.*

## 6.137.1 Detailed Description

Information about a stored property.

A vector of these structures is returned by [get\\_properties\(\)](#).

See also

[get\\_properties](#)

## 6.137.2 Constructor & Destructor Documentation

### 6.137.2.1 [property\\_info\(\)](#) [1/2]

```
GiNaC::archive_node::property_info::property_info () [inline]
```

### 6.137.2.2 [property\\_info\(\)](#) [2/2]

```
GiNaC::archive_node::property_info::property_info (
 property_type t,
 const std::string & n,
 unsigned c = 1) [inline]
```

References [count](#), [name](#), and [type](#).

## 6.137.3 Member Data Documentation

### 6.137.3.1 [type](#)

[property\\_type](#) GiNaC::archive\_node::property\_info::type

Data type of property.

Referenced by [property\\_info\(\)](#).

### 6.137.3.2 name

```
std::string GiNaC::archive_node::property_info::name
```

Name of property.

Referenced by [property\\_info\(\)](#).

### 6.137.3.3 count

```
unsigned GiNaC::archive_node::property_info::count
```

Number of occurrences.

Referenced by [property\\_info\(\)](#).

The documentation for this struct was generated from the following file:

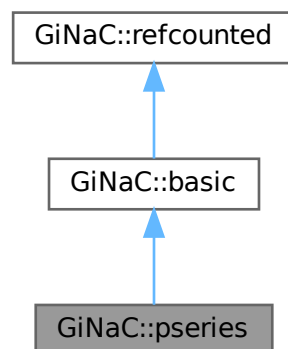
- [archive.h](#)

## 6.138 GiNaC::pseries Class Reference

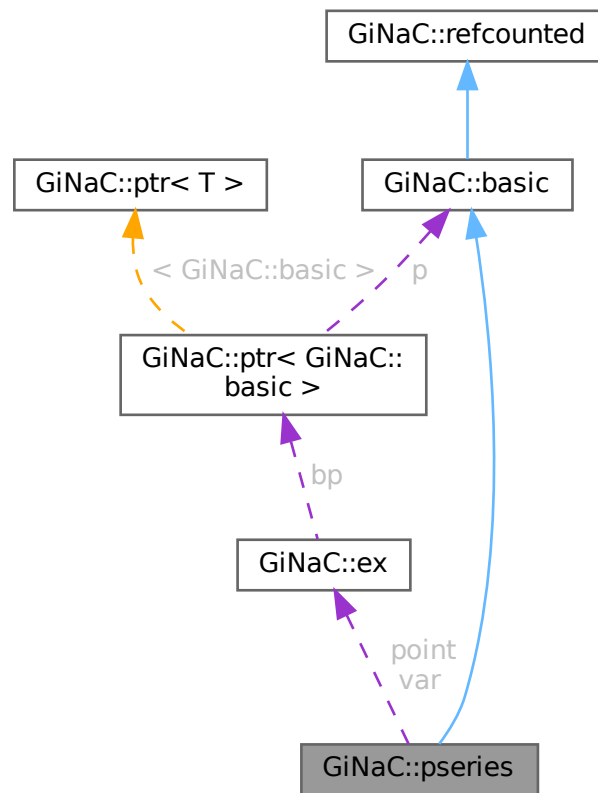
This class holds a extended truncated power series (positive and negative integer powers).

```
#include <pseries.h>
```

Inheritance diagram for GiNaC::pseries:



Collaboration diagram for GiNaC::pseries:



## Public Member Functions

- `pseries` (const `ex` &rel\_, const `epvector` &ops\_)  
Construct `pseries` from a vector of coefficients and powers.
- `pseries` (const `ex` &rel\_, `epvector` &&ops\_)
- unsigned `precedence` () const override  
Return relative operator precedence (for parenthezing output).
- `size_t nops` () const override  
Return the number of operands including a possible order term.
- `ex op` (size\_t i) const override  
Return the *i*th term in the series when represented as a sum.
- int `degree` (const `ex` &s) const override  
Return degree of highest power of the series.
- int `ldegree` (const `ex` &s) const override  
Return degree of lowest power of the series.
- `ex coeff` (const `ex` &s, int n=1) const override  
Return coefficient of degree *n* in power series if *s* is the expansion variable.
- `ex collect` (const `ex` &s, bool distributed=false) const override  
Does nothing.

- `ex eval ()` const override  
*Perform coefficient-wise automatic term rewriting rules in this class.*
- `ex evalf ()` const override  
*Evaluate coefficients numerically.*
- `ex series (const relational &r, int order, unsigned options=0)` const override  
*Re-expansion of a pseries object.*
- `ex subs (const exmap &m, unsigned options=0)` const override  
*Substitute a set of objects by arbitrary expressions.*
- `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier)` const override  
*Implementation of `ex::normal()` for pseries.*
- `ex expand (unsigned options=0)` const override  
*Implementation of `ex::expand()` for a power series.*
- `ex conjugate ()` const override
- `ex real_part ()` const override
- `ex imag_part ()` const override
- `ex eval_integ ()` const override  
*Evaluate integrals, if result is known.*
- `ex evalm ()` const override  
*Evaluate sums, products and integer powers of matrices.*
- `void archive (archive_node &n)` const override  
*Save (a.k.a.*
- `void read_archive (const archive_node &n, lst &syms)` override  
*Read (a.k.a.*
- `ex get_var ()` const  
*Get the expansion variable.*
- `ex get_point ()` const  
*Get the expansion point.*
- `ex convert_to_poly (bool no_order=false)` const  
*Convert the pseries object to an ordinary polynomial.*
- `bool is_compatible_to (const pseries &other)` const  
*Check whether series is compatible to another series (expansion variable and point are the same.*
- `bool is_zero ()` const  
*Check whether series has the value zero.*
- `bool is_terminating ()` const  
*Returns true if there is no order term, i.e.*
- `ex coeffop (size_t i)` const  
*Get coefficients and exponents.*
- `ex exponop (size_t i)` const
- `ex add_series (const pseries &other)` const  
*Add one series object to another, producing a pseries object that represents the sum.*
- `ex mul_const (const numeric &other)` const  
*Multiply a pseries object with a numeric constant, producing a pseries object that represents the product.*
- `ex mul_series (const pseries &other)` const  
*Multiply one pseries object to another, producing a pseries object that represents the product.*
- `ex power_const (const numeric &p, int deg)` const  
*Compute the p-th power of a series.*
- `pseries shift_exponents (int deg)` const  
*Return a new pseries object with the powers shifted by deg.*



## Public Member Functions inherited from GiNaC::basic

- virtual `~basic` ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic` \* `duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval_indexed` (const `basic` &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree` () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual bool `info` (unsigned inf) const  
*Information about the object.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex` & `let_op` (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual `ex` & `operator[]` (const `ex` &index)
- virtual `ex` & `operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const  
*Check whether the expression matches a given pattern.*
- virtual `ex map` (`map_function` &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual `ex to_rational` (`exmap` &repl) const  
*Default implementation of `ex::to_rational()`.*
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const  
*Implementation `ex::max_coefficient()`.*
- virtual `exvector get_free_indices` () const  
*Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_info` () const

- `template<class T>`  
`void print_dispatch (const print_context &c, unsigned level) const`  
*Like `print()`, but dispatch to the specified class.*
- `void print_dispatch (const registered_class_info &ri, const print_context &c, unsigned level) const`  
*Like `print()`, but dispatch to the specified class.*
- `ex subs_one_level (const exmap &m, unsigned options) const`  
*Helper function for `subs()`.*
- `ex diff (const symbol &s, unsigned nth=1) const`  
*Default interface of `nth` derivative `ex::diff(s, n)`.*
- `int compare (const basic &other) const`  
*Compare objects syntactically to establish canonical ordering.*
- `bool is_equal (const basic &other) const`  
*Test for syntactic equality.*
- `const basic & hold () const`  
*Stop further evaluation.*
- `unsigned gethash () const`
- `const basic & setflag (unsigned f) const`  
*Set some `status_flags`.*
- `const basic & clearflag (unsigned f) const`  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted () noexcept`
- `unsigned int add_reference () noexcept`
- `unsigned int remove_reference () noexcept`
- `unsigned int get_refcount () const noexcept`
- `void set_refcount (unsigned int r) noexcept`

## Protected Member Functions

- `ex derivative (const symbol &s) const override`  
*Implementation of `ex::diff()` for a power series.*
- `void print_series (const print_context &c, const char *openbrace, const char *closebrace, const char *mul←  
_sym, const char *pow_sym, unsigned level) const`
- `void do_print (const print_context &c, unsigned level) const`
- `void do_print_latex (const print_latex &c, unsigned level) const`
- `void do_print_tree (const print_tree &c, unsigned level) const`
- `void do_print_python (const print_python &c, unsigned level) const`
- `void do_print_python_repr (const print_python_repr &c, unsigned level) const`

## Protected Member Functions inherited from `GiNaC::basic`

- `basic ()`
- `virtual ex eval_ncmul (const exvector &v) const`
- `virtual bool match_same_type (const basic &other) const`  
*Returns true if the attributes of two objects are similar enough for a match.*
- `virtual int compare_same_type (const basic &other) const`  
*Returns order relation between two objects of same type.*
- `virtual bool is_equal_same_type (const basic &other) const`

- Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

### Protected Attributes

- [epvector seq](#)  
*Vector of {coefficient, power} pairs.*
- [ex var](#)  
*Series variable (holds a symbol)*
- [ex point](#)  
*Expansion point.*

### Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

## 6.138.1 Detailed Description

This class holds a extended truncated power series (positive and negative integer powers).

It consists of expression coefficients (only non-zero coefficients are stored), an expansion variable and an expansion point. Other classes must provide members to convert into this type.

## 6.138.2 Constructor & Destructor Documentation

### 6.138.2.1 [pseries\(\)](#) [1/2]

```
GiNaC::pseries::pseries (
 const ex & rel_,
 const epvector & ops_)
```

Construct pseries from a vector of coefficients and powers.

[expair.rest](#) holds the coefficient, [expair.coeff](#) holds the power. The powers must be integers (positive or negative) and in ascending order; the last coefficient can be `Order(_ex1)` to represent a truncated, non-terminating series.

## Parameters

|                   |                                                                     |
|-------------------|---------------------------------------------------------------------|
| <i>rel</i> ↔<br>— | expansion variable and point (must hold a relational)               |
| <i>ops</i> ↔<br>— | vector of {coefficient, power} pairs (coefficient must not be zero) |

References [GiNaC::basic::ex](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [GiNaC::ex::lhs\(\)](#), [point](#), [GiNaC::ex::rhs\(\)](#), [seq](#), and [var](#).

Referenced by [add\\_series\(\)](#), [derivative\(\)](#), [is\\_compatible\\_to\(\)](#), [mul\\_const\(\)](#), [mul\\_series\(\)](#), [normal\(\)](#), [power\\_const\(\)](#), [series\(\)](#), and [shift\\_exponents\(\)](#).

### 6.138.2.2 pseries() [2/2]

```
GiNaC::pseries::pseries (
 const ex & rel_,
 epvector && ops_)
```

References [GiNaC::basic::ex](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [GiNaC::ex::lhs\(\)](#), [point](#), [GiNaC::ex::rhs\(\)](#), [seq](#), and [var](#).

## 6.138.3 Member Function Documentation

### 6.138.3.1 precedence()

```
unsigned GiNaC::pseries::precedence () const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Referenced by [print\\_series\(\)](#).

### 6.138.3.2 nops()

```
size_t GiNaC::pseries::nops () const [override], [virtual]
```

Return the number of operands including a possible order term.

Reimplemented from [GiNaC::basic](#).

References [seq](#).

Referenced by [coeffop\(\)](#), [exponop\(\)](#), and [GiNaC::log\\_series\(\)](#).

### 6.138.3.3 op()

```
ex GiNaC::pseries::op (
 size_t i) const [override], [virtual]
```

Return the ith term in the series when represented as a sum.

Reimplemented from [GiNaC::basic](#).

References [coeff\(\)](#), [GiNaC::basic::ex](#), [GiNaC::is\\_order\\_function\(\)](#), [point](#), [GiNaC::pow\(\)](#), [seq](#), and [var](#).

### 6.138.3.4 degree()

```
int GiNaC::pseries::degree (
 const ex & s) const [override], [virtual]
```

Return degree of highest power of the series.

This is usually the exponent of the Order term. If s is not the expansion variable of the series, the series is examined termwise.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [seq](#), and [var](#).

Referenced by [mul\\_series\(\)](#), [power\\_const\(\)](#), and [series\(\)](#).

### 6.138.3.5 ldegree()

```
int GiNaC::pseries::ldegree (
 const ex & s) const [override], [virtual]
```

Return degree of lowest power of the series.

This is usually the exponent of the leading term. If s is not the expansion variable of the series, the series is examined termwise. If s is the expansion variable but the expansion point is not zero the series is not expanded to find the degree. I.e.:  $(1-x) + (1-x)^2 + \text{Order}((1-x)^3)$  has `ldegree(x)` 1, not 0.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [seq](#), and [var](#).

Referenced by [GiNaC::log\\_series\(\)](#), [mul\\_series\(\)](#), and [power\\_const\(\)](#).

### 6.138.3.6 coeff()

```
ex GiNaC::pseries::coeff (
 const ex & s,
 int n = 1) const [override], [virtual]
```

Return coefficient of degree n in power series if s is the expansion variable.

If the expansion point is nonzero, by definition the n=1 coefficient in s of  $a+b*(s-z)+c*(s-z)^2+\text{Order}((s-z)^3)$  is b (assuming the expansion took place in the s in the first place). If s is not the expansion variable, an attempt is made to convert the series to a polynomial and return the corresponding coefficient from there.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex0](#), [GiNaC::ex::coeff\(\)](#), [coeff\(\)](#), [convert\\_to\\_poly\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), [seq](#), and [var](#).

Referenced by [coeff\(\)](#), [GiNaC::log\\_series\(\)](#), [mul\\_series\(\)](#), [op\(\)](#), [power\\_const\(\)](#), and [read\\_archive\(\)](#).

**6.138.3.7 collect()**

```
ex GiNaC::pseries::collect (
 const ex & s,
 bool distributed = false) const [override], [virtual]
```

Does nothing.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.138.3.8 eval()**

```
ex GiNaC::pseries::eval () const [override], [virtual]
```

Perform coefficient-wise automatic term rewriting rules in this class.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), and [GiNaC::basic::hold\(\)](#).

**6.138.3.9 evalf()**

```
ex GiNaC::pseries::evalf () const [override], [virtual]
```

Evaluate coefficients numerically.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::dynallocate\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::basic::ex](#), [point](#), [seq](#), and [var](#).

**6.138.3.10 series()**

```
ex GiNaC::pseries::series (
 const relational & r,
 int order,
 unsigned options = 0) const [override], [virtual]
```

Re-expansion of a pseries object.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex1](#), [convert\\_to\\_poly\(\)](#), [degree\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [GiNaC::relational::lhs\(\)](#), [point](#), [pseries\(\)](#), [GiNaC::relational::rhs\(\)](#), [seq](#), [GiNaC::ex::series\(\)](#), and [var](#).

**6.138.3.11 subs()**

```
ex GiNaC::pseries::subs (
 const exmap & m,
 unsigned options = 0) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [convert\\_to\\_poly\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [point](#), [seq](#), [GiNaC::ex::subs\(\)](#), and [var](#).

**6.138.3.12 normal()**

```
ex GiNaC::pseries::normal (
 exmap & repl,
 exmap & rev_lookup,
 lst & modifier) const [override], [virtual]
```

Implementation of [ex::normal\(\)](#) for pseries.

It normalizes each coefficient and replaces the series by a temporary symbol.

See also

[ex::normal](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex::is\\_zero\(\)](#), [point](#), [pseries\(\)](#), [GiNaC::replace\\_with\\_symbol\(\)](#), [seq](#), and [var](#).

**6.138.3.13 expand()**

```
ex GiNaC::pseries::expand (
 unsigned options = 0) const [override], [virtual]
```

Implementation of [ex::expand\(\)](#) for a power series.

It expands all the terms individually and returns the resulting series as a new pseries.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::coeff\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::ex::is\\_zero\(\)](#), [point](#), [seq](#), and [var](#).

#### 6.138.3.14 conjugate()

```
ex GiNaC::pseries::conjugate () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [GiNaC::conjugateepvector\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [point](#), [GiNaC::info\\_flags::real](#), [seq](#), and [var](#).

#### 6.138.3.15 real\_part()

```
ex GiNaC::pseries::real_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [point](#), [GiNaC::info\\_flags::real](#), [seq](#), and [var](#).

#### 6.138.3.16 imag\_part()

```
ex GiNaC::pseries::imag_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [point](#), [GiNaC::info\\_flags::real](#), [seq](#), and [var](#).

#### 6.138.3.17 eval\_integ()

```
ex GiNaC::pseries::eval_integ () const [override], [virtual]
```

Evaluate integrals, if result is known.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [point](#), [seq](#), and [var](#).

#### 6.138.3.18 evalm()

```
ex GiNaC::pseries::evalm () const [override], [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex::is\\_zero\(\)](#), [point](#), [seq](#), and [var](#).



**6.138.3.19 archive()**

```
void GiNaC::pseries::archive (
 archive_node & n) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::add\\_ex\(\)](#), [point](#), [seq](#), and [var](#).

**6.138.3.20 read\_archive()**

```
void GiNaC::pseries::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [coeff\(\)](#), [GiNaC::basic::ex](#), [GiNaC::archive\\_node::find\\_ex\(\)](#), [GiNaC::archive\\_node::find\\_ex\\_by\\_loc\(\)](#), [GiNaC::archive\\_node::find\\_property\\_range\(\)](#), [point](#), [seq](#), and [var](#).

**6.138.3.21 derivative()**

```
ex GiNaC::pseries::derivative (
 const symbol & s) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for a power series.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::coeff\(\)](#), [GiNaC::basic::ex](#), [GiNaC::is\\_order\\_function\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [point](#), [pseries\(\)](#), [seq](#), and [var](#).

**6.138.3.22 get\_var()**

```
ex GiNaC::pseries::get_var () const [inline]
```

Get the expansion variable.

References [GiNaC::basic::ex](#), and [var](#).

**6.138.3.23 get\_point()**

```
ex GiNaC::pseries::get_point () const [inline]
```

Get the expansion point.

References [GiNaC::basic::ex](#), and [point](#).

**6.138.3.24 convert\_to\_poly()**

```
ex GiNaC::pseries::convert_to_poly (
 bool no_order = false) const
```

Convert the pseries object to an ordinary polynomial.

## Parameters

|                       |                                  |
|-----------------------|----------------------------------|
| <code>no_order</code> | flag: discard higher order terms |
|-----------------------|----------------------------------|

References [GiNaC::basic::ex](#), [GiNaC::is\\_order\\_function\(\)](#), [point](#), [GiNaC::pow\(\)](#), [seq](#), and [var](#).

Referenced by [coeff\(\)](#), [series\(\)](#), and [subs\(\)](#).

**6.138.3.25 is\_compatible\_to()**

```
bool GiNaC::pseries::is_compatible_to (
 const pseries & other) const [inline]
```

Check whether series is compatible to another series (expansion variable and point are the same).

References [point](#), [pseries\(\)](#), and [var](#).

Referenced by [add\\_series\(\)](#), and [mul\\_series\(\)](#).

**6.138.3.26 is\_zero()**

```
bool GiNaC::pseries::is_zero () const [inline]
```

Check whether series has the value zero.

References [seq](#).

Referenced by [power\\_const\(\)](#).

**6.138.3.27 is\_terminating()**

```
bool GiNaC::pseries::is_terminating () const
```

Returns true if there is no order term, i.e.

the series terminates and false otherwise.

References [GiNaC::is\\_order\\_function\(\)](#), and [seq](#).

Referenced by [GiNaC::is\\_terminating\(\)](#), and [GiNaC::log\\_series\(\)](#).

**6.138.3.28 coeffop()**

```
ex GiNaC::pseries::coeffop (
 size_t i) const
```

Get coefficients and exponents.

References [GiNaC::basic::ex](#), [nops\(\)](#), and [seq](#).

**6.138.3.29 exponop()**

```
ex GiNaC::pseries::exponop (
 size_t i) const
```

References [GiNaC::basic::ex](#), [nops\(\)](#), and [seq](#).

**6.138.3.30 add\_series()**

```
ex GiNaC::pseries::add_series (
 const pseries & other) const
```

Add one series object to another, producing a pseries object that represents the sum.

## Parameters

|              |                            |
|--------------|----------------------------|
| <i>other</i> | pseries object to add with |
|--------------|----------------------------|

## Returns

the sum as a pseries

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [is\\_compatible\\_to\(\)](#), [GiNaC::is\\_order\\_function\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [point](#), [pseries\(\)](#), [seq](#), and [var](#).

Referenced by [GiNaC::log\\_series\(\)](#).

**6.138.3.31 mul\_const()**

```
ex GiNaC::pseries::mul_const (
 const numeric & other) const
```

Multiply a pseries object with a numeric constant, producing a pseries object that represents the product.

## Parameters

|              |                           |
|--------------|---------------------------|
| <i>other</i> | constant to multiply with |
|--------------|---------------------------|

## Returns

the product as a pseries

References [GiNaC::numeric::coeff\(\)](#), [GiNaC::basic::ex](#), [GiNaC::is\\_order\\_function\(\)](#), [point](#), [pseries\(\)](#), [seq](#), and [var](#).

Referenced by [GiNaC::mul::series\(\)](#).

**6.138.3.32 mul\_series()**

```
ex GiNaC::pseries::mul_series (
 const pseries & other) const
```

Multiply one pseries object to another, producing a pseries object that represents the product.

## Parameters

|              |                                 |
|--------------|---------------------------------|
| <i>other</i> | pseries object to multiply with |
|--------------|---------------------------------|

## Returns

the product as a pseries

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [coeff\(\)](#), [degree\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [is\\_compatible\\_to\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::is\\_order\\_function\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [ldegree\(\)](#), [point](#), [pseries\(\)](#), [seq](#), and [var](#).

Referenced by [GiNaC::mul::series\(\)](#).

**6.138.3.33 power\_const()**

```
ex GiNaC::pseries::power_const (
 const numeric & p,
 int deg) const
```

Compute the p-th power of a series.

## Parameters

|       |                                        |
|-------|----------------------------------------|
| $p$   | power to compute                       |
| $deg$ | truncation order of series calculation |

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [coeff\(\)](#), [degree\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [GiNaC::is\\_integer\(\)](#), [GiNaC::numeric::is\\_negative\(\)](#), [GiNaC::is\\_order\\_function\(\)](#), [GiNaC::numeric::is\\_pos\\_integer\(\)](#), [GiNaC::numeric::is\\_zero\(\)](#), [is\\_zero\(\)](#), [ldegree\(\)](#), [point](#), [GiNaC::pow\(\)](#), [pseries\(\)](#), [GiNaC::numeric::real\(\)](#), [seq](#), [GiNaC::to\\_int\(\)](#), and [var](#).

**6.138.3.34 shift\_exponents()**

```
pseries GiNaC::pseries::shift_exponents (
 int deg) const
```

Return a new pseries object with the powers shifted by deg.

References [point](#), [pseries\(\)](#), [seq](#), and [var](#).

**6.138.3.35 print\_series()**

```
void GiNaC::pseries::print_series (
 const print_context & c,
 const char * openbrace,
 const char * closebrace,
 const char * mul_sym,
 const char * pow_sym,
 unsigned level) const [protected]
```

References [GiNaC::\\_ex1](#), [GiNaC::is\\_order\\_function\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::numeric](#), [point](#), [GiNaC::info\\_flags::positive](#), [GiNaC::pow\(\)](#), [precedence\(\)](#), [GiNaC::basic::print\(\)](#), [GiNaC::print\\_context::s](#), [seq](#), and [var](#).

Referenced by [do\\_print\(\)](#), [do\\_print\\_latex\(\)](#), and [do\\_print\\_python\(\)](#).

**6.138.3.36 do\_print()**

```
void GiNaC::pseries::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [print\\_series\(\)](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.138.3.37 do\_print\_latex()**

```
void GiNaC::pseries::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

References [print\\_series\(\)](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.138.3.38 do\_print\_tree()**

```
void GiNaC::pseries::do_print_tree (
 const print_tree & c,
 unsigned level) const [protected]
```

References [GiNaC::print\\_tree::delta\\_indent](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [point](#), [GiNaC::print\\_context::s](#), [seq](#), and [var](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.138.3.39 do\_print\_python()**

```
void GiNaC::pseries::do_print_python (
 const print_python & c,
 unsigned level) const [protected]
```

References [print\\_series\(\)](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.138.3.40 do\_print\_python\_repr()**

```
void GiNaC::pseries::do_print_python_repr (
 const print_python_repr & c,
 unsigned level) const [protected]
```

References [point](#), [GiNaC::print\\_context::s](#), [seq](#), and [var](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.138.4 Member Data Documentation****6.138.4.1 seq**

```
epvector GiNaC::pseries::seq [protected]
```

Vector of {coefficient, power} pairs.

Referenced by [add\\_series\(\)](#), [archive\(\)](#), [coeff\(\)](#), [coeffop\(\)](#), [conjugate\(\)](#), [convert\\_to\\_poly\(\)](#), [degree\(\)](#), [derivative\(\)](#), [do\\_print\\_python\\_repr\(\)](#), [do\\_print\\_tree\(\)](#), [eval\\_integ\(\)](#), [evalf\(\)](#), [evalm\(\)](#), [expand\(\)](#), [exponop\(\)](#), [imag\\_part\(\)](#), [is\\_terminating\(\)](#), [is\\_zero\(\)](#), [ldegree\(\)](#), [mul\\_const\(\)](#), [mul\\_series\(\)](#), [nops\(\)](#), [normal\(\)](#), [op\(\)](#), [power\\_const\(\)](#), [print\\_series\(\)](#), [pseries\(\)](#), [pseries\(\)](#), [read\\_archive\(\)](#), [real\\_part\(\)](#), [series\(\)](#), [shift\\_exponents\(\)](#), and [subs\(\)](#).

**6.138.4.2 var**

```
ex GiNaC::pseries::var [protected]
```

Series variable (holds a symbol)

Referenced by [add\\_series\(\)](#), [archive\(\)](#), [coeff\(\)](#), [conjugate\(\)](#), [convert\\_to\\_poly\(\)](#), [degree\(\)](#), [derivative\(\)](#), [do\\_print\\_python\\_repr\(\)](#), [do\\_print\\_tree\(\)](#), [eval\\_integ\(\)](#), [evalf\(\)](#), [evalm\(\)](#), [expand\(\)](#), [get\\_var\(\)](#), [imag\\_part\(\)](#), [is\\_compatible\\_to\(\)](#), [ldegree\(\)](#), [mul\\_const\(\)](#), [mul\\_series\(\)](#), [normal\(\)](#), [op\(\)](#), [power\\_const\(\)](#), [print\\_series\(\)](#), [pseries\(\)](#), [pseries\(\)](#), [read\\_archive\(\)](#), [real\\_part\(\)](#), [series\(\)](#), [shift\\_exponents\(\)](#), and [subs\(\)](#).

### 6.138.4.3 point

ex `GiNaC::pseries::point` [protected]

Expansion point.

Referenced by [add\\_series\(\)](#), [archive\(\)](#), [conjugate\(\)](#), [convert\\_to\\_poly\(\)](#), [derivative\(\)](#), [do\\_print\\_python\\_repr\(\)](#), [do\\_print\\_tree\(\)](#), [eval\\_integ\(\)](#), [evalf\(\)](#), [evalm\(\)](#), [expand\(\)](#), [get\\_point\(\)](#), [imag\\_part\(\)](#), [is\\_compatible\\_to\(\)](#), [mul\\_const\(\)](#), [mul\\_series\(\)](#), [normal\(\)](#), [op\(\)](#), [power\\_const\(\)](#), [print\\_series\(\)](#), [pseries\(\)](#), [pseries\(\)](#), [read\\_archive\(\)](#), [real\\_part\(\)](#), [series\(\)](#), [shift\\_exponents\(\)](#), and [subs\(\)](#).

The documentation for this class was generated from the following files:

- [pseries.h](#)
- [normal.cpp](#)
- [pseries.cpp](#)

## 6.139 GiNaC::psi1\_SERIAL Class Reference

Polylogarithm and multiple polylogarithm.

```
#include <inifcns.h>
```

### Static Public Attributes

- static unsigned [serial](#)

### 6.139.1 Detailed Description

Polylogarithm and multiple polylogarithm.

Nielsen's generalized polylogarithm. Harmonic polylogarithm. Gamma-function. Beta-function. Psi-function (aka digamma-function).

### 6.139.2 Member Data Documentation

#### 6.139.2.1 serial

```
unsigned GiNaC::psi1_SERIAL::serial [static]
```

**Initial value:**

```
=
function::register_new(function_options("psi", 1).
 eval_func(psil_eval).
 evalf_func(psil_evalf).
 derivative_func(psil_deriv).
 series_func(psil_series).
 latex_name("\\psi").
 overloaded(2))
```

Referenced by [GiNaC::psi\(\)](#).

The documentation for this class was generated from the following files:

- [inifcns.h](#)
- [inifcns\\_gamma.cpp](#)

## 6.140 GiNaC::psi2\_SERIAL Class Reference

Derivatives of Psi-function (aka polygamma-functions).

```
#include <inifcns.h>
```

### Static Public Attributes

- static unsigned [serial](#)

### 6.140.1 Detailed Description

Derivatives of Psi-function (aka polygamma-functions).

### 6.140.2 Member Data Documentation

#### 6.140.2.1 serial

```
unsigned GiNaC::psi2_SERIAL::serial [static]
```

**Initial value:**

```
=
 function::register_new(function_options("psi", 2).
 eval_func(psi2_eval).
 evalf_func(psi2_evalf).
 derivative_func(psi2_deriv).
 series_func(psi2_series).
 latex_name("\\psi").
 overloaded(2))
```

Referenced by [GiNaC::psi\(\)](#).

The documentation for this class was generated from the following files:

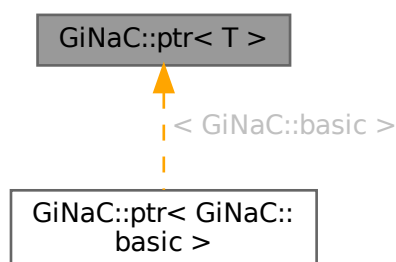
- [inifcns.h](#)
- [inifcns\\_gamma.cpp](#)

## 6.141 GiNaC::ptr< T > Class Template Reference

Class of (intrusively) reference-counted pointers that support copy-on-write semantics.

```
#include <ptr.h>
```

Inheritance diagram for GiNaC::ptr< T >:



## Public Member Functions

- `ptr (T *t)` noexcept  
*Bind ptr to newly created object, start reference counting.*
- `ptr (T &t)` noexcept  
*Bind ptr to existing reference-counted object.*
- `ptr (const ptr &other)` noexcept
- `~ptr ()`
- `ptr & operator= (const ptr &other)`
- `T & operator* ()` const noexcept
- `T * operator-> ()` const noexcept
- `void makewritable ()`  
*Announce your intention to modify the object bound to this ptr.*
- `void swap (ptr &other)` noexcept  
*Swap the bound object of this ptr with another ptr.*
- `template<class U>`  
`bool operator== (const ptr< U > &rhs)` const noexcept
- `template<class U>`  
`bool operator!= (const ptr< U > &rhs)` const noexcept

## Private Attributes

- `T * p`

## Friends

- `struct std::less< ptr< T > >`
- `T * get_pointer (const ptr &x)` noexcept
- `template<class U>`  
`bool operator== (const ptr &lhs, const U *rhs)` noexcept
- `template<class U>`  
`bool operator!= (const ptr &lhs, const U *rhs)` noexcept
- `template<class U>`  
`bool operator== (const U *lhs, const ptr &rhs)` noexcept
- `template<class U>`  
`bool operator!= (const U *lhs, const ptr &rhs)` noexcept
- `std::ostream & operator<< (std::ostream &os, const ptr< T > &rhs)`

### 6.141.1 Detailed Description

**template<class T>**  
**class GiNaC::ptr< T >**

Class of (intrusively) reference-counted pointers that support copy-on-write semantics.

Requirements for T: must support the refcounted interface (usually by being derived from refcounted) T\* T↔  
::duplicate() member function (only if makewritable() is used)



## 6.141.2 Constructor & Destructor Documentation

### 6.141.2.1 ptr() [1/3]

```
template<class T>
GiNaC::ptr< T >::ptr (
 T * t) [inline], [noexcept]
```

Bind ptr to newly created object, start reference counting.

References [GINAC\\_ASSERT](#), and [p](#).

Referenced by [get\\_pointer](#), [operator!=](#), [operator!==\(](#), [operator!=](#), [operator<<](#), [operator=\(\)](#), [operator==](#), [operator==\(](#), [operator==](#), [ptr\(\)](#), and [swap\(\)](#).

### 6.141.2.2 ptr() [2/3]

```
template<class T>
GiNaC::ptr< T >::ptr (
 T & t) [inline], [explicit], [noexcept]
```

Bind ptr to existing reference-counted object.

References [p](#).

### 6.141.2.3 ptr() [3/3]

```
template<class T>
GiNaC::ptr< T >::ptr (
 const ptr< T > & other) [inline], [noexcept]
```

References [p](#), and [ptr\(\)](#).

### 6.141.2.4 ~ptr()

```
template<class T>
GiNaC::ptr< T >::~~ptr () [inline]
```

References [p](#).

## 6.141.3 Member Function Documentation

### 6.141.3.1 operator=()

```
template<class T>
ptr & GiNaC::ptr< T >::operator= (
 const ptr< T > & other) [inline]
```

References [p](#), and [ptr\(\)](#).

### 6.141.3.2 operator\*()

```
template<class T>
T & GiNaC::ptr< T >::operator* () const [inline], [noexcept]
```

References [p](#).

### 6.141.3.3 operator->()

```
template<class T>
T * GiNaC::ptr< T >::operator-> () const [inline], [noexcept]
```

References [p](#).

### 6.141.3.4 makewritable()

```
template<class T>
void GiNaC::ptr< T >::makewritable () [inline]
```

Announce your intention to modify the object bound to this ptr.

This ensures that the object is not shared by any other ptrs.

References [p](#).

### 6.141.3.5 swap()

```
template<class T>
void GiNaC::ptr< T >::swap (
 ptr< T > & other) [inline], [noexcept]
```

Swap the bound object of this ptr with another ptr.

References [p](#), and [ptr\(\)](#).

### 6.141.3.6 operator==()

```
template<class T>
template<class U>
bool GiNaC::ptr< T >::operator== (
 const ptr< U > & rhs) const [inline], [noexcept]
```

References [get\\_pointer](#), [p](#), [ptr\(\)](#), and [GiNaC::rhs\(\)](#).

### 6.141.3.7 operator"!="()

```
template<class T>
template<class U>
bool GiNaC::ptr< T >::operator!= (
 const ptr< U > & rhs) const [inline], [noexcept]
```

References [get\\_pointer](#), [p](#), [ptr\(\)](#), and [GiNaC::rhs\(\)](#).

## 6.141.4 Friends And Related Symbol Documentation

### 6.141.4.1 std::less< ptr< T > >

```
template<class T>
friend struct std::less< ptr< T > > [friend]
```

### 6.141.4.2 get\_pointer

```
template<class T>
T * get_pointer (
 const ptr< T > & x) [friend]
```

References [ptr\(\)](#).

Referenced by [operator!=\(\)](#), and [operator==\(\)](#).

### 6.141.4.3 operator== [1/2]

```
template<class T>
template<class U>
bool operator== (
 const ptr< T > & lhs,
 const U * rhs) [friend]
```

References [GiNaC::lhs\(\)](#), [ptr\(\)](#), and [GiNaC::rhs\(\)](#).

### 6.141.4.4 operator"!=" [1/2]

```
template<class T>
template<class U>
bool operator!= (
 const ptr< T > & lhs,
 const U * rhs) [friend]
```

References [GiNaC::lhs\(\)](#), [ptr\(\)](#), and [GiNaC::rhs\(\)](#).

### 6.141.4.5 operator== [2/2]

```
template<class T>
template<class U>
bool operator== (
 const U * lhs,
 const ptr< T > & rhs) [friend]
```

References [GiNaC::lhs\(\)](#), [ptr\(\)](#), and [GiNaC::rhs\(\)](#).

#### 6.141.4.6 `operator"!=` [2/2]

```
template<class T>
template<class U>
bool operator!= (
 const U * lhs,
 const ptr< T > & rhs) [friend]
```

References [GiNaC::lhs\(\)](#), [ptr\(\)](#), and [GiNaC::rhs\(\)](#).

#### 6.141.4.7 `operator<<`

```
template<class T>
std::ostream & operator<< (
 std::ostream & os,
 const ptr< T > & rhs) [friend]
```

References [ptr\(\)](#), and [GiNaC::rhs\(\)](#).

### 6.141.5 Member Data Documentation

#### 6.141.5.1 `p`

```
template<class T>
T* GiNaC::ptr< T >::p [private]
```

Referenced by [makewritable\(\)](#), [operator!=\(\)](#), [operator\\*\(\)](#), [operator->\(\)](#), [operator=\(\)](#), [operator==\(\)](#), [ptr\(\)](#), [ptr\(\)](#), [ptr\(\)](#), [swap\(\)](#), and [~ptr\(\)](#).

The documentation for this class was generated from the following file:

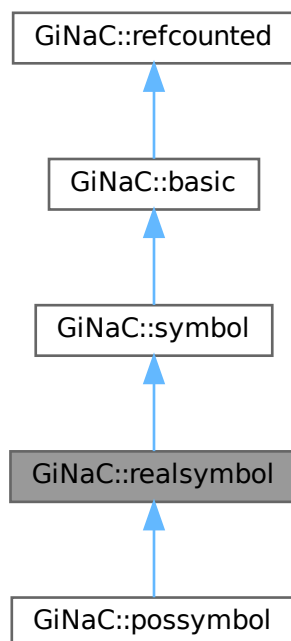
- [ptr.h](#)

## 6.142 `GiNaC::realsymbol` Class Reference

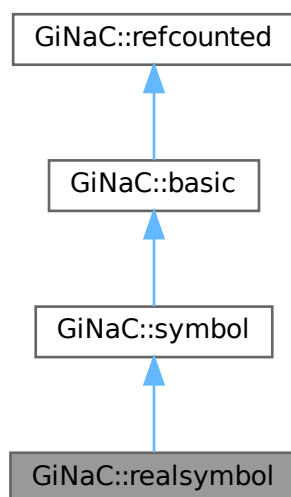
Specialization of `symbol` to real domain.

```
#include <symbol.h>
```

Inheritance diagram for GiNaC::realsymbol:



Collaboration diagram for GiNaC::realsymbol:



## Public Member Functions

- [realsymbol](#) ()
- [realsymbol](#) (const std::string &initname)
- [realsymbol](#) (const std::string &initname, const std::string &texname)
- unsigned [get\\_domain](#) () const override
- [ex conjugate](#) () const override
- [ex real\\_part](#) () const override
- [ex imag\\_part](#) () const override
- [realsymbol](#) \* [duplicate](#) () const override

*Create a clone of this object on the heap.*

## Public Member Functions inherited from [GiNaC::symbol](#)

- [symbol](#) (const std::string &initname)
  - [symbol](#) (const std::string &initname, const std::string &texname)
  - bool [info](#) (unsigned inf) const override
- Information about the object.*
- [ex eval](#) () const override
- Perform automatic non-interruptive term rewriting rules.*
- [ex evalf](#) () const override
- Evaluate object numerically.*
- [ex series](#) (const [relational](#) &s, int order, unsigned options=0) const override
- Implementation of [ex::series\(\)](#) for symbols.*
- [ex subs](#) (const [exmap](#) &m, unsigned options=0) const override
- Substitute a set of objects by arbitrary expressions.*
- [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev\_lookup, [lst](#) &modifier) const override
- Implementation of [ex::normal\(\)](#) for symbols.*
- [ex to\\_rational](#) ([exmap](#) &repl) const override
- Implementation of [ex::to\\_rational\(\)](#) for symbols.*
- [ex to\\_polynomial](#) ([exmap](#) &repl) const override
- Implementation of [ex::to\\_polynomial\(\)](#) for symbols.*
- [ex conjugate](#) () const override
  - [ex real\\_part](#) () const override
  - [ex imag\\_part](#) () const override
  - bool [is\\_polynomial](#) (const [ex](#) &var) const override
- Check whether this is a polynomial in the given variables.*
- void [archive](#) ([archive\\_node](#) &n) const override
- Save (a.k.a.*
- void [read\\_archive](#) (const [archive\\_node](#) &n, [lst](#) &syms) override
- Read (a.k.a.*
- void [set\\_name](#) (const std::string &n)
  - void [set\\_TeX\\_name](#) (const std::string &n)
  - std::string [get\\_name](#) () const
  - std::string [get\\_TeX\\_name](#) () const

Public Member Functions inherited from **GiNaC::basic**

- virtual `~basic` ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree` () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence` () const  
*Return relative operator precedence (for parenthezing output).*
- virtual size\_t `nops` () const  
*Number of operands/members.*
- virtual `ex op` (size\_t i) const  
*Return operand/member at position i.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex` & `let_op` (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual `ex` & `operator[]` (const `ex` &index)
- virtual `ex` & `operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const  
*Check whether the expression matches a given pattern.*
- virtual `ex map` (`map_function` &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual int `degree` (const `ex` &s) const  
*Return degree of highest power in object s.*
- virtual int `ldegree` (const `ex` &s) const  
*Return degree of lowest power in object s.*
- virtual `ex coeff` (const `ex` &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual `ex expand` (unsigned options=0) const  
*Expand expression, i.e.*
- virtual `ex collect` (const `ex` &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

- virtual `numeric max_coefficient ()` const  
*Implementation `ex::max_coefficient()`.*
- virtual `exvector get_free_indices ()` const  
*Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed (const ex &self, const ex &other)` const  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed (const ex &self, const numeric &other)` const  
*Multiply an indexed expression with a scalar.*
- virtual `bool contract_with (exvector::iterator self, exvector::iterator other, exvector &v)` const  
*Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned `return_type ()` const
- virtual `return_type_t return_type_tinfo ()` const
- template<class T>  
void `print_dispatch (const print_context &c, unsigned level)` const  
*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch (const registered_class_info &ri, const print_context &c, unsigned level)` const  
*Like `print()`, but dispatch to the specified class.*
- `ex subs_one_level (const exmap &m, unsigned options)` const  
*Helper function for `subs()`.*
- `ex diff (const symbol &s, unsigned nth=1)` const  
*Default interface of `nth` derivative `ex::diff(s, n)`.*
- int `compare (const basic &other)` const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal (const basic &other)` const  
*Test for syntactic equality.*
- const `basic & hold ()` const  
*Stop further evaluation.*
- unsigned `gethash ()` const
- const `basic & setflag (unsigned f)` const  
*Set some `status_flags`.*
- const `basic & clearflag (unsigned f)` const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted ()` noexcept
- unsigned int `add_reference ()` noexcept
- unsigned int `remove_reference ()` noexcept
- unsigned int `get_refcount ()` const noexcept
- void `set_refcount (unsigned int r)` noexcept

## Additional Inherited Members

## Protected Member Functions inherited from `GiNaC::symbol`

- `ex derivative (const symbol &s)` const override  
*Implementation of `ex::diff()` for single differentiation of a symbol.*
- bool `is_equal_same_type (const basic &other)` const override  
*Returns true if two objects of same type are equal.*
- unsigned `calchash ()` const override  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `do_print (const print_context &c, unsigned level)` const
- void `do_print_latex (const print_latex &c, unsigned level)` const
- void `do_print_tree (const print_tree &c, unsigned level)` const
- void `do_print_python_repr (const print_python_repr &c, unsigned level)` const



## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Attributes inherited from [GiNaC::symbol](#)

- unsigned [serial](#)  
*unique serial number for comparison*
- std::string [name](#)  
*printname of this symbol*
- std::string [TeX\\_name](#)  
*LaTeX name of this symbol.*

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.142.1 Detailed Description

Specialization of symbol to real domain.

### 6.142.2 Constructor & Destructor Documentation

#### 6.142.2.1 [realsymbol](#)() [1/3]

`GiNaC::realsymbol::realsymbol ()`

References [realsymbol\(\)](#), and [GiNaC::symbol::symbol\(\)](#).

Referenced by [duplicate\(\)](#), [GiNaC::possymbol::possymbol\(\)](#), [GiNaC::possymbol::possymbol\(\)](#), [GiNaC::possymbol::possymbol\(\)](#), and [realsymbol\(\)](#).

#### 6.142.2.2 realsymbol() [2/3]

```
GiNaC::realsymbol::realsymbol (
 const std::string & initname) [explicit]
```

References [GiNaC::symbol::symbol\(\)](#).

#### 6.142.2.3 realsymbol() [3/3]

```
GiNaC::realsymbol::realsymbol (
 const std::string & initname,
 const std::string & texname)
```

References [GiNaC::symbol::symbol\(\)](#).

### 6.142.3 Member Function Documentation

#### 6.142.3.1 get\_domain()

```
unsigned GiNaC::realsymbol::get_domain () const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::symbol](#).

References [GiNaC::domain::real](#).

#### 6.142.3.2 conjugate()

```
ex GiNaC::realsymbol::conjugate () const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

#### 6.142.3.3 real\_part()

```
ex GiNaC::realsymbol::real_part () const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

#### 6.142.3.4 imag\_part()

```
ex GiNaC::realsymbol::imag_part () const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

### 6.142.3.5 duplicate()

```
realsymbol * GiNaC::realsymbol::duplicate () const [inline], [override], [virtual]
```

Create a clone of this object on the heap.

One can think of this as simulating a virtual copy constructor which is needed for instance by the refcounted construction of an ex from a basic.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::status\\_flags::dynallocated](#), [realsymbol\(\)](#), and [GiNaC::basic::setflag\(\)](#).

The documentation for this class was generated from the following files:

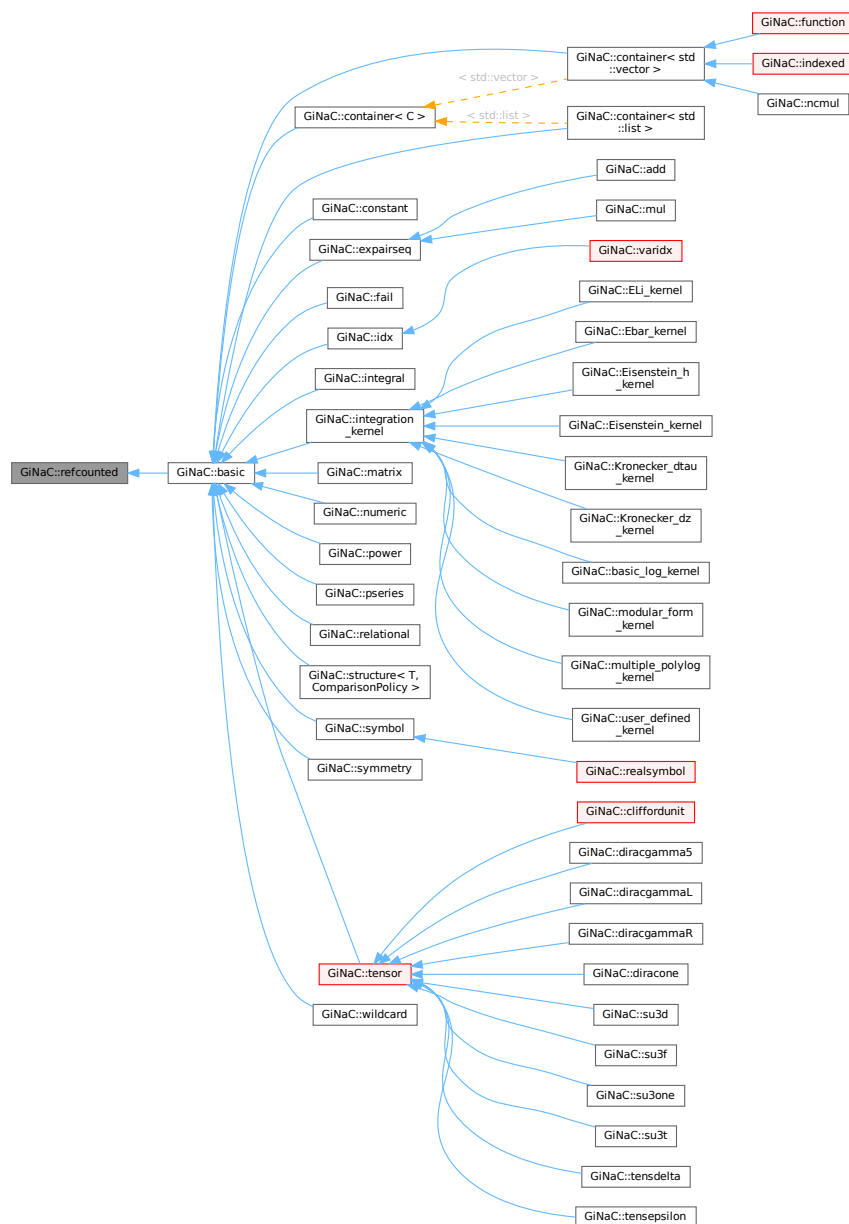
- [symbol.h](#)
- [symbol.cpp](#)

## 6.143 GiNaC::refcounted Class Reference

Base class for reference-counted objects.

```
#include <ptr.h>
```

Inheritance diagram for `GiNaC::refcounted`:



## Public Member Functions

- `refcounted()` noexcept
- unsigned int `add_reference()` noexcept
- unsigned int `remove_reference()` noexcept
- unsigned int `get_refcount()` const noexcept
- void `set_refcount` (unsigned int r) noexcept

## Private Attributes

- unsigned int `refcount`  
*reference counter*

### 6.143.1 Detailed Description

Base class for reference-counted objects.

### 6.143.2 Constructor & Destructor Documentation

#### 6.143.2.1 refcounted()

```
GiNaC::refcounted::refcounted () [inline], [noexcept]
```

References [refcount](#).

### 6.143.3 Member Function Documentation

#### 6.143.3.1 add\_reference()

```
unsigned int GiNaC::refcounted::add_reference () [inline], [noexcept]
```

References [refcount](#).

#### 6.143.3.2 remove\_reference()

```
unsigned int GiNaC::refcounted::remove_reference () [inline], [noexcept]
```

References [refcount](#).

#### 6.143.3.3 get\_refcount()

```
unsigned int GiNaC::refcounted::get_refcount () const [inline], [noexcept]
```

References [refcount](#).

Referenced by [GiNaC::ex::construct\\_from\\_basic\(\)](#), [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), and [GiNaC::basic::~~basic\(\)](#).

#### 6.143.3.4 set\_refcount()

```
void GiNaC::refcounted::set_refcount (
 unsigned int r) [inline], [noexcept]
```

References [refcount](#).

Referenced by [GiNaC::basic::operator=\(\)](#).

## 6.143.4 Member Data Documentation

### 6.143.4.1 refcount

```
unsigned int GiNaC::refcounted::refcount [private]
```

reference counter

Referenced by [add\\_reference\(\)](#), [get\\_refcount\(\)](#), [refcounted\(\)](#), [remove\\_reference\(\)](#), and [set\\_refcount\(\)](#).

The documentation for this class was generated from the following file:

- [ptr.h](#)

## 6.144 GiNaC::registered\_class\_options Class Reference

This class stores information about a registered [GiNaC](#) class.

```
#include <registrar.h>
```

### Public Member Functions

- [registered\\_class\\_options](#) (const char \*n, const char \*p, const std::type\_info &ti)
- const char \* [get\\_name](#) () const
- const char \* [get\\_parent\\_name](#) () const
- std::type\_info const \* [get\\_id](#) () const
- const std::vector< [print\\_functor](#) > & [get\\_print\\_dispatch\\_table](#) () const
- template<class Ctx, class T, class C>  
[registered\\_class\\_options](#) & [print\\_func](#) (void f(const T &, const C &c, unsigned))
- template<class Ctx, class T, class C>  
[registered\\_class\\_options](#) & [print\\_func](#) (void(T::\*f)(const C &, unsigned))
- template<class Ctx>  
[registered\\_class\\_options](#) & [print\\_func](#) (const [print\\_functor](#) &f)
- void [set\\_print\\_func](#) (unsigned id, const [print\\_functor](#) &f)

### Private Attributes

- const char \* [name](#)  
*Class name.*
- const char \* [parent\\_name](#)  
*Name of superclass.*
- std::type\_info const \* [tinfo\\_key](#)  
*Type information key.*
- std::vector< [print\\_functor](#) > [print\\_dispatch\\_table](#)  
*Method table for print() dispatch.*

### 6.144.1 Detailed Description

This class stores information about a registered [GiNaC](#) class.

## 6.144.2 Constructor & Destructor Documentation

### 6.144.2.1 registered\_class\_options()

```
GiNaC::registered_class_options::registered_class_options (
 const char * n,
 const char * p,
 const std::type_info & ti) [inline]
```

References [name](#), [parent\\_name](#), and [tinfo\\_key](#).

Referenced by [print\\_func\(\)](#), [print\\_func\(\)](#), and [print\\_func\(\)](#).

## 6.144.3 Member Function Documentation

### 6.144.3.1 get\_name()

```
const char * GiNaC::registered_class_options::get_name () const [inline]
```

References [name](#).

### 6.144.3.2 get\_parent\_name()

```
const char * GiNaC::registered_class_options::get_parent_name () const [inline]
```

References [parent\\_name](#).

### 6.144.3.3 get\_id()

```
std::type_info const * GiNaC::registered_class_options::get_id () const [inline]
```

References [tinfo\\_key](#).

### 6.144.3.4 get\_print\_dispatch\_table()

```
const std::vector< print_func > & GiNaC::registered_class_options::get_print_dispatch_table
() const [inline]
```

References [print\\_dispatch\\_table](#).

### 6.144.3.5 print\_func() [1/3]

```
template<class Ctx, class T, class C>
registered_class_options & GiNaC::registered_class_options::print_func (
 void fconst T &, const C &c, unsigned) [inline]
```

References [registered\\_class\\_options\(\)](#), and [set\\_print\\_func\(\)](#).

### 6.144.3.6 `print_func()` [2/3]

```
template<class Ctx, class T, class C>
registered_class_options & GiNaC::registered_class_options::print_func (
 void(T::* f) (const C &, unsigned)) [inline]
```

References [registered\\_class\\_options\(\)](#), and [set\\_print\\_func\(\)](#).

### 6.144.3.7 `print_func()` [3/3]

```
template<class Ctx>
registered_class_options & GiNaC::registered_class_options::print_func (
 const print_functor & f) [inline]
```

References [registered\\_class\\_options\(\)](#), and [set\\_print\\_func\(\)](#).

### 6.144.3.8 `set_print_func()`

```
void GiNaC::registered_class_options::set_print_func (
 unsigned id,
 const print_functor & f) [inline]
```

References [print\\_dispatch\\_table](#).

Referenced by [print\\_func\(\)](#), [print\\_func\(\)](#), and [print\\_func\(\)](#).

## 6.144.4 Member Data Documentation

### 6.144.4.1 `name`

```
const char* GiNaC::registered_class_options::name [private]
```

Class name.

Referenced by [get\\_name\(\)](#), and [registered\\_class\\_options\(\)](#).

### 6.144.4.2 `parent_name`

```
const char* GiNaC::registered_class_options::parent_name [private]
```

Name of superclass.

Referenced by [get\\_parent\\_name\(\)](#), and [registered\\_class\\_options\(\)](#).

### 6.144.4.3 `tinfo_key`

```
std::type_info const* GiNaC::registered_class_options::tinfo_key [private]
```

Type information key.

Referenced by [get\\_id\(\)](#), and [registered\\_class\\_options\(\)](#).



#### 6.144.4.4 print\_dispatch\_table

```
std::vector<print_functor> GiNaC::registered_class_options::print_dispatch_table [private]
```

Method table for print() dispatch.

Referenced by [get\\_print\\_dispatch\\_table\(\)](#), and [set\\_print\\_func\(\)](#).

The documentation for this class was generated from the following file:

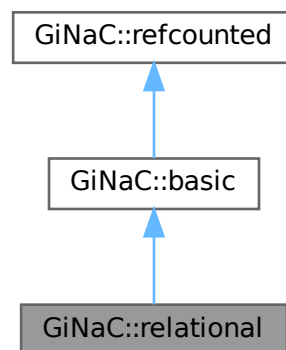
- [registrar.h](#)

## 6.145 GiNaC::relational Class Reference

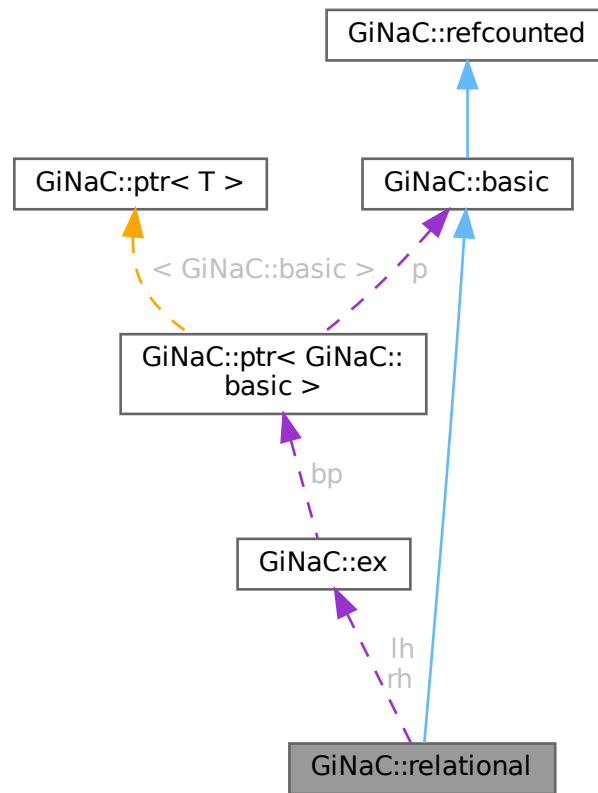
This class holds a relation consisting of two expressions and a logical relation between them.

```
#include <relational.h>
```

Inheritance diagram for GiNaC::relational:



Collaboration diagram for `GiNaC::relational`:



## Classes

- struct `safe_bool_helper`

## Public Types

- enum `operators` {  
`equal` , `not_equal` , `less` , `less_or_equal` ,  
`greater` , `greater_or_equal` }

## Public Member Functions

- `relational` (const `ex` &`lhs`, const `ex` &`rhs`, `operators` oper=`equal`)
- unsigned `precedence` () const override  
*Return relative operator precedence (for parenthezing output).*
- bool `info` (unsigned inf) const override  
*Information about the object.*
- size\_t `nops` () const override  
*Number of operands/members.*

- `ex op` (`size_t i`) `const` override  
*Return operand/member at position  $i$ .*
- `ex map` (`map_function &f`) `const` override  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- `ex subs` (`const exmap &m`, `unsigned options=0`) `const` override  
*Substitute a set of objects by arbitrary expressions.*
- `void archive` (`archive_node &n`) `const` override  
*Save (a.k.a.*
- `void read_archive` (`const archive_node &n`, `lst &syms`) `override`  
*Read (a.k.a.*
- `ex canonical` () `const`  
*Returns an equivalent relational with zero right-hand side.*
- `ex lhs` () `const`
- `ex rhs` () `const`
- `operator safe_bool` () `const`  
*Cast the relational into a Boolean, mainly for evaluation within an if-statement.*
- `safe_bool operator!` () `const`

## Public Member Functions inherited from GiNaC::basic

- `virtual ~basic` ()  
*basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic` (`const basic &other`)
- `const basic & operator=` (`const basic &other`)  
*basic assignment operator: the other object might be of a derived class.*
- `virtual basic * duplicate` () `const`  
*Create a clone of this object on the heap.*
- `virtual ex eval` () `const`  
*Perform automatic non-interruptive term rewriting rules.*
- `virtual ex evalf` () `const`  
*Evaluate object numerically.*
- `virtual ex evalm` () `const`  
*Evaluate sums, products and integer powers of matrices.*
- `virtual ex eval_integ` () `const`  
*Evaluate integrals, if result is known.*
- `virtual ex eval_indexed` (`const basic &i`) `const`  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- `virtual void print` (`const print_context &c`, `unsigned level=0`) `const`  
*Output to stream.*
- `virtual void dbgprint` () `const`  
*Little wrapper around `print` to be called within a debugger.*
- `virtual void dbgprinttree` () `const`  
*Little wrapper around `printtree` to be called within a debugger.*
- `virtual ex operator[]` (`const ex &index`) `const`
- `virtual ex operator[]` (`size_t i`) `const`
- `virtual ex & let_op` (`size_t i`)  
*Return modifiable operand/member at position  $i$ .*
- `virtual ex & operator[]` (`const ex &index`)
- `virtual ex & operator[]` (`size_t i`)
- `virtual bool has` (`const ex &other`, `unsigned options=0`) `const`

- Test for occurrence of a pattern.*

  - virtual bool `match` (const `ex` &pattern, `exmap` &repls) const

*Check whether the expression matches a given pattern.*
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const

*Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const

*Return degree of highest power in object s.*
- virtual int `ldegree` (const `ex` &s) const

*Return degree of lowest power in object s.*
- virtual `ex` `coeff` (const `ex` &s, int n=1) const

*Return coefficient of degree n in object s.*
- virtual `ex` `expand` (unsigned options=0) const

*Expand expression, i.e.*
- virtual `ex` `collect` (const `ex` &s, bool distributed=false) const

*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex` `series` (const `relational` &r, int order, unsigned options=0) const

*Default implementation of `ex::series()`.*
- virtual `ex` `normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const

*Default implementation of `ex::normal()`.*
- virtual `ex` `to_rational` (`exmap` &repl) const

*Default implementation of `ex::to_rational()`.*
- virtual `ex` `to_polynomial` (`exmap` &repl) const
- virtual `numeric` `integer_content` () const
- virtual `ex` `smod` (const `numeric` &xi) const

*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric` `max_coefficient` () const

*Implementation `ex::max_coefficient()`.*
- virtual `exvector` `get_free_indices` () const

*Return a vector containing the free indices of an expression.*
- virtual `ex` `add_indexed` (const `ex` &self, const `ex` &other) const

*Add two indexed expressions.*
- virtual `ex` `scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const

*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const

*Try to contract two indexed expressions that appear in the same product.*
- virtual `ex` `conjugate` () const
- virtual `ex` `real_part` () const
- virtual `ex` `imag_part` () const
- template<class T>
  - void `print_dispatch` (const `print_context` &c, unsigned level) const

*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const

*Like `print()`, but dispatch to the specified class.*
- `ex` `subs_one_level` (const `exmap` &m, unsigned options) const

*Helper function for `subs()`.*
- `ex` `diff` (const `symbol` &s, unsigned nth=1) const

*Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const

*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const

*Test for syntactic equality.*

- const [basic](#) & [hold](#) () const

*Stop further evaluation.*

- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const

*Set some [status\\_flags](#).*

- const [basic](#) & [clearflag](#) (unsigned f) const

*Clear some [status\\_flags](#).*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Member Functions

- [ex eval\\_ncmul](#) (const [exvector](#) &v) const override
- bool [match\\_same\\_type](#) (const [basic](#) &other) const override
 

*Returns true if the attributes of two objects are similar enough for a match.*
- unsigned [return\\_type](#) () const override
- [return\\_type\\_t](#) [return\\_type\\_tinfo](#) () const override
- unsigned [calchash](#) () const override
 

*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex derivative](#) (const [symbol](#) &s) const
 

*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const
 

*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const
 

*Returns true if two objects of same type are equal.*
- void [ensure\\_if\\_modifiable](#) () const
 

*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
 

*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const
 

*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const
 

*Python parsable output to stream.*

**Protected Attributes**

- [ex lh](#)
- [ex rh](#)
- [operators o](#)

**Protected Attributes inherited from [GiNaC::basic](#)**

- unsigned [flags](#)  
of type [status\\_flags](#)
- unsigned [hashvalue](#)  
hash value

**Private Types**

- typedef void(safe\_bool\_helper::\* [safe\\_bool](#)) ()

**Private Member Functions**

- [safe\\_bool make\\_safe\\_bool](#) (bool) const

**6.145.1 Detailed Description**

This class holds a relation consisting of two expressions and a logical relation between them.

**6.145.2 Member Typedef Documentation****6.145.2.1 [safe\\_bool](#)**

```
typedef void(safe_bool_helper::* GiNaC::relational::safe_bool) () [private]
```

**6.145.3 Member Enumeration Documentation****6.145.3.1 [operators](#)**

```
enum GiNaC::relational::operators
```

**Enumerator**

|                                  |  |
|----------------------------------|--|
| <a href="#">equal</a>            |  |
| <a href="#">not_equal</a>        |  |
| <a href="#">less</a>             |  |
| <a href="#">less_or_equal</a>    |  |
| <a href="#">greater</a>          |  |
| <a href="#">greater_or_equal</a> |  |

## 6.145.4 Constructor & Destructor Documentation

### 6.145.4.1 relational()

```
GiNaC::relational::relational (
 const ex & lhs,
 const ex & rhs,
 operators oper = equal)
```

References [GiNaC::basic::ex](#), [lh](#), [lhs\(\)](#), [o](#), [rh](#), and [rhs\(\)](#).

Referenced by [canonical\(\)](#), [match\\_same\\_type\(\)](#), and [subs\(\)](#).

## 6.145.5 Member Function Documentation

### 6.145.5.1 precedence()

```
unsigned GiNaC::relational::precedence () const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Referenced by [do\\_print\(\)](#).

### 6.145.5.2 info()

```
bool GiNaC::relational::info (
 unsigned inf) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::basic](#).

References [equal](#), [greater](#), [greater\\_or\\_equal](#), [less](#), [less\\_or\\_equal](#), [not\\_equal](#), [o](#), [GiNaC::info\\_flags::relation](#), [GiNaC::info\\_flags::relation\\_equal](#), [GiNaC::info\\_flags::relation\\_greater](#), [GiNaC::info\\_flags::relation\\_greater\\_or\\_equal](#), [GiNaC::info\\_flags::relation\\_less](#), [GiNaC::info\\_flags::relation\\_less\\_or\\_equal](#), and [GiNaC::info\\_flags::relation\\_not\\_equal](#).

Referenced by [operator safe\\_bool\(\)](#).

### 6.145.5.3 nops()

```
size_t GiNaC::relational::nops () const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

#### 6.145.5.4 op()

```
ex GiNaC::relational::op (
 size_t i) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), [GINAC\\_ASSERT](#), [lh](#), and [rh](#).

#### 6.145.5.5 map()

```
ex GiNaC::relational::map (
 map_function & f) const [override], [virtual]
```

Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [GiNaC::dynallocate\(\)](#), [GiNaC::basic::ex](#), [lh](#), [o](#), and [rh](#).

#### 6.145.5.6 subs()

```
ex GiNaC::relational::subs (
 const exmap & m,
 unsigned options = 0) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are\\_ex\\_trivially\\_equal\(\)](#), [GiNaC::basic::ex](#), [lh](#), [o](#), [relational\(\)](#), [rh](#), and [GiNaC::basic::subs\\_one\\_level\(\)](#).

#### 6.145.5.7 archive()

```
void GiNaC::relational::archive (
 archive_node & n) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::add\\_ex\(\)](#), [GiNaC::archive\\_node::add\\_unsigned\(\)](#), [lh](#), [o](#), and [rh](#).



### 6.145.5.8 read\_archive()

```
void GiNaC::relational::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::find\\_ex\(\)](#), [GiNaC::archive\\_node::find\\_unsigned\(\)](#), [lh](#), [o](#), and [rh](#).

### 6.145.5.9 canonical()

```
ex GiNaC::relational::canonical () const
```

Returns an equivalent relational with zero right-hand side.

References [GiNaC::\\_ex0](#), [GiNaC::basic::ex](#), [lh](#), [o](#), [relational\(\)](#), and [rh](#).

### 6.145.5.10 eval\_ncmul()

```
ex GiNaC::relational::eval_ncmul (
 const exvector & v) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), and [lh](#).

### 6.145.5.11 match\_same\_type()

```
bool GiNaC::relational::match_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is\\_equal\\_same\\_type\(\)](#) is automatically used instead of [match\\_same\\_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::basic\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), [o](#), and [relational\(\)](#).

**6.145.5.12 return\_type()**

```
unsigned GiNaC::relational::return_type () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GINAC\\_ASSERT](#), [lh](#), and [rh](#).

**6.145.5.13 return\_type\_tinfo()**

```
return_type_t GiNaC::relational::return_type_tinfo () const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GINAC\\_ASSERT](#), [lh](#), and [rh](#).

**6.145.5.14 calchash()**

```
unsigned GiNaC::relational::calchash () const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [equal](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::basic::flags](#), [greater](#), [greater\\_or\\_equal](#), [GiNaC::status\\_flags::hash\\_calculat](#), [GiNaC::basic::hashvalue](#), [less](#), [less\\_or\\_equal](#), [lh](#), [GiNaC::make\\_hash\\_seed\(\)](#), [not\\_equal](#), [o](#), [rh](#), [GiNaC::rotate\\_left\(\)](#), and [GiNaC::basic::setflag\(\)](#).

**6.145.5.15 do\_print()**

```
void GiNaC::relational::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [lh](#), [o](#), [precedence\(\)](#), [GiNaC::print\\_operator\(\)](#), [rh](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.145.5.16 do\_print\_python\_repr()**

```
void GiNaC::relational::do_print_python_repr (
 const print_python_repr & c,
 unsigned level) const [protected]
```

References [lh](#), [o](#), [GiNaC::print\\_operator\(\)](#), [rh](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.145.5.17 lhs()**

```
ex GiNaC::relational::lhs () const [inline]
```

References [GiNaC::basic::ex](#), and [lh](#).

Referenced by [GiNaC::atan\\_series\(\)](#), [GiNaC::atanh\\_series\(\)](#), [GiNaC::beta\\_series\(\)](#), [GiNaC::Li2\\_series\(\)](#), [GiNaC::log\\_series\(\)](#), [GiNaC::Order\\_series\(\)](#), [relational\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::Eisenstein\\_kernel::series\(\)](#), [GiNaC::integration\\_kernel::series\(\)](#), [GiNaC::modular\\_form\\_kernel::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::pseries::series\(\)](#), [GiNaC::symbol::series\(\)](#), [GiNaC::tan\\_series\(\)](#), and [GiNaC::tanh\\_series\(\)](#).

**6.145.5.18 rhs()**

```
ex GiNaC::relational::rhs () const [inline]
```

References [GiNaC::basic::ex](#), and [rh](#).

Referenced by [GiNaC::atan\\_series\(\)](#), [GiNaC::atanh\\_series\(\)](#), [GiNaC::Li2\\_series\(\)](#), [GiNaC::log\\_series\(\)](#), [relational\(\)](#), [GiNaC::Eisenstein\\_kernel::series\(\)](#), [GiNaC::integration\\_kernel::series\(\)](#), [GiNaC::modular\\_form\\_kernel::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::pseries::series\(\)](#), and [GiNaC::symbol::series\(\)](#).

**6.145.5.19 make\_safe\_bool()**

```
relational::safe_bool GiNaC::relational::make_safe_bool (
 bool cond) const [private]
```

References [GiNaC::relational::safe\\_bool\\_helper::nonnull\(\)](#).

Referenced by [operator safe\\_bool\(\)](#), and [operator!\(\)](#).

**6.145.5.20 operator safe\_bool()**

```
GiNaC::relational::operator relational::safe_bool () const
```

Cast the relational into a Boolean, mainly for evaluation within an if-statement.

Note that  $(a < b) == \text{false}$  does not imply  $(a \geq b) == \text{true}$  in the general symbolic case. A false result means the comparison is either false or undecidable (except of course for  $!=$ , where true means either unequal or undecidable).

References [GiNaC::\\_num0\\_p](#), [equal](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [greater](#), [greater\\_or\\_equal](#), [GiNaC::ex::info\(\)](#), [info\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::is\\_zero\(\)](#), [less](#), [less\\_or\\_equal](#), [lh](#), [make\\_safe\\_bool\(\)](#), [GiNaC::info\\_flags::negative](#), [GiNaC::info\\_flags::nonnegative](#), [not\\_equal](#), [o](#), [GiNaC::info\\_flags::positive](#), and [rh](#).

**6.145.5.21 operator"!()**

```
relational::safe_bool GiNaC::relational::operator! () const [inline]
```

References [make\\_safe\\_bool\(\)](#).

## 6.145.6 Member Data Documentation

### 6.145.6.1 lh

`ex GiNaC::relational::lh` [protected]

Referenced by [archive\(\)](#), [calchash\(\)](#), [canonical\(\)](#), [do\\_print\(\)](#), [do\\_print\\_python\\_repr\(\)](#), [eval\\_ncmul\(\)](#), [lhs\(\)](#), [map\(\)](#), [op\(\)](#), [operator safe\\_bool\(\)](#), [read\\_archive\(\)](#), [relational\(\)](#), [return\\_type\(\)](#), [return\\_type\\_tinfo\(\)](#), and [subs\(\)](#).

### 6.145.6.2 rh

`ex GiNaC::relational::rh` [protected]

Referenced by [archive\(\)](#), [calchash\(\)](#), [canonical\(\)](#), [do\\_print\(\)](#), [do\\_print\\_python\\_repr\(\)](#), [map\(\)](#), [op\(\)](#), [operator safe\\_bool\(\)](#), [read\\_archive\(\)](#), [relational\(\)](#), [return\\_type\(\)](#), [return\\_type\\_tinfo\(\)](#), [rhs\(\)](#), and [subs\(\)](#).

### 6.145.6.3 o

`operators GiNaC::relational::o` [protected]

Referenced by [archive\(\)](#), [calchash\(\)](#), [canonical\(\)](#), [do\\_print\(\)](#), [do\\_print\\_python\\_repr\(\)](#), [info\(\)](#), [map\(\)](#), [match\\_same\\_type\(\)](#), [operator safe\\_bool\(\)](#), [read\\_archive\(\)](#), [relational\(\)](#), and [subs\(\)](#).

The documentation for this class was generated from the following files:

- [relational.h](#)
- [relational.cpp](#)

## 6.146 GiNaC::remember\_strategies Class Reference

Strategies how to clean up the function remember cache.

```
#include <flags.h>
```

### Public Types

- enum { [delete\\_never](#), [delete\\_lru](#), [delete\\_lfu](#), [delete\\_cyclic](#) }

### 6.146.1 Detailed Description

Strategies how to clean up the function remember cache.

See also

[remember\\_table](#)

## 6.146.2 Member Enumeration Documentation

### 6.146.2.1 anonymous enum

anonymous enum

## Enumerator

|               |                              |
|---------------|------------------------------|
| delete_never  | Let table grow indefinitely. |
| delete_lru    | Least recently used.         |
| delete_lfu    | Least frequently used.       |
| delete_cyclic | First (oldest) one in list.  |

The documentation for this class was generated from the following file:

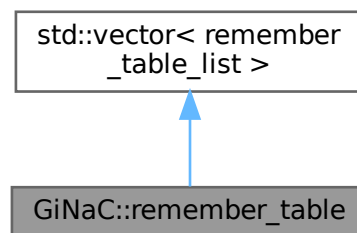
- [flags.h](#)

## 6.147 GiNaC::remember\_table Class Reference

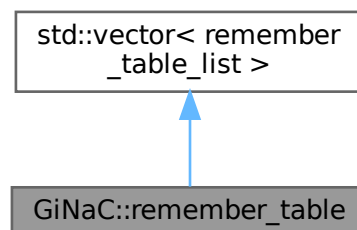
The remember table is organized like an n-fold associative cache in a microprocessor.

```
#include <remember.h>
```

Inheritance diagram for GiNaC::remember\_table:



Collaboration diagram for GiNaC::remember\_table:



### Public Member Functions

- [remember\\_table](#) ()
- [remember\\_table](#) (unsigned s, unsigned as, unsigned strat)
- bool [lookup\\_entry](#) (function const &f, [ex](#) &result) const
- void [add\\_entry](#) (function const &f, [ex](#) const &result)
- void [clear\\_all\\_entries](#) ()
- void [show\\_statistics](#) (std::ostream &os, unsigned level) const

### Static Public Member Functions

- static std::vector< [remember\\_table](#) > & [remember\\_tables](#) ()

### Protected Member Functions

- void [init\\_table](#) ()

### Protected Attributes

- unsigned [table\\_size](#)
- unsigned [max\\_assoc\\_size](#)
- unsigned [remember\\_strategy](#)

## 6.147.1 Detailed Description

The remember table is organized like an n-fold associative cache in a microprocessor.

The table has a width of 's' (which is rounded to [table\\_size](#), some power of 2 near 's', internally) and a depth of 'as' (unless you choose that entries are never discarded). The place where an entry is stored depends on the hashvalue of the parameters of the function (this corresponds to the address of byte to be cached). The '[log\\_2\(table\\_size\)](#)' least significant bits of this hashvalue give the slot in which the entry will be stored or looked up. Each slot can take up to 'as' entries. If a slot is full, an older entry is removed by one of the following strategies:

- oldest entry (the first one in the list)
- least recently used (the one with the lowest 'last\_access')
- least frequently used (the one with the lowest 'successful\_hits') or all entries are kept which means that the table grows indefinitely.

## 6.147.2 Constructor & Destructor Documentation

### 6.147.2.1 [remember\\_table](#)() [1/2]

```
GiNaC::remember_table::remember_table ()
```

References [GiNaC::remember\\_strategies::delete\\_never](#), [max\\_assoc\\_size](#), [remember\\_strategy](#), and [table\\_size](#).

### 6.147.2.2 remember\_table() [2/2]

```
GiNaC::remember_table::remember_table (
 unsigned s,
 unsigned as,
 unsigned strat)
```

References [init\\_table\(\)](#), [GiNaC::log2\(\)](#), [max\\_assoc\\_size](#), [remember\\_strategy](#), and [table\\_size](#).

## 6.147.3 Member Function Documentation

### 6.147.3.1 lookup\_entry()

```
bool GiNaC::remember_table::lookup_entry (
 function const & f,
 ex & result) const
```

References [GiNaC::basic::gethash\(\)](#), [GINAC\\_ASSERT](#), and [table\\_size](#).

### 6.147.3.2 add\_entry()

```
void GiNaC::remember_table::add_entry (
 function const & f,
 ex const & result)
```

References [GiNaC::basic::gethash\(\)](#), [GINAC\\_ASSERT](#), and [table\\_size](#).

### 6.147.3.3 clear\_all\_entries()

```
void GiNaC::remember_table::clear_all_entries ()
```

References [init\\_table\(\)](#).

### 6.147.3.4 show\_statistics()

```
void GiNaC::remember_table::show_statistics (
 std::ostream & os,
 unsigned level) const
```

### 6.147.3.5 remember\_tables()

```
std::vector< remember_table > & GiNaC::remember_table::remember_tables () [static]
```

Referenced by [GiNaC::function::lookup\\_remember\\_table\(\)](#), [GiNaC::function::register\\_new\(\)](#), and [GiNaC::function::store\\_remember\\_t](#)

### 6.147.3.6 `init_table()`

```
void GiNaC::remember_table::init_table () [protected]
```

References [max\\_assoc\\_size](#), [remember\\_strategy](#), and [table\\_size](#).

Referenced by [clear\\_all\\_entries\(\)](#), and [remember\\_table\(\)](#).

## 6.147.4 Member Data Documentation

### 6.147.4.1 `table_size`

```
unsigned GiNaC::remember_table::table_size [protected]
```

Referenced by [add\\_entry\(\)](#), [init\\_table\(\)](#), [lookup\\_entry\(\)](#), [remember\\_table\(\)](#), and [remember\\_table\(\)](#).

### 6.147.4.2 `max_assoc_size`

```
unsigned GiNaC::remember_table::max_assoc_size [protected]
```

Referenced by [init\\_table\(\)](#), [remember\\_table\(\)](#), and [remember\\_table\(\)](#).

### 6.147.4.3 `remember_strategy`

```
unsigned GiNaC::remember_table::remember_strategy [protected]
```

Referenced by [init\\_table\(\)](#), [remember\\_table\(\)](#), and [remember\\_table\(\)](#).

The documentation for this class was generated from the following files:

- [remember.h](#)
- [remember.cpp](#)

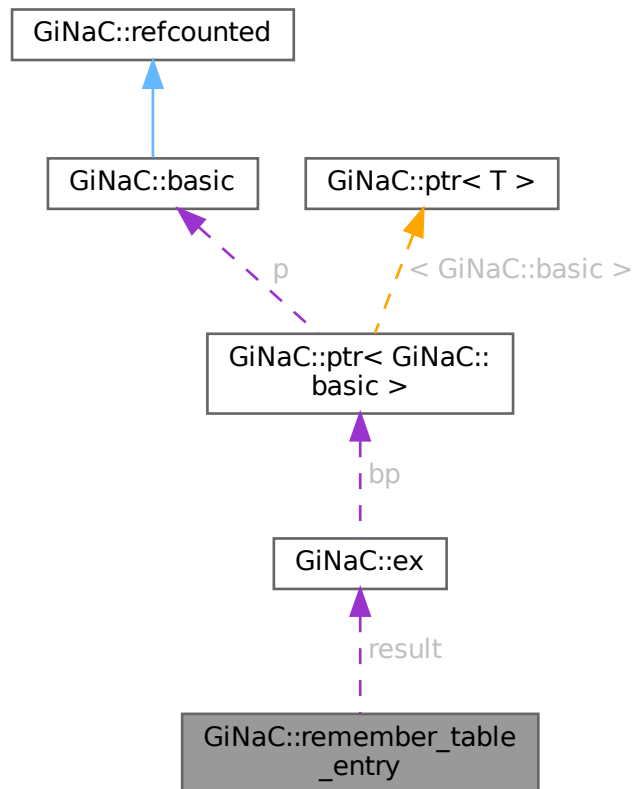


## 6.148 GiNaC::remember\_table\_entry Class Reference

A single entry in the remember table of a function.

```
#include <remember.h>
```

Collaboration diagram for GiNaC::remember\_table\_entry:



### Public Member Functions

- `remember_table_entry` (function const &f, ex const &r)
- bool `is_equal` (function const &f) const
- ex `get_result` () const
- unsigned long `get_last_access` () const
- unsigned long `get_successful_hits` () const

### Protected Attributes

- unsigned `hashvalue`
- `exvector` seq
- ex `result`
- unsigned long `last_access`
- unsigned `successful_hits`

## Static Protected Attributes

- static unsigned long [access\\_counter](#) = 0

## 6.148.1 Detailed Description

A single entry in the remember table of a function.

Needs to be a friend of class function to access 'seq'. 'last\_access' and 'successful\_hits' are updated at each successful 'is\_equal'.

## 6.148.2 Constructor & Destructor Documentation

### 6.148.2.1 remember\_table\_entry()

```
GiNaC::remember_table_entry::remember_table_entry (
 function const & f,
 ex const & r)
```

References [access\\_counter](#), [hashvalue](#), [last\\_access](#), [result](#), [seq](#), and [successful\\_hits](#).

## 6.148.3 Member Function Documentation

### 6.148.3.1 is\_equal()

```
bool GiNaC::remember_table_entry::is_equal (
 function const & f) const
```

References [access\\_counter](#), [GiNaC::basic::gethash\(\)](#), [GINAC\\_ASSERT](#), [hashvalue](#), [is\\_equal\(\)](#), [last\\_access](#), [GiNaC::container\\_storage< C >::seq](#), [seq](#), and [successful\\_hits](#).

Referenced by [is\\_equal\(\)](#).

### 6.148.3.2 get\_result()

```
ex GiNaC::remember_table_entry::get_result () const [inline]
```

References [result](#).

### 6.148.3.3 get\_last\_access()

```
unsigned long GiNaC::remember_table_entry::get_last_access () const [inline]
```

References [last\\_access](#).

### 6.148.3.4 get\_successful\_hits()

```
unsigned long GiNaC::remember_table_entry::get_successful_hits () const [inline]
```

References [successful\\_hits](#).

## 6.148.4 Member Data Documentation

### 6.148.4.1 hashvalue

```
unsigned GiNaC::remember_table_entry::hashvalue [protected]
```

Referenced by [is\\_equal\(\)](#), and [remember\\_table\\_entry\(\)](#).

### 6.148.4.2 seq

```
exvector GiNaC::remember_table_entry::seq [protected]
```

Referenced by [is\\_equal\(\)](#), and [remember\\_table\\_entry\(\)](#).

### 6.148.4.3 result

```
ex GiNaC::remember_table_entry::result [protected]
```

Referenced by [get\\_result\(\)](#), and [remember\\_table\\_entry\(\)](#).

### 6.148.4.4 last\_access

```
unsigned long GiNaC::remember_table_entry::last_access [mutable], [protected]
```

Referenced by [get\\_last\\_access\(\)](#), [is\\_equal\(\)](#), and [remember\\_table\\_entry\(\)](#).

### 6.148.4.5 successful\_hits

```
unsigned GiNaC::remember_table_entry::successful_hits [mutable], [protected]
```

Referenced by [get\\_successful\\_hits\(\)](#), [is\\_equal\(\)](#), and [remember\\_table\\_entry\(\)](#).

### 6.148.4.6 access\_counter

```
unsigned long GiNaC::remember_table_entry::access_counter = 0 [static], [protected]
```

Referenced by [is\\_equal\(\)](#), and [remember\\_table\\_entry\(\)](#).

The documentation for this class was generated from the following files:

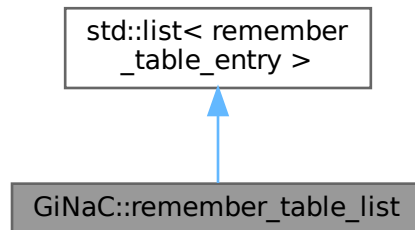
- [remember.h](#)
- [remember.cpp](#)

## 6.149 GiNaC::remember\_table\_list Class Reference

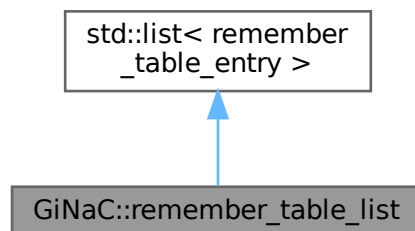
A list of entries in the remember table having some least significant bits of the hashvalue in common.

```
#include <remember.h>
```

Inheritance diagram for GiNaC::remember\_table\_list:



Collaboration diagram for GiNaC::remember\_table\_list:



### Public Member Functions

- [remember\\_table\\_list](#) (unsigned as, unsigned strat)
- void [add\\_entry](#) (function const &f, [ex](#) const &result)
- bool [lookup\\_entry](#) (function const &f, [ex](#) &result) const

### Protected Attributes

- unsigned [max\\_assoc\\_size](#)
- unsigned [remember\\_strategy](#)

## 6.149.1 Detailed Description

A list of entries in the remember table having some least significant bits of the hashvalue in common.

## 6.149.2 Constructor & Destructor Documentation

### 6.149.2.1 remember\_table\_list()

```
GiNaC::remember_table_list::remember_table_list (
 unsigned as,
 unsigned strat)
```

References [max\\_assoc\\_size](#), and [remember\\_strategy](#).

## 6.149.3 Member Function Documentation

### 6.149.3.1 add\_entry()

```
void GiNaC::remember_table_list::add_entry (
 function const & f,
 ex const & result)
```

References [GiNaC::remember\\_strategies::delete\\_cyclic](#), [GiNaC::remember\\_strategies::delete\\_ifu](#), [GiNaC::remember\\_strategies::delete\\_never](#), [GINAC\\_ASSERT](#), [max\\_assoc\\_size](#), and [remember\\_strategy](#).

### 6.149.3.2 lookup\_entry()

```
bool GiNaC::remember_table_list::lookup_entry (
 function const & f,
 ex & result) const
```

## 6.149.4 Member Data Documentation

### 6.149.4.1 max\_assoc\_size

```
unsigned GiNaC::remember_table_list::max_assoc_size [protected]
```

Referenced by [add\\_entry\(\)](#), and [remember\\_table\\_list\(\)](#).

### 6.149.4.2 remember\_strategy

```
unsigned GiNaC::remember_table_list::remember_strategy [protected]
```

Referenced by [add\\_entry\(\)](#), and [remember\\_table\\_list\(\)](#).

The documentation for this class was generated from the following files:

- [remember.h](#)
- [remember.cpp](#)

## 6.150 GiNaC::return\_type\_t Struct Reference

To distinguish between different kinds of non-commutative objects.

```
#include <registrar.h>
```

### Public Member Functions

- bool `operator<` (const `return_type_t` &other) const  
*Strict weak ordering (so one can put `return_type_t`'s into a STL container).*
- bool `operator==` (const `return_type_t` &other) const
- bool `operator!=` (const `return_type_t` &other) const

### Public Attributes

- `std::type_info` const \* `tinfo`  
*to distinguish between non-commutative objects of different type.*
- unsigned `rl`  
*to distinguish between non-commutative objects of the same type.*

### 6.150.1 Detailed Description

To distinguish between different kinds of non-commutative objects.

### 6.150.2 Member Function Documentation

#### 6.150.2.1 `operator<()`

```
bool GiNaC::return_type_t::operator< (
 const return_type_t & other) const [inline]
```

Strict weak ordering (so one can put `return_type_t`'s into a STL container).

References `rl`, and `tinfo`.

#### 6.150.2.2 `operator==()`

```
bool GiNaC::return_type_t::operator== (
 const return_type_t & other) const [inline]
```

References `rl`, and `tinfo`.

Referenced by `operator!=()`.

### 6.150.2.3 operator"!=()

```
bool GiNaC::return_type_t::operator!= (
 const return_type_t & other) const [inline]
```

References [operator==\(.\)](#).

## 6.150.3 Member Data Documentation

### 6.150.3.1 tinfo

```
std::type_info const* GiNaC::return_type_t::tinfo
```

to distinguish between non-commutative objects of different type.

Referenced by [GiNaC::is\\_clifford\\_tinfo\(\)](#), [GiNaC::is\\_color\\_tinfo\(\)](#), [GiNaC::make\\_return\\_type\\_t\(\)](#), [operator<\(\)](#), [operator==\(.\)](#), [GiNaC::basic::return\\_type\\_tinfo\(\)](#), and [GiNaC::structure< T, ComparisonPolicy >::return\\_type\\_tinfo\(\)](#).

### 6.150.3.2 rl

```
unsigned GiNaC::return_type_t::rl
```

to distinguish between non-commutative objects of the same type.

Think of gamma matrices with different representation labels.

Referenced by [GiNaC::get\\_representation\\_label\(\)](#), [GiNaC::make\\_return\\_type\\_t\(\)](#), [operator<\(\)](#), [operator==\(.\)](#), [GiNaC::basic::return\\_type\\_tinfo\(\)](#), and [GiNaC::structure< T, ComparisonPolicy >::return\\_type\\_tinfo\(\)](#).

The documentation for this struct was generated from the following file:

- [registrar.h](#)

## 6.151 GiNaC::return\_types Class Reference

```
#include <flags.h>
```

### Public Types

- enum { [commutative](#) , [noncommutative](#) , [noncommutative\\_composite](#) }

## 6.151.1 Member Enumeration Documentation

### 6.151.1.1 anonymous enum

```
anonymous enum
```

## Enumerator

|                          |  |
|--------------------------|--|
| commutative              |  |
| noncommutative           |  |
| noncommutative_composite |  |

The documentation for this class was generated from the following file:

- [flags.h](#)

## 6.152 GiNaC::relational::safe\_bool\_helper Struct Reference

### Public Member Functions

- void [nonnull](#) ()

### 6.152.1 Member Function Documentation

#### 6.152.1.1 nonnull()

```
void GiNaC::relational::safe_bool_helper::nonnull () [inline]
```

Referenced by [GiNaC::relational::make\\_safe\\_bool\(\)](#).

The documentation for this struct was generated from the following file:

- [relational.h](#)

## 6.153 GiNaC::scalar\_products Class Reference

Helper class for storing information about known scalar products which are to be automatically replaced by [simplify\\_indexed\(\)](#).

```
#include <indexed.h>
```

### Public Member Functions

- void [add](#) (const [ex](#) &v1, const [ex](#) &v2, const [ex](#) &sp)  
*Register scalar product pair and its value.*
- void [add](#) (const [ex](#) &v1, const [ex](#) &v2, const [ex](#) &dim, const [ex](#) &sp)  
*Register scalar product pair and its value for a specific space dimension.*
- void [add\\_vectors](#) (const [lst](#) &l, const [ex](#) &dim=[wild](#)())  
*Register list of vectors.*
- void [clear](#) ()  
*Clear all registered scalar products.*
- bool [is\\_defined](#) (const [ex](#) &v1, const [ex](#) &v2, const [ex](#) &dim) const  
*Check whether scalar product pair is defined.*
- [ex](#) [evaluate](#) (const [ex](#) &v1, const [ex](#) &v2, const [ex](#) &dim) const  
*Return value of defined scalar product pair.*
- void [debugprint](#) () const



## Protected Attributes

- [smap](#) `spm`

### 6.153.1 Detailed Description

Helper class for storing information about known scalar products which are to be automatically replaced by [simplify\\_indexed\(\)](#).

See also

[simplify\\_indexed](#)

### 6.153.2 Member Function Documentation

#### 6.153.2.1 `add()` [1/2]

```
void GiNaC::scalar_products::add (
 const ex & v1,
 const ex & v2,
 const ex & sp)
```

Register scalar product pair and its value.

References [spm](#).

Referenced by [add\\_vectors\(\)](#).

#### 6.153.2.2 `add()` [2/2]

```
void GiNaC::scalar_products::add (
 const ex & v1,
 const ex & v2,
 const ex & dim,
 const ex & sp)
```

Register scalar product pair and its value for a specific space dimension.

References [spm](#).

#### 6.153.2.3 `add_vectors()`

```
void GiNaC::scalar_products::add_vectors (
 const lst & l,
 const ex & dim = wild\(\))
```

Register list of vectors.

This adds all possible pairs of products  $a.i * b.i$  with the value  $a*b$  (note that this is not a scalar vector product but an ordinary product of scalars).

References [add\(\)](#).

#### 6.153.2.4 clear()

```
void GiNaC::scalar_products::clear ()
```

Clear all registered scalar products.

References [spm](#).

#### 6.153.2.5 is\_defined()

```
bool GiNaC::scalar_products::is_defined (
 const ex & v1,
 const ex & v2,
 const ex & dim) const
```

Check whether scalar product pair is defined.

References [spm](#).

Referenced by [GiNaC::indexed::simplify\\_indexed\\_product](#).

#### 6.153.2.6 evaluate()

```
ex GiNaC::scalar_products::evaluate (
 const ex & v1,
 const ex & v2,
 const ex & dim) const
```

Return value of defined scalar product pair.

References [spm](#).

Referenced by [GiNaC::indexed::simplify\\_indexed\\_product](#).

#### 6.153.2.7 debugprint()

```
void GiNaC::scalar_products::debugprint () const
```

References [GiNaC::spmapkey::debugprint\(\)](#), and [spm](#).

### 6.153.3 Member Data Documentation

#### 6.153.3.1 spm

```
spmap GiNaC::scalar_products::spm [protected]
```

Referenced by [add\(\)](#), [add\(\)](#), [clear\(\)](#), [debugprint\(\)](#), [evaluate\(\)](#), and [is\\_defined\(\)](#).

The documentation for this class was generated from the following files:

- [indexed.h](#)
- [indexed.cpp](#)

## 6.154 GiNaC::series\_options Class Reference

Flags to control series expansion.

```
#include <flags.h>
```

### Public Types

- enum { [suppress\\_branchcut](#) = 0x0001 }

### 6.154.1 Detailed Description

Flags to control series expansion.

### 6.154.2 Member Enumeration Documentation

#### 6.154.2.1 anonymous enum

```
anonymous enum
```

#### Enumerator

|                                    |                                                                                                                                                                                                                                                        |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <a href="#">suppress_branchcut</a> | Suppress branch cuts in series expansion. Branch cuts manifest themselves as step functions, if this option is not passed. If it is passed and expansion at a point on a cut is performed, then the analytic continuation of the function is expanded. |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

The documentation for this class was generated from the following file:

- [flags.h](#)

## 6.155 GiNaC::solve\_algo Class Reference

Switch to control algorithm for linear system solving.

```
#include <flags.h>
```

### Public Types

- enum {  
[automatic](#) , [gauss](#) , [divfree](#) , [bareiss](#) ,  
[markowitz](#) }

### 6.155.1 Detailed Description

Switch to control algorithm for linear system solving.

### 6.155.2 Member Enumeration Documentation

#### 6.155.2.1 anonymous enum

```
anonymous enum
```

## Enumerator

|           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| automatic | Let the system choose. A heuristics is applied for automatic determination of a suitable algorithm.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| gauss     | <p>Gauss elimination. If <math>m_{i,j}^{(0)}</math> are the entries of the original matrix, then the matrix is transformed into triangular form by applying the rules</p> $m_{i,j}^{(k+1)} = m_{i,j}^{(k)} - m_{i,k}^{(k)} m_{k,j}^{(k)} / m_{k,k}^{(k)}$ <p>This algorithm is well-suited for numerical matrices but generally suffers from the expensive division (and computation of GCDs) at each step.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| divfree   | <p>Division-free elimination. This is a modification of Gauss elimination where the division by the pivot element is not carried out. If <math>m_{i,j}^{(0)}</math> are the entries of the original matrix, then the matrix is transformed into triangular form by applying the rules</p> $m_{i,j}^{(k+1)} = m_{i,j}^{(k)} m_{k,k}^{(k)} - m_{i,k}^{(k)} m_{k,j}^{(k)}$ <p>This algorithm is only there for the purpose of cross-checks. It suffers from exponential intermediate expression swell. Use it only for small systems.</p>                                                                                                                                                                                                                                                                                                                                                                        |
| bareiss   | <p>Bareiss fraction-free elimination. This is a modification of Gauss elimination where the division by the pivot element is <i>delayed</i> until it can be carried out without computing GCDs. If <math>m_{i,j}^{(0)}</math> are the entries of the original matrix, then the matrix is transformed into triangular form by applying the rules</p> $m_{i,j}^{(k+1)} = (m_{i,j}^{(k)} m_{k,k}^{(k)} - m_{i,k}^{(k)} m_{k,j}^{(k)}) / m_{k-1,k-1}^{(k-1)}$ <p>(We have set <math>m_{-1,-1}^{(-1)} = 1</math> in order to avoid a case distinction in above formula.) It can be shown that nothing more than polynomial long division is needed for carrying out the division. This is generally the fastest algorithm for solving linear systems. In contrast to division-free elimination it only has a linear expression swell. For two-dimensional systems, the two algorithms are equivalent, however.</p> |
| markowitz | Markowitz-ordered Gaussian elimination. Same as the usual Gaussian elimination, but with additional effort spent on selecting pivots that minimize fill-in. Faster than the methods above for large sparse matrices (particularly with symbolic coefficients), otherwise slightly slower than Gaussian elimination.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

The documentation for this class was generated from the following file:

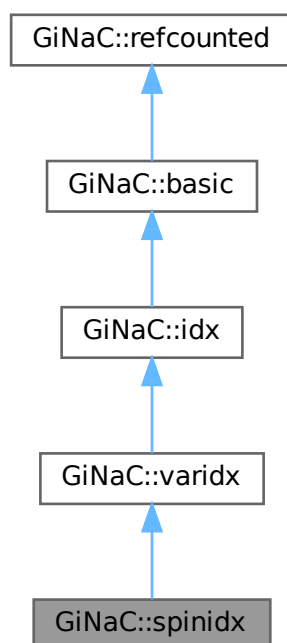
- [flags.h](#)

## 6.156 GiNaC::spinidx Class Reference

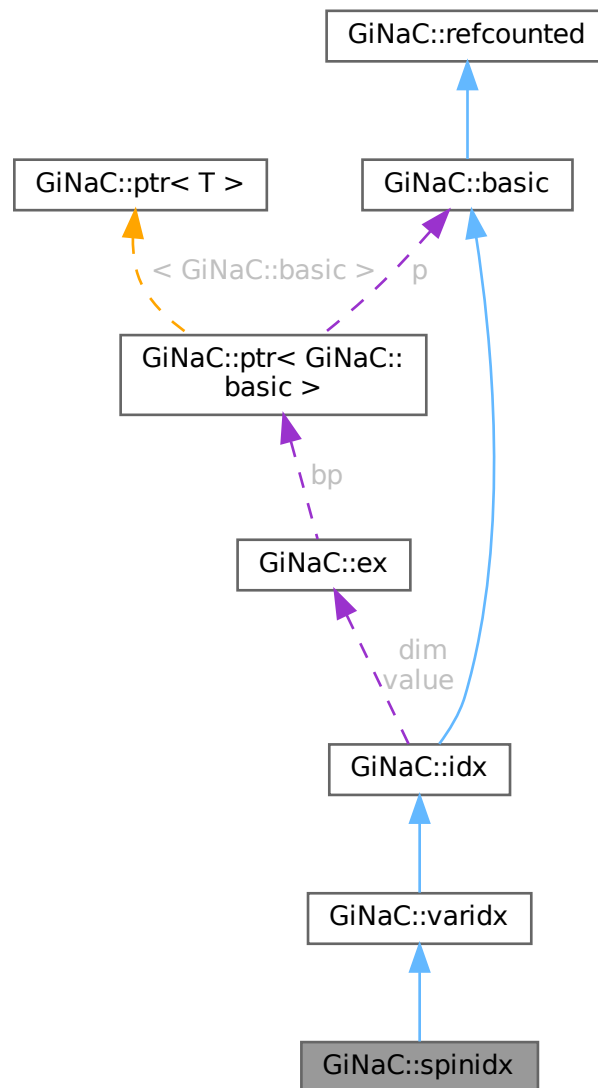
This class holds a spinor index that can be dotted or undotted and that also has a variance.

```
#include <idx.h>
```

Inheritance diagram for GiNaC::spinidx:



Collaboration diagram for `GiNaC::spindex`:



## Public Member Functions

- `spindex` (const `ex` &`v`, const `ex` &`dim`=2, bool `covariant`=false, bool `dotted`=false)  
Construct index with given value, dimension, variance and dot.
- bool `is_dummy_pair_same_type` (const `basic` &`other`) const override  
Check whether the index forms a dummy index pair with another index of the same type.
- `ex conjugate` () const override
- void `archive` (`archive_node` &`n`) const override  
Save (serialize) the object into archive node.
- void `read_archive` (const `archive_node` &`n`, `lst` &`syms`) override  
Load (deserialize) the object from an archive node.

- `bool is_dotted () const`  
*Check whether the index is dotted.*
- `bool is_undotted () const`  
*Check whether the index is not dotted.*
- `ex toggle_dot () const`  
*Make a new index with the same value and variance but the opposite dottedness.*
- `ex toggle_variance_dot () const`  
*Make a new index with the same value but opposite variance and dottedness.*

## Public Member Functions inherited from `GiNaC::varidx`

- `varidx (const ex &v, const ex &dim, bool covariant=false)`  
*Construct index with given value, dimension and variance.*
- `bool is_dummy_pair_same_type (const basic &other) const override`  
*Check whether the index forms a dummy index pair with another index of the same type.*
- `void archive (archive_node &n) const override`  
*Save (serialize) the object into archive node.*
- `void read_archive (const archive_node &n, lst &syms) override`  
*Load (deserialize) the object from an archive node.*
- `bool is_covariant () const`  
*Check whether the index is covariant.*
- `bool is_contravariant () const`  
*Check whether the index is contravariant (not covariant).*
- `ex toggle_variance () const`  
*Make a new index with the same value but the opposite variance.*

## Public Member Functions inherited from `GiNaC::idx`

- `idx (const ex &v, const ex &dim)`  
*Construct index with given value and dimension.*
- `bool info (unsigned inf) const override`  
*Information about the object.*
- `size_t nops () const override`  
*Number of operands/members.*
- `ex op (size_t i) const override`  
*Return operand/member at position i.*
- `ex map (map_function &f) const override`  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- `ex evalf () const override`  
*By default, `basic::evalf` would evaluate the index value but we don't want a.1 to become a.*
- `ex subs (const exmap &m, unsigned options=0) const override`  
*Substitute a set of objects by arbitrary expressions.*
- `ex get_value () const`  
*Get value of index.*
- `bool is_numeric () const`  
*Check whether the index is numeric.*
- `bool is_symbolic () const`  
*Check whether the index is symbolic.*
- `ex get_dim () const`

- *Get dimension of index space.*
- `bool is_dim_numeric () const`  
*Check whether the dimension is numeric.*
- `bool is_dim_symbolic () const`  
*Check whether the dimension is symbolic.*
- `ex replace_dim (const ex &new_dim) const`  
*Make a new index with the same value but a different dimension.*
- `ex minimal_dim (const idx &other) const`  
*Return the minimum of the dimensions of this and another index.*

## Public Member Functions inherited from `GiNaC::basic`

- `virtual ~basic ()`  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`  
*basic assignment operator: the other object might be of a derived class.*
- `virtual basic * duplicate () const`  
*Create a clone of this object on the heap.*
- `virtual ex eval () const`  
*Perform automatic non-interruptive term rewriting rules.*
- `virtual ex evalm () const`  
*Evaluate sums, products and integer powers of matrices.*
- `virtual ex eval_integ () const`  
*Evaluate integrals, if result is known.*
- `virtual ex eval_indexed (const basic &i) const`  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- `virtual void print (const print_context &c, unsigned level=0) const`  
*Output to stream.*
- `virtual void dbgprint () const`  
*Little wrapper around print to be called within a debugger.*
- `virtual void dbgprinttree () const`  
*Little wrapper around printtree to be called within a debugger.*
- `virtual unsigned precedence () const`  
*Return relative operator precedence (for parenthezing output).*
- `virtual ex operator[] (const ex &index) const`
- `virtual ex operator[] (size_t i) const`
- `virtual ex & let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- `virtual ex & operator[] (const ex &index)`
- `virtual ex & operator[] (size_t i)`
- `virtual bool has (const ex &other, unsigned options=0) const`  
*Test for occurrence of a pattern.*
- `virtual bool match (const ex &pattern, exmap &repls) const`  
*Check whether the expression matches a given pattern.*
- `virtual void accept (GiNaC::visitor &v) const`
- `virtual bool is_polynomial (const ex &var) const`  
*Check whether this is a polynomial in the given variables.*
- `virtual int degree (const ex &s) const`  
*Return degree of highest power in object s.*



- virtual int `ldegree` (const `ex` &s) const  
*Return degree of lowest power in object s.*
- virtual `ex coeff` (const `ex` &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual `ex expand` (unsigned options=0) const  
*Expand expression, i.e.*
- virtual `ex collect` (const `ex` &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series` (const `relational` &r, int order, unsigned options=0) const  
*Default implementation of `ex::series()`.*
- virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const  
*Default implementation of `ex::normal()`.*
- virtual `ex to_rational` (`exmap` &repl) const  
*Default implementation of `ex::to_rational()`.*
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const  
*Implementation `ex::max_coefficient()`.*
- virtual `exvector get_free_indices` () const  
*Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T>  
void `print_dispatch` (const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- const `basic` & `hold` () const  
*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const  
*Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Member Functions

- bool [match\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if the attributes of two objects are similar enough for a match.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_latex](#) (const [print\\_latex](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::varidx](#)

- bool [match\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if the attributes of two objects are similar enough for a match.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::idx](#)

- [ex\\_derivative](#) (const [symbol](#) &s) const override  
*Implementation of [ex::diff\(\)](#) for an index always returns 0.*
- unsigned [calchash](#) () const override  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [print\\_index](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_csrc](#) (const [print\\_csrc](#) &c, unsigned level) const
- void [do\\_print\\_latex](#) (const [print\\_latex](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

**Protected Attributes**

- bool [dotted](#)

**Protected Attributes inherited from [GiNaC::varidx](#)**

- bool [covariant](#)  
 *$x.mu$ , default is contravariant:  $x \sim mu$*

**Protected Attributes inherited from [GiNaC::idx](#)**

- [ex value](#)  
*Expression that constitutes the index (numeric or symbolic name)*
- [ex dim](#)  
*Dimension of space (can be symbolic or numeric)*

**Protected Attributes inherited from [GiNaC::basic](#)**

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

**6.156.1 Detailed Description**

This class holds a spinor index that can be dotted or undotted and that also has a variance.

This is used in the Weyl-van-der-Waerden formalism where the dot indicates complex conjugation. There is an associated (asymmetric) metric tensor that can be used to raise/lower spinor indices.

**6.156.2 Constructor & Destructor Documentation****6.156.2.1 [spinidx\(\)](#)**

```
GiNaC::spinidx::spinidx (
 const ex & v,
 const ex & dim = 2,
 bool covariant = false,
 bool dotted = false)
```

Construct index with given value, dimension, variance and dot.

**Parameters**

|                  |                                                 |
|------------------|-------------------------------------------------|
| <i>v</i>         | Value of index (numeric or symbolic)            |
| <i>dim</i>       | Dimension of index space (numeric or symbolic)  |
| <i>covariant</i> | Make covariant index (default is contravariant) |
| <i>dotted</i>    | Make covariant dotted (default is undotted)     |

References [dotted](#).

Referenced by [is\\_dummy\\_pair\\_same\\_type\(\)](#), [match\\_same\\_type\(\)](#), [toggle\\_dot\(\)](#), and [toggle\\_variance\\_dot\(\)](#).

## 6.156.3 Member Function Documentation

### 6.156.3.1 `is_dummy_pair_same_type()`

```
bool GiNaC::spinidx::is_dummy_pair_same_type (
 const basic & other) const \[override\], \[virtual\]
```

Check whether the index forms a dummy index pair with another index of the same type.

Reimplemented from [GiNaC::idx](#).

References [dotted](#), and [spinidx\(\)](#).

### 6.156.3.2 `conjugate()`

```
ex GiNaC::spinidx::conjugate () const \[inline\], \[override\], \[virtual\]
```

Reimplemented from [GiNaC::basic](#).

References [toggle\\_dot\(\)](#).

### 6.156.3.3 `archive()`

```
void GiNaC::spinidx::archive (
 archive_node & n) const \[override\], \[virtual\]
```

Save (serialize) the object into archive node.

Archive the object.

Losely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented from [GiNaC::idx](#).

References [GiNaC::archive\\_node::add\\_bool\(\)](#), and [dotted](#).

### 6.156.3.4 `read_archive()`

```
void GiNaC::spinidx::read_archive (
 const archive_node & n,
 lst & syms) \[override\], \[virtual\]
```

Load (deserialize) the object from an archive node.

Construct object from [archive\\_node](#).

#### Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::idx](#).

References [dotted](#), and [GiNaC::archive\\_node::find\\_bool\(\)](#).

### 6.156.3.5 match\_same\_type()

```
bool GiNaC::spinidx::match_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is\\_equal\\_same\\_type\(\)](#) is automatically used instead of [match\\_same\\_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::idx](#).

References [dotted](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), and [spinidx\(\)](#).

### 6.156.3.6 is\_dotted()

```
bool GiNaC::spinidx::is_dotted () const [inline]
```

Check whether the index is dotted.

References [dotted](#).

### 6.156.3.7 is\_undotted()

```
bool GiNaC::spinidx::is_undotted () const [inline]
```

Check whether the index is not dotted.

References [dotted](#).

### 6.156.3.8 toggle\_dot()

```
ex GiNaC::spinidx::toggle_dot () const
```

Make a new index with the same value and variance but the opposite dottedness.

References [GiNaC::basic::clearflag\(\)](#), [dotted](#), [GiNaC::basic::duplicate\(\)](#), [GiNaC::status\\_flags::hash\\_calculated](#), and [spinidx\(\)](#).

Referenced by [conjugate\(\)](#).

### 6.156.3.9 toggle\_variance\_dot()

```
ex GiNaC::spinidx::toggle_variance_dot () const
```

Make a new index with the same value but opposite variance and dottedness.

References [GiNaC::basic::clearflag\(\)](#), [GiNaC::varidx::covariant](#), [dotted](#), [GiNaC::basic::duplicate\(\)](#), [GiNaC::status\\_flags::hash\\_calculat](#) and [spinidx\(\)](#).

### 6.156.3.10 do\_print()

```
void GiNaC::spinidx::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [GiNaC::varidx::covariant](#), [dotted](#), [GiNaC::idx::print\\_index\(\)](#), and [GiNaC::print\\_context::s](#).

### 6.156.3.11 do\_print\_latex()

```
void GiNaC::spinidx::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

References [dotted](#), [GiNaC::idx::print\\_index\(\)](#), and [GiNaC::print\\_context::s](#).

### 6.156.3.12 do\_print\_tree()

```
void GiNaC::spinidx::do_print_tree (
 const print_tree & c,
 unsigned level) const [protected]
```

References [GiNaC::varidx::covariant](#), [GiNaC::print\\_tree::delta\\_indent](#), [GiNaC::idx::dim](#), [dotted](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [GiNaC::print\\_context::s](#), and [GiNaC::idx::value](#).

## 6.156.4 Member Data Documentation

### 6.156.4.1 dotted

```
bool GiNaC::spinidx::dotted [protected]
```

Referenced by [archive\(\)](#), [do\\_print\(\)](#), [do\\_print\\_latex\(\)](#), [do\\_print\\_tree\(\)](#), [is\\_dotted\(\)](#), [is\\_dummy\\_pair\\_same\\_type\(\)](#), [is\\_undotted\(\)](#), [match\\_same\\_type\(\)](#), [read\\_archive\(\)](#), [spinidx\(\)](#), [toggle\\_dot\(\)](#), and [toggle\\_variance\\_dot\(\)](#).

The documentation for this class was generated from the following files:

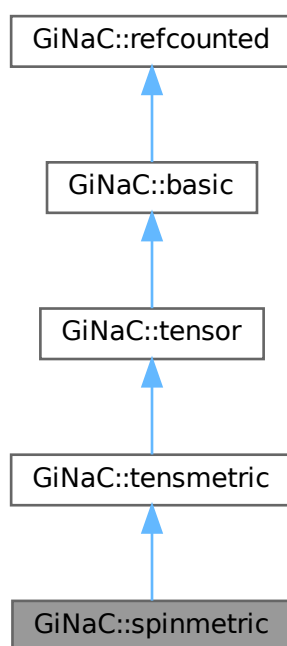
- [idx.h](#)
- [idx.cpp](#)

## 6.157 GiNaC::spinmetric Class Reference

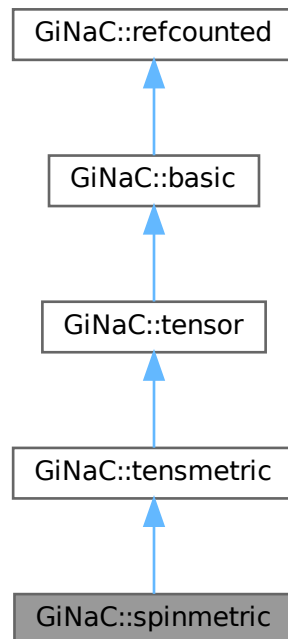
This class represents an antisymmetric spinor metric tensor which can be used to raise/lower indices of 2-component Weyl spinors.

```
#include <tensor.h>
```

Inheritance diagram for GiNaC::spinmetric:



Collaboration diagram for `GiNaC::spinmetric`:



### Public Member Functions

- `bool info` (unsigned inf) const override  
*Information about the object.*
- `ex eval_indexed` (const `basic` &i) const override  
*Automatic symbolic evaluation of an indexed metric tensor.*
- `bool contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const override  
*Contraction of an indexed spinor metric with something else.*

### Public Member Functions inherited from `GiNaC::tensmetric`

- `bool info` (unsigned inf) const override  
*Information about the object.*
- `ex eval_indexed` (const `basic` &i) const override  
*Automatic symbolic evaluation of an indexed metric tensor.*
- `bool contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const override  
*Contraction of an indexed metric tensor with something else.*

### Public Member Functions inherited from `GiNaC::tensor`

- `bool replace_contr_index` (exvector::iterator self, exvector::iterator other) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).*



Public Member Functions inherited from **GiNaC::basic**

- virtual `~basic ()`  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate () const`  
*Create a clone of this object on the heap.*
- virtual `ex eval () const`  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf () const`  
*Evaluate object numerically.*
- virtual `ex evalm () const`  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ () const`  
*Evaluate integrals, if result is known.*
- virtual void `print (const print_context &c, unsigned level=0) const`  
*Output to stream.*
- virtual void `dbgprint () const`  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprnttree () const`  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence () const`  
*Return relative operator precedence (for parenthezing output).*
- virtual size\_t `nops () const`  
*Number of operands/members.*
- virtual `ex op (size_t i) const`  
*Return operand/member at position i.*
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`
- virtual `ex & let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual bool `has (const ex &other, unsigned options=0) const`  
*Test for occurrence of a pattern.*
- virtual bool `match (const ex &pattern, exmap &repls) const`  
*Check whether the expression matches a given pattern.*
- virtual `ex subs (const exmap &m, unsigned options=0) const`  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map (map_function &f) const`  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept (GiNaC::visitor &v) const`
- virtual bool `is_polynomial (const ex &var) const`  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree (const ex &s) const`  
*Return degree of highest power in object s.*
- virtual int `ldegree (const ex &s) const`  
*Return degree of lowest power in object s.*
- virtual `ex coeff (const ex &s, int n=1) const`

- Return coefficient of degree  $n$  in object  $s$ .*

  - virtual `ex expand` (unsigned options=0) const

*Expand expression, i.e.*

  - virtual `ex collect` (const `ex` & $s$ , bool distributed=false) const

*Sort expanded expression in terms of powers of some object(s).*

  - virtual `ex series` (const `relational` & $r$ , int order, unsigned options=0) const

*Default implementation of `ex::series()`.*

  - virtual `ex normal` (`exmap` & $repl$ , `exmap` & $rev\_lookup$ , `lst` & $modifier$ ) const

*Default implementation of `ex::normal()`.*

  - virtual `ex to_rational` (`exmap` & $repl$ ) const

*Default implementation of `ex::to_rational()`.*

  - virtual `ex to_polynomial` (`exmap` & $repl$ ) const
  - virtual `numeric integer_content` () const
  - virtual `ex smod` (const `numeric` & $xi$ ) const

*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

  - virtual `numeric max_coefficient` () const

*Implementation `ex::max_coefficient()`.*

  - virtual `exvector get_free_indices` () const

*Return a vector containing the free indices of an expression.*

  - virtual `ex add_indexed` (const `ex` & $self$ , const `ex` & $other$ ) const

*Add two indexed expressions.*

  - virtual `ex scalar_mul_indexed` (const `ex` & $self$ , const `numeric` & $other$ ) const

*Multiply an indexed expression with a scalar.*

  - virtual `return_type_t return_type_info` () const
  - virtual `ex conjugate` () const
  - virtual `ex real_part` () const
  - virtual `ex imag_part` () const
  - template<class  $T$ >
  - void `print_dispatch` (const `print_context` & $c$ , unsigned level) const

*Like `print()`, but dispatch to the specified class.*

  - void `print_dispatch` (const `registered_class_info` & $ri$ , const `print_context` & $c$ , unsigned level) const

*Like `print()`, but dispatch to the specified class.*

  - virtual void `archive` (`archive_node` & $n$ ) const

*Save (serialize) the object into archive node.*

  - virtual void `read_archive` (const `archive_node` & $n$ , `lst` & $syms$ )

*Load (deserialize) the object from an archive node.*

  - `ex subs_one_level` (const `exmap` & $m$ , unsigned options) const

*Helper function for `subs()`.*

  - `ex diff` (const `symbol` & $s$ , unsigned  $nth$ =1) const

*Default interface of  $n$ th derivative `ex::diff(s, n)`.*

  - int `compare` (const `basic` & $other$ ) const

*Compare objects syntactically to establish canonical ordering.*

  - bool `is_equal` (const `basic` & $other$ ) const

*Test for syntactic equality.*

  - const `basic` & `hold` () const

*Stop further evaluation.*

  - unsigned `gethash` () const
  - const `basic` & `setflag` (unsigned  $f$ ) const

*Set some `status_flags`.*

  - const `basic` & `clearflag` (unsigned  $f$ ) const

*Clear some `status_flags`.*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Member Functions

- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_latex](#) (const [print\\_latex](#) &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::tensmetric](#)

- unsigned [return\\_type](#) () const override
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::tensor](#)

- unsigned [return\\_type](#) () const override

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual [ex derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Additional Inherited Members

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
of type [status\\_flags](#)
- unsigned [hashvalue](#)  
hash value

### 6.157.1 Detailed Description

This class represents an antisymmetric spinor metric tensor which can be used to raise/lower indices of 2-component Weyl spinors.

If indexed, it must have exactly two indices of the same type which must be of class `spinidx` or a subclass and have dimension 2.

### 6.157.2 Member Function Documentation

#### 6.157.2.1 `info()`

```
bool GiNaC::spinmetric::info (
 unsigned int) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info\\_flags::real](#).

#### 6.157.2.2 `eval_indexed()`

```
ex GiNaC::spinmetric::eval_indexed (
 const basic & i) const [override], [virtual]
```

Automatic symbolic evaluation of an indexed metric tensor.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [GiNaC::\\_ex\\_1](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::idx::get\\_value\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::basic::nops\(\)](#), and [GiNaC::basic::op\(\)](#).

### 6.157.2.3 contract\_with()

```
bool GiNaC::spinmetric::contract_with (
 exvector::iterator self,
 exvector::iterator other,
 exvector & v) const [override], [virtual]
```

Contraction of an indexed spinor metric with something else.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [GiNaC::\\_ex2](#), [GiNaC::\\_ex\\_2](#), [GiNaC::delta\\_tensor\(\)](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [GiNaC::varidx::is\\_covariant\(\)](#), [GiNaC::is\\_dummy\\_pair\(\)](#), and [GiNaC::idx::is\\_symbolic\(\)](#).

### 6.157.2.4 do\_print()

```
void GiNaC::spinmetric::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

### 6.157.2.5 do\_print\_latex()

```
void GiNaC::spinmetric::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

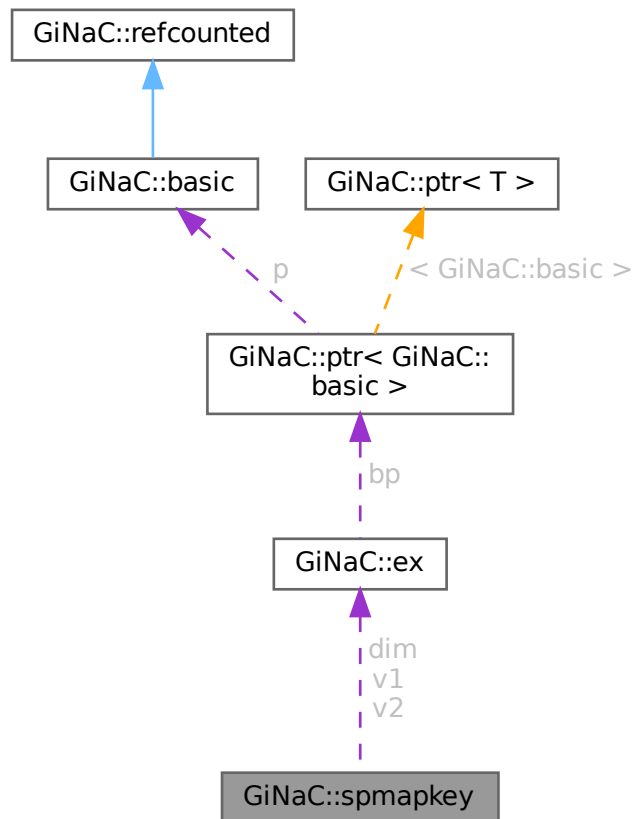
The documentation for this class was generated from the following files:

- [tensor.h](#)
- [tensor.cpp](#)

## 6.158 GiNaC::spmapkey Class Reference

```
#include <indexed.h>
```

Collaboration diagram for `GiNaC::spmapkey`:



## Public Member Functions

- `spmapkey()`
- `spmapkey(const ex &v1, const ex &v2, const ex &dim=wild())`
- `bool operator==(const spmapkey &other) const`
- `bool operator<(const spmapkey &other) const`
- `void debugprint() const`

## Protected Attributes

- `ex v1`
- `ex v2`
- `ex dim`

## 6.158.1 Constructor & Destructor Documentation

### 6.158.1.1 `spmapkey()` [1/2]

`GiNaC::spmapkey::spmapkey()` [inline]

References `dim`, and `GiNaC::wild()`.

Referenced by `operator<()`, and `operator==()`.

### 6.158.1.2 spmapkey() [2/2]

```
GiNaC::spmapkey::spmapkey (
 const ex & v1,
 const ex & v2,
 const ex & dim = wild\(\))
```

References [GiNaC::ex::compare\(\)](#), [dim](#), [GiNaC::is\\_a\(\)](#), [GiNaC::ex::op\(\)](#), [v1](#), and [v2](#).

## 6.158.2 Member Function Documentation

### 6.158.2.1 operator==(())

```
bool GiNaC::spmapkey::operator==(
 const spmapkey & other) const
```

References [dim](#), [GiNaC::is\\_a\(\)](#), [spmapkey\(\)](#), [v1](#), and [v2](#).

### 6.158.2.2 operator<()

```
bool GiNaC::spmapkey::operator< (
 const spmapkey & other) const
```

References [dim](#), [GiNaC::is\\_a\(\)](#), [spmapkey\(\)](#), [v1](#), and [v2](#).

### 6.158.2.3 debugprint()

```
void GiNaC::spmapkey::debugprint () const
```

References [dim](#), [v1](#), and [v2](#).

Referenced by [GiNaC::scalar\\_products::debugprint\(\)](#).

## 6.158.3 Member Data Documentation

### 6.158.3.1 v1

```
ex GiNaC::spmapkey::v1 [protected]
```

Referenced by [debugprint\(\)](#), [operator<\(\)](#), [operator==\(\(\)\)](#), and [spmapkey\(\)](#).

### 6.158.3.2 v2

```
ex GiNaC::spmapkey::v2 [protected]
```

Referenced by [debugprint\(\)](#), [operator<\(\)](#), [operator==\(\(\)\)](#), and [spmapkey\(\)](#).

### 6.158.3.3 dim

```
ex GiNaC::spmapkey::dim [protected]
```

Referenced by [debugprint\(\)](#), [operator<\(\)](#), [operator==\(\)](#), [spmapkey\(\)](#), and [spmapkey\(\)](#).

The documentation for this class was generated from the following files:

- [indexed.h](#)
- [indexed.cpp](#)

## 6.159 GiNaC::status\_flags Class Reference

Flags to store information about the state of an object.

```
#include <flags.h>
```

### Public Types

- enum {  
[dynallocated](#) = 0x0001 , [evaluated](#) = 0x0002 , [expanded](#) = 0x0004 , [hash\\_calculated](#) = 0x0008 ,  
[not\\_shareable](#) = 0x0010 , [has\\_indices](#) = 0x0020 , [has\\_no\\_indices](#) = 0x0040 , [is\\_positive](#) = 0x0080 ,  
[is\\_negative](#) = 0x0100 , [purely\\_indefinite](#) = 0x0200 }

### 6.159.1 Detailed Description

Flags to store information about the state of an object.

See also

[basic::flags](#)

## 6.159.2 Member Enumeration Documentation

### 6.159.2.1 anonymous enum

```
anonymous enum
```

#### Enumerator

|                                 |                                                                                                                                                       |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| <a href="#">dynallocated</a>    | heap-allocated (i.e. created by new if we want to be clever and bypass the stack,<br><br>See also<br><br><a href="#">ex::construct_from_basic()</a> ) |
| <a href="#">evaluated</a>       | <a href="#">.eval()</a> has already done its job                                                                                                      |
| <a href="#">expanded</a>        | <a href="#">.expand(0)</a> has already done its job (other <a href="#">expand()</a> options ignore this flag)                                         |
| <a href="#">hash_calculated</a> | <a href="#">.calchash()</a> has already done its job                                                                                                  |



|                   |                                                                                                                                        |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| not_shareable     | don't share instances of this object between different expressions unless explicitly asked to (used by <a href="#">ex::compare()</a> ) |
| has_indices       |                                                                                                                                        |
| has_no_indices    |                                                                                                                                        |
| is_positive       |                                                                                                                                        |
| is_negative       |                                                                                                                                        |
| purely_indefinite |                                                                                                                                        |

The documentation for this class was generated from the following file:

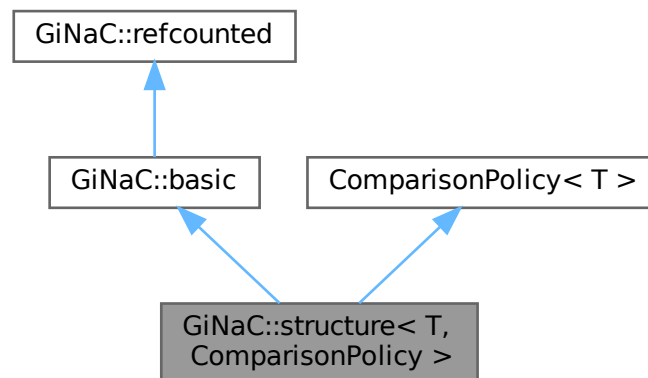
- [flags.h](#)

## 6.160 GiNaC::structure< T, ComparisonPolicy > Class Template Reference

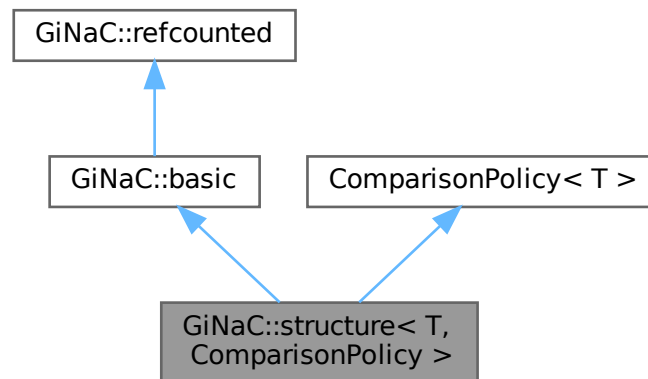
Wrapper template for making [GiNaC](#) classes out of C++ structures.

```
#include <structure.h>
```

Inheritance diagram for GiNaC::structure< T, ComparisonPolicy >:



Collaboration diagram for `GiNaC::structure< T, ComparisonPolicy >`:



## Public Member Functions

- `structure` (const T &t)  
*Construct structure as a copy of a given C++ structure.*
- `ex eval` () const override  
*Perform automatic non-interruptive term rewriting rules.*
- `ex evalm` () const override  
*Evaluate sums, products and integer powers of matrices.*
- `ex eval_indexed` (const `basic` &i) const override  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- void `print` (const `print_context` &c, unsigned level=0) const override  
*Output to stream.*
- unsigned `precedence` () const override  
*Return relative operator precedence (for parenthezing output).*
- bool `info` (unsigned inf) const override  
*Information about the object.*
- size\_t `nops` () const override  
*Number of operands/members.*
- `ex op` (size\_t i) const override  
*Return operand/member at position i.*
- `ex operator[]` (const `ex` &index) const override
- `ex operator[]` (size\_t i) const override
- `ex & let_op` (size\_t i) override  
*Return modifiable operand/member at position i.*
- `ex & operator[]` (const `ex` &index) override
- `ex & operator[]` (size\_t i) override
- bool `has` (const `ex` &other, unsigned options=0) const override  
*Test for occurrence of a pattern.*
- bool `match` (const `ex` &pattern, `exmap` &repl\_lst) const override  
*Check whether the expression matches a given pattern.*
- `ex subs` (const `exmap` &m, unsigned options=0) const override

- Substitute a set of objects by arbitrary expressions.*

  - `ex map` (`map_function` &f) const override

*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- `int degree` (const `ex` &s) const override

*Return degree of highest power in object s.*
- `int ldegree` (const `ex` &s) const override

*Return degree of lowest power in object s.*
- `ex coeff` (const `ex` &s, int n=1) const override

*Return coefficient of degree n in object s.*
- `ex expand` (unsigned options=0) const override

*Expand expression, i.e.*
- `ex collect` (const `ex` &s, bool distributed=false) const override

*Sort expanded expression in terms of powers of some object(s).*
- `ex series` (const `relational` &r, int order, unsigned options=0) const override

*Default implementation of `ex::series()`.*
- `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const override

*Default implementation of `ex::normal()`.*
- `ex to_rational` (`exmap` &repl) const override

*Default implementation of `ex::to_rational()`.*
- `ex to_polynomial` (`exmap` &repl) const override
- `numeric integer_content` () const override
- `ex smod` (const `numeric` &xi) const override

*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- `numeric max_coefficient` () const override

*Implementation `ex::max_coefficient()`.*
- `exvector get_free_indices` () const override

*Return a vector containing the free indices of an expression.*
- `ex add_indexed` (const `ex` &self, const `ex` &other) const override

*Add two indexed expressions.*
- `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const override

*Multiply an indexed expression with a scalar.*
- `bool contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const override

*Try to contract two indexed expressions that appear in the same product.*
- unsigned `return_type` () const override
- `return_type_t` `return_type_tinfo` () const override
- const T \* `operator->` () const
- T & `get_struct` ()
- const T & `get_struct` () const

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()

*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)

*basic assignment operator: the other object might be of a derived class.*
- virtual `basic` \* `duplicate` () const

*Create a clone of this object on the heap.*
- virtual `ex evalf` () const

*Evaluate object numerically.*
- virtual `ex eval_integ` () const

- *Evaluate integrals, if result is known.*
- virtual void `dbgprint` () const
- *Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree` () const
- *Little wrapper around printtree to be called within a debugger.*
- virtual void `accept` (`GiNaC::visitor` &*v*) const
- virtual bool `is_polynomial` (const `ex` &*var*) const
- *Check whether this is a polynomial in the given variables.*
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class *T*>
- void `print_dispatch` (const `print_context` &*c*, unsigned level) const
- *Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &*ri*, const `print_context` &*c*, unsigned level) const
- *Like `print()`, but dispatch to the specified class.*
- virtual void `archive` (`archive_node` &*n*) const
- *Save (serialize) the object into archive node.*
- virtual void `read_archive` (const `archive_node` &*n*, `lst` &*syms*)
- *Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &*m*, unsigned options) const
- *Helper function for `subs()`.*
- `ex diff` (const `symbol` &*s*, unsigned *nth*=1) const
- *Default interface of *nth* derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &*other*) const
- *Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &*other*) const
- *Test for syntactic equality.*
- const `basic` & `hold` () const
- *Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned *f*) const
- *Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned *f*) const
- *Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int *r*) noexcept

## Protected Member Functions

- `ex eval_ncmul` (const `exvector` &*v*) const override
- bool `match_same_type` (const `basic` &*other*) const override
- *Returns true if the attributes of two objects are similar enough for a match.*
- `ex derivative` (const `symbol` &*s*) const override
- *Default implementation of `ex::diff()`.*
- bool `is_equal_same_type` (const `basic` &*other*) const override
- *Returns true if two objects of same type are equal.*
- unsigned `calchash` () const override
- *Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Static Private Member Functions

- static const char \* [get\\_class\\_name](#) ()

## Private Attributes

- T [obj](#)

## Additional Inherited Members

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.160.1 Detailed Description

**template<class T, template< class > class ComparisonPolicy>**  
**class GiNaC::structure< T, ComparisonPolicy >**

Wrapper template for making [GiNaC](#) classes out of C++ structures.

### 6.160.2 Constructor & Destructor Documentation

#### 6.160.2.1 structure()

```
template<class T, template< class > class ComparisonPolicy>
GiNaC::structure< T, CP >::structure (
 const T & t) [inline]
```

Construct structure as a copy of a given C++ structure.

Default constructor.

References [obj](#).

Referenced by [is\\_equal\\_same\\_type](#)().

### 6.160.3 Member Function Documentation

#### 6.160.3.1 `get_class_name()`

```
template<class T, template< class > class ComparisonPolicy>
static const char * GiNaC::structure< T, ComparisonPolicy >::get_class_name () [inline],
[static], [private]
```

References [get\\_class\\_name\(\)](#).

Referenced by [get\\_class\\_name\(\)](#).

#### 6.160.3.2 `eval()`

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::eval () const [inline], [override], [virtual]
```

Perform automatic non-interruptive term rewriting rules.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), and [GiNaC::basic::hold\(\)](#).

#### 6.160.3.3 `evalm()`

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::evalm () const [inline], [override], [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

#### 6.160.3.4 `eval_ncmul()`

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::eval_ncmul (
 const exvector & v) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), and [GiNaC::hold\\_ncmul\(\)](#).

#### 6.160.3.5 `eval_indexed()`

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::eval_indexed (
 const basic & i) const [inline], [override], [virtual]
```

Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::basic\(\)](#), [GiNaC::basic::ex](#), and [GiNaC::basic::hold\(\)](#).

### 6.160.3.6 print()

```
template<class T, template< class > class ComparisonPolicy>
void GiNaC::structure< T, ComparisonPolicy >::print (
 const print_context & c,
 unsigned level = 0) const [inline], [override], [virtual]
```

Output to stream.

This performs double dispatch on the dynamic type of \*this and the dynamic type of the supplied print context.

#### Parameters

|              |                                                                                                           |
|--------------|-----------------------------------------------------------------------------------------------------------|
| <i>c</i>     | print context object that describes the output formatting                                                 |
| <i>level</i> | value that is used to identify the precedence or indentation level for placing parentheses and formatting |

Reimplemented from [GiNaC::basic](#).

### 6.160.3.7 precedence()

```
template<class T, template< class > class ComparisonPolicy>
unsigned GiNaC::structure< T, ComparisonPolicy >::precedence () const [inline], [override],
[virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

### 6.160.3.8 info()

```
template<class T, template< class > class ComparisonPolicy>
bool GiNaC::structure< T, ComparisonPolicy >::info (
 unsigned inf) const [inline], [override], [virtual]
```

Information about the object.

#### See also

class [info\\_flags](#)

Reimplemented from [GiNaC::basic](#).

### 6.160.3.9 nops()

```
template<class T, template< class > class ComparisonPolicy>
size_t GiNaC::structure< T, ComparisonPolicy >::nops () const [inline], [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

**6.160.3.10 op()**

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::op (
 size_t i) const [inline], [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.11 operator[]() [1/4]**

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::operator[] (
 const ex & index) const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.12 operator[]() [2/4]**

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::operator[] (
 size_t i) const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.13 let\_op()**

```
template<class T, template< class > class ComparisonPolicy>
ex & GiNaC::structure< T, ComparisonPolicy >::let_op (
 size_t i) [inline], [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.14 operator[]() [3/4]**

```
template<class T, template< class > class ComparisonPolicy>
ex & GiNaC::structure< T, ComparisonPolicy >::operator[] (
 const ex & index) [inline], [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).



**6.160.3.15 operator[]()** [4/4]

```
template<class T, template< class > class ComparisonPolicy>
ex & GiNaC::structure< T, ComparisonPolicy >::operator[] (
 size_t i) [inline], [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.16 has()**

```
template<class T, template< class > class ComparisonPolicy>
bool GiNaC::structure< T, ComparisonPolicy >::has (
 const ex & pattern,
 unsigned options = 0) const [inline], [override], [virtual]
```

Test for occurrence of a pattern.

An object 'has' a pattern if it matches the pattern itself or one of the children 'has' it. As a consequence (according to the definition of children) given  $e=x+y+z$ ,  $e.has(x)$  is true but  $e.has(x+y)$  is false.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.17 match()**

```
template<class T, template< class > class ComparisonPolicy>
bool GiNaC::structure< T, ComparisonPolicy >::match (
 const ex & pattern,
 exmap & repl_lst) const [inline], [override], [virtual]
```

Check whether the expression matches a given pattern.

For every wildcard object in the pattern, a pair with the wildcard as a key and matching expression as a value is added to `repl_lst`.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.18 match\_same\_type()**

```
template<class T, template< class > class ComparisonPolicy>
bool GiNaC::structure< T, ComparisonPolicy >::match_same_type (
 const basic & other) const [inline], [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is\\_equal\\_same\\_type\(\)](#) is automatically used instead of [match\\_same\\_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::basic\(\)](#).

**6.160.3.19 subs()**

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::subs (
 const exmap & m,
 unsigned options = 0) const [inline], [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.20 map()**

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::map (
 map_function & f) const [inline], [override], [virtual]
```

Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.21 degree()**

```
template<class T, template< class > class ComparisonPolicy>
int GiNaC::structure< T, ComparisonPolicy >::degree (
 const ex & s) const [inline], [override], [virtual]
```

Return degree of highest power in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.22 ldegree()**

```
template<class T, template< class > class ComparisonPolicy>
int GiNaC::structure< T, ComparisonPolicy >::ldegree (
 const ex & s) const [inline], [override], [virtual]
```

Return degree of lowest power in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.23 coeff()**

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::coeff (
 const ex & s,
 int n = 1) const [inline], [override], [virtual]
```

Return coefficient of degree n in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.24 expand()**

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::expand (
 unsigned options = 0) const [inline], [override], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.25 collect()**

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::collect (
 const ex & s,
 bool distributed = false) const [inline], [override], [virtual]
```

Sort expanded expression in terms of powers of some object(s).

**Parameters**

|                    |                                                            |
|--------------------|------------------------------------------------------------|
| <i>s</i>           | object(s) to sort in                                       |
| <i>distributed</i> | recursive or distributed form (only used when s is a list) |

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

### 6.160.3.26 derivative()

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::derivative (
 const symbol & s) const [inline], [override], [protected], [virtual]
```

Default implementation of [ex::diff\(\)](#).

It maps the operation on the operands (or returns 0 when the object has no operands).

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

### 6.160.3.27 series()

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::series (
 const relational & r,
 int order,
 unsigned options = 0) const [inline], [override], [virtual]
```

Default implementation of [ex::series\(\)](#).

This performs Taylor expansion.

See also

[ex::series](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

### 6.160.3.28 normal()

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::normal (
 exmap & repl,
 exmap & rev_lookup,
 lst & modifier) const [inline], [override], [virtual]
```

Default implementation of [ex::normal\(\)](#).

It normalizes the children and replaces the object with a temporary symbol.

See also

[ex::normal](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.29 to\_rational()**

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::to_rational (
 exmap & repl) const [inline], [override], [virtual]
```

Default implementation of [ex::to\\_rational\(\)](#).

This replaces the object with a temporary symbol.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.30 to\_polynomial()**

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::to_polynomial (
 exmap & repl) const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.31 integer\_content()**

```
template<class T, template< class > class ComparisonPolicy>
numeric GiNaC::structure< T, ComparisonPolicy >::integer_content () const [inline], [override],
[virtual]
```

Reimplemented from [GiNaC::basic](#).

**6.160.3.32 smod()**

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::smod (
 const numeric & xi) const [inline], [override], [virtual]
```

Apply symmetric modular homomorphism to an expanded multivariate polynomial.

This function is usually used internally by [heur\\_gcd\(\)](#).

**Parameters**

|      |         |
|------|---------|
| $xi$ | modulus |
|------|---------|

**Returns**

mapped polynomial

**See also**

[heur\\_gcd](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.33 max\_coefficient()**

```
template<class T, template< class > class ComparisonPolicy>
numeric GiNaC::structure< T, ComparisonPolicy >::max_coefficient () const [inline], [override],
[virtual]
```

Implementation [ex::max\\_coefficient\(\)](#).

See also

[heur\\_gcd](#)

Reimplemented from [GiNaC::basic](#).

**6.160.3.34 get\_free\_indices()**

```
template<class T, template< class > class ComparisonPolicy>
exvector GiNaC::structure< T, ComparisonPolicy >::get_free_indices () const [inline], [override],
[virtual]
```

Return a vector containing the free indices of an expression.

Reimplemented from [GiNaC::basic](#).

**6.160.3.35 add\_indexed()**

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::add_indexed (
 const ex & self,
 const ex & other) const [inline], [override], [virtual]
```

Add two indexed expressions.

They are guaranteed to be of class indexed (or a subclass) and their indices are compatible. This function is used internally by [simplify\\_indexed\(\)](#).

Parameters

|              |                                                    |
|--------------|----------------------------------------------------|
| <i>self</i>  | First indexed expression; its base object is *this |
| <i>other</i> | Second indexed expression                          |

Returns

sum of self and other

See also

[ex::simplify\\_indexed\(\)](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.36 scalar\_mul\_indexed()**

```
template<class T, template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::scalar_mul_indexed (
 const ex & self,
 const numeric & other) const [inline], [override], [virtual]
```

Multiply an indexed expression with a scalar.

This function is used internally by [simplify\\_indexed\(\)](#).

## Parameters

|              |                                              |
|--------------|----------------------------------------------|
| <i>self</i>  | Indexed expression; its base object is *this |
| <i>other</i> | Numeric value                                |

## Returns

product of self and other

## See also

[ex::simplify\\_indexed\(\)](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.160.3.37 contract\_with()**

```
template<class T, template< class > class ComparisonPolicy>
bool GiNaC::structure< T, ComparisonPolicy >::contract_with (
 exvector::iterator self,
 exvector::iterator other,
 exvector & v) const [inline], [override], [virtual]
```

Try to contract two indexed expressions that appear in the same product.

If a contraction exists, the function overwrites one or both of the expressions and returns true. Otherwise it returns false. It is guaranteed that both expressions are of class indexed (or a subclass) and that at least one dummy index has been found. This functions is used internally by [simplify\\_indexed\(\)](#).

## Parameters

|              |                                                               |
|--------------|---------------------------------------------------------------|
| <i>self</i>  | Pointer to first indexed expression; its base object is *this |
| <i>other</i> | Pointer to second indexed expression                          |
| <i>v</i>     | The complete vector of factors                                |

## Returns

true if the contraction was successful, false otherwise

## See also

[ex::simplify\\_indexed\(\)](#)

Reimplemented from [GiNaC::basic](#).

**6.160.3.38 return\_type()**

```
template<class T, template< class > class ComparisonPolicy>
unsigned GiNaC::structure< T, ComparisonPolicy >::return_type () const [inline], [override],
[virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::commutative](#).

**6.160.3.39 return\_type\_tinfo()**

```
template<class T, template< class > class ComparisonPolicy>
return_type_t GiNaC::structure< T, ComparisonPolicy >::return_type_tinfo () const [inline],
[override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_type\\_t::rl](#), and [GiNaC::return\\_type\\_t::tinfo](#).

**6.160.3.40 is\_equal\_same\_type()**

```
template<class T, template< class > class ComparisonPolicy>
bool GiNaC::structure< T, ComparisonPolicy >::is_equal_same_type (
 const basic & other) const [inline], [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare\\_same\\_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::basic\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [obj](#), and [structure\(\)](#).

**6.160.3.41 calchash()**

```
template<class T, template< class > class ComparisonPolicy>
unsigned GiNaC::structure< T, ComparisonPolicy >::calchash () const [inline], [override],
[protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).



#### 6.160.3.42 operator->()

```
template<class T, template< class > class ComparisonPolicy>
const T * GiNaC::structure< T, ComparisonPolicy >::operator-> () const [inline]
```

References [obj](#).

#### 6.160.3.43 get\_struct() [1/2]

```
template<class T, template< class > class ComparisonPolicy>
T & GiNaC::structure< T, ComparisonPolicy >::get_struct () [inline]
```

References [obj](#).

#### 6.160.3.44 get\_struct() [2/2]

```
template<class T, template< class > class ComparisonPolicy>
const T & GiNaC::structure< T, ComparisonPolicy >::get_struct () const [inline]
```

References [obj](#).

### 6.160.4 Member Data Documentation

#### 6.160.4.1 obj

```
template<class T, template< class > class ComparisonPolicy>
T GiNaC::structure< T, ComparisonPolicy >::obj [private]
```

Referenced by [get\\_struct\(\)](#), [get\\_struct\(\)](#), [is\\_equal\\_same\\_type\(\)](#), [operator->\(\)](#), and [structure\(\)](#).

The documentation for this class was generated from the following file:

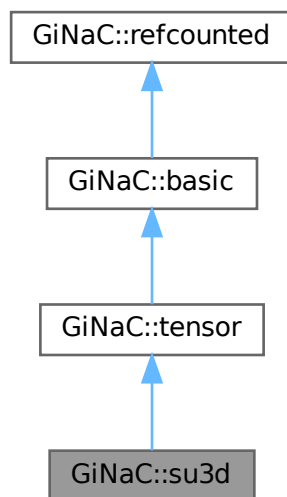
- [structure.h](#)

## 6.161 GiNaC::su3d Class Reference

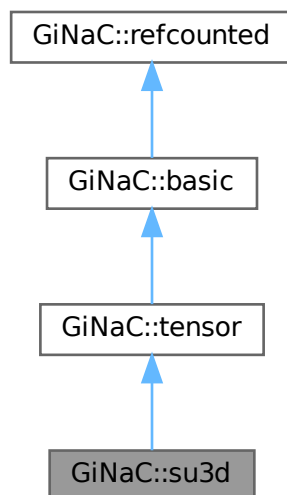
This class represents the tensor of symmetric su(3) structure constants.

```
#include <color.h>
```

Inheritance diagram for GiNaC::su3d:



Collaboration diagram for GiNaC::su3d:



## Public Member Functions

- `ex eval_indexed` (const `basic` &i) const override  
*Automatic symbolic evaluation of indexed symmetric structure constant.*
- `bool contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const override  
*Contraction of an indexed symmetric structure constant with something else.*

## Public Member Functions inherited from `GiNaC::tensor`

- `bool replace_contr_index` (exvector::iterator self, exvector::iterator other) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).*

## Public Member Functions inherited from `GiNaC::basic`

- `virtual ~basic` ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (const `basic` &other)
- `const basic & operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- `virtual basic * duplicate` () const  
*Create a clone of this object on the heap.*
- `virtual ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*
- `virtual ex evalf` () const  
*Evaluate object numerically.*
- `virtual ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*
- `virtual ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- `virtual void print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- `virtual void dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- `virtual void dbgprinttree` () const  
*Little wrapper around printtree to be called within a debugger.*
- `virtual unsigned precedence` () const  
*Return relative operator precedence (for parenthesizing output).*
- `virtual bool info` (unsigned inf) const  
*Information about the object.*
- `virtual size_t nops` () const  
*Number of operands/members.*
- `virtual ex op` (size\_t i) const  
*Return operand/member at position i.*
- `virtual ex operator[]` (const `ex` &index) const
- `virtual ex operator[]` (size\_t i) const
- `virtual ex & let_op` (size\_t i)  
*Return modifiable operand/member at position i.*
- `virtual ex & operator[]` (const `ex` &index)
- `virtual ex & operator[]` (size\_t i)

- virtual bool [has](#) (const [ex](#) &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const  
*Check whether the expression matches a given pattern.*
- virtual [ex subs](#) (const [exmap](#) &m, unsigned options=0) const  
*Substitute a set of objects by arbitrary expressions.*
- virtual [ex map](#) ([map\\_function](#) &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is\\_polynomial](#) (const [ex](#) &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int [degree](#) (const [ex](#) &s) const  
*Return degree of highest power in object s.*
- virtual int [ldegree](#) (const [ex](#) &s) const  
*Return degree of lowest power in object s.*
- virtual [ex coeff](#) (const [ex](#) &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual [ex expand](#) (unsigned options=0) const  
*Expand expression, i.e.*
- virtual [ex collect](#) (const [ex](#) &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual [ex series](#) (const [relational](#) &r, int order, unsigned options=0) const  
*Default implementation of [ex::series\(\)](#).*
- virtual [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev\_lookup, [lst](#) &modifier) const  
*Default implementation of [ex::normal\(\)](#).*
- virtual [ex to\\_rational](#) ([exmap](#) &repl) const  
*Default implementation of [ex::to\\_rational\(\)](#).*
- virtual [ex to\\_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer\\_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual [numeric max\\_coefficient](#) () const  
*Implementation [ex::max\\_coefficient\(\)](#).*
- virtual [exvector get\\_free\\_indices](#) () const  
*Return a vector containing the free indices of an expression.*
- virtual [ex add\\_indexed](#) (const [ex](#) &self, const [ex](#) &other) const  
*Add two indexed expressions.*
- virtual [ex scalar\\_mul\\_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const  
*Multiply an indexed expression with a scalar.*
- virtual [return\\_type\\_t return\\_type\\_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real\\_part](#) () const
- virtual [ex imag\\_part](#) () const
- template<class T>  
void [print\\_dispatch](#) (const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- void [print\\_dispatch](#) (const [registered\\_class\\_info](#) &ri, const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- virtual void [archive](#) ([archive\\_node](#) &n) const  
*Save (serialize) the object into archive node.*
- virtual void [read\\_archive](#) (const [archive\\_node](#) &n, [lst](#) &syms)

- *Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- `int compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- `bool is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- `const basic & hold` () const  
*Stop further evaluation.*
- `unsigned gethash` () const
- `const basic & setflag` (unsigned f) const  
*Set some `status_flags`.*
- `const basic & clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- `unsigned int add_reference` () noexcept
- `unsigned int remove_reference` () noexcept
- `unsigned int get_refcount` () const noexcept
- `void set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- `unsigned return_type` () const override
- `void do_print` (const `print_context` &c, unsigned level) const
- `void do_print_latex` (const `print_latex` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::tensor`

- `unsigned return_type` () const override

## Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- `virtual ex eval_ncmul` (const `exvector` &v) const
- `virtual bool match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- `virtual ex derivative` (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- `virtual int compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- `virtual bool is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- `virtual unsigned calchash` () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*

- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Additional Inherited Members

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.161.1 Detailed Description

This class represents the tensor of symmetric  $\text{su}(3)$  structure constants.

### 6.161.2 Member Function Documentation

#### 6.161.2.1 [eval\\_indexed\(\)](#)

```
ex GiNaC::su3d::eval_indexed (
 const basic & i) const [override], [virtual]
```

Automatic symbolic evaluation of indexed symmetric structure constant.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1\\_2](#), [GiNaC::\\_ex1\\_3](#), [GiNaC::\\_ex3](#), [GiNaC::\\_ex\\_1\\_2](#), [GiNaC::\\_ex\\_1\\_3](#), [GiNaC::\\_ex\\_6](#), [CMPINDICES](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::basic::nops\(\)](#), [GiNaC::basic::op\(\)](#), [GiNaC::sqrt\(\)](#), and [std::swap\(\)](#).

#### 6.161.2.2 [contract\\_with\(\)](#)

```
bool GiNaC::su3d::contract_with (
 exvector::iterator self,
 exvector::iterator other,
 exvector & v) const [override], [virtual]
```

Contraction of an indexed symmetric structure constant with something else.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [GiNaC::color\\_T\(\)](#), [GiNaC::delta\\_tensor\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::find\\_free\\_and\\_dummy\(\)](#), [GiNaC::get\\_representation\\_label\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [GiNaC::permute\\_free\\_index\\_to\\_from](#)

### 6.161.2.3 return\_type()

```
unsigned GiNaC::su3d::return_type () const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::commutative](#).

### 6.161.2.4 do\_print()

```
void GiNaC::su3d::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

### 6.161.2.5 do\_print\_latex()

```
void GiNaC::su3d::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

The documentation for this class was generated from the following files:

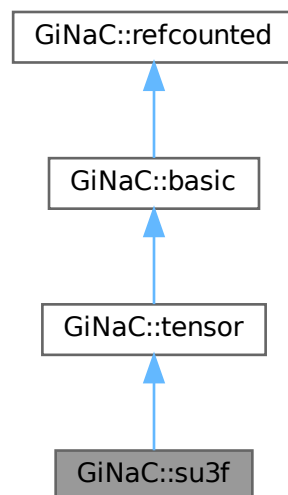
- [color.h](#)
- [color.cpp](#)

## 6.162 GiNaC::su3f Class Reference

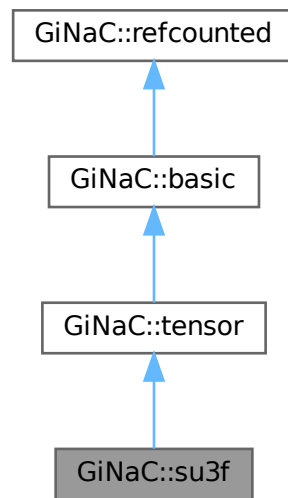
This class represents the tensor of antisymmetric su(3) structure constants.

```
#include <color.h>
```

Inheritance diagram for GiNaC::su3f:



Collaboration diagram for `GiNaC::su3f`:



### Public Member Functions

- `ex eval_indexed` (const `basic` &i) const override  
*Automatic symbolic evaluation of indexed antisymmetric structure constant.*
- bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const override  
*Contraction of an indexed antisymmetric structure constant with something else.*

### Public Member Functions inherited from `GiNaC::tensor`

- bool `replace_contr_index` (exvector::iterator self, exvector::iterator other) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).*

### Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf` () const  
*Evaluate object numerically.*



- virtual `ex evalm ()` const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ ()` const  
*Evaluate integrals, if result is known.*
- virtual void `print (const print_context &c, unsigned level=0)` const  
*Output to stream.*
- virtual void `dbgprint ()` const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree ()` const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence ()` const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool `info (unsigned inf)` const  
*Information about the object.*
- virtual size\_t `nops ()` const  
*Number of operands/members.*
- virtual `ex op (size_t i)` const  
*Return operand/member at position i.*
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex &let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- virtual `ex &operator[] (const ex &index)`
- virtual `ex &operator[] (size_t i)`
- virtual bool `has (const ex &other, unsigned options=0)` const  
*Test for occurrence of a pattern.*
- virtual bool `match (const ex &pattern, exmap &repls)` const  
*Check whether the expression matches a given pattern.*
- virtual `ex subs (const exmap &m, unsigned options=0)` const  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map (map_function &f)` const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept (GiNaC::visitor &v)` const
- virtual bool `is_polynomial (const ex &var)` const  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree (const ex &s)` const  
*Return degree of highest power in object s.*
- virtual int `ldegree (const ex &s)` const  
*Return degree of lowest power in object s.*
- virtual `ex coeff (const ex &s, int n=1)` const  
*Return coefficient of degree n in object s.*
- virtual `ex expand (unsigned options=0)` const  
*Expand expression, i.e.*
- virtual `ex collect (const ex &s, bool distributed=false)` const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series (const relational &r, int order, unsigned options=0)` const  
*Default implementation of `ex::series()`.*
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier)` const  
*Default implementation of `ex::normal()`.*
- virtual `ex to_rational (exmap &repl)` const  
*Default implementation of `ex::to_rational()`.*

- virtual [ex to\\_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer\\_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual [numeric max\\_coefficient](#) () const  
*Implementation [ex::max\\_coefficient\(\)](#).*
- virtual [exvector get\\_free\\_indices](#) () const  
*Return a vector containing the free indices of an expression.*
- virtual [ex add\\_indexed](#) (const [ex](#) &self, const [ex](#) &other) const  
*Add two indexed expressions.*
- virtual [ex scalar\\_mul\\_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const  
*Multiply an indexed expression with a scalar.*
- virtual [return\\_type\\_t return\\_type\\_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real\\_part](#) () const
- virtual [ex imag\\_part](#) () const
- template<class T>  
void [print\\_dispatch](#) (const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- void [print\\_dispatch](#) (const [registered\\_class\\_info](#) &ri, const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- virtual void [archive](#) ([archive\\_node](#) &n) const  
*Save (serialize) the object into archive node.*
- virtual void [read\\_archive](#) (const [archive\\_node](#) &n, [lst](#) &syms)  
*Load (deserialize) the object from an archive node.*
- [ex subs\\_one\\_level](#) (const [exmap](#) &m, unsigned options) const  
*Helper function for [subs\(\)](#).*
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const  
*Default interface of nth derivative [ex::diff\(s, n\)](#).*
- int [compare](#) (const [basic](#) &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool [is\\_equal](#) (const [basic](#) &other) const  
*Test for syntactic equality.*
- const [basic](#) & [hold](#) () const  
*Stop further evaluation.*
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const  
*Set some [status\\_flags](#).*
- const [basic](#) & [clearflag](#) (unsigned f) const  
*Clear some [status\\_flags](#).*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

### Protected Member Functions

- unsigned `return_type` () const override
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

### Protected Member Functions inherited from `GiNaC::tensor`

- unsigned `return_type` () const override

### Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual `ex derivative` (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned `calchash` () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void `do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

### Additional Inherited Members

### Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`  
*of type `status_flags`*
- unsigned `hashvalue`  
*hash value*

## 6.162.1 Detailed Description

This class represents the tensor of antisymmetric su(3) structure constants.

## 6.162.2 Member Function Documentation

### 6.162.2.1 `eval_indexed()`

```
ex GiNaC::su3f::eval_indexed (
 const basic & i) const [override], [virtual]
```

Automatic symbolic evaluation of indexed antisymmetric structure constant.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1\\_2](#), [GiNaC::\\_ex3](#), [GiNaC::\\_ex\\_1\\_2](#), [CMPINDICES](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::basic::nops\(\)](#), [GiNaC::basic::op\(\)](#), [GiNaC::sqrt\(\)](#), and [std::swap\(\)](#).

### 6.162.2.2 `contract_with()`

```
bool GiNaC::su3f::contract_with (
 exvector::iterator self,
 exvector::iterator other,
 exvector & v) const [override], [virtual]
```

Contraction of an indexed antisymmetric structure constant with something else.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [GiNaC::color\\_T\(\)](#), [GiNaC::delta\\_tensor\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::get\\_representation\\_label\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::I](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [GiNaC::permute\\_free\\_index\\_to\\_front\(\)](#).

### 6.162.2.3 `return_type()`

```
unsigned GiNaC::su3f::return_type () const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::commutative](#).

### 6.162.2.4 `do_print()`

```
void GiNaC::su3f::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

### 6.162.2.5 `do_print_latex()`

```
void GiNaC::su3f::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

The documentation for this class was generated from the following files:

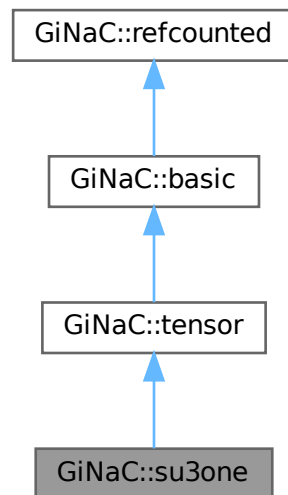
- [color.h](#)
- [color.cpp](#)

## 6.163 GiNaC::su3one Class Reference

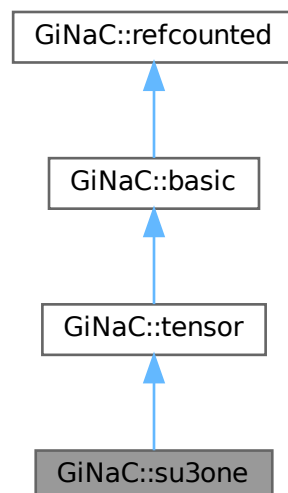
This class represents the  $\text{su}(3)$  unity element.

```
#include <color.h>
```

Inheritance diagram for GiNaC::su3one:



Collaboration diagram for GiNaC::su3one:



### Protected Member Functions

- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

### Protected Member Functions inherited from `GiNaC::tensor`

- unsigned `return_type` () const override

### Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual `ex derivative` (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- virtual int `compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- virtual bool `is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned `calchash` () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `ensure_if_modifiable` () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void `do_print` (const `print_context` &c, unsigned level) const  
*Default output to stream.*
- void `do_print_tree` (const `print_tree` &c, unsigned level) const  
*Tree output to stream.*
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const  
*Python parsable output to stream.*

### Additional Inherited Members

### Public Member Functions inherited from `GiNaC::tensor`

- bool `replace_contr_index` (`exvector::iterator` self, `exvector::iterator` other) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).*

## Public Member Functions inherited from GiNaC::basic

- virtual `~basic ()`  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate () const`  
*Create a clone of this object on the heap.*
- virtual `ex eval () const`  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf () const`  
*Evaluate object numerically.*
- virtual `ex evalm () const`  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ () const`  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed (const basic &i) const`  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual `void print (const print_context &c, unsigned level=0) const`  
*Output to stream.*
- virtual `void dbgprint () const`  
*Little wrapper around print to be called within a debugger.*
- virtual `void dbgprinttree () const`  
*Little wrapper around printtree to be called within a debugger.*
- virtual `unsigned precedence () const`  
*Return relative operator precedence (for parenthezing output).*
- virtual `bool info (unsigned inf) const`  
*Information about the object.*
- virtual `size_t nops () const`  
*Number of operands/members.*
- virtual `ex op (size_t i) const`  
*Return operand/member at position i.*
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`
- virtual `ex & let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual `bool has (const ex &other, unsigned options=0) const`  
*Test for occurrence of a pattern.*
- virtual `bool match (const ex &pattern, exmap &repls) const`  
*Check whether the expression matches a given pattern.*
- virtual `ex subs (const exmap &m, unsigned options=0) const`  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map (map_function &f) const`  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual `void accept (GiNaC::visitor &v) const`
- virtual `bool is_polynomial (const ex &var) const`  
*Check whether this is a polynomial in the given variables.*
- virtual `int degree (const ex &s) const`

- Return degree of highest power in object s.*

  - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

  - virtual `ex coeff` (const `ex` &s, int n=1) const
- Return coefficient of degree n in object s.*

  - virtual `ex expand` (unsigned options=0) const
- Expand expression, i.e.*

  - virtual `ex collect` (const `ex` &s, bool distributed=false) const
- Sort expanded expression in terms of powers of some object(s).*

  - virtual `ex series` (const `relational` &r, int order, unsigned options=0) const
- Default implementation of `ex::series()`.*

  - virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

  - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

  - virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

  - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

  - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

  - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

  - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

  - virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

  - virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T>
  - void `print_dispatch` (const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

  - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
- Load (deserialize) the object from an archive node.*

  - `ex subs_one_level` (const `exmap` &m, unsigned options) const
- Helper function for `subs()`.*

  - `ex diff` (const `symbol` &s, unsigned nth=1) const
- Default interface of nth derivative `ex::diff(s, n)`.*

  - int `compare` (const `basic` &other) const
- Compare objects syntactically to establish canonical ordering.*

  - bool `is_equal` (const `basic` &other) const
- Test for syntactic equality.*

  - const `basic` & `hold` () const



*Stop further evaluation.*

- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const

*Set some [status\\_flags](#).*

- const [basic](#) & [clearflag](#) (unsigned f) const

*Clear some [status\\_flags](#).*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.163.1 Detailed Description

This class represents the su(3) unity element.

### 6.163.2 Member Function Documentation

#### 6.163.2.1 [do\\_print\(\)](#)

```
void GiNaC::su3one::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

#### 6.163.2.2 [do\\_print\\_latex\(\)](#)

```
void GiNaC::su3one::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

The documentation for this class was generated from the following file:

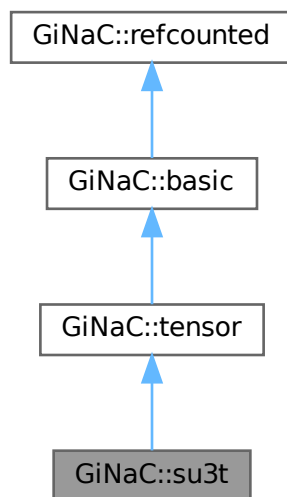
- [color.h](#)

## 6.164 GiNaC::su3t Class Reference

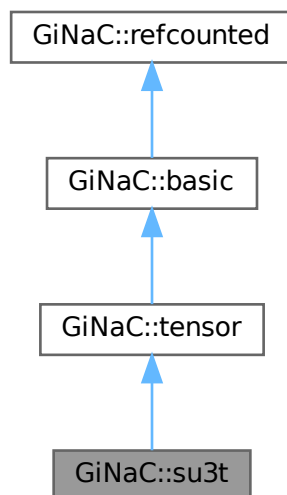
This class represents an  $su(3)$  generator.

```
#include <color.h>
```

Inheritance diagram for GiNaC::su3t:



Collaboration diagram for GiNaC::su3t:



## Public Member Functions

- bool [contract\\_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const override  
*Contraction of generator with something else.*

## Public Member Functions inherited from [GiNaC::tensor](#)

- bool [replace\\_contr\\_index](#) (exvector::iterator self, exvector::iterator other) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).*

## Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual [basic](#) \* [duplicate](#) () const  
*Create a clone of this object on the heap.*
- virtual [ex eval](#) () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual [ex evalf](#) () const  
*Evaluate object numerically.*
- virtual [ex evalm](#) () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual [ex eval\\_integ](#) () const  
*Evaluate integrals, if result is known.*
- virtual [ex eval\\_indexed](#) (const [basic](#) &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void [print](#) (const [print\\_context](#) &c, unsigned level=0) const  
*Output to stream.*
- virtual void [dbgprint](#) () const  
*Little wrapper around print to be called within a debugger.*
- virtual void [dbgprinttree](#) () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned [precedence](#) () const  
*Return relative operator precedence (for parenthesizing output).*
- virtual bool [info](#) (unsigned inf) const  
*Information about the object.*
- virtual size\_t [nops](#) () const  
*Number of operands/members.*
- virtual [ex op](#) (size\_t i) const  
*Return operand/member at position i.*
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size\_t i) const
- virtual [ex](#) & [let\\_op](#) (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size\_t i)

- virtual bool [has](#) (const [ex](#) &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const  
*Check whether the expression matches a given pattern.*
- virtual [ex subs](#) (const [exmap](#) &m, unsigned options=0) const  
*Substitute a set of objects by arbitrary expressions.*
- virtual [ex map](#) ([map\\_function](#) &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is\\_polynomial](#) (const [ex](#) &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int [degree](#) (const [ex](#) &s) const  
*Return degree of highest power in object s.*
- virtual int [ldegree](#) (const [ex](#) &s) const  
*Return degree of lowest power in object s.*
- virtual [ex coeff](#) (const [ex](#) &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual [ex expand](#) (unsigned options=0) const  
*Expand expression, i.e.*
- virtual [ex collect](#) (const [ex](#) &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual [ex series](#) (const [relational](#) &r, int order, unsigned options=0) const  
*Default implementation of [ex::series\(\)](#).*
- virtual [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev\_lookup, [lst](#) &modifier) const  
*Default implementation of [ex::normal\(\)](#).*
- virtual [ex to\\_rational](#) ([exmap](#) &repl) const  
*Default implementation of [ex::to\\_rational\(\)](#).*
- virtual [ex to\\_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer\\_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual [numeric max\\_coefficient](#) () const  
*Implementation [ex::max\\_coefficient\(\)](#).*
- virtual [exvector get\\_free\\_indices](#) () const  
*Return a vector containing the free indices of an expression.*
- virtual [ex add\\_indexed](#) (const [ex](#) &self, const [ex](#) &other) const  
*Add two indexed expressions.*
- virtual [ex scalar\\_mul\\_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const  
*Multiply an indexed expression with a scalar.*
- virtual [return\\_type\\_t return\\_type\\_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real\\_part](#) () const
- virtual [ex imag\\_part](#) () const
- template<class T>  
void [print\\_dispatch](#) (const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- void [print\\_dispatch](#) (const [registered\\_class\\_info](#) &ri, const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- virtual void [archive](#) ([archive\\_node](#) &n) const  
*Save (serialize) the object into archive node.*
- virtual void [read\\_archive](#) (const [archive\\_node](#) &n, [lst](#) &syms)

- *Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- `int compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- `bool is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- `const basic & hold` () const  
*Stop further evaluation.*
- `unsigned gethash` () const
- `const basic & setflag` (unsigned f) const  
*Set some `status_flags`.*
- `const basic & clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- `unsigned int add_reference` () noexcept
- `unsigned int remove_reference` () noexcept
- `unsigned int get_refcount` () const noexcept
- `void set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- `void do_print` (const `print_context` &c, unsigned level) const
- `void do_print_latex` (const `print_latex` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::tensor`

- `unsigned return_type` () const override

## Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- `virtual ex eval_ncmul` (const `exvector` &v) const
- `virtual bool match_same_type` (const `basic` &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- `virtual ex derivative` (const `symbol` &s) const  
*Default implementation of `ex::diff()`.*
- `virtual int compare_same_type` (const `basic` &other) const  
*Returns order relation between two objects of same type.*
- `virtual bool is_equal_same_type` (const `basic` &other) const  
*Returns true if two objects of same type are equal.*
- `virtual unsigned calchash` () const  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- `void ensure_if_modifiable` () const

*Ensure the object may be modified without hurting others, throws if this is not the case.*

- void `do_print` (const `print_context` &c, unsigned level) const

*Default output to stream.*

- void `do_print_tree` (const `print_tree` &c, unsigned level) const

*Tree output to stream.*

- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const

*Python parsable output to stream.*

## Additional Inherited Members

## Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`  
*of type `status_flags`*
- unsigned `hashvalue`  
*hash value*

### 6.164.1 Detailed Description

This class represents an  $su(3)$  generator.

### 6.164.2 Member Function Documentation

#### 6.164.2.1 `contract_with()`

```
bool GiNaC::su3t::contract_with (
 exvector::iterator self,
 exvector::iterator other,
 exvector & v) const [override], [virtual]
```

Contraction of generator with something else.

Reimplemented from `GiNaC::basic`.

References `GiNaC::_ex1`, `GiNaC::color_ONE()`, `GiNaC::color_trace()`, `GiNaC::ex_to()`, `GINAC_ASSERT`, `GiNaC::is_a()`, and `GiNaC::is_exactly_a()`.

#### 6.164.2.2 `do_print()`

```
void GiNaC::su3t::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

### 6.164.2.3 do\_print\_latex()

```
void GiNaC::su3t::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

The documentation for this class was generated from the following files:

- [color.h](#)
- [color.cpp](#)

## 6.165 GiNaC::subs\_options Class Reference

Flags to control the behavior of [subs\(\)](#).

```
#include <flags.h>
```

### Public Types

- enum {  
[no\\_pattern](#) = 0x0001 , [subs\\_no\\_pattern](#) = 0x0001 , [algebraic](#) = 0x0002 , [subs\\_algebraic](#) = 0x0002 ,  
[pattern\\_is\\_product](#) = 0x0004 , [pattern\\_is\\_not\\_product](#) = 0x0008 , [no\\_index\\_renaming](#) = 0x0010 ,  
[really\\_subs\\_idx](#) = 0x0020 }

### 6.165.1 Detailed Description

Flags to control the behavior of [subs\(\)](#).

### 6.165.2 Member Enumeration Documentation

#### 6.165.2.1 anonymous enum

anonymous enum

#### Enumerator

|                                        |                                                              |
|----------------------------------------|--------------------------------------------------------------|
| <a href="#">no_pattern</a>             | disable pattern matching                                     |
| <a href="#">subs_no_pattern</a>        |                                                              |
| <a href="#">algebraic</a>              | enable algebraic substitutions                               |
| <a href="#">subs_algebraic</a>         |                                                              |
| <a href="#">pattern_is_product</a>     | used internally by <a href="#">expairseq::subschildren()</a> |
| <a href="#">pattern_is_not_product</a> | used internally by <a href="#">expairseq::subschildren()</a> |
| <a href="#">no_index_renaming</a>      |                                                              |
| <a href="#">really_subs_idx</a>        |                                                              |

The documentation for this class was generated from the following file:

- [flags.h](#)

## 6.166 GiNaC::sy\_is\_less Class Reference

### Public Member Functions

- [sy\\_is\\_less](#) (exvector::iterator v\_)
- bool [operator\(\)](#) (const [ex](#) &lh, const [ex](#) &rh) const

### Private Attributes

- exvector::iterator [v](#)

### 6.166.1 Constructor & Destructor Documentation

#### 6.166.1.1 sy\_is\_less()

```
GiNaC::sy_is_less::sy_is_less (
 exvector::iterator v_) [inline]
```

References [v](#).

### 6.166.2 Member Function Documentation

#### 6.166.2.1 operator>()()

```
bool GiNaC::sy_is_less::operator() (
 const ex & lh,
 const ex & rh) const [inline]
```

References [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), and [v](#).

### 6.166.3 Member Data Documentation

#### 6.166.3.1 v

```
exvector::iterator GiNaC::sy_is_less::v [private]
```

Referenced by [operator>\(\)\(\)](#), and [sy\\_is\\_less\(\)](#).

The documentation for this class was generated from the following file:

- [symmetry.cpp](#)

## 6.167 GiNaC::sy\_swap Class Reference

### Public Member Functions

- [sy\\_swap](#) (exvector::iterator v\_, bool &s)
- void [operator\(\)](#) (const [ex](#) &lh, const [ex](#) &rh)



## Public Attributes

- [bool & swapped](#)

## Private Attributes

- [exvector::iterator v](#)

## 6.167.1 Constructor & Destructor Documentation

### 6.167.1.1 sy\_swap()

```
GiNaC::sy_swap::sy_swap (
 exvector::iterator v_,
 bool & s) [inline]
```

References [swapped](#), and [v](#).

## 6.167.2 Member Function Documentation

### 6.167.2.1 operator>()()

```
void GiNaC::sy_swap::operator() (
 const ex & lh,
 const ex & rh) [inline]
```

References [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), [swapped](#), and [v](#).

## 6.167.3 Member Data Documentation

### 6.167.3.1 v

```
exvector::iterator GiNaC::sy_swap::v [private]
```

Referenced by [operator>\(\)\(\)](#), and [sy\\_swap\(\)](#).

### 6.167.3.2 swapped

```
bool& GiNaC::sy_swap::swapped
```

Referenced by [operator>\(\)\(\)](#), and [sy\\_swap\(\)](#).

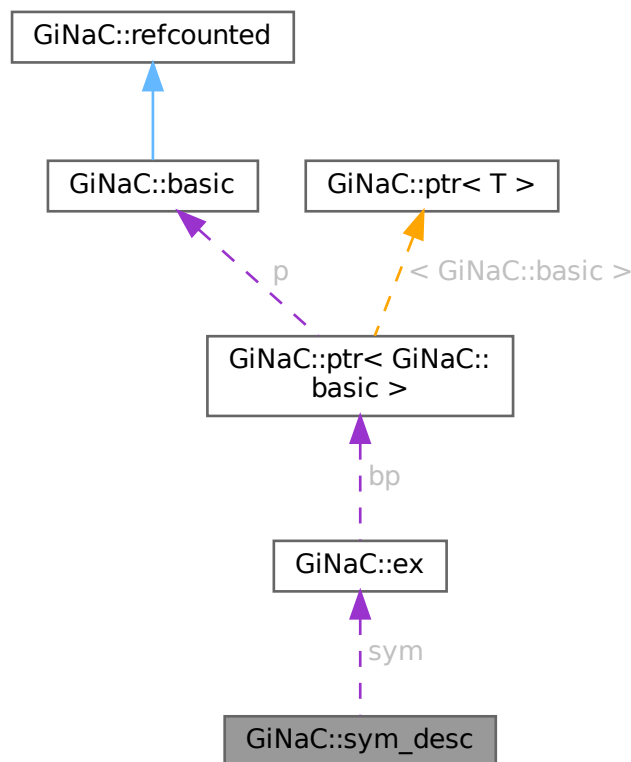
The documentation for this class was generated from the following file:

- [symmetry.cpp](#)

## 6.168 GiNaC::sym\_desc Struct Reference

This structure holds information about the highest and lowest degrees in which a symbol appears in two multivariate polynomials "a" and "b".

Collaboration diagram for GiNaC::sym\_desc:



### Public Member Functions

- `sym_desc` (const `ex` &s)  
*Initialize symbol, leave other variables uninitialized.*
- bool `operator<` (const `sym_desc` &x) const  
*Comparison operator for sorting.*

### Public Attributes

- `ex sym`  
*Reference to symbol.*
- int `deg_a`  
*Highest degree of symbol in polynomial "a".*
- int `deg_b`

- *Highest degree of symbol in polynomial "b".*  
int [ldeg\\_a](#)
- *Lowest degree of symbol in polynomial "a".*  
int [ldeg\\_b](#)
- *Lowest degree of symbol in polynomial "b".*  
int [max\\_deg](#)
- *Maximum of deg\_a and deg\_b (Used for sorting)*  
size\_t [max\\_lcnops](#)
- *Maximum number of terms of leading coefficient of symbol in both polynomials.*

## 6.168.1 Detailed Description

This structure holds information about the highest and lowest degrees in which a symbol appears in two multivariate polynomials "a" and "b".

A vector of these structures with information about all symbols in two polynomials can be created with the function [get\\_symbol\\_stats\(\)](#).

See also

[get\\_symbol\\_stats](#)

## 6.168.2 Constructor & Destructor Documentation

### 6.168.2.1 sym\_desc()

```
GiNaC::sym_desc::sym_desc (
 const ex & s) [inline]
```

Initialize symbol, leave other variables uninitialized.

References [deg\\_a](#), [deg\\_b](#), [ldeg\\_a](#), [ldeg\\_b](#), [max\\_deg](#), [max\\_lcnops](#), and [sym](#).

Referenced by [operator<\(\)](#).

## 6.168.3 Member Function Documentation

### 6.168.3.1 operator<()

```
bool GiNaC::sym_desc::operator< (
 const sym_desc & x) const [inline]
```

Comparison operator for sorting.

References [max\\_deg](#), [max\\_lcnops](#), and [sym\\_desc\(\)](#).

## 6.168.4 Member Data Documentation

### 6.168.4.1 `sym`

```
ex GiNaC::sym_desc::sym
```

Reference to symbol.

Referenced by [sym\\_desc\(\)](#).

### 6.168.4.2 `deg_a`

```
int GiNaC::sym_desc::deg_a
```

Highest degree of symbol in polynomial "a".

Referenced by [sym\\_desc\(\)](#).

### 6.168.4.3 `deg_b`

```
int GiNaC::sym_desc::deg_b
```

Highest degree of symbol in polynomial "b".

Referenced by [sym\\_desc\(\)](#).

### 6.168.4.4 `ldeg_a`

```
int GiNaC::sym_desc::ldeg_a
```

Lowest degree of symbol in polynomial "a".

Referenced by [sym\\_desc\(\)](#).

### 6.168.4.5 `ldeg_b`

```
int GiNaC::sym_desc::ldeg_b
```

Lowest degree of symbol in polynomial "b".

Referenced by [sym\\_desc\(\)](#).

### 6.168.4.6 `max_deg`

```
int GiNaC::sym_desc::max_deg
```

Maximum of `deg_a` and `deg_b` (Used for sorting)

Referenced by [operator<\(\)](#), and [sym\\_desc\(\)](#).

#### 6.168.4.7 max\_lcnops

```
size_t GiNaC::sym_desc::max_lcnops
```

Maximum number of terms of leading coefficient of symbol in both polynomials.

Referenced by [operator<\(\)](#), and [sym\\_desc\(\)](#).

The documentation for this struct was generated from the following file:

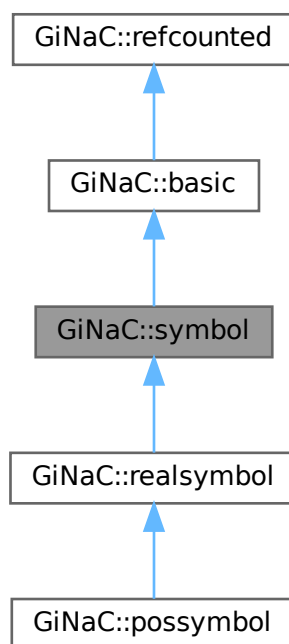
- [normal.cpp](#)

## 6.169 GiNaC::symbol Class Reference

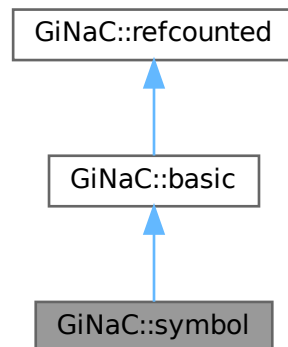
Basic CAS symbol.

```
#include <symbol.h>
```

Inheritance diagram for GiNaC::symbol:



Collaboration diagram for GiNaC::symbol:



### Public Member Functions

- [symbol](#) (const std::string &initname)
- [symbol](#) (const std::string &initname, const std::string &texname)
- bool [info](#) (unsigned inf) const override  
*Information about the object.*
- [ex eval](#) () const override  
*Perform automatic non-interruptive term rewriting rules.*
- [ex evalf](#) () const override  
*Evaluate object numerically.*
- [ex series](#) (const [relational](#) &s, int order, unsigned options=0) const override  
*Implementation of [ex::series\(\)](#) for symbols.*
- [ex subs](#) (const [exmap](#) &m, unsigned options=0) const override  
*Substitute a set of objects by arbitrary expressions.*
- [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev\_lookup, [lst](#) &modifier) const override  
*Implementation of [ex::normal\(\)](#) for symbols.*
- [ex to\\_rational](#) ([exmap](#) &repl) const override  
*Implementation of [ex::to\\_rational\(\)](#) for symbols.*
- [ex to\\_polynomial](#) ([exmap](#) &repl) const override  
*Implementation of [ex::to\\_polynomial\(\)](#) for symbols.*
- [ex conjugate](#) () const override
- [ex real\\_part](#) () const override
- [ex imag\\_part](#) () const override
- bool [is\\_polynomial](#) (const [ex](#) &var) const override  
*Check whether this is a polynomial in the given variables.*
- void [archive](#) ([archive\\_node](#) &n) const override  
*Save (a.k.a.*
- void [read\\_archive](#) (const [archive\\_node](#) &n, [lst](#) &syms) override  
*Read (a.k.a.*
- virtual unsigned [get\\_domain](#) () const
- void [set\\_name](#) (const std::string &n)
- void [set\\_TeX\\_name](#) (const std::string &n)
- std::string [get\\_name](#) () const
- std::string [get\\_TeX\\_name](#) () const

Public Member Functions inherited from **GiNaC::basic**

- virtual `~basic ()`  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate () const`  
*Create a clone of this object on the heap.*
- virtual `ex evalm () const`  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ () const`  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed (const basic &i) const`  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual `void print (const print_context &c, unsigned level=0) const`  
*Output to stream.*
- virtual `void dbgprint () const`  
*Little wrapper around print to be called within a debugger.*
- virtual `void dbgprinttree () const`  
*Little wrapper around printtree to be called within a debugger.*
- virtual `unsigned precedence () const`  
*Return relative operator precedence (for parenthesizing output).*
- virtual `size_t nops () const`  
*Number of operands/members.*
- virtual `ex op (size_t i) const`  
*Return operand/member at position i.*
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`
- virtual `ex & let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual `bool has (const ex &other, unsigned options=0) const`  
*Test for occurrence of a pattern.*
- virtual `bool match (const ex &pattern, exmap &repls) const`  
*Check whether the expression matches a given pattern.*
- virtual `ex map (map_function &f) const`  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual `void accept (GiNaC::visitor &v) const`
- virtual `int degree (const ex &s) const`  
*Return degree of highest power in object s.*
- virtual `int ldegree (const ex &s) const`  
*Return degree of lowest power in object s.*
- virtual `ex coeff (const ex &s, int n=1) const`  
*Return coefficient of degree n in object s.*
- virtual `ex expand (unsigned options=0) const`  
*Expand expression, i.e.*
- virtual `ex collect (const ex &s, bool distributed=false) const`  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `numeric integer_content () const`

- virtual `ex smod` (const `numeric` &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const  
*Implementation `ex::max_coefficient()`.*
- virtual `exvector get_free_indices` () const  
*Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- template<class T>  
void `print_dispatch` (const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- const `basic` & `hold` () const  
*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const  
*Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- `ex derivative` (const `symbol` &s) const override  
*Implementation of `ex::diff()` for single differentiation of a symbol.*
- bool `is_equal_same_type` (const `basic` &other) const override  
*Returns true if two objects of same type are equal.*
- unsigned `calchash` () const override  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const



## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Attributes

- unsigned [serial](#)  
*unique serial number for comparison*
- std::string [name](#)  
*printrname of this symbol*
- std::string [TeX\\_name](#)  
*LaTeX name of this symbol.*

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

## Static Private Attributes

- static unsigned [next\\_serial](#) = 0

### 6.169.1 Detailed Description

Basic CAS symbol.

It has a name because it must know how to output itself.

## 6.169.2 Constructor & Destructor Documentation

### 6.169.2.1 `symbol()` [1/2]

```
GiNaC::symbol::symbol (
 const std::string & initname) [explicit]
```

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [name](#), [next\\_serial](#), [serial](#), [GiNaC::basic::setflag\(\)](#), and [TeX\\_name](#).

Referenced by [derivative\(\)](#), [is\\_equal\\_same\\_type\(\)](#), [GiNaC::realsymbol::realsymbol\(\)](#), [GiNaC::realsymbol::realsymbol\(\)](#), and [GiNaC::realsymbol::realsymbol\(\)](#).

### 6.169.2.2 `symbol()` [2/2]

```
GiNaC::symbol::symbol (
 const std::string & initname,
 const std::string & texname)
```

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [name](#), [next\\_serial](#), [serial](#), [GiNaC::basic::setflag\(\)](#), and [TeX\\_name](#).

## 6.169.3 Member Function Documentation

### 6.169.3.1 `info()`

```
bool GiNaC::symbol::info (
 unsigned inf) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info\\_flags::cinteger\\_polynomial](#), [GiNaC::info\\_flags::crational\\_polynomial](#), [GiNaC::info\\_flags::expanded](#), [get\\_domain\(\)](#), [GiNaC::info\\_flags::has\\_indices](#), [GiNaC::info\\_flags::integer\\_polynomial](#), [GiNaC::info\\_flags::nonnegative](#), [GiNaC::info\\_flags::polynomial](#), [GiNaC::domain::positive](#), [GiNaC::info\\_flags::positive](#), [GiNaC::info\\_flags::rational\\_function](#), [GiNaC::info\\_flags::rational\\_polynomial](#), [GiNaC::domain::real](#), [GiNaC::info\\_flags::real](#), and [GiNaC::info\\_flags::symbol](#).

Referenced by [GiNaC::conjugate\\_expl\\_derivative\(\)](#), [GiNaC::imag\\_part\\_expl\\_derivative\(\)](#), and [GiNaC::real\\_part\\_expl\\_derivative\(\)](#).

### 6.169.3.2 `eval()`

```
ex GiNaC::symbol::eval () const [inline], [override], [virtual]
```

Perform automatic non-interruptive term rewriting rules.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

### 6.169.3.3 evalf()

```
ex GiNaC::symbol::evalf () const [inline], [override], [virtual]
```

Evaluate object numerically.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

### 6.169.3.4 series()

```
ex GiNaC::symbol::series (
 const relational & r,
 int order,
 unsigned options = 0) const [override], [virtual]
```

Implementation of [ex::series\(\)](#) for symbols.

See also

[ex::series](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [is\\_equal\\_same\\_type\(\)](#), [GiNaC::ex::is\\_zero\(\)](#), [GiNaC::relational::lhs\(\)](#), and [GiNaC::relational::rhs\(\)](#).

### 6.169.3.5 subs()

```
ex GiNaC::symbol::subs (
 const exmap & m,
 unsigned options = 0) const [inline], [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), and [GiNaC::basic::subs\\_one\\_level\(\)](#).

### 6.169.3.6 normal()

```
ex GiNaC::symbol::normal (
 exmap & repl,
 exmap & rev_lookup,
 lst & modifier) const [override], [virtual]
```

Implementation of [ex::normal\(\)](#) for symbols.

This returns the unmodified symbol.

See also

[ex::normal](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [GiNaC::dynallocate\(\)](#), and [GiNaC::basic::ex](#).

### 6.169.3.7 to\_rational()

```
ex GiNaC::symbol::to_rational (
 exmap & repl) const [override], [virtual]
```

Implementation of [ex::to\\_rational\(\)](#) for symbols.

This returns the unmodified symbol.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

### 6.169.3.8 to\_polynomial()

```
ex GiNaC::symbol::to_polynomial (
 exmap & repl) const [override], [virtual]
```

Implementation of [ex::to\\_polynomial\(\)](#) for symbols.

This returns the unmodified symbol.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

### 6.169.3.9 conjugate()

```
ex GiNaC::symbol::conjugate () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

### 6.169.3.10 real\_part()

```
ex GiNaC::symbol::real_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

### 6.169.3.11 imag\_part()

```
ex GiNaC::symbol::imag_part () const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.169.3.12 is\_polynomial()**

```
bool GiNaC::symbol::is_polynomial (
 const ex & var) const [override], [virtual]
```

Check whether this is a polynomial in the given variables.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

**6.169.3.13 archive()**

```
void GiNaC::symbol::archive (
 archive_node & n) const [override], [virtual]
```

Save (a.k.a.

Archive the object.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::add\\_string\(\)](#), [name](#), and [TeX\\_name](#).

**6.169.3.14 read\_archive()**

```
void GiNaC::symbol::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Read (a.k.a.

Read object from [archive\\_node](#).

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::container< C >::append\(\)](#), [GiNaC::status\\_flags::dynallocated](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::archive\\_node::find\\_string\(\)](#), [GiNaC::is\\_a\(\)](#), [name](#), [next\\_serial](#), [serial](#), [GiNaC::basic::setflag\(\)](#), and [TeX\\_name](#).

**6.169.3.15 derivative()**

```
ex GiNaC::symbol::derivative (
 const symbol & s) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for single differentiation of a symbol.

It returns 1 or 0.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [GiNaC::basic::compare\\_same\\_type\(\)](#), [GiNaC::basic::ex](#), and [symbol\(\)](#).

**6.169.3.16 is\_equal\_same\_type()**

```
bool GiNaC::symbol::is_equal_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare\\_same\\_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::basic\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [serial](#), and [symbol\(\)](#).

Referenced by [series\(\)](#).

**6.169.3.17 calchash()**

```
unsigned GiNaC::symbol::calchash () const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::golden\\_ratio\\_hash\(\)](#), [GiNaC::status\\_flags::hash\\_calculated](#), [GiNaC::basic::hashvalue](#), [GiNaC::make\\_hash\\_seed\(\)](#), [serial](#), and [GiNaC::basic::setflag\(\)](#).

**6.169.3.18 get\_domain()**

```
virtual unsigned GiNaC::symbol::get_domain () const [inline], [virtual]
```

Reimplemented in [GiNaC::possymbol](#), and [GiNaC::realsymbol](#).

References [GiNaC::domain::complex](#).

Referenced by [do\\_print\\_tree\(\)](#), and [info\(\)](#).

**6.169.3.19 set\_name()**

```
void GiNaC::symbol::set_name (
 const std::string & n) [inline]
```

References [name](#).

### 6.169.3.20 set\_TeX\_name()

```
void GiNaC::symbol::set_TeX_name (
 const std::string & n) [inline]
```

References [TeX\\_name](#).

### 6.169.3.21 get\_name()

```
std::string GiNaC::symbol::get_name () const
```

References [name](#), and [serial](#).

Referenced by [do\\_print\(\)](#), and [get\\_TeX\\_name\(\)](#).

### 6.169.3.22 get\_TeX\_name()

```
std::string GiNaC::symbol::get_TeX_name () const
```

References [GiNaC::get\\_default\\_TeX\\_name\(\)](#), [get\\_name\(\)](#), and [TeX\\_name](#).

### 6.169.3.23 do\_print()

```
void GiNaC::symbol::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [get\\_name\(\)](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.169.3.24 do\_print\_latex()

```
void GiNaC::symbol::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

References [GiNaC::get\\_default\\_TeX\\_name\(\)](#), [name](#), [GiNaC::print\\_context::s](#), [serial](#), and [TeX\\_name](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.169.3.25 do\_print\_tree()

```
void GiNaC::symbol::do_print_tree (
 const print_tree & c,
 unsigned level) const [protected]
```

References [GiNaC::basic::flags](#), [get\\_domain\(\)](#), [GiNaC::basic::hashvalue](#), [name](#), [GiNaC::print\\_context::s](#), and [serial](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.169.3.26 do\_print\_python\_repr()

```
void GiNaC::symbol::do_print_python_repr (
 const print_python_repr & c,
 unsigned level) const [protected]
```

References [name](#), [GiNaC::print\\_context::s](#), [serial](#), and [TeX\\_name](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.169.4 Member Data Documentation

### 6.169.4.1 serial

```
unsigned GiNaC::symbol::serial [protected]
```

unique serial number for comparison

Referenced by [calchash\(\)](#), [do\\_print\\_latex\(\)](#), [do\\_print\\_python\\_repr\(\)](#), [do\\_print\\_tree\(\)](#), [get\\_name\(\)](#), [is\\_equal\\_same\\_type\(\)](#), [read\\_archive\(\)](#), [symbol\(\)](#), and [symbol\(\)](#).

### 6.169.4.2 name

```
std::string GiNaC::symbol::name [mutable], [protected]
```

printname of this symbol

Referenced by [archive\(\)](#), [do\\_print\\_latex\(\)](#), [do\\_print\\_python\\_repr\(\)](#), [do\\_print\\_tree\(\)](#), [get\\_name\(\)](#), [read\\_archive\(\)](#), [set\\_name\(\)](#), [symbol\(\)](#), and [symbol\(\)](#).

### 6.169.4.3 TeX\_name

```
std::string GiNaC::symbol::TeX_name [protected]
```

LaTeX name of this symbol.

Referenced by [archive\(\)](#), [do\\_print\\_latex\(\)](#), [do\\_print\\_python\\_repr\(\)](#), [get\\_TeX\\_name\(\)](#), [read\\_archive\(\)](#), [set\\_TeX\\_name\(\)](#), [symbol\(\)](#), and [symbol\(\)](#).

### 6.169.4.4 next\_serial

```
unsigned GiNaC::symbol::next_serial = 0 [static], [private]
```

Referenced by [GiNaC::GINAC\\_BIND\\_UNARCHIVER\(\)](#), [read\\_archive\(\)](#), [symbol\(\)](#), and [symbol\(\)](#).

The documentation for this class was generated from the following files:

- [symbol.h](#)
- [normal.cpp](#)
- [pseries.cpp](#)
- [symbol.cpp](#)



## 6.170 GiNaC::symbolset Class Reference

### Public Member Functions

- [symbolset](#) (const [ex](#) &e)
- bool [has](#) (const [ex](#) &e) const

### Private Member Functions

- void [insert\\_symbols](#) (const [ex](#) &e)

### Private Attributes

- [exset](#) [s](#)

## 6.170.1 Constructor & Destructor Documentation

### 6.170.1.1 symbolset()

```
GiNaC::symbolset::symbolset (
 const ex & e) [inline], [explicit]
```

References [insert\\_symbols\(\)](#).

## 6.170.2 Member Function Documentation

### 6.170.2.1 insert\_symbols()

```
void GiNaC::symbolset::insert_symbols (
 const ex & e) [inline], [private]
```

References [insert\\_symbols\(\)](#), [GiNaC::is\\_a\(\)](#), and [s](#).

Referenced by [insert\\_symbols\(\)](#), and [symbolset\(\)](#).

### 6.170.2.2 has()

```
bool GiNaC::symbolset::has (
 const ex & e) const [inline]
```

References [s](#).

Referenced by [GiNaC::lsolve\(\)](#).

### 6.170.3 Member Data Documentation

#### 6.170.3.1 s

```
exset GiNaC::symbolset::s [private]
```

Referenced by [has\(\)](#), and [insert\\_symbols\(\)](#).

The documentation for this class was generated from the following file:

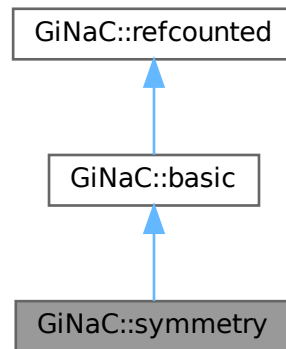
- [inifcns.cpp](#)

## 6.171 GiNaC::symmetry Class Reference

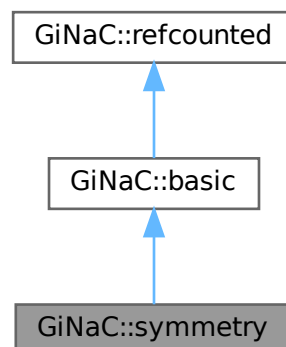
This class describes the symmetry of a group of indices.

```
#include <symmetry.h>
```

Inheritance diagram for GiNaC::symmetry:



Collaboration diagram for GiNaC::symmetry:



## Public Types

- enum `symmetry_type` { `none` , `symmetric` , `antisymmetric` , `cyclic` }  
Type of symmetry.

## Public Member Functions

- `symmetry` (unsigned i)  
Create leaf node that represents one index.
- `symmetry` (`symmetry_type` t, const `symmetry` &c1, const `symmetry` &c2)  
Create node with two children.
- void `archive` (`archive_node` &n) const override  
Save (a.k.a.
- void `read_archive` (const `archive_node` &n, `lst` &syms) override  
Read (a.k.a.
- `symmetry_type` `get_type` () const  
Get symmetry type.
- void `set_type` (`symmetry_type` t)  
Set symmetry type.
- `symmetry` & `add` (const `symmetry` &c)  
Add child node, check index sets for consistency.
- void `validate` (unsigned n)  
Verify that all indices of this node are in the range [0..n-1].
- bool `has_symmetry` () const  
Check whether this node actually represents any kind of symmetry.
- bool `has_nonsymmetric` () const  
Check whether this node involves anything non symmetric.
- bool `has_cyclic` () const  
Check whether this node involves a cyclic symmetry.

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
basic assignment operator: the other object might be of a derived class.
- virtual `basic` \* `duplicate` () const  
Create a clone of this object on the heap.
- virtual `ex` `eval` () const  
Perform automatic non-interruptive term rewriting rules.
- virtual `ex` `evalf` () const  
Evaluate object numerically.
- virtual `ex` `evalm` () const  
Evaluate sums, products and integer powers of matrices.
- virtual `ex` `eval_integ` () const  
Evaluate integrals, if result is known.
- virtual `ex` `eval_indexed` (const `basic` &i) const  
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print` (const `print_context` &c, unsigned level=0) const

- *Output to stream.*  
virtual void [dbgprint](#) () const
- *Little wrapper around print to be called within a debugger.*  
virtual void [dbgprinttree](#) () const
- *Little wrapper around printtree to be called within a debugger.*  
virtual unsigned [precedence](#) () const
- *Return relative operator precedence (for parenthezing output).*  
virtual bool [info](#) (unsigned inf) const
- *Information about the object.*  
virtual size\_t [nops](#) () const
- *Number of operands/members.*  
virtual [ex op](#) (size\_t i) const
- *Return operand/member at position i.*  
virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size\_t i) const
- virtual [ex](#) & [let\\_op](#) (size\_t i)
- *Return modifiable operand/member at position i.*  
virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size\_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned options=0) const
- *Test for occurrence of a pattern.*  
virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
- *Check whether the expression matches a given pattern.*  
virtual [ex subs](#) (const [exmap](#) &m, unsigned options=0) const
- *Substitute a set of objects by arbitrary expressions.*  
virtual [ex map](#) ([map\\_function](#) &f) const
- *Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*  
virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is\\_polynomial](#) (const [ex](#) &var) const
- *Check whether this is a polynomial in the given variables.*  
virtual int [degree](#) (const [ex](#) &s) const
- *Return degree of highest power in object s.*  
virtual int [ldegree](#) (const [ex](#) &s) const
- *Return degree of lowest power in object s.*  
virtual [ex coeff](#) (const [ex](#) &s, int n=1) const
- *Return coefficient of degree n in object s.*  
virtual [ex expand](#) (unsigned options=0) const
- *Expand expression, i.e.*  
virtual [ex collect](#) (const [ex](#) &s, bool distributed=false) const
- *Sort expanded expression in terms of powers of some object(s).*  
virtual [ex series](#) (const [relational](#) &r, int order, unsigned options=0) const
- *Default implementation of [ex::series\(\)](#).*  
virtual [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev\_lookup, [lst](#) &modifier) const
- *Default implementation of [ex::normal\(\)](#).*  
virtual [ex to\\_rational](#) ([exmap](#) &repl) const
- *Default implementation of [ex::to\\_rational\(\)](#).*  
virtual [ex to\\_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer\\_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const
- *Apply symmetric modular homomorphism to an expanded multivariate polynomial.*  
virtual [numeric max\\_coefficient](#) () const

- Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices ()` const  
*Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed (const ex &self, const ex &other)` const  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed (const ex &self, const numeric &other)` const  
*Multiply an indexed expression with a scalar.*
- virtual `bool contract_with (exvector::iterator self, exvector::iterator other, exvector &v)` const  
*Try to contract two indexed expressions that appear in the same product.*
- virtual `unsigned return_type ()` const
- virtual `return_type_t return_type_info ()` const
- virtual `ex conjugate ()` const
- virtual `ex real_part ()` const
- virtual `ex imag_part ()` const
- template<class T>  
`void print_dispatch (const print_context &c, unsigned level)` const  
*Like `print()`, but dispatch to the specified class.*
- `void print_dispatch (const registered_class_info &ri, const print_context &c, unsigned level)` const  
*Like `print()`, but dispatch to the specified class.*
- `ex subs_one_level (const exmap &m, unsigned options)` const  
*Helper function for `subs()`.*
- `ex diff (const symbol &s, unsigned nth=1)` const  
*Default interface of `nth` derivative `ex::diff(s, n)`.*
- `int compare (const basic &other)` const  
*Compare objects syntactically to establish canonical ordering.*
- `bool is_equal (const basic &other)` const  
*Test for syntactic equality.*
- `const basic & hold ()` const  
*Stop further evaluation.*
- `unsigned gethash ()` const
- `const basic & setflag (unsigned f)` const  
*Set some `status_flags`.*
- `const basic & clearflag (unsigned f)` const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted ()` noexcept
- `unsigned int add_reference ()` noexcept
- `unsigned int remove_reference ()` noexcept
- `unsigned int get_refcount ()` const noexcept
- `void set_refcount (unsigned int r)` noexcept

## Protected Member Functions

- `unsigned calchash ()` const override  
*Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.*
- `void do_print (const print_context &c, unsigned level)` const
- `void do_print_tree (const print_tree &c, unsigned level)` const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual [ex derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Private Attributes

- [symmetry\\_type](#) type  
*Type of symmetry described by this node.*
- std::set< unsigned > [indices](#)  
*Sorted union set of all indices handled by this node.*
- [exvector children](#)  
*Vector of child nodes.*

## Friends

- class [sy\\_is\\_less](#)
- class [sy\\_swap](#)
- int [canonicalize](#) (exvector::iterator v, const [symmetry](#) &symm)  
*Canonicalize the order of elements of an expression vector, according to the symmetry properties defined in a symmetry tree.*

## Additional Inherited Members

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.171.1 Detailed Description

This class describes the symmetry of a group of indices.

These objects can be grouped into a tree to form complex mixed symmetries.

### 6.171.2 Member Enumeration Documentation

#### 6.171.2.1 symmetry\_type

```
enum GiNaC::symmetry::symmetry_type
```

Type of symmetry.

Enumerator

|               |                        |
|---------------|------------------------|
| none          | no symmetry properties |
| symmetric     | totally symmetric      |
| antisymmetric | totally antisymmetric  |
| cyclic        | cyclic symmetry        |

### 6.171.3 Constructor & Destructor Documentation

#### 6.171.3.1 symmetry() [1/2]

```
GiNaC::symmetry::symmetry (
 unsigned i)
```

Create leaf node that represents one index.

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [indices](#), [none](#), [GiNaC::basic::setflag\(\)](#), [symmetry\(\)](#), and [type](#).

Referenced by [add\(\)](#), [canonicalize](#), [sy\\_swap](#), [symmetry\(\)](#), and [symmetry\(\)](#).

#### 6.171.3.2 symmetry() [2/2]

```
GiNaC::symmetry::symmetry (
 symmetry_type t,
 const symmetry & c1,
 const symmetry & c2)
```

Create node with two children.

References [add\(\)](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), [symmetry\(\)](#), and [type](#).

## 6.171.4 Member Function Documentation

### 6.171.4.1 archive()

```
void GiNaC::symmetry::archive (
 archive_node & n) const [override], [virtual]
```

Save (a.k.a.

Archive the object.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::add\\_ex\(\)](#), [GiNaC::archive\\_node::add\\_unsigned\(\)](#), [children](#), [indices](#), and [type](#).

### 6.171.4.2 read\_archive()

```
void GiNaC::symmetry::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Read (a.k.a.

Construct object from [archive\\_node](#).

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [add\(\)](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::archive\\_node::find\\_ex\(\)](#), [GiNaC::archive\\_node::find\\_unsigned\(\)](#), [indices](#), and [type](#).

### 6.171.4.3 calchash()

```
unsigned GiNaC::symmetry::calchash () const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [children](#), [GiNaC::status\\_flags::evaluated](#), [GiNaC::basic::flags](#), [GiNaC::status\\_flags::hash\\_calculated](#), [GiNaC::basic::hashvalue](#), [indices](#), [GiNaC::make\\_hash\\_seed\(\)](#), [none](#), [GiNaC::rotate\\_left\(\)](#), [GiNaC::basic::setflag\(\)](#), and [type](#).



#### 6.171.4.4 get\_type()

```
symmetry_type GiNaC::symmetry::get_type () const [inline]
```

Get symmetry type.

References [type](#).

#### 6.171.4.5 set\_type()

```
void GiNaC::symmetry::set_type (
 symmetry_type t) [inline]
```

Set symmetry type.

References [type](#).

Referenced by [GiNaC::sy\\_anti\(\)](#), [GiNaC::sy\\_cycl\(\)](#), and [GiNaC::sy\\_symm\(\)](#).

#### 6.171.4.6 add()

```
symmetry & GiNaC::symmetry::add (
 const symmetry & c)
```

Add child node, check index sets for consistency.

References [children](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [indices](#), [GiNaC::is\\_exactly\\_a\(\)](#), [none](#), [symmetry\(\)](#), and [type](#).

Referenced by [read\\_archive\(\)](#), [GiNaC::sy\\_anti\(\)](#), [GiNaC::sy\\_anti\(\)](#), [GiNaC::sy\\_cycl\(\)](#), [GiNaC::sy\\_cycl\(\)](#), [GiNaC::sy\\_none\(\)](#), [GiNaC::sy\\_none\(\)](#), [GiNaC::sy\\_symm\(\)](#), [GiNaC::sy\\_symm\(\)](#), [symmetry\(\)](#), and [validate\(\)](#).

#### 6.171.4.7 validate()

```
void GiNaC::symmetry::validate (
 unsigned n)
```

Verify that all indices of this node are in the range [0..n-1].

This function throws an exception if the verification fails. If the top node has a type != none and no children, add all indices in the range [0..n-1] as children.

References [add\(\)](#), [indices](#), [none](#), and [type](#).

#### 6.171.4.8 has\_symmetry()

```
bool GiNaC::symmetry::has_symmetry () const [inline]
```

Check whether this node actually represents any kind of symmetry.

References [children](#), [none](#), and [type](#).

**6.171.4.9 has\_nonsymmetric()**

```
bool GiNaC::symmetry::has_nonsymmetric () const
```

Check whether this node involves anything non symmetric.

References [antisymmetric](#), [children](#), [cyclic](#), [GiNaC::ex\\_to\(\)](#), [has\\_nonsymmetric\(\)](#), and [type](#).

Referenced by [has\\_nonsymmetric\(\)](#).

**6.171.4.10 has\_cyclic()**

```
bool GiNaC::symmetry::has_cyclic () const
```

Check whether this node involves a cyclic symmetry.

References [children](#), [cyclic](#), [GiNaC::ex\\_to\(\)](#), [has\\_cyclic\(\)](#), and [type](#).

Referenced by [has\\_cyclic\(\)](#).

**6.171.4.11 do\_print()**

```
void GiNaC::symmetry::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [antisymmetric](#), [children](#), [cyclic](#), [indices](#), [none](#), [GiNaC::print\\_context::s](#), [symmetric](#), and [type](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.171.4.12 do\_print\_tree()**

```
void GiNaC::symmetry::do_print_tree (
 const print_tree & c,
 unsigned level) const [protected]
```

References [antisymmetric](#), [children](#), [cyclic](#), [GiNaC::print\\_tree::delta\\_indent](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [indices](#), [none](#), [GiNaC::print\\_context::s](#), [symmetric](#), and [type](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

**6.171.5 Friends And Related Symbol Documentation****6.171.5.1 sy\_is\_less**

```
friend class sy_is_less [friend]
```

References [sy\\_is\\_less](#).

Referenced by [canonicalize](#), and [sy\\_is\\_less](#).

### 6.171.5.2 sy\_swap

```
friend class sy_swap [friend]
```

References [GiNaC::basic::basic\(\)](#), [sy\\_swap](#), [GiNaC::symm\(\)](#), and [symmetry\(\)](#).

Referenced by [canonicalize](#), and [sy\\_swap](#).

### 6.171.5.3 canonicalize

```
int canonicalize (
 exvector::iterator v,
 const symmetry & symm) [friend]
```

Canonicalize the order of elements of an expression vector, according to the symmetry properties defined in a symmetry tree.

#### Parameters

|             |                            |
|-------------|----------------------------|
| <i>v</i>    | Start of expression vector |
| <i>symm</i> | Root node of symmetry tree |

#### Returns

the overall sign introduced by the reordering (+1, -1 or 0) or `numeric_limits<int>::max()` if nothing changed

References [antisymmetric](#), [GiNaC::canonicalize\(\)](#), [GiNaC::class\\_info< OPT >::first](#), [cyclic](#), [GiNaC::cyclic\\_permutation\(\)](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::permutation\\_sign\(\)](#), [GiNaC::shaker\\_sort\(\)](#), [sy\\_is\\_less](#), [sy\\_swap](#), [GiNaC::symm\(\)](#), [symmetric](#), and [symmetry\(\)](#).

## 6.171.6 Member Data Documentation

### 6.171.6.1 type

```
symmetry_type GiNaC::symmetry::type [private]
```

Type of symmetry described by this node.

Referenced by [add\(\)](#), [archive\(\)](#), [calchash\(\)](#), [do\\_print\(\)](#), [do\\_print\\_tree\(\)](#), [get\\_type\(\)](#), [has\\_cyclic\(\)](#), [has\\_nonsymmetric\(\)](#), [has\\_symmetry\(\)](#), [read\\_archive\(\)](#), [set\\_type\(\)](#), [symmetry\(\)](#), [symmetry\(\)](#), and [validate\(\)](#).

### 6.171.6.2 indices

```
std::set<unsigned> GiNaC::symmetry::indices [private]
```

Sorted union set of all indices handled by this node.

Referenced by [add\(\)](#), [archive\(\)](#), [calchash\(\)](#), [do\\_print\(\)](#), [do\\_print\\_tree\(\)](#), [read\\_archive\(\)](#), [symmetry\(\)](#), and [validate\(\)](#).

### 6.171.6.3 children

`exvector` `GiNaC::symmetry::children` [private]

Vector of child nodes.

Referenced by [add\(\)](#), [archive\(\)](#), [calchash\(\)](#), [do\\_print\(\)](#), [do\\_print\\_tree\(\)](#), [has\\_cyclic\(\)](#), [has\\_nonsymmetric\(\)](#), and [has\\_symmetry\(\)](#).

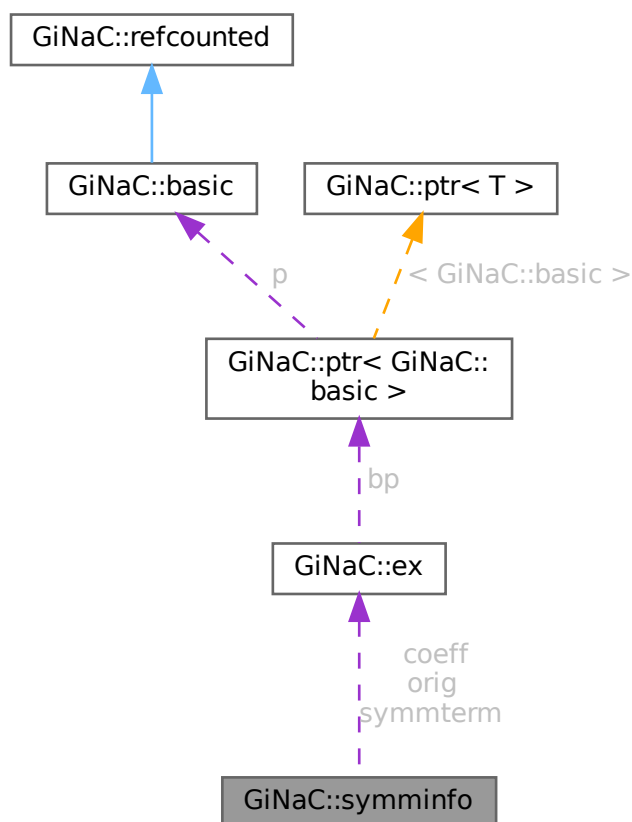
The documentation for this class was generated from the following files:

- [symmetry.h](#)
- [symmetry.cpp](#)

## 6.172 GiNaC::symminfo Class Reference

This structure stores the individual symmetrized terms obtained during the simplification of sums.

Collaboration diagram for `GiNaC::symminfo`:



## Public Member Functions

- [symminfo](#) ()
- [symminfo](#) (const [ex](#) &symmterm\_, const [ex](#) &orig\_, size\_t num\_)

## Public Attributes

- [ex symmterm](#)  
*symmetrized term*
- [ex coeff](#)  
*coefficient of symmetrized term*
- [ex orig](#)  
*original term*
- [size\\_t num](#)  
*how many symmetrized terms resulted from the original term*

### 6.172.1 Detailed Description

This structure stores the individual symmetrized terms obtained during the simplification of sums.

### 6.172.2 Constructor & Destructor Documentation

#### 6.172.2.1 [symminfo](#)() [1/2]

```
GiNaC::symminfo::symminfo () [inline]
```

References [num](#).

#### 6.172.2.2 [symminfo](#)() [2/2]

```
GiNaC::symminfo::symminfo (
 const ex & symmterm_,
 const ex & orig_,
 size_t num_) [inline]
```

References [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::ex::nops\(\)](#), [num](#), [GiNaC::ex::op\(\)](#), and [orig](#).

### 6.172.3 Member Data Documentation

#### 6.172.3.1 [symmterm](#)

```
ex GiNaC::symminfo::symmterm
```

symmetrized term

Referenced by [GiNaC::symminfo\\_is\\_less\\_by\\_symmterm::operator\(\)\(\)](#).

### 6.172.3.2 `coeff`

`ex` `GiNaC::symminfo::coeff`

coefficient of symmetrized term

### 6.172.3.3 `orig`

`ex` `GiNaC::symminfo::orig`

original term

Referenced by [GiNaC::symminfo\\_is\\_less\\_by\\_orig::operator\(\)\(\)](#), and [symminfo\(\)](#).

### 6.172.3.4 `num`

`size_t` `GiNaC::symminfo::num`

how many symmetrized terms resulted from the original term

Referenced by [symminfo\(\)](#), and [symminfo\(\)](#).

The documentation for this class was generated from the following file:

- [indexed.cpp](#)

## 6.173 `GiNaC::symminfo_is_less_by_orig` Class Reference

### Public Member Functions

- `bool operator()` (const [symminfo](#) &si1, const [symminfo](#) &si2) const

### 6.173.1 Member Function Documentation

#### 6.173.1.1 `operator()()`

```
bool GiNaC::symminfo_is_less_by_orig::operator() (
 const symminfo & si1,
 const symminfo & si2) const [inline]
```

References [GiNaC::ex::compare\(\)](#), and [GiNaC::symminfo::orig](#).

The documentation for this class was generated from the following file:

- [indexed.cpp](#)

## 6.174 GiNaC::symminfo\_is\_less\_by\_symmterm Class Reference

### Public Member Functions

- bool [operator\(\)](#) (const [symminfo](#) &si1, const [symminfo](#) &si2) const

### 6.174.1 Member Function Documentation

#### 6.174.1.1 operator>()

```
bool GiNaC::symminfo_is_less_by_symmterm::operator() (
 const symminfo & si1,
 const symminfo & si2) const [inline]
```

References [GiNaC::ex::compare\(\)](#), and [GiNaC::symminfo::symmterm](#).

The documentation for this class was generated from the following file:

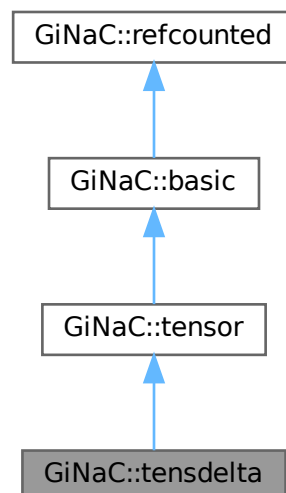
- [indexed.cpp](#)

## 6.175 GiNaC::tensdelta Class Reference

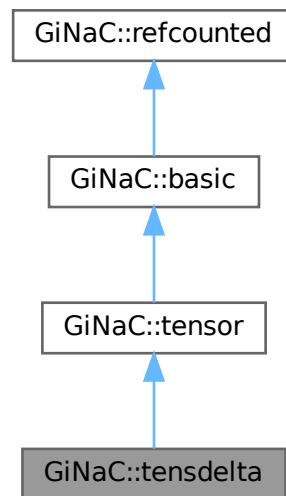
This class represents the delta tensor.

```
#include <tensor.h>
```

Inheritance diagram for GiNaC::tensdelta:



Collaboration diagram for `GiNaC::tensdelta`:



### Public Member Functions

- `bool info` (unsigned int) const override  
*Information about the object.*
- `ex eval_indexed` (const `basic` &i) const override  
*Automatic symbolic evaluation of an indexed delta tensor.*
- `bool contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const override  
*Contraction of an indexed delta tensor with something else.*

### Public Member Functions inherited from `GiNaC::tensor`

- `bool replace_contr_index` (exvector::iterator self, exvector::iterator other) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).*

### Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic` \* `duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*



- virtual `ex evalf ()` const  
*Evaluate object numerically.*
- virtual `ex evalm ()` const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ ()` const  
*Evaluate integrals, if result is known.*
- virtual void `print (const print_context &c, unsigned level=0)` const  
*Output to stream.*
- virtual void `dbgprint ()` const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprintree ()` const  
*Little wrapper around printree to be called within a debugger.*
- virtual unsigned `precedence ()` const  
*Return relative operator precedence (for parenthezing output).*
- virtual `size_t nops ()` const  
*Number of operands/members.*
- virtual `ex op (size_t i)` const  
*Return operand/member at position i.*
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex & let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual bool `has (const ex &other, unsigned options=0)` const  
*Test for occurrence of a pattern.*
- virtual bool `match (const ex &pattern, exmap &repls)` const  
*Check whether the expression matches a given pattern.*
- virtual `ex subs (const exmap &m, unsigned options=0)` const  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map (map_function &f)` const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept (GiNaC::visitor &v)` const
- virtual bool `is_polynomial (const ex &var)` const  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree (const ex &s)` const  
*Return degree of highest power in object s.*
- virtual int `ldegree (const ex &s)` const  
*Return degree of lowest power in object s.*
- virtual `ex coeff (const ex &s, int n=1)` const  
*Return coefficient of degree n in object s.*
- virtual `ex expand (unsigned options=0)` const  
*Expand expression, i.e.*
- virtual `ex collect (const ex &s, bool distributed=false)` const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series (const relational &r, int order, unsigned options=0)` const  
*Default implementation of `ex::series()`.*
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier)` const  
*Default implementation of `ex::normal()`.*
- virtual `ex to_rational (exmap &repl)` const  
*Default implementation of `ex::to_rational()`.*

- virtual [ex to\\_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer\\_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual [numeric max\\_coefficient](#) () const  
*Implementation [ex::max\\_coefficient\(\)](#).*
- virtual [exvector get\\_free\\_indices](#) () const  
*Return a vector containing the free indices of an expression.*
- virtual [ex add\\_indexed](#) (const [ex](#) &self, const [ex](#) &other) const  
*Add two indexed expressions.*
- virtual [ex scalar\\_mul\\_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const  
*Multiply an indexed expression with a scalar.*
- virtual [return\\_type\\_t return\\_type\\_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real\\_part](#) () const
- virtual [ex imag\\_part](#) () const
- template<class T>  
void [print\\_dispatch](#) (const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- void [print\\_dispatch](#) (const [registered\\_class\\_info](#) &ri, const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- virtual void [archive](#) ([archive\\_node](#) &n) const  
*Save (serialize) the object into archive node.*
- virtual void [read\\_archive](#) (const [archive\\_node](#) &n, [lst](#) &syms)  
*Load (deserialize) the object from an archive node.*
- [ex subs\\_one\\_level](#) (const [exmap](#) &m, unsigned options) const  
*Helper function for [subs\(\)](#).*
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const  
*Default interface of nth derivative [ex::diff\(s, n\)](#).*
- int [compare](#) (const [basic](#) &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool [is\\_equal](#) (const [basic](#) &other) const  
*Test for syntactic equality.*
- const [basic](#) & [hold](#) () const  
*Stop further evaluation.*
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const  
*Set some [status\\_flags](#).*
- const [basic](#) & [clearflag](#) (unsigned f) const  
*Clear some [status\\_flags](#).*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Member Functions

- unsigned [return\\_type](#) () const override
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_latex](#) (const [print\\_latex](#) &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::tensor](#)

- unsigned [return\\_type](#) () const override

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual [ex derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Additional Inherited Members

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.175.1 Detailed Description

This class represents the delta tensor.

If indexed, it must have exactly two indices of the same type.

## 6.175.2 Member Function Documentation

### 6.175.2.1 info()

```
bool GiNaC::tensdelta::info (
 unsigned int) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::basic](#).

References [info\(\)](#), and [GiNaC::info\\_flags::real](#).

Referenced by [info\(\)](#).

### 6.175.2.2 eval\_indexed()

```
ex GiNaC::tensdelta::eval_indexed (
 const basic & i) const [override], [virtual]
```

Automatic symbolic evaluation of an indexed delta tensor.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::\\_ex1](#), [eval\\_indexed\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::idx::get\\_dim\(\)](#), [GiNaC::idx::get\\_value\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::info\\_flags::integer](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_dummy\\_pair\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::idx::minimal\\_dim\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::idx::replace\\_dim\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [eval\\_indexed\(\)](#).

### 6.175.2.3 contract\_with()

```
bool GiNaC::tensdelta::contract_with (
 exvector::iterator self,
 exvector::iterator other,
 exvector & v) const [override], [virtual]
```

Contraction of an indexed delta tensor with something else.

Reimplemented from [GiNaC::basic](#).

References [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), and [GiNaC::tensor::replace\\_contr\\_index\(\)](#).

### 6.175.2.4 return\_type()

```
unsigned GiNaC::tensdelta::return_type () const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::commutative](#).

### 6.175.2.5 do\_print()

```
void GiNaC::tensdelta::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

### 6.175.2.6 do\_print\_latex()

```
void GiNaC::tensdelta::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

The documentation for this class was generated from the following files:

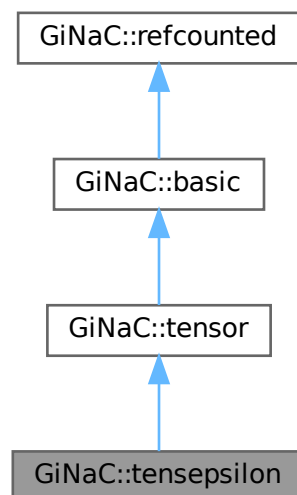
- [tensor.h](#)
- [tensor.cpp](#)

## 6.176 GiNaC::tensepsilon Class Reference

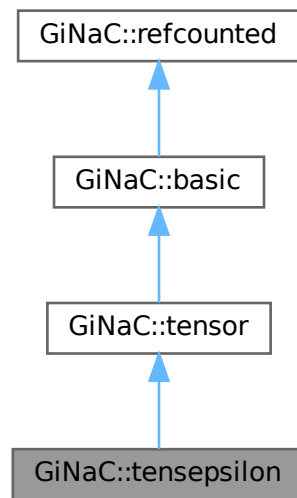
This class represents the totally antisymmetric epsilon tensor.

```
#include <tensor.h>
```

Inheritance diagram for GiNaC::tensepsilon:



Collaboration diagram for `GiNaC::tensepsilon`:



### Public Member Functions

- `tensepsilon` (bool `minkowski`, bool `pos_sig`)
- bool `info` (unsigned `inf`) const override  
*Information about the object.*
- `ex eval_indexed` (const `basic` &`i`) const override  
*Automatic symbolic evaluation of an indexed epsilon tensor.*
- bool `contract_with` (exvector::iterator `self`, exvector::iterator `other`, `exvector` &`v`) const override  
*Contraction of epsilon tensor with something else.*
- void `archive` (`archive_node` &`n`) const override  
*Save (a.k.a.*
- void `read_archive` (const `archive_node` &`n`, `lst` &`syms`) override  
*Read (a.k.a.*

### Public Member Functions inherited from `GiNaC::tensor`

- bool `replace_contr_index` (exvector::iterator `self`, exvector::iterator `other`) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions.*

### Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic` (const `basic` &`other`)
- const `basic` & `operator=` (const `basic` &`other`)

- basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate () const`  
*Create a clone of this object on the heap.*
- virtual `ex eval () const`  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf () const`  
*Evaluate object numerically.*
- virtual `ex evalm () const`  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ () const`  
*Evaluate integrals, if result is known.*
- virtual `void print (const print_context &c, unsigned level=0) const`  
*Output to stream.*
- virtual `void dbgprint () const`  
*Little wrapper around print to be called within a debugger.*
- virtual `void dbgprinttree () const`  
*Little wrapper around printtree to be called within a debugger.*
- virtual `unsigned precedence () const`  
*Return relative operator precedence (for parenthezing output).*
- virtual `size_t nops () const`  
*Number of operands/members.*
- virtual `ex op (size_t i) const`  
*Return operand/member at position i.*
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`
- virtual `ex & let_op (size_t i)`  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual `bool has (const ex &other, unsigned options=0) const`  
*Test for occurrence of a pattern.*
- virtual `bool match (const ex &pattern, exmap &repls) const`  
*Check whether the expression matches a given pattern.*
- virtual `ex subs (const exmap &m, unsigned options=0) const`  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map (map_function &f) const`  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual `void accept (GiNaC::visitor &v) const`
- virtual `bool is_polynomial (const ex &var) const`  
*Check whether this is a polynomial in the given variables.*
- virtual `int degree (const ex &s) const`  
*Return degree of highest power in object s.*
- virtual `int ldegree (const ex &s) const`  
*Return degree of lowest power in object s.*
- virtual `ex coeff (const ex &s, int n=1) const`  
*Return coefficient of degree n in object s.*
- virtual `ex expand (unsigned options=0) const`  
*Expand expression, i.e.*
- virtual `ex collect (const ex &s, bool distributed=false) const`  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series (const relational &r, int order, unsigned options=0) const`

- *Default implementation of `ex::series()`.*
- virtual `ex normal` (`exmap &repl`, `exmap &rev_lookup`, `lst &modifier`) const
- *Default implementation of `ex::normal()`.*
- virtual `ex to_rational` (`exmap &repl`) const
- *Default implementation of `ex::to_rational()`.*
- virtual `ex to_polynomial` (`exmap &repl`) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric &xi`) const
- *Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const
- *Implementation `ex::max_coefficient()`.*
- virtual `exvector get_free_indices` () const
- *Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed` (const `ex &self`, const `ex &other`) const
- *Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex &self`, const `numeric &other`) const
- *Multiply an indexed expression with a scalar.*
- virtual `return_type_t return_type_info` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T>
- void `print_dispatch` (const `print_context &c`, unsigned level) const
- *Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info &ri`, const `print_context &c`, unsigned level) const
- *Like `print()`, but dispatch to the specified class.*
- `ex subs_one_level` (const `exmap &m`, unsigned options) const
- *Helper function for `subs()`.*
- `ex diff` (const `symbol &s`, unsigned nth=1) const
- *Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic &other`) const
- *Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic &other`) const
- *Test for syntactic equality.*
- const `basic &hold` () const
- *Stop further evaluation.*
- unsigned `gethash` () const
- const `basic &setflag` (unsigned f) const
- *Set some `status_flags`.*
- const `basic &clearflag` (unsigned f) const
- *Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept



## Protected Member Functions

- unsigned [return\\_type](#) () const override
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_latex](#) (const [print\\_latex](#) &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::tensor](#)

- unsigned [return\\_type](#) () const override

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual [ex derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Private Attributes

- bool [minkowski](#)  
*If true, tensor is in Minkowski-type space.*
- bool [pos\\_sig](#)  
*If true, the metric is assumed to be  $\text{diag}(-1, 1, 1 \dots)$ .*

## Additional Inherited Members

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.176.1 Detailed Description

This class represents the totally antisymmetric epsilon tensor.

If indexed, all indices must be of the same type and their number must be equal to the dimension of the index space.

### 6.176.2 Constructor & Destructor Documentation

#### 6.176.2.1 `tensepsilon()`

```
GiNaC::tensepsilon::tensepsilon (
 bool minkowski,
 bool pos_sig)
```

References [minkowski](#), and [pos\\_sig](#).

### 6.176.3 Member Function Documentation

#### 6.176.3.1 `info()`

```
bool GiNaC::tensepsilon::info (
 unsigned inf) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info\\_flags::real](#).

#### 6.176.3.2 `eval_indexed()`

```
ex GiNaC::tensepsilon::eval_indexed (
 const basic & i) const [override], [virtual]
```

Automatic symbolic evaluation of an indexed epsilon tensor.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex0](#), [GiNaC::ex\\_to\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_zero\(\)](#), [minkowski](#), [GiNaC::info\\_flags::nonnegint](#), [GiNaC::basic::nops\(\)](#), [GiNaC::basic::op\(\)](#), [GiNaC::permutation\\_sign\(\)](#), and [pos\\_sig](#).

### 6.176.3.3 contract\_with()

```
bool GiNaC::tensepsilon::contract_with (
 exvector::iterator self,
 exvector::iterator other,
 exvector & v) const [override], [virtual]
```

Contraction of epsilon tensor with something else.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::\\_ex1](#), [GiNaC::delta\\_tensor\(\)](#), [GiNaC::matrix::determinant\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_exactly\\_a\(\)](#), [GiNaC::lorentz\\_g\(\)](#), [GiNaC::metric\\_tensor\(\)](#), [minkowski](#), [pos\\_sig](#), and [GiNaC::ex::simplify\\_indexed\(\)](#).

### 6.176.3.4 archive()

```
void GiNaC::tensepsilon::archive (
 archive_node & n) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::add\\_bool\(\)](#), [minkowski](#), and [pos\\_sig](#).

### 6.176.3.5 read\_archive()

```
void GiNaC::tensepsilon::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::find\\_bool\(\)](#), [minkowski](#), and [pos\\_sig](#).

### 6.176.3.6 return\_type()

```
unsigned GiNaC::tensepsilon::return_type () const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::commutative](#).

### 6.176.3.7 do\_print()

```
void GiNaC::tensepsilon::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

### 6.176.3.8 do\_print\_latex()

```
void GiNaC::tensepsilon::do_print_latex (
 const print_latex & c,
 unsigned level) const [protected]
```

## 6.176.4 Member Data Documentation

### 6.176.4.1 minkowski

```
bool GiNaC::tensepsilon::minkowski [private]
```

If true, tensor is in Minkowski-type space.

Otherwise it is in a Euclidean space.

Referenced by [archive\(\)](#), [contract\\_with\(\)](#), [eval\\_indexed\(\)](#), [read\\_archive\(\)](#), and [tensepsilon\(\)](#).

### 6.176.4.2 pos\_sig

```
bool GiNaC::tensepsilon::pos_sig [private]
```

If true, the metric is assumed to be  $\text{diag}(-1, 1, 1, \dots)$ .

Otherwise it is  $\text{diag}(1, -1, -1, \dots)$ . This is only relevant if `minkowski = true`.

Referenced by [archive\(\)](#), [contract\\_with\(\)](#), [eval\\_indexed\(\)](#), [read\\_archive\(\)](#), and [tensepsilon\(\)](#).

The documentation for this class was generated from the following files:

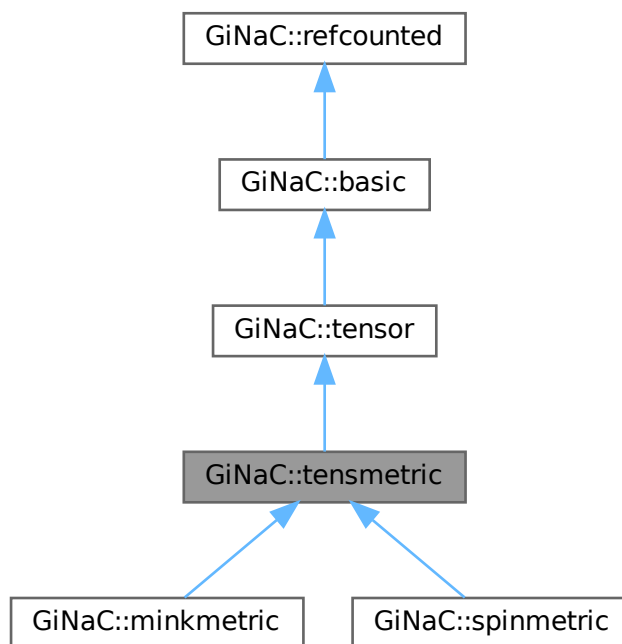
- [tensor.h](#)
- [tensor.cpp](#)

## 6.177 GiNaC::tensmetric Class Reference

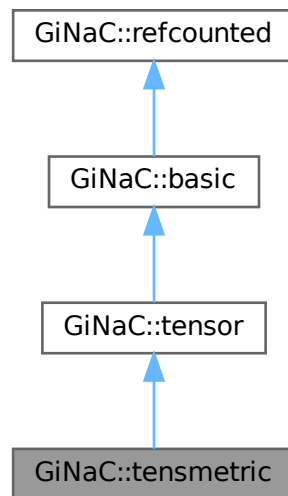
This class represents a general metric tensor which can be used to raise/lower indices.

```
#include <tensor.h>
```

Inheritance diagram for GiNaC::tensmetric:



Collaboration diagram for `GiNaC::tensmetric`:



### Public Member Functions

- `bool info` (unsigned int) const override  
*Information about the object.*
- `ex eval_indexed` (const `basic` &i) const override  
*Automatic symbolic evaluation of an indexed metric tensor.*
- `bool contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const override  
*Contraction of an indexed metric tensor with something else.*

### Public Member Functions inherited from `GiNaC::tensor`

- `bool replace_contr_index` (exvector::iterator self, exvector::iterator other) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).*

### Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*

- virtual `ex evalf` () const  
*Evaluate object numerically.*
- virtual `ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprintree` () const  
*Little wrapper around printree to be called within a debugger.*
- virtual unsigned `precedence` () const  
*Return relative operator precedence (for parenthezing output).*
- virtual size\_t `nops` () const  
*Number of operands/members.*
- virtual `ex op` (size\_t i) const  
*Return operand/member at position i.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex & let_op` (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const  
*Check whether the expression matches a given pattern.*
- virtual `ex subs` (const `exmap` &m, unsigned options=0) const  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map` (`map_function` &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const  
*Return degree of highest power in object s.*
- virtual int `ldegree` (const `ex` &s) const  
*Return degree of lowest power in object s.*
- virtual `ex coeff` (const `ex` &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual `ex expand` (unsigned options=0) const  
*Expand expression, i.e.*
- virtual `ex collect` (const `ex` &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series` (const `relational` &r, int order, unsigned options=0) const  
*Default implementation of `ex::series()`.*
- virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const  
*Default implementation of `ex::normal()`.*
- virtual `ex to_rational` (`exmap` &repl) const  
*Default implementation of `ex::to_rational()`.*

- virtual [ex to\\_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer\\_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual [numeric max\\_coefficient](#) () const  
*Implementation [ex::max\\_coefficient\(\)](#).*
- virtual [exvector get\\_free\\_indices](#) () const  
*Return a vector containing the free indices of an expression.*
- virtual [ex add\\_indexed](#) (const [ex](#) &self, const [ex](#) &other) const  
*Add two indexed expressions.*
- virtual [ex scalar\\_mul\\_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const  
*Multiply an indexed expression with a scalar.*
- virtual [return\\_type\\_t return\\_type\\_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real\\_part](#) () const
- virtual [ex imag\\_part](#) () const
- template<class T>  
void [print\\_dispatch](#) (const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- void [print\\_dispatch](#) (const [registered\\_class\\_info](#) &ri, const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- virtual void [archive](#) ([archive\\_node](#) &n) const  
*Save (serialize) the object into archive node.*
- virtual void [read\\_archive](#) (const [archive\\_node](#) &n, [lst](#) &syms)  
*Load (deserialize) the object from an archive node.*
- [ex subs\\_one\\_level](#) (const [exmap](#) &m, unsigned options) const  
*Helper function for [subs\(\)](#).*
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const  
*Default interface of nth derivative [ex::diff\(s, n\)](#).*
- int [compare](#) (const [basic](#) &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool [is\\_equal](#) (const [basic](#) &other) const  
*Test for syntactic equality.*
- const [basic](#) & [hold](#) () const  
*Stop further evaluation.*
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const  
*Set some [status\\_flags](#).*
- const [basic](#) & [clearflag](#) (unsigned f) const  
*Clear some [status\\_flags](#).*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept



**Protected Member Functions**

- unsigned [return\\_type](#) () const override
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const

**Protected Member Functions inherited from [GiNaC::tensor](#)**

- unsigned [return\\_type](#) () const override

**Protected Member Functions inherited from [GiNaC::basic](#)**

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual [ex derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

**Additional Inherited Members****Protected Attributes inherited from [GiNaC::basic](#)**

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

**6.177.1 Detailed Description**

This class represents a general metric tensor which can be used to raise/lower indices.

If indexed, it must have exactly two indices of the same type which must be of class `varidx` or a subclass.

## 6.177.2 Member Function Documentation

### 6.177.2.1 info()

```
bool GiNaC::tensmetric::info (
 unsigned inf) const [override], [virtual]
```

Information about the object.

See also

class [info\\_flags](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info\\_flags::real](#).

### 6.177.2.2 eval\_indexed()

```
ex GiNaC::tensmetric::eval_indexed (
 const basic & i) const [override], [virtual]
```

Automatic symbolic evaluation of an indexed metric tensor.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::delta\\_tensor\(\)](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::idx::get\\_dim\(\)](#), [GINAC\\_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::varidx::is\\_covariant\(\)](#), [GiNaC::ex::is\\_equal\(\)](#), [GiNaC::idx::minimal\\_dim\(\)](#), [GiNaC::subs\\_options::no\\_pattern](#), [GiNaC::basic::nops\(\)](#), [GiNaC::basic::op\(\)](#), [GiNaC::idx::replace\\_dim\(\)](#), and [GiNaC::basic::subs\(\)](#).

### 6.177.2.3 contract\_with()

```
bool GiNaC::tensmetric::contract_with (
 exvector::iterator self,
 exvector::iterator other,
 exvector & v) const [override], [virtual]
```

Contraction of an indexed metric tensor with something else.

Reimplemented from [GiNaC::basic](#).

References [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), and [GiNaC::tensor::replace\\_contr\\_index\(\)](#).

### 6.177.2.4 return\_type()

```
unsigned GiNaC::tensmetric::return_type () const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::commutative](#).

## 6.177.2.5 do\_print()

```
void GiNaC::tensmetric::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

The documentation for this class was generated from the following files:

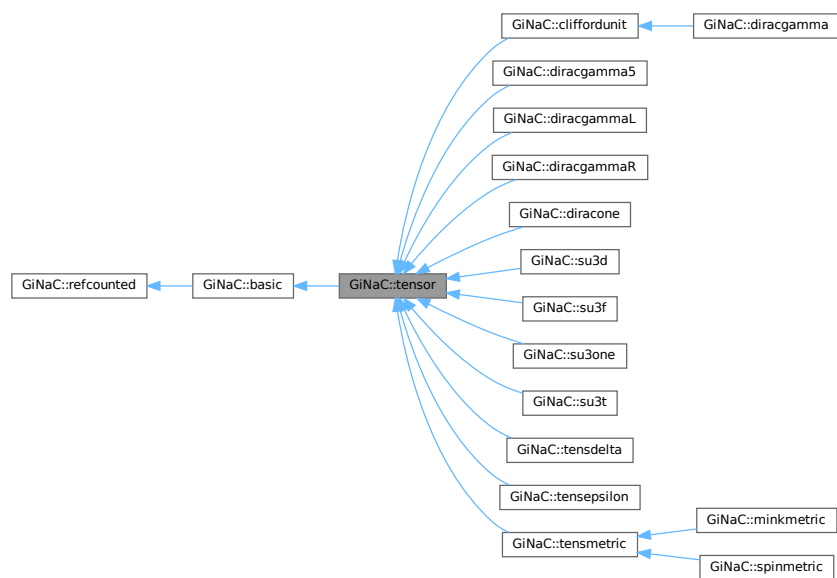
- [tensor.h](#)
- [tensor.cpp](#)

## 6.178 GiNaC::tensor Class Reference

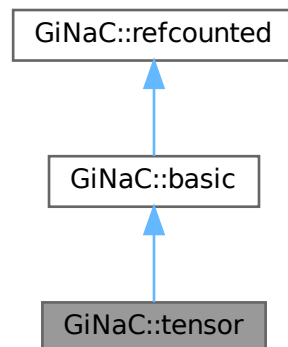
This class holds one of [GiNaC](#)'s predefined special tensors such as the delta and the metric tensors.

```
#include <tensor.h>
```

Inheritance diagram for GiNaC::tensor:



Collaboration diagram for `GiNaC::tensor`:



## Public Member Functions

- bool `replace_contr_index` (exvector::iterator self, exvector::iterator other) const  
*Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).*

## Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic` \* `duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf` () const  
*Evaluate object numerically.*
- virtual `ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree` () const  
*Little wrapper around printtree to be called within a debugger.*

- virtual unsigned [precedence](#) () const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool [info](#) (unsigned inf) const  
*Information about the object.*
- virtual size\_t [nops](#) () const  
*Number of operands/members.*
- virtual [ex op](#) (size\_t i) const  
*Return operand/member at position i.*
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size\_t i) const
- virtual [ex](#) & [let\\_op](#) (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size\_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const  
*Check whether the expression matches a given pattern.*
- virtual [ex subs](#) (const [exmap](#) &m, unsigned options=0) const  
*Substitute a set of objects by arbitrary expressions.*
- virtual [ex map](#) ([map\\_function](#) &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is\\_polynomial](#) (const [ex](#) &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int [degree](#) (const [ex](#) &s) const  
*Return degree of highest power in object s.*
- virtual int [ldegree](#) (const [ex](#) &s) const  
*Return degree of lowest power in object s.*
- virtual [ex coeff](#) (const [ex](#) &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual [ex expand](#) (unsigned options=0) const  
*Expand expression, i.e.*
- virtual [ex collect](#) (const [ex](#) &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual [ex series](#) (const [relational](#) &r, int order, unsigned options=0) const  
*Default implementation of [ex::series\(\)](#).*
- virtual [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev\_lookup, [lst](#) &modifier) const  
*Default implementation of [ex::normal\(\)](#).*
- virtual [ex to\\_rational](#) ([exmap](#) &repl) const  
*Default implementation of [ex::to\\_rational\(\)](#).*
- virtual [ex to\\_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer\\_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual [numeric max\\_coefficient](#) () const  
*Implementation [ex::max\\_coefficient\(\)](#).*
- virtual [exvector get\\_free\\_indices](#) () const  
*Return a vector containing the free indices of an expression.*
- virtual [ex add\\_indexed](#) (const [ex](#) &self, const [ex](#) &other) const  
*Add two indexed expressions.*

- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T>  
void `print_dispatch` (const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const  
*Like `print()`, but dispatch to the specified class.*
- virtual void `archive` (`archive_node` &n) const  
*Save (serialize) the object into archive node.*
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)  
*Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- const `basic` & `hold` () const  
*Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const  
*Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- unsigned `return_type` () const override

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual [ex derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Additional Inherited Members

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.178.1 Detailed Description

This class holds one of [GiNaC](#)'s predefined special tensors such as the delta and the metric tensors.

They are represented without indices. To attach indices to them, wrap them in an object of class [indexed](#).

### 6.178.2 Member Function Documentation

#### 6.178.2.1 [return\\_type\(\)](#)

```
unsigned GiNaC::tensor::return_type () const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return\\_types::noncommutative\\_composite](#).

### 6.178.2.2 `replace_contr_index()`

```
bool GiNaC::tensor::replace_contr_index (
 exvector::iterator self,
 exvector::iterator other) const
```

Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

References [GiNaC::\\_ex1](#), [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), [GiNaC::is\\_a\(\)](#), [GiNaC::is\\_dummy\\_pair\(\)](#), [GiNaC::idx::is\\_symbolic\(\)](#), [GiNaC::idx::minimal\\_dim\(\)](#), [GiNaC::idx::replace\\_dim\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [GiNaC::tensdelta::contract\\_with\(\)](#), and [GiNaC::tensmetric::contract\\_with\(\)](#).

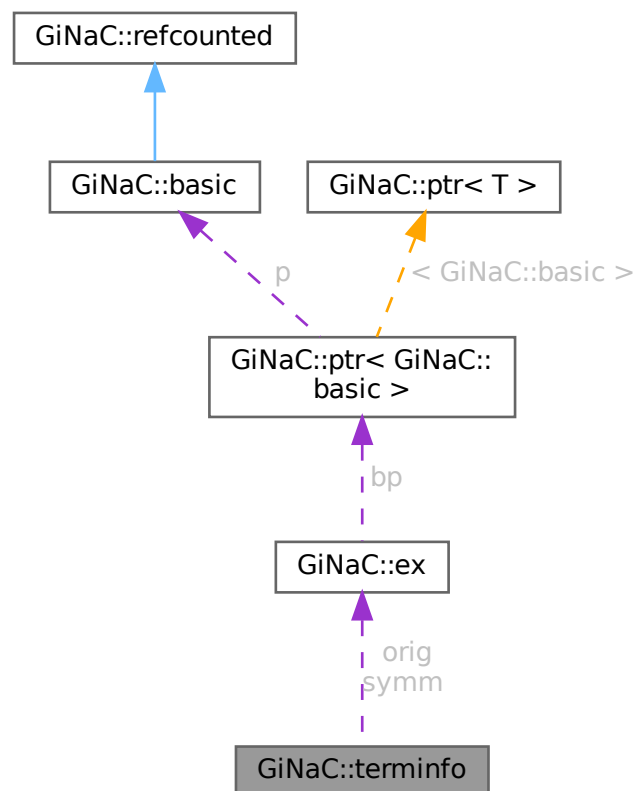
The documentation for this class was generated from the following files:

- [tensor.h](#)
- [tensor.cpp](#)

## 6.179 GiNaC::terminfo Class Reference

This structure stores the original and symmetrized versions of terms obtained during the simplification of sums.

Collaboration diagram for GiNaC::terminfo:





## Public Member Functions

- [terminfo](#) (const [ex](#) &orig\_, const [ex](#) &symm\_)

## Public Attributes

- [ex orig](#)  
*original term*
- [ex symm](#)  
*symmetrized term*

### 6.179.1 Detailed Description

This structure stores the original and symmetrized versions of terms obtained during the simplification of sums.

### 6.179.2 Constructor & Destructor Documentation

#### 6.179.2.1 [terminfo\(\)](#)

```
GiNaC::terminfo::terminfo (
 const ex & orig_,
 const ex & symm_) [inline]
```

References [orig](#), and [symm](#).

### 6.179.3 Member Data Documentation

#### 6.179.3.1 [orig](#)

```
ex GiNaC::terminfo::orig
```

original term

Referenced by [terminfo\(\)](#).

#### 6.179.3.2 [symm](#)

```
ex GiNaC::terminfo::symm
```

symmetrized term

Referenced by [GiNaC::terminfo\\_is\\_less::operator>\(\)](#), and [terminfo\(\)](#).

The documentation for this class was generated from the following file:

- [indexed.cpp](#)

## 6.180 GiNaC::terminfo\_is\_less Class Reference

### Public Member Functions

- `bool operator()` (const `terminfo` &ti1, const `terminfo` &ti2) const

### 6.180.1 Member Function Documentation

#### 6.180.1.1 operator>()

```
bool GiNaC::terminfo_is_less::operator() (
 const terminfo & ti1,
 const terminfo & ti2) const [inline]
```

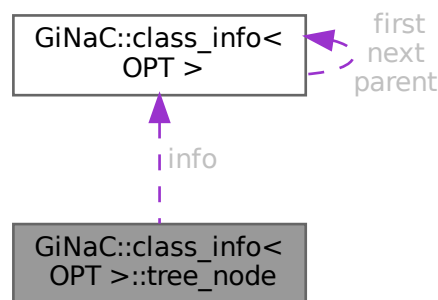
References `GiNaC::ex::compare()`, and `GiNaC::terminfo::symm`.

The documentation for this class was generated from the following file:

- `indexed.cpp`

## 6.181 GiNaC::class\_info< OPT >::tree\_node Struct Reference

Collaboration diagram for `GiNaC::class_info< OPT >::tree_node`:



### Public Member Functions

- `tree_node` (`class_info` \*i)
- void `add_child` (`tree_node` \*n)

### Public Attributes

- `std::vector< tree_node * >` children
- `class_info *` info

## 6.181.1 Constructor & Destructor Documentation

### 6.181.1.1 tree\_node()

```
template<class OPT>
GiNaC::class_info< OPT >::tree_node::tree_node (
 class_info * i) [inline]
```

References [GiNaC::class\\_info< OPT >::class\\_info\(\)](#), and [info](#).

Referenced by [add\\_child\(\)](#).

## 6.181.2 Member Function Documentation

### 6.181.2.1 add\_child()

```
template<class OPT>
void GiNaC::class_info< OPT >::tree_node::add_child (
 tree_node * n) [inline]
```

References [children](#), and [tree\\_node\(\)](#).

## 6.181.3 Member Data Documentation

### 6.181.3.1 children

```
template<class OPT>
std::vector<tree_node *> GiNaC::class_info< OPT >::tree_node::children
```

Referenced by [add\\_child\(\)](#), and [GiNaC::class\\_info< OPT >::dump\\_tree\(\)](#).

### 6.181.3.2 info

```
template<class OPT>
class_info* GiNaC::class_info< OPT >::tree_node::info
```

Referenced by [GiNaC::class\\_info< OPT >::dump\\_tree\(\)](#), and [tree\\_node\(\)](#).

The documentation for this struct was generated from the following file:

- [class\\_info.h](#)

## 6.182 GiNaC::unarchive\_table\_t Class Reference

```
#include <archive.h>
```

## Public Member Functions

- [unarchive\\_table\\_t](#) ()
- [~unarchive\\_table\\_t](#) ()
- [synthesize\\_func](#) find (const std::string &classname) const
- void [insert](#) (const std::string &classname, [synthesize\\_func](#) f)

## Static Private Attributes

- static int [usecount](#) = 0
- static [unarchive\\_map\\_t](#) \* [unarch\\_map](#) = nullptr

## 6.182.1 Constructor & Destructor Documentation

### 6.182.1.1 [unarchive\\_table\\_t](#)()

```
GiNaC::unarchive_table_t::unarchive_table_t ()
```

References [unarch\\_map](#), and [usecount](#).

### 6.182.1.2 [~unarchive\\_table\\_t](#)()

```
GiNaC::unarchive_table_t::~~unarchive_table_t ()
```

References [unarch\\_map](#), and [usecount](#).

## 6.182.2 Member Function Documentation

### 6.182.2.1 [find](#)()

```
synthesize_func GiNaC::unarchive_table_t::find (
 const std::string & classname) const
```

References [unarch\\_map](#).

Referenced by [GiNaC::find\\_factory\\_fcn](#)().

### 6.182.2.2 [insert](#)()

```
void GiNaC::unarchive_table_t::insert (
 const std::string & classname,
 synthesize_func f)
```

References [unarch\\_map](#).

### 6.182.3 Member Data Documentation

#### 6.182.3.1 usecount

```
int GiNaC::unarchive_table_t::usecount = 0 [static], [private]
```

Referenced by [unarchive\\_table\\_t\(\)](#), and [~unarchive\\_table\\_t\(\)](#).

#### 6.182.3.2 unarch\_map

```
unarchive_map_t * GiNaC::unarchive_table_t::unarch_map = nullptr [static], [private]
```

Referenced by [find\(\)](#), [insert\(\)](#), [unarchive\\_table\\_t\(\)](#), and [~unarchive\\_table\\_t\(\)](#).

The documentation for this class was generated from the following files:

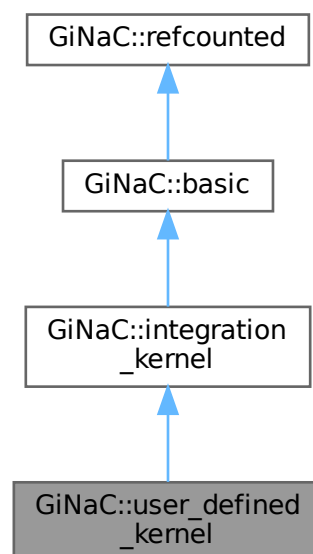
- [archive.h](#)
- [archive.cpp](#)

## 6.183 GiNaC::user\_defined\_kernel Class Reference

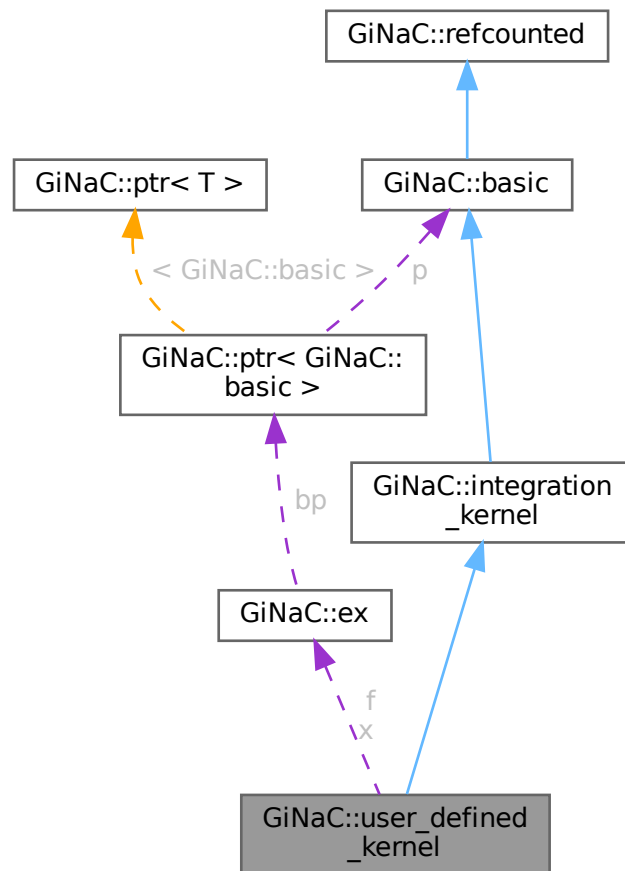
A user-defined integration kernel.

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::user\_defined\_kernel:



Collaboration diagram for `GiNaC::user_defined_kernel`:



## Public Member Functions

- `user_defined_kernel` (const `ex` &`f`, const `ex` &`x`)
- `size_t nops` () const override  
*Number of operands/members.*
- `ex op` (size\_t `i`) const override  
*Return operand/member at position `i`.*
- `ex & let_op` (size\_t `i`) override  
*Return modifiable operand/member at position `i`.*
- `bool is_numeric` (void) const override  
*This routine returns true, if the integration kernel can be evaluated numerically.*
- `ex Laurent_series` (const `ex` &`x`, int `order`) const override  
*Returns the Laurent series, starting possibly with the pole term.*

## Public Member Functions inherited from GiNaC::integration\_kernel

- **ex series** (const **relational** &r, int order, unsigned options=0) const override  
*Default implementation of ex::series().*
- virtual bool **has\_trailing\_zero** (void) const  
*This routine returns true, if the integration kernel has a trailing zero.*
- virtual **ex get\_numerical\_value** (const **ex** &lambda, int N\_trunc=0) const  
*Evaluates the integrand at lambda.*
- size\_t **get\_cache\_size** (void) const  
*Returns the current size of the cache.*
- void **set\_cache\_step** (int cache\_steps) const  
*Sets the step size by which the cache is increased.*
- **ex get\_series\_coeff** (int i) const  
*Wrapper around series\_coeff(i), converts cl\_N to numeric.*
- cln::cl\_N **series\_coeff** (int i) const  
*Subclasses have either to implement series\_coeff\_impl or the two methods Laurent\_series and uses\_Laurent\_series.*

## Public Member Functions inherited from GiNaC::basic

- virtual **~basic** ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- **basic** (const **basic** &other)
- const **basic** & **operator=** (const **basic** &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual **basic** \* **duplicate** () const  
*Create a clone of this object on the heap.*
- virtual **ex eval** () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual **ex evalf** () const  
*Evaluate object numerically.*
- virtual **ex evalm** () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual **ex eval\_integ** () const  
*Evaluate integrals, if result is known.*
- virtual **ex eval\_indexed** (const **basic** &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void **print** (const **print\_context** &c, unsigned level=0) const  
*Output to stream.*
- virtual void **dbgprint** () const  
*Little wrapper around print to be called within a debugger.*
- virtual void **dbgprinttree** () const  
*Little wrapper around printtree to be called within a debugger.*
- virtual unsigned **precedence** () const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool **info** (unsigned inf) const  
*Information about the object.*
- virtual **ex operator[]** (const **ex** &index) const
- virtual **ex operator[]** (size\_t i) const
- virtual **ex** & **operator[]** (const **ex** &index)
- virtual **ex** & **operator[]** (size\_t i)
- virtual bool **has** (const **ex** &other, unsigned options=0) const

- Test for occurrence of a pattern.*

  - virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
- Check whether the expression matches a given pattern.*

  - virtual `ex subs` (const `exmap` &m, unsigned options=0) const
- Substitute a set of objects by arbitrary expressions.*

  - virtual `ex map` (`map_function` &f) const
- Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*

  - virtual void `accept` (`GiNaC::visitor` &v) const
  - virtual bool `is_polynomial` (const `ex` &var) const
- Check whether this is a polynomial in the given variables.*

  - virtual int `degree` (const `ex` &s) const
- Return degree of highest power in object s.*

  - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

  - virtual `ex coeff` (const `ex` &s, int n=1) const
- Return coefficient of degree n in object s.*

  - virtual `ex expand` (unsigned options=0) const
- Expand expression, i.e.*

  - virtual `ex collect` (const `ex` &s, bool distributed=false) const
- Sort expanded expression in terms of powers of some object(s).*

  - virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

  - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

  - virtual `ex to_polynomial` (`exmap` &repl) const
  - virtual `numeric integer_content` () const
  - virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

  - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

  - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

  - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

  - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

  - virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

  - virtual unsigned `return_type` () const
  - virtual `return_type_t return_type_tinfo` () const
  - virtual `ex conjugate` () const
  - virtual `ex real_part` () const
  - virtual `ex imag_part` () const
- template<class T>

  - void `print_dispatch` (const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

  - virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

  - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)



- *Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned options) const  
*Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const  
*Default interface of nth derivative `ex::diff(s, n)`.*
- `int compare` (const `basic` &other) const  
*Compare objects syntactically to establish canonical ordering.*
- `bool is_equal` (const `basic` &other) const  
*Test for syntactic equality.*
- `const basic & hold` () const  
*Stop further evaluation.*
- `unsigned gethash` () const
- `const basic & setflag` (unsigned f) const  
*Set some `status_flags`.*
- `const basic & clearflag` (unsigned f) const  
*Clear some `status_flags`.*

## Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- `unsigned int add_reference` () noexcept
- `unsigned int remove_reference` () noexcept
- `unsigned int get_refcount` () const noexcept
- `void set_refcount` (unsigned int r) noexcept

## Protected Member Functions

- `bool uses_Laurent_series` () const override  
*Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).*
- `void do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from `GiNaC::integration_kernel`

- `virtual cln::cl_N series_coeff_impl` (int i) const  
*For  $\omega = d\lambda$  only the coefficient of  $\lambda^0$  is non-zero.*
- `ex get_numerical_value_impl` (const `ex` &lambda, const `ex` &pre, int shift, int N\_trunc) const  
*The actual implementation for computing a numerical value for the integrand.*
- `void do_print` (const `print_context` &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual [ex derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- virtual unsigned [calchash](#) () const  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Attributes

- [ex f](#)
- [ex x](#)

## Protected Attributes inherited from [GiNaC::integration\\_kernel](#)

- int [cache\\_step\\_size](#)
- `std::vector< cln::cl\_N >` [series\\_vec](#)

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.183.1 Detailed Description

A user-defined integration kernel.

The input is an expression  $f$ , depending on a variable  $x$ . It is assumed that  $f$  has a Laurent expansion around  $x = 0$  and maximally a simple pole at  $x = 0$ .

## 6.183.2 Constructor & Destructor Documentation

### 6.183.2.1 user\_defined\_kernel()

```
GiNaC::user_defined_kernel::user_defined_kernel (
 const ex & f,
 const ex & x)
```

References [f](#), [user\\_defined\\_kernel\(\)](#), and [x](#).

Referenced by [user\\_defined\\_kernel\(\)](#).

## 6.183.3 Member Function Documentation

### 6.183.3.1 nops()

```
size_t GiNaC::user_defined_kernel::nops () const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

### 6.183.3.2 op()

```
ex GiNaC::user_defined_kernel::op (
 size_t i) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [f](#), and [x](#).

### 6.183.3.3 let\_op()

```
ex & GiNaC::user_defined_kernel::let_op (
 size_t i) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ensure\\_if\\_modifiable\(\)](#), [f](#), and [x](#).

### 6.183.3.4 is\_numeric()

```
bool GiNaC::user_defined_kernel::is_numeric (
 void) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration\\_kernel](#).

References [f](#), [GiNaC::info\\_flags::numeric](#), and [x](#).

### 6.183.3.5 Laurent\_series()

```
ex GiNaC::user_defined_kernel::Laurent_series (
 const ex & x,
 int order) const [override], [virtual]
```

Returns the Laurent series, starting possibly with the pole term.

Neglected terms are of order  $O(x^{order})$ .

Reimplemented from [GiNaC::integration\\_kernel](#).

References [f](#), and [x](#).

### 6.183.3.6 uses\_Laurent\_series()

```
bool GiNaC::user_defined_kernel::uses_Laurent_series () const [override], [protected], [virtual]
```

Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).

Returns false if this is not the case (and the class has an implementation of `series_coeff_impl`).

Reimplemented from [GiNaC::integration\\_kernel](#).

### 6.183.3.7 do\_print()

```
void GiNaC::user_defined_kernel::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [f](#), [GiNaC::print\\_context::s](#), and [x](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.183.4 Member Data Documentation

### 6.183.4.1 f

```
ex GiNaC::user_defined_kernel::f [protected]
```

Referenced by [do\\_print\(\)](#), [is\\_numeric\(\)](#), [Laurent\\_series\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [user\\_defined\\_kernel\(\)](#).

### 6.183.4.2 x

```
ex GiNaC::user_defined_kernel::x [protected]
```

Referenced by [do\\_print\(\)](#), [is\\_numeric\(\)](#), [Laurent\\_series\(\)](#), [let\\_op\(\)](#), [op\(\)](#), and [user\\_defined\\_kernel\(\)](#).

The documentation for this class was generated from the following files:

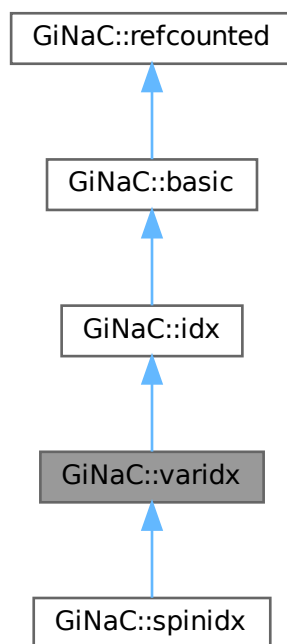
- [integration\\_kernel.h](#)
- [integration\\_kernel.cpp](#)

## 6.184 GiNaC::varidx Class Reference

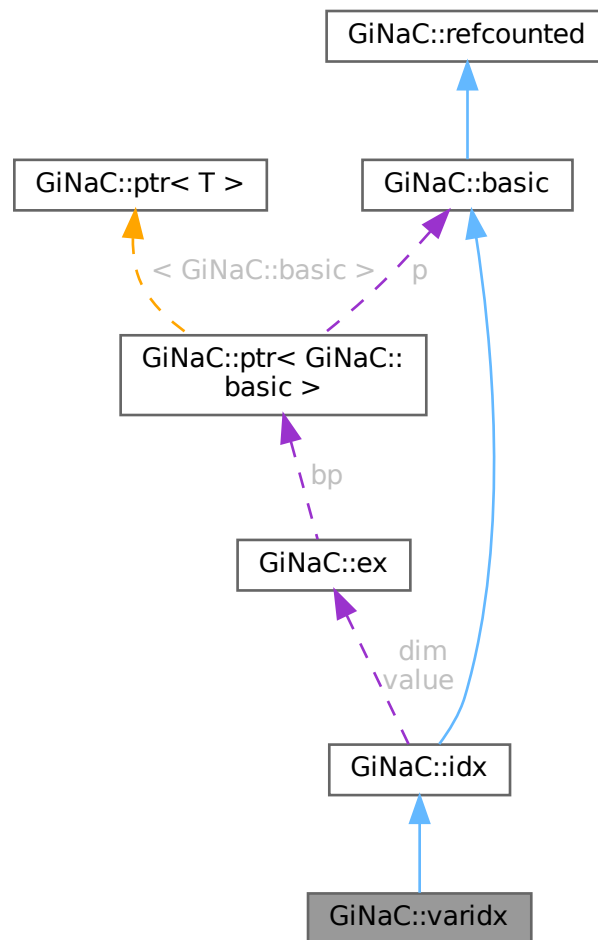
This class holds an index with a variance (co- or contravariant).

```
#include <idx.h>
```

Inheritance diagram for GiNaC::varidx:



Collaboration diagram for `GiNaC::varidx`:



## Public Member Functions

- `varidx` (const `ex` &`v`, const `ex` &`dim`, bool `covariant`=false)  
Construct index with given value, dimension and variance.
- bool `is_dummy_pair_same_type` (const `basic` &`other`) const override  
Check whether the index forms a dummy index pair with another index of the same type.
- void `archive` (`archive_node` &`n`) const override  
Save (serialize) the object into archive node.
- void `read_archive` (const `archive_node` &`n`, `lst` &`syms`) override  
Load (deserialize) the object from an archive node.
- bool `is_covariant` () const  
Check whether the index is covariant.
- bool `is_contravariant` () const  
Check whether the index is contravariant (not covariant).
- `ex toggle_variance` () const  
Make a new index with the same value but the opposite variance.

## Public Member Functions inherited from GiNaC::idx

- **idx** (const **ex** &v, const **ex** &dim)  
*Construct index with given value and dimension.*
- bool **info** (unsigned inf) const override  
*Information about the object.*
- size\_t **nops** () const override  
*Number of operands/members.*
- **ex op** (size\_t i) const override  
*Return operand/member at position i.*
- **ex map** (map\_function &f) const override  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- **ex evalf** () const override  
*By default, **basic::evalf** would evaluate the index value but we don't want a.1 to become a.*
- **ex subs** (const **exmap** &m, unsigned options=0) const override  
*Substitute a set of objects by arbitrary expressions.*
- **ex get\_value** () const  
*Get value of index.*
- bool **is\_numeric** () const  
*Check whether the index is numeric.*
- bool **is\_symbolic** () const  
*Check whether the index is symbolic.*
- **ex get\_dim** () const  
*Get dimension of index space.*
- bool **is\_dim\_numeric** () const  
*Check whether the dimension is numeric.*
- bool **is\_dim\_symbolic** () const  
*Check whether the dimension is symbolic.*
- **ex replace\_dim** (const **ex** &new\_dim) const  
*Make a new index with the same value but a different dimension.*
- **ex minimal\_dim** (const **idx** &other) const  
*Return the minimum of the dimensions of this and another index.*

## Public Member Functions inherited from GiNaC::basic

- virtual **~basic** ()  
*basic destructor, virtual because class ex will delete objects of derived classes via a basic\*.*
- **basic** (const **basic** &other)
- const **basic** & **operator=** (const **basic** &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual **basic** \* **duplicate** () const  
*Create a clone of this object on the heap.*
- virtual **ex eval** () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual **ex evalm** () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual **ex eval\_integ** () const  
*Evaluate integrals, if result is known.*
- virtual **ex eval\_indexed** (const **basic** &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*

- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprnttree` () const  
*Little wrapper around prnttree to be called within a debugger.*
- virtual unsigned `precedence` () const  
*Return relative operator precedence (for parenthezing output).*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex & let_op` (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const  
*Check whether the expression matches a given pattern.*
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const  
*Return degree of highest power in object s.*
- virtual int `ldegree` (const `ex` &s) const  
*Return degree of lowest power in object s.*
- virtual `ex coeff` (const `ex` &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual `ex expand` (unsigned options=0) const  
*Expand expression, i.e.*
- virtual `ex collect` (const `ex` &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series` (const `relational` &r, int order, unsigned options=0) const  
*Default implementation of `ex::series()`.*
- virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const  
*Default implementation of `ex::normal()`.*
- virtual `ex to_rational` (`exmap` &repl) const  
*Default implementation of `ex::to_rational()`.*
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const  
*Implementation `ex::max_coefficient()`.*
- virtual `exvector get_free_indices` () const  
*Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const  
*Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const  
*Try to contract two indexed expressions that appear in the same product.*



- virtual unsigned [return\\_type](#) () const
- virtual [return\\_type\\_t](#) [return\\_type\\_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real\\_part](#) () const
- virtual [ex imag\\_part](#) () const
- template<class T>  
void [print\\_dispatch](#) (const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- void [print\\_dispatch](#) (const [registered\\_class\\_info](#) &ri, const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- [ex subs\\_one\\_level](#) (const [exmap](#) &m, unsigned options) const  
*Helper function for [subs\(\)](#).*
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const  
*Default interface of nth derivative [ex::diff\(s, n\)](#).*
- int [compare](#) (const [basic](#) &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool [is\\_equal](#) (const [basic](#) &other) const  
*Test for syntactic equality.*
- const [basic](#) & [hold](#) () const  
*Stop further evaluation.*
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const  
*Set some [status\\_flags](#).*
- const [basic](#) & [clearflag](#) (unsigned f) const  
*Clear some [status\\_flags](#).*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Member Functions

- bool [match\\_same\\_type](#) (const [basic](#) &other) const override  
*Returns true if the attributes of two objects are similar enough for a match.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::idx](#)

- [ex derivative](#) (const [symbol](#) &s) const override  
*Implementation of [ex::diff\(\)](#) for an index always returns 0.*
- unsigned [calchash](#) () const override  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [print\\_index](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_csrc](#) (const [print\\_csrc](#) &c, unsigned level) const
- void [do\\_print\\_latex](#) (const [print\\_latex](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Protected Attributes

- bool [covariant](#)  
 *$x.mu$ , default is contravariant:  $x \sim mu$*

## Protected Attributes inherited from [GiNaC::idx](#)

- [ex value](#)  
*Expression that constitutes the index (numeric or symbolic name)*
- [ex dim](#)  
*Dimension of space (can be symbolic or numeric)*

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.184.1 Detailed Description

This class holds an index with a variance (co- or contravariant).

There is an associated metric tensor that can be used to raise/lower indices.

### 6.184.2 Constructor & Destructor Documentation

#### 6.184.2.1 [varidx\(\)](#)

```
GiNaC::varidx::varidx (
 const ex & v,
 const ex & dim,
 bool covariant = false)
```

Construct index with given value, dimension and variance.

## Parameters

|                  |                                                 |
|------------------|-------------------------------------------------|
| <i>v</i>         | Value of index (numeric or symbolic)            |
| <i>dim</i>       | Dimension of index space (numeric or symbolic)  |
| <i>covariant</i> | Make covariant index (default is contravariant) |

References [covariant](#).

Referenced by [is\\_dummy\\_pair\\_same\\_type\(\)](#), [match\\_same\\_type\(\)](#), and [toggle\\_variance\(\)](#).

## 6.184.3 Member Function Documentation

### 6.184.3.1 is\_dummy\_pair\_same\_type()

```
bool GiNaC::varidx::is_dummy_pair_same_type (
 const basic & other) const [override], [virtual]
```

Check whether the index forms a dummy index pair with another index of the same type.

Reimplemented from [GiNaC::idx](#).

References [covariant](#), and [varidx\(\)](#).

### 6.184.3.2 archive()

```
void GiNaC::varidx::archive (
 archive_node & n) const [override], [virtual]
```

Save (serialize) the object into archive node.

Archive the object.

Losely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented from [GiNaC::idx](#).

References [GiNaC::archive\\_node::add\\_bool\(\)](#), and [covariant](#).

### 6.184.3.3 read\_archive()

```
void GiNaC::varidx::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive\\_node](#).

#### Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::idx](#).

References [covariant](#), and [GiNaC::archive\\_node::find\\_bool\(\)](#).

#### 6.184.3.4 `match_same_type()`

```
bool GiNaC::varidx::match_same_type (
 const basic & other) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is\\_equal\\_same\\_type\(\)](#) is automatically used instead of [match\\_same\\_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::idx](#).

References [covariant](#), [GINAC\\_ASSERT](#), [GiNaC::is\\_a\(\)](#), and [varidx\(\)](#).

#### 6.184.3.5 `is_covariant()`

```
bool GiNaC::varidx::is_covariant () const [inline]
```

Check whether the index is covariant.

References [covariant](#).

Referenced by [GiNaC::spinmetric::contract\\_with\(\)](#), and [GiNaC::tensmetric::eval\\_indexed\(\)](#).

#### 6.184.3.6 `is_contravariant()`

```
bool GiNaC::varidx::is_contravariant () const [inline]
```

Check whether the index is contravariant (not covariant).

References [covariant](#).

#### 6.184.3.7 `toggle_variance()`

```
ex GiNaC::varidx::toggle_variance () const
```

Make a new index with the same value but the opposite variance.

References [GiNaC::basic::clearflag\(\)](#), [covariant](#), [GiNaC::basic::duplicate\(\)](#), [GiNaC::status\\_flags::hash\\_calculated](#), and [varidx\(\)](#).

Referenced by [GiNaC::base\\_and\\_index\(\)](#), and [GiNaC::clifford::eval\\_ncmul\(\)](#).

### 6.184.3.8 do\_print()

```
void GiNaC::varidx::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [covariant](#), [GiNaC::idx::print\\_index\(\)](#), and [GiNaC::print\\_context::s](#).

### 6.184.3.9 do\_print\_tree()

```
void GiNaC::varidx::do_print_tree (
 const print_tree & c,
 unsigned level) const [protected]
```

References [covariant](#), [GiNaC::print\\_tree::delta\\_indent](#), [GiNaC::idx::dim](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [GiNaC::print\\_context::s](#), and [GiNaC::idx::value](#).

## 6.184.4 Member Data Documentation

### 6.184.4.1 covariant

```
bool GiNaC::varidx::covariant [protected]
```

x.mu, default is contravariant:  $x \sim \mu$

Referenced by [archive\(\)](#), [GiNaC::spinidx::do\\_print\(\)](#), [do\\_print\(\)](#), [GiNaC::spinidx::do\\_print\\_tree\(\)](#), [do\\_print\\_tree\(\)](#), [is\\_contravariant\(\)](#), [is\\_covariant\(\)](#), [is\\_dummy\\_pair\\_same\\_type\(\)](#), [match\\_same\\_type\(\)](#), [read\\_archive\(\)](#), [toggle\\_variance\(\)](#), [GiNaC::spinidx::toggle\\_variance\\_dot\(\)](#), and [varidx\(\)](#).

The documentation for this class was generated from the following files:

- [idx.h](#)
- [idx.cpp](#)

## 6.185 GiNaC::visitor Class Reference

Degenerate base class for visitors.

```
#include <basic.h>
```

### Protected Member Functions

- virtual [~visitor](#) ()

### 6.185.1 Detailed Description

Degenerate base class for visitors.

basic and derivative classes support Robert C. Martin's Acyclic Visitor pattern (cf. <http://condor.depaul.edu/dmumaugh/OOT/Design-Principles/acv.pdf> or chapter 10 of Andrei Alexandrescu's "Modern C++ Design").

### 6.185.2 Constructor & Destructor Documentation

#### 6.185.2.1 ~visitor()

```
virtual GiNaC::visitor::~~visitor () [inline], [protected], [virtual]
```

The documentation for this class was generated from the following file:

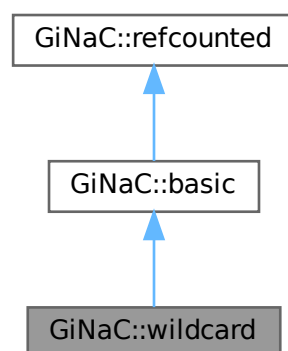
- [basic.h](#)

## 6.186 GiNaC::wildcard Class Reference

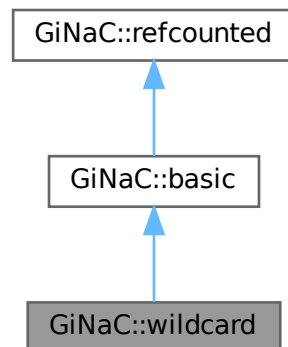
This class acts as a wildcard for [subs\(\)](#), [match\(\)](#), [has\(\)](#) and [find\(\)](#).

```
#include <wildcard.h>
```

Inheritance diagram for GiNaC::wildcard:



Collaboration diagram for GiNaC::wildcard:



### Public Member Functions

- `wildcard` (unsigned `label`)  
*Construct wildcard with specified label.*
- `bool match` (const `ex` &pattern, `exmap` &repl\_lst) const override  
*Check whether the expression matches a given pattern.*
- `void archive` (`archive_node` &n) const override  
*Save (a.k.a.*
- `void read_archive` (const `archive_node` &n, `lst` &syms) override  
*Read (a.k.a.*
- unsigned `get_label` () const

### Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()  
*basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)  
*basic assignment operator: the other object might be of a derived class.*
- virtual `basic` \* `duplicate` () const  
*Create a clone of this object on the heap.*
- virtual `ex eval` () const  
*Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf` () const  
*Evaluate object numerically.*
- virtual `ex evalm` () const  
*Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const  
*Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &i) const  
*Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*

- virtual void `print` (const `print_context` &c, unsigned level=0) const  
*Output to stream.*
- virtual void `dbgprint` () const  
*Little wrapper around print to be called within a debugger.*
- virtual void `dbgprntree` () const  
*Little wrapper around prntree to be called within a debugger.*
- virtual unsigned `precedence` () const  
*Return relative operator precedence (for parenthezing output).*
- virtual bool `info` (unsigned inf) const  
*Information about the object.*
- virtual size\_t `nops` () const  
*Number of operands/members.*
- virtual `ex op` (size\_t i) const  
*Return operand/member at position i.*
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size\_t i) const
- virtual `ex & let_op` (size\_t i)  
*Return modifiable operand/member at position i.*
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size\_t i)
- virtual bool `has` (const `ex` &other, unsigned options=0) const  
*Test for occurrence of a pattern.*
- virtual `ex subs` (const `exmap` &m, unsigned options=0) const  
*Substitute a set of objects by arbitrary expressions.*
- virtual `ex map` (`map_function` &f) const  
*Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const  
*Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const  
*Return degree of highest power in object s.*
- virtual int `ldegree` (const `ex` &s) const  
*Return degree of lowest power in object s.*
- virtual `ex coeff` (const `ex` &s, int n=1) const  
*Return coefficient of degree n in object s.*
- virtual `ex expand` (unsigned options=0) const  
*Expand expression, i.e.*
- virtual `ex collect` (const `ex` &s, bool distributed=false) const  
*Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series` (const `relational` &r, int order, unsigned options=0) const  
*Default implementation of `ex::series()`.*
- virtual `ex normal` (`exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier) const  
*Default implementation of `ex::normal()`.*
- virtual `ex to_rational` (`exmap` &repl) const  
*Default implementation of `ex::to_rational()`.*
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const  
*Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const  
*Implementation `ex::max_coefficient()`.*



- virtual [exvector](#) [get\\_free\\_indices](#) () const  
*Return a vector containing the free indices of an expression.*
- virtual [ex](#) [add\\_indexed](#) (const [ex](#) &self, const [ex](#) &other) const  
*Add two indexed expressions.*
- virtual [ex](#) [scalar\\_mul\\_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const  
*Multiply an indexed expression with a scalar.*
- virtual bool [contract\\_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const  
*Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned [return\\_type](#) () const
- virtual [return\\_type\\_t](#) [return\\_type\\_tinfo](#) () const
- virtual [ex](#) [conjugate](#) () const
- virtual [ex](#) [real\\_part](#) () const
- virtual [ex](#) [imag\\_part](#) () const
- template<class T>  
void [print\\_dispatch](#) (const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- void [print\\_dispatch](#) (const [registered\\_class\\_info](#) &ri, const [print\\_context](#) &c, unsigned level) const  
*Like [print\(\)](#), but dispatch to the specified class.*
- [ex](#) [subs\\_one\\_level](#) (const [exmap](#) &m, unsigned options) const  
*Helper function for [subs\(\)](#).*
- [ex](#) [diff](#) (const [symbol](#) &s, unsigned nth=1) const  
*Default interface of nth derivative [ex::diff\(s, n\)](#).*
- int [compare](#) (const [basic](#) &other) const  
*Compare objects syntactically to establish canonical ordering.*
- bool [is\\_equal](#) (const [basic](#) &other) const  
*Test for syntactic equality.*
- const [basic](#) & [hold](#) () const  
*Stop further evaluation.*
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const  
*Set some [status\\_flags](#).*
- const [basic](#) & [clearflag](#) (unsigned f) const  
*Clear some [status\\_flags](#).*

## Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add\\_reference](#) () noexcept
- unsigned int [remove\\_reference](#) () noexcept
- unsigned int [get\\_refcount](#) () const noexcept
- void [set\\_refcount](#) (unsigned int r) noexcept

## Protected Member Functions

- unsigned [calchash](#) () const override  
*Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const

## Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval\\_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if the attributes of two objects are similar enough for a match.*
- virtual [ex derivative](#) (const [symbol](#) &s) const  
*Default implementation of [ex::diff\(\)](#).*
- virtual int [compare\\_same\\_type](#) (const [basic](#) &other) const  
*Returns order relation between two objects of same type.*
- virtual bool [is\\_equal\\_same\\_type](#) (const [basic](#) &other) const  
*Returns true if two objects of same type are equal.*
- void [ensure\\_if\\_modifiable](#) () const  
*Ensure the object may be modified without hurting others, throws if this is not the case.*
- void [do\\_print](#) (const [print\\_context](#) &c, unsigned level) const  
*Default output to stream.*
- void [do\\_print\\_tree](#) (const [print\\_tree](#) &c, unsigned level) const  
*Tree output to stream.*
- void [do\\_print\\_python\\_repr](#) (const [print\\_python\\_repr](#) &c, unsigned level) const  
*Python parsable output to stream.*

## Private Attributes

- unsigned [label](#)  
*Label used to distinguish different wildcards.*

## Additional Inherited Members

## Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)  
*of type [status\\_flags](#)*
- unsigned [hashvalue](#)  
*hash value*

### 6.186.1 Detailed Description

This class acts as a wildcard for [subs\(\)](#), [match\(\)](#), [has\(\)](#) and [find\(\)](#).

An integer label is used to identify different wildcards.

### 6.186.2 Constructor & Destructor Documentation

#### 6.186.2.1 wildcard()

```
GiNaC::wildcard::wildcard (
 unsigned label)
```

Construct wildcard with specified label.

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [label](#), [GiNaC::basic::setflag\(\)](#), and [wildcard\(\)](#).

Referenced by [wildcard\(\)](#).

## 6.186.3 Member Function Documentation

### 6.186.3.1 match()

```
bool GiNaC::wildcard::match (
 const ex & pattern,
 exmap & repl_lst) const [override], [virtual]
```

Check whether the expression matches a given pattern.

For every wildcard object in the pattern, a pair with the wildcard as a key and matching expression as a value is added to *repl\_lst*.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#), [GiNaC::ex\\_to\(\)](#), and [GiNaC::basic::is\\_equal\(\)](#).

### 6.186.3.2 archive()

```
void GiNaC::wildcard::archive (
 archive_node & n) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::archive\\_node::add\\_unsigned\(\)](#), and [label](#).

### 6.186.3.3 read\_archive()

```
void GiNaC::wildcard::read_archive (
 const archive_node & n,
 lst & syms) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::status\\_flags::evaluated](#), [GiNaC::status\\_flags::expanded](#), [GiNaC::archive\\_node::find\\_unsigned\(\)](#), [label](#), and [GiNaC::basic::setflag\(\)](#).

### 6.186.3.4 calchash()

```
unsigned GiNaC::wildcard::calchash () const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status\\_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::golden\\_ratio\\_hash\(\)](#), [GiNaC::status\\_flags::hash\\_calculated](#), [GiNaC::basic::hashvalue](#), [label](#), [GiNaC::make\\_hash\\_seed\(\)](#), and [GiNaC::basic::setflag\(\)](#).

### 6.186.3.5 `get_label()`

```
unsigned GiNaC::wildcard::get_label () const [inline]
```

References [label](#).

### 6.186.3.6 `do_print()`

```
void GiNaC::wildcard::do_print (
 const print_context & c,
 unsigned level) const [protected]
```

References [label](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.186.3.7 `do_print_tree()`

```
void GiNaC::wildcard::do_print_tree (
 const print_tree & c,
 unsigned level) const [protected]
```

References [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [label](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

### 6.186.3.8 `do_print_python_repr()`

```
void GiNaC::wildcard::do_print_python_repr (
 const print_python_repr & c,
 unsigned level) const [protected]
```

References [label](#), and [GiNaC::print\\_context::s](#).

Referenced by [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\(\)](#).

## 6.186.4 Member Data Documentation

### 6.186.4.1 `label`

```
unsigned GiNaC::wildcard::label [private]
```

Label used to distinguish different wildcards.

Referenced by [archive\(\)](#), [calchash\(\)](#), [do\\_print\(\)](#), [do\\_print\\_python\\_repr\(\)](#), [do\\_print\\_tree\(\)](#), [get\\_label\(\)](#), [read\\_archive\(\)](#), and [wildcard\(\)](#).

The documentation for this class was generated from the following files:

- [wildcard.h](#)
- [wildcard.cpp](#)

## 6.187 GiNaC::zeta1\_SERIAL Class Reference

Complex conjugate.

```
#include <inifcns.h>
```

### Static Public Attributes

- static unsigned [serial](#)

### 6.187.1 Detailed Description

Complex conjugate.

Real part. Imaginary part. Absolute value. Step function. Complex sign. Eta function:  $\log(a*b) == \log(a) + \log(b) + \eta(a, b)$ . Sine. Cosine. Tangent. Exponential function. Natural logarithm. Inverse sine (arc sine). Inverse cosine (arc cosine). Inverse tangent (arc tangent). Inverse tangent with two arguments. Hyperbolic Sine. Hyperbolic Cosine. Hyperbolic Tangent. Inverse hyperbolic Sine (area hyperbolic sine). Inverse hyperbolic Cosine (area hyperbolic cosine). Inverse hyperbolic Tangent (area hyperbolic tangent). Dilogarithm. Trilogarithm. Derivatives of Riemann's Zeta-function. Multiple zeta value including Riemann's zeta-function.

### 6.187.2 Member Data Documentation

#### 6.187.2.1 serial

```
unsigned GiNaC::zeta1_SERIAL::serial [static]
```

#### Initial value:

```
= function::register_new(function_options("zeta", 1).
 evalf_func(zetal_evalf).
 eval_func(zetal_eval).
 derivative_func(zetal_deriv).
 print_func<print_latex>(zetal_print_latex).
 do_not_evalf_params().
 overloaded(2))
```

Referenced by [GiNaC::zeta\(\)](#).

The documentation for this class was generated from the following files:

- [inifcns.h](#)
- [inifcns\\_nstdsums.cpp](#)

## 6.188 GiNaC::zeta2\_SERIAL Class Reference

Alternating Euler sum or colored MZV.

```
#include <inifcns.h>
```

### Static Public Attributes

- static unsigned [serial](#)

## 6.188.1 Detailed Description

Alternating Euler sum or colored MZV.

## 6.188.2 Member Data Documentation

### 6.188.2.1 [serial](#)

```
unsigned GiNaC::zeta2_SERIAL::serial [static]
```

#### Initial value:

```
= function::register_new(function_options("zeta", 2).
 evalf_func(zeta2_evalf).
 eval_func(zeta2_eval).
 derivative_func(zeta2_deriv).
 print_func<print_latex>(zeta2_print_latex).
 do_not_evalf_params().
 overloaded(2))
```

Referenced by [GiNaC::zeta\(\)](#).

The documentation for this class was generated from the following files:

- [inifcns.h](#)
- [inifcns\\_nstdsums.cpp](#)

# Chapter 7

## File Documentation

### 7.1 add.cpp File Reference

Implementation of [GiNaC](#)'s sums of expressions.

```
#include "add.h"
#include "mul.h"
#include "archive.h"
#include "operators.h"
#include "matrix.h"
#include "utils.h"
#include "clifford.h"
#include "ncmul.h"
#include "compiler.h"
#include <iostream>
#include <limits>
#include <stdexcept>
#include <string>
```

#### Namespaces

- namespace [GiNaC](#)

#### Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (add, expairseq, print\_func< [print\\_context](#) >(&add::do\_print). print\_func< [print\\_latex](#) >(&add::do\_print\_latex). print\_func< [print\\_csrc](#) >(&add::do\_print\_csrc). print\_func< [print\\_tree](#) >(&add::do\_print\_tree). print\_func< [print\\_python\\_repr](#) >(&add::do\_print\_python\_repr))  
add
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) (add)

#### 7.1.1 Detailed Description

Implementation of [GiNaC](#)'s sums of expressions.

## 7.2 add.h File Reference

Interface to [GiNaC](#)'s sums of expressions.

```
#include "expairseq.h"
```

### Classes

- class [GiNaC::add](#)  
*Sum of expressions.*

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([add](#))

### 7.2.1 Detailed Description

Interface to [GiNaC](#)'s sums of expressions.

## 7.3 archive.cpp File Reference

Archiving of [GiNaC](#) expressions.

```
#include "archive.h"
#include "registrar.h"
#include "ex.h"
#include "lst.h"
#include "version.h"
#include <iostream>
#include <stdexcept>
```

### Namespaces

- namespace [GiNaC](#)



## Functions

- static void [GiNaC::write\\_unsigned](#) (std::ostream &os, unsigned val)  
*Write unsigned integer quantity to stream.*
- static unsigned [GiNaC::read\\_unsigned](#) (std::istream &is)  
*Read unsigned integer quantity from stream.*
- std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const [archive\\_node](#) &n)  
*Write [archive\\_node](#) to binary data stream.*
- std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const [archive](#) &ar)  
*Write archive to binary data stream.*
- std::istream & [GiNaC::operator>>](#) (std::istream &is, [archive\\_node](#) &n)  
*Read [archive\\_node](#) from binary data stream.*
- std::istream & [GiNaC::operator>>](#) (std::istream &is, [archive](#) &ar)  
*Read archive from binary data stream.*
- static [synthesize\\_func](#) [GiNaC::find\\_factory\\_fcn](#) (const std::string &name)

### 7.3.1 Detailed Description

Archiving of [GiNaC](#) expressions.

## 7.4 archive.h File Reference

Archiving of [GiNaC](#) expressions.

```
#include "ex.h"
#include <iosfwd>
#include <map>
#include <string>
#include <vector>
```

## Classes

- class [GiNaC::archive\\_node](#)  
*This class stores all properties needed to record/retrieve the state of one object of class basic (or a derived class).*
- struct [GiNaC::archive\\_node::property\\_info](#)  
*Information about a stored property.*
- struct [GiNaC::archive\\_node::property](#)  
*Archived property (data type, name and associated data)*
- struct [GiNaC::archive\\_node::archive\\_node\\_cit\\_range](#)
- class [GiNaC::unarchive\\_table\\_t](#)
- class [GiNaC::archive](#)  
*This class holds archived versions of [GiNaC](#) expressions (class ex).*
- struct [GiNaC::archive::archived\\_ex](#)  
*Archived expression descriptor.*

## Namespaces

- namespace [GiNaC](#)

## Macros

- #define `GINAC_DECLARE_UNARCHIVER`(classname)  
*Helper macros to register a class with (un)archiving (a.k.a.*
- #define `GINAC_BIND_UNARCHIVER`(classname)

## Typedefs

- typedef unsigned `GiNaC::archive_node_id`  
*Numerical ID value to refer to an [archive\\_node](#).*
- typedef unsigned `GiNaC::archive_atom`  
*Numerical ID value to refer to a string.*
- typedef `basic` \*(\* `GiNaC::synthesize_func`) ()
- typedef `std::map`< `std::string`, `synthesize_func` > `GiNaC::unarchive_map_t`

## Functions

- `std::ostream` & `GiNaC::operator<<` (`std::ostream` &os, const `archive` &ar)  
*Write archive to binary data stream.*
- `std::istream` & `GiNaC::operator>>` (`std::istream` &is, `archive` &ar)  
*Read archive from binary data stream.*

## Variables

- static `unarchive_table_t` `GiNaC::unarch_table_instance`

### 7.4.1 Detailed Description

Archiving of `GiNaC` expressions.

### 7.4.2 Macro Definition Documentation

#### 7.4.2.1 GINAC\_DECLARE\_UNARCHIVER

```
#define GINAC_DECLARE_UNARCHIVER(
 classname)
```

#### Value:

```
class classname ## _unarchiver \
{ \
 static int usecount; \
public: \
 static GiNaC::basic* create(); \
 classname ## _unarchiver(); \
 ~ classname ## _unarchiver(); \
}; \
static classname ## _unarchiver classname ## _unarchiver_instance
```

Helper macros to register a class with (un)archiving (a.k.a.

(de)serialization).

Usage: put

`GINAC_DECLARE_UNARCHIVER(myclass);`

into the header file (in the global or namespace scope), and

`GINAC_BIND_UNARCHIVER(myclass);`

into the source file.

Effect: the 'myclass' (being a class derived directly or indirectly from `GiNaC::basic`) can be archived and unarchived.

Note: you need to use `GINAC_{DECLARE,BIND}_UNARCHIVER` incantations in order to make your class (un)archivable *even if your class does not overload 'read\_archive' method*. Sorry for inconvenience.

How it works:

The 'basic' class has a 'read\_archive' virtual method which reads an expression from archive. Derived classes can overload that method. There's a small problem, though. On unarchiving all we have is a set of named byte streams. In C++ the class name (as written in the source code) has nothing to do with its actual type. Thus, we need establish a correspondence ourselves. To do so we maintain a 'class\_name' => 'function\_pointer' table (see the `unarchive_table_t` class above). Every function in this table is supposed to create a new object of the 'class\_name' type. The 'archive\_node' class uses that table to construct an object of correct type. Next it invokes `read_archive` virtual method of newly created object, which does the actual job.

Note: this approach is very simple-minded (it does not handle classes with same names from different namespaces, multiple inheritance, etc), but it happens to work surprisingly well.

#### 7.4.2.2 GINAC\_BIND\_UNARCHIVER

```
#define GINAC_BIND_UNARCHIVER(
 classname)
```

**Value:**

```
classname ## _unarchiver::classname ## _unarchiver() \
{ \
 static GiNaC::unarchive_table_t table; \
 if (usecount++ == 0) { \
 table.insert(std::string(#classname), \
 &(classname ## _unarchiver::create)); \
 } \
} \
GiNaC::basic* classname ## _unarchiver::create() \
{ \
 return new classname(); \
} \
classname ## _unarchiver::~~ classname ## _unarchiver() { } \
int classname ## _unarchiver::usecount = 0
```

## 7.5 assertion.h File Reference

Assertion macro definition.

### Macros

- `#define GINAC_ASSERT(X)`  
Assertion macro for checking invariances.



[GiNaC::permute\\_free\\_index\\_to\\_front\(\)](#), [GiNaC::matrix::pivot\(\)](#), [GiNaC::function::power\(\)](#), [GiNaC::function::print\(\)](#),  
[GiNaC::product\\_to\\_exvector\(\)](#), [GiNaC::pseries::pseries\(\)](#), [GiNaC::pseries::pseries\(\)](#), [GiNaC::psi1\\_deriv\(\)](#),  
[GiNaC::psi2\\_deriv\(\)](#), [GiNaC::ptr< T >::ptr\(\)](#), [GiNaC::matrix::rank\(\)](#), [GiNaC::expairseq::read\\_archive\(\)](#), [GiNaC::function::real\\_part\(\)](#),  
[GiNaC::rename\\_dummy\\_indices\(\)](#), [GiNaC::function::return\\_type\(\)](#), [GiNaC::ncmul::return\\_type\(\)](#), [GiNaC::relational::return\\_type\(\)](#),  
[GiNaC::function::return\\_type\\_tinfo\(\)](#), [GiNaC::relational::return\\_type\\_tinfo\(\)](#), [GiNaC::S\\_deriv\(\)](#), [GiNaC::matrix::scalar\\_mul\\_indexed\(\)](#),  
[GiNaC::function::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::pseries::series\(\)](#), [GiNaC::symbol::series\(\)](#), [GiNaC::indexed::simplify\\_indexed\(\)](#),  
[GiNaC::sin\\_deriv\(\)](#), [GiNaC::sinh\\_deriv\(\)](#), [GiNaC::add::smod\(\)](#), [GiNaC::mul::smod\(\)](#), [GiNaC::sqrfree\\_parfrac\(\)](#),  
[GiNaC::ex::subs\(\)](#), [GiNaC::ex::subs\(\)](#), [GiNaC::ex::swap\(\)](#), [GiNaC::tan\\_deriv\(\)](#), [GiNaC::tan\\_series\(\)](#), [GiNaC::tanh\\_deriv\(\)](#),  
[GiNaC::tanh\\_series\(\)](#), [GiNaC::tgamma\\_deriv\(\)](#), [GiNaC::numeric::to\\_double\(\)](#), [GiNaC::numeric::to\\_int\(\)](#), [GiNaC::numeric::to\\_long\(\)](#),  
[GiNaC::indexed::validate\(\)](#), [GiNaC::zeta1\\_deriv\(\)](#), [GiNaC::zeta2\\_deriv\(\)](#), [GiNaC::zetaderiv\\_deriv\(\)](#), and [GiNaC::basic::~~basic\(\)](#).

## 7.6 basic.cpp File Reference

Implementation of [GiNaC](#)'s ABC.

```

#include "basic.h"
#include "ex.h"
#include "numeric.h"
#include "power.h"
#include "add.h"
#include "symbol.h"
#include "lst.h"
#include "ncmul.h"
#include "relational.h"
#include "operators.h"
#include "wildcard.h"
#include "archive.h"
#include "utils.h"
#include "hash_seed.h"
#include "inifcns.h"
#include <iostream>
#include <stdexcept>
#include <typeinfo>

```

### Classes

- struct [GiNaC::evalf\\_map\\_function](#)  
*Function object to be applied by [basic::evalf\(\)](#).*
- struct [GiNaC::evalm\\_map\\_function](#)  
*Function object to be applied by [basic::evalm\(\)](#).*
- struct [GiNaC::eval\\_integ\\_map\\_function](#)  
*Function object to be applied by [basic::eval\\_integ\(\)](#).*
- struct [GiNaC::derivative\\_map\\_function](#)  
*Function object to be applied by [basic::derivative\(\)](#).*
- struct [GiNaC::expand\\_map\\_function](#)  
*Function object to be applied by [basic::expand\(\)](#).*

### Namespaces

- namespace [GiNaC](#)

## Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([basic](#), void, [print\\_func](#)< [print\\_context](#)>(&[basic::do\\_print](#)), [print\\_func](#)< [print\\_tree](#)>(&[basic::do\\_print\\_tree](#)), [print\\_func](#)< [print\\_python\\_repr](#)>(&[basic::do\\_print\\_python\\_repr](#))) [basic](#)

*basic copy constructor: implicitly assumes that the other class is of the exact same type (as it's used by [duplicate\(\)](#)), so it can copy the [tinfo\\_key](#) and the hash value.*

## Variables

- [GiNaC::evalm\\_map\\_function](#) [GiNaC::map\\_evalm](#)
- [GiNaC::eval\\_integ\\_map\\_function](#) [GiNaC::map\\_eval\\_integ](#)

### 7.6.1 Detailed Description

Implementation of [GiNaC](#)'s ABC.

## 7.7 basic.h File Reference

Interface to [GiNaC](#)'s ABC.

```
#include "flags.h"
#include "ptr.h"
#include "assertion.h"
#include "registrar.h"
#include <cstdint>
#include <map>
#include <set>
#include <typeinfo>
#include <vector>
#include <utility>
```

## Classes

- struct [GiNaC::map\\_function](#)  
*Function object for [map\(\)](#).*
- class [GiNaC::visitor](#)  
*Degenerate base class for visitors.*
- class [GiNaC::basic](#)  
*This class is the ABC (abstract base class) of [GiNaC](#)'s class hierarchy.*

## Namespaces

- namespace [GiNaC](#)

## Typedefs

- typedef std::vector< [ex](#) > [GiNaC::exvector](#)
- typedef std::set< [ex](#), [ex\\_is\\_less](#) > [GiNaC::exset](#)
- typedef std::map< [ex](#), [ex](#), [ex\\_is\\_less](#) > [GiNaC::exmap](#)

## Functions

- template<class T>  
bool [GiNaC::is\\_a](#) (const [basic](#) &obj)  
*Check if obj is a T, including base classes.*
- template<class T>  
bool [GiNaC::is\\_exactly\\_a](#) (const [basic](#) &obj)  
*Check if obj is a T, not including base classes.*
- template<class B, typename... Args>  
B & [GiNaC::dynallocate](#) (Args &&... args)  
*Constructs a new (class basic or derived) B object on the heap.*
- template<class B>  
B & [GiNaC::dynallocate](#) (std::initializer\_list< [ex](#) > il)  
*Constructs a new (class basic or derived) B object on the heap.*

### 7.7.1 Detailed Description

Interface to [GiNaC](#)'s ABC.

## 7.8 class\_info.h File Reference

Helper templates to provide per-class information for class hierarchies.

```
#include <cstddef>
#include <cstring>
#include <iomanip>
#include <iostream>
#include <map>
#include <stdexcept>
#include <string>
#include <vector>
```

## Classes

- class [GiNaC::class\\_info](#)< [OPT](#) >
- struct [GiNaC::class\\_info](#)< [OPT](#) >::tree\_node

## Namespaces

- namespace [GiNaC](#)

## Variables

- `template<class OPT>`  
`class_info< OPT > * GiNaC::class_info< OPT >::first = nullptr`
- `template<class OPT>`  
`bool GiNaC::class_info< OPT >::parents_identified = false`

## 7.8.1 Detailed Description

Helper templates to provide per-class information for class hierarchies.

## 7.9 clifford.cpp File Reference

Implementation of [GiNaC](#)'s clifford algebra (Dirac gamma) objects.

```
#include "clifford.h"
#include "ex.h"
#include "idx.h"
#include "ncmul.h"
#include "symbol.h"
#include "numeric.h"
#include "symmetry.h"
#include "lst.h"
#include "relational.h"
#include "operators.h"
#include "add.h"
#include "mul.h"
#include "power.h"
#include "matrix.h"
#include "archive.h"
#include "utils.h"
#include <stdexcept>
```

## Classes

- struct [GiNaC::is\\_not\\_a\\_clifford](#)  
*Predicate for finding non-clifford objects.*

## Namespaces

- namespace [GiNaC](#)



## Functions

- `GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`clifford`, `indexed`, `print_func< print_dflt >(&clifford::do_print_dflt)`, `print_func< print_latex >(&clifford::do_print_latex)`, `print_func< print_tree >(&clifford::do_print_tree)`) `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT`(`diracone`
- `GiNaC::print_func< print_dflt >(&diracone::do_print)`, `print_func< print_latex >(&diracone`
- `GiNaC::GINAC_BIND_UNARCHIVER` (`clifford`)
- `GiNaC::GINAC_BIND_UNARCHIVER` (`cliffordunit`)
- `GiNaC::GINAC_BIND_UNARCHIVER` (`diracone`)
- `GiNaC::GINAC_BIND_UNARCHIVER` (`diracgamma`)
- `GiNaC::GINAC_BIND_UNARCHIVER` (`diracgamma5`)
- `GiNaC::GINAC_BIND_UNARCHIVER` (`diracgammaL`)
- `GiNaC::GINAC_BIND_UNARCHIVER` (`diracgammaR`)
- static bool `GiNaC::is_dirac_slash` (const `ex` &seq0)
- static void `GiNaC::base_and_index` (const `ex` &c, `ex` &b, `ex` &i)  
*This function decomposes  $\gamma \sim \mu \rightarrow (1, \mu)$  and  $a \rightarrow (a.ix, ix)$*
- `ex` `GiNaC::dirac_ONE` (unsigned char rl=0)  
*Create a Clifford unity object.*
- static unsigned `GiNaC::get_dim_uint` (const `ex` &e)
- `ex` `GiNaC::clifford_unit` (const `ex` &mu, const `ex` &metr, unsigned char rl=0)  
*Create a Clifford unit object.*
- `ex` `GiNaC::dirac_gamma` (const `ex` &mu, unsigned char rl=0)  
*Create a Dirac gamma object.*
- `ex` `GiNaC::dirac_gamma5` (unsigned char rl=0)  
*Create a Dirac gamma5 object.*
- `ex` `GiNaC::dirac_gammaL` (unsigned char rl=0)  
*Create a Dirac gammaL object.*
- `ex` `GiNaC::dirac_gammaR` (unsigned char rl=0)  
*Create a Dirac gammaR object.*
- `ex` `GiNaC::dirac_slash` (const `ex` &e, const `ex` &dim, unsigned char rl=0)  
*Create a term of the form  $e_\mu * \gamma \sim \mu$  with a unique index  $\mu$ .*
- static unsigned char `GiNaC::get_representation_label` (const `return_type_t` &ti)  
*Extract representation label from tinfo key (as returned by `return_type_tinfo()`).*
- static `ex` `GiNaC::trace_string` (`exvector::const_iterator` ix, `size_t` num)  
*Take trace of a string of an even number of Dirac gammas given a vector of indices.*
- `ex` `GiNaC::dirac_trace` (const `ex` &e, const `std::set< unsigned char >` &rls, const `ex` &trONE=4)  
*Calculate dirac traces over the specified set of representation labels.*
- `ex` `GiNaC::dirac_trace` (const `ex` &e, const `lst` &rl, const `ex` &trONE=4)  
*Calculate dirac traces over the specified list of representation labels.*
- `ex` `GiNaC::dirac_trace` (const `ex` &e, unsigned char rl=0, const `ex` &trONE=4)  
*Calculate the trace of an expression containing gamma objects with a specified representation label.*
- `ex` `GiNaC::canonicalize_clifford` (const `ex` &e)  
*Bring all products of clifford objects in an expression into a canonical order.*
- `ex` `GiNaC::clifford_star_bar` (const `ex` &e, bool do\_bar, unsigned options)  
*An auxillary function performing `clifford_star()` and `clifford_bar()`.*
- `ex` `GiNaC::clifford_prime` (const `ex` &e)  
*Automorphism of the Clifford algebra, simply changes signs of all clifford units.*
- `ex` `GiNaC::remove_dirac_ONE` (const `ex` &e, unsigned char rl=0, unsigned options=0)  
*Replaces `dirac_ONE`'s (with a `representation_label` no less than `rl`) in `e` with 1.*
- int `GiNaC::clifford_max_label` (const `ex` &e, bool ignore\_ONE=false)  
*Returns the maximal representation label of a clifford object if `e` contains at least one, otherwise returns -1.*
- `ex` `GiNaC::clifford_norm` (const `ex` &e)

- Calculation of the norm in the Clifford algebra.*

  - `ex GiNaC::clifford_inverse` (const `ex` &`e`)

*Calculation of the inverse in the Clifford algebra.*

  - `ex GiNaC::lst_to_clifford` (const `ex` &`v`, const `ex` &`mu`, const `ex` &`metr`, unsigned char `rl=0`)

*List or vector conversion into the Clifford vector.*

  - `ex GiNaC::lst_to_clifford` (const `ex` &`v`, const `ex` &`e`)

*List or vector conversion into the Clifford vector.*

  - static `ex GiNaC::get_clifford_comp` (const `ex` &`e`, const `ex` &`c`, bool `root=true`)

*Auxiliary structure to define a function for stripping one Clifford unit from vectors.*

  - `lst GiNaC::clifford_to_lst` (const `ex` &`e`, const `ex` &`c`, bool `algebraic=true`)

*An inverse function to `lst_to_clifford()`.*

  - `ex GiNaC::clifford_moebius_map` (const `ex` &`a`, const `ex` &`b`, const `ex` &`c`, const `ex` &`d`, const `ex` &`v`, const `ex` &`G`, unsigned char `rl=0`)

*Calculations of Moebius transformations (conformal map) defined by a 2x2 Clifford matrix (a b|c d) in linear spaces with arbitrary signature.*

  - `ex GiNaC::clifford_moebius_map` (const `ex` &`M`, const `ex` &`v`, const `ex` &`G`, unsigned char `rl=0`)

*The second form of Moebius transformations defined by a 2x2 Clifford matrix M This function takes the transformation matrix M as a single entity.*

## Variables

- `GiNaC::tensor`

## 7.9.1 Detailed Description

Implementation of `GiNaC`'s clifford algebra (Dirac gamma) objects.

## 7.10 clifford.h File Reference

Interface to `GiNaC`'s clifford algebra (Dirac gamma) objects.

```
#include "indexed.h"
#include "tensor.h"
#include "symbol.h"
#include "idx.h"
#include <set>
```

## Classes

- class `GiNaC::clifford`

*This class holds an object representing an element of the Clifford algebra (the Dirac gamma matrices).*
- class `GiNaC::diracone`

*This class represents the Clifford algebra unity element.*
- class `GiNaC::cliffordunit`

*This class represents the Clifford algebra generators (units).*
- class `GiNaC::diracgamma`

*This class represents the Dirac gamma Lorentz vector.*
- class `GiNaC::diracgamma5`

*This class represents the Dirac gamma5 object which anticommutes with all other gammas.*
- class `GiNaC::diracgammaL`

*This class represents the Dirac gammaL object which behaves like 1/2 (1-gamma5).*
- class `GiNaC::diracgammaR`

*This class represents the Dirac gammaL object which behaves like 1/2 (1+gamma5).*

## Namespaces

- namespace [GiNaC](#)

## Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([clifford](#))
- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([diracone](#))
- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([cliffordunit](#))
- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([diracgamma](#))
- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([diracgamma5](#))
- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([diracgammaL](#))
- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([diracgammaR](#))
- [bool GiNaC::is\\_clifford\\_tinfo](#) (const [return\\_type\\_t](#) &ti)
 

*Check whether a given [return\\_type\\_t](#) object (as returned by [return\\_type\\_tinfo\(\)](#)) is that of a clifford object (with an arbitrary representation label).*
- [ex GiNaC::dirac\\_ONE](#) (unsigned char rl=0)
 

*Create a Clifford unity object.*
- [ex GiNaC::clifford\\_unit](#) (const [ex](#) &mu, const [ex](#) &metr, unsigned char rl=0)
 

*Create a Clifford unit object.*
- [ex GiNaC::dirac\\_gamma](#) (const [ex](#) &mu, unsigned char rl=0)
 

*Create a Dirac gamma object.*
- [ex GiNaC::dirac\\_gamma5](#) (unsigned char rl=0)
 

*Create a Dirac gamma5 object.*
- [ex GiNaC::dirac\\_gammaL](#) (unsigned char rl=0)
 

*Create a Dirac gammaL object.*
- [ex GiNaC::dirac\\_gammaR](#) (unsigned char rl=0)
 

*Create a Dirac gammaR object.*
- [ex GiNaC::dirac\\_slash](#) (const [ex](#) &e, const [ex](#) &dim, unsigned char rl=0)
 

*Create a term of the form  $e_{\mu} * \gamma^{\sim\mu}$  with a unique index  $\mu$ .*
- [ex GiNaC::dirac\\_trace](#) (const [ex](#) &e, const std::set< unsigned char > &rls, const [ex](#) &trONE=4)
 

*Calculate dirac traces over the specified set of representation labels.*
- [ex GiNaC::dirac\\_trace](#) (const [ex](#) &e, const [lst](#) &rl, const [ex](#) &trONE=4)
 

*Calculate dirac traces over the specified list of representation labels.*
- [ex GiNaC::dirac\\_trace](#) (const [ex](#) &e, unsigned char rl=0, const [ex](#) &trONE=4)
 

*Calculate the trace of an expression containing gamma objects with a specified representation label.*
- [ex GiNaC::canonicalize\\_clifford](#) (const [ex](#) &e)
 

*Bring all products of clifford objects in an expression into a canonical order.*
- [ex GiNaC::clifford\\_prime](#) (const [ex](#) &e)
 

*Automorphism of the Clifford algebra, simply changes signs of all clifford units.*
- [ex GiNaC::clifford\\_star\\_bar](#) (const [ex](#) &e, bool do\_bar, unsigned options)
 

*An auxillary function performing [clifford\\_star\(\)](#) and [clifford\\_bar\(\)](#).*
- [ex GiNaC::clifford\\_bar](#) (const [ex](#) &e)
 

*Main anti-automorphism of the Clifford algebra: makes reversion and changes signs of all clifford units.*
- [ex GiNaC::clifford\\_star](#) (const [ex](#) &e)
 

*Reversion of the Clifford algebra, reverse the order of all clifford units in ncmul.*
- [ex GiNaC::remove\\_dirac\\_ONE](#) (const [ex](#) &e, unsigned char rl=0, unsigned options=0)
 

*Replaces [dirac\\_ONE](#)'s (with a [representation\\_label](#) no less than  $rl$ ) in  $e$  with 1.*
- [int GiNaC::clifford\\_max\\_label](#) (const [ex](#) &e, bool ignore\_ONE=false)
 

*Returns the maximal representation label of a clifford object if  $e$  contains at least one, otherwise returns -1.*
- [ex GiNaC::clifford\\_norm](#) (const [ex](#) &e)

- Calculation of the norm in the Clifford algebra.*

  - `ex GiNaC::clifford_inverse` (const `ex` &e)
- Calculation of the inverse in the Clifford algebra.*

  - `ex GiNaC::lst_to_clifford` (const `ex` &v, const `ex` &mu, const `ex` &metr, unsigned char rl=0)
- List or vector conversion into the Clifford vector.*

  - `ex GiNaC::lst_to_clifford` (const `ex` &v, const `ex` &e)
- List or vector conversion into the Clifford vector.*

  - `lst GiNaC::clifford_to_lst` (const `ex` &e, const `ex` &c, bool algebraic=true)
- An inverse function to `lst_to_clifford()`.*

  - `ex GiNaC::clifford_moebius_map` (const `ex` &a, const `ex` &b, const `ex` &c, const `ex` &d, const `ex` &v, const `ex` &G, unsigned char rl=0)
- Calculations of Moebius transformations (conformal map) defined by a 2x2 Clifford matrix (a b\c d) in linear spaces with arbitrary signature.*

  - `ex GiNaC::clifford_moebius_map` (const `ex` &M, const `ex` &v, const `ex` &G, unsigned char rl=0)
- The second form of Moebius transformations defined by a 2x2 Clifford matrix M This function takes the transformation matrix M as a single entity.*

### 7.10.1 Detailed Description

Interface to `GiNaC`'s clifford algebra (Dirac gamma) objects.

## 7.11 color.cpp File Reference

Implementation of `GiNaC`'s color (SU(3) Lie algebra) objects.

```
#include "color.h"
#include "idx.h"
#include "ncmul.h"
#include "symmetry.h"
#include "operators.h"
#include "numeric.h"
#include "mul.h"
#include "power.h"
#include "symbol.h"
#include "archive.h"
#include "utils.h"
#include <iostream>
#include <stdexcept>
```

### Namespaces

- namespace `GiNaC`

### Macros

- `#define TEST_PERMUTATION(A, B, C, P)`
- `#define CMPINDICES(A, B, C)`

## Functions

- `GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`su3one`, `tensor`, `print_func< print_dflt >(&su3one::do_print)`, `print_func< print_latex >(&su3one::do_print_latex)`) `GINAC_IMPLEMENT_↵`  
`REGISTERED_CLASS_OPT(su3t`
- `GiNaC::print_func< print_dflt > (&su3t::do_print)`, `print_func< print_latex >(&su3t`
- `GiNaC::GINAC_BIND_UNARCHIVER` (`color`)
- `GiNaC::GINAC_BIND_UNARCHIVER` (`su3one`)
- `GiNaC::GINAC_BIND_UNARCHIVER` (`su3t`)
- `GiNaC::GINAC_BIND_UNARCHIVER` (`su3f`)
- `GiNaC::GINAC_BIND_UNARCHIVER` (`su3d`)
- static `ex` `GiNaC::permute_free_index_to_front` (const `exvector` &iv3, const `exvector` &iv2, int &sig)  
*Given a vector iv3 of three indices and a vector iv2 of two indices that is a subset of iv3, return the (free) index that is in iv3 but not in iv2 and the sign introduced by permuting that index to the front.*
- `ex` `GiNaC::color_ONE` (unsigned char rl=0)  
*Create the su(3) unity element.*
- `ex` `GiNaC::color_T` (const `ex` &a, unsigned char rl=0)  
*Create an su(3) generator.*
- `ex` `GiNaC::color_f` (const `ex` &a, const `ex` &b, const `ex` &c)  
*Create an su(3) antisymmetric structure constant.*
- `ex` `GiNaC::color_d` (const `ex` &a, const `ex` &b, const `ex` &c)  
*Create an su(3) symmetric structure constant.*
- `ex` `GiNaC::color_h` (const `ex` &a, const `ex` &b, const `ex` &c)  
*This returns the linear combination d.a.b.c+l\*f.a.b.c.*
- static bool `GiNaC::is_color_tinfo` (const `return_type_t` &ti)  
*Check whether a given tinfo key (as returned by `return_type_tinfo()`) is that of a color object (with an arbitrary representation label).*
- static unsigned char `GiNaC::get_representation_label` (const `return_type_t` &ti)  
*Extract representation label from tinfo key (as returned by `return_type_tinfo()`).*
- `ex` `GiNaC::color_trace` (const `ex` &e, const `std::set< unsigned char >` &rls)  
*Calculate color traces over the specified set of representation labels.*
- `ex` `GiNaC::color_trace` (const `ex` &e, const `lst` &rls)  
*Calculate color traces over the specified list of representation labels.*
- `ex` `GiNaC::color_trace` (const `ex` &e, unsigned char rl=0)  
*Calculate the trace of an expression containing color objects with a specified representation label.*

### 7.11.1 Detailed Description

Implementation of `GiNaC`'s color (SU(3) Lie algebra) objects.

### 7.11.2 Macro Definition Documentation

#### 7.11.2.1 TEST\_PERMUTATION

```
#define TEST_PERMUTATION(
 A,
 B,
 C,
 P)
```

**Value:**

```
if (iv3[B].is_equal(iv2[0]) && iv3[C].is_equal(iv2[1])) { \
 sig = P; \
 return iv3[A]; \
}
```

Referenced by `GiNaC::permute_free_index_to_front()`.

### 7.11.2.2 CMPINDICES

```
#define CMPINDICES(
 A,
 B,
 C)
```

**Value:**

```
((v[0] == (A)) && (v[1] == (B)) && (v[2] == (C)))
```

Referenced by [GiNaC::su3d::eval\\_indexed\(\)](#), and [GiNaC::su3f::eval\\_indexed\(\)](#).

## 7.12 color.h File Reference

Interface to [GiNaC](#)'s color (SU(3) Lie algebra) objects.

```
#include "indexed.h"
#include "tensor.h"
#include <set>
```

**Classes**

- class [GiNaC::color](#)  
*This class holds a generator  $T_a$  or the unity element of the Lie algebra of SU(3), as used for calculations in quantum chromodynamics.*
- class [GiNaC::su3one](#)  
*This class represents the su(3) unity element.*
- class [GiNaC::su3t](#)  
*This class represents an su(3) generator.*
- class [GiNaC::su3f](#)  
*This class represents the tensor of antisymmetric su(3) structure constants.*
- class [GiNaC::su3d](#)  
*This class represents the tensor of symmetric su(3) structure constants.*

**Namespaces**

- namespace [GiNaC](#)

## Functions

- `GiNaC::GINAC_DECLARE_UNARCHIVER (color)`
- `GiNaC::GINAC_DECLARE_UNARCHIVER (su3one)`
- `GiNaC::GINAC_DECLARE_UNARCHIVER (su3t)`
- `GiNaC::GINAC_DECLARE_UNARCHIVER (su3f)`
- `GiNaC::GINAC_DECLARE_UNARCHIVER (su3d)`
- `ex GiNaC::color_ONE` (unsigned char rl=0)  
*Create the su(3) unity element.*
- `ex GiNaC::color_T` (const `ex` &a, unsigned char rl=0)  
*Create an su(3) generator.*
- `ex GiNaC::color_f` (const `ex` &a, const `ex` &b, const `ex` &c)  
*Create an su(3) antisymmetric structure constant.*
- `ex GiNaC::color_d` (const `ex` &a, const `ex` &b, const `ex` &c)  
*Create an su(3) symmetric structure constant.*
- `ex GiNaC::color_h` (const `ex` &a, const `ex` &b, const `ex` &c)  
*This returns the linear combination d.a.b.c+l\*f.a.b.c.*
- `ex GiNaC::color_trace` (const `ex` &e, const `std::set< unsigned char >` &rls)  
*Calculate color traces over the specified set of representation labels.*
- `ex GiNaC::color_trace` (const `ex` &e, const `lst` &rl)  
*Calculate color traces over the specified list of representation labels.*
- `ex GiNaC::color_trace` (const `ex` &e, unsigned char rl=0)  
*Calculate the trace of an expression containing color objects with a specified representation label.*

### 7.12.1 Detailed Description

Interface to `GiNaC`'s color (SU(3) Lie algebra) objects.

## 7.13 compiler.h File Reference

Definition of optimizing macros.

### Macros

- `#define unlikely(cond)`
- `#define likely(cond)`
- `#define attribute_deprecated`

### 7.13.1 Detailed Description

Definition of optimizing macros.

## 7.13.2 Macro Definition Documentation

### 7.13.2.1 unlikely

```
#define unlikely(
 cond)
```

**Value:**

(cond)

Referenced by [GiNaC::add::eval\(\)](#), [GiNaC::mul::eval\(\)](#), and [GiNaC::expairseq::evalchildren\(\)](#).

### 7.13.2.2 likely

```
#define likely(
 cond)
```

**Value:**

(cond)

Referenced by [GiNaC::add::combine\\_ex\\_with\\_coeff\\_to\\_pair\(\)](#), [GiNaC::mul::eval\(\)](#), and [GiNaC::power::eval\(\)](#).

### 7.13.2.3 attribute\_deprecated

```
#define attribute_deprecated
```

## 7.14 constant.cpp File Reference

Implementation of [GiNaC](#)'s constant types and some special constants.

```
#include "constant.h"
#include "numeric.h"
#include "ex.h"
#include "archive.h"
#include "utils.h"
#include "inifcns.h"
#include <iostream>
#include <stdexcept>
#include <string>
```

**Namespaces**

- namespace [GiNaC](#)



## Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([constant](#), [basic](#), [print\\_func< print\\_context >\(&constant::do\\_print\)](#), [print\\_func< print\\_latex >\(&constant::do\\_print\\_latex\)](#), [print\\_func< print\\_tree >\(&constant::do\\_print\\_tree\)](#), [print\\_func< print\\_python\\_repr >\(&constant::do\\_print\\_python\\_repr\)](#)) [constant](#)
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([constant](#))

## Variables

- [const constant GiNaC::Pi](#) ("Pi", [PiEvalf](#), "\\pi", [domain::positive](#))  
*Pi.*
- [const constant GiNaC::Euler](#) ("Euler", [EulerEvalf](#), "\\gamma\_E", [domain::positive](#))  
*Euler's constant.*
- [const constant GiNaC::Catalan](#) ("Catalan", [CatalanEvalf](#), "G", [domain::positive](#))  
*Catalan's constant.*

### 7.14.1 Detailed Description

Implementation of [GiNaC](#)'s constant types and some special constants.

## 7.15 constant.h File Reference

Interface to [GiNaC](#)'s constant types and some special constants.

```
#include "basic.h"
#include "ex.h"
#include "archive.h"
#include <string>
```

## Classes

- class [GiNaC::constant](#)  
*This class holds constants, symbols with specific numerical value.*

## Namespaces

- namespace [GiNaC](#)

## Typedefs

- typedef [ex](#)(\* [GiNaC::evalffunctype](#)) ()

## Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([constant](#))

### 7.15.1 Detailed Description

Interface to [GiNaC](#)'s constant types and some special constants.

## 7.16 container.h File Reference

Wrapper template for making [GiNaC](#) classes out of STL containers.

```
#include "ex.h"
#include "print.h"
#include "archive.h"
#include "assertion.h"
#include "compiler.h"
#include <algorithm>
#include <iterator>
#include <list>
#include <memory>
#include <stdexcept>
#include <vector>
```

### Classes

- class [GiNaC::container\\_storage< C >](#)  
*Helper template for encapsulating the [reserve\(\)](#) mechanics of STL containers.*
- class [GiNaC::container< C >](#)  
*Wrapper template for making [GiNaC](#) classes out of STL containers.*

### Namespaces

- namespace [GiNaC](#)

### 7.16.1 Detailed Description

Wrapper template for making [GiNaC](#) classes out of STL containers.

## 7.17 crc32.h File Reference

CRC32 hash function.

### Namespaces

- namespace [GiNaC](#)

## Functions

- static unsigned [GiNaC::crc32](#) (const char \*c, const unsigned len, const unsigned crcinit)

## Variables

- static unsigned const [GiNaC::crctab](#) [256]

### 7.17.1 Detailed Description

CRC32 hash function.

Shamelessly stolen from GNU coreutils (cksum.c).

## 7.18 ex.cpp File Reference

Implementation of [GiNaC](#)'s light-weight expression handles.

```
#include "ex.h"
#include "add.h"
#include "mul.h"
#include "ncmul.h"
#include "numeric.h"
#include "matrix.h"
#include "power.h"
#include "lst.h"
#include "relational.h"
#include "utils.h"
#include <iostream>
#include <stdexcept>
```

## Namespaces

- namespace [GiNaC](#)

### 7.18.1 Detailed Description

Implementation of [GiNaC](#)'s light-weight expression handles.

## 7.19 ex.h File Reference

Interface to [GiNaC](#)'s light-weight expression handles.

```
#include "basic.h"
#include "ptr.h"
#include <functional>
#include <iosfwd>
#include <iterator>
#include <memory>
#include <stack>
```

## Classes

- class [GiNaC::library\\_init](#)  
*Helper class to initialize the library.*
- class [GiNaC::ex](#)  
*Lightweight wrapper for [GiNaC](#)'s symbolic objects.*
- class [GiNaC::const\\_iterator](#)
- struct [GiNaC::internal::\\_iter\\_rep](#)
- class [GiNaC::const\\_preorder\\_iterator](#)
- class [GiNaC::const\\_postorder\\_iterator](#)
- struct [GiNaC::ex\\_is\\_less](#)
- struct [GiNaC::ex\\_is\\_equal](#)
- struct [GiNaC::op0\\_is\\_equal](#)
- struct [GiNaC::ex\\_swap](#)
- class [GiNaC::pointer\\_to\\_map\\_function](#)
- class [GiNaC::pointer\\_to\\_map\\_function\\_1arg< T1 >](#)
- class [GiNaC::pointer\\_to\\_map\\_function\\_2args< T1, T2 >](#)
- class [GiNaC::pointer\\_to\\_map\\_function\\_3args< T1, T2, T3 >](#)
- class [GiNaC::pointer\\_to\\_member\\_to\\_map\\_function< C >](#)
- class [GiNaC::pointer\\_to\\_member\\_to\\_map\\_function\\_1arg< C, T1 >](#)
- class [GiNaC::pointer\\_to\\_member\\_to\\_map\\_function\\_2args< C, T1, T2 >](#)
- class [GiNaC::pointer\\_to\\_member\\_to\\_map\\_function\\_3args< C, T1, T2, T3 >](#)
- struct [std::hash< GiNaC::ex >](#)  
*Specialization of `std::hash()` for `ex` objects.*
- struct [std::equal\\_to< GiNaC::ex >](#)  
*Specialization of `std::equal_to()` for `ex` objects.*

## Namespaces

- namespace [GiNaC](#)
- namespace [GiNaC::internal](#)
- namespace [std](#)

## Functions

- bool [GiNaC::are\\_ex\\_trivially\\_equal](#) (const [ex](#) &e1, const [ex](#) &e2)  
*Compare two objects of class quickly without doing a deep tree traversal.*
- [std::ostream & GiNaC::operator<<](#) (std::ostream &os, const [exvector](#) &e)
- [std::ostream & GiNaC::operator<<](#) (std::ostream &os, const [exset](#) &e)
- [std::ostream & GiNaC::operator<<](#) (std::ostream &os, const [exmap](#) &e)
- [size\\_t GiNaC::nops](#) (const [ex](#) &thisex)
- [ex GiNaC::expand](#) (const [ex](#) &thisex, unsigned options=0)
- [ex GiNaC::conjugate](#) (const [ex](#) &thisex)
- [ex GiNaC::real\\_part](#) (const [ex](#) &thisex)
- [ex GiNaC::imag\\_part](#) (const [ex](#) &thisex)
- bool [GiNaC::has](#) (const [ex](#) &thisex, const [ex](#) &pattern, unsigned options=0)
- bool [GiNaC::find](#) (const [ex](#) &thisex, const [ex](#) &pattern, [exset](#) &found)
- bool [GiNaC::is\\_polynomial](#) (const [ex](#) &thisex, const [ex](#) &vars)
- int [GiNaC::degree](#) (const [ex](#) &thisex, const [ex](#) &s)
- int [GiNaC::ldegree](#) (const [ex](#) &thisex, const [ex](#) &s)
- [ex GiNaC::coeff](#) (const [ex](#) &thisex, const [ex](#) &s, int n=1)
- [ex GiNaC::numer](#) (const [ex](#) &thisex)

- `ex GiNaC::denom` (const `ex` &thisex)
- `ex GiNaC::numer_denom` (const `ex` &thisex)
- `ex GiNaC::normal` (const `ex` &thisex)
- `ex GiNaC::to_rational` (const `ex` &thisex, `exmap` &repl)
- `ex GiNaC::to_polynomial` (const `ex` &thisex, `exmap` &repl)
- `ex GiNaC::collect` (const `ex` &thisex, const `ex` &s, bool distributed=false)
- `ex GiNaC::eval` (const `ex` &thisex)
- `ex GiNaC::evalf` (const `ex` &thisex)
- `ex GiNaC::evalm` (const `ex` &thisex)
- `ex GiNaC::eval_integ` (const `ex` &thisex)
- `ex GiNaC::diff` (const `ex` &thisex, const `symbol` &s, unsigned nth=1)
- `ex GiNaC::series` (const `ex` &thisex, const `ex` &r, int order, unsigned options=0)
- bool `GiNaC::match` (const `ex` &thisex, const `ex` &pattern, `exmap` &repl\_lst)
- `ex GiNaC::simplify_indexed` (const `ex` &thisex, unsigned options=0)
- `ex GiNaC::simplify_indexed` (const `ex` &thisex, const `scalar_products` &sp, unsigned options=0)
- `ex GiNaC::symmetrize` (const `ex` &thisex)
- `ex GiNaC::symmetrize` (const `ex` &thisex, const `lst` &l)
- `ex GiNaC::antisymmetrize` (const `ex` &thisex)
- `ex GiNaC::antisymmetrize` (const `ex` &thisex, const `lst` &l)
- `ex GiNaC::symmetrize_cyclic` (const `ex` &thisex)
- `ex GiNaC::symmetrize_cyclic` (const `ex` &thisex, const `lst` &l)
- `ex GiNaC::op` (const `ex` &thisex, size\_t i)
- `ex GiNaC::lhs` (const `ex` &thisex)
- `ex GiNaC::rhs` (const `ex` &thisex)
- bool `GiNaC::is_zero` (const `ex` &thisex)
- void `GiNaC::swap` (`ex` &e1, `ex` &e2)
- `ex GiNaC::subs` (const `ex` &thisex, const `exmap` &m, unsigned options=0)
- `ex GiNaC::subs` (const `ex` &thisex, const `lst` &ls, const `lst` &lr, unsigned options=0)
- `ex GiNaC::subs` (const `ex` &thisex, const `ex` &e, unsigned options=0)
- template<class T>  
bool `GiNaC::is_a` (const `ex` &obj)  
*Check if ex is a handle to a T, including base classes.*
- template<class T>  
bool `GiNaC::is_exactly_a` (const `ex` &obj)  
*Check if ex is a handle to a T, not including base classes.*
- template<class T>  
const T & `GiNaC::ex_to` (const `ex` &e)  
*Return a reference to the basic-derived class T object embedded in an expression.*
- template<> void `std::swap` (`GiNaC::ex` &a, `GiNaC::ex` &b)  
*Specialization of `std::swap()` for ex objects.*

## Variables

- static `library_init GiNaC::library_initializer`  
*For construction of flyweights, etc.*
- const `basic * GiNaC::_num0_bp`

### 7.19.1 Detailed Description

Interface to `GiNaC`'s light-weight expression handles.

## 7.20 excompiler.cpp File Reference

Functions to facilitate the conversion of a `ex` to a function pointer suited for fast numerical integration.

```
#include "excompiler.h"
#include "ex.h"
#include "lst.h"
#include "operators.h"
#include "relational.h"
#include "symbol.h"
#include <cstdlib>
#include <fstream>
#include <ios>
#include <sstream>
#include <stdexcept>
#include <string>
#include <vector>
```

### Namespaces

- namespace [GiNaC](#)

### Functions

- void [GiNaC::compile\\_ex](#) (const [ex](#) &expr, const [symbol](#) &sym, [FUNCP\\_1P](#) &fp, const std::string filename="")  
*Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.*
- void [GiNaC::compile\\_ex](#) (const [ex](#) &expr, const [symbol](#) &sym1, const [symbol](#) &sym2, [FUNCP\\_2P](#) &fp, const std::string filename="")  
*Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.*
- void [GiNaC::compile\\_ex](#) (const [lst](#) &exprs, const [lst](#) &syms, [FUNCP\\_CUBA](#) &fp, const std::string filename="")  
*Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.*
- void [GiNaC::link\\_ex](#) (const std::string filename, [FUNCP\\_1P](#) &fp)  
*Opens an existing so-file and returns a function pointer of type [FUNCP\\_1P](#) to the contained function.*
- void [GiNaC::link\\_ex](#) (const std::string filename, [FUNCP\\_2P](#) &fp)  
*Opens an existing so-file and returns a function pointer of type [FUNCP\\_2P](#) to the contained function.*
- void [GiNaC::link\\_ex](#) (const std::string filename, [FUNCP\\_CUBA](#) &fp)  
*Opens an existing so-file and returns a function pointer of type [FUNCP\\_CUBA](#) to the contained function.*
- void [GiNaC::unlink\\_ex](#) (const std::string filename)  
*Closes all linked .so files that have the supplied filename.*

### 7.20.1 Detailed Description

Functions to facilitate the conversion of a `ex` to a function pointer suited for fast numerical integration.

## 7.21 excompiler.h File Reference

Functions to facilitate the conversion of a `ex` to a function pointer suited for fast numerical integration.

```
#include "lst.h"
#include <string>
```

## Namespaces

- namespace [GiNaC](#)

## Typedefs

- typedef double(\* [GiNaC::FUNCP\\_1P](#)) (double)  
*Function pointer with one function parameter.*
- typedef double(\* [GiNaC::FUNCP\\_2P](#)) (double, double)  
*Function pointer with two function parameters.*
- typedef void(\* [GiNaC::FUNCP\\_CUBA](#)) (const int \*, const double[], const int \*, double[])  
*Function pointer for use with the CUBA library ( <http://www.feynarts.de/cuba>).*

## Functions

- void [GiNaC::compile\\_ex](#) (const [ex](#) &expr, const [symbol](#) &sym, [FUNCP\\_1P](#) &fp, const std::string filename="")  
*Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.*
- void [GiNaC::compile\\_ex](#) (const [ex](#) &expr, const [symbol](#) &sym1, const [symbol](#) &sym2, [FUNCP\\_2P](#) &fp, const std::string filename="")  
*Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.*
- void [GiNaC::compile\\_ex](#) (const [lst](#) &exprs, const [lst](#) &syms, [FUNCP\\_CUBA](#) &fp, const std::string filename="")  
*Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.*
- void [GiNaC::link\\_ex](#) (const std::string filename, [FUNCP\\_1P](#) &fp)  
*Opens an existing so-file and returns a function pointer of type [FUNCP\\_1P](#) to the contained function.*
- void [GiNaC::link\\_ex](#) (const std::string filename, [FUNCP\\_2P](#) &fp)  
*Opens an existing so-file and returns a function pointer of type [FUNCP\\_2P](#) to the contained function.*
- void [GiNaC::link\\_ex](#) (const std::string filename, [FUNCP\\_CUBA](#) &fp)  
*Opens an existing so-file and returns a function pointer of type [FUNCP\\_CUBA](#) to the contained function.*
- void [GiNaC::unlink\\_ex](#) (const std::string filename)  
*Closes all linked .so files that have the supplied filename.*

### 7.21.1 Detailed Description

Functions to facilitate the conversion of a `ex` to a function pointer suited for fast numerical integration.

## 7.22 expair.cpp File Reference

Implementation of expression pairs (building blocks of `expairseq`).

```
#include "expair.h"
#include "operators.h"
#include <iostream>
```

## Namespaces

- namespace [GiNaC](#)

### 7.22.1 Detailed Description

Implementation of expression pairs (building blocks of `expairseq`).

## 7.23 `expair.h` File Reference

Definition of expression pairs (building blocks of `expairseq`).

```
#include "ex.h"
#include "numeric.h"
#include "print.h"
```

### Classes

- class [GiNaC::expair](#)  
*A pair of expressions.*
- struct [GiNaC::expair\\_is\\_less](#)  
*Function object for insertion into third argument of STL's `sort()` etc.*
- struct [GiNaC::expair\\_rest\\_is\\_less](#)  
*Function object not caring about the numerical coefficients for insertion into third argument of STL's `sort()`.*
- struct [GiNaC::expair\\_swap](#)

### Namespaces

- namespace [GiNaC](#)

### Functions

- void [GiNaC::swap](#) ([expair](#) &e1, [expair](#) &e2)

### 7.23.1 Detailed Description

Definition of expression pairs (building blocks of `expairseq`).



## 7.24 expairseq.cpp File Reference

Implementation of sequences of expression pairs.

```
#include "expairseq.h"
#include "lst.h"
#include "add.h"
#include "mul.h"
#include "power.h"
#include "relational.h"
#include "wildcard.h"
#include "archive.h"
#include "operators.h"
#include "utils.h"
#include "hash_seed.h"
#include "indexed.h"
#include "compiler.h"
#include <algorithm>
#include <iostream>
#include <iterator>
#include <memory>
#include <stdexcept>
#include <string>
```

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([expairseq](#), [basic](#), [print\\_func< print\\_context >\(&expairseq::do\\_print\)](#), [print\\_func< print\\_tree >\(&expairseq::do\\_print\\_tree\)](#)) [class epp\\_is\\_less](#)
- [epvector](#) \* [GiNaC::conjugateepvector](#) (const [epvector](#) &)

*Complex conjugate every element of an epvector.*

### 7.24.1 Detailed Description

Implementation of sequences of expression pairs.

## 7.25 expairseq.h File Reference

Interface to sequences of expression pairs.

```
#include "expair.h"
#include "indexed.h"
#include <vector>
```

## Classes

- class [GiNaC::expairseq](#)  
*A sequence of class expair.*
- class [GiNaC::make\\_flat\\_inserter](#)  
*Class to handle the renaming of dummy indices.*

## Namespaces

- namespace [GiNaC](#)

## Typedefs

- typedef std::vector< [expair](#) > [GiNaC::epvector](#)  
*expair-vector*
- typedef epvector::iterator [GiNaC::epp](#)  
*expair-vector pointer*

## Functions

- [epvector](#) \* [GiNaC::conjugateepvector](#) (const [epvector](#) &)  
*Complex conjugate every element of an epvector.*

### 7.25.1 Detailed Description

Interface to sequences of expression pairs.

## 7.26 exprseq.cpp File Reference

Implementation of [GiNaC](#)'s exprseq.

```
#include "exprseq.h"
```

## Namespaces

- namespace [GiNaC](#)

### 7.26.1 Detailed Description

Implementation of [GiNaC](#)'s exprseq.

## 7.27 exprseq.h File Reference

Definition of [GiNaC](#)'s exprseq.

```
#include "container.h"
#include <vector>
```

### Namespaces

- namespace [GiNaC](#)

### Typedefs

- typedef [container](#)< std::vector > [GiNaC::exprseq](#)

### 7.27.1 Detailed Description

Definition of [GiNaC](#)'s exprseq.

## 7.28 factor.cpp File Reference

Polynomial factorization (implementation).

```
#include "factor.h"
#include "ex.h"
#include "numeric.h"
#include "operators.h"
#include "inifcns.h"
#include "symbol.h"
#include "relational.h"
#include "power.h"
#include "mul.h"
#include "normal.h"
#include "add.h"
#include <type_traits>
#include <algorithm>
#include <limits>
#include <list>
#include <vector>
#include <stack>
#include <cln/cln.h>
```

### Namespaces

- namespace [GiNaC](#)

## Macros

- `#define DCOUT(str)`
- `#define DCOUTVAR(var)`
- `#define DCOUT2(str, var)`
- `#define USE_SAME_DEGREE_FACTOR`

## Functions

- `ex GiNaC::factor` (const `ex` &poly, unsigned options)

*Interface function to the outside world.*

### 7.28.1 Detailed Description

Polynomial factorization (implementation).

The interface function `factor()` at the end of this file is defined in the `GiNaC` namespace. All other utility functions and classes are defined in an additional anonymous namespace.

Factorization starts by doing a square free factorization and making the coefficients integer. Then, depending on the number of free variables it proceeds either in dedicated univariate or multivariate factorization code.

Univariate factorization does a modular factorization via Berlekamp's algorithm and distinct degree factorization. Hensel lifting is used at the end.

Multivariate factorization uses the univariate factorization (applying a evaluation homomorphism first) and Hensel lifting raises the answer to the multivariate domain. The Hensel lifting code is completely distinct from the code used by the univariate factorization.

Algorithms used can be found in [Wan] An Improved Multivariate Polynomial Factoring Algorithm, P.S.Wang, Mathematics of Computation, Vol. 32, No. 144 (1978) 1215–1231. [GCL] Algorithms for Computer Algebra, K.O.Geddes, S.R.Czapor, G.Labahn, Springer Verlag, 1992. [Mig] Some Useful Bounds, M.Mignotte, In "Computer Algebra, Symbolic and Algebraic Computation" (B.Buchberger et al., eds.), pp. 259-263, Springer-Verlag, New York, 1982.

### 7.28.2 Macro Definition Documentation

#### 7.28.2.1 DCOUT

```
#define DCOUT(
 str)
```

#### 7.28.2.2 DCOUTVAR

```
#define DCOUTVAR(
 var)
```

#### 7.28.2.3 DCOUT2

```
#define DCOUT2(
 str,
 var)
```

### 7.28.2.4 USE\_SAME\_DEGREE\_FACTOR

```
#define USE_SAME_DEGREE_FACTOR
```

## 7.29 factor.h File Reference

Polynomial factorization.

### Namespaces

- namespace [GiNaC](#)

### Functions

- [ex GiNaC::factor](#) (const [ex](#) &poly, unsigned options)  
*Interface function to the outside world.*

### 7.29.1 Detailed Description

Polynomial factorization.

## 7.30 fail.cpp File Reference

Implementation of class signaling failure of operation.

```
#include "fail.h"
#include "archive.h"
#include "utils.h"
#include <iostream>
```

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (fail, basic, print\_func< [print\\_context](#) >(&fail::do\_print). print\_func< [print\\_tree](#) >(&fail::do\_print\_tree)) [GINAC\\_BIND\\_UNARCHIVER](#)(fail)

### 7.30.1 Detailed Description

Implementation of class signaling failure of operation.

Considered somewhat obsolete (most of this can be replaced by exceptions).

## 7.31 fail.h File Reference

Interface to class signaling failure of operation.

```
#include "basic.h"
#include "archive.h"
```

### Classes

- class [GiNaC::fail](#)

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([fail](#))

### 7.31.1 Detailed Description

Interface to class signaling failure of operation.

Considered obsolete somewhat obsolete (most of this can be replaced by exceptions).

## 7.32 fderivative.cpp File Reference

Implementation of abstract derivatives of functions.

```
#include "fderivative.h"
#include "operators.h"
#include "archive.h"
#include "utils.h"
#include <iostream>
```

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([fderivative](#), [function](#), [print\\_func< print\\_context >\(&fderivative::do\\_print\)](#), [print\\_func< print\\_latex >\(&fderivative::do\\_print\\_latex\)](#), [print\\_func< print\\_csrc >\(&fderivative::do\\_print\\_csrc\)](#), [print\\_func< print\\_tree >\(&fderivative::do\\_print\\_tree\)](#)) [fderivative](#)
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([fderivative](#))

### 7.32.1 Detailed Description

Implementation of abstract derivatives of functions.

## 7.33 fderivative.h File Reference

Interface to abstract derivatives of functions.

```
#include "function.h"
#include <set>
```

### Classes

- class [GiNaC::fderivative](#)  
*This class represents the (abstract) derivative of a symbolic function.*

### Namespaces

- namespace [GiNaC](#)

### Typedefs

- typedef std::multiset< unsigned > [GiNaC::paramset](#)

### Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([fderivative](#))

### 7.33.1 Detailed Description

Interface to abstract derivatives of functions.

## 7.34 flags.h File Reference

Collection of all flags used through the [GiNaC](#) framework.

## Classes

- class [GiNaC::expand\\_options](#)  
*Flags to control the behavior of `expand()`.*
- class [GiNaC::has\\_options](#)  
*Flags to control the behavior of `has()`.*
- class [GiNaC::subs\\_options](#)  
*Flags to control the behavior of `subs()`.*
- class [GiNaC::domain](#)  
*Domain of an object.*
- class [GiNaC::series\\_options](#)  
*Flags to control series expansion.*
- class [GiNaC::determinant\\_algo](#)  
*Switch to control algorithm for determinant computation.*
- class [GiNaC::solve\\_algo](#)  
*Switch to control algorithm for linear system solving.*
- class [GiNaC::status\\_flags](#)  
*Flags to store information about the state of an object.*
- class [GiNaC::info\\_flags](#)  
*Possible attributes an object can have.*
- class [GiNaC::return\\_types](#)
- class [GiNaC::remember\\_strategies](#)  
*Strategies how to clean up the function remember cache.*
- class [GiNaC::factor\\_options](#)  
*Flags to control the polynomial factorization.*

## Namespaces

- namespace [GiNaC](#)

### 7.34.1 Detailed Description

Collection of all flags used through the [GiNaC](#) framework.

## 7.35 `function.cpp` File Reference

Implementation of class of symbolic functions.

```
#include "function.h"
#include "operators.h"
#include "fderivative.h"
#include "ex.h"
#include "lst.h"
#include "symmetry.h"
#include "print.h"
#include "power.h"
#include "archive.h"
#include "inifcns.h"
#include "utils.h"
```



```
#include "hash_seed.h"
#include "remember.h"
#include <iostream>
#include <limits>
#include <list>
#include <stdexcept>
#include <string>
```

## Namespaces

- namespace [GiNaC](#)

## Functions

- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) (function)

### 7.35.1 Detailed Description

Implementation of class of symbolic functions.

## 7.36 function.h File Reference

Interface to class of symbolic functions.

```
#include "exprseq.h"
#include <string>
#include <vector>
```

## Classes

- class [GiNaC::function\\_options](#)
- class [GiNaC::do\\_taylor](#)

*Exception class thrown by classes which provide their own series expansion to signal that ordinary Taylor expansion is safe.*

- class [GiNaC::function](#)

*The class function is used to implement builtin functions like sin, cos... and user defined functions.*

## Namespaces

- namespace [GiNaC](#)

## Macros

- `#define DECLARE_FUNCTION_1P(NAME)`
- `#define DECLARE_FUNCTION_2P(NAME)`
- `#define DECLARE_FUNCTION_3P(NAME)`
- `#define DECLARE_FUNCTION_4P(NAME)`
- `#define DECLARE_FUNCTION_5P(NAME)`
- `#define DECLARE_FUNCTION_6P(NAME)`
- `#define DECLARE_FUNCTION_7P(NAME)`
- `#define DECLARE_FUNCTION_8P(NAME)`
- `#define DECLARE_FUNCTION_9P(NAME)`
- `#define DECLARE_FUNCTION_10P(NAME)`
- `#define DECLARE_FUNCTION_11P(NAME)`
- `#define DECLARE_FUNCTION_12P(NAME)`
- `#define DECLARE_FUNCTION_13P(NAME)`
- `#define DECLARE_FUNCTION_14P(NAME)`
- `#define REGISTER_FUNCTION(NAME, OPT)`
- `#define is_ex_the_function(OBJ, FUNCNAME)`

## Typedefs

- `typedef ex(* GiNaC::eval_funcp) ()`
- `typedef ex(* GiNaC::evalf_funcp) ()`
- `typedef ex(* GiNaC::conjugate_funcp) ()`
- `typedef ex(* GiNaC::real_part_funcp) ()`
- `typedef ex(* GiNaC::imag_part_funcp) ()`
- `typedef ex(* GiNaC::expand_funcp) ()`
- `typedef ex(* GiNaC::derivative_funcp) ()`
- `typedef ex(* GiNaC::expl_derivative_funcp) ()`
- `typedef ex(* GiNaC::power_funcp) ()`
- `typedef ex(* GiNaC::series_funcp) ()`
- `typedef void(* GiNaC::print_funcp) ()`
- `typedef bool(* GiNaC::info_funcp) ()`
- `typedef ex(* GiNaC::eval_funcp_1) (const ex &)`
- `typedef ex(* GiNaC::evalf_funcp_1) (const ex &)`
- `typedef ex(* GiNaC::conjugate_funcp_1) (const ex &)`
- `typedef ex(* GiNaC::real_part_funcp_1) (const ex &)`
- `typedef ex(* GiNaC::imag_part_funcp_1) (const ex &)`
- `typedef ex(* GiNaC::expand_funcp_1) (const ex &, unsigned)`
- `typedef ex(* GiNaC::derivative_funcp_1) (const ex &, unsigned)`
- `typedef ex(* GiNaC::expl_derivative_funcp_1) (const ex &, const symbol &)`
- `typedef ex(* GiNaC::power_funcp_1) (const ex &, const ex &)`
- `typedef ex(* GiNaC::series_funcp_1) (const ex &, const relational &, int, unsigned)`
- `typedef void(* GiNaC::print_funcp_1) (const ex &, const print_context &)`
- `typedef bool(* GiNaC::info_funcp_1) (const ex &, unsigned)`
- `typedef ex(* GiNaC::eval_funcp_2) (const ex &, const ex &)`
- `typedef ex(* GiNaC::evalf_funcp_2) (const ex &, const ex &)`
- `typedef ex(* GiNaC::conjugate_funcp_2) (const ex &, const ex &)`
- `typedef ex(* GiNaC::real_part_funcp_2) (const ex &, const ex &)`
- `typedef ex(* GiNaC::imag_part_funcp_2) (const ex &, const ex &)`
- `typedef ex(* GiNaC::expand_funcp_2) (const ex &, const ex &, unsigned)`
- `typedef ex(* GiNaC::derivative_funcp_2) (const ex &, const ex &, unsigned)`
- `typedef ex(* GiNaC::expl_derivative_funcp_2) (const ex &, const ex &, const symbol &)`
- `typedef ex(* GiNaC::power_funcp_2) (const ex &, const ex &, const ex &)`

- [illegible]



- [illegible]





- [illegible]

## Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) (function)
- `template<typename T>`  
`bool GiNaC::is\_the\_function (const ex &x)`

### 7.36.1 Detailed Description

Interface to class of symbolic functions.

### 7.36.2 Macro Definition Documentation

#### 7.36.2.1 DECLARE\_FUNCTION\_1P

```
#define DECLARE_FUNCTION_1P(
 NAME)
```

##### Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 1; \
template< typename T1 > const GiNaC::function NAME(const T1 & p1) { \
 return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1)); \
}
```

#### 7.36.2.2 DECLARE\_FUNCTION\_2P

```
#define DECLARE_FUNCTION_2P(
 NAME)
```

##### Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 2; \
template< typename T1, typename T2 > const GiNaC::function NAME(const T1 & p1, const T2 & p2) { \
 return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2)); \
}
```

#### 7.36.2.3 DECLARE\_FUNCTION\_3P

```
#define DECLARE_FUNCTION_3P(
 NAME)
```

##### Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 3; \
template< typename T1, typename T2, typename T3 > const GiNaC::function NAME(const T1 & p1, const T2 & p2, \
 const T3 & p3) { \
 return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3)); \
}
```



## 7.36.2.4 DECLARE\_FUNCTION\_4P

```
#define DECLARE_FUNCTION_4P (
 NAME)
```

**Value:**

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 4; \
template< typename T1, typename T2, typename T3, typename T4 > const GiNaC::function NAME(const T1 & p1,
 const T2 & p2, const T3 & p3, const T4 & p4) { \
 return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3), GiNaC::ex(p4)
); \
}
```

## 7.36.2.5 DECLARE\_FUNCTION\_5P

```
#define DECLARE_FUNCTION_5P (
 NAME)
```

**Value:**

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 5; \
template< typename T1, typename T2, typename T3, typename T4, typename T5 > const GiNaC::function NAME(
 const T1 & p1, const T2 & p2, const T3 & p3, const T4 & p4, const T5 & p5) { \
 return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
 GiNaC::ex(p4), GiNaC::ex(p5)); \
}
```

## 7.36.2.6 DECLARE\_FUNCTION\_6P

```
#define DECLARE_FUNCTION_6P (
 NAME)
```

**Value:**

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 6; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6 > const
 GiNaC::function NAME(const T1 & p1, const T2 & p2, const T3 & p3, const T4 & p4, const T5 & p5, const
 T6 & p6) { \
 return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
 GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6)); \
}
```

## 7.36.2.7 DECLARE\_FUNCTION\_7P

```
#define DECLARE_FUNCTION_7P (
 NAME)
```

**Value:**

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 7; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7 > const
 GiNaC::function NAME(const T1 & p1, const T2 & p2, const T3 & p3, const T4 & p4, const T5 & p5, const
 T6 & p6, const T7 & p7) { \
 return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
 GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7)); \
}
```

### 7.36.2.8 DECLARE\_FUNCTION\_8P

```
#define DECLARE_FUNCTION_8P (
 NAME)
```

#### Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 8; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7,
 typename T8 > const GiNaC::function NAME(const T1 & p1, const T2 & p2, const T3 & p3, const T4 & p4,
 const T5 & p5, const T6 & p6, const T7 & p7, const T8 & p8) { \
 return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
 GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7), GiNaC::ex(p8)); \
}
```

### 7.36.2.9 DECLARE\_FUNCTION\_9P

```
#define DECLARE_FUNCTION_9P (
 NAME)
```

#### Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 9; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7,
 typename T8, typename T9 > const GiNaC::function NAME(const T1 & p1, const T2 & p2, const T3 & p3,
 const T4 & p4, const T5 & p5, const T6 & p6, const T7 & p7, const T8 & p8, const T9 & p9) { \
 return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
 GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7), GiNaC::ex(p8), GiNaC::ex(p9)); \
}
```

### 7.36.2.10 DECLARE\_FUNCTION\_10P

```
#define DECLARE_FUNCTION_10P (
 NAME)
```

#### Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 10; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7,
 typename T8, typename T9, typename T10 > const GiNaC::function NAME(const T1 & p1, const T2 & p2,
 const T3 & p3, const T4 & p4, const T5 & p5, const T6 & p6, const T7 & p7, const T8 & p8, const T9 &
 p9, const T10 & p10) { \
 return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
 GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7), GiNaC::ex(p8), GiNaC::ex(p9),
 GiNaC::ex(p10)); \
}
```

### 7.36.2.11 DECLARE\_FUNCTION\_11P

```
#define DECLARE_FUNCTION_11P (
 NAME)
```

#### Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 11; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7,
 typename T8, typename T9, typename T10, typename T11 > const GiNaC::function NAME(const T1 & p1,
 const T2 & p2, const T3 & p3, const T4 & p4, const T5 & p5, const T6 & p6, const T7 & p7, const T8 &
 p8, const T9 & p9, const T10 & p10, const T11 & p11) { \
 return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
 GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7), GiNaC::ex(p8), GiNaC::ex(p9),
 GiNaC::ex(p10), GiNaC::ex(p11)); \
}
```

## 7.36.2.12 DECLARE\_FUNCTION\_12P

```
#define DECLARE_FUNCTION_12P(
 NAME)
```

## Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 12; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7,
 typename T8, typename T9, typename T10, typename T11, typename T12 > const GiNaC::function NAME(const
 T1 & p1, const T2 & p2, const T3 & p3, const T4 & p4, const T5 & p5, const T6 & p6, const T7 & p7,
 const T8 & p8, const T9 & p9, const T10 & p10, const T11 & p11, const T12 & p12) { \
 return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
 GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7), GiNaC::ex(p8), GiNaC::ex(p9),
 GiNaC::ex(p10), GiNaC::ex(p11), GiNaC::ex(p12)); \
}
```

## 7.36.2.13 DECLARE\_FUNCTION\_13P

```
#define DECLARE_FUNCTION_13P(
 NAME)
```

## Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 13; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7,
 typename T8, typename T9, typename T10, typename T11, typename T12, typename T13 > const
 GiNaC::function NAME(const T1 & p1, const T2 & p2, const T3 & p3, const T4 & p4, const T5 & p5, const
 T6 & p6, const T7 & p7, const T8 & p8, const T9 & p9, const T10 & p10, const T11 & p11, const T12 &
 p12, const T13 & p13) { \
 return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
 GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7), GiNaC::ex(p8), GiNaC::ex(p9),
 GiNaC::ex(p10), GiNaC::ex(p11), GiNaC::ex(p12), GiNaC::ex(p13)); \
}
```

## 7.36.2.14 DECLARE\_FUNCTION\_14P

```
#define DECLARE_FUNCTION_14P(
 NAME)
```

## Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 14; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7,
 typename T8, typename T9, typename T10, typename T11, typename T12, typename T13, typename T14 > const
 GiNaC::function NAME(const T1 & p1, const T2 & p2, const T3 & p3, const T4 & p4, const T5 & p5, const
 T6 & p6, const T7 & p7, const T8 & p8, const T9 & p9, const T10 & p10, const T11 & p11, const T12 &
 p12, const T13 & p13, const T14 & p14) { \
 return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
 GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7), GiNaC::ex(p8), GiNaC::ex(p9),
 GiNaC::ex(p10), GiNaC::ex(p11), GiNaC::ex(p12), GiNaC::ex(p13), GiNaC::ex(p14)); \
}
```

## 7.36.2.15 REGISTER\_FUNCTION

```
#define REGISTER_FUNCTION(
 NAME,
 OPT)
```

## Value:

```
unsigned NAME##_SERIAL::serial = \
 GiNaC::function::register_new(GiNaC::function_options(#NAME, NAME##_NPARAMS).OPT);
```

### 7.36.2.16 is\_ex\_the\_function

```
#define is_ex_the_function(
 OBJ,
 FUNCNAME)
```

#### Value:

(GiNaC::is\_the\_function<FUNCNAME##\_SERIAL> (OBJ) )

Referenced by [GiNaC::abs\\_eval\(\)](#), [GiNaC::cos\\_eval\(\)](#), [GiNaC::cosh\\_eval\(\)](#), [GiNaC::exp\\_eval\(\)](#), [GiNaC::is\\_order\\_function\(\)](#), [GiNaC::log\\_eval\(\)](#), [GiNaC::replace\\_with\\_symbol\(\)](#), [GiNaC::sin\\_eval\(\)](#), [GiNaC::sinh\\_eval\(\)](#), [GiNaC::tan\\_eval\(\)](#), and [GiNaC::tanh\\_eval\(\)](#).

## 7.37 ginac.h File Reference

This include file includes all other public [GiNaC](#) headers.

```
#include "version.h"
#include "basic.h"
#include "ex.h"
#include "normal.h"
#include "archive.h"
#include "print.h"
#include "constant.h"
#include "fail.h"
#include "integral.h"
#include "lst.h"
#include "matrix.h"
#include "numeric.h"
#include "power.h"
#include "relational.h"
#include "structure.h"
#include "symbol.h"
#include "pseries.h"
#include "wildcard.h"
#include "symmetry.h"
#include "expair.h"
#include "expairseq.h"
#include "add.h"
#include "mul.h"
#include "exprseq.h"
#include "function.h"
#include "ncmul.h"
#include "inifcns.h"
#include "fderivative.h"
#include "operators.h"
#include "hash_map.h"
#include "idx.h"
#include "indexed.h"
#include "tensor.h"
#include "color.h"
#include "clifford.h"
#include "factor.h"
#include "integration_kernel.h"
#include "excompiler.h"
#include "parser.h"
```

### 7.37.1 Detailed Description

This include file includes all other public [GiNaC](#) headers.

## 7.38 hash\_map.h File Reference

Replacement for map<> using hash tables.

```
#include <unordered_map>
```

### Namespaces

- namespace [GiNaC](#)

### Typedefs

- `template<typename T, class Hash = std::hash<ex>, class KeyEqual = std::equal_to<ex>, class Allocator = std::allocator<std::pair<const ex, T>>>>`  
using [GiNaC::exhashmap](#) = std::unordered\_map<[ex](#), T, Hash, KeyEqual, Allocator>

### 7.38.1 Detailed Description

Replacement for map<> using hash tables.

## 7.39 hash\_seed.h File Reference

Type-specific hash seed.

```
#include <typeinfo>
#include <cstring>
#include "utils.h"
```

### Namespaces

- namespace [GiNaC](#)

### Functions

- static unsigned [GiNaC::make\\_hash\\_seed](#) (const std::type\_info &tinfo)  
*We need a hash function which gives different values for objects of different types.*

### 7.39.1 Detailed Description

Type-specific hash seed.

## 7.40 idx.cpp File Reference

Implementation of [GiNaC](#)'s indices.

```
#include "idx.h"
#include "symbol.h"
#include "lst.h"
#include "relational.h"
#include "operators.h"
#include "archive.h"
#include "utils.h"
#include "hash_seed.h"
#include <iostream>
#include <sstream>
#include <stdexcept>
```

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([idx](#), [basic](#), [print\\_func< print\\_context >\(&idx::do\\_print\)](#), [print\\_func< print\\_latex >\(&idx::do\\_print\\_latex\)](#), [print\\_func< print\\_csrc >\(&idx::do\\_print\\_csrc\)](#), [print\\_func< print\\_tree >\(&idx::do\\_print\\_tree\)](#)) [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#)([varidx](#)
- [GiNaC::print\\_func< print\\_context > \(&varidx::do\\_print\)](#), [print\\_func< print\\_latex >\(&varidx](#)
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([idx](#))
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([varidx](#))
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([spinidx](#))
- [bool GiNaC::is\\_dummy\\_pair](#) (const [idx](#) &i1, const [idx](#) &i2)  
*Check whether two indices form a dummy pair.*
- [bool GiNaC::is\\_dummy\\_pair](#) (const [ex](#) &e1, const [ex](#) &e2)  
*Check whether two expressions form a dummy index pair.*
- [void GiNaC::find\\_free\\_and\\_dummy](#) ([exvector::const\\_iterator](#) it, [exvector::const\\_iterator](#) itend, [exvector](#) &out←  
\_free, [exvector](#) &out\_dummy)  
*Given a vector of indices, split them into two vectors, one containing the free indices, the other containing the dummy indices (numeric indices are neither free nor dummy ones).*
- [ex GiNaC::minimal\\_dim](#) (const [ex](#) &dim1, const [ex](#) &dim2)  
*Return the minimum of two index dimensions.*

### Variables

- [GiNaC::idx](#)

### 7.40.1 Detailed Description

Implementation of [GiNaC](#)'s indices.

## 7.41 idx.h File Reference

Interface to [GiNaC](#)'s indices.

```
#include "ex.h"
#include "numeric.h"
```

### Classes

- class [GiNaC::idx](#)  
*This class holds one index of an indexed object.*
- class [GiNaC::varidx](#)  
*This class holds an index with a variance (co- or contravariant).*
- class [GiNaC::spinidx](#)  
*This class holds a spinor index that can be dotted or undotted and that also has a variance.*

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([idx](#))
- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([varidx](#))
- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([spinidx](#))
- bool [GiNaC::is\\_dummy\\_pair](#) (const [idx](#) &i1, const [idx](#) &i2)  
*Check whether two indices form a dummy pair.*
- bool [GiNaC::is\\_dummy\\_pair](#) (const [ex](#) &e1, const [ex](#) &e2)  
*Check whether two expressions form a dummy index pair.*
- void [GiNaC::find\\_free\\_and\\_dummy](#) (exvector::const\_iterator it, exvector::const\_iterator itend, [exvector](#) &out\_free, [exvector](#) &out\_dummy)  
*Given a vector of indices, split them into two vectors, one containing the free indices, the other containing the dummy indices (numeric indices are neither free nor dummy ones).*
- void [GiNaC::find\\_free\\_and\\_dummy](#) (const [exvector](#) &v, [exvector](#) &out\_free, [exvector](#) &out\_dummy)  
*Given a vector of indices, split them into two vectors, one containing the free indices, the other containing the dummy indices (numeric indices are neither free nor dummy ones).*
- void [GiNaC::find\\_dummy\\_indices](#) (const [exvector](#) &v, [exvector](#) &out\_dummy)  
*Given a vector of indices, find the dummy indices.*
- size\_t [GiNaC::count\\_dummy\\_indices](#) (const [exvector](#) &v)  
*Count the number of dummy index pairs in an index vector.*
- size\_t [GiNaC::count\\_free\\_indices](#) (const [exvector](#) &v)  
*Count the number of dummy index pairs in an index vector.*
- [ex](#) [GiNaC::minimal\\_dim](#) (const [ex](#) &dim1, const [ex](#) &dim2)  
*Return the minimum of two index dimensions.*

### 7.41.1 Detailed Description

Interface to [GiNaC](#)'s indices.

## 7.42 indexed.cpp File Reference

Implementation of [GiNaC](#)'s indexed expressions.

```
#include "indexed.h"
#include "idx.h"
#include "add.h"
#include "mul.h"
#include "ncmul.h"
#include "power.h"
#include "relational.h"
#include "symmetry.h"
#include "operators.h"
#include "lst.h"
#include "archive.h"
#include "symbol.h"
#include "utils.h"
#include "integral.h"
#include "matrix.h"
#include "inifcns.h"
#include <iostream>
#include <limits>
#include <sstream>
#include <stdexcept>
```

### Classes

- struct [GiNaC::idx\\_is\\_equal\\_ignore\\_dim](#)
- struct [GiNaC::is\\_summation\\_idx](#)
- struct [GiNaC::ex\\_base\\_is\\_less](#)
- class [GiNaC::terminfo](#)

*This structure stores the original and symmetrized versions of terms obtained during the simplification of sums.*

- class [GiNaC::terminfo\\_is\\_less](#)
- class [GiNaC::symminfo](#)

*This structure stores the individual symmetrized terms obtained during the simplification of sums.*

- class [GiNaC::symminfo\\_is\\_less\\_by\\_symmterm](#)
- class [GiNaC::symminfo\\_is\\_less\\_by\\_orig](#)

### Namespaces

- namespace [GiNaC](#)



## Functions

- `GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`indexed`, `exprseq`, `print_func< print_context >(&indexed::do_print)`, `print_func< print_latex >(&indexed::do_print_latex)`, `print_func< print_tree >(&indexed::do_print_tree)`) `indexed`
- `GiNaC::GINAC_BIND_UNARCHIVER` (`indexed`)
- static bool `GiNaC::indices_consistent` (const `exvector` &v1, const `exvector` &v2)  
*Check whether two sorted index vectors are consistent (i.e.*
- template<class T>  
`size_t GiNaC::number_of_type` (const `exvector` &v)
- template<class T>  
`static ex GiNaC::rename_dummy_indices` (const `ex` &e, `exvector` &global\_dummy\_indices, `exvector` &local\_↵  
`_dummy_indices`)  
*Rename dummy indices in an expression.*
- static void `GiNaC::find_variant_indices` (const `exvector` &v, `exvector` &variant\_indices)  
*Given a set of indices, extract those of class varidx.*
- bool `GiNaC::reposition_dummy_indices` (`ex` &e, `exvector` &variant\_dummy\_indices, `exvector` &moved\_↵  
`indices`)  
*Raise/lower dummy indices in a single indexed objects to canonicalize their variance.*
- static void `GiNaC::product_to_exvector` (const `ex` &e, `exvector` &v, bool &non\_commutative)
- template<class T>  
`ex GiNaC::idx_symmetrization` (const `ex` &r, const `exvector` &local\_dummy\_indices)
- `ex GiNaC::simplify_indexed` (const `ex` &e, `exvector` &free\_indices, `exvector` &dummy\_indices, const  
`scalar_products` &sp)  
*Simplify indexed expression, return list of free indices.*
- `ex GiNaC::simplify_indexed_product` (const `ex` &e, `exvector` &free\_indices, `exvector` &dummy\_indices, const  
`scalar_products` &sp)  
*Simplify product of indexed expressions (commutative, noncommutative and simple squares), return list of free in-  
indices.*
- bool `GiNaC::hasindex` (const `ex` &x, const `ex` &sym)
- `exvector GiNaC::get_all_dummy_indices_safely` (const `ex` &e)  
*More reliable version of the form.*
- `exvector GiNaC::get_all_dummy_indices` (const `ex` &e)  
*Returns all dummy indices from the exvector.*
- `lst GiNaC::rename_dummy_indices_uniquely` (const `exvector` &va, const `exvector` &vb)  
*Similar to above, where va and vb are the same and the return value is a list of two lists for substitution in b.*
- `ex GiNaC::rename_dummy_indices_uniquely` (const `exvector` &va, const `exvector` &vb, const `ex` &b)  
*Same as above, where va and vb contain the indices of a and b and are sorted.*
- `ex GiNaC::rename_dummy_indices_uniquely` (const `ex` &a, const `ex` &b)  
*Returns b with all dummy indices, which are common with a, renamed.*
- `ex GiNaC::rename_dummy_indices_uniquely` (`exvector` &va, const `ex` &b, bool modify\_va=false)  
*Returns b with all dummy indices, which are listed in va, renamed if modify\_va is set to TRUE all dummy indices of b  
will be appended to va.*
- `ex GiNaC::expand_dummy_sum` (const `ex` &e, bool subs\_idx=false)  
*This function returns the given expression with expanded sums for all dummy index summations, where the dimen-  
sionality of the dummy index is a nonnegative integer.*

### 7.42.1 Detailed Description

Implementation of `GiNaC`'s indexed expressions.

## 7.43 indexed.h File Reference

Interface to [GiNaC](#)'s indexed expressions.

```
#include "exprseq.h"
#include "wildcard.h"
#include <map>
```

### Classes

- class [GiNaC::indexed](#)  
*This class holds an indexed expression.*
- class [GiNaC::spmapkey](#)
- class [GiNaC::scalar\\_products](#)  
*Helper class for storing information about known scalar products which are to be automatically replaced by [simplify\\_indexed\(\)](#).*

### Namespaces

- namespace [GiNaC](#)

### Typedefs

- typedef std::map< [spmapkey](#), [ex](#) > [GiNaC::spmap](#)

### Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([indexed](#))
- [exvector](#) [GiNaC::get\\_all\\_dummy\\_indices](#) (const [ex](#) &[e](#))  
*Returns all dummy indices from the exvector.*
- [exvector](#) [GiNaC::get\\_all\\_dummy\\_indices\\_safely](#) (const [ex](#) &[e](#))  
*More reliable version of the form.*
- [ex](#) [GiNaC::rename\\_dummy\\_indices\\_uniquely](#) ([exvector](#) &[va](#), const [ex](#) &[b](#), bool [modify\\_va](#)=false)  
*Returns [b](#) with all dummy indices, which are listed in [va](#), renamed if [modify\\_va](#) is set to TRUE all dummy indices of [b](#) will be appended to [va](#).*
- [ex](#) [GiNaC::rename\\_dummy\\_indices\\_uniquely](#) (const [ex](#) &[a](#), const [ex](#) &[b](#))  
*Returns [b](#) with all dummy indices, which are common with [a](#), renamed.*
- [ex](#) [GiNaC::rename\\_dummy\\_indices\\_uniquely](#) (const [exvector](#) &[va](#), const [exvector](#) &[vb](#), const [ex](#) &[b](#))  
*Same as above, where [va](#) and [vb](#) contain the indices of [a](#) and [b](#) and are sorted.*
- [lst](#) [GiNaC::rename\\_dummy\\_indices\\_uniquely](#) (const [exvector](#) &[va](#), const [exvector](#) &[vb](#))  
*Similar to above, where [va](#) and [vb](#) are the same and the return value is a list of two lists for substitution in [b](#).*
- [ex](#) [GiNaC::expand\\_dummy\\_sum](#) (const [ex](#) &[e](#), bool [subs\\_idx](#)=false)  
*This function returns the given expression with expanded sums for all dummy index summations, where the dimensionality of the dummy index is a nonnegative integer.*

### 7.43.1 Detailed Description

Interface to [GiNaC](#)'s indexed expressions.

## 7.44 inifcns.cpp File Reference

Implementation of [GiNaC](#)'s initially known functions.

```
#include "inifcns.h"
#include "ex.h"
#include "constant.h"
#include "lst.h"
#include "fderivative.h"
#include "matrix.h"
#include "mul.h"
#include "power.h"
#include "operators.h"
#include "relational.h"
#include "pseries.h"
#include "symbol.h"
#include "symmetry.h"
#include "utils.h"
#include <stdexcept>
#include <vector>
```

### Classes

- class [GiNaC::symbolset](#)

### Namespaces

- namespace [GiNaC](#)

### Functions

- static [ex](#) [GiNaC::conjugate\\_evalf](#) (const [ex](#) &arg)
- static [ex](#) [GiNaC::conjugate\\_eval](#) (const [ex](#) &arg)
- static void [GiNaC::conjugate\\_print\\_latex](#) (const [ex](#) &arg, const [print\\_context](#) &c)
- static [ex](#) [GiNaC::conjugate\\_conjugate](#) (const [ex](#) &arg)
- static [ex](#) [GiNaC::conjugate\\_expl\\_derivative](#) (const [ex](#) &arg, const [symbol](#) &s)
- static [ex](#) [GiNaC::conjugate\\_real\\_part](#) (const [ex](#) &arg)
- static [ex](#) [GiNaC::conjugate\\_imag\\_part](#) (const [ex](#) &arg)
- static bool [GiNaC::func\\_arg\\_info](#) (const [ex](#) &arg, unsigned inf)
- static bool [GiNaC::conjugate\\_info](#) (const [ex](#) &arg, unsigned inf)
- [GiNaC::REGISTER\\_FUNCTION](#) (conjugate\_function, eval\_func([conjugate\\_eval](#)). evalf\_func([conjugate\\_evalf](#)).  
expl\_derivative\_func([conjugate\\_expl\\_derivative](#)). info\_func([conjugate\\_info](#)). print\_func< [print\\_latex](#)  
>([conjugate\\_print\\_latex](#)). conjugate\_func([conjugate\\_conjugate](#)). real\_part\_func([conjugate\\_real\\_part](#)).  
imag\_part\_func([conjugate\\_imag\\_part](#)). set\_name("conjugate","conjugate"))
- static [ex](#) [GiNaC::real\\_part\\_evalf](#) (const [ex](#) &arg)
- static [ex](#) [GiNaC::real\\_part\\_eval](#) (const [ex](#) &arg)
- static void [GiNaC::real\\_part\\_print\\_latex](#) (const [ex](#) &arg, const [print\\_context](#) &c)
- static [ex](#) [GiNaC::real\\_part\\_conjugate](#) (const [ex](#) &arg)
- static [ex](#) [GiNaC::real\\_part\\_real\\_part](#) (const [ex](#) &arg)
- static [ex](#) [GiNaC::real\\_part\\_imag\\_part](#) (const [ex](#) &arg)
- static [ex](#) [GiNaC::real\\_part\\_expl\\_derivative](#) (const [ex](#) &arg, const [symbol](#) &s)

- `GiNaC::REGISTER_FUNCTION` (real\_part\_function, eval\_func(real\_part\_eval). evalf\_func(real\_part\_evalf). expl\_derivative\_func(real\_part\_expl\_derivative). print\_func< print\_latex >(real\_part\_print\_latex). conjugate\_func(real\_part\_conjugate). real\_part\_func(real\_part\_real\_part). imag\_part\_func(real\_part\_imag\_part). set\_name("real\_part", "real\_part"))
- static `ex` `GiNaC::imag_part_evalf` (const `ex` &arg)
- static `ex` `GiNaC::imag_part_eval` (const `ex` &arg)
- static void `GiNaC::imag_part_print_latex` (const `ex` &arg, const `print_context` &c)
- static `ex` `GiNaC::imag_part_conjugate` (const `ex` &arg)
- static `ex` `GiNaC::imag_part_real_part` (const `ex` &arg)
- static `ex` `GiNaC::imag_part_imag_part` (const `ex` &arg)
- static `ex` `GiNaC::imag_part_expl_derivative` (const `ex` &arg, const `symbol` &s)
- `GiNaC::REGISTER_FUNCTION` (imag\_part\_function, eval\_func(imag\_part\_eval). evalf\_func(imag\_part\_evalf). expl\_derivative\_func(imag\_part\_expl\_derivative). print\_func< print\_latex >(imag\_part\_print\_latex). conjugate\_func(imag\_part\_conjugate). real\_part\_func(imag\_part\_real\_part). imag\_part\_func(imag\_part\_imag\_part). set\_name("imag\_part", "imag\_part"))
- static `ex` `GiNaC::abs_evalf` (const `ex` &arg)
- static `ex` `GiNaC::abs_eval` (const `ex` &arg)
- static `ex` `GiNaC::abs_expand` (const `ex` &arg, unsigned options)
- static `ex` `GiNaC::abs_expl_derivative` (const `ex` &arg, const `symbol` &s)
- static void `GiNaC::abs_print_latex` (const `ex` &arg, const `print_context` &c)
- static void `GiNaC::abs_print_csrc_float` (const `ex` &arg, const `print_context` &c)
- static `ex` `GiNaC::abs_conjugate` (const `ex` &arg)
- static `ex` `GiNaC::abs_real_part` (const `ex` &arg)
- static `ex` `GiNaC::abs_imag_part` (const `ex` &arg)
- static `ex` `GiNaC::abs_power` (const `ex` &arg, const `ex` &exp)
- bool `GiNaC::abs_info` (const `ex` &arg, unsigned inf)
- `GiNaC::REGISTER_FUNCTION` (abs, eval\_func(abs\_eval). evalf\_func(abs\_evalf). expand\_func(abs\_expand). expl\_derivative\_func(abs\_expl\_derivative). info\_func(abs\_info). print\_func< print\_latex >(abs\_print\_latex). print\_func< print\_csrc\_float >(abs\_print\_csrc\_float). print\_func< print\_csrc\_double >(abs\_print\_csrc\_double). conjugate\_func(abs\_conjugate). real\_part\_func(abs\_real\_part). imag\_part\_func(abs\_imag\_part). power\_func(abs\_power))
- static `ex` `GiNaC::step_evalf` (const `ex` &arg)
- static `ex` `GiNaC::step_eval` (const `ex` &arg)
- static `ex` `GiNaC::step_series` (const `ex` &arg, const `relational` &rel, int order, unsigned options)
- static `ex` `GiNaC::step_conjugate` (const `ex` &arg)
- static `ex` `GiNaC::step_real_part` (const `ex` &arg)
- static `ex` `GiNaC::step_imag_part` (const `ex` &arg)
- `GiNaC::REGISTER_FUNCTION` (step, eval\_func(step\_eval). evalf\_func(step\_evalf). series\_func(step\_series). conjugate\_func(step\_conjugate). real\_part\_func(step\_real\_part). imag\_part\_func(step\_imag\_part))
- static `ex` `GiNaC::csgn_evalf` (const `ex` &arg)
- static `ex` `GiNaC::csgn_eval` (const `ex` &arg)
- static `ex` `GiNaC::csgn_series` (const `ex` &arg, const `relational` &rel, int order, unsigned options)
- static `ex` `GiNaC::csgn_conjugate` (const `ex` &arg)
- static `ex` `GiNaC::csgn_real_part` (const `ex` &arg)
- static `ex` `GiNaC::csgn_imag_part` (const `ex` &arg)
- static `ex` `GiNaC::csgn_power` (const `ex` &arg, const `ex` &exp)
- `GiNaC::REGISTER_FUNCTION` (csgn, eval\_func(csgn\_eval). evalf\_func(csgn\_evalf). series\_func(csgn\_series). conjugate\_func(csgn\_conjugate). real\_part\_func(csgn\_real\_part). imag\_part\_func(csgn\_imag\_part). power\_func(csgn\_power))
- static `ex` `GiNaC::eta_evalf` (const `ex` &x, const `ex` &y)
- static `ex` `GiNaC::eta_eval` (const `ex` &x, const `ex` &y)
- static `ex` `GiNaC::eta_series` (const `ex` &x, const `ex` &y, const `relational` &rel, int order, unsigned options)
- static `ex` `GiNaC::eta_conjugate` (const `ex` &x, const `ex` &y)
- static `ex` `GiNaC::eta_real_part` (const `ex` &x, const `ex` &y)
- static `ex` `GiNaC::eta_imag_part` (const `ex` &x, const `ex` &y)

- `GiNaC::REGISTER_FUNCTION` (`eta`, `eval_func(eta_eval)`, `evalf_func(eta_evalf)`, `series_func(eta_series)`, `latex_name("\\eta")`, `set_symmetry(sy_symm(0, 1))`, `conjugate_func(eta_conjugate)`, `real_part_func(eta_real_part)`, `imag_part_func(eta_imag_part)`)
  - static `ex` `GiNaC::Li2_evalf` (`const ex &x`)
  - static `ex` `GiNaC::Li2_eval` (`const ex &x`)
  - static `ex` `GiNaC::Li2_deriv` (`const ex &x`, unsigned `deriv_param`)
  - static `ex` `GiNaC::Li2_series` (`const ex &x`, `const relational &rel`, `int order`, unsigned `options`)
  - static `ex` `GiNaC::Li2_conjugate` (`const ex &x`)
  - `GiNaC::REGISTER_FUNCTION` (`Li2`, `eval_func(Li2_eval)`, `evalf_func(Li2_evalf)`, `derivative_func(Li2_deriv)`, `series_func(Li2_series)`, `conjugate_func(Li2_conjugate)`, `latex_name("\\mathrm{Li}_2")`)
  - static `ex` `GiNaC::Li3_eval` (`const ex &x`)
  - `GiNaC::REGISTER_FUNCTION` (`Li3`, `eval_func(Li3_eval)`, `latex_name("\\mathrm{Li}_3")`)
  - static `ex` `GiNaC::zetaderiv_eval` (`const ex &n`, `const ex &x`)
  - static `ex` `GiNaC::zetaderiv_deriv` (`const ex &n`, `const ex &x`, unsigned `deriv_param`)
  - `GiNaC::REGISTER_FUNCTION` (`zetaderiv`, `eval_func(zetaderiv_eval)`, `derivative_func(zetaderiv_deriv)`, `latex_name("\\zeta^{\\prime}")`)
  - static `ex` `GiNaC::factorial_evalf` (`const ex &x`)
  - static `ex` `GiNaC::factorial_eval` (`const ex &x`)
  - static void `GiNaC::factorial_print_dflt_latex` (`const ex &x`, `const print_context &c`)
  - static `ex` `GiNaC::factorial_conjugate` (`const ex &x`)
  - static `ex` `GiNaC::factorial_real_part` (`const ex &x`)
  - static `ex` `GiNaC::factorial_imag_part` (`const ex &x`)
  - `GiNaC::REGISTER_FUNCTION` (`factorial`, `eval_func(factorial_eval)`, `evalf_func(factorial_evalf)`, `print_func< print_dflt >(factorial_print_dflt_latex)`, `print_func< print_latex >(factorial_print_dflt_latex)`, `conjugate_func(factorial_conjugate)`, `real_part_func(factorial_real_part)`, `imag_part_func(factorial_imag_part)`)
  - static `ex` `GiNaC::binomial_evalf` (`const ex &x`, `const ex &y`)
  - static `ex` `GiNaC::binomial_sym` (`const ex &x`, `const numeric &y`)
  - static `ex` `GiNaC::binomial_eval` (`const ex &x`, `const ex &y`)
  - static `ex` `GiNaC::binomial_conjugate` (`const ex &x`, `const ex &y`)
  - static `ex` `GiNaC::binomial_real_part` (`const ex &x`, `const ex &y`)
  - static `ex` `GiNaC::binomial_imag_part` (`const ex &x`, `const ex &y`)
  - `GiNaC::REGISTER_FUNCTION` (`binomial`, `eval_func(binomial_eval)`, `evalf_func(binomial_evalf)`, `conjugate_func(binomial_conjugate)`, `real_part_func(binomial_real_part)`, `imag_part_func(binomial_imag_part)`)
  - static `ex` `GiNaC::Order_eval` (`const ex &x`)
  - static `ex` `GiNaC::Order_series` (`const ex &x`, `const relational &r`, `int order`, unsigned `options`)
  - static `ex` `GiNaC::Order_conjugate` (`const ex &x`)
  - static `ex` `GiNaC::Order_real_part` (`const ex &x`)
  - static `ex` `GiNaC::Order_imag_part` (`const ex &x`)
  - static `ex` `GiNaC::Order_power` (`const ex &x`, `const ex &e`)
  - static `ex` `GiNaC::Order_expl_derivative` (`const ex &arg`, `const symbol &s`)
  - `GiNaC::REGISTER_FUNCTION` (`Order`, `eval_func(Order_eval)`, `series_func(Order_series)`, `latex_name("\\mathcal{O}")`, `expl_derivative_func(Order_expl_derivative)`, `conjugate_func(Order_conjugate)`, `real_part_func(Order_real_part)`, `imag_part_func(Order_imag_part)`, `power_func(Order_power)`)
  - `ex` `GiNaC::lsolve` (`const ex &eqns`, `const ex &symbols`, unsigned `options=solve_algo::automatic`)
- Factorial function.*
- `const numeric` `GiNaC::fsolve` (`const ex &f`, `const symbol &x`, `const numeric &x1`, `const numeric &x2`)
- Find a real root of real-valued function f(x) numerically within a given interval.*

## Variables

- unsigned `GiNaC::force_include_tgamma` = `tgamma_SERIAL::serial`
- unsigned `GiNaC::force_include_zeta1` = `zeta1_SERIAL::serial`

### 7.44.1 Detailed Description

Implementation of [GiNaC](#)'s initially known functions.

## 7.45 inifcns.h File Reference

Interface to [GiNaC](#)'s initially known functions.

```
#include "numeric.h"
#include "function.h"
#include "ex.h"
```

### Classes

- class [GiNaC::zeta1\\_SERIAL](#)  
*Complex conjugate.*
- class [GiNaC::zeta2\\_SERIAL](#)  
*Alternating Euler sum or colored MZV.*
- class [GiNaC::G2\\_SERIAL](#)  
*Generalized multiple polylogarithm.*
- class [GiNaC::G3\\_SERIAL](#)  
*Generalized multiple polylogarithm with explicit imaginary parts.*
- class [GiNaC::psi1\\_SERIAL](#)  
*Polylogarithm and multiple polylogarithm.*
- class [GiNaC::psi2\\_SERIAL](#)  
*Derivatives of Psi-function (aka polygamma-functions).*
- class [GiNaC::iterated\\_integral2\\_SERIAL](#)  
*Complete elliptic integral of the first kind.*
- class [GiNaC::iterated\\_integral3\\_SERIAL](#)  
*Iterated integral with explicit truncation.*

### Namespaces

- namespace [GiNaC](#)

### Functions

- `template<typename T1>`  
`function GiNaC::zeta (const T1 &p1)`
- `template<typename T1, typename T2>`  
`function GiNaC::zeta (const T1 &p1, const T2 &p2)`
- `template<> bool GiNaC::is\_the\_function< zeta\_SERIAL > (const ex &x)`
- `template<typename T1, typename T2>`  
`function GiNaC::G (const T1 &x, const T2 &y)`
- `template<typename T1, typename T2, typename T3>`  
`function GiNaC::G (const T1 &x, const T2 &s, const T3 &y)`
- `template<> bool GiNaC::is\_the\_function< G\_SERIAL > (const ex &x)`

- `template<typename T1>`  
`function GiNaC::psi` (const T1 &p1)
- `template<typename T1, typename T2>`  
`function GiNaC::psi` (const T1 &p1, const T2 &p2)
- `template<> bool GiNaC::is_the_function< psi_SERIAL >` (const `ex` &x)
- `template<typename T1, typename T2>`  
`function GiNaC::iterated_integral` (const T1 &kernel\_lst, const T2 &lambda)
- `template<typename T1, typename T2, typename T3>`  
`function GiNaC::iterated_integral` (const T1 &kernel\_lst, const T2 &lambda, const T3 &N\_trunc)
- `template<> bool GiNaC::is_the_function< iterated_integral_SERIAL >` (const `ex` &x)
- `ex GiNaC::lsolve` (const `ex` &eqns, const `ex` &symbols, unsigned options=`solve_algo::automatic`)  
*Factorial function.*
- const `numeric GiNaC::fsolve` (const `ex` &f, const `symbol` &x, const `numeric` &x1, const `numeric` &x2)  
*Find a real root of real-valued function f(x) numerically within a given interval.*
- bool `GiNaC::is_order_function` (const `ex` &e)  
*Check whether a function is the Order (O(n)) function.*
- `ex GiNaC::convert_H_to_Li` (const `ex` &parameterlst, const `ex` &arg)  
*Converts a given list containing parameters for H in Remiddi/Vermaseren notation into the corresponding GiNaC functions.*

### 7.45.1 Detailed Description

Interface to [GiNaC](#)'s initially known functions.

## 7.46 inifcns\_elliptic.cpp File Reference

Implementation of some special functions related to elliptic curves.

```
#include "inifcns.h"
#include "add.h"
#include "constant.h"
#include "lst.h"
#include "mul.h"
#include "numeric.h"
#include "operators.h"
#include "power.h"
#include "pseries.h"
#include "relational.h"
#include "symbol.h"
#include "utils.h"
#include "wildcard.h"
#include "integration_kernel.h"
#include "utils_multi_iterator.h"
#include <cln/cln.h>
#include <sstream>
#include <stdexcept>
#include <vector>
#include <cmath>
```

### Namespaces

- namespace [GiNaC](#)

## Functions

- static `ex` `GiNaC::EllipticK_evalf` (const `ex` &k)
- static `ex` `GiNaC::EllipticK_eval` (const `ex` &k)
- static `ex` `GiNaC::EllipticK_deriv` (const `ex` &k, unsigned `deriv_param`)
- static `ex` `GiNaC::EllipticK_series` (const `ex` &k, const `relational` &rel, int `order`, unsigned `options`)
- static void `GiNaC::EllipticK_print_latex` (const `ex` &k, const `print_context` &c)
- `GiNaC::REGISTER_FUNCTION` (`EllipticK`, `evalf_func`(`EllipticK_evalf`). `eval_func`(`EllipticK_eval`). `derivative`↔  
\_func(`EllipticK_deriv`). `series_func`(`EllipticK_series`). `print_func`< `print_latex` >(`EllipticK_print_latex`). `do_`↔  
not\_evalf\_params())
- static `ex` `GiNaC::EllipticE_evalf` (const `ex` &k)
- static `ex` `GiNaC::EllipticE_eval` (const `ex` &k)
- static `ex` `GiNaC::EllipticE_deriv` (const `ex` &k, unsigned `deriv_param`)
- static `ex` `GiNaC::EllipticE_series` (const `ex` &k, const `relational` &rel, int `order`, unsigned `options`)
- static void `GiNaC::EllipticE_print_latex` (const `ex` &k, const `print_context` &c)
- `GiNaC::REGISTER_FUNCTION` (`EllipticE`, `evalf_func`(`EllipticE_evalf`). `eval_func`(`EllipticE_eval`). `derivative`↔  
\_func(`EllipticE_deriv`). `series_func`(`EllipticE_series`). `print_func`< `print_latex` >(`EllipticE_print_latex`). `do_`↔  
not\_evalf\_params())
- static `ex` `GiNaC::iterated_integral_evalf_impl` (const `ex` &kernel\_lst, const `ex` &lambda, const `ex` &N\_trunc)
- static `ex` `GiNaC::iterated_integral2_evalf` (const `ex` &kernel\_lst, const `ex` &lambda)
- static `ex` `GiNaC::iterated_integral3_evalf` (const `ex` &kernel\_lst, const `ex` &lambda, const `ex` &N\_trunc)
- static `ex` `GiNaC::iterated_integral2_eval` (const `ex` &kernel\_lst, const `ex` &lambda)
- static `ex` `GiNaC::iterated_integral3_eval` (const `ex` &kernel\_lst, const `ex` &lambda, const `ex` &N\_trunc)

### 7.46.1 Detailed Description

Implementation of some special functions related to elliptic curves.

The functions are: complete elliptic integral of the first kind `EllipticK(k)` complete elliptic integral of the second kind `EllipticE(k)` iterated integral `iterated_integral(a,y)` or `iterated_integral(a,y,N_trunc)`

Some remarks:

- All formulae used can be looked up in the following publication: [WW] Numerical evaluation of iterated integrals related to elliptic Feynman integrals, M.Walden, S.Weinzierl, arXiv:2010.05271
- When these routines and methods are used for scientific work that leads to publication in a scientific journal, please refer to this program as : M.Walden, S.Weinzierl, "Numerical evaluation of iterated integrals related to elliptic Feynman integrals", arXiv:2010.05271
- As these routines build on the core part of `GiNaC`, it is also polite to acknowledge C. Bauer, A. Frink, R. Kreckel, "Introduction to the GiNaC Framework for Symbolic Computation within the C++ Programming Language", J. Symbolic Computations 33, 1 (2002), cs.sc/0004015



## 7.47 inifcns\_gamma.cpp File Reference

Implementation of Gamma-function, Beta-function, Polygamma-functions, and some related stuff.

```
#include "inifcns.h"
#include "constant.h"
#include "pseries.h"
#include "numeric.h"
#include "power.h"
#include "relational.h"
#include "operators.h"
#include "symbol.h"
#include "symmetry.h"
#include "utils.h"
#include <stdexcept>
#include <vector>
```

### Namespaces

- namespace [GiNaC](#)

### Functions

- static [ex](#) [GiNaC::lgamma\\_evalf](#) (const [ex](#) &x)
- static [ex](#) [GiNaC::lgamma\\_eval](#) (const [ex](#) &x)  
*Evaluation of  $\lgamma(x)$ , the natural logarithm of the Gamma function.*
- static [ex](#) [GiNaC::lgamma\\_deriv](#) (const [ex](#) &x, unsigned deriv\_param)
- static [ex](#) [GiNaC::lgamma\\_series](#) (const [ex](#) &arg, const [relational](#) &rel, int order, unsigned options)
- static [ex](#) [GiNaC::lgamma\\_conjugate](#) (const [ex](#) &x)
- [GiNaC::REGISTER\\_FUNCTION](#) (lgamma, eval\_func([lgamma\\_eval](#)). evalf\_func([lgamma\\_evalf](#)). derivative\_↔\_func([lgamma\\_deriv](#)). series\_func([lgamma\\_series](#)). conjugate\_func([lgamma\\_conjugate](#)). latex\_name("\\log \\Gamma"))
- static [ex](#) [GiNaC::tgamma\\_evalf](#) (const [ex](#) &x)
- static [ex](#) [GiNaC::tgamma\\_eval](#) (const [ex](#) &x)  
*Evaluation of  $tgamma(x)$ , the true Gamma function.*
- static [ex](#) [GiNaC::tgamma\\_deriv](#) (const [ex](#) &x, unsigned deriv\_param)
- static [ex](#) [GiNaC::tgamma\\_series](#) (const [ex](#) &arg, const [relational](#) &rel, int order, unsigned options)
- static [ex](#) [GiNaC::tgamma\\_conjugate](#) (const [ex](#) &x)
- [GiNaC::REGISTER\\_FUNCTION](#) (tgamma, eval\_func([tgamma\\_eval](#)). evalf\_func([tgamma\\_evalf](#)). derivative\_↔\_func([tgamma\\_deriv](#)). series\_func([tgamma\\_series](#)). conjugate\_func([tgamma\\_conjugate](#)). latex\_↔\_name("\\Gamma"))
- static [ex](#) [GiNaC::beta\\_evalf](#) (const [ex](#) &x, const [ex](#) &y)
- static [ex](#) [GiNaC::beta\\_eval](#) (const [ex](#) &x, const [ex](#) &y)
- static [ex](#) [GiNaC::beta\\_deriv](#) (const [ex](#) &x, const [ex](#) &y, unsigned deriv\_param)
- static [ex](#) [GiNaC::beta\\_series](#) (const [ex](#) &arg1, const [ex](#) &arg2, const [relational](#) &rel, int order, unsigned options)
- [GiNaC::REGISTER\\_FUNCTION](#) (beta, eval\_func([beta\\_eval](#)). evalf\_func([beta\\_evalf](#)). derivative\_↔\_func([beta\\_deriv](#)). series\_func([beta\\_series](#)). latex\_name("\\mathrm{B}"). set\_symmetry([sy\\_symm](#)(0, 1)))
- static [ex](#) [GiNaC::psi1\\_evalf](#) (const [ex](#) &x)
- static [ex](#) [GiNaC::psi1\\_eval](#) (const [ex](#) &x)  
*Evaluation of digamma-function  $\psi(x)$ .*
- static [ex](#) [GiNaC::psi1\\_deriv](#) (const [ex](#) &x, unsigned deriv\_param)

- static `ex` `GiNaC::psi1_series` (const `ex` &arg, const `relational` &rel, int order, unsigned options)
- static `ex` `GiNaC::psi2_evalf` (const `ex` &n, const `ex` &x)
- static `ex` `GiNaC::psi2_eval` (const `ex` &n, const `ex` &x)  
*Evaluation of polygamma-function  $\psi(n,x)$ .*
- static `ex` `GiNaC::psi2_deriv` (const `ex` &n, const `ex` &x, unsigned deriv\_param)
- static `ex` `GiNaC::psi2_series` (const `ex` &n, const `ex` &arg, const `relational` &rel, int order, unsigned options)

### 7.47.1 Detailed Description

Implementation of Gamma-function, Beta-function, Polygamma-functions, and some related stuff.

## 7.48 inifcns\_nstdsums.cpp File Reference

Implementation of some special functions that have a representation as nested sums.

```
#include "inifcns.h"
#include "add.h"
#include "constant.h"
#include "lst.h"
#include "mul.h"
#include "numeric.h"
#include "operators.h"
#include "power.h"
#include "pseries.h"
#include "relational.h"
#include "symbol.h"
#include "utils.h"
#include "wildcard.h"
#include <cln/cln.h>
#include <sstream>
#include <stdexcept>
#include <vector>
#include <cmath>
```

### Namespaces

- namespace `GiNaC`

### Functions

- static `ex` `GiNaC::G2_evalf` (const `ex` &x\_, const `ex` &y)
- static `ex` `GiNaC::G2_eval` (const `ex` &x\_, const `ex` &y)
- static `ex` `GiNaC::G3_evalf` (const `ex` &x\_, const `ex` &s\_, const `ex` &y)
- static `ex` `GiNaC::G3_eval` (const `ex` &x\_, const `ex` &s\_, const `ex` &y)
- static `ex` `GiNaC::Li_evalf` (const `ex` &m\_, const `ex` &x\_)
- static `ex` `GiNaC::Li_eval` (const `ex` &m\_, const `ex` &x\_)
- static `ex` `GiNaC::Li_series` (const `ex` &m, const `ex` &x, const `relational` &rel, int order, unsigned options)
- static `ex` `GiNaC::Li_deriv` (const `ex` &m\_, const `ex` &x\_, unsigned deriv\_param)
- static void `GiNaC::Li_print_latex` (const `ex` &m\_, const `ex` &x\_, const `print_context` &c)

- `GiNaC::REGISTER_FUNCTION` (`Li`, `evalf_func(Li_evalf)`. `eval_func(Li_eval)`. `series_func(Li_series)`. `derivative_func(Li_deriv)`. `print_func< print_latex >(Li_print_latex)`. `do_not_evalf_params()`)
- static `ex` `GiNaC::S_evalf` (const `ex` &n, const `ex` &p, const `ex` &x)
- static `ex` `GiNaC::S_eval` (const `ex` &n, const `ex` &p, const `ex` &x)
- static `ex` `GiNaC::S_series` (const `ex` &n, const `ex` &p, const `ex` &x, const `relational` &rel, int order, unsigned options)
- static `ex` `GiNaC::S_deriv` (const `ex` &n, const `ex` &p, const `ex` &x, unsigned deriv\_param)
- static void `GiNaC::S_print_latex` (const `ex` &n, const `ex` &p, const `ex` &x, const `print_context` &c)
- `GiNaC::REGISTER_FUNCTION` (`S`, `evalf_func(S_evalf)`. `eval_func(S_eval)`. `series_func(S_series)`. `derivative_func(S_deriv)`. `print_func< print_latex >(S_print_latex)`. `do_not_evalf_params()`)
- static `ex` `GiNaC::H_evalf` (const `ex` &x1, const `ex` &x2)
- static `ex` `GiNaC::H_eval` (const `ex` &m\_, const `ex` &x)
- static `ex` `GiNaC::H_series` (const `ex` &m, const `ex` &x, const `relational` &rel, int order, unsigned options)
- static `ex` `GiNaC::H_deriv` (const `ex` &m\_, const `ex` &x, unsigned deriv\_param)
- static void `GiNaC::H_print_latex` (const `ex` &m\_, const `ex` &x, const `print_context` &c)
- `GiNaC::REGISTER_FUNCTION` (`H`, `evalf_func(H_evalf)`. `eval_func(H_eval)`. `series_func(H_series)`. `derivative_func(H_deriv)`. `print_func< print_latex >(H_print_latex)`. `do_not_evalf_params()`)
- `ex` `GiNaC::convert_H_to_Li` (const `ex` &parameterlst, const `ex` &arg)  
*Converts a given list containing parameters for H in Remiddi/Vermaseren notation into the corresponding GiNaC functions.*
- static `ex` `GiNaC::zeta1_evalf` (const `ex` &x)
- static `ex` `GiNaC::zeta1_eval` (const `ex` &m)
- static `ex` `GiNaC::zeta1_deriv` (const `ex` &m, unsigned deriv\_param)
- static void `GiNaC::zeta1_print_latex` (const `ex` &m\_, const `print_context` &c)
- static `ex` `GiNaC::zeta2_evalf` (const `ex` &x, const `ex` &s)
- static `ex` `GiNaC::zeta2_eval` (const `ex` &m, const `ex` &s\_)
- static `ex` `GiNaC::zeta2_deriv` (const `ex` &m, const `ex` &s, unsigned deriv\_param)
- static void `GiNaC::zeta2_print_latex` (const `ex` &m\_, const `ex` &s\_, const `print_context` &c)

### 7.48.1 Detailed Description

Implementation of some special functions that have a representation as nested sums.

The functions are: classical polylogarithm  $\text{Li}(n,x)$  multiple polylogarithm  $\text{Li}(\{m_1,\dots,m_k\},\{x_1,\dots,x_k\})$   $G(\{a_1,\dots,a_k\},y)$  or  $G(\{a_1,\dots,a_k\},\{s_1,\dots,s_k\},y)$  Nielsen's generalized polylogarithm  $S(n,p,x)$  harmonic polylogarithm  $H(m,x)$  or  $H(\{m_1,\dots,m_k\},x)$  multiple zeta value  $\text{zeta}(m)$  or  $\text{zeta}(\{m_1,\dots,m_k\})$  alternating Euler sum  $\text{zeta}(m,s)$  or  $\text{zeta}(\{m_1,\dots,m_k\},\{s_1,\dots,s_k\})$

Some remarks:

- All formulae used can be looked up in the following publications: [Kol] Nielsen's Generalized Polylogarithms, K.S.Kolbig, SIAM J.Math.Anal. 17 (1986), pp. 1232-1258. [Cra] Fast Evaluation of Multiple Zeta Sums, R.E.Crandall, Math.Comp. 67 (1998), pp. 1163-1172. [ReV] Harmonic Polylogarithms, E.Remiddi, J.A. Vermaseren, Int.J.Mod.Phys. A15 (2000), pp. 725-754 [BBB] Special Values of Multiple Polylogarithms, J.Borwein, D.Bradley, D.Broadhurst, P.Lisonek, Trans.Amer.Math.Soc. 353/3 (2001), pp. 907-941 [VSW] Numerical evaluation of multiple polylogarithms, J.Vollinga, S.Weinzierl, hep-ph/0410259
- The order of parameters and arguments of Li and zeta is defined according to the nested sums representation. The parameters for H are understood as in [ReV]. They can be in expanded — only 0, 1 and -1 — or in compactified — a string with zeros in front of 1 or -1 is written as a single number — notation.
- All functions can be numerically evaluated with arguments in the whole complex plane. The parameters for Li, zeta and S must be positive integers. If you want to have an alternating Euler sum, you have to give the signs of the parameters as a second argument s to  $\text{zeta}(m,s)$  containing 1 and -1.

- The calculation of classical polylogarithms is speeded up by using Bernoulli numbers and look-up tables. S uses look-up tables as well. The zeta function applies the algorithms in [Cra] and [BBB] for speed up. Multiple polylogarithms use Hoelder convolution [BBB].
- The functions have no means to do a series expansion into nested sums. To do this, you have to convert these functions into the appropriate objects from the nestedsums library, do the expansion and convert the result back.
- Numerical testing of this implementation has been performed by doing a comparison of results between this software and the commercial M..... 4.1. Multiple zeta values have been checked by means of evaluations into simple zeta values. Harmonic polylogarithms have been checked by comparison to  $S(n,p,x)$  for corresponding parameter combinations and by continuity checks around  $|x|=1$  along with comparisons to corresponding zeta functions. Multiple polylogarithms were checked against H and zeta and by means of shuffle and quasi-shuffle relations.

## 7.49 inifcns\_trans.cpp File Reference

Implementation of transcendental (and trigonometric and hyperbolic) functions.

```
#include "inifcns.h"
#include "ex.h"
#include "constant.h"
#include "add.h"
#include "mul.h"
#include "numeric.h"
#include "power.h"
#include "operators.h"
#include "relational.h"
#include "symbol.h"
#include "pseries.h"
#include "utils.h"
#include <stdexcept>
#include <vector>
```

### Namespaces

- namespace [GiNaC](#)

### Functions

- static [ex](#) [GiNaC::exp\\_evalf](#) (const [ex](#) &x)
- static [ex](#) [GiNaC::exp\\_eval](#) (const [ex](#) &x)
- static [ex](#) [GiNaC::exp\\_expand](#) (const [ex](#) &arg, unsigned options)
- static [ex](#) [GiNaC::exp\\_deriv](#) (const [ex](#) &x, unsigned deriv\_param)
- static [ex](#) [GiNaC::exp\\_real\\_part](#) (const [ex](#) &x)
- static [ex](#) [GiNaC::exp\\_imag\\_part](#) (const [ex](#) &x)
- static [ex](#) [GiNaC::exp\\_conjugate](#) (const [ex](#) &x)
- static [ex](#) [GiNaC::exp\\_power](#) (const [ex](#) &x, const [ex](#) &a)
- static bool [GiNaC::exp\\_info](#) (const [ex](#) &x, unsigned inf)
- [GiNaC::REGISTER\\_FUNCTION](#) ([exp](#), [eval\\_func](#)([exp\\_eval](#)). [evalf\\_func](#)([exp\\_evalf](#)). [info\\_func](#)([exp\\_info](#)). [expand\\_func](#)([exp\\_expand](#)). [derivative\\_func](#)([exp\\_deriv](#)). [real\\_part\\_func](#)([exp\\_real\\_part](#)). [imag\\_part\\_func](#)([exp\\_imag\\_part](#)). [conjugate\\_func](#)([exp\\_conjugate](#)). [power\\_func](#)([exp\\_power](#)). [latex\\_name](#)("\\exp"))

- static `ex` `GiNaC::log_evalf` (const `ex` &`x`)
- static `ex` `GiNaC::log_eval` (const `ex` &`x`)
- static `ex` `GiNaC::log_deriv` (const `ex` &`x`, unsigned `deriv_param`)
- static `ex` `GiNaC::log_series` (const `ex` &`arg`, const `relational` &`rel`, int `order`, unsigned `options`)
- static `ex` `GiNaC::log_real_part` (const `ex` &`x`)
- static `ex` `GiNaC::log_imag_part` (const `ex` &`x`)
- static `ex` `GiNaC::log_expand` (const `ex` &`arg`, unsigned `options`)
- static `ex` `GiNaC::log_conjugate` (const `ex` &`x`)
- static bool `GiNaC::log_info` (const `ex` &`x`, unsigned `inf`)
- `GiNaC::REGISTER_FUNCTION` (`log`, `eval_func(log_eval)`. `evalf_func(log_evalf)`. `info_func(log_info)`. `expand_func(log_expand)`. `derivative_func(log_deriv)`. `series_func(log_series)`. `real_part_func(log_real_part)`. `imag_part_func(log_imag_part)`. `conjugate_func(log_conjugate)`. `latex_name("\\ln")`)
- static `ex` `GiNaC::sin_evalf` (const `ex` &`x`)
- static `ex` `GiNaC::sin_eval` (const `ex` &`x`)
- static `ex` `GiNaC::sin_deriv` (const `ex` &`x`, unsigned `deriv_param`)
- static `ex` `GiNaC::sin_real_part` (const `ex` &`x`)
- static `ex` `GiNaC::sin_imag_part` (const `ex` &`x`)
- static `ex` `GiNaC::sin_conjugate` (const `ex` &`x`)
- static bool `GiNaC::trig_info` (const `ex` &`x`, unsigned `inf`)
- `GiNaC::REGISTER_FUNCTION` (`sin`, `eval_func(sin_eval)`. `evalf_func(sin_evalf)`. `info_func(trig_info)`. `derivative_func(sin_deriv)`. `real_part_func(sin_real_part)`. `imag_part_func(sin_imag_part)`. `conjugate_↵  
func(sin_conjugate)`. `latex_name("\\sin")`)
- static `ex` `GiNaC::cos_evalf` (const `ex` &`x`)
- static `ex` `GiNaC::cos_eval` (const `ex` &`x`)
- static `ex` `GiNaC::cos_deriv` (const `ex` &`x`, unsigned `deriv_param`)
- static `ex` `GiNaC::cos_real_part` (const `ex` &`x`)
- static `ex` `GiNaC::cos_imag_part` (const `ex` &`x`)
- static `ex` `GiNaC::cos_conjugate` (const `ex` &`x`)
- `GiNaC::REGISTER_FUNCTION` (`cos`, `eval_func(cos_eval)`. `info_func(trig_info)`. `evalf_func(cos_evalf)`. `derivative_func(cos_deriv)`. `real_part_func(cos_real_part)`. `imag_part_func(cos_imag_part)`. `conjugate_↵  
func(cos_conjugate)`. `latex_name("\\cos")`)
- static `ex` `GiNaC::tan_evalf` (const `ex` &`x`)
- static `ex` `GiNaC::tan_eval` (const `ex` &`x`)
- static `ex` `GiNaC::tan_deriv` (const `ex` &`x`, unsigned `deriv_param`)
- static `ex` `GiNaC::tan_real_part` (const `ex` &`x`)
- static `ex` `GiNaC::tan_imag_part` (const `ex` &`x`)
- static `ex` `GiNaC::tan_series` (const `ex` &`x`, const `relational` &`rel`, int `order`, unsigned `options`)
- static `ex` `GiNaC::tan_conjugate` (const `ex` &`x`)
- `GiNaC::REGISTER_FUNCTION` (`tan`, `eval_func(tan_eval)`. `evalf_func(tan_evalf)`. `info_func(trig_info)`. `derivative_func(tan_deriv)`. `series_func(tan_series)`. `real_part_func(tan_real_part)`. `imag_part_↵  
func(tan_imag_part)`. `conjugate_func(tan_conjugate)`. `latex_name("\\tan")`)
- static `ex` `GiNaC::asin_evalf` (const `ex` &`x`)
- static `ex` `GiNaC::asin_eval` (const `ex` &`x`)
- static `ex` `GiNaC::asin_deriv` (const `ex` &`x`, unsigned `deriv_param`)
- static `ex` `GiNaC::asin_conjugate` (const `ex` &`x`)
- static bool `GiNaC::asin_info` (const `ex` &`x`, unsigned `inf`)
- `GiNaC::REGISTER_FUNCTION` (`asin`, `eval_func(asin_eval)`. `evalf_func(asin_evalf)`. `info_func(asin_info)`. `derivative_func(asin_deriv)`. `conjugate_func(asin_conjugate)`. `latex_name("\\arcsin")`)
- static `ex` `GiNaC::acos_evalf` (const `ex` &`x`)
- static `ex` `GiNaC::acos_eval` (const `ex` &`x`)
- static `ex` `GiNaC::acos_deriv` (const `ex` &`x`, unsigned `deriv_param`)
- static `ex` `GiNaC::acos_conjugate` (const `ex` &`x`)
- `GiNaC::REGISTER_FUNCTION` (`acos`, `eval_func(acos_eval)`. `evalf_func(acos_evalf)`. `info_func(asin_info)`. `derivative_func(acos_deriv)`. `conjugate_func(acos_conjugate)`. `latex_name("\\arccos")`)
- static `ex` `GiNaC::atan_evalf` (const `ex` &`x`)

- static `ex` `GiNaC::atan_eval` (const `ex` &x)
- static `ex` `GiNaC::atan_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex` `GiNaC::atan_series` (const `ex` &arg, const `relational` &rel, int order, unsigned options)
- static `ex` `GiNaC::atan_conjugate` (const `ex` &x)
- static bool `GiNaC::atan_info` (const `ex` &x, unsigned inf)
- `GiNaC::REGISTER_FUNCTION` (`atan`, `eval_func(atan_eval)`. `evalf_func(atan_evalf)`. `info_func(atan_info)`. `derivative_func(atan_deriv)`. `series_func(atan_series)`. `conjugate_func(atan_conjugate)`. `latex_name("\\arctan")`)
- static `ex` `GiNaC::atan2_evalf` (const `ex` &y, const `ex` &x)
- static `ex` `GiNaC::atan2_eval` (const `ex` &y, const `ex` &x)
- static `ex` `GiNaC::atan2_deriv` (const `ex` &y, const `ex` &x, unsigned deriv\_param)
- static bool `GiNaC::atan2_info` (const `ex` &y, const `ex` &x, unsigned inf)
- `GiNaC::REGISTER_FUNCTION` (`atan2`, `eval_func(atan2_eval)`. `evalf_func(atan2_evalf)`. `info_func(atan2_info)`. `evalf_func(atan2_evalf)`. `derivative_func(atan2_deriv)`)
- static `ex` `GiNaC::sinh_evalf` (const `ex` &x)
- static `ex` `GiNaC::sinh_eval` (const `ex` &x)
- static `ex` `GiNaC::sinh_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex` `GiNaC::sinh_real_part` (const `ex` &x)
- static `ex` `GiNaC::sinh_imag_part` (const `ex` &x)
- static `ex` `GiNaC::sinh_conjugate` (const `ex` &x)
- `GiNaC::REGISTER_FUNCTION` (`sinh`, `eval_func(sinh_eval)`. `evalf_func(sinh_evalf)`. `info_func(atan_info)`. `derivative_func(sinh_deriv)`. `real_part_func(sinh_real_part)`. `imag_part_func(sinh_imag_part)`. `conjugate_func(sinh_conjugate)`. `latex_name("\\sinh")`)
- static `ex` `GiNaC::cosh_evalf` (const `ex` &x)
- static `ex` `GiNaC::cosh_eval` (const `ex` &x)
- static `ex` `GiNaC::cosh_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex` `GiNaC::cosh_real_part` (const `ex` &x)
- static `ex` `GiNaC::cosh_imag_part` (const `ex` &x)
- static `ex` `GiNaC::cosh_conjugate` (const `ex` &x)
- `GiNaC::REGISTER_FUNCTION` (`cosh`, `eval_func(cosh_eval)`. `evalf_func(cosh_evalf)`. `info_func(exp_info)`. `derivative_func(cosh_deriv)`. `real_part_func(cosh_real_part)`. `imag_part_func(cosh_imag_part)`. `conjugate_func(cosh_conjugate)`. `latex_name("\\cosh")`)
- static `ex` `GiNaC::tanh_evalf` (const `ex` &x)
- static `ex` `GiNaC::tanh_eval` (const `ex` &x)
- static `ex` `GiNaC::tanh_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex` `GiNaC::tanh_series` (const `ex` &x, const `relational` &rel, int order, unsigned options)
- static `ex` `GiNaC::tanh_real_part` (const `ex` &x)
- static `ex` `GiNaC::tanh_imag_part` (const `ex` &x)
- static `ex` `GiNaC::tanh_conjugate` (const `ex` &x)
- `GiNaC::REGISTER_FUNCTION` (`tanh`, `eval_func(tanh_eval)`. `evalf_func(tanh_evalf)`. `info_func(atan_info)`. `derivative_func(tanh_deriv)`. `series_func(tanh_series)`. `real_part_func(tanh_real_part)`. `imag_part_func(tanh_imag_part)`. `conjugate_func(tanh_conjugate)`. `latex_name("\\tanh")`)
- static `ex` `GiNaC::asinh_evalf` (const `ex` &x)
- static `ex` `GiNaC::asinh_eval` (const `ex` &x)
- static `ex` `GiNaC::asinh_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex` `GiNaC::asinh_conjugate` (const `ex` &x)
- `GiNaC::REGISTER_FUNCTION` (`asinh`, `eval_func(asinh_eval)`. `evalf_func(asinh_evalf)`. `info_func(atan_info)`. `derivative_func(asinh_deriv)`. `conjugate_func(asinh_conjugate)`)
- static `ex` `GiNaC::acosh_evalf` (const `ex` &x)
- static `ex` `GiNaC::acosh_eval` (const `ex` &x)
- static `ex` `GiNaC::acosh_deriv` (const `ex` &x, unsigned deriv\_param)
- static `ex` `GiNaC::acosh_conjugate` (const `ex` &x)
- `GiNaC::REGISTER_FUNCTION` (`acosh`, `eval_func(acosh_eval)`. `evalf_func(acosh_evalf)`. `info_func(asin_info)`. `derivative_func(acosh_deriv)`. `conjugate_func(acosh_conjugate)`)
- static `ex` `GiNaC::atanh_evalf` (const `ex` &x)

- static [ex](#) [GiNaC::atanh\\_eval](#) (const [ex](#) &x)
- static [ex](#) [GiNaC::atanh\\_deriv](#) (const [ex](#) &x, unsigned deriv\_param)
- static [ex](#) [GiNaC::atanh\\_series](#) (const [ex](#) &arg, const [relational](#) &rel, int order, unsigned options)
- static [ex](#) [GiNaC::atanh\\_conjugate](#) (const [ex](#) &x)
- [GiNaC::REGISTER\\_FUNCTION](#) ([atanh](#), [eval\\_func](#)([atanh\\_eval](#)). [evalf\\_func](#)([atanh\\_evalf](#)). [info\\_↔](#)  
[func](#)([asin\\_info](#)). [derivative\\_func](#)([atanh\\_deriv](#)). [series\\_func](#)([atanh\\_series](#)). [conjugate\\_func](#)([atanh\\_conjugate](#)))

### 7.49.1 Detailed Description

Implementation of transcendental (and trigonometric and hyperbolic) functions.

## 7.50 integral.cpp File Reference

Implementation of [GiNaC](#)'s symbolic integral.

```
#include "integral.h"
#include "numeric.h"
#include "symbol.h"
#include "add.h"
#include "mul.h"
#include "power.h"
#include "inifcns.h"
#include "wildcard.h"
#include "archive.h"
#include "registrar.h"
#include "utils.h"
#include "operators.h"
#include "relational.h"
```

### Classes

- struct [GiNaC::error\\_and\\_integral](#)
- struct [GiNaC::error\\_and\\_integral\\_is\\_less](#)

### Namespaces

- namespace [GiNaC](#)

### Typedefs

- typedef map< [error\\_and\\_integral](#), [ex](#), [error\\_and\\_integral\\_is\\_less](#) > [GiNaC::lookup\\_map](#)

### Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([integral](#), [basic](#), [print\\_func](#)< [print\\_dflt](#)  
>(&[integral::do\\_print](#)). [print\\_func](#)< [print\\_python](#) >(&[integral::do\\_print](#)). [print\\_func](#)< [print\\_latex](#)  
>(&[integral::do\\_print\\_latex](#))) [integral](#)
- [ex](#) [GiNaC::subvalue](#) (const [ex](#) &var, const [ex](#) &value, const [ex](#) &fun)
- [ex](#) [GiNaC::adaptivesimpson](#) (const [ex](#) &x, const [ex](#) &a\_in, const [ex](#) &b\_in, const [ex](#) &f, const [ex](#) &error)  
*Numeric integration routine based upon the "Adaptive Quadrature" one in "Numerical Analysis" by Burden and Faires.*
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([integral](#))

### 7.50.1 Detailed Description

Implementation of [GiNaC](#)'s symbolic integral.

## 7.51 integral.h File Reference

Interface to [GiNaC](#)'s symbolic integral.

```
#include "basic.h"
#include "ex.h"
#include "archive.h"
```

### Classes

- class [GiNaC::integral](#)  
*Symbolic integral.*

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([integral](#))
- [ex GiNaC::adaptivesimpson](#) (const [ex](#) &x, const [ex](#) &a\_in, const [ex](#) &b\_in, const [ex](#) &f, const [ex](#) &error)  
*Numeric integration routine based upon the "Adaptive Quadrature" one in "Numerical Analysis" by Burden and Faires.*

### 7.51.1 Detailed Description

Interface to [GiNaC](#)'s symbolic integral.

## 7.52 integration\_kernel.cpp File Reference

Implementation of [GiNaC](#)'s integration kernels for iterated integrals.

```
#include "integration_kernel.h"
#include "add.h"
#include "mul.h"
#include "operators.h"
#include "power.h"
#include "relational.h"
#include "symbol.h"
#include "constant.h"
#include "numeric.h"
#include "function.h"
#include "pseries.h"
#include "utils.h"
#include "inifcns.h"
#include <iostream>
#include <stdexcept>
#include <cln/cln.h>
```



## Namespaces

- namespace [GiNaC](#)

## Functions

- [ex GiNaC::ifactor](#) (const [numeric](#) &n)  
*Returns the decomposition of the positive integer  $n$  into prime numbers in the form  $lst(p_1, \dots, pr), lst(a_1, \dots, ar)$  such that  $n = p_1^{a_1} \dots p_r^{a_r}$ .*
- [bool GiNaC::is\\_discriminant\\_of\\_quadratic\\_number\\_field](#) (const [numeric](#) &n)  
*Returns true if the integer  $n$  is either one or the discriminant of a quadratic number field.*
- [numeric GiNaC::kronecker\\_symbol](#) (const [numeric](#) &a, const [numeric](#) &n)  
*Returns the Kronecker symbol  $a: integer\ n: integer$ .*
- [numeric GiNaC::primitive\\_dirichlet\\_character](#) (const [numeric](#) &n, const [numeric](#) &a)  
*Defines a primitive Dirichlet character through the Kronecker symbol.*
- [numeric GiNaC::dirichlet\\_character](#) (const [numeric](#) &n, const [numeric](#) &a, const [numeric](#) &N)  
*Defines a Dirichlet character through the Kronecker symbol.*
- [numeric GiNaC::generalised\\_Bernoulli\\_number](#) (const [numeric](#) &k, const [numeric](#) &b)  
*The generalised Bernoulli number.*
- [ex GiNaC::Bernoulli\\_polynomial](#) (const [numeric](#) &k, const [ex](#) &x)  
*The Bernoulli polynomials.*
- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (integration\_kernel, basic, print\_func< print\_context >(&integration\_kernel::do\_print)) integration\_kernel
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) (integration\_kernel)
- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (basic\_log\_kernel, integration\_kernel, print\_func< print\_context >(&basic\_log\_kernel::do\_print)) basic\_log\_kernel
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) (basic\_log\_kernel)
- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (multiple\_polylog\_kernel, integration\_kernel, print\_func< print\_context >(&multiple\_polylog\_kernel::do\_print)) multiple\_polylog\_kernel
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) (multiple\_polylog\_kernel)
- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (ELi\_kernel, integration\_kernel, print\_func< print\_context >(&ELi\_kernel::do\_print)) ELi\_kernel
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) (ELi\_kernel)
- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (Ebar\_kernel, integration\_kernel, print\_func< print\_context >(&Ebar\_kernel::do\_print)) Ebar\_kernel
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) (Ebar\_kernel)
- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (Kronecker\_dtau\_kernel, integration\_kernel, print\_func< print\_context >(&Kronecker\_dtau\_kernel::do\_print)) Kronecker\_dtau\_kernel
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) (Kronecker\_dtau\_kernel)
- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (Kronecker\_dz\_kernel, integration\_kernel, print\_func< print\_context >(&Kronecker\_dz\_kernel::do\_print)) Kronecker\_dz\_kernel
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) (Kronecker\_dz\_kernel)
- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (Eisenstein\_kernel, integration\_kernel, print\_func< print\_context >(&Eisenstein\_kernel::do\_print)) Eisenstein\_kernel
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) (Eisenstein\_kernel)
- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (Eisenstein\_h\_kernel, integration\_kernel, print\_func< print\_context >(&Eisenstein\_h\_kernel::do\_print)) Eisenstein\_h\_kernel
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) (Eisenstein\_h\_kernel)
- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (modular\_form\_kernel, integration\_kernel, print\_func< print\_context >(&modular\_form\_kernel::do\_print)) modular\_form\_kernel
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) (modular\_form\_kernel)
- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (user\_defined\_kernel, integration\_kernel, print\_func< print\_context >(&user\_defined\_kernel::do\_print)) user\_defined\_kernel
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) (user\_defined\_kernel)

### 7.52.1 Detailed Description

Implementation of [GiNaC](#)'s integration kernels for iterated integrals.

## 7.53 integration\_kernel.h File Reference

Interface to [GiNaC](#)'s integration kernels for iterated integrals.

```
#include "basic.h"
#include "archive.h"
#include "numeric.h"
#include "lst.h"
#include <cln/complex.h>
#include <vector>
```

### Classes

- class [GiNaC::integration\\_kernel](#)  
*The base class for integration kernels for iterated integrals.*
- class [GiNaC::basic\\_log\\_kernel](#)  
*The basic integration kernel with a logarithmic singularity at the origin.*
- class [GiNaC::multiple\\_polylog\\_kernel](#)  
*The integration kernel for multiple polylogarithms.*
- class [GiNaC::ELi\\_kernel](#)  
*The ELi-kernel.*
- class [GiNaC::Ebar\\_kernel](#)  
*The Ebar-kernel.*
- class [GiNaC::Kronecker\\_dtau\\_kernel](#)  
*The kernel corresponding to integrating the Kronecker coefficient function  $g^{(n)}(z_j, K\tau)$  in  $\tau$  (or equivalently in  $\bar{q}$ ).*
- class [GiNaC::Kronecker\\_dz\\_kernel](#)  
*The kernel corresponding to integrating the Kronecker coefficient function  $g^{(n-1)}(z - z_j, K\tau)$  in  $z$ .*
- class [GiNaC::Eisenstein\\_kernel](#)  
*The kernel corresponding to the Eisenstein series  $E_{k,N,a,b,K}(\tau)$ .*
- class [GiNaC::Eisenstein\\_h\\_kernel](#)  
*The kernel corresponding to the Eisenstein series  $h_{k,N,r,s}(\tau)$ .*
- class [GiNaC::modular\\_form\\_kernel](#)  
*A kernel corresponding to a polynomial in Eisenstein series.*
- class [GiNaC::user\\_defined\\_kernel](#)  
*A user-defined integration kernel.*

### Namespaces

- namespace [GiNaC](#)

## Functions

- `ex GiNaC::ifactor` (const `numeric` &n)  
Returns the decomposition of the positive integer  $n$  into prime numbers in the form  $lst(lst(p_1, \dots, pr), lst(a_1, \dots, ar))$  such that  $n = p_1^{a_1} \dots p_r^{a_r}$ .
- `bool GiNaC::is_discriminant_of_quadratic_number_field` (const `numeric` &n)  
Returns true if the integer  $n$  is either one or the discriminant of a quadratic number field.
- `numeric GiNaC::kronecker_symbol` (const `numeric` &a, const `numeric` &n)  
Returns the Kronecker symbol  $a: integer\ n: integer$ .
- `numeric GiNaC::primitive_dirichlet_character` (const `numeric` &n, const `numeric` &a)  
Defines a primitive Dirichlet character through the Kronecker symbol.
- `numeric GiNaC::dirichlet_character` (const `numeric` &n, const `numeric` &a, const `numeric` &N)  
Defines a Dirichlet character through the Kronecker symbol.
- `numeric GiNaC::generalised_Bernoulli_number` (const `numeric` &k, const `numeric` &b)  
The generalised Bernoulli number.
- `ex GiNaC::Bernoulli_polynomial` (const `numeric` &k, const `ex` &x)  
The Bernoulli polynomials.
- `GiNaC::GINAC_DECLARE_UNARCHIVER` (integration\_kernel)
- `GiNaC::GINAC_DECLARE_UNARCHIVER` (basic\_log\_kernel)
- `GiNaC::GINAC_DECLARE_UNARCHIVER` (multiple\_polylog\_kernel)
- `GiNaC::GINAC_DECLARE_UNARCHIVER` (ELi\_kernel)
- `GiNaC::GINAC_DECLARE_UNARCHIVER` (Ebar\_kernel)
- `GiNaC::GINAC_DECLARE_UNARCHIVER` (Kronecker\_dtau\_kernel)
- `GiNaC::GINAC_DECLARE_UNARCHIVER` (Kronecker\_dz\_kernel)
- `GiNaC::GINAC_DECLARE_UNARCHIVER` (Eisenstein\_kernel)
- `GiNaC::GINAC_DECLARE_UNARCHIVER` (Eisenstein\_h\_kernel)
- `GiNaC::GINAC_DECLARE_UNARCHIVER` (modular\_form\_kernel)
- `GiNaC::GINAC_DECLARE_UNARCHIVER` (user\_defined\_kernel)

### 7.53.1 Detailed Description

Interface to `GiNaC`'s integration kernels for iterated integrals.

## 7.54 Ist.cpp File Reference

Implementation of `GiNaC`'s `Ist`.

```
#include "lst.h"
#include "archive.h"
```

## Namespaces

- namespace `GiNaC`

## Variables

- `template<> GINAC_IMPLEMENT_REGISTERED_CLASS_OPT_T(Ist, basic, print_func< print_context >(&Ist::do_print). print_func< print_tree >(&Ist::do_print_tree))` `template<> bool Is GiNaC::GINAC_BIND_UNARCHIVER(Ist)`  
Specialization of `container::info()` for `Ist`.

### 7.54.1 Detailed Description

Implementation of [GiNaC](#)'s `lst`.

## 7.55 `lst.h` File Reference

Definition of [GiNaC](#)'s `lst`.

```
#include "container.h"
#include <list>
```

### Namespaces

- namespace [GiNaC](#)

### Typedefs

- typedef [container](#)< [std::list](#) > [GiNaC::lst](#)

### Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([lst](#))

### 7.55.1 Detailed Description

Definition of [GiNaC](#)'s `lst`.

## 7.56 `matrix.cpp` File Reference

Implementation of symbolic matrices.

```
#include "matrix.h"
#include "numeric.h"
#include "lst.h"
#include "idx.h"
#include "indexed.h"
#include "add.h"
#include "power.h"
#include "symbol.h"
#include "operators.h"
#include "normal.h"
#include "archive.h"
#include "utils.h"
#include <algorithm>
#include <iostream>
#include <map>
#include <sstream>
#include <stdexcept>
#include <string>
```

## Namespaces

- namespace [GiNaC](#)

## Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([matrix](#), [basic](#), [print\\_func](#)< [print\\_context](#) >(&[matrix::do\\_print](#)). [print\\_func](#)< [print\\_latex](#) >(&[matrix::do\\_print\\_latex](#)). [print\\_func](#)< [print\\_tree](#) >(&[matrix::do\\_print\\_tree](#)). [print\\_func](#)< [print\\_python\\_repr](#) >(&[matrix::do\\_print\\_python\\_repr](#))) [matrix](#)  
*Default ctor.*
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([matrix](#))
- [ex GiNaC::lst\\_to\\_matrix](#) (const [lst](#) &l)  
*Convert list of lists to matrix.*
- [ex GiNaC::diag\\_matrix](#) (const [lst](#) &l)  
*Convert list of diagonal elements to matrix.*
- [ex GiNaC::diag\\_matrix](#) (std::initializer\_list< [ex](#) > l)
- [ex GiNaC::unit\\_matrix](#) (unsigned r, unsigned c)  
*Create an r times c unit matrix.*
- [ex GiNaC::symbolic\\_matrix](#) (unsigned r, unsigned c, const std::string &base\_name, const std::string &tex\_↵  
base\_name)  
*Create an r times c matrix of newly generated symbols consisting of the given base name plus the numeric row/column position of each element.*
- [ex GiNaC::reduced\\_matrix](#) (const [matrix](#) &m, unsigned r, unsigned c)  
*Return the reduced matrix that is formed by deleting the rth row and cth column of matrix m.*
- [ex GiNaC::sub\\_matrix](#) (const [matrix](#) &m, unsigned r, unsigned nr, unsigned c, unsigned nc)  
*Return the nr times nc submatrix starting at position r, c of matrix m.*

### 7.56.1 Detailed Description

Implementation of symbolic matrices.

## 7.57 matrix.h File Reference

Interface to symbolic matrices.

```
#include "basic.h"
#include "ex.h"
#include "archive.h"
#include "compiler.h"
#include <string>
#include <vector>
```

## Classes

- class [GiNaC::matrix](#)  
*Symbolic matrices.*

## Namespaces

- namespace [GiNaC](#)

## Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([matrix](#))
- [size\\_t GiNaC::nops](#) (const [matrix](#) &m)
- [ex GiNaC::expand](#) (const [matrix](#) &m, unsigned options=0)
- [ex GiNaC::evalf](#) (const [matrix](#) &m)
- unsigned [GiNaC::rows](#) (const [matrix](#) &m)
- unsigned [GiNaC::cols](#) (const [matrix](#) &m)
- [matrix GiNaC::transpose](#) (const [matrix](#) &m)
- [ex GiNaC::determinant](#) (const [matrix](#) &m, unsigned options=[determinant\\_algo::automatic](#))
- [ex GiNaC::trace](#) (const [matrix](#) &m)
- [ex GiNaC::charpoly](#) (const [matrix](#) &m, const [ex](#) &lambda)
- [matrix GiNaC::inverse](#) (const [matrix](#) &m)
- [matrix GiNaC::inverse](#) (const [matrix](#) &m, unsigned algo)
- unsigned [GiNaC::rank](#) (const [matrix](#) &m)
- unsigned [GiNaC::rank](#) (const [matrix](#) &m, unsigned [solve\\_algo](#))
- [ex GiNaC::lst\\_to\\_matrix](#) (const [lst](#) &l)  
*Convert list of lists to matrix.*
- [ex GiNaC::diag\\_matrix](#) (const [lst](#) &l)  
*Convert list of diagonal elements to matrix.*
- [ex GiNaC::diag\\_matrix](#) (std::initializer\_list< [ex](#) > l)
- [ex GiNaC::unit\\_matrix](#) (unsigned r, unsigned c)  
*Create an r times c unit matrix.*
- [ex GiNaC::unit\\_matrix](#) (unsigned x)  
*Create a x times x unit matrix.*
- [ex GiNaC::symbolic\\_matrix](#) (unsigned r, unsigned c, const std::string &base\_name, const std::string &tex\_↵  
base\_name)  
*Create an r times c matrix of newly generated symbols consisting of the given base name plus the numeric row/column position of each element.*
- [ex GiNaC::reduced\\_matrix](#) (const [matrix](#) &m, unsigned r, unsigned c)  
*Return the reduced matrix that is formed by deleting the rth row and cth column of matrix m.*
- [ex GiNaC::sub\\_matrix](#) (const [matrix](#) &m, unsigned r, unsigned nr, unsigned c, unsigned nc)  
*Return the nr times nc submatrix starting at position r, c of matrix m.*
- [ex GiNaC::symbolic\\_matrix](#) (unsigned r, unsigned c, const std::string &base\_name)  
*Create an r times c matrix of newly generated symbols consisting of the given base name plus the numeric row/column position of each element.*

### 7.57.1 Detailed Description

Interface to symbolic matrices.

## 7.58 mul.cpp File Reference

Implementation of [GiNaC](#)'s products of expressions.

```
#include "mul.h"
#include "add.h"
#include "power.h"
#include "operators.h"
#include "matrix.h"
#include "indexed.h"
#include "lst.h"
#include "archive.h"
#include "utils.h"
#include "symbol.h"
#include "compiler.h"
#include <iostream>
#include <limits>
#include <stdexcept>
#include <vector>
```

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([mul](#), [expairseq](#), [print\\_func< print\\_context >\(&mul::do\\_print\)](#), [print\\_func< print\\_latex >\(&mul::do\\_print\\_latex\)](#), [print\\_func< print\\_csrc >\(&mul::do\\_print\\_csrc\)](#), [print\\_func< print\\_tree >\(&mul::do\\_print\\_tree\)](#), [print\\_func< print\\_python\\_repr >\(&mul::do\\_print\\_python\\_repr\)](#))  
[mul](#)
- bool [GiNaC::tryfactsubs](#) (const [ex](#) &origfactor, const [ex](#) &patternfactor, int &nummatches, [exmap](#) &repls)
- bool [GiNaC::algebraic\\_match\\_mul\\_with\\_mul](#) (const [mul](#) &e, const [ex](#) &pat, [exmap](#) &repls, int [factor](#), int &nummatches, const std::vector< bool > &subsed, std::vector< bool > &matched)  
*Checks whether e matches to the pattern pat and the (possibly to be updated) list of replacements repls.*
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([mul](#))

### 7.58.1 Detailed Description

Implementation of [GiNaC](#)'s products of expressions.

## 7.59 mul.h File Reference

Interface to [GiNaC](#)'s products of expressions.

```
#include "expairseq.h"
```

## Classes

- class [GiNaC::mul](#)  
*Product of expressions.*

## Namespaces

- namespace [GiNaC](#)

## Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([mul](#))

### 7.59.1 Detailed Description

Interface to [GiNaC](#)'s products of expressions.

## 7.60 ncmul.cpp File Reference

Implementation of [GiNaC](#)'s non-commutative products of expressions.

```
#include "ncmul.h"
#include "ex.h"
#include "add.h"
#include "mul.h"
#include "clifford.h"
#include "matrix.h"
#include "archive.h"
#include "indexed.h"
#include "utils.h"
#include <algorithm>
#include <iostream>
#include <stdexcept>
```

## Namespaces

- namespace [GiNaC](#)

## Typedefs

- typedef std::vector< std::size\_t > [GiNaC::uintvector](#)
- typedef std::vector< unsigned > [GiNaC::unsignedvector](#)
- typedef std::vector< [exvector](#) > [GiNaC::exvectorvector](#)



## Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([ncmul](#), [exprseq](#), [print\\_func](#)< [print\\_context](#) >(&[ncmul::do\\_print](#)). [print\\_func](#)< [print\\_tree](#) >(&[ncmul::do\\_print\\_tree](#)). [print\\_func](#)< [print\\_csrc](#) >(&[ncmul::do\\_print\\_csrc](#)). [print\\_func](#)< [print\\_python\\_repr](#) >(&[ncmul::do\\_print\\_csrc](#))) [ncmul](#)
- [ex GiNaC::reeval\\_ncmul](#) (const [exvector](#) &[v](#))
- [ex GiNaC::hold\\_ncmul](#) (const [exvector](#) &[v](#))
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([ncmul](#))

### 7.60.1 Detailed Description

Implementation of [GiNaC](#)'s non-commutative products of expressions.

## 7.61 ncmul.h File Reference

Interface to [GiNaC](#)'s non-commutative products of expressions.

```
#include "exprseq.h"
#include "archive.h"
```

## Classes

- class [GiNaC::ncmul](#)  
*Non-commutative product of expressions.*

## Namespaces

- namespace [GiNaC](#)

## Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([ncmul](#))
- [ex GiNaC::reeval\\_ncmul](#) (const [exvector](#) &[v](#))
- [ex GiNaC::hold\\_ncmul](#) (const [exvector](#) &[v](#))

### 7.61.1 Detailed Description

Interface to [GiNaC](#)'s non-commutative products of expressions.

## 7.62 normal.cpp File Reference

This file implements several functions that work on univariate and multivariate polynomials and rational functions.

```
#include "normal.h"
#include "basic.h"
#include "ex.h"
#include "add.h"
#include "constant.h"
#include "expairseq.h"
#include "fail.h"
#include "inifcns.h"
#include "lst.h"
#include "mul.h"
#include "numeric.h"
#include "power.h"
#include "relational.h"
#include "operators.h"
#include "matrix.h"
#include "pseries.h"
#include "symbol.h"
#include "utils.h"
#include "polynomial/chinrem_gcd.h"
#include <algorithm>
#include <map>
```

### Classes

- struct [GiNaC::sym\\_desc](#)  
*This structure holds information about the highest and lowest degrees in which a symbol appears in two multivariate polynomials "a" and "b".*
- class [GiNaC::gcdheu\\_failed](#)  
*Exception thrown by [heur\\_gcd\(\)](#) to signal failure.*
- struct [GiNaC::normal\\_map\\_function](#)  
*Function object to be applied by [basic::normal\(\)](#).*

### Namespaces

- namespace [GiNaC](#)

### Macros

- `#define` [FAST\\_COMPARE](#) 1
- `#define` [USE\\_REMEMBER](#) 0
- `#define` [USE\\_TRIAL\\_DIVISION](#) 0
- `#define` [STATISTICS](#) 0

### Typedefs

- `typedef` `std::vector< sym\_desc >` [GiNaC::sym\\_desc\\_vec](#)

## Functions

- static bool `GiNaC::get_first_symbol` (const `ex` &e, `ex` &x)  
*Return pointer to first symbol found in expression.*
- static void `GiNaC::add_symbol` (const `ex` &s, `sym_desc_vec` &v)
- static void `GiNaC::collect_symbols` (const `ex` &e, `sym_desc_vec` &v)
- static void `GiNaC::get_symbol_stats` (const `ex` &a, const `ex` &b, `sym_desc_vec` &v)  
*Collect statistical information about symbols in polynomials.*
- static `numeric` `GiNaC::lcmcoeff` (const `ex` &e, const `numeric` &l)
- static `numeric` `GiNaC::lcm_of_coefficients_denominators` (const `ex` &e)  
*Compute LCM of denominators of coefficients of a polynomial.*
- static `ex` `GiNaC::multiply_lcm` (const `ex` &e, const `numeric` &lcm)  
*Bring polynomial from  $Q[X]$  to  $Z[X]$  by multiplying in the previously determined LCM of the coefficient's denominators.*
- `ex` `GiNaC::quo` (const `ex` &a, const `ex` &b, const `ex` &x, bool check\_args)  
*Quotient  $q(x)$  of polynomials  $a(x)$  and  $b(x)$  in  $Q[x]$ .*
- `ex` `GiNaC::rem` (const `ex` &a, const `ex` &b, const `ex` &x, bool check\_args)  
*Remainder  $r(x)$  of polynomials  $a(x)$  and  $b(x)$  in  $Q[x]$ .*
- `ex` `GiNaC::decomp_rational` (const `ex` &a, const `ex` &x)  
*Decompose rational function  $a(x)=N(x)/D(x)$  into  $P(x)+n(x)/D(x)$  with  $\text{degree}(n, x) < \text{degree}(D, x)$ .*
- `ex` `GiNaC::prem` (const `ex` &a, const `ex` &b, const `ex` &x, bool check\_args)  
*Pseudo-remainder of polynomials  $a(x)$  and  $b(x)$  in  $Q[x]$ .*
- `ex` `GiNaC::sprem` (const `ex` &a, const `ex` &b, const `ex` &x, bool check\_args)  
*Sparse pseudo-remainder of polynomials  $a(x)$  and  $b(x)$  in  $Q[x]$ .*
- bool `GiNaC::divide` (const `ex` &a, const `ex` &b, `ex` &q, bool check\_args)  
*Exact polynomial division of  $a(X)$  by  $b(X)$  in  $Q[X]$ .*
- static bool `GiNaC::divide_in_z` (const `ex` &a, const `ex` &b, `ex` &q, `sym_desc_vec::const_iterator` var)  
*Exact polynomial division of  $a(X)$  by  $b(X)$  in  $Z[X]$ .*
- static `ex` `GiNaC::sr_gcd` (const `ex` &a, const `ex` &b, `sym_desc_vec::const_iterator` var)  
*Compute GCD of multivariate polynomials using the subresultant PRS algorithm.*
- static `ex` `GiNaC::interpolate` (const `ex` &gamma, const `numeric` &xi, const `ex` &x, int degree\_hint=1)  
 *$\xi$ -adic polynomial interpolation*
- static bool `GiNaC::heur_gcd_z` (`ex` &res, const `ex` &a, const `ex` &b, `ex` \*ca, `ex` \*cb, `sym_desc_vec::const_iterator` var)  
*Compute GCD of multivariate polynomials using the heuristic GCD algorithm.*
- static bool `GiNaC::heur_gcd` (`ex` &res, const `ex` &a, const `ex` &b, `ex` \*ca, `ex` \*cb, `sym_desc_vec::const_iterator` var)  
*Compute GCD of multivariate polynomials using the heuristic GCD algorithm.*
- static `ex` `GiNaC::gcd_pf_pow` (const `ex` &a, const `ex` &b, `ex` \*ca, `ex` \*cb)
- static `ex` `GiNaC::gcd_pf_mul` (const `ex` &a, const `ex` &b, `ex` \*ca, `ex` \*cb)
- `ex` `GiNaC::gcd` (const `ex` &a, const `ex` &b, `ex` \*ca, `ex` \*cb, bool check\_args, unsigned options)  
*Compute GCD (Greatest Common Divisor) of multivariate polynomials  $a(X)$  and  $b(X)$  in  $Z[X]$ .*
- static `ex` `GiNaC::gcd_pf_pow_pow` (const `ex` &a, const `ex` &b, `ex` \*ca, `ex` \*cb)
- `ex` `GiNaC::lcm` (const `ex` &a, const `ex` &b, bool check\_args)  
*Compute LCM (Least Common Multiple) of multivariate polynomials in  $Z[X]$ .*
- static `epvector` `GiNaC::sqrfree_yun` (const `ex` &a, const `symbol` &x)  
*Compute square-free factorization of multivariate polynomial  $a(x)$  using Yun's algorithm.*
- `ex` `GiNaC::sqrfree` (const `ex` &a, const `lst` &l)  
*Compute a square-free factorization of a multivariate polynomial in  $Q[X]$ .*
- `ex` `GiNaC::sqrfree_parfrac` (const `ex` &a, const `symbol` &x)  
*Compute square-free partial fraction decomposition of rational function  $a(x)$ .*
- static `ex` `GiNaC::replace_with_symbol` (const `ex` &e, `exmap` &repl, `exmap` &rev\_lookup, `lst` &modifier)  
*Create a symbol for replacing the expression "e" (or return a previously assigned symbol).*

- static `ex GiNaC::replace_with_symbol` (const `ex` &e, `exmap` &repl)  
*Create a symbol for replacing the expression "e" (or return a previously assigned symbol).*
- static `ex GiNaC::frac_cancel` (const `ex` &n, const `ex` &d)  
*Fraction cancellation.*
- static `ex GiNaC::find_common_factor` (const `ex` &e, `ex` &factor, `exmap` &repl)  
*Remove the common factor in the terms of a sum 'e' by calculating the GCD, and multiply it into the expression 'factor' (which needs to be initialized to 1, unless you're accumulating factors).*
- `ex GiNaC::collect_common_factors` (const `ex` &e)  
*Collect common factors in sums.*
- `ex GiNaC::resultant` (const `ex` &e1, const `ex` &e2, const `ex` &s)  
*Resultant of two expressions e1,e2 with respect to symbol s.*

### 7.62.1 Detailed Description

This file implements several functions that work on univariate and multivariate polynomials and rational functions.

These functions include polynomial quotient and remainder, GCD and LCM computation, square-free factorization and rational function normalization.

### 7.62.2 Macro Definition Documentation

#### 7.62.2.1 FAST\_COMPARE

```
#define FAST_COMPARE 1
```

#### 7.62.2.2 USE\_REMEMBER

```
#define USE_REMEMBER 0
```

#### 7.62.2.3 USE\_TRIAL\_DIVISION

```
#define USE_TRIAL_DIVISION 0
```

#### 7.62.2.4 STATISTICS

```
#define STATISTICS 0
```

## 7.63 normal.h File Reference

This file defines several functions that work on univariate and multivariate polynomials and rational functions.

```
#include "lst.h"
```

## Classes

- struct [GiNaC::gcd\\_options](#)  
*Flags to control the behavior of `gcd()` and friends.*

## Namespaces

- namespace [GiNaC](#)

## Functions

- [ex GiNaC::quo](#) (const [ex](#) &a, const [ex](#) &b, const [ex](#) &x, bool check\_args)  
*Quotient  $q(x)$  of polynomials  $a(x)$  and  $b(x)$  in  $Q[x]$ .*
- [ex GiNaC::rem](#) (const [ex](#) &a, const [ex](#) &b, const [ex](#) &x, bool check\_args)  
*Remainder  $r(x)$  of polynomials  $a(x)$  and  $b(x)$  in  $Q[x]$ .*
- [ex GiNaC::decomp\\_rational](#) (const [ex](#) &a, const [ex](#) &x)  
*Decompose rational function  $a(x)=N(x)/D(x)$  into  $P(x)+n(x)/D(x)$  with  $\text{degree}(n, x) < \text{degree}(D, x)$ .*
- [ex GiNaC::prem](#) (const [ex](#) &a, const [ex](#) &b, const [ex](#) &x, bool check\_args)  
*Pseudo-remainder of polynomials  $a(x)$  and  $b(x)$  in  $Q[x]$ .*
- [ex GiNaC::sprem](#) (const [ex](#) &a, const [ex](#) &b, const [ex](#) &x, bool check\_args)  
*Sparse pseudo-remainder of polynomials  $a(x)$  and  $b(x)$  in  $Q[x]$ .*
- [bool GiNaC::divide](#) (const [ex](#) &a, const [ex](#) &b, [ex](#) &q, bool check\_args)  
*Exact polynomial division of  $a(X)$  by  $b(X)$  in  $Q[X]$ .*
- [ex GiNaC::gcd](#) (const [ex](#) &a, const [ex](#) &b, [ex](#) \*ca, [ex](#) \*cb, bool check\_args, unsigned options)  
*Compute GCD (Greatest Common Divisor) of multivariate polynomials  $a(X)$  and  $b(X)$  in  $Z[X]$ .*
- [ex GiNaC::lcm](#) (const [ex](#) &a, const [ex](#) &b, bool check\_args)  
*Compute LCM (Least Common Multiple) of multivariate polynomials in  $Z[X]$ .*
- [ex GiNaC::sqrfree](#) (const [ex](#) &a, const [lst](#) &l)  
*Compute a square-free factorization of a multivariate polynomial in  $Q[X]$ .*
- [ex GiNaC::sqrfree\\_parfrac](#) (const [ex](#) &a, const [symbol](#) &x)  
*Compute square-free partial fraction decomposition of rational function  $a(x)$ .*
- [ex GiNaC::collect\\_common\\_factors](#) (const [ex](#) &e)  
*Collect common factors in sums.*
- [ex GiNaC::resultant](#) (const [ex](#) &e1, const [ex](#) &e2, const [ex](#) &s)  
*Resultant of two expressions  $e1, e2$  with respect to symbol  $s$ .*

### 7.63.1 Detailed Description

This file defines several functions that work on univariate and multivariate polynomials and rational functions.

These functions include polynomial quotient and remainder, GCD and LCM computation, square-free factorization and rational function normalization.

## 7.64 numeric.cpp File Reference

This file contains the interface to the underlying bignum package.

```
#include "numeric.h"
#include "ex.h"
#include "operators.h"
#include "archive.h"
#include "utils.h"
#include <limits>
#include <sstream>
#include <stdexcept>
#include <string>
#include <vector>
#include <cln/output.h>
#include <cln/integer_io.h>
#include <cln/integer_ring.h>
#include <cln/rational_io.h>
#include <cln/rational_ring.h>
#include <cln/lfloat_class.h>
#include <cln/lfloat_io.h>
#include <cln/real_io.h>
#include <cln/real_ring.h>
#include <cln/complex_io.h>
#include <cln/complex_ring.h>
#include <cln/numtheory.h>
```

### Classes

- class [GiNaC::lanczos\\_coeffs](#)

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([numeric](#), [basic](#), [print\\_func< print\\_context >\(&numeric::do\\_print\)](#), [print\\_func< print\\_latex >\(&numeric::do\\_print\\_latex\)](#), [print\\_func< print\\_csrc >\(&numeric::do\\_print\\_csrc\)](#), [print\\_func< print\\_csrc\\_cl\\_N >\(&numeric::do\\_print\\_csrc\\_cl\\_N\)](#), [print\\_func< print\\_tree >\(&numeric::do\\_print\\_tree\)](#), [print\\_func< print\\_python\\_repr >\(&numeric::do\\_print\\_python\\_repr\)](#))  
[numeric](#)  
*default ctor.*
- static const [cln::cl\\_F](#) [GiNaC::make\\_real\\_float](#) (const [cln::cl\\_idecoded\\_float](#) &dec)  
*Construct a floating point number from sign, mantissa, and exponent.*
- static const [cln::cl\\_F](#) [GiNaC::read\\_real\\_float](#) (std::istream &s)  
*Read serialized floating point number.*
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([numeric](#))
- static void [GiNaC::write\\_real\\_float](#) (std::ostream &s, const [cln::cl\\_R](#) &n)
- static void [GiNaC::print\\_real\\_number](#) (const [print\\_context](#) &c, const [cln::cl\\_R](#) &x)  
*Helper function to print a real number in a nicer way than is CLN's default.*
- static void [GiNaC::print\\_integer\\_csrc](#) (const [print\\_context](#) &c, const [cln::cl\\_I](#) &x)

- Helper function to print integer number in C++ source format.*
- static void `GiNaC::print_real_csrc` (const `print_context` &c, const `cln::cl_R` &x)
- Helper function to print real number in C++ source format.*
- template<typename T1, typename T2>  
static bool `GiNaC::coerce` (T1 &dst, const T2 &arg)
- template<> bool `GiNaC::coerce< int, cln::cl_I >` (int &dst, const `cln::cl_I` &arg)
- Check if CLN integer can be converted into int.*
- template<> bool `GiNaC::coerce< unsigned int, cln::cl_I >` (unsigned int &dst, const `cln::cl_I` &arg)
- static void `GiNaC::print_real_cl_N` (const `print_context` &c, const `cln::cl_R` &x)
- Helper function to print real number in C++ source format using cl\_N types.*
- const `numeric` `GiNaC::exp` (const `numeric` &x)
- Exponential function.*
- const `numeric` `GiNaC::log` (const `numeric` &x)
- Natural logarithm.*
- const `numeric` `GiNaC::sin` (const `numeric` &x)
- Numeric sine (trigonometric function).*
- const `numeric` `GiNaC::cos` (const `numeric` &x)
- Numeric cosine (trigonometric function).*
- const `numeric` `GiNaC::tan` (const `numeric` &x)
- Numeric tangent (trigonometric function).*
- const `numeric` `GiNaC::asin` (const `numeric` &x)
- Numeric inverse sine (trigonometric function).*
- const `numeric` `GiNaC::acos` (const `numeric` &x)
- Numeric inverse cosine (trigonometric function).*
- const `numeric` `GiNaC::atan` (const `numeric` &x)
- Numeric arcustangent.*
- const `numeric` `GiNaC::atan` (const `numeric` &y, const `numeric` &x)
- Numeric arcustangent of two arguments, analytically continued in a suitable way.*
- const `numeric` `GiNaC::sinh` (const `numeric` &x)
- Numeric hyperbolic sine (trigonometric function).*
- const `numeric` `GiNaC::cosh` (const `numeric` &x)
- Numeric hyperbolic cosine (trigonometric function).*
- const `numeric` `GiNaC::tanh` (const `numeric` &x)
- Numeric hyperbolic tangent (trigonometric function).*
- const `numeric` `GiNaC::asinh` (const `numeric` &x)
- Numeric inverse hyperbolic sine (trigonometric function).*
- const `numeric` `GiNaC::acosh` (const `numeric` &x)
- Numeric inverse hyperbolic cosine (trigonometric function).*
- const `numeric` `GiNaC::atanh` (const `numeric` &x)
- Numeric inverse hyperbolic tangent (trigonometric function).*
- static `cln::cl_N` `GiNaC::Li2_series` (const `cln::cl_N` &x, const `cln::float_format_t` &prec)
- Numeric evaluation of Dilogarithm within circle of convergence (unit circle) using a power series.*
- static `cln::cl_N` `GiNaC::Li2_projection` (const `cln::cl_N` &x, const `cln::float_format_t` &prec)
- Folds Li2's argument inside a small rectangle to enhance convergence.*
- const `cln::cl_N` `GiNaC::Li2_` (const `cln::cl_N` &value)
- Numeric evaluation of Dilogarithm.*
- const `numeric` `GiNaC::Li2` (const `numeric` &x)
- const `numeric` `GiNaC::zeta` (const `numeric` &x)
- Numeric evaluation of Riemann's Zeta function.*
- static `cln::float_format_t` `GiNaC::guess_precision` (const `cln::cl_N` &x)
- const `cln::cl_N` `GiNaC::lgamma` (const `cln::cl_N` &x)

*The Gamma function.*

- const `numeric GiNaC::lgamma` (const `numeric` &x)
- const `cln::cl_N GiNaC::tgamma` (const `cln::cl_N` &x)
- const `numeric GiNaC::tgamma` (const `numeric` &x)
- const `numeric GiNaC::psi` (const `numeric` &x)

*The psi function (aka polygamma function).*

- const `numeric GiNaC::psi` (const `numeric` &n, const `numeric` &x)

*The psi functions (aka polygamma functions).*

- const `numeric GiNaC::factorial` (const `numeric` &n)

*Factorial combinatorial function.*

- const `numeric GiNaC::doublefactorial` (const `numeric` &n)

*The double factorial combinatorial function.*

- const `numeric GiNaC::binomial` (const `numeric` &n, const `numeric` &k)

*The Binomial coefficients.*

- const `numeric GiNaC::bernoulli` (const `numeric` &nn)

*Bernoulli number.*

- const `numeric GiNaC::fibonacci` (const `numeric` &n)

*Fibonacci number.*

- const `numeric GiNaC::abs` (const `numeric` &x)

*Absolute value.*

- const `numeric GiNaC::mod` (const `numeric` &a, const `numeric` &b)

*Modulus (in positive representation).*

- const `numeric GiNaC::smod` (const `numeric` &a\_, const `numeric` &b\_)

*Modulus (in symmetric representation).*

- const `numeric GiNaC::irem` (const `numeric` &a, const `numeric` &b)

*Numeric integer remainder.*

- const `numeric GiNaC::irem` (const `numeric` &a, const `numeric` &b, `numeric` &q)

*Numeric integer remainder.*

- const `numeric GiNaC::iquo` (const `numeric` &a, const `numeric` &b)

*Numeric integer quotient.*

- const `numeric GiNaC::iquo` (const `numeric` &a, const `numeric` &b, `numeric` &r)

*Numeric integer quotient.*

- const `numeric GiNaC::gcd` (const `numeric` &a, const `numeric` &b)

*Greatest Common Divisor.*

- const `numeric GiNaC::lcm` (const `numeric` &a, const `numeric` &b)

*Least Common Multiple.*

- const `numeric GiNaC::sqrt` (const `numeric` &x)

*Numeric square root.*

- const `numeric GiNaC::isqrt` (const `numeric` &x)

*Integer numeric square root.*

- `ex GiNaC::PiEvalf` ()

*Floating point evaluation of Archimedes' constant Pi.*

- `ex GiNaC::EulerEvalf` ()

*Floating point evaluation of Euler's constant gamma.*

- `ex GiNaC::CatalanEvalf` ()

*Floating point evaluation of Catalan's constant.*

- `std::ostream & GiNaC::operator<<` (std::ostream &os, const `_numeric_digits` &e)



## Variables

- const [numeric GiNaC::I](#) = [numeric](#)(cln::complex(cln::cl\_I(0),cln::cl\_I(1)))  
*Imaginary unit.*
- [\\_numeric\\_digits GiNaC::Digits](#)  
*Accuracy in decimal digits.*

### 7.64.1 Detailed Description

This file contains the interface to the underlying bignum package.

Its most important design principle is to completely hide the inner working of that other package from the user of [GiNaC](#). It must either provide implementation of arithmetic operators and numerical evaluation of special functions or implement the interface to the bignum package.

## 7.65 numeric.h File Reference

Makes the interface to the underlying bignum package available.

```
#include "basic.h"
#include "ex.h"
#include "archive.h"
#include <cln/complex.h>
#include <stdexcept>
#include <vector>
```

## Classes

- class [GiNaC::\\_numeric\\_digits](#)  
*This class is used to instantiate a global singleton object Digits which behaves just like Maple's Digits.*
- class [GiNaC::pole\\_error](#)  
*Exception class thrown when a singularity is encountered.*
- class [GiNaC::numeric](#)  
*This class is a wrapper around CLN-numbers within the [GiNaC](#) class hierarchy.*

## Namespaces

- namespace [GiNaC](#)

## Typedefs

- typedef void(\* [GiNaC::digits\\_changed\\_callback](#)) (long)  
*Function pointer to implement callbacks in the case 'Digits' gets changed.*

## Functions

- `GiNaC::GINAC_DECLARE_UNARCHIVER` (numeric)
- `const numeric GiNaC::exp` (const numeric &x)  
*Exponential function.*
- `const numeric GiNaC::log` (const numeric &x)  
*Natural logarithm.*
- `const numeric GiNaC::sin` (const numeric &x)  
*Numeric sine (trigonometric function).*
- `const numeric GiNaC::cos` (const numeric &x)  
*Numeric cosine (trigonometric function).*
- `const numeric GiNaC::tan` (const numeric &x)  
*Numeric tangent (trigonometric function).*
- `const numeric GiNaC::asin` (const numeric &x)  
*Numeric inverse sine (trigonometric function).*
- `const numeric GiNaC::acos` (const numeric &x)  
*Numeric inverse cosine (trigonometric function).*
- `const numeric GiNaC::atan` (const numeric &x)  
*Numeric arcustangent.*
- `const numeric GiNaC::atan` (const numeric &y, const numeric &x)  
*Numeric arcustangent of two arguments, analytically continued in a suitable way.*
- `const numeric GiNaC::sinh` (const numeric &x)  
*Numeric hyperbolic sine (trigonometric function).*
- `const numeric GiNaC::cosh` (const numeric &x)  
*Numeric hyperbolic cosine (trigonometric function).*
- `const numeric GiNaC::tanh` (const numeric &x)  
*Numeric hyperbolic tangent (trigonometric function).*
- `const numeric GiNaC::asinh` (const numeric &x)  
*Numeric inverse hyperbolic sine (trigonometric function).*
- `const numeric GiNaC::acosh` (const numeric &x)  
*Numeric inverse hyperbolic cosine (trigonometric function).*
- `const numeric GiNaC::atanh` (const numeric &x)  
*Numeric inverse hyperbolic tangent (trigonometric function).*
- `const numeric GiNaC::Li2` (const numeric &x)
- `const numeric GiNaC::zeta` (const numeric &x)  
*Numeric evaluation of Riemann's Zeta function.*
- `const numeric GiNaC::lgamma` (const numeric &x)
- `const numeric GiNaC::tgamma` (const numeric &x)
- `const numeric GiNaC::psi` (const numeric &x)  
*The psi function (aka polygamma function).*
- `const numeric GiNaC::psi` (const numeric &n, const numeric &x)  
*The psi functions (aka polygamma functions).*
- `const numeric GiNaC::factorial` (const numeric &n)  
*Factorial combinatorial function.*
- `const numeric GiNaC::doublefactorial` (const numeric &n)  
*The double factorial combinatorial function.*
- `const numeric GiNaC::binomial` (const numeric &n, const numeric &k)  
*The Binomial coefficients.*
- `const numeric GiNaC::bernoulli` (const numeric &nn)  
*Bernoulli number.*
- `const numeric GiNaC::fibonacci` (const numeric &n)

- Fibonacci number.*
  - const [numeric GiNaC::isqrt](#) (const [numeric](#) &x)
  - Integer numeric square root.*
  - const [numeric GiNaC::sqrt](#) (const [numeric](#) &x)
  - Numeric square root.*
  - const [numeric GiNaC::abs](#) (const [numeric](#) &x)
  - Absolute value.*
  - const [numeric GiNaC::mod](#) (const [numeric](#) &a, const [numeric](#) &b)
  - Modulus (in positive representation).*
  - const [numeric GiNaC::smod](#) (const [numeric](#) &a\_, const [numeric](#) &b\_)
  - Modulus (in symmetric representation).*
  - const [numeric GiNaC::irem](#) (const [numeric](#) &a, const [numeric](#) &b)
  - Numeric integer remainder.*
  - const [numeric GiNaC::irem](#) (const [numeric](#) &a, const [numeric](#) &b, [numeric](#) &q)
  - Numeric integer remainder.*
  - const [numeric GiNaC::iquo](#) (const [numeric](#) &a, const [numeric](#) &b)
  - Numeric integer quotient.*
  - const [numeric GiNaC::iquo](#) (const [numeric](#) &a, const [numeric](#) &b, [numeric](#) &r)
  - Numeric integer quotient.*
  - const [numeric GiNaC::gcd](#) (const [numeric](#) &a, const [numeric](#) &b)
  - Greatest Common Divisor.*
  - const [numeric GiNaC::lcm](#) (const [numeric](#) &a, const [numeric](#) &b)
  - Least Common Multiple.*
  - const [numeric GiNaC::pow](#) (const [numeric](#) &x, const [numeric](#) &y)
  - const [numeric GiNaC::inverse](#) (const [numeric](#) &x)
  - [numeric GiNaC::step](#) (const [numeric](#) &x)
  - int [GiNaC::csgn](#) (const [numeric](#) &x)
  - bool [GiNaC::is\\_zero](#) (const [numeric](#) &x)
  - bool [GiNaC::is\\_positive](#) (const [numeric](#) &x)
  - bool [GiNaC::is\\_negative](#) (const [numeric](#) &x)
  - bool [GiNaC::is\\_integer](#) (const [numeric](#) &x)
  - bool [GiNaC::is\\_pos\\_integer](#) (const [numeric](#) &x)
  - bool [GiNaC::is\\_nonneg\\_integer](#) (const [numeric](#) &x)
  - bool [GiNaC::is\\_even](#) (const [numeric](#) &x)
  - bool [GiNaC::is\\_odd](#) (const [numeric](#) &x)
  - bool [GiNaC::is\\_prime](#) (const [numeric](#) &x)
  - bool [GiNaC::is\\_rational](#) (const [numeric](#) &x)
  - bool [GiNaC::is\\_real](#) (const [numeric](#) &x)
  - bool [GiNaC::is\\_cinteger](#) (const [numeric](#) &x)
  - bool [GiNaC::is\\_crational](#) (const [numeric](#) &x)
  - int [GiNaC::to\\_int](#) (const [numeric](#) &x)
  - long [GiNaC::to\\_long](#) (const [numeric](#) &x)
  - double [GiNaC::to\\_double](#) (const [numeric](#) &x)
  - const [numeric GiNaC::real](#) (const [numeric](#) &x)
  - const [numeric GiNaC::imag](#) (const [numeric](#) &x)
  - const [numeric GiNaC::numer](#) (const [numeric](#) &x)
  - const [numeric GiNaC::denom](#) (const [numeric](#) &x)
  - [ex GiNaC::PiEvalf](#) ()
  - Floating point evaluation of Archimedes' constant Pi.*
  - [ex GiNaC::EulerEvalf](#) ()
  - Floating point evaluation of Euler's constant gamma.*
  - [ex GiNaC::CatalanEvalf](#) ()
  - Floating point evaluation of Catalan's constant.*

### 7.65.1 Detailed Description

Makes the interface to the underlying bignum package available.

## 7.66 operators.cpp File Reference

Implementation of [GiNaC](#)'s overloaded operators.

```
#include "operators.h"
#include "numeric.h"
#include "add.h"
#include "mul.h"
#include "power.h"
#include "ncmul.h"
#include "relational.h"
#include "print.h"
#include "utils.h"
#include <iostream>
```

### Namespaces

- namespace [GiNaC](#)

### Enumerations

- enum { [GiNaC::callback\\_registered](#) = 1 }

### Functions

- static const [ex](#) [GiNaC::exadd](#) (const [ex](#) &lh, const [ex](#) &rh)  
*Used internally by [operator+](#)() to add two ex objects.*
- static const [ex](#) [GiNaC::exmul](#) (const [ex](#) &lh, const [ex](#) &rh)  
*Used internally by [operator\\*](#)() to multiply two ex objects.*
- static const [ex](#) [GiNaC::exminus](#) (const [ex](#) &lh)  
*Used internally by [operator-](#)() and friends to change the sign of an argument.*
- const [ex](#) [GiNaC::operator+](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [ex](#) [GiNaC::operator-](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [ex](#) [GiNaC::operator\\*](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [ex](#) [GiNaC::operator/](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [numeric](#) [GiNaC::operator+](#) (const [numeric](#) &lh, const [numeric](#) &rh)
- const [numeric](#) [GiNaC::operator-](#) (const [numeric](#) &lh, const [numeric](#) &rh)
- const [numeric](#) [GiNaC::operator\\*](#) (const [numeric](#) &lh, const [numeric](#) &rh)
- const [numeric](#) [GiNaC::operator/](#) (const [numeric](#) &lh, const [numeric](#) &rh)
- [ex](#) & [GiNaC::operator+=](#) ([ex](#) &lh, const [ex](#) &rh)
- [ex](#) & [GiNaC::operator-=](#) ([ex](#) &lh, const [ex](#) &rh)
- [ex](#) & [GiNaC::operator\\*=](#) ([ex](#) &lh, const [ex](#) &rh)
- [ex](#) & [GiNaC::operator/=](#) ([ex](#) &lh, const [ex](#) &rh)
- [numeric](#) & [GiNaC::operator+=](#) ([numeric](#) &lh, const [numeric](#) &rh)
- [numeric](#) & [GiNaC::operator-=](#) ([numeric](#) &lh, const [numeric](#) &rh)

- `numeric & GiNaC::operator*=(numeric &lh, const numeric &rh)`
- `numeric & GiNaC::operator/=(numeric &lh, const numeric &rh)`
- `const ex GiNaC::operator+(const ex &lh)`
- `const ex GiNaC::operator-(const ex &lh)`
- `const numeric GiNaC::operator+(const numeric &lh)`
- `const numeric GiNaC::operator-(const numeric &lh)`
- `ex & GiNaC::operator++(ex &rh)`  
*Expression prefix increment.*
- `ex & GiNaC::operator--(ex &rh)`  
*Expression prefix decrement.*
- `const ex GiNaC::operator++(ex &lh, int)`  
*Expression postfix increment.*
- `const ex GiNaC::operator--(ex &lh, int)`  
*Expression postfix decrement.*
- `numeric & GiNaC::operator++(numeric &rh)`  
*Numeric prefix increment.*
- `numeric & GiNaC::operator--(numeric &rh)`  
*Numeric prefix decrement.*
- `const numeric GiNaC::operator++(numeric &lh, int)`  
*Numeric postfix increment.*
- `const numeric GiNaC::operator--(numeric &lh, int)`  
*Numeric postfix decrement.*
- `const relational GiNaC::operator==(const ex &lh, const ex &rh)`
- `const relational GiNaC::operator!=(const ex &lh, const ex &rh)`
- `const relational GiNaC::operator<(const ex &lh, const ex &rh)`
- `const relational GiNaC::operator<=(const ex &lh, const ex &rh)`
- `const relational GiNaC::operator>(const ex &lh, const ex &rh)`
- `const relational GiNaC::operator>=(const ex &lh, const ex &rh)`
- `static int GiNaC::my_ios_index ()`
- `static void GiNaC::my_ios_callback (std::ios_base::event ev, std::ios_base &s, int i)`
- `static print_context * GiNaC::get_print_context (std::ios_base &s)`
- `static void GiNaC::set_print_context (std::ios_base &s, const print_context &c)`
- `static unsigned GiNaC::get_print_options (std::ios_base &s)`
- `static void GiNaC::set_print_options (std::ostream &s, unsigned options)`
- `std::ostream & GiNaC::operator<< (std::ostream &os, const ex &e)`
- `std::ostream & GiNaC::operator<< (std::ostream &os, const exvector &e)`
- `std::ostream & GiNaC::operator<< (std::ostream &os, const exset &e)`
- `std::ostream & GiNaC::operator<< (std::ostream &os, const exmap &e)`
- `std::istream & GiNaC::operator>> (std::istream &is, ex &e)`
- `std::ostream & GiNaC::dflt (std::ostream &os)`
- `std::ostream & GiNaC::latex (std::ostream &os)`
- `std::ostream & GiNaC::python (std::ostream &os)`
- `std::ostream & GiNaC::python_repr (std::ostream &os)`
- `std::ostream & GiNaC::tree (std::ostream &os)`
- `std::ostream & GiNaC::csrc (std::ostream &os)`
- `std::ostream & GiNaC::csrc_float (std::ostream &os)`
- `std::ostream & GiNaC::csrc_double (std::ostream &os)`
- `std::ostream & GiNaC::csrc_cl_N (std::ostream &os)`
- `std::ostream & GiNaC::index_dimensions (std::ostream &os)`
- `std::ostream & GiNaC::no_index_dimensions (std::ostream &os)`

### 7.66.1 Detailed Description

Implementation of [GiNaC](#)'s overloaded operators.

## 7.67 operators.h File Reference

Interface to [GiNaC](#)'s overloaded operators.

```
#include <iosfwd>
```

### Namespaces

- namespace [GiNaC](#)

### Functions

- const [ex](#) [GiNaC::operator+](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [ex](#) [GiNaC::operator-](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [ex](#) [GiNaC::operator\\*](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [ex](#) [GiNaC::operator/](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [numeric](#) [GiNaC::operator+](#) (const [numeric](#) &lh, const [numeric](#) &rh)
- const [numeric](#) [GiNaC::operator-](#) (const [numeric](#) &lh, const [numeric](#) &rh)
- const [numeric](#) [GiNaC::operator\\*](#) (const [numeric](#) &lh, const [numeric](#) &rh)
- const [numeric](#) [GiNaC::operator/](#) (const [numeric](#) &lh, const [numeric](#) &rh)
- [ex](#) & [GiNaC::operator+=](#) ([ex](#) &lh, const [ex](#) &rh)
- [ex](#) & [GiNaC::operator-=](#) ([ex](#) &lh, const [ex](#) &rh)
- [ex](#) & [GiNaC::operator\\*=](#) ([ex](#) &lh, const [ex](#) &rh)
- [ex](#) & [GiNaC::operator/=](#) ([ex](#) &lh, const [ex](#) &rh)
- [numeric](#) & [GiNaC::operator+=](#) ([numeric](#) &lh, const [numeric](#) &rh)
- [numeric](#) & [GiNaC::operator-=](#) ([numeric](#) &lh, const [numeric](#) &rh)
- [numeric](#) & [GiNaC::operator\\*=](#) ([numeric](#) &lh, const [numeric](#) &rh)
- [numeric](#) & [GiNaC::operator/=](#) ([numeric](#) &lh, const [numeric](#) &rh)
- const [ex](#) [GiNaC::operator+](#) (const [ex](#) &lh)
- const [ex](#) [GiNaC::operator-](#) (const [ex](#) &lh)
- const [numeric](#) [GiNaC::operator+](#) (const [numeric](#) &lh)
- const [numeric](#) [GiNaC::operator-](#) (const [numeric](#) &lh)
- [ex](#) & [GiNaC::operator++](#) ([ex](#) &rh)  
*Expression prefix increment.*
- [ex](#) & [GiNaC::operator--](#) ([ex](#) &rh)  
*Expression prefix decrement.*
- const [ex](#) [GiNaC::operator++](#) ([ex](#) &lh, int)  
*Expression postfix increment.*
- const [ex](#) [GiNaC::operator--](#) ([ex](#) &lh, int)  
*Expression postfix decrement.*
- [numeric](#) & [GiNaC::operator++](#) ([numeric](#) &rh)  
*Numeric prefix increment.*
- [numeric](#) & [GiNaC::operator--](#) ([numeric](#) &rh)  
*Numeric prefix decrement.*
- const [numeric](#) [GiNaC::operator++](#) ([numeric](#) &lh, int)

*Numeric postfix increment.*

- const [numeric](#) [GiNaC::operator--](#) ([numeric](#) &lh, int)

*Numeric postfix decrement.*

- const [relational](#) [GiNaC::operator==](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [relational](#) [GiNaC::operator!=](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [relational](#) [GiNaC::operator<](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [relational](#) [GiNaC::operator<=](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [relational](#) [GiNaC::operator>](#) (const [ex](#) &lh, const [ex](#) &rh)
- const [relational](#) [GiNaC::operator>=](#) (const [ex](#) &lh, const [ex](#) &rh)
- std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const [ex](#) &e)
- std::istream & [GiNaC::operator>>](#) (std::istream &is, [ex](#) &e)
- std::ostream & [GiNaC::dflt](#) (std::ostream &os)
- std::ostream & [GiNaC::latex](#) (std::ostream &os)
- std::ostream & [GiNaC::python](#) (std::ostream &os)
- std::ostream & [GiNaC::python\\_repr](#) (std::ostream &os)
- std::ostream & [GiNaC::tree](#) (std::ostream &os)
- std::ostream & [GiNaC::csrc](#) (std::ostream &os)
- std::ostream & [GiNaC::csrc\\_float](#) (std::ostream &os)
- std::ostream & [GiNaC::csrc\\_double](#) (std::ostream &os)
- std::ostream & [GiNaC::csrc\\_cl\\_N](#) (std::ostream &os)
- std::ostream & [GiNaC::index\\_dimensions](#) (std::ostream &os)
- std::ostream & [GiNaC::no\\_index\\_dimensions](#) (std::ostream &os)

### 7.67.1 Detailed Description

Interface to [GiNaC](#)'s overloaded operators.

## 7.68 power.cpp File Reference

Implementation of [GiNaC](#)'s symbolic exponentiation ( $\text{basis}^{\text{exponent}}$ ).

```
#include "power.h"
#include "expairseq.h"
#include "add.h"
#include "mul.h"
#include "ncmul.h"
#include "numeric.h"
#include "constant.h"
#include "operators.h"
#include "inifcns.h"
#include "matrix.h"
#include "indexed.h"
#include "symbol.h"
#include "lst.h"
#include "archive.h"
#include "utils.h"
#include "relational.h"
#include "compiler.h"
#include <iostream>
#include <limits>
#include <stdexcept>
#include <vector>
#include <algorithm>
```

## Namespaces

- namespace [GiNaC](#)

## Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([power](#), [basic](#), [print\\_func](#)<[print\\_dflt](#)>(&[power::do\\_print\\_dflt](#)), [print\\_func](#)<[print\\_latex](#)>(&[power::do\\_print\\_latex](#)), [print\\_func](#)<[print\\_csrc](#)>(&[power::do\\_print\\_csrc](#)), [print\\_func](#)<[print\\_python](#)>(&[power::do\\_print\\_python](#)), [print\\_func](#)<[print\\_python\\_repr](#)>(&[power::do\\_print\\_python\\_repr](#)), [print\\_func](#)<[print\\_csrc\\_cl\\_N](#)>(&[power::do\\_print\\_csrc\\_cl\\_N](#))) [power](#)
- static void [GiNaC::print\\_sym\\_pow](#) (const [print\\_context](#) &c, const [symbol](#) &x, int [exp](#))
- bool [GiNaC::tryfactsubs](#) (const [ex](#) &origfactor, const [ex](#) &patternfactor, int &nummatches, [exmap](#) &repls)
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([power](#))

### 7.68.1 Detailed Description

Implementation of [GiNaC](#)'s symbolic exponentiation ( $\text{basis}^{\text{exponent}}$ ).

## 7.69 power.h File Reference

Interface to [GiNaC](#)'s symbolic exponentiation ( $\text{basis}^{\text{exponent}}$ ).

```
#include "basic.h"
#include "ex.h"
#include "archive.h"
```

## Classes

- class [GiNaC::power](#)

*This class holds a two-component object, a basis and an exponent representing exponentiation.*

## Namespaces

- namespace [GiNaC](#)

## Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([power](#))
- [ex GiNaC::pow](#) (const [ex](#) &b, const [ex](#) &e)  
*Symbolic exponentiation.*
- [template<typename T1, typename T2> ex GiNaC::pow](#) (const T1 &b, const T2 &e)
- [ex GiNaC::sqrt](#) (const [ex](#) &a)  
*Square root expression.*



### 7.69.1 Detailed Description

Interface to [GiNaC](#)'s symbolic exponentiation ( $\text{basis}^{\text{exponent}}$ ).

## 7.70 print.cpp File Reference

Implementation of helper classes for expression output.

```
#include "print.h"
#include <iostream>
```

### Namespaces

- namespace [GiNaC](#)

### Variables

- unsigned [GiNaC::next\\_print\\_context\\_id](#) = 0  
*Next free ID for [print\\_context](#) types.*

### 7.70.1 Detailed Description

Implementation of helper classes for expression output.

## 7.71 print.h File Reference

Definition of helper classes for expression output.

```
#include "class_info.h"
#include <iosfwd>
#include <memory>
#include <string>
```

## Classes

- class [GiNaC::print\\_context\\_options](#)  
*This class stores information about a registered [print\\_context](#) class.*
- class [GiNaC::print\\_options](#)  
*Flags to control the behavior of a [print\\_context](#).*
- class [GiNaC::print\\_context](#)  
*Base class for [print\\_contexts](#).*
- class [GiNaC::print\\_dflt](#)  
*Context for default (ginsh-parsable) output.*
- class [GiNaC::print\\_latex](#)  
*Context for latex-parsable output.*
- class [GiNaC::print\\_python](#)  
*Context for python pretty-print output.*
- class [GiNaC::print\\_python\\_repr](#)  
*Context for python-parsable output.*
- class [GiNaC::print\\_tree](#)  
*Context for tree-like output for debugging.*
- class [GiNaC::print\\_csrc](#)  
*Base context for C source output.*
- class [GiNaC::print\\_csrc\\_float](#)  
*Context for C source output using float precision.*
- class [GiNaC::print\\_csrc\\_double](#)  
*Context for C source output using double precision.*
- class [GiNaC::print\\_csrc\\_cl\\_N](#)  
*Context for C source output using CLN numbers.*
- class [GiNaC::print\\_functor\\_impl](#)  
*Base class for [print\\_functor](#) handlers.*
- class [GiNaC::print\\_ptrfun\\_handler< T, C >](#)  
*[print\\_functor](#) handler for pointer-to-functions of class T, context type C*
- class [GiNaC::print\\_memfun\\_handler< T, C >](#)  
*[print\\_functor](#) handler for member functions of class T, context type C*
- class [GiNaC::print\\_functor](#)  
*This class represents a print method for a certain algebraic class and [print\\_context](#) type.*

## Namespaces

- namespace [GiNaC](#)

## Macros

- `#define GINAC\_DECLARE\_PRINT\_CONTEXT\_COMMON(classname)`  
*Common part of [GINAC\\_DECLARE\\_PRINT\\_CONTEXT\\_BASE](#) and [GINAC\\_DECLARE\\_PRINT\\_CONTEXT\\_DERIVED](#).*
- `#define GINAC\_DECLARE\_PRINT\_CONTEXT\_BASE(classname)`
- `#define GINAC\_DECLARE\_PRINT\_CONTEXT(classname, supertype)`  
*Macro for inclusion in the declaration of a [print\\_context](#) class.*
- `#define GINAC\_IMPLEMENT\_PRINT\_CONTEXT(classname, supertype)`  
*Macro for inclusion in the implementation of each [print\\_context](#) class.*

## Typedefs

- typedef [class\\_info](#)< [print\\_context\\_options](#) > [GiNaC::print\\_context\\_class\\_info](#)

## Functions

- template<class T>  
bool [GiNaC::is\\_a](#) (const [print\\_context](#) &obj)  
*Check if obj is a T, including base classes.*

## 7.71.1 Detailed Description

Definition of helper classes for expression output.

## 7.71.2 Macro Definition Documentation

### 7.71.2.1 GINAC\_DECLARE\_PRINT\_CONTEXT\_COMMON

```
#define GINAC_DECLARE_PRINT_CONTEXT_COMMON(
 classname)
```

#### Value:

```
public: \
 friend class function_options; \
 friend class registered_class_options; \
 static const GiNaC::print_context_class_info &get_class_info_static(); \
 classname();
```

Common part of GINAC\_DECLARE\_PRINT\_CONTEXT\_BASE and GINAC\_DECLARE\_PRINT\_CONTEXT\_DERIVED.

### 7.71.2.2 GINAC\_DECLARE\_PRINT\_CONTEXT\_BASE

```
#define GINAC_DECLARE_PRINT_CONTEXT_BASE(
 classname)
```

#### Value:

```
GINAC_DECLARE_PRINT_CONTEXT_COMMON(classname) \
virtual const GiNaC::print_context_class_info &get_class_info() const { return
 classname::get_class_info_static(); } \
virtual const char *class_name() const { return classname::get_class_info_static().options.get_name(); }
\
virtual classname * duplicate() const { return new classname(*this); } \
private:
```

### 7.71.2.3 GINAC\_DECLARE\_PRINT\_CONTEXT

```
#define GINAC_DECLARE_PRINT_CONTEXT(
 classname,
 supertype)
```

**Value:**

```
GINAC_DECLARE_PRINT_CONTEXT_COMMON(classname) \
typedef supertype inherited; \
const GiNaC::print_context_class_info &get_class_info() const override { return
 classname::get_class_info_static(); } \
const char *class_name() const override { return classname::get_class_info_static().options.get_name();
} \
classname * duplicate() const override { return new classname(*this); } \
private:
```

Macro for inclusion in the declaration of a `print_context` class.

It declares some functions that are common to all classes derived from 'print\_context' as well as all required stuff for the [GiNaC](#) registry.

### 7.71.2.4 GINAC\_IMPLEMENT\_PRINT\_CONTEXT

```
#define GINAC_IMPLEMENT_PRINT_CONTEXT(
 classname,
 supertype)
```

**Value:**

```
const GiNaC::print_context_class_info &classname::get_class_info_static() \
{ \
 static GiNaC::print_context_class_info reg_info =
 GiNaC::print_context_class_info(GiNaC::print_context_options(#classname, #supertype,
 GiNaC::next_print_context_id++)); \
 return reg_info; \
}
```

Macro for inclusion in the implementation of each `print_context` class.

## 7.72 pseries.cpp File Reference

Implementation of class for extended truncated power series and methods for series expansion.

```
#include "pseries.h"
#include "add.h"
#include "inifcns.h"
#include "lst.h"
#include "mul.h"
#include "power.h"
#include "relational.h"
#include "operators.h"
#include "symbol.h"
#include "integral.h"
#include "archive.h"
#include "utils.h"
#include <limits>
#include <numeric>
#include <stdexcept>
```

## Namespaces

- namespace [GiNaC](#)

## Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([pseries](#), [basic](#), [print\\_func](#)< [print\\_context](#)>(&[pseries::do\\_print](#)), [print\\_func](#)< [print\\_latex](#)>(&[pseries::do\\_print\\_latex](#)), [print\\_func](#)< [print\\_tree](#)>(&[pseries::do\\_print\\_tree](#)), [print\\_func](#)< [print\\_python](#)>(&[pseries::do\\_print\\_python](#)), [print\\_func](#)< [print\\_python\\_repr](#)>(&[pseries::do\\_print\\_python\\_repr](#))) [pseries](#)
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([pseries](#))

### 7.72.1 Detailed Description

Implementation of class for extended truncated power series and methods for series expansion.

## 7.73 pseries.h File Reference

Interface to class for extended truncated power series.

```
#include "basic.h"
#include "expairseq.h"
```

## Classes

- class [GiNaC::pseries](#)  
*This class holds a extended truncated power series (positive and negative integer powers).*

## Namespaces

- namespace [GiNaC](#)

## Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([pseries](#))
- [ex GiNaC::series\\_to\\_poly](#) (const [ex](#) &e)  
*Convert the pseries object embedded in an expression to an ordinary polynomial in the expansion variable.*
- bool [GiNaC::is\\_terminating](#) (const [pseries](#) &s)

### 7.73.1 Detailed Description

Interface to class for extended truncated power series.

## 7.74 ptr.h File Reference

Reference-counted pointer template.

```
#include "assertion.h"
#include <cstdlib>
#include <functional>
#include <iosfwd>
```

### Classes

- class [GiNaC::refcounted](#)  
*Base class for reference-counted objects.*
- class [GiNaC::ptr< T >](#)  
*Class of (intrusively) reference-counted pointers that support copy-on-write semantics.*
- struct [std::less< GiNaC::ptr< T > >](#)  
*Specialization of std::less for ptr<T> to enable ordering of ptr<T> objects (e.g.*

### Namespaces

- namespace [GiNaC](#)
- namespace [std](#)

### 7.74.1 Detailed Description

Reference-counted pointer template.

## 7.75 registrar.cpp File Reference

[GiNaC](#)'s class registrar (for class basic and all classes derived from it).

```
#include "registrar.h"
#include <map>
#include <stdexcept>
#include <string>
```

### Namespaces

- namespace [GiNaC](#)

### 7.75.1 Detailed Description

[GiNaC](#)'s class registrar (for class basic and all classes derived from it).

## 7.76 registrar.h File Reference

GiNaC's class registrar (for class basic and all classes derived from it).

```
#include "class_info.h"
#include "print.h"
#include <list>
#include <string>
#include <typeinfo>
#include <vector>
```

### Classes

- struct [GiNaC::return\\_type\\_t](#)  
*To distinguish between different kinds of non-commutative objects.*
- class [GiNaC::registered\\_class\\_options](#)  
*This class stores information about a registered [GiNaC](#) class.*

### Namespaces

- namespace [GiNaC](#)

### Macros

- #define [GINAC\\_DECLARE\\_REGISTERED\\_CLASS\\_COMMON](#)(classname)  
*Common part of [GINAC\\_DECLARE\\_REGISTERED\\_CLASS\\_NO\\_CTORS](#) and [GINAC\\_DECLARE\\_REGISTERED\\_CLASS](#).*
- #define [GINAC\\_DECLARE\\_REGISTERED\\_CLASS\\_NO\\_CTORS](#)(classname, supertype)  
*Primary macro for inclusion in the declaration of each registered class.*
- #define [GINAC\\_DECLARE\\_REGISTERED\\_CLASS](#)(classname, supertype)  
*Macro for inclusion in the declaration of each registered class.*
- #define [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS](#)(classname, supertype)  
*Macro for inclusion in the implementation of each registered class.*
- #define [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#)(classname, supertype, options)  
*Macro for inclusion in the implementation of each registered class.*
- #define [GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT\\_T](#)(classname, supertype, options)  
*Macro for inclusion in the implementation of each registered class.*

### Typedefs

- typedef [class\\_info](#)< [registered\\_class\\_options](#) > [GiNaC::registered\\_class\\_info](#)

### Functions

- template<typename T>  
[return\\_type\\_t](#) [GiNaC::make\\_return\\_type\\_t](#) (const unsigned rl=0)
- template<class Alg, class Ctx, class T, class C>  
void [GiNaC::set\\_print\\_func](#) (void f(const T &, const C &c, unsigned))  
*Add or replace a print method.*
- template<class Alg, class Ctx, class T, class C>  
void [GiNaC::set\\_print\\_func](#) (void(T::\*f)(const C &, unsigned))  
*Add or replace a print method.*

### 7.76.1 Detailed Description

GiNaC's class registrar (for class basic and all classes derived from it).

### 7.76.2 Macro Definition Documentation

#### 7.76.2.1 GINAC\_DECLARE\_REGISTERED\_CLASS\_COMMON

```
#define GINAC_DECLARE_REGISTERED_CLASS_COMMON(
 classname)
```

**Value:**

```
private: \
 static GiNaC::registered_class_info reg_info; \
public: \
 static GiNaC::registered_class_info &get_class_info_static() { return reg_info; } \
 class visitor { \
 public: \
 virtual void visit(const classname &) = 0; \
 virtual ~visitor() {}; \
 };
```

Common part of GINAC\_DECLARE\_REGISTERED\_CLASS\_NO\_CTORS and GINAC\_DECLARE\_REGISTERED\_CLASS.

#### 7.76.2.2 GINAC\_DECLARE\_REGISTERED\_CLASS\_NO\_CTORS

```
#define GINAC_DECLARE_REGISTERED_CLASS_NO_CTORS(
 classname,
 supertype)
```

**Value:**

```
GINAC_DECLARE_REGISTERED_CLASS_COMMON(classname) \
typedef supertype inherited; \
virtual const GiNaC::registered_class_info &get_class_info() const { return
 classname::get_class_info_static(); } \
virtual GiNaC::registered_class_info &get_class_info() { return classname::get_class_info_static(); } \
virtual const char *class_name() const { return classname::get_class_info_static().options.get_name(); } \
private:
```

Primary macro for inclusion in the declaration of each registered class.

#### 7.76.2.3 GINAC\_DECLARE\_REGISTERED\_CLASS

```
#define GINAC_DECLARE_REGISTERED_CLASS(
 classname,
 supertype)
```

**Value:**

```
GINAC_DECLARE_REGISTERED_CLASS_COMMON(classname) \
template<class B, typename... Args> friend B & dynallocate(Args &&... args); \
typedef supertype inherited; \
classname(); \
classname * duplicate() const override { \
 classname * bp = new classname(*this); \
 bp->setflag(GiNaC::status_flags::dynallocated); \
 return bp; \
} \
```



```

void accept(GiNaC::visitor & v) const override \
{ \
 if (visitor *p = dynamic_cast<visitor *>(&v)) \
 p->visit(*this); \
 else \
 inherited::accept(v); \
} \
const GiNaC::registered_class_info &get_class_info() const override { return
 classname::get_class_info_static(); } \
GiNaC::registered_class_info &get_class_info() override { return classname::get_class_info_static(); } \
const char *class_name() const override { return classname::get_class_info_static().options.get_name();
} \
protected: \
 int compare_same_type(const GiNaC::basic & other) const override; \
private:

```

Macro for inclusion in the declaration of each registered class.

It declares some functions that are common to all classes derived from 'basic' as well as all required stuff for the [GiNaC](#) class registry (mainly needed for archiving).

#### 7.76.2.4 GINAC\_IMPLEMENT\_REGISTERED\_CLASS

```

#define GINAC_IMPLEMENT_REGISTERED_CLASS(
 classname,
 supertype)

```

**Value:**

```

GiNaC::registered_class_info classname::reg_info =
 GiNaC::registered_class_info(GiNaC::registered_class_options(#classname, #supertype,
 typeid(classname)));

```

Macro for inclusion in the implementation of each registered class.

#### 7.76.2.5 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT

```

#define GINAC_IMPLEMENT_REGISTERED_CLASS_OPT(
 classname,
 supertype,
 options)

```

**Value:**

```

GiNaC::registered_class_info classname::reg_info =
 GiNaC::registered_class_info(GiNaC::registered_class_options(#classname, #supertype,
 typeid(classname)).options);

```

Macro for inclusion in the implementation of each registered class.

Additional options can be specified.

#### 7.76.2.6 GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT\_T

```

#define GINAC_IMPLEMENT_REGISTERED_CLASS_OPT_T(
 classname,
 supertype,
 options)

```

**Value:**

```

GiNaC::registered_class_info classname::reg_info =
 GiNaC::registered_class_info(GiNaC::registered_class_options(#classname, #supertype,
 typeid(classname)).options);

```

Macro for inclusion in the implementation of each registered class.

Additional options can be specified.

## 7.77 relational.cpp File Reference

Implementation of relations between expressions.

```
#include "relational.h"
#include "operators.h"
#include "numeric.h"
#include "archive.h"
#include "utils.h"
#include "hash_seed.h"
#include <iostream>
#include <stdexcept>
```

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([relational](#), [basic](#), [print\\_func](#)< [print\\_context](#)>(&[relational::do\\_print](#)). [print\\_func](#)< [print\\_tree](#)>(&[relational::do\\_print\\_tree](#)). [print\\_func](#)< [print\\_python\\_repr](#)>(&[relational::do\\_print\\_python\\_repr](#))) [relational](#)
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([relational](#))
- static void [GiNaC::print\\_operator](#) (const [print\\_context](#) &c, [relational::operators](#) o)

### 7.77.1 Detailed Description

Implementation of relations between expressions.

## 7.78 relational.h File Reference

Interface to relations between expressions.

```
#include "basic.h"
#include "ex.h"
#include "archive.h"
```

### Classes

- class [GiNaC::relational](#)  
*This class holds a relation consisting of two expressions and a logical relation between them.*
- struct [GiNaC::relational::safe\\_bool\\_helper](#)

### Namespaces

- namespace [GiNaC](#)

## Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([relational](#))

### 7.78.1 Detailed Description

Interface to relations between expressions.

## 7.79 remember.cpp File Reference

Implementation of helper classes for using the remember option in [GiNaC](#) functions.

```
#include "function.h"
#include "utils.h"
#include "remember.h"
#include <stdexcept>
```

## Namespaces

- namespace [GiNaC](#)

### 7.79.1 Detailed Description

Implementation of helper classes for using the remember option in [GiNaC](#) functions.

## 7.80 remember.h File Reference

Interface to helper classes for using the remember option in [GiNaC](#) functions.

```
#include <iosfwd>
#include <list>
#include <vector>
```

## Classes

- class [GiNaC::remember\\_table\\_entry](#)  
*A single entry in the remember table of a function.*
- class [GiNaC::remember\\_table\\_list](#)  
*A list of entries in the remember table having some least significant bits of the hashvalue in common.*
- class [GiNaC::remember\\_table](#)  
*The remember table is organized like an n-fold associative cache in a microprocessor.*

## Namespaces

- namespace [GiNaC](#)

### 7.80.1 Detailed Description

Interface to helper classes for using the remember option in [GiNaC](#) functions.

## 7.81 structure.h File Reference

Wrapper template for making [GiNaC](#) classes out of C++ structures.

```
#include "ex.h"
#include "ncmul.h"
#include "numeric.h"
#include "operators.h"
#include "print.h"
#include <functional>
```

## Classes

- class [GiNaC::compare\\_all\\_equal< T >](#)  
*Comparison policy: all structures of one type are equal.*
- class [GiNaC::compare\\_std\\_less< T >](#)  
*Comparison policy: use std::equal\_to/std::less (defaults to operators == and <) to compare structures.*
- class [GiNaC::compare\\_bitwise< T >](#)  
*Comparison policy: use bit-wise comparison to compare structures.*
- class [GiNaC::structure< T, ComparisonPolicy >](#)  
*Wrapper template for making [GiNaC](#) classes out of C++ structures.*

## Namespaces

- namespace [GiNaC](#)

## Variables

- template<class T, template< class > class CP>  
[registered\\_class\\_info](#) [GiNaC::structure< T, CP >::reg\\_info](#) = [registered\\_class\\_info](#)([registered\\_class\\_options](#)([structure::get\\_cla](#)  
"basic", typeid([structure<T, CP>](#))))

### 7.81.1 Detailed Description

Wrapper template for making [GiNaC](#) classes out of C++ structures.

## 7.82 symbol.cpp File Reference

Implementation of [GiNaC](#)'s symbolic objects.

```
#include "symbol.h"
#include "lst.h"
#include "archive.h"
#include "utils.h"
#include "hash_seed.h"
#include "inifcns.h"
#include <map>
#include <stdexcept>
#include <string>
```

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([symbol](#), [basic](#), [print\\_func< print\\_context >\(&symbol::do\\_print\)](#), [print\\_func< print\\_latex >\(&symbol::do\\_print\\_latex\)](#), [print\\_func< print\\_tree >\(&symbol::do\\_print\\_tree\)](#), [print\\_func< print\\_python\\_repr >\(&symbol::do\\_print\\_python\\_repr\)](#)) [symbol](#)
- static const std::string & [GiNaC::get\\_default\\_TeX\\_name](#) (const std::string &name)  
*Return default TeX name for symbol.*
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([symbol](#))
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([realsymbol](#))
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([possymbol](#))

### 7.82.1 Detailed Description

Implementation of [GiNaC](#)'s symbolic objects.

## 7.83 symbol.h File Reference

Interface to [GiNaC](#)'s symbolic objects.

```
#include "basic.h"
#include "ex.h"
#include "ptr.h"
#include "archive.h"
#include <string>
#include <typeinfo>
```

## Classes

- class [GiNaC::symbol](#)  
*Basic CAS symbol.*
- class [GiNaC::realsymbol](#)  
*Specialization of symbol to real domain.*
- class [GiNaC::possymbol](#)  
*Specialization of symbol to real positive domain.*

## Namespaces

- namespace [GiNaC](#)

## Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([symbol](#))
- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([realsymbol](#))
- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([possymbol](#))

### 7.83.1 Detailed Description

Interface to [GiNaC](#)'s symbolic objects.

## 7.84 symmetry.cpp File Reference

Implementation of [GiNaC](#)'s symmetry definitions.

```
#include "symmetry.h"
#include "lst.h"
#include "add.h"
#include "numeric.h"
#include "operators.h"
#include "archive.h"
#include "utils.h"
#include "hash_seed.h"
#include <functional>
#include <iostream>
#include <limits>
#include <stdexcept>
```

## Classes

- class [GiNaC::sy\\_is\\_less](#)
- class [GiNaC::sy\\_swap](#)

## Namespaces

- namespace [GiNaC](#)

## Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([symmetry](#), [basic](#), [print\\_func](#)< [print\\_context](#)>(&[symmetry::do\\_print](#)). [print\\_func](#)< [print\\_tree](#)>(&[symmetry::do\\_print\\_tree](#))) [symmetry](#)
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([symmetry](#))
- static const [symmetry](#) & [GiNaC::index0](#) ()
- static const [symmetry](#) & [GiNaC::index1](#) ()
- static const [symmetry](#) & [GiNaC::index2](#) ()
- static const [symmetry](#) & [GiNaC::index3](#) ()
- const [symmetry](#) & [GiNaC::not\\_symmetric](#) ()
- const [symmetry](#) & [GiNaC::symmetric2](#) ()
- const [symmetry](#) & [GiNaC::symmetric3](#) ()
- const [symmetry](#) & [GiNaC::symmetric4](#) ()
- const [symmetry](#) & [GiNaC::antisymmetric2](#) ()
- const [symmetry](#) & [GiNaC::antisymmetric3](#) ()
- const [symmetry](#) & [GiNaC::antisymmetric4](#) ()
- int [GiNaC::canonicalize](#) ([exvector::iterator](#) v, const [symmetry](#) &[symm](#))  
*Canonicalize the order of elements of an expression vector, according to the symmetry properties defined in a symmetry tree.*
- static [ex](#) [GiNaC::symm](#) (const [ex](#) &[e](#), [exvector::const\\_iterator](#) [first](#), [exvector::const\\_iterator](#) last, bool asymmetric)
- [ex](#) [GiNaC::symmetrize](#) (const [ex](#) &[e](#), [exvector::const\\_iterator](#) [first](#), [exvector::const\\_iterator](#) last)  
*Symmetrize expression over a set of objects (symbols, indices).*
- [ex](#) [GiNaC::antisymmetrize](#) (const [ex](#) &[e](#), [exvector::const\\_iterator](#) [first](#), [exvector::const\\_iterator](#) last)  
*Antisymmetrize expression over a set of objects (symbols, indices).*
- [ex](#) [GiNaC::symmetrize\\_cyclic](#) (const [ex](#) &[e](#), [exvector::const\\_iterator](#) [first](#), [exvector::const\\_iterator](#) last)  
*Symmetrize expression by cyclic permutation over a set of objects (symbols, indices).*

### 7.84.1 Detailed Description

Implementation of [GiNaC](#)'s symmetry definitions.

## 7.85 symmetry.h File Reference

Interface to [GiNaC](#)'s symmetry definitions.

```
#include "ex.h"
#include "archive.h"
#include <set>
```

## Classes

- class [GiNaC::symmetry](#)  
*This class describes the symmetry of a group of indices.*

## Namespaces

- namespace [GiNaC](#)

## Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([symmetry](#))
- [symmetry GiNaC::sy\\_none](#) ()
- [symmetry GiNaC::sy\\_none](#) (const [symmetry](#) &c1, const [symmetry](#) &c2)
- [symmetry GiNaC::sy\\_none](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3)
- [symmetry GiNaC::sy\\_none](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3, const [symmetry](#) &c4)
- [symmetry GiNaC::sy\\_symm](#) ()
- [symmetry GiNaC::sy\\_symm](#) (const [symmetry](#) &c1, const [symmetry](#) &c2)
- [symmetry GiNaC::sy\\_symm](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3)
- [symmetry GiNaC::sy\\_symm](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3, const [symmetry](#) &c4)
- [symmetry GiNaC::sy\\_anti](#) ()
- [symmetry GiNaC::sy\\_anti](#) (const [symmetry](#) &c1, const [symmetry](#) &c2)
- [symmetry GiNaC::sy\\_anti](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3)
- [symmetry GiNaC::sy\\_anti](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3, const [symmetry](#) &c4)
- [symmetry GiNaC::sy\\_cycl](#) ()
- [symmetry GiNaC::sy\\_cycl](#) (const [symmetry](#) &c1, const [symmetry](#) &c2)
- [symmetry GiNaC::sy\\_cycl](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3)
- [symmetry GiNaC::sy\\_cycl](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3, const [symmetry](#) &c4)
- const [symmetry](#) & [GiNaC::not\\_symmetric](#) ()
- const [symmetry](#) & [GiNaC::symmetric2](#) ()
- const [symmetry](#) & [GiNaC::symmetric3](#) ()
- const [symmetry](#) & [GiNaC::symmetric4](#) ()
- const [symmetry](#) & [GiNaC::antisymmetric2](#) ()
- const [symmetry](#) & [GiNaC::antisymmetric3](#) ()
- const [symmetry](#) & [GiNaC::antisymmetric4](#) ()
- int [GiNaC::canonicalize](#) (exvector::iterator v, const [symmetry](#) &symm)  
*Canonicalize the order of elements of an expression vector, according to the symmetry properties defined in a symmetry tree.*
- [ex GiNaC::symmetrize](#) (const [ex](#) &e, exvector::const\_iterator first, exvector::const\_iterator last)  
*Symmetrize expression over a set of objects (symbols, indices).*
- [ex GiNaC::symmetrize](#) (const [ex](#) &e, const [exvector](#) &v)  
*Symmetrize expression over a set of objects (symbols, indices).*
- [ex GiNaC::antisymmetrize](#) (const [ex](#) &e, exvector::const\_iterator first, exvector::const\_iterator last)  
*Antisymmetrize expression over a set of objects (symbols, indices).*
- [ex GiNaC::antisymmetrize](#) (const [ex](#) &e, const [exvector](#) &v)  
*Antisymmetrize expression over a set of objects (symbols, indices).*
- [ex GiNaC::symmetrize\\_cyclic](#) (const [ex](#) &e, exvector::const\_iterator first, exvector::const\_iterator last)  
*Symmetrize expression by cyclic permutation over a set of objects (symbols, indices).*
- [ex GiNaC::symmetrize\\_cyclic](#) (const [ex](#) &e, const [exvector](#) &v)  
*Symmetrize expression by cyclic permutation over a set of objects (symbols, indices).*

### 7.85.1 Detailed Description

Interface to [GiNaC](#)'s symmetry definitions.



## 7.86 tensor.cpp File Reference

Implementation of [GiNaC](#)'s special tensors.

```
#include "tensor.h"
#include "idx.h"
#include "indexed.h"
#include "symmetry.h"
#include "relational.h"
#include "operators.h"
#include "lst.h"
#include "numeric.h"
#include "matrix.h"
#include "archive.h"
#include "utils.h"
#include <iostream>
#include <stdexcept>
#include <vector>
```

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) ([tensdelta](#), [tensor](#), [print\\_func< print\\_dflt >](#)(&[tensdelta::do\\_print](#)), [print\\_func< print\\_latex >](#)(&[tensdelta::do\\_print\\_latex](#))) [GINAC\\_IMPLEMENT\\_](#)↵  
[REGISTERED\\_CLASS\\_OPT](#)([tensmetric](#)
- [GiNaC::print\\_func< print\\_dflt >](#) (&[tensmetric::do\\_print](#)). [print\\_func< print\\_latex >](#)(&[tensmetric](#)
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([minkmetric](#))
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([tensepsilon](#))
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([tensdelta](#))
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([tensmetric](#))
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) ([spinmetric](#))
- [ex GiNaC::delta\\_tensor](#) (const [ex](#) &i1, const [ex](#) &i2)  
*Create a delta tensor with specified indices.*
- [ex GiNaC::metric\\_tensor](#) (const [ex](#) &i1, const [ex](#) &i2)  
*Create a symmetric metric tensor with specified indices.*
- [ex GiNaC::lorentz\\_g](#) (const [ex](#) &i1, const [ex](#) &i2, bool pos\_sig=false)  
*Create a Minkowski metric tensor with specified indices.*
- [ex GiNaC::spinor\\_metric](#) (const [ex](#) &i1, const [ex](#) &i2)  
*Create a spinor metric tensor with specified indices.*
- [ex GiNaC::epsilon\\_tensor](#) (const [ex](#) &i1, const [ex](#) &i2)  
*Create an epsilon tensor in a Euclidean space with two indices.*
- [ex GiNaC::epsilon\\_tensor](#) (const [ex](#) &i1, const [ex](#) &i2, const [ex](#) &i3)  
*Create an epsilon tensor in a Euclidean space with three indices.*
- [ex GiNaC::lorentz\\_eps](#) (const [ex](#) &i1, const [ex](#) &i2, const [ex](#) &i3, const [ex](#) &i4, bool pos\_sig=false)  
*Create an epsilon tensor in a Minkowski space with four indices.*

### 7.86.1 Detailed Description

Implementation of [GiNaC](#)'s special tensors.

## 7.87 tensor.h File Reference

Interface to [GiNaC](#)'s special tensors.

```
#include "ex.h"
#include "archive.h"
```

### Classes

- class [GiNaC::tensor](#)  
*This class holds one of [GiNaC](#)'s predefined special tensors such as the delta and the metric tensors.*
- class [GiNaC::tensdelta](#)  
*This class represents the delta tensor.*
- class [GiNaC::tensmetric](#)  
*This class represents a general metric tensor which can be used to raise/lower indices.*
- class [GiNaC::minkmetric](#)  
*This class represents a Minkowski metric tensor.*
- class [GiNaC::spinmetric](#)  
*This class represents an antisymmetric spinor metric tensor which can be used to raise/lower indices of 2-component Weyl spinors.*
- class [GiNaC::tensepsilon](#)  
*This class represents the totally antisymmetric epsilon tensor.*

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([tensdelta](#))
- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([tensmetric](#))
- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([minkmetric](#))
- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([spinmetric](#))
- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([tensepsilon](#))
- [ex GiNaC::delta\\_tensor](#) (const [ex](#) &i1, const [ex](#) &i2)  
*Create a delta tensor with specified indices.*
- [ex GiNaC::metric\\_tensor](#) (const [ex](#) &i1, const [ex](#) &i2)  
*Create a symmetric metric tensor with specified indices.*
- [ex GiNaC::lorentz\\_g](#) (const [ex](#) &i1, const [ex](#) &i2, bool pos\_sig=false)  
*Create a Minkowski metric tensor with specified indices.*
- [ex GiNaC::spinor\\_metric](#) (const [ex](#) &i1, const [ex](#) &i2)  
*Create a spinor metric tensor with specified indices.*
- [ex GiNaC::epsilon\\_tensor](#) (const [ex](#) &i1, const [ex](#) &i2)  
*Create an epsilon tensor in a Euclidean space with two indices.*
- [ex GiNaC::epsilon\\_tensor](#) (const [ex](#) &i1, const [ex](#) &i2, const [ex](#) &i3)  
*Create an epsilon tensor in a Euclidean space with three indices.*
- [ex GiNaC::lorentz\\_eps](#) (const [ex](#) &i1, const [ex](#) &i2, const [ex](#) &i3, const [ex](#) &i4, bool pos\_sig=false)  
*Create an epsilon tensor in a Minkowski space with four indices.*

### 7.87.1 Detailed Description

Interface to [GiNaC](#)'s special tensors.

## 7.88 utils.cpp File Reference

Implementation of several small and furry utilities needed within [GiNaC](#) but not of any interest to the user of the library.

```
#include "ex.h"
#include "numeric.h"
#include "utils.h"
#include "version.h"
```

### Namespaces

- namespace [GiNaC](#)

### Functions

- unsigned [GiNaC::log2](#) (unsigned n)  
*Integer binary logarithm.*
- const [numeric](#) [GiNaC::multinomial\\_coefficient](#) (const std::vector< unsigned > &p)  
*Compute the multinomial coefficient  $n!$*

### Variables

- const int [GiNaC::version\\_major](#) = GINACLIB\_MAJOR\_VERSION
- const int [GiNaC::version\\_minor](#) = GINACLIB\_MINOR\_VERSION
- const int [GiNaC::version\\_micro](#) = GINACLIB\_MICRO\_VERSION
- const [numeric](#) \* [GiNaC::\\_num\\_120\\_p](#)
- const [ex](#) [GiNaC::\\_ex\\_120](#) = [ex](#)(\*[\\_num\\_120\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num\\_60\\_p](#)
- const [ex](#) [GiNaC::\\_ex\\_60](#) = [ex](#)(\*[\\_num\\_60\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num\\_48\\_p](#)
- const [ex](#) [GiNaC::\\_ex\\_48](#) = [ex](#)(\*[\\_num\\_48\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num\\_30\\_p](#)
- const [ex](#) [GiNaC::\\_ex\\_30](#) = [ex](#)(\*[\\_num\\_30\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num\\_25\\_p](#)
- const [ex](#) [GiNaC::\\_ex\\_25](#) = [ex](#)(\*[\\_num\\_25\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num\\_24\\_p](#)
- const [ex](#) [GiNaC::\\_ex\\_24](#) = [ex](#)(\*[\\_num\\_24\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num\\_20\\_p](#)
- const [ex](#) [GiNaC::\\_ex\\_20](#) = [ex](#)(\*[\\_num\\_20\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num\\_18\\_p](#)
- const [ex](#) [GiNaC::\\_ex\\_18](#) = [ex](#)(\*[\\_num\\_18\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num\\_15\\_p](#)
- const [ex](#) [GiNaC::\\_ex\\_15](#) = [ex](#)(\*[\\_num\\_15\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num\\_12\\_p](#)

- `const ex GiNaC::_ex_12 = ex(*_num_12_p)`
- `const numeric * GiNaC::_num_11_p`
- `const ex GiNaC::_ex_11 = ex(*_num_11_p)`
- `const numeric * GiNaC::_num_10_p`
- `const ex GiNaC::_ex_10 = ex(*_num_10_p)`
- `const numeric * GiNaC::_num_9_p`
- `const ex GiNaC::_ex_9 = ex(*_num_9_p)`
- `const numeric * GiNaC::_num_8_p`
- `const ex GiNaC::_ex_8 = ex(*_num_8_p)`
- `const numeric * GiNaC::_num_7_p`
- `const ex GiNaC::_ex_7 = ex(*_num_7_p)`
- `const numeric * GiNaC::_num_6_p`
- `const ex GiNaC::_ex_6 = ex(*_num_6_p)`
- `const numeric * GiNaC::_num_5_p`
- `const ex GiNaC::_ex_5 = ex(*_num_5_p)`
- `const numeric * GiNaC::_num_4_p`
- `const ex GiNaC::_ex_4 = ex(*_num_4_p)`
- `const numeric * GiNaC::_num_3_p`
- `const ex GiNaC::_ex_3 = ex(*_num_3_p)`
- `const numeric * GiNaC::_num_2_p`
- `const ex GiNaC::_ex_2 = ex(*_num_2_p)`
- `const numeric * GiNaC::_num_1_p`
- `const ex GiNaC::_ex_1 = ex(*_num_1_p)`
- `const numeric * GiNaC::_num_1_2_p`
- `const ex GiNaC::_ex_1_2 = ex(*_num_1_2_p)`
- `const numeric * GiNaC::_num_1_3_p`
- `const ex GiNaC::_ex_1_3 = ex(*_num_1_3_p)`
- `const numeric * GiNaC::_num_1_4_p`
- `const ex GiNaC::_ex_1_4 = ex(*_num_1_4_p)`
- `const numeric * GiNaC::_num0_p`
- `const ex GiNaC::_ex0 = ex(*_num0_p)`
- `const numeric * GiNaC::_num1_4_p`
- `const ex GiNaC::_ex1_4 = ex(*_num1_4_p)`
- `const numeric * GiNaC::_num1_3_p`
- `const ex GiNaC::_ex1_3 = ex(*_num1_3_p)`
- `const numeric * GiNaC::_num1_2_p`
- `const ex GiNaC::_ex1_2 = ex(*_num1_2_p)`
- `const numeric * GiNaC::_num1_p`
- `const ex GiNaC::_ex1 = ex(*_num1_p)`
- `const numeric * GiNaC::_num2_p`
- `const ex GiNaC::_ex2 = ex(*_num2_p)`
- `const numeric * GiNaC::_num3_p`
- `const ex GiNaC::_ex3 = ex(*_num3_p)`
- `const numeric * GiNaC::_num4_p`
- `const ex GiNaC::_ex4 = ex(*_num4_p)`
- `const numeric * GiNaC::_num5_p`
- `const ex GiNaC::_ex5 = ex(*_num5_p)`
- `const numeric * GiNaC::_num6_p`
- `const ex GiNaC::_ex6 = ex(*_num6_p)`
- `const numeric * GiNaC::_num7_p`
- `const ex GiNaC::_ex7 = ex(*_num7_p)`
- `const numeric * GiNaC::_num8_p`
- `const ex GiNaC::_ex8 = ex(*_num8_p)`
- `const numeric * GiNaC::_num9_p`
- `const ex GiNaC::_ex9 = ex(*_num9_p)`

- const [numeric](#) \* [GiNaC::\\_num10\\_p](#)
- const [ex](#) [GiNaC::\\_ex10](#) = [ex](#)(\*[\\_num10\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num11\\_p](#)
- const [ex](#) [GiNaC::\\_ex11](#) = [ex](#)(\*[\\_num11\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num12\\_p](#)
- const [ex](#) [GiNaC::\\_ex12](#) = [ex](#)(\*[\\_num12\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num15\\_p](#)
- const [ex](#) [GiNaC::\\_ex15](#) = [ex](#)(\*[\\_num15\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num18\\_p](#)
- const [ex](#) [GiNaC::\\_ex18](#) = [ex](#)(\*[\\_num18\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num20\\_p](#)
- const [ex](#) [GiNaC::\\_ex20](#) = [ex](#)(\*[\\_num20\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num24\\_p](#)
- const [ex](#) [GiNaC::\\_ex24](#) = [ex](#)(\*[\\_num24\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num25\\_p](#)
- const [ex](#) [GiNaC::\\_ex25](#) = [ex](#)(\*[\\_num25\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num30\\_p](#)
- const [ex](#) [GiNaC::\\_ex30](#) = [ex](#)(\*[\\_num30\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num48\\_p](#)
- const [ex](#) [GiNaC::\\_ex48](#) = [ex](#)(\*[\\_num48\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num60\\_p](#)
- const [ex](#) [GiNaC::\\_ex60](#) = [ex](#)(\*[\\_num60\\_p](#))
- const [numeric](#) \* [GiNaC::\\_num120\\_p](#)
- const [ex](#) [GiNaC::\\_ex120](#) = [ex](#)(\*[\\_num120\\_p](#))

### 7.88.1 Detailed Description

Implementation of several small and furry utilities needed within [GiNaC](#) but not of any interest to the user of the library.

## 7.89 utils.h File Reference

Interface to several small and furry utilities needed within [GiNaC](#) but not of any interest to the user of the library.

```
#include "assertion.h"
#include <functional>
#include <cstdint>
#include <string>
```

### Classes

- class [GiNaC::dunno](#)  
*Exception class thrown by functions to signal unimplemented functionality so the expression may just be .hold()*
- class [GiNaC::basic\\_partition\\_generator](#)  
*Base class for generating all bounded combinatorial partitions of an integer n with exactly m parts in non-decreasing order.*
- struct [GiNaC::basic\\_partition\\_generator::mpartition2](#)
- class [GiNaC::partition\\_with\\_zero\\_parts\\_generator](#)

*Generate all bounded combinatorial partitions of an integer  $n$  with exactly  $m$  parts (including zero parts) in non-decreasing order.*

- class [GiNaC::partition\\_generator](#)

*Generate all bounded combinatorial partitions of an integer  $n$  with exactly  $m$  parts (not including zero parts) in non-decreasing order.*

- class [GiNaC::composition\\_generator](#)

*Generate all compositions of a partition of an integer  $n$ , starting with the compositions which has non-decreasing order.*

- struct [GiNaC::composition\\_generator::coolmulti](#)
- struct [GiNaC::composition\\_generator::coolmulti::element](#)

## Namespaces

- namespace [GiNaC](#)

## Macros

- `#define` [DEFAULT\\_CTOR](#)(classname)
- `#define` [DEFAULT\\_COMPARE](#)(classname)
- `#define` [DEFAULT\\_PRINT](#)(classname, text)
- `#define` [DEFAULT\\_PRINT\\_LATEX](#)(classname, text, latex)

## Functions

- unsigned [GiNaC::log2](#) (unsigned n)  
*Integer binary logarithm.*
- unsigned [GiNaC::rotate\\_left](#) (unsigned n)  
*Rotate bits of unsigned value by one bit to the left.*
- `template<class T>`  
int [GiNaC::compare\\_pointers](#) (const T \*a, const T \*b)  
*Compare two pointers (just to establish some sort of canonical order).*
- unsigned [GiNaC::golden\\_ratio\\_hash](#) (uintptr\_t n)  
*Truncated multiplication with golden ratio, for computing hash values.*
- `template<class It>`  
int [GiNaC::permutation\\_sign](#) (It first, It last)
- `template<class It, class Cmp, class Swap>`  
int [GiNaC::permutation\\_sign](#) (It first, It last, Cmp comp, Swap swapit)
- `template<class It, class Cmp, class Swap>`  
void [GiNaC::shaker\\_sort](#) (It first, It last, Cmp comp, Swap swapit)
- `template<class It, class Swap>`  
void [GiNaC::cyclic\\_permutation](#) (It first, It last, It new\_first, Swap swapit)
- const numeric [GiNaC::multinomial\\_coefficient](#) (const std::vector< unsigned > &p)  
*Compute the multinomial coefficient  $n!$*

## 7.89.1 Detailed Description

Interface to several small and furry utilities needed within [GiNaC](#) but not of any interest to the user of the library.

## 7.89.2 Macro Definition Documentation

### 7.89.2.1 DEFAULT\_CTOR

```
#define DEFAULT_CTOR(
 classname)
```

**Value:**

```
classname::classname() { setflag(status_flags::evaluated | status_flags::expanded); }
```

### 7.89.2.2 DEFAULT\_COMPARE

```
#define DEFAULT_COMPARE(
 classname)
```

**Value:**

```
int classname::compare_same_type(const basic & other) const \
{ \
 /* by default, the objects are always identical */ \
 return 0; \
}
```

### 7.89.2.3 DEFAULT\_PRINT

```
#define DEFAULT_PRINT(
 classname,
 text)
```

**Value:**

```
void classname::do_print(const print_context & c, unsigned level) const \
{ \
 c.s << text; \
}
```

### 7.89.2.4 DEFAULT\_PRINT\_LATEX

```
#define DEFAULT_PRINT_LATEX(
 classname,
 text,
 latex)
```

**Value:**

```
DEFAULT_PRINT(classname, text) \
void classname::do_print_latex(const print_latex & c, unsigned level) const \
{ \
 c.s << latex; \
}
```

## 7.90 utils\_multi\_iterator.h File Reference

Utilities for summing over multiple indices.

```
#include <cstddef>
#include <vector>
#include <ostream>
#include <iterator>
```

## Classes

- class [GiNaC::has\\_distance< T >](#)  
*SFINAE test for distance.*
- class [GiNaC::basic\\_multi\\_iterator< T >](#)  
*basic\_multi\_iterator is a base class.*
- class [GiNaC::multi\\_iterator\\_ordered< T >](#)  
*The class multi\_iterator\_ordered defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , such that.*
- class [GiNaC::multi\\_iterator\\_ordered\\_eq< T >](#)  
*The class multi\_iterator\_ordered\_eq defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , such that.*
- class [GiNaC::multi\\_iterator\\_ordered\\_eq\\_indv< T >](#)  
*The class multi\_iterator\_ordered\_eq\_indv defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , such that.*
- class [GiNaC::multi\\_iterator\\_counter< T >](#)  
*The class multi\_iterator\_counter defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , such that.*
- class [GiNaC::multi\\_iterator\\_counter\\_indv< T >](#)  
*The class multi\_iterator\_counter\_indv defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , such that.*
- class [GiNaC::multi\\_iterator\\_permutation< T >](#)  
*The class multi\_iterator\_permutation defines a multi\_iterator  $(i_1, i_2, \dots, i_k)$ , for which.*
- class [GiNaC::multi\\_iterator\\_shuffle< T >](#)  
*The class multi\_iterator\_shuffle defines a multi\_iterator, which runs over all shuffles of a and b.*
- class [GiNaC::multi\\_iterator\\_shuffle\\_prime< T >](#)  
*The class multi\_iterator\_shuffle\_prime defines a multi\_iterator, which runs over all shuffles of a and b, excluding the first one (a,b).*

## Namespaces

- namespace [GiNaC](#)

## Functions

- `template<typename T>`  
`std::enable_if< has\_distance< T >::value, typename std::iterator_traits< T >::difference_type >::type`  
`GiNaC::format\_index\_value (const T &a, const T &b)`  
*For printing a multi-index: If the templates are used, where T is an iterator, printing the address where the iterator points to is not meaningful.*
- `template<typename T>`  
`std::enable_if<!has\_distance< T >::value, T >::type GiNaC::format\_index\_value (const T &a, const T &b)`  
*For all other cases we simply print the value.*
- `template<class T>`  
`std::ostream & GiNaC::operator<< (std::ostream &os, const basic\_multi\_iterator< T > &v)`  
*Output operator.*
- `template<class T>`  
`std::ostream & GiNaC::operator<< (std::ostream &os, const multi\_iterator\_ordered< T > &v)`  
*Output operator.*
- `template<class T>`  
`std::ostream & GiNaC::operator<< (std::ostream &os, const multi\_iterator\_ordered\_eq< T > &v)`  
*Output operator.*
- `template<class T>`  
`std::ostream & GiNaC::operator<< (std::ostream &os, const multi\_iterator\_ordered\_eq\_indv< T > &v)`  
*Output operator.*



- `template<class T>`  
`std::ostream & GiNaC::operator<< (std::ostream &os, const multi_iterator_counter< T > &v)`  
*Output operator.*
- `template<class T>`  
`std::ostream & GiNaC::operator<< (std::ostream &os, const multi_iterator_counter_indv< T > &v)`  
*Output operator.*
- `template<class T>`  
`std::ostream & GiNaC::operator<< (std::ostream &os, const multi_iterator_permutation< T > &v)`  
*Output operator.*
- `template<class T>`  
`std::ostream & GiNaC::operator<< (std::ostream &os, const multi_iterator_shuffle< T > &v)`  
*Output operator.*
- `template<class T>`  
`std::ostream & GiNaC::operator<< (std::ostream &os, const multi_iterator_shuffle_prime< T > &v)`  
*Output operator.*

### 7.90.1 Detailed Description

Utilities for summing over multiple indices.

## 7.91 version.h File Reference

[GiNaC](#) library version information.

### Namespaces

- namespace [GiNaC](#)

### Macros

- `#define GINACLIB_MAJOR_VERSION 1`
- `#define GINACLIB_MINOR_VERSION 8`
- `#define GINACLIB_MICRO_VERSION 7`
- `#define GINAC_LT_CURRENT 12`
- `#define GINAC_LT_REVISION 6`
- `#define GINAC_LT_AGE 1`
- `#define GINACLIB_ARCHIVE_VERSION 3`
- `#define GINACLIB_ARCHIVE_AGE 3`
- `#define GINACLIB_STR_HELPER(x)`
- `#define GINACLIB_STR(x)`
- `#define GINACLIB_VERSION`

### 7.91.1 Detailed Description

[GiNaC](#) library version information.

## 7.91.2 Macro Definition Documentation

### 7.91.2.1 GINACLIB\_MAJOR\_VERSION

```
#define GINACLIB_MAJOR_VERSION 1
```

### 7.91.2.2 GINACLIB\_MINOR\_VERSION

```
#define GINACLIB_MINOR_VERSION 8
```

### 7.91.2.3 GINACLIB\_MICRO\_VERSION

```
#define GINACLIB_MICRO_VERSION 7
```

### 7.91.2.4 GINAC\_LT\_CURRENT

```
#define GINAC_LT_CURRENT 12
```

### 7.91.2.5 GINAC\_LT\_REVISION

```
#define GINAC_LT_REVISION 6
```

### 7.91.2.6 GINAC\_LT\_AGE

```
#define GINAC_LT_AGE 1
```

### 7.91.2.7 GINACLIB\_ARCHIVE\_VERSION

```
#define GINACLIB_ARCHIVE_VERSION 3
```

Referenced by [GiNaC::archive::operator<<](#), and [GiNaC::archive::operator>>](#).

### 7.91.2.8 GINACLIB\_ARCHIVE\_AGE

```
#define GINACLIB_ARCHIVE_AGE 3
```

Referenced by [GiNaC::archive::operator>>](#).

### 7.91.2.9 GINACLIB\_STR\_HELPER

```
#define GINACLIB_STR_HELPER(
 x)
```

**Value:**

```
#x
```

### 7.91.2.10 GINACLIB\_STR

```
#define GINACLIB_STR(
 x)
```

#### Value:

[GINACLIB\\_STR\\_HELPER](#)(x)

### 7.91.2.11 GINACLIB\_VERSION

```
#define GINACLIB_VERSION
```

#### Value:

```
GINACLIB_STR(GINACLIB_MAJOR_VERSION) "." \
GINACLIB_STR(GINACLIB_MINOR_VERSION) "." \
GINACLIB_STR(GINACLIB_MICRO_VERSION)
```

## 7.92 wildcard.cpp File Reference

Implementation of [GiNaC](#)'s wildcard objects.

```
#include "wildcard.h"
#include "archive.h"
#include "utils.h"
#include "hash_seed.h"
#include <iostream>
```

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_IMPLEMENT\\_REGISTERED\\_CLASS\\_OPT](#) (wildcard, basic, print\_func< [print\\_context](#) >(&wildcard::do\_print). print\_func< [print\\_tree](#) >(&wildcard::do\_print\_tree). print\_func< [print\\_python\\_repr](#) >(&wildcard::do\_print\_python\_repr)) wildcard
- [GiNaC::GINAC\\_BIND\\_UNARCHIVER](#) (wildcard)
- bool [GiNaC::haswild](#) (const [ex](#) &x)

*Check whether x has a wildcard anywhere as a subexpression.*

### 7.92.1 Detailed Description

Implementation of [GiNaC](#)'s wildcard objects.

## 7.93 wildcard.h File Reference

Interface to [GiNaC](#)'s wildcard objects.

```
#include "ex.h"
#include "archive.h"
```

### Classes

- class [GiNaC::wildcard](#)  
*This class acts as a wildcard for [subs\(\)](#), [match\(\)](#), [has\(\)](#) and [find\(\)](#).*

### Namespaces

- namespace [GiNaC](#)

### Functions

- [GiNaC::GINAC\\_DECLARE\\_UNARCHIVER](#) ([wildcard](#))
- [ex GiNaC::wild](#) (unsigned label=0)  
*Create a wildcard object with the specified label.*
- bool [GiNaC::haswild](#) (const [ex](#) &x)  
*Check whether x has a wildcard anywhere as a subexpression.*

### 7.93.1 Detailed Description

Interface to [GiNaC](#)'s wildcard objects.

# Index

[\\_ex0](#)  
    [GiNaC, 279](#)

[\\_ex1](#)  
    [GiNaC, 280](#)

[\\_ex10](#)  
    [GiNaC, 284](#)

[\\_ex11](#)  
    [GiNaC, 284](#)

[\\_ex12](#)  
    [GiNaC, 284](#)

[\\_ex120](#)  
    [GiNaC, 286](#)

[\\_ex15](#)  
    [GiNaC, 284](#)

[\\_ex18](#)  
    [GiNaC, 285](#)

[\\_ex1\\_2](#)  
    [GiNaC, 280](#)

[\\_ex1\\_3](#)  
    [GiNaC, 280](#)

[\\_ex1\\_4](#)  
    [GiNaC, 279](#)

[\\_ex2](#)  
    [GiNaC, 281](#)

[\\_ex20](#)  
    [GiNaC, 285](#)

[\\_ex24](#)  
    [GiNaC, 285](#)

[\\_ex25](#)  
    [GiNaC, 285](#)

[\\_ex3](#)  
    [GiNaC, 282](#)

[\\_ex30](#)  
    [GiNaC, 286](#)

[\\_ex4](#)  
    [GiNaC, 282](#)

[\\_ex48](#)  
    [GiNaC, 286](#)

[\\_ex5](#)  
    [GiNaC, 282](#)

[\\_ex6](#)  
    [GiNaC, 282](#)

[\\_ex60](#)  
    [GiNaC, 286](#)

[\\_ex7](#)  
    [GiNaC, 283](#)

[\\_ex8](#)  
    [GiNaC, 283](#)

[\\_ex9](#)  
    [GiNaC, 283](#)

[\\_ex\\_1](#)  
    [GiNaC, 277](#)

[\\_ex\\_10](#)  
    [GiNaC, 275](#)

[\\_ex\\_11](#)  
    [GiNaC, 275](#)

[\\_ex\\_12](#)  
    [GiNaC, 274](#)

[\\_ex\\_120](#)  
    [GiNaC, 272](#)

[\\_ex\\_15](#)  
    [GiNaC, 274](#)

[\\_ex\\_18](#)  
    [GiNaC, 274](#)

[\\_ex\\_1\\_2](#)  
    [GiNaC, 278](#)

[\\_ex\\_1\\_3](#)  
    [GiNaC, 278](#)

[\\_ex\\_1\\_4](#)  
    [GiNaC, 278](#)

[\\_ex\\_2](#)  
    [GiNaC, 277](#)

[\\_ex\\_20](#)  
    [GiNaC, 274](#)

[\\_ex\\_24](#)  
    [GiNaC, 273](#)

[\\_ex\\_25](#)  
    [GiNaC, 273](#)

[\\_ex\\_3](#)  
    [GiNaC, 277](#)

[\\_ex\\_30](#)  
    [GiNaC, 273](#)

[\\_ex\\_4](#)  
    [GiNaC, 276](#)

[\\_ex\\_48](#)  
    [GiNaC, 273](#)

[\\_ex\\_5](#)  
    [GiNaC, 276](#)

[\\_ex\\_6](#)  
    [GiNaC, 276](#)

[\\_ex\\_60](#)  
    [GiNaC, 272](#)

[\\_ex\\_7](#)  
    [GiNaC, 276](#)

[\\_ex\\_8](#)  
    [GiNaC, 275](#)

[\\_ex\\_9](#)  
    [GiNaC, 275](#)

\_iter\_rep  
     GiNaC::internal::\_iter\_rep, 290  
 \_num0\_bp  
     GiNaC, 270  
 \_num0\_p  
     GiNaC, 279  
 \_num10\_p  
     GiNaC, 283  
 \_num11\_p  
     GiNaC, 284  
 \_num120\_p  
     GiNaC, 286  
 \_num12\_p  
     GiNaC, 284  
 \_num15\_p  
     GiNaC, 284  
 \_num18\_p  
     GiNaC, 285  
 \_num1\_2\_p  
     GiNaC, 280  
 \_num1\_3\_p  
     GiNaC, 280  
 \_num1\_4\_p  
     GiNaC, 279  
 \_num1\_p  
     GiNaC, 280  
 \_num20\_p  
     GiNaC, 285  
 \_num24\_p  
     GiNaC, 285  
 \_num25\_p  
     GiNaC, 285  
 \_num2\_p  
     GiNaC, 281  
 \_num30\_p  
     GiNaC, 286  
 \_num3\_p  
     GiNaC, 281  
 \_num48\_p  
     GiNaC, 286  
 \_num4\_p  
     GiNaC, 282  
 \_num5\_p  
     GiNaC, 282  
 \_num60\_p  
     GiNaC, 286  
 \_num6\_p  
     GiNaC, 282  
 \_num7\_p  
     GiNaC, 283  
 \_num8\_p  
     GiNaC, 283  
 \_num9\_p  
     GiNaC, 283  
 \_num\_10\_p  
     GiNaC, 275  
 \_num\_11\_p  
     GiNaC, 275  
 \_num\_120\_p  
     GiNaC, 272  
 \_num\_12\_p  
     GiNaC, 274  
 \_num\_15\_p  
     GiNaC, 274  
 \_num\_18\_p  
     GiNaC, 274  
 \_num\_1\_2\_p  
     GiNaC, 278  
 \_num\_1\_3\_p  
     GiNaC, 278  
 \_num\_1\_4\_p  
     GiNaC, 278  
 \_num\_1\_p  
     GiNaC, 277  
 \_num\_20\_p  
     GiNaC, 274  
 \_num\_24\_p  
     GiNaC, 273  
 \_num\_25\_p  
     GiNaC, 273  
 \_num\_2\_p  
     GiNaC, 277  
 \_num\_30\_p  
     GiNaC, 273  
 \_num\_3\_p  
     GiNaC, 277  
 \_num\_48\_p  
     GiNaC, 273  
 \_num\_4\_p  
     GiNaC, 276  
 \_num\_5\_p  
     GiNaC, 276  
 \_num\_60\_p  
     GiNaC, 272  
 \_num\_6\_p  
     GiNaC, 276  
 \_num\_7\_p  
     GiNaC, 276  
 \_num\_8\_p  
     GiNaC, 275  
 \_num\_9\_p  
     GiNaC, 275  
 \_numeric\_digits  
     GiNaC::\_numeric\_digits, 292  
 ~archive  
     GiNaC::archive, 312  
 ~basic  
     GiNaC::basic, 335  
 ~basic\_multi\_iterator  
     GiNaC::basic\_multi\_iterator< T >, 367  
 ~compare\_all\_equal  
     GiNaC::compare\_all\_equal< T >, 410  
 ~compare\_bitwise  
     GiNaC::compare\_bitwise< T >, 411  
 ~compare\_std\_less  
     GiNaC::compare\_std\_less< T >, 412

- ~container\_storage
  - GiNaC::container\_storage< C >, 455
- ~coolmulti
  - GiNaC::composition\_generator::coolmulti, 457
- ~element
  - GiNaC::composition\_generator::coolmulti::element, 518
- ~function\_options
  - GiNaC::function\_options, 643
- ~library\_init
  - GiNaC::library\_init, 759
- ~map\_function
  - GiNaC::map\_function, 764
- ~print\_context
  - GiNaC::print\_context, 957
- ~print\_functor\_impl
  - GiNaC::print\_functor\_impl, 972
- ~ptr
  - GiNaC::ptr< T >, 1007
- ~unarchive\_table\_t
  - GiNaC::unarchive\_table\_t, 1170
- ~visitor
  - GiNaC::visitor, 1188
- a
  - GiNaC::archive\_node, 327
  - GiNaC::Eisenstein\_kernel, 517
  - GiNaC::integral, 726
- abs
  - GiNaC, 228
- abs\_conjugate
  - GiNaC, 136
- abs\_eval
  - GiNaC, 135
- abs\_evalf
  - GiNaC, 135
- abs\_expand
  - GiNaC, 135
- abs\_expl\_derivative
  - GiNaC, 135
- abs\_imag\_part
  - GiNaC, 136
- abs\_info
  - GiNaC, 137
- abs\_power
  - GiNaC, 136
- abs\_print\_csrc\_float
  - GiNaC, 136
- abs\_print\_latex
  - GiNaC, 135
- abs\_real\_part
  - GiNaC, 136
- accept
  - GiNaC::basic, 342
  - GiNaC::ex, 548
- access\_counter
  - GiNaC::remember\_table\_entry, 1041
- acos
  - GiNaC, 220
- acos\_conjugate
  - GiNaC, 177
- acos\_deriv
  - GiNaC, 176
- acos\_eval
  - GiNaC, 176
- acos\_evalf
  - GiNaC, 176
- acosh
  - GiNaC, 222
- acosh\_conjugate
  - GiNaC, 185
- acosh\_deriv
  - GiNaC, 185
- acosh\_eval
  - GiNaC, 185
- acosh\_evalf
  - GiNaC, 185
- adaptivesimpson
  - GiNaC, 187
- add
  - GiNaC::add, 300, 301
  - GiNaC::matrix, 776
  - GiNaC::mul, 822
  - GiNaC::numeric, 891
  - GiNaC::scalar\_products, 1047
  - GiNaC::symmetry, 1135
- add.cpp, 1197
- add.h, 1198
- add\_bool
  - GiNaC::archive\_node, 321
- add\_callback
  - GiNaC::\_numeric\_digits, 292
- add\_child
  - GiNaC::class\_info< OPT >::tree\_node, 1169
- add\_dyn
  - GiNaC::numeric, 893
- add\_entry
  - GiNaC::remember\_table, 1037
  - GiNaC::remember\_table\_list, 1043
- add\_ex
  - GiNaC::archive\_node, 322
- add\_indexed
  - GiNaC::basic, 347
  - GiNaC::matrix, 773
  - GiNaC::structure< T, ComparisonPolicy >, 1084
- add\_node
  - GiNaC::archive, 315
- add\_reference
  - GiNaC::refcounted, 1019
- add\_series
  - GiNaC::pseries, 1000
- add\_string
  - GiNaC::archive\_node, 322
- add\_symbol
  - GiNaC, 202
- add\_unsigned
  - GiNaC::archive\_node, 321

- add\_vectors
  - GiNaC::scalar\_products, [1047](#)
- after\_i
  - GiNaC::composition\_generator::coolmulti, [458](#)
- algebraic
  - GiNaC::has\_options, [682](#)
  - GiNaC::subs\_options, [1109](#)
- algebraic\_match\_mul\_with\_mul
  - GiNaC, [200](#)
- algebraic\_subs\_mul
  - GiNaC::mul, [820](#)
- all
  - GiNaC::factor\_options, [595](#)
- all\_index\_values\_are
  - GiNaC::indexed, [710](#)
- antisymmetric
  - GiNaC::symmetry, [1133](#)
- antisymmetric2
  - GiNaC, [253](#)
- antisymmetric3
  - GiNaC, [253](#)
- antisymmetric4
  - GiNaC, [253](#)
- antisymmetrize
  - GiNaC, [112](#), [254](#), [258](#)
  - GiNaC::ex, [560](#)
- append
  - GiNaC::container< C >, [450](#)
- append\_factors
  - GiNaC::ncmul, [874](#)
- archive
  - GiNaC::archive, [312](#)
  - GiNaC::basic, [352](#)
  - GiNaC::clifford, [386](#)
  - GiNaC::color, [407](#)
  - GiNaC::constant, [434](#)
  - GiNaC::container< C >, [447](#)
  - GiNaC::expairseq, [583](#)
  - GiNaC::fderivative, [611](#)
  - GiNaC::function, [631](#)
  - GiNaC::idx, [689](#)
  - GiNaC::indexed, [708](#)
  - GiNaC::integral, [724](#)
  - GiNaC::matrix, [774](#)
  - GiNaC::minkmetric, [793](#)
  - GiNaC::numeric, [890](#)
  - GiNaC::power, [951](#)
  - GiNaC::pseries, [998](#)
  - GiNaC::relational, [1030](#)
  - GiNaC::spinidx, [1058](#)
  - GiNaC::symbol, [1123](#)
  - GiNaC::symmetry, [1134](#)
  - GiNaC::tensepsilon, [1153](#)
  - GiNaC::varidx, [1185](#)
  - GiNaC::wildcard, [1193](#)
- archive.cpp, [1198](#)
- archive.h, [1199](#)
  - GINAC\_BIND\_UNARCHIVER, [1201](#)
  - GINAC\_DECLARE\_UNARCHIVER, [1200](#)
- archive\_atom
  - GiNaC, [58](#)
- archive\_ex
  - GiNaC::archive, [313](#)
- archive\_node
  - GiNaC::archive\_node, [321](#)
  - GiNaC::ex, [564](#)
- archive\_node\_cit
  - GiNaC::archive\_node, [320](#)
- archive\_node\_id
  - GiNaC, [58](#)
- archived\_ex
  - GiNaC::archive::archived\_ex, [329](#)
- are\_ex\_trivially\_equal
  - GiNaC, [106](#)
  - GiNaC::ex, [564](#)
- arg1
  - GiNaC::pointer\_to\_map\_function\_1arg< T1 >, [915](#)
  - GiNaC::pointer\_to\_map\_function\_2args< T1, T2 >, [918](#)
  - GiNaC::pointer\_to\_map\_function\_3args< T1, T2, T3 >, [920](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function\_1arg< C, T1 >, [926](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function\_2args< C, T1, T2 >, [928](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function\_3args< C, T1, T2, T3 >, [931](#)
- arg2
  - GiNaC::pointer\_to\_map\_function\_2args< T1, T2 >, [918](#)
  - GiNaC::pointer\_to\_map\_function\_3args< T1, T2, T3 >, [920](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function\_2args< C, T1, T2 >, [928](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function\_3args< C, T1, T2, T3 >, [932](#)
- arg3
  - GiNaC::pointer\_to\_map\_function\_3args< T1, T2, T3 >, [920](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function\_3args< C, T1, T2, T3 >, [932](#)
- argument\_type
  - GiNaC::map\_function, [764](#)
- asin
  - GiNaC, [220](#)
- asin\_conjugate
  - GiNaC, [175](#)
- asin\_deriv
  - GiNaC, [175](#)
- asin\_eval
  - GiNaC, [175](#)
- asin\_evalf
  - GiNaC, [175](#)
- asin\_info
  - GiNaC, [176](#)



- asinh
  - GiNaC, [222](#)
- asinh\_conjugate
  - GiNaC, [184](#)
- asinh\_deriv
  - GiNaC, [184](#)
- asinh\_eval
  - GiNaC, [184](#)
- asinh\_evalf
  - GiNaC, [184](#)
- assertion.h, [1201](#)
  - GINAC\_ASSERT, [1202](#)
- atan
  - GiNaC, [220](#), [221](#)
- atan2\_deriv
  - GiNaC, [179](#)
- atan2\_eval
  - GiNaC, [179](#)
- atan2\_evalf
  - GiNaC, [178](#)
- atan2\_info
  - GiNaC, [179](#)
- atan\_conjugate
  - GiNaC, [178](#)
- atan\_deriv
  - GiNaC, [177](#)
- atan\_eval
  - GiNaC, [177](#)
- atan\_evalf
  - GiNaC, [177](#)
- atan\_info
  - GiNaC, [178](#)
- atan\_series
  - GiNaC, [178](#)
- atanh
  - GiNaC, [223](#)
- atanh\_conjugate
  - GiNaC, [187](#)
- atanh\_deriv
  - GiNaC, [186](#)
- atanh\_eval
  - GiNaC, [186](#)
- atanh\_evalf
  - GiNaC, [186](#)
- atanh\_series
  - GiNaC, [186](#)
- atend
  - GiNaC::composition\_generator, [414](#)
- atomize
  - GiNaC::archive, [315](#)
- atoms
  - GiNaC::archive, [317](#)
- attribute\_deprecated
  - compiler.h, [1214](#)
- automatic
  - GiNaC::determinant\_algo, [461](#)
  - GiNaC::solve\_algo, [1050](#)
- B
  - GiNaC::basic\_multi\_iterator< T >, [370](#)
- b
  - GiNaC::Eisenstein\_kernel, [517](#)
  - GiNaC::integral, [726](#)
- bareiss
  - GiNaC::determinant\_algo, [461](#)
  - GiNaC::solve\_algo, [1050](#)
- base\_and\_index
  - GiNaC, [88](#)
- basic
  - GiNaC::basic, [335](#)
- basic.cpp, [1203](#)
- basic.h, [1204](#)
- basic\_multi\_iterator
  - GiNaC::basic\_multi\_iterator< T >, [366](#), [367](#)
- basic\_partition\_generator
  - GiNaC::basic\_partition\_generator, [372](#)
- basis
  - GiNaC::power, [956](#)
- begin
  - GiNaC::archive\_node::archive\_node\_cit\_range, [328](#)
  - GiNaC::container< C >, [451](#)
  - GiNaC::ex, [540](#)
- bernoulli
  - GiNaC, [227](#)
- Bernoulli\_polynomial
  - GiNaC, [190](#)
- beta\_deriv
  - GiNaC, [158](#)
- beta\_eval
  - GiNaC, [158](#)
- beta\_evalf
  - GiNaC, [157](#)
- beta\_series
  - GiNaC, [158](#)
- binomial
  - GiNaC, [227](#)
- binomial\_conjugate
  - GiNaC, [146](#)
- binomial\_eval
  - GiNaC, [145](#)
- binomial\_evalf
  - GiNaC, [145](#)
- binomial\_imag\_part
  - GiNaC, [146](#)
- binomial\_real\_part
  - GiNaC, [146](#)
- binomial\_sym
  - GiNaC, [145](#)
- bp
  - GiNaC::ex, [566](#)
- c
  - GiNaC::pointer\_to\_member\_to\_map\_function< C >, [923](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function\_1arg< C, T1 >, [926](#)

- GiNaC::pointer\_to\_member\_to\_map\_function\_2args< C, T1, T2 >, [928](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function\_3args< C, T1, T2, T3 >, [931](#)
- C\_norm
  - GiNaC::Eisenstein\_h\_kernel, [507](#)
  - GiNaC::Eisenstein\_kernel, [517](#)
  - GiNaC::Kronecker\_dtau\_kernel, [747](#)
  - GiNaC::Kronecker\_dz\_kernel, [756](#)
  - GiNaC::modular\_form\_kernel, [802](#)
- cache\_step\_size
  - GiNaC::integration\_kernel, [736](#)
- calc\_lanczos\_A
  - GiNaC::lanczos\_coeffs, [757](#)
- calchash
  - GiNaC::basic, [351](#)
  - GiNaC::constant, [435](#)
  - GiNaC::expairseq, [584](#)
  - GiNaC::function, [629](#)
  - GiNaC::idx, [691](#)
  - GiNaC::numeric, [891](#)
  - GiNaC::relational, [1032](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1086](#)
  - GiNaC::symbol, [1124](#)
  - GiNaC::symmetry, [1134](#)
  - GiNaC::wildcard, [1193](#)
- callback\_registered
  - GiNaC, [82](#)
- callbacklist
  - GiNaC::\_numeric\_digits, [293](#)
- can\_be\_further\_expanded
  - GiNaC::mul, [821](#)
- can\_make\_flat
  - GiNaC::expairseq, [587](#)
  - GiNaC::mul, [819](#)
- canonical
  - GiNaC::relational, [1031](#)
- canonicalize
  - GiNaC, [253](#)
  - GiNaC::expairseq, [589](#)
  - GiNaC::symmetry, [1137](#)
- canonicalize\_clifford
  - GiNaC, [93](#)
- Catalan
  - GiNaC, [270](#)
- CatalanEvalf
  - GiNaC, [232](#)
- charpoly
  - GiNaC, [198](#)
  - GiNaC::matrix, [780](#)
- children
  - GiNaC::class\_info< OPT >::tree\_node, [1169](#)
  - GiNaC::symmetry, [1137](#)
- cinteger
  - GiNaC::info\_flags, [715](#)
- cinteger\_polynomial
  - GiNaC::info\_flags, [715](#)
- class\_info
  - GiNaC::class\_info< OPT >, [374](#)
  - class\_info< OPT >::first
  - class\_info< OPT >::parents\_identified
  - GiNaC, [269](#)
  - class\_info.h, [1205](#)
  - clear
    - GiNaC::archive, [314](#)
    - GiNaC::scalar\_products, [1047](#)
  - clear\_all\_entries
  - GiNaC::remember\_table, [1037](#)
  - clearflag
    - GiNaC::basic, [355](#)
  - clifford
    - GiNaC::clifford, [385](#), [386](#)
  - clifford.cpp, [1206](#)
  - clifford.h, [1208](#)
  - clifford\_bar
    - GiNaC, [99](#)
  - clifford\_inverse
    - GiNaC, [95](#)
  - clifford\_max\_label
    - GiNaC, [94](#)
  - clifford\_moebius\_map
    - GiNaC, [96](#), [97](#)
  - clifford\_norm
    - GiNaC, [94](#)
  - clifford\_prime
    - GiNaC, [93](#)
  - clifford\_star
    - GiNaC, [99](#)
  - clifford\_star\_bar
    - GiNaC, [93](#)
  - clifford\_to\_lst
    - GiNaC, [96](#)
  - clifford\_unit
    - GiNaC, [89](#)
  - cmgen
    - GiNaC::composition\_generator, [414](#)
  - CMPINDICES
    - color.cpp, [1211](#)
  - coeff
    - GiNaC, [109](#)
    - GiNaC::add, [302](#)
    - GiNaC::basic, [343](#)
    - GiNaC::ex, [549](#)
    - GiNaC::expair, [571](#)
    - GiNaC::mul, [812](#)
    - GiNaC::ncmul, [870](#)
    - GiNaC::numeric, [886](#)
    - GiNaC::power, [947](#)
    - GiNaC::pseries, [995](#)
    - GiNaC::structure< T, ComparisonPolicy >, [1080](#)
    - GiNaC::symminfo, [1139](#)
  - coefficient\_a0
    - GiNaC::Eisenstein\_h\_kernel, [506](#)
  - coefficient\_an
    - GiNaC::Eisenstein\_h\_kernel, [506](#)

- coeffop
  - GiNaC::pseries, [1000](#)
- coeffs
  - GiNaC::lanczos\_coeffs, [758](#)
- coerce
  - GiNaC, [217](#)
- coerce< int, cln::cl\_I >
  - GiNaC, [217](#)
- coerce< unsigned int, cln::cl\_I >
  - GiNaC, [217](#)
- col
  - GiNaC::matrix, [786](#)
- collect
  - GiNaC, [110](#)
  - GiNaC::basic, [344](#)
  - GiNaC::ex, [550](#)
  - GiNaC::pseries, [995](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1081](#)
- collect\_common\_factors
  - GiNaC, [214](#)
- collect\_symbols
  - GiNaC, [202](#)
- color
  - GiNaC::color, [406](#)
- color.cpp, [1210](#)
  - CMPINDICES, [1211](#)
  - TEST\_PERMUTATION, [1211](#)
- color.h, [1212](#)
- color\_d
  - GiNaC, [101](#)
- color\_f
  - GiNaC, [101](#)
- color\_h
  - GiNaC, [102](#)
- color\_ONE
  - GiNaC, [100](#)
- color\_T
  - GiNaC, [101](#)
- color\_trace
  - GiNaC, [103](#), [104](#)
- cols
  - GiNaC, [198](#)
  - GiNaC::matrix, [775](#)
- combine\_ex\_with\_coeff\_to\_pair
  - GiNaC::add, [307](#)
  - GiNaC::expairseq, [586](#)
  - GiNaC::mul, [818](#)
- combine\_indices
  - GiNaC::make\_flat\_inserter, [761](#)
- combine\_overall\_coeff
  - GiNaC::expairseq, [587](#)
  - GiNaC::mul, [819](#)
- combine\_pair\_with\_coeff\_to\_pair
  - GiNaC::add, [308](#)
  - GiNaC::expairseq, [586](#)
  - GiNaC::mul, [818](#)
- combine\_same\_terms\_sorted\_seq
  - GiNaC::expairseq, [590](#)
- commutative
  - GiNaC::return\_types, [1046](#)
- commutator\_sign
  - GiNaC::clifford, [391](#)
- compare
  - GiNaC::basic, [353](#)
  - GiNaC::ex, [558](#)
  - GiNaC::expair, [570](#)
  - GiNaC::numeric, [896](#)
- compare\_pointers
  - GiNaC, [263](#)
- compare\_same\_type
  - GiNaC::basic, [350](#)
- compile\_ex
  - GiNaC, [117](#)
- compiler.h, [1213](#)
  - attribute\_deprecated, [1214](#)
  - likely, [1214](#)
  - unlikely, [1214](#)
- complex
  - GiNaC::domain, [488](#)
- composition
  - GiNaC::composition\_generator, [415](#)
- composition\_generator
  - GiNaC::composition\_generator, [414](#)
- conjugate
  - GiNaC, [107](#)
  - GiNaC::add, [305](#)
  - GiNaC::basic, [349](#)
  - GiNaC::constant, [433](#)
  - GiNaC::container< C >, [447](#)
  - GiNaC::diracgamma5, [472](#)
  - GiNaC::diracgammaL, [477](#)
  - GiNaC::diracgammaR, [482](#)
  - GiNaC::ex, [545](#)
  - GiNaC::expair, [571](#)
  - GiNaC::expairseq, [582](#)
  - GiNaC::function, [630](#)
  - GiNaC::integral, [723](#)
  - GiNaC::matrix, [774](#)
  - GiNaC::mul, [816](#)
  - GiNaC::ncmul, [872](#)
  - GiNaC::numeric, [890](#)
  - GiNaC::power, [951](#)
  - GiNaC::pseries, [997](#)
  - GiNaC::realsymbol, [1016](#)
  - GiNaC::spinidx, [1058](#)
  - GiNaC::symbol, [1122](#)
- conjugate\_conjugate
  - GiNaC, [130](#)
- conjugate\_eval
  - GiNaC, [130](#)
- conjugate\_evalf
  - GiNaC, [130](#)
- conjugate\_expl\_derivative
  - GiNaC, [130](#)
- conjugate\_f
  - GiNaC::function\_options, [673](#)

- conjugate\_func
  - GiNaC::function\_options, 648–650, 666
- conjugate\_funcp
  - GiNaC, 60
- conjugate\_funcp\_1
  - GiNaC, 61
- conjugate\_funcp\_10
  - GiNaC, 73
- conjugate\_funcp\_11
  - GiNaC, 74
- conjugate\_funcp\_12
  - GiNaC, 75
- conjugate\_funcp\_13
  - GiNaC, 77
- conjugate\_funcp\_14
  - GiNaC, 78
- conjugate\_funcp\_2
  - GiNaC, 62
- conjugate\_funcp\_3
  - GiNaC, 63
- conjugate\_funcp\_4
  - GiNaC, 65
- conjugate\_funcp\_5
  - GiNaC, 66
- conjugate\_funcp\_6
  - GiNaC, 67
- conjugate\_funcp\_7
  - GiNaC, 69
- conjugate\_funcp\_8
  - GiNaC, 70
- conjugate\_funcp\_9
  - GiNaC, 71
- conjugate\_funcp\_exvector
  - GiNaC, 80
- conjugate\_imag\_part
  - GiNaC, 131
- conjugate\_info
  - GiNaC, 131
- conjugate\_print\_latex
  - GiNaC, 130
- conjugate\_real\_part
  - GiNaC, 131
- conjugate\_use\_exvector\_args
  - GiNaC::function\_options, 676
- conjugateepvector
  - GiNaC, 119
- const\_iterator
  - GiNaC::const\_iterator, 417
  - GiNaC::container< C >, 444
- const\_postorder\_iterator
  - GiNaC::const\_iterator, 420
  - GiNaC::const\_postorder\_iterator, 422
- const\_preorder\_iterator
  - GiNaC::const\_iterator, 420
  - GiNaC::const\_preorder\_iterator, 425
- const\_reverse\_iterator
  - GiNaC::container< C >, 444
- constant
  - GiNaC::constant, 432
- constant.cpp, 1214
- constant.h, 1215
- construct\_from\_2\_ex
  - GiNaC::expairseq, 588
- construct\_from\_2\_expairseq
  - GiNaC::expairseq, 588
- construct\_from\_basic
  - GiNaC::ex, 561
- construct\_from\_double
  - GiNaC::ex, 563
- construct\_from\_epvector
  - GiNaC::expairseq, 589
- construct\_from\_expairseq\_ex
  - GiNaC::expairseq, 588
- construct\_from\_exvector
  - GiNaC::expairseq, 588
- construct\_from\_int
  - GiNaC::ex, 561
- construct\_from\_long
  - GiNaC::ex, 562
- construct\_from\_longlong
  - GiNaC::ex, 562
- construct\_from\_string\_and\_lst
  - GiNaC::ex, 563
- construct\_from\_uint
  - GiNaC::ex, 562
- construct\_from\_ulong
  - GiNaC::ex, 562
- construct\_from\_ulonglong
  - GiNaC::ex, 563
- container
  - GiNaC::container< C >, 444
- container.h, 1216
- container\_storage
  - GiNaC::container\_storage< C >, 454, 455
- content
  - GiNaC::ex, 554
- contract\_with
  - GiNaC::basic, 348
  - GiNaC::cliffordunit, 397
  - GiNaC::diracgamma, 467
  - GiNaC::matrix, 773
  - GiNaC::spinmetric, 1066
  - GiNaC::structure< T, ComparisonPolicy >, 1085
  - GiNaC::su3d, 1092
  - GiNaC::su3f, 1098
  - GiNaC::su3t, 1108
  - GiNaC::tensdelta, 1146
  - GiNaC::tensepsilon, 1152
  - GiNaC::tensmetric, 1160
- convert\_H\_to\_Li
  - GiNaC, 151
- convert\_to\_poly
  - GiNaC::pseries, 999
- coolmulti
  - GiNaC::composition\_generator::coolmulti, 457
- cos

- GiNaC, [219](#)
- cos\_conjugate
  - GiNaC, [173](#)
- cos\_deriv
  - GiNaC, [172](#)
- cos\_eval
  - GiNaC, [172](#)
- cos\_evalf
  - GiNaC, [172](#)
- cos\_imag\_part
  - GiNaC, [173](#)
- cos\_real\_part
  - GiNaC, [172](#)
- cosh
  - GiNaC, [221](#)
- cosh\_conjugate
  - GiNaC, [182](#)
- cosh\_deriv
  - GiNaC, [181](#)
- cosh\_eval
  - GiNaC, [181](#)
- cosh\_evalf
  - GiNaC, [181](#)
- cosh\_imag\_part
  - GiNaC, [182](#)
- cosh\_real\_part
  - GiNaC, [181](#)
- count
  - GiNaC::archive\_node::property\_info, [988](#)
  - GiNaC::library\_init, [760](#)
- count\_dummy\_indices
  - GiNaC, [125](#)
- count\_factors
  - GiNaC::ncmul, [874](#)
- count\_free\_indices
  - GiNaC, [125](#)
- covariant
  - GiNaC::varidx, [1187](#)
- crational
  - GiNaC::info\_flags, [715](#)
- crational\_polynomial
  - GiNaC::info\_flags, [715](#)
- crc32
  - GiNaC, [105](#)
- crc32.h, [1216](#)
- crctab
  - GiNaC, [270](#)
- csgn
  - GiNaC, [233](#)
  - GiNaC::numeric, [896](#)
- csgn\_conjugate
  - GiNaC, [139](#)
- csgn\_eval
  - GiNaC, [139](#)
- csgn\_evalf
  - GiNaC, [138](#)
- csgn\_imag\_part
  - GiNaC, [139](#)
- csgn\_power
  - GiNaC, [140](#)
- csgn\_real\_part
  - GiNaC, [139](#)
- csgn\_series
  - GiNaC, [139](#)
- csrc
  - GiNaC, [245](#)
- csrc\_cl\_N
  - GiNaC, [246](#)
- csrc\_double
  - GiNaC, [246](#)
- csrc\_float
  - GiNaC, [246](#)
- current\_serial
  - GiNaC::function, [635](#)
- current\_updated
  - GiNaC::composition\_generator, [415](#)
  - GiNaC::partition\_generator, [908](#)
  - GiNaC::partition\_with\_zero\_parts\_generator, [910](#)
- current\_vector
  - GiNaC::lanczos\_coeffs, [758](#)
- cyclic
  - GiNaC::symmetry, [1133](#)
- cyclic\_permutation
  - GiNaC, [264](#)
- dbgprint
  - GiNaC::basic, [338](#)
  - GiNaC::ex, [542](#)
- dbgprinttree
  - GiNaC::basic, [338](#)
  - GiNaC::ex, [542](#)
- DCOUT
  - factor.cpp, [1226](#)
- DCOUT2
  - factor.cpp, [1226](#)
- DCOUTVAR
  - factor.cpp, [1226](#)
- debugprint
  - GiNaC::scalar\_products, [1048](#)
  - GiNaC::spmapkey, [1069](#)
- DECLARE\_FUNCTION\_10P
  - function.h, [1240](#)
- DECLARE\_FUNCTION\_11P
  - function.h, [1240](#)
- DECLARE\_FUNCTION\_12P
  - function.h, [1240](#)
- DECLARE\_FUNCTION\_13P
  - function.h, [1241](#)
- DECLARE\_FUNCTION\_14P
  - function.h, [1241](#)
- DECLARE\_FUNCTION\_1P
  - function.h, [1238](#)
- DECLARE\_FUNCTION\_2P
  - function.h, [1238](#)
- DECLARE\_FUNCTION\_3P
  - function.h, [1238](#)
- DECLARE\_FUNCTION\_4P

- function.h, [1238](#)
- DECLARE\_FUNCTION\_5P
  - function.h, [1239](#)
- DECLARE\_FUNCTION\_6P
  - function.h, [1239](#)
- DECLARE\_FUNCTION\_7P
  - function.h, [1239](#)
- DECLARE\_FUNCTION\_8P
  - function.h, [1239](#)
- DECLARE\_FUNCTION\_9P
  - function.h, [1240](#)
- decomp\_rational
  - GiNaC, [204](#)
- DEFAULT\_COMPARE
  - utils.h, [1309](#)
- DEFAULT\_CTOR
  - utils.h, [1309](#)
- default\_overall\_coeff
  - GiNaC::expairseq, [587](#)
  - GiNaC::mul, [819](#)
- DEFAULT\_PRINT
  - utils.h, [1309](#)
- DEFAULT\_PRINT\_LATEX
  - utils.h, [1309](#)
- deg
  - GiNaC::pole\_error, [934](#)
- deg\_a
  - GiNaC::sym\_desc, [1114](#)
- deg\_b
  - GiNaC::sym\_desc, [1114](#)
- degree
  - GiNaC, [108](#)
  - GiNaC::add, [302](#)
  - GiNaC::basic, [343](#)
  - GiNaC::ex, [549](#)
  - GiNaC::integral, [721](#)
  - GiNaC::mul, [812](#)
  - GiNaC::ncmul, [870](#)
  - GiNaC::numeric, [886](#)
  - GiNaC::pole\_error, [933](#)
  - GiNaC::power, [947](#)
  - GiNaC::pseries, [995](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1080](#)
- delete\_cyclic
  - GiNaC::remember\_strategies, [1035](#)
- delete\_lfu
  - GiNaC::remember\_strategies, [1035](#)
- delete\_lru
  - GiNaC::remember\_strategies, [1035](#)
- delete\_never
  - GiNaC::remember\_strategies, [1035](#)
- delta\_indent
  - GiNaC::print\_tree, [985](#)
- delta\_tensor
  - GiNaC, [259](#)
- denom
  - GiNaC, [109](#), [237](#)
  - GiNaC::ex, [553](#)
- GiNaC::numeric, [903](#)
- derivative
  - GiNaC::add, [306](#)
  - GiNaC::basic, [344](#)
  - GiNaC::constant, [434](#)
  - GiNaC::fderivative, [612](#)
  - GiNaC::function, [631](#)
  - GiNaC::idx, [690](#)
  - GiNaC::indexed, [708](#)
  - GiNaC::integral, [724](#)
  - GiNaC::mul, [816](#)
  - GiNaC::ncmul, [873](#)
  - GiNaC::numeric, [891](#)
  - GiNaC::power, [952](#)
  - GiNaC::pseries, [999](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1081](#)
  - GiNaC::symbol, [1123](#)
- derivative\_f
  - GiNaC::function\_options, [674](#)
- derivative\_func
  - GiNaC::function\_options, [656–658](#), [667](#)
- derivative\_funcp
  - GiNaC, [60](#)
- derivative\_funcp\_1
  - GiNaC, [61](#)
- derivative\_funcp\_10
  - GiNaC, [73](#)
- derivative\_funcp\_11
  - GiNaC, [74](#)
- derivative\_funcp\_12
  - GiNaC, [76](#)
- derivative\_funcp\_13
  - GiNaC, [77](#)
- derivative\_funcp\_14
  - GiNaC, [79](#)
- derivative\_funcp\_2
  - GiNaC, [63](#)
- derivative\_funcp\_3
  - GiNaC, [64](#)
- derivative\_funcp\_4
  - GiNaC, [65](#)
- derivative\_funcp\_5
  - GiNaC, [66](#)
- derivative\_funcp\_6
  - GiNaC, [68](#)
- derivative\_funcp\_7
  - GiNaC, [69](#)
- derivative\_funcp\_8
  - GiNaC, [70](#)
- derivative\_funcp\_9
  - GiNaC, [72](#)
- derivative\_funcp\_exvector
  - GiNaC, [80](#)
- derivative\_map\_function
  - GiNaC::derivative\_map\_function, [460](#)
- derivative\_use\_exvector\_args
  - GiNaC::function\_options, [677](#)
- derivatives

- GiNaC::fderivative, [613](#)
- descend
  - GiNaC::const\_postorder\_iterator, [423](#)
- determinant
  - GiNaC, [198](#)
  - GiNaC::matrix, [778](#)
- determinant\_minor
  - GiNaC::matrix, [782](#)
- dfft
  - GiNaC, [245](#)
- diag\_matrix
  - GiNaC, [195](#), [196](#)
- diff
  - GiNaC, [111](#)
  - GiNaC::basic, [353](#)
  - GiNaC::ex, [550](#)
- difference\_type
  - GiNaC::const\_iterator, [417](#)
  - GiNaC::const\_postorder\_iterator, [422](#)
  - GiNaC::const\_preorder\_iterator, [425](#)
- Digits
  - GiNaC, [271](#)
- digits
  - GiNaC::\_numeric\_digits, [293](#)
- digits\_changed\_callback
  - GiNaC, [82](#)
- dim
  - GiNaC::idx, [694](#)
  - GiNaC::spmapkey, [1069](#)
- dirac\_gamma
  - GiNaC, [90](#)
- dirac\_gamma5
  - GiNaC, [90](#)
- dirac\_gammaL
  - GiNaC, [90](#)
- dirac\_gammaR
  - GiNaC, [91](#)
- dirac\_ONE
  - GiNaC, [89](#)
- dirac\_slash
  - GiNaC, [91](#)
- dirac\_trace
  - GiNaC, [92](#), [93](#)
- dirichlet\_character
  - GiNaC, [189](#)
- div
  - GiNaC::numeric, [892](#)
- div\_dyn
  - GiNaC::numeric, [894](#)
- divfree
  - GiNaC::determinant\_algo, [461](#)
  - GiNaC::solve\_algo, [1050](#)
- divide
  - GiNaC, [206](#)
- divide\_in\_z
  - GiNaC, [206](#)
- division\_free\_elimination
  - GiNaC::matrix, [783](#)
- do\_not\_evalf\_params
  - GiNaC::function\_options, [670](#)
- do\_print
  - GiNaC::add, [309](#)
  - GiNaC::basic, [356](#)
  - GiNaC::basic\_log\_kernel, [364](#)
  - GiNaC::cliffordunit, [397](#)
  - GiNaC::constant, [435](#)
  - GiNaC::container< C >, [452](#)
  - GiNaC::diracgamma, [467](#)
  - GiNaC::diracgamma5, [472](#)
  - GiNaC::diracgammaL, [477](#)
  - GiNaC::diracgammaR, [482](#)
  - GiNaC::diracone, [487](#)
  - GiNaC::Ebar\_kernel, [496](#)
  - GiNaC::Eisenstein\_h\_kernel, [506](#)
  - GiNaC::Eisenstein\_kernel, [516](#)
  - GiNaC::ELi\_kernel, [526](#)
  - GiNaC::expairseq, [587](#)
  - GiNaC::fail, [600](#)
  - GiNaC::fderivative, [613](#)
  - GiNaC::idx, [693](#)
  - GiNaC::indexed, [711](#)
  - GiNaC::integral, [725](#)
  - GiNaC::integration\_kernel, [735](#)
  - GiNaC::Kronecker\_dtau\_kernel, [746](#)
  - GiNaC::Kronecker\_dz\_kernel, [755](#)
  - GiNaC::matrix, [785](#)
  - GiNaC::minkmetric, [793](#)
  - GiNaC::modular\_form\_kernel, [802](#)
  - GiNaC::mul, [820](#)
  - GiNaC::multiple\_polylog\_kernel, [860](#)
  - GiNaC::ncmul, [873](#)
  - GiNaC::numeric, [903](#)
  - GiNaC::pseries, [1002](#)
  - GiNaC::relational, [1032](#)
  - GiNaC::spinidx, [1060](#)
  - GiNaC::spinmetric, [1067](#)
  - GiNaC::su3d, [1093](#)
  - GiNaC::su3f, [1098](#)
  - GiNaC::su3one, [1103](#)
  - GiNaC::su3t, [1108](#)
  - GiNaC::symbol, [1125](#)
  - GiNaC::symmetry, [1136](#)
  - GiNaC::tensdelta, [1146](#)
  - GiNaC::tensepsilon, [1153](#)
  - GiNaC::tensmetric, [1160](#)
  - GiNaC::user\_defined\_kernel, [1178](#)
  - GiNaC::varidx, [1186](#)
  - GiNaC::wildcard, [1194](#)
- do\_print\_csrc
  - GiNaC::add, [309](#)
  - GiNaC::fderivative, [614](#)
  - GiNaC::idx, [693](#)
  - GiNaC::mul, [821](#)
  - GiNaC::ncmul, [874](#)
  - GiNaC::numeric, [904](#)
  - GiNaC::power, [954](#)

- do\_print\_csrc\_cl\_N
  - GiNaC::numeric, 904
  - GiNaC::power, 954
- do\_print\_dflt
  - GiNaC::clifford, 390
  - GiNaC::power, 953
- do\_print\_latex
  - GiNaC::add, 309
  - GiNaC::clifford, 390
  - GiNaC::cliffordunit, 397
  - GiNaC::constant, 436
  - GiNaC::diracgamma, 467
  - GiNaC::diracgamma5, 472
  - GiNaC::diracgammaL, 477
  - GiNaC::diracgammaR, 482
  - GiNaC::diracone, 487
  - GiNaC::fderivative, 613
  - GiNaC::idx, 694
  - GiNaC::indexed, 712
  - GiNaC::integral, 725
  - GiNaC::matrix, 785
  - GiNaC::minkmetric, 793
  - GiNaC::mul, 821
  - GiNaC::numeric, 904
  - GiNaC::power, 953
  - GiNaC::pseries, 1002
  - GiNaC::spinidx, 1060
  - GiNaC::spinmetric, 1067
  - GiNaC::su3d, 1093
  - GiNaC::su3f, 1098
  - GiNaC::su3one, 1103
  - GiNaC::su3t, 1108
  - GiNaC::symbol, 1125
  - GiNaC::tensdelta, 1147
  - GiNaC::tensepsilon, 1154
- do\_print\_python
  - GiNaC::container< C >, 452
  - GiNaC::power, 954
  - GiNaC::pseries, 1003
- do\_print\_python\_repr
  - GiNaC::add, 309
  - GiNaC::basic, 356
  - GiNaC::constant, 436
  - GiNaC::container< C >, 452
  - GiNaC::matrix, 785
  - GiNaC::mul, 821
  - GiNaC::numeric, 904
  - GiNaC::power, 954
  - GiNaC::pseries, 1003
  - GiNaC::relational, 1032
  - GiNaC::symbol, 1125
  - GiNaC::wildcard, 1194
- do\_print\_tree
  - GiNaC::basic, 356
  - GiNaC::clifford, 391
  - GiNaC::constant, 435
  - GiNaC::container< C >, 452
  - GiNaC::expairseq, 588
  - GiNaC::fderivative, 614
  - GiNaC::idx, 694
  - GiNaC::indexed, 712
  - GiNaC::numeric, 904
  - GiNaC::pseries, 1002
  - GiNaC::spinidx, 1060
  - GiNaC::symbol, 1125
  - GiNaC::symmetry, 1136
  - GiNaC::varidx, 1187
  - GiNaC::wildcard, 1194
- do\_renaming
  - GiNaC::make\_flat\_inserter, 762
- domain
  - GiNaC::constant, 437
- dotted
  - GiNaC::spinidx, 1060
- doublefactorial
  - GiNaC, 226
- dummy
  - GiNaC::function\_options, 643
- dump\_hierarchy
  - GiNaC::class\_info< OPT >, 375
- dump\_tree
  - GiNaC::class\_info< OPT >, 375
- duplicate
  - GiNaC::basic, 336
  - GiNaC::possymbol, 940
  - GiNaC::print\_functor\_impl, 972
  - GiNaC::print\_memfun\_handler< T, C >, 976
  - GiNaC::print\_ptrfun\_handler< T, C >, 979
  - GiNaC::realsymbol, 1016
- dynallocate
  - GiNaC, 86, 87
- dynallocated
  - GiNaC::status\_flags, 1070
- e
  - GiNaC::archive\_node, 327
  - GiNaC::const\_iterator, 421
  - GiNaC::internal::\_iter\_rep, 290
- Ebar\_kernel
  - GiNaC::Ebar\_kernel, 495
- echelon\_form
  - GiNaC::matrix, 782
- ef
  - GiNaC::constant, 436
- Eisenstein\_h\_kernel
  - GiNaC::Eisenstein\_h\_kernel, 504
- Eisenstein\_kernel
  - GiNaC::Eisenstein\_kernel, 514
- element
  - GiNaC::composition\_generator::coolmulti::element, 518
- ELi\_kernel
  - GiNaC::ELi\_kernel, 525
- EllipticE\_deriv
  - GiNaC, 153
- EllipticE\_eval
  - GiNaC, 153



- EllipticE\_evalf
  - GiNaC, [153](#)
- EllipticE\_print\_latex
  - GiNaC, [153](#)
- EllipticE\_series
  - GiNaC, [153](#)
- EllipticK\_deriv
  - GiNaC, [152](#)
- EllipticK\_eval
  - GiNaC, [152](#)
- EllipticK\_evalf
  - GiNaC, [151](#)
- EllipticK\_print\_latex
  - GiNaC, [152](#)
- EllipticK\_series
  - GiNaC, [152](#)
- end
  - GiNaC::archive\_node::archive\_node\_cit\_range, [328](#)
  - GiNaC::container< C >, [451](#)
  - GiNaC::ex, [540](#)
- ensure\_if\_modifiable
  - GiNaC::basic, [355](#)
- epp
  - GiNaC, [59](#)
- epsilon\_tensor
  - GiNaC, [261](#)
- epvector
  - GiNaC, [59](#)
- equal
  - GiNaC::relational, [1028](#)
- error
  - GiNaC::error\_and\_integral, [529](#)
- error\_and\_integral
  - GiNaC::error\_and\_integral, [528](#)
- eta\_conjugate
  - GiNaC, [141](#)
- eta\_eval
  - GiNaC, [140](#)
- eta\_evalf
  - GiNaC, [140](#)
- eta\_imag\_part
  - GiNaC, [141](#)
- eta\_real\_part
  - GiNaC, [141](#)
- eta\_series
  - GiNaC, [140](#)
- Euler
  - GiNaC, [269](#)
- EulerEvalf
  - GiNaC, [232](#)
- eval
  - GiNaC, [110](#)
  - GiNaC::add, [303](#)
  - GiNaC::basic, [336](#)
  - GiNaC::ex, [541](#)
  - GiNaC::expairseq, [581](#)
  - GiNaC::fderivative, [610](#)
  - GiNaC::function, [628](#)
  - GiNaC::indexed, [707](#)
  - GiNaC::integral, [721](#)
  - GiNaC::mul, [813](#)
  - GiNaC::ncmul, [871](#)
  - GiNaC::numeric, [887](#)
  - GiNaC::power, [947](#)
  - GiNaC::pseries, [996](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1076](#)
  - GiNaC::symbol, [1120](#)
- eval\_f
  - GiNaC::function\_options, [673](#)
- eval\_func
  - GiNaC::function\_options, [644–646](#), [666](#)
- eval\_funcp
  - GiNaC, [60](#)
- eval\_funcp\_1
  - GiNaC, [61](#)
- eval\_funcp\_10
  - GiNaC, [72](#)
- eval\_funcp\_11
  - GiNaC, [74](#)
- eval\_funcp\_12
  - GiNaC, [75](#)
- eval\_funcp\_13
  - GiNaC, [77](#)
- eval\_funcp\_14
  - GiNaC, [78](#)
- eval\_funcp\_2
  - GiNaC, [62](#)
- eval\_funcp\_3
  - GiNaC, [63](#)
- eval\_funcp\_4
  - GiNaC, [64](#)
- eval\_funcp\_5
  - GiNaC, [66](#)
- eval\_funcp\_6
  - GiNaC, [67](#)
- eval\_funcp\_7
  - GiNaC, [68](#)
- eval\_funcp\_8
  - GiNaC, [70](#)
- eval\_funcp\_9
  - GiNaC, [71](#)
- eval\_funcp\_exvector
  - GiNaC, [80](#)
- eval\_indexed
  - GiNaC::basic, [337](#)
  - GiNaC::matrix, [773](#)
  - GiNaC::minkmetric, [792](#)
  - GiNaC::spinmetric, [1066](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1076](#)
  - GiNaC::su3d, [1092](#)
  - GiNaC::su3f, [1098](#)
  - GiNaC::tensdelta, [1146](#)
  - GiNaC::tensepsilon, [1152](#)
  - GiNaC::tensmetric, [1160](#)
- eval\_integ

- GiNaC, [111](#)
  - GiNaC::basic, [337](#)
  - GiNaC::ex, [541](#)
  - GiNaC::integral, [724](#)
  - GiNaC::pseries, [998](#)
- eval\_ncmul
  - GiNaC::add, [306](#)
  - GiNaC::basic, [337](#)
  - GiNaC::clifford, [387](#)
  - GiNaC::color, [407](#)
  - GiNaC::ex, [541](#)
  - GiNaC::function, [629](#)
  - GiNaC::integral, [722](#)
  - GiNaC::mul, [816](#)
  - GiNaC::power, [952](#)
  - GiNaC::relational, [1031](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1076](#)
- eval\_use\_exvector\_args
  - GiNaC::function\_options, [676](#)
- evalchildren
  - GiNaC::expireseq, [590](#)
- evalf
  - GiNaC, [110](#), [197](#)
  - GiNaC::basic, [336](#)
  - GiNaC::constant, [433](#)
  - GiNaC::ex, [541](#)
  - GiNaC::function, [628](#)
  - GiNaC::idx, [689](#)
  - GiNaC::integral, [721](#)
  - GiNaC::mul, [813](#)
  - GiNaC::numeric, [887](#)
  - GiNaC::power, [948](#)
  - GiNaC::pseries, [996](#)
  - GiNaC::symbol, [1120](#)
- evalf\_f
  - GiNaC::function\_options, [673](#)
- evalf\_func
  - GiNaC::function\_options, [646–648](#), [666](#)
- evalf\_funcp
  - GiNaC, [60](#)
- evalf\_funcp\_1
  - GiNaC, [61](#)
- evalf\_funcp\_10
  - GiNaC, [72](#)
- evalf\_funcp\_11
  - GiNaC, [74](#)
- evalf\_funcp\_12
  - GiNaC, [75](#)
- evalf\_funcp\_13
  - GiNaC, [77](#)
- evalf\_funcp\_14
  - GiNaC, [78](#)
- evalf\_funcp\_2
  - GiNaC, [62](#)
- evalf\_funcp\_3
  - GiNaC, [63](#)
- evalf\_funcp\_4
  - GiNaC, [65](#)
- evalf\_funcp\_5
  - GiNaC, [66](#)
- evalf\_funcp\_6
  - GiNaC, [67](#)
- evalf\_funcp\_7
  - GiNaC, [68](#)
- evalf\_funcp\_8
  - GiNaC, [70](#)
- evalf\_funcp\_9
  - GiNaC, [71](#)
- evalf\_funcp\_exvector
  - GiNaC, [80](#)
- evalf\_params\_first
  - GiNaC::function\_options, [675](#)
- evalf\_use\_exvector\_args
  - GiNaC::function\_options, [676](#)
- evalffunctype
  - GiNaC, [59](#)
- evalm
  - GiNaC, [110](#)
  - GiNaC::add, [303](#)
  - GiNaC::basic, [336](#)
  - GiNaC::ex, [541](#)
  - GiNaC::matrix, [772](#)
  - GiNaC::mul, [814](#)
  - GiNaC::ncmul, [871](#)
  - GiNaC::power, [948](#)
  - GiNaC::pseries, [998](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1076](#)
- evaluate
  - GiNaC::scalar\_products, [1048](#)
- evaluated
  - GiNaC::status\_flags, [1070](#)
- even
  - GiNaC::info\_flags, [715](#)
- ex
  - GiNaC::basic, [357](#)
  - GiNaC::const\_iterator, [420](#)
  - GiNaC::ex, [538](#), [539](#)
- ex.cpp, [1217](#)
- ex.h, [1217](#)
- ex\_to
  - GiNaC, [115](#)
  - GiNaC::ex, [564](#)
- exadd
  - GiNaC, [237](#)
- excompiler.cpp, [1220](#)
- excompiler.h, [1220](#)
- exhashmap
  - GiNaC, [81](#)
- exmap
  - GiNaC, [59](#)
- exminus
  - GiNaC, [237](#)
- exmul
  - GiNaC, [237](#)
- exp
  - GiNaC, [218](#)

- exp\_conjugate
  - GiNaC, [167](#)
- exp\_deriv
  - GiNaC, [167](#)
- exp\_eval
  - GiNaC, [166](#)
- exp\_evalf
  - GiNaC, [166](#)
- exp\_expand
  - GiNaC, [167](#)
- exp\_imag\_part
  - GiNaC, [167](#)
- exp\_info
  - GiNaC, [168](#)
- exp\_power
  - GiNaC, [168](#)
- exp\_real\_part
  - GiNaC, [167](#)
- expair
  - GiNaC::expair, [569](#)
- expair.cpp, [1221](#)
- expair.h, [1222](#)
- expair\_needs\_further\_processing
  - GiNaC::expairseq, [586](#)
  - GiNaC::mul, [818](#)
- expairseq
  - GiNaC::expairseq, [579](#), [580](#)
- expairseq.cpp, [1223](#)
- expairseq.h, [1223](#)
- expand
  - GiNaC, [107](#), [197](#)
  - GiNaC::add, [308](#)
  - GiNaC::basic, [344](#)
  - GiNaC::ex, [550](#)
  - GiNaC::expairseq, [584](#)
  - GiNaC::function, [628](#)
  - GiNaC::indexed, [710](#)
  - GiNaC::integral, [723](#)
  - GiNaC::mul, [819](#)
  - GiNaC::ncmul, [870](#)
  - GiNaC::power, [953](#)
  - GiNaC::pseries, [997](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1081](#)
- expand\_add
  - GiNaC::power, [954](#)
- expand\_add\_2
  - GiNaC::power, [955](#)
- expand\_dummy\_sum
  - GiNaC, [129](#)
- expand\_f
  - GiNaC::function\_options, [674](#)
- expand\_func
  - GiNaC::function\_options, [654–656](#), [667](#)
- expand\_funcp
  - GiNaC, [60](#)
- expand\_funcp\_1
  - GiNaC, [61](#)
- expand\_funcp\_10
  - GiNaC, [73](#)
- expand\_funcp\_11
  - GiNaC, [74](#)
- expand\_funcp\_12
  - GiNaC, [76](#)
- expand\_funcp\_13
  - GiNaC, [77](#)
- expand\_funcp\_14
  - GiNaC, [79](#)
- expand\_funcp\_2
  - GiNaC, [63](#)
- expand\_funcp\_3
  - GiNaC, [64](#)
- expand\_funcp\_4
  - GiNaC, [65](#)
- expand\_funcp\_5
  - GiNaC, [66](#)
- expand\_funcp\_6
  - GiNaC, [68](#)
- expand\_funcp\_7
  - GiNaC, [69](#)
- expand\_funcp\_8
  - GiNaC, [70](#)
- expand\_funcp\_9
  - GiNaC, [72](#)
- expand\_funcp\_exvector
  - GiNaC, [80](#)
- expand\_function\_args
  - GiNaC::expand\_options, [595](#)
- expand\_indexed
  - GiNaC::expand\_options, [595](#)
- expand\_map\_function
  - GiNaC::expand\_map\_function, [593](#)
- expand\_mul
  - GiNaC::power, [955](#)
- expand\_rename\_idx
  - GiNaC::expand\_options, [595](#)
- expand\_transcendental
  - GiNaC::expand\_options, [595](#)
- expand\_use\_exvector\_args
  - GiNaC::function\_options, [677](#)
- expandchildren
  - GiNaC::expairseq, [590](#)
  - GiNaC::mul, [821](#)
  - GiNaC::ncmul, [874](#)
- expanded
  - GiNaC::info\_flags, [715](#)
  - GiNaC::status\_flags, [1070](#)
- expl\_derivative
  - GiNaC::function, [633](#)
- expl\_derivative\_f
  - GiNaC::function\_options, [674](#)
- expl\_derivative\_func
  - GiNaC::function\_options, [658–660](#), [667](#)
- expl\_derivative\_funcp
  - GiNaC, [60](#)
- expl\_derivative\_funcp\_1
  - GiNaC, [62](#)

- expl\_derivative\_funcp\_10
  - GiNaC, [73](#)
- expl\_derivative\_funcp\_11
  - GiNaC, [74](#)
- expl\_derivative\_funcp\_12
  - GiNaC, [76](#)
- expl\_derivative\_funcp\_13
  - GiNaC, [77](#)
- expl\_derivative\_funcp\_14
  - GiNaC, [79](#)
- expl\_derivative\_funcp\_2
  - GiNaC, [63](#)
- expl\_derivative\_funcp\_3
  - GiNaC, [64](#)
- expl\_derivative\_funcp\_4
  - GiNaC, [65](#)
- expl\_derivative\_funcp\_5
  - GiNaC, [66](#)
- expl\_derivative\_funcp\_6
  - GiNaC, [68](#)
- expl\_derivative\_funcp\_7
  - GiNaC, [69](#)
- expl\_derivative\_funcp\_8
  - GiNaC, [70](#)
- expl\_derivative\_funcp\_9
  - GiNaC, [72](#)
- expl\_derivative\_funcp\_exvector
  - GiNaC, [80](#)
- expl\_derivative\_use\_exvector\_args
  - GiNaC::function\_options, [677](#)
- exponent
  - GiNaC::power, [956](#)
- exponop
  - GiNaC::pseries, [1000](#)
- exprs
  - GiNaC::archive, [317](#)
- exprseq
  - GiNaC, [59](#)
  - GiNaC::info\_flags, [715](#)
- exprseq.cpp, [1224](#)
- exprseq.h, [1225](#)
- exprtable
  - GiNaC::archive, [317](#)
- exset
  - GiNaC, [58](#)
- exvector
  - GiNaC, [58](#)
- exvectorvector
  - GiNaC, [81](#)
- F
  - GiNaC::print\_memfun\_handler< T, C >, [976](#)
  - GiNaC::print\_ptrfun\_handler< T, C >, [979](#)
- f
  - GiNaC::integral, [726](#)
  - GiNaC::print\_memfun\_handler< T, C >, [977](#)
  - GiNaC::print\_ptrfun\_handler< T, C >, [980](#)
  - GiNaC::user\_defined\_kernel, [1178](#)
- factor
  - GiNaC, [120](#)
- factor.cpp, [1225](#)
  - DCOUT, [1226](#)
  - DCOUT2, [1226](#)
  - DCOUTVAR, [1226](#)
  - USE\_SAME\_DEGREE\_FACTOR, [1226](#)
- factor.h, [1227](#)
- factorial
  - GiNaC, [226](#)
- factorial\_conjugate
  - GiNaC, [144](#)
- factorial\_eval
  - GiNaC, [144](#)
- factorial\_evalf
  - GiNaC, [144](#)
- factorial\_imag\_part
  - GiNaC, [145](#)
- factorial\_print\_dflt\_latex
  - GiNaC, [144](#)
- factorial\_real\_part
  - GiNaC, [144](#)
- fail.cpp, [1227](#)
- fail.h, [1228](#)
- FAST\_COMPARE
  - normal.cpp, [1274](#)
- fderivative
  - GiNaC::fderivative, [609](#), [610](#)
  - GiNaC::function\_options, [672](#)
- fderivative.cpp, [1228](#)
- fderivative.h, [1229](#)
- fibonacci
  - GiNaC, [227](#)
- find
  - GiNaC, [108](#)
  - GiNaC::class\_info< OPT >, [375](#)
  - GiNaC::ex, [546](#)
  - GiNaC::unarchive\_table\_t, [1170](#)
- find\_bool
  - GiNaC::archive\_node, [322](#)
- find\_common\_factor
  - GiNaC, [214](#)
- find\_dummy\_indices
  - GiNaC, [124](#)
- find\_ex
  - GiNaC::archive\_node, [324](#)
- find\_ex\_by\_loc
  - GiNaC::archive\_node, [324](#)
- find\_ex\_node
  - GiNaC::archive\_node, [324](#)
- find\_factory\_fcn
  - GiNaC, [84](#)
- find\_first
  - GiNaC::archive\_node, [323](#)
- find\_free\_and\_dummy
  - GiNaC, [123](#), [124](#)
- find\_function
  - GiNaC::function, [634](#)
- find\_last

- GiNaC::archive\_node, [323](#)
- find\_property\_range
  - GiNaC::archive\_node, [323](#)
- find\_real\_imag
  - GiNaC::mul, [820](#)
- find\_string
  - GiNaC::archive\_node, [323](#)
- find\_unsigned
  - GiNaC::archive\_node, [322](#)
- find\_variant\_indices
  - GiNaC, [126](#)
- finished
  - GiNaC::composition\_generator::coolmulti, [458](#)
- first
  - GiNaC::class\_info< OPT >, [376](#)
- flag\_overflow
  - GiNaC::basic\_multi\_iterator< T >, [370](#)
- flags
  - GiNaC::basic, [358](#)
- flags.h, [1229](#)
- force\_include\_tgamma
  - GiNaC, [270](#)
- force\_include\_zeta1
  - GiNaC, [271](#)
- forget
  - GiNaC::archive, [315](#)
  - GiNaC::archive\_node, [326](#)
- format\_index\_value
  - GiNaC, [265](#)
- frac\_cancel
  - GiNaC, [214](#)
- fraction\_free\_elimination
  - GiNaC::matrix, [783](#)
- fsolve
  - GiNaC, [148](#)
- func\_arg\_info
  - GiNaC, [131](#)
- FUNCP\_1P
  - GiNaC, [59](#)
- FUNCP\_2P
  - GiNaC, [59](#)
- FUNCP\_CUBA
  - GiNaC, [59](#)
- function
  - GiNaC::function, [623–627](#)
  - GiNaC::function\_options, [672](#)
- function.cpp, [1230](#)
- function.h, [1231](#)
  - DECLARE\_FUNCTION\_10P, [1240](#)
  - DECLARE\_FUNCTION\_11P, [1240](#)
  - DECLARE\_FUNCTION\_12P, [1240](#)
  - DECLARE\_FUNCTION\_13P, [1241](#)
  - DECLARE\_FUNCTION\_14P, [1241](#)
  - DECLARE\_FUNCTION\_1P, [1238](#)
  - DECLARE\_FUNCTION\_2P, [1238](#)
  - DECLARE\_FUNCTION\_3P, [1238](#)
  - DECLARE\_FUNCTION\_4P, [1238](#)
  - DECLARE\_FUNCTION\_5P, [1239](#)
  - DECLARE\_FUNCTION\_6P, [1239](#)
  - DECLARE\_FUNCTION\_7P, [1239](#)
  - DECLARE\_FUNCTION\_8P, [1239](#)
  - DECLARE\_FUNCTION\_9P, [1240](#)
  - is\_ex\_the\_function, [1241](#)
  - REGISTER\_FUNCTION, [1241](#)
- function\_options
  - GiNaC::function\_options, [642, 643](#)
- functions\_with\_same\_name
  - GiNaC::function\_options, [678](#)
- G
  - GiNaC, [149](#)
- G2\_eval
  - GiNaC, [160](#)
- G2\_evalf
  - GiNaC, [160](#)
- G3\_eval
  - GiNaC, [161](#)
- G3\_evalf
  - GiNaC, [160](#)
- gauss
  - GiNaC::determinant\_algo, [461](#)
  - GiNaC::solve\_algo, [1050](#)
- gauss\_elimination
  - GiNaC::matrix, [783](#)
- gcd
  - GiNaC, [210, 230](#)
- gcd\_pf\_mul
  - GiNaC, [209](#)
- gcd\_pf\_pow
  - GiNaC, [209](#)
- gcd\_pf\_pow\_pow
  - GiNaC, [210](#)
- generalised\_Bernoulli\_number
  - GiNaC, [190](#)
- get
  - GiNaC::composition\_generator, [414](#)
  - GiNaC::partition\_generator, [907](#)
  - GiNaC::partition\_with\_zero\_parts\_generator, [910](#)
- get\_all\_dummy\_indices
  - GiNaC, [128](#)
- get\_all\_dummy\_indices\_safely
  - GiNaC, [128](#)
- get\_cache\_size
  - GiNaC::integration\_kernel, [734](#)
- get\_class\_name
  - GiNaC::structure< T, ComparisonPolicy >, [1076](#)
- get\_clifford\_comp
  - GiNaC, [96](#)
- get\_close\_delim
  - GiNaC::container< C >, [445](#)
- get\_commutator\_sign
  - GiNaC::clifford, [389](#)
- get\_default\_flags
  - GiNaC::container< C >, [445](#)
- get\_default\_TeX\_name
  - GiNaC, [250](#)
- get\_dim

- GiNaC::idx, [692](#)
- get\_dim\_uint
  - GiNaC, [89](#)
- get\_domain
  - GiNaC::possymbol, [940](#)
  - GiNaC::realsymbol, [1016](#)
  - GiNaC::symbol, [1124](#)
- get\_dummy\_indices
  - GiNaC::indexed, [710](#)
- get\_ex
  - GiNaC::archive\_node, [325](#)
- get\_factors
  - GiNaC::ncmul, [874](#)
- get\_first\_symbol
  - GiNaC, [201](#)
- get\_free\_indices
  - GiNaC::add, [306](#)
  - GiNaC::basic, [347](#)
  - GiNaC::ex, [557](#)
  - GiNaC::indexed, [708](#)
  - GiNaC::integral, [723](#)
  - GiNaC::mul, [816](#)
  - GiNaC::ncmul, [871](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1084](#)
- get\_id
  - GiNaC::print\_context\_options, [960](#)
  - GiNaC::registered\_class\_options, [1021](#)
- get\_indices
  - GiNaC::indexed, [710](#)
- get\_label
  - GiNaC::wildcard, [1193](#)
- get\_last\_access
  - GiNaC::remember\_table\_entry, [1040](#)
- get\_metric
  - GiNaC::clifford, [388](#), [389](#)
- get\_name
  - GiNaC::function, [635](#)
  - GiNaC::function\_options, [671](#)
  - GiNaC::print\_context\_options, [959](#)
  - GiNaC::registered\_class\_options, [1021](#)
  - GiNaC::symbol, [1125](#)
- get\_node
  - GiNaC::archive, [315](#)
- get\_nparams
  - GiNaC::function\_options, [671](#)
- get\_numerical\_value
  - GiNaC::Ebar\_kernel, [496](#)
  - GiNaC::Eisenstein\_h\_kernel, [505](#)
  - GiNaC::Eisenstein\_kernel, [515](#)
  - GiNaC::ELi\_kernel, [526](#)
  - GiNaC::integration\_kernel, [733](#)
  - GiNaC::Kronecker\_dtau\_kernel, [746](#)
  - GiNaC::Kronecker\_dz\_kernel, [755](#)
  - GiNaC::modular\_form\_kernel, [801](#)
- get\_numerical\_value\_impl
  - GiNaC::integration\_kernel, [735](#)
- get\_open\_delim
  - GiNaC::container< C >, [445](#)
- get\_order
  - GiNaC::lanczos\_coeffs, [757](#)
- get\_parent
  - GiNaC::class\_info< OPT >, [375](#)
- get\_parent\_name
  - GiNaC::print\_context\_options, [959](#)
  - GiNaC::registered\_class\_options, [1021](#)
- get\_point
  - GiNaC::pseries, [999](#)
- get\_pointer
  - GiNaC::ptr< T >, [1009](#)
- get\_print\_context
  - GiNaC, [244](#)
- get\_print\_dispatch\_table
  - GiNaC::registered\_class\_options, [1021](#)
- get\_print\_options
  - GiNaC, [244](#)
- get\_properties
  - GiNaC::archive\_node, [325](#)
- get\_refcount
  - GiNaC::refcounted, [1019](#)
- get\_registered\_functions
  - GiNaC::function, [634](#)
- get\_representation\_label
  - GiNaC, [91](#), [102](#)
  - GiNaC::clifford, [388](#)
  - GiNaC::color, [409](#)
- get\_result
  - GiNaC::remember\_table\_entry, [1040](#)
- get\_serial
  - GiNaC::function, [635](#)
- get\_series\_coeff
  - GiNaC::integration\_kernel, [734](#)
- get\_sign
  - GiNaC::multi\_iterator\_permutation< T >, [845](#)
- get\_struct
  - GiNaC::structure< T, ComparisonPolicy >, [1087](#)
- get\_successful\_hits
  - GiNaC::remember\_table\_entry, [1040](#)
- get\_symbol\_stats
  - GiNaC, [202](#)
- get\_symmetry
  - GiNaC::indexed, [711](#)
- get\_TeX\_name
  - GiNaC::symbol, [1125](#)
- get\_top\_node
  - GiNaC::archive, [314](#)
- get\_type
  - GiNaC::symmetry, [1134](#)
- get\_value
  - GiNaC::idx, [691](#)
- get\_var
  - GiNaC::pseries, [999](#)
- get\_vector
  - GiNaC::basic\_multi\_iterator< T >, [368](#)
- gethash
  - GiNaC::basic, [354](#)
  - GiNaC::ex, [561](#)

## GiNaC, 19

- [\\_ex0](#), 279
- [\\_ex1](#), 280
- [\\_ex10](#), 284
- [\\_ex11](#), 284
- [\\_ex12](#), 284
- [\\_ex120](#), 286
- [\\_ex15](#), 284
- [\\_ex18](#), 285
- [\\_ex1\\_2](#), 280
- [\\_ex1\\_3](#), 280
- [\\_ex1\\_4](#), 279
- [\\_ex2](#), 281
- [\\_ex20](#), 285
- [\\_ex24](#), 285
- [\\_ex25](#), 285
- [\\_ex3](#), 282
- [\\_ex30](#), 286
- [\\_ex4](#), 282
- [\\_ex48](#), 286
- [\\_ex5](#), 282
- [\\_ex6](#), 282
- [\\_ex60](#), 286
- [\\_ex7](#), 283
- [\\_ex8](#), 283
- [\\_ex9](#), 283
- [\\_ex\\_1](#), 277
- [\\_ex\\_10](#), 275
- [\\_ex\\_11](#), 275
- [\\_ex\\_12](#), 274
- [\\_ex\\_120](#), 272
- [\\_ex\\_15](#), 274
- [\\_ex\\_18](#), 274
- [\\_ex\\_1\\_2](#), 278
- [\\_ex\\_1\\_3](#), 278
- [\\_ex\\_1\\_4](#), 278
- [\\_ex\\_2](#), 277
- [\\_ex\\_20](#), 274
- [\\_ex\\_24](#), 273
- [\\_ex\\_25](#), 273
- [\\_ex\\_3](#), 277
- [\\_ex\\_30](#), 273
- [\\_ex\\_4](#), 276
- [\\_ex\\_48](#), 273
- [\\_ex\\_5](#), 276
- [\\_ex\\_6](#), 276
- [\\_ex\\_60](#), 272
- [\\_ex\\_7](#), 276
- [\\_ex\\_8](#), 275
- [\\_ex\\_9](#), 275
- [\\_num0\\_bp](#), 270
- [\\_num0\\_p](#), 279
- [\\_num10\\_p](#), 283
- [\\_num11\\_p](#), 284
- [\\_num120\\_p](#), 286
- [\\_num12\\_p](#), 284
- [\\_num15\\_p](#), 284
- [\\_num18\\_p](#), 285
- [\\_num1\\_2\\_p](#), 280
- [\\_num1\\_3\\_p](#), 280
- [\\_num1\\_4\\_p](#), 279
- [\\_num1\\_p](#), 280
- [\\_num20\\_p](#), 285
- [\\_num24\\_p](#), 285
- [\\_num25\\_p](#), 285
- [\\_num2\\_p](#), 281
- [\\_num30\\_p](#), 286
- [\\_num3\\_p](#), 281
- [\\_num48\\_p](#), 286
- [\\_num4\\_p](#), 282
- [\\_num5\\_p](#), 282
- [\\_num60\\_p](#), 286
- [\\_num6\\_p](#), 282
- [\\_num7\\_p](#), 283
- [\\_num8\\_p](#), 283
- [\\_num9\\_p](#), 283
- [\\_num\\_10\\_p](#), 275
- [\\_num\\_11\\_p](#), 275
- [\\_num\\_120\\_p](#), 272
- [\\_num\\_12\\_p](#), 274
- [\\_num\\_15\\_p](#), 274
- [\\_num\\_18\\_p](#), 274
- [\\_num\\_1\\_2\\_p](#), 278
- [\\_num\\_1\\_3\\_p](#), 278
- [\\_num\\_1\\_4\\_p](#), 278
- [\\_num\\_1\\_p](#), 277
- [\\_num\\_20\\_p](#), 274
- [\\_num\\_24\\_p](#), 273
- [\\_num\\_25\\_p](#), 273
- [\\_num\\_2\\_p](#), 277
- [\\_num\\_30\\_p](#), 273
- [\\_num\\_3\\_p](#), 277
- [\\_num\\_48\\_p](#), 273
- [\\_num\\_4\\_p](#), 276
- [\\_num\\_5\\_p](#), 276
- [\\_num\\_60\\_p](#), 272
- [\\_num\\_6\\_p](#), 276
- [\\_num\\_7\\_p](#), 276
- [\\_num\\_8\\_p](#), 275
- [\\_num\\_9\\_p](#), 275
- [abs](#), 228
- [abs\\_conjugate](#), 136
- [abs\\_eval](#), 135
- [abs\\_evalf](#), 135
- [abs\\_expand](#), 135
- [abs\\_expl\\_derivative](#), 135
- [abs\\_imag\\_part](#), 136
- [abs\\_info](#), 137
- [abs\\_power](#), 136
- [abs\\_print\\_csrc\\_float](#), 136
- [abs\\_print\\_latex](#), 135
- [abs\\_real\\_part](#), 136
- [acos](#), 220
- [acos\\_conjugate](#), 177
- [acos\\_deriv](#), 176
- [acos\\_eval](#), 176

acos\_evalf, 176  
 acosh, 222  
 acosh\_conjugate, 185  
 acosh\_deriv, 185  
 acosh\_eval, 185  
 acosh\_evalf, 185  
 adaptivesimpson, 187  
 add\_symbol, 202  
 algebraic\_match\_mul\_with\_mul, 200  
 antisymmetric2, 253  
 antisymmetric3, 253  
 antisymmetric4, 253  
 antisymmetrize, 112, 254, 258  
 archive\_atom, 58  
 archive\_node\_id, 58  
 are\_ex\_trivially\_equal, 106  
 asin, 220  
 asin\_conjugate, 175  
 asin\_deriv, 175  
 asin\_eval, 175  
 asin\_evalf, 175  
 asin\_info, 176  
 asinh, 222  
 asinh\_conjugate, 184  
 asinh\_deriv, 184  
 asinh\_eval, 184  
 asinh\_evalf, 184  
 atan, 220, 221  
 atan2\_deriv, 179  
 atan2\_eval, 179  
 atan2\_evalf, 178  
 atan2\_info, 179  
 atan\_conjugate, 178  
 atan\_deriv, 177  
 atan\_eval, 177  
 atan\_evalf, 177  
 atan\_info, 178  
 atan\_series, 178  
 atanh, 223  
 atanh\_conjugate, 187  
 atanh\_deriv, 186  
 atanh\_eval, 186  
 atanh\_evalf, 186  
 atanh\_series, 186  
 base\_and\_index, 88  
 bernoulli, 227  
 Bernoulli\_polynomial, 190  
 beta\_deriv, 158  
 beta\_eval, 158  
 beta\_evalf, 157  
 beta\_series, 158  
 binomial, 227  
 binomial\_conjugate, 146  
 binomial\_eval, 145  
 binomial\_evalf, 145  
 binomial\_imag\_part, 146  
 binomial\_real\_part, 146  
 binomial\_sym, 145  
 callback\_registered, 82  
 canonicalize, 253  
 canonicalize\_clifford, 93  
 Catalan, 270  
 CatalanEvalf, 232  
 charpoly, 198  
 class\_info< OPT >::first, 269  
 class\_info< OPT >::parents\_identified, 269  
 clifford\_bar, 99  
 clifford\_inverse, 95  
 clifford\_max\_label, 94  
 clifford\_moebius\_map, 96, 97  
 clifford\_norm, 94  
 clifford\_prime, 93  
 clifford\_star, 99  
 clifford\_star\_bar, 93  
 clifford\_to\_lst, 96  
 clifford\_unit, 89  
 coeff, 109  
 coerce, 217  
 coerce< int, cln::cl\_I >, 217  
 coerce< unsigned int, cln::cl\_I >, 217  
 collect, 110  
 collect\_common\_factors, 214  
 collect\_symbols, 202  
 color\_d, 101  
 color\_f, 101  
 color\_h, 102  
 color\_ONE, 100  
 color\_T, 101  
 color\_trace, 103, 104  
 cols, 198  
 compare\_pointers, 263  
 compile\_ex, 117  
 conjugate, 107  
 conjugate\_conjugate, 130  
 conjugate\_eval, 130  
 conjugate\_evalf, 130  
 conjugate\_expl\_derivative, 130  
 conjugate\_funcp, 60  
 conjugate\_funcp\_1, 61  
 conjugate\_funcp\_10, 73  
 conjugate\_funcp\_11, 74  
 conjugate\_funcp\_12, 75  
 conjugate\_funcp\_13, 77  
 conjugate\_funcp\_14, 78  
 conjugate\_funcp\_2, 62  
 conjugate\_funcp\_3, 63  
 conjugate\_funcp\_4, 65  
 conjugate\_funcp\_5, 66  
 conjugate\_funcp\_6, 67  
 conjugate\_funcp\_7, 69  
 conjugate\_funcp\_8, 70  
 conjugate\_funcp\_9, 71  
 conjugate\_funcp\_exvector, 80  
 conjugate\_imag\_part, 131  
 conjugate\_info, 131  
 conjugate\_print\_latex, 130



conjugate\_real\_part, 131  
conjugateepvector, 119  
convert\_H\_to\_Li, 151  
cos, 219  
cos\_conjugate, 173  
cos\_deriv, 172  
cos\_eval, 172  
cos\_evalf, 172  
cos\_imag\_part, 173  
cos\_real\_part, 172  
cosh, 221  
cosh\_conjugate, 182  
cosh\_deriv, 181  
cosh\_eval, 181  
cosh\_evalf, 181  
cosh\_imag\_part, 182  
cosh\_real\_part, 181  
count\_dummy\_indices, 125  
count\_free\_indices, 125  
crc32, 105  
crctab, 270  
csgn, 233  
csgn\_conjugate, 139  
csgn\_eval, 139  
csgn\_evalf, 138  
csgn\_imag\_part, 139  
csgn\_power, 140  
csgn\_real\_part, 139  
csgn\_series, 139  
csrc, 245  
csrc\_cl\_N, 246  
csrc\_double, 246  
csrc\_float, 246  
cyclic\_permutation, 264  
decomp\_rational, 204  
degree, 108  
delta\_tensor, 259  
denom, 109, 237  
derivative\_funcp, 60  
derivative\_funcp\_1, 61  
derivative\_funcp\_10, 73  
derivative\_funcp\_11, 74  
derivative\_funcp\_12, 76  
derivative\_funcp\_13, 77  
derivative\_funcp\_14, 79  
derivative\_funcp\_2, 63  
derivative\_funcp\_3, 64  
derivative\_funcp\_4, 65  
derivative\_funcp\_5, 66  
derivative\_funcp\_6, 68  
derivative\_funcp\_7, 69  
derivative\_funcp\_8, 70  
derivative\_funcp\_9, 72  
derivative\_funcp\_exvector, 80  
determinant, 198  
dflt, 245  
diag\_matrix, 195, 196  
diff, 111  
Digits, 271  
digits\_changed\_callback, 82  
dirac\_gamma, 90  
dirac\_gamma5, 90  
dirac\_gammaL, 90  
dirac\_gammaR, 91  
dirac\_ONE, 89  
dirac\_slash, 91  
dirac\_trace, 92, 93  
dirichlet\_character, 189  
divide, 206  
divide\_in\_z, 206  
doublefactorial, 226  
dynallocate, 86, 87  
EllipticE\_deriv, 153  
EllipticE\_eval, 153  
EllipticE\_evalf, 153  
EllipticE\_print\_latex, 153  
EllipticE\_series, 153  
EllipticK\_deriv, 152  
EllipticK\_eval, 152  
EllipticK\_evalf, 151  
EllipticK\_print\_latex, 152  
EllipticK\_series, 152  
epp, 59  
epsilon\_tensor, 261  
epvector, 59  
eta\_conjugate, 141  
eta\_eval, 140  
eta\_evalf, 140  
eta\_imag\_part, 141  
eta\_real\_part, 141  
eta\_series, 140  
Euler, 269  
EulerEvalf, 232  
eval, 110  
eval\_funcp, 60  
eval\_funcp\_1, 61  
eval\_funcp\_10, 72  
eval\_funcp\_11, 74  
eval\_funcp\_12, 75  
eval\_funcp\_13, 77  
eval\_funcp\_14, 78  
eval\_funcp\_2, 62  
eval\_funcp\_3, 63  
eval\_funcp\_4, 64  
eval\_funcp\_5, 66  
eval\_funcp\_6, 67  
eval\_funcp\_7, 68  
eval\_funcp\_8, 70  
eval\_funcp\_9, 71  
eval\_funcp\_exvector, 80  
eval\_integ, 111  
evalf, 110, 197  
evalf\_funcp, 60  
evalf\_funcp\_1, 61  
evalf\_funcp\_10, 72  
evalf\_funcp\_11, 74

- evalf\_funcp\_12, 75
- evalf\_funcp\_13, 77
- evalf\_funcp\_14, 78
- evalf\_funcp\_2, 62
- evalf\_funcp\_3, 63
- evalf\_funcp\_4, 65
- evalf\_funcp\_5, 66
- evalf\_funcp\_6, 67
- evalf\_funcp\_7, 68
- evalf\_funcp\_8, 70
- evalf\_funcp\_9, 71
- evalf\_funcp\_exvector, 80
- evalfunctype, 59
- evalm, 110
- ex\_to, 115
- exadd, 237
- exhashmap, 81
- exmap, 59
- exminus, 237
- exmul, 237
- exp, 218
- exp\_conjugate, 167
- exp\_deriv, 167
- exp\_eval, 166
- exp\_evalf, 166
- exp\_expand, 167
- exp\_imag\_part, 167
- exp\_info, 168
- exp\_power, 168
- exp\_real\_part, 167
- expand, 107, 197
- expand\_dummy\_sum, 129
- expand\_funcp, 60
- expand\_funcp\_1, 61
- expand\_funcp\_10, 73
- expand\_funcp\_11, 74
- expand\_funcp\_12, 76
- expand\_funcp\_13, 77
- expand\_funcp\_14, 79
- expand\_funcp\_2, 63
- expand\_funcp\_3, 64
- expand\_funcp\_4, 65
- expand\_funcp\_5, 66
- expand\_funcp\_6, 68
- expand\_funcp\_7, 69
- expand\_funcp\_8, 70
- expand\_funcp\_9, 72
- expand\_funcp\_exvector, 80
- expl\_derivative\_funcp, 60
- expl\_derivative\_funcp\_1, 62
- expl\_derivative\_funcp\_10, 73
- expl\_derivative\_funcp\_11, 74
- expl\_derivative\_funcp\_12, 76
- expl\_derivative\_funcp\_13, 77
- expl\_derivative\_funcp\_14, 79
- expl\_derivative\_funcp\_2, 63
- expl\_derivative\_funcp\_3, 64
- expl\_derivative\_funcp\_4, 65
- expl\_derivative\_funcp\_5, 66
- expl\_derivative\_funcp\_6, 68
- expl\_derivative\_funcp\_7, 69
- expl\_derivative\_funcp\_8, 70
- expl\_derivative\_funcp\_9, 72
- expl\_derivative\_funcp\_exvector, 80
- exprseq, 59
- exset, 58
- exvector, 58
- exvectorvector, 81
- factor, 120
- factorial, 226
- factorial\_conjugate, 144
- factorial\_eval, 144
- factorial\_evalf, 144
- factorial\_imag\_part, 145
- factorial\_print\_dflt\_latex, 144
- factorial\_real\_part, 144
- fibonacci, 227
- find, 108
- find\_common\_factor, 214
- find\_dummy\_indices, 124
- find\_factory\_fcn, 84
- find\_free\_and\_dummy, 123, 124
- find\_variant\_indices, 126
- force\_include\_tgamma, 270
- force\_include\_zeta1, 271
- format\_index\_value, 265
- frac\_cancel, 214
- fsolve, 148
- func\_arg\_info, 131
- FUNCP\_1P, 59
- FUNCP\_2P, 59
- FUNCP\_CUBA, 59
- G, 149
- G2\_eval, 160
- G2\_evalf, 160
- G3\_eval, 161
- G3\_evalf, 160
- gcd, 210, 230
- gcd\_pf\_mul, 209
- gcd\_pf\_pow, 209
- gcd\_pf\_pow\_pow, 210
- generalised\_Bernoulli\_number, 190
- get\_all\_dummy\_indices, 128
- get\_all\_dummy\_indices\_safely, 128
- get\_clifford\_comp, 96
- get\_default\_TeX\_name, 250
- get\_dim\_uint, 89
- get\_first\_symbol, 201
- get\_print\_context, 244
- get\_print\_options, 244
- get\_representation\_label, 91, 102
- get\_symbol\_stats, 202
- GINAC\_BIND\_UNARCHIVER, 82, 87, 88, 99, 100, 105, 121, 122, 125, 188, 190–193, 195, 200, 201, 216, 247, 248, 250, 251, 258, 259, 268, 271

- GINAC\_DECLARE\_UNARCHIVER, [83](#), [97](#), [98](#),  
[104](#), [105](#), [120](#), [121](#), [124](#), [130](#), [188](#), [193–195](#),  
[197](#), [201](#), [232](#), [247](#), [248](#), [250](#), [251](#), [255](#), [262](#),  
[268](#)
- GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT,  
[82](#), [84](#), [87](#), [99](#), [105](#), [119–122](#), [125](#), [187](#), [190–](#)  
[193](#), [195](#), [200](#), [201](#), [215](#), [246](#), [248–251](#), [258](#),  
[267](#)
- golden\_ratio\_hash, [263](#)
- guess\_precision, [224](#)
- H\_deriv, [164](#)
- H\_eval, [164](#)
- H\_evalf, [164](#)
- H\_print\_latex, [164](#)
- H\_series, [164](#)
- has, [108](#)
- hasindex, [128](#)
- haswild, [268](#)
- heur\_gcd, [208](#)
- heur\_gcd\_z, [208](#)
- hold\_ncmul, [201](#)
- I, [271](#)
- idx, [270](#)
- idx\_symmetrization, [127](#)
- ifactor, [188](#)
- imag, [236](#)
- imag\_part, [107](#)
- imag\_part\_conjugate, [134](#)
- imag\_part\_eval, [133](#)
- imag\_part\_evalf, [133](#)
- imag\_part\_expl\_derivative, [134](#)
- imag\_part\_funcp, [60](#)
- imag\_part\_funcp\_1, [61](#)
- imag\_part\_funcp\_10, [73](#)
- imag\_part\_funcp\_11, [74](#)
- imag\_part\_funcp\_12, [76](#)
- imag\_part\_funcp\_13, [77](#)
- imag\_part\_funcp\_14, [79](#)
- imag\_part\_funcp\_2, [62](#)
- imag\_part\_funcp\_3, [64](#)
- imag\_part\_funcp\_4, [65](#)
- imag\_part\_funcp\_5, [66](#)
- imag\_part\_funcp\_6, [67](#)
- imag\_part\_funcp\_7, [69](#)
- imag\_part\_funcp\_8, [70](#)
- imag\_part\_funcp\_9, [71](#)
- imag\_part\_funcp\_exvector, [80](#)
- imag\_part\_imag\_part, [134](#)
- imag\_part\_print\_latex, [134](#)
- imag\_part\_real\_part, [134](#)
- index0, [251](#)
- index1, [252](#)
- index2, [252](#)
- index3, [252](#)
- index\_dimensions, [246](#)
- indices\_consistent, [125](#)
- info\_funcp, [61](#)
- info\_funcp\_1, [62](#)
- info\_funcp\_10, [74](#)
- info\_funcp\_11, [75](#)
- info\_funcp\_12, [76](#)
- info\_funcp\_13, [78](#)
- info\_funcp\_14, [79](#)
- info\_funcp\_2, [63](#)
- info\_funcp\_3, [64](#)
- info\_funcp\_4, [66](#)
- info\_funcp\_5, [67](#)
- info\_funcp\_6, [68](#)
- info\_funcp\_7, [70](#)
- info\_funcp\_8, [71](#)
- info\_funcp\_9, [72](#)
- info\_funcp\_exvector, [81](#)
- interpolate, [207](#)
- inverse, [199](#), [233](#)
- iquo, [230](#)
- irem, [229](#)
- is\_a, [84](#), [115](#), [248](#)
- is\_cinteger, [235](#)
- is\_clifford\_tinfo, [98](#)
- is\_color\_tinfo, [102](#)
- is\_crational, [235](#)
- is\_dirac\_slash, [88](#)
- is\_discriminant\_of\_quadratic\_number\_field, [188](#)
- is\_dummy\_pair, [122](#), [123](#)
- is\_even, [234](#)
- is\_exactly\_a, [85](#), [115](#)
- is\_integer, [234](#)
- is\_negative, [234](#)
- is\_nonneg\_integer, [234](#)
- is\_odd, [235](#)
- is\_order\_function, [151](#)
- is\_polynomial, [108](#)
- is\_pos\_integer, [234](#)
- is\_positive, [234](#)
- is\_prime, [235](#)
- is\_rational, [235](#)
- is\_real, [235](#)
- is\_terminating, [249](#)
- is\_the\_function, [121](#)
- is\_the\_function< G\_SERIAL >, [150](#)
- is\_the\_function< iterated\_integral\_SERIAL >, [151](#)
- is\_the\_function< psi\_SERIAL >, [150](#)
- is\_the\_function< zeta\_SERIAL >, [149](#)
- is\_zero, [114](#), [233](#)
- isqrt, [231](#)
- iterated\_integral, [150](#), [151](#)
- iterated\_integral2\_eval, [154](#)
- iterated\_integral2\_evalf, [154](#)
- iterated\_integral3\_eval, [155](#)
- iterated\_integral3\_evalf, [154](#)
- iterated\_integral\_evalf\_impl, [154](#)
- kronecker\_symbol, [189](#)
- latex, [245](#)
- lcm, [211](#), [231](#)
- lcm\_of\_coefficients\_denominators, [203](#)
- lcmcoeff, [202](#)

- ldegree, 108
- lgamma, 224, 225
- lgamma\_conjugate, 156
- lgamma\_deriv, 155
- lgamma\_eval, 155
- lgamma\_evalf, 155
- lgamma\_series, 156
- lhs, 113
- Li2, 224
- Li2\_, 223
- Li2\_conjugate, 142
- Li2\_deriv, 142
- Li2\_eval, 142
- Li2\_evalf, 141
- Li2\_projection, 223
- Li2\_series, 142, 223
- Li3\_eval, 143
- Li\_deriv, 162
- Li\_eval, 161
- Li\_evalf, 161
- Li\_print\_latex, 162
- Li\_series, 161
- library\_initializer, 270
- link\_ex, 118
- log, 218
- log2, 263
- log\_conjugate, 170
- log\_deriv, 169
- log\_eval, 168
- log\_evalf, 168
- log\_expand, 169
- log\_imag\_part, 169
- log\_info, 170
- log\_real\_part, 169
- log\_series, 169
- lookup\_map, 81
- lorentz\_eps, 261
- lorentz\_g, 260
- lsolve, 148
- lst, 81
- lst\_to\_clifford, 95
- lst\_to\_matrix, 195
- make\_hash\_seed, 121
- make\_real\_float, 215
- make\_return\_type\_t, 249
- map\_eval\_integ, 269
- map\_evalm, 268
- match, 111
- metric\_tensor, 259
- minimal\_dim, 123
- mod, 228
- multinomial\_coefficient, 263
- multiply\_lcm, 203
- my\_ios\_callback, 243
- my\_ios\_index, 243
- next\_print\_context\_id, 271
- no\_index\_dimensions, 246
- nops, 107, 197
- normal, 109
- not\_symmetric, 252
- number\_of\_type, 125
- numer, 109, 236
- numer\_denom, 109
- op, 113
- operator!=, 242
- operator<, 243
- operator<<, 83, 106, 232, 244, 265–267
- operator<=, 243
- operator>, 243
- operator>>, 83, 84, 245
- operator>=, 243
- operator+, 237, 238, 240
- operator++, 241, 242
- operator+=", 239
- operator-, 238, 240
- operator--, 241, 242
- operator-=, 239, 240
- operator/, 238, 239
- operator/=", 239, 240
- operator==, 242
- operator\*, 238
- operator\*=", 239, 240
- Order\_conjugate, 147
- Order\_eval, 146
- Order\_expl\_derivative, 147
- Order\_imag\_part, 147
- Order\_power, 147
- Order\_real\_part, 147
- Order\_series, 147
- paramset, 60
- permutation\_sign, 264
- permute\_free\_index\_to\_front, 100
- Pi, 269
- PiEvalf, 232
- pow, 232, 247
- power\_funcp, 60
- power\_funcp\_1, 62
- power\_funcp\_10, 73
- power\_funcp\_11, 75
- power\_funcp\_12, 76
- power\_funcp\_13, 78
- power\_funcp\_14, 79
- power\_funcp\_2, 63
- power\_funcp\_3, 64
- power\_funcp\_4, 65
- power\_funcp\_5, 67
- power\_funcp\_6, 68
- power\_funcp\_7, 69
- power\_funcp\_8, 71
- power\_funcp\_9, 72
- power\_funcp\_exvector, 80
- prem, 205
- primitive\_dirichlet\_character, 189
- print\_context\_class\_info, 82
- print\_func< print\_context >, 122
- print\_func< print\_dfft >, 87, 99, 258

print\_funcp, 61  
print\_funcp\_1, 62  
print\_funcp\_10, 73  
print\_funcp\_11, 75  
print\_funcp\_12, 76  
print\_funcp\_13, 78  
print\_funcp\_14, 79  
print\_funcp\_2, 63  
print\_funcp\_3, 64  
print\_funcp\_4, 65  
print\_funcp\_5, 67  
print\_funcp\_6, 68  
print\_funcp\_7, 69  
print\_funcp\_8, 71  
print\_funcp\_9, 72  
print\_funcp\_exvector, 81  
print\_integer\_csrc, 216  
print\_operator, 250  
print\_real\_cl\_N, 218  
print\_real\_csrc, 217  
print\_real\_number, 216  
print\_sym\_pow, 247  
product\_to\_exvector, 127  
psi, 150, 225  
psi1\_deriv, 159  
psi1\_eval, 159  
psi1\_evalf, 158  
psi1\_series, 159  
psi2\_deriv, 160  
psi2\_eval, 159  
psi2\_evalf, 159  
psi2\_series, 160  
python, 245  
python\_repr, 245  
quo, 203  
rank, 199  
read\_real\_float, 215  
read\_unsigned, 83  
real, 236  
real\_part, 107  
real\_part\_conjugate, 132  
real\_part\_eval, 132  
real\_part\_evalf, 132  
real\_part\_expl\_derivative, 133  
real\_part\_funcp, 60  
real\_part\_funcp\_1, 61  
real\_part\_funcp\_10, 73  
real\_part\_funcp\_11, 74  
real\_part\_funcp\_12, 75  
real\_part\_funcp\_13, 77  
real\_part\_funcp\_14, 78  
real\_part\_funcp\_2, 62  
real\_part\_funcp\_3, 64  
real\_part\_funcp\_4, 65  
real\_part\_funcp\_5, 66  
real\_part\_funcp\_6, 67  
real\_part\_funcp\_7, 69  
real\_part\_funcp\_8, 70  
real\_part\_funcp\_9, 71  
real\_part\_funcp\_exvector, 80  
real\_part\_imag\_part, 133  
real\_part\_print\_latex, 132  
real\_part\_real\_part, 132  
reduced\_matrix, 196  
reeval\_ncmul, 201  
REGISTER\_FUNCTION, 131, 133, 134, 137, 138,  
140–143, 145, 146, 148, 152, 154, 156–158,  
162, 163, 165, 168, 170, 172, 173, 175–179,  
181, 182, 184–187  
registered\_class\_info, 82  
rem, 204  
remove\_dirac\_ONE, 94  
rename\_dummy\_indices, 126  
rename\_dummy\_indices\_uniquely, 128, 129  
replace\_with\_symbol, 213  
reposition\_dummy\_indices, 126  
resultant, 215  
rhs, 113  
rotate\_left, 263  
rows, 198  
S\_deriv, 163  
S\_eval, 162  
S\_evalf, 162  
S\_print\_latex, 163  
S\_series, 163  
series, 111  
series\_funcp, 61  
series\_funcp\_1, 62  
series\_funcp\_10, 73  
series\_funcp\_11, 75  
series\_funcp\_12, 76  
series\_funcp\_13, 78  
series\_funcp\_14, 79  
series\_funcp\_2, 63  
series\_funcp\_3, 64  
series\_funcp\_4, 65  
series\_funcp\_5, 67  
series\_funcp\_6, 68  
series\_funcp\_7, 69  
series\_funcp\_8, 71  
series\_funcp\_9, 72  
series\_funcp\_exvector, 80  
series\_to\_poly, 248  
set\_print\_context, 244  
set\_print\_func, 249  
set\_print\_options, 244  
shaker\_sort, 264  
simplify\_indexed, 111, 112, 127  
simplify\_indexed\_product, 127  
sin, 219  
sin\_conjugate, 171  
sin\_deriv, 171  
sin\_eval, 170  
sin\_evalf, 170  
sin\_imag\_part, 171  
sin\_real\_part, 171

- sinh, 221
- sinh\_conjugate, 180
- sinh\_deriv, 180
- sinh\_eval, 180
- sinh\_evalf, 179
- sinh\_imag\_part, 180
- sinh\_real\_part, 180
- smod, 228
- spinor\_metric, 260
- spmap, 81
- sprem, 205
- sqrfree, 211
- sqrfree\_parfrac, 212
- sqrfree\_yun, 211
- sqrt, 231, 248
- sr\_gcd, 207
- step, 233
- step\_conjugate, 138
- step\_eval, 137
- step\_evalf, 137
- step\_imag\_part, 138
- step\_real\_part, 138
- step\_series, 137
- structure< T, CP >::reg\_info, 272
- sub\_matrix, 197
- subs, 114
- subsvalue, 187
- swap, 114, 119
- sy\_anti, 256, 257
- sy\_cycl, 257
- sy\_none, 255
- sy\_symm, 255, 256
- sym\_desc\_vec, 81
- symbolic\_matrix, 196, 199
- symm, 254
- symmetric2, 252
- symmetric3, 252
- symmetric4, 253
- symmetrize, 112, 254, 257
- symmetrize\_cyclic, 113, 254, 258
- synthesize\_func, 58
- tan, 219
- tan\_conjugate, 174
- tan\_deriv, 174
- tan\_eval, 173
- tan\_evalf, 173
- tan\_imag\_part, 174
- tan\_real\_part, 174
- tan\_series, 174
- tanh, 222
- tanh\_conjugate, 183
- tanh\_deriv, 183
- tanh\_eval, 182
- tanh\_evalf, 182
- tanh\_imag\_part, 183
- tanh\_real\_part, 183
- tanh\_series, 183
- tensor, 269
- tgamma, 225
- tgamma\_conjugate, 157
- tgamma\_deriv, 157
- tgamma\_eval, 156
- tgamma\_evalf, 156
- tgamma\_series, 157
- to\_double, 236
- to\_int, 236
- to\_long, 236
- to\_polynomial, 110
- to\_rational, 110
- trace, 198
- trace\_string, 92
- transpose, 198
- tree, 245
- trig\_info, 171
- tryfactsubs, 200
- uintvector, 81
- unarch\_table\_instance, 268
- unarchive\_map\_t, 58
- unit\_matrix, 196, 199
- unlink\_ex, 119
- unsignedvector, 81
- version\_major, 272
- version\_micro, 272
- version\_minor, 272
- wild, 268
- write\_real\_float, 216
- write\_unsigned, 83
- zeta, 149, 224
- zeta1\_deriv, 165
- zeta1\_eval, 165
- zeta1\_evalf, 165
- zeta1\_print\_latex, 165
- zeta2\_deriv, 166
- zeta2\_eval, 166
- zeta2\_evalf, 166
- zeta2\_print\_latex, 166
- zetaderiv\_deriv, 143
- zetaderiv\_eval, 143
- ginac.h, 1242
- GiNaC::numeric\_digits, 291
- \_numeric\_digits, 292
- add\_callback, 292
- callbacklist, 293
- digits, 293
- operator long, 292
- operator=, 292
- print, 292
- too\_late, 293
- GiNaC::add, 294
- add, 300, 301
- coeff, 302
- combine\_ex\_with\_coeff\_to\_pair, 307
- combine\_pair\_with\_coeff\_to\_pair, 308
- conjugate, 305
- degree, 302
- derivative, 306

- do\_print, 309
- do\_print\_csrc, 309
- do\_print\_latex, 309
- do\_print\_python\_repr, 309
- eval, 303
- eval\_ncmul, 306
- evalm, 303
- expand, 308
- get\_free\_indices, 306
- imag\_part, 305
- info, 301
- integer\_content, 304
- is\_polynomial, 302
- ldegree, 302
- max\_coefficient, 305
- mul, 310
- normal, 304
- power, 310
- precedence, 301
- print\_add, 308
- real\_part, 305
- recombine\_pair\_to\_ex, 308
- return\_type, 306
- return\_type\_tinfo, 306
- series, 303
- smod, 304
- split\_ex\_to\_pair, 307
- thisexpairseq, 307
- GiNaC::archive, 310
  - ~archive, 312
  - add\_node, 315
  - archive, 312
  - archive\_ex, 313
  - atomize, 315
  - atoms, 317
  - clear, 314
  - exprs, 317
  - exprtable, 317
  - forget, 315
  - get\_node, 315
  - get\_top\_node, 314
  - inv\_at\_cit, 312
  - inverse\_atoms, 317
  - nodes, 317
  - num\_expressions, 314
  - operator<<, 316
  - operator>>, 316
  - printraw, 315
  - unarchive\_ex, 313, 314
  - unatomize, 316
- GiNaC::archive::archived\_ex, 329
  - archived\_ex, 329
  - name, 330
  - root, 330
- GiNaC::archive\_node, 318
  - a, 327
  - add\_bool, 321
  - add\_ex, 322
  - add\_string, 322
  - add\_unsigned, 321
  - archive\_node, 321
  - archive\_node\_cit, 320
  - e, 327
  - find\_bool, 322
  - find\_ex, 324
  - find\_ex\_by\_loc, 324
  - find\_ex\_node, 324
  - find\_first, 323
  - find\_last, 323
  - find\_property\_range, 323
  - find\_string, 323
  - find\_unsigned, 322
  - forget, 326
  - get\_ex, 325
  - get\_properties, 325
  - has\_ex, 325
  - has\_expression, 327
  - has\_same\_ex\_as, 325
  - operator<<, 326
  - operator>>, 326
  - operator=, 321
  - printraw, 326
  - property\_type, 320
  - propinfovector, 320
  - props, 327
  - PTYPE\_BOOL, 320
  - PTYPE\_NODE, 320
  - PTYPE\_STRING, 320
  - PTYPE\_UNSIGNED, 320
  - unarchive, 325
- GiNaC::archive\_node::archive\_node\_cit\_range, 328
  - begin, 328
  - end, 328
- GiNaC::archive\_node::property, 985
  - name, 986
  - property, 985
  - type, 986
  - value, 986
- GiNaC::archive\_node::property\_info, 986
  - count, 988
  - name, 987
  - property\_info, 987
  - type, 987
- GiNaC::basic, 330
  - ~basic, 335
  - accept, 342
  - add\_indexed, 347
  - archive, 352
  - basic, 335
  - calchash, 351
  - clearflag, 355
  - coeff, 343
  - collect, 344
  - compare, 353
  - compare\_same\_type, 350
  - conjugate, 349

- contract\_with, 348
- dbgprint, 338
- dbgprinttree, 338
- degree, 343
- derivative, 344
- diff, 353
- do\_print, 356
- do\_print\_python\_repr, 356
- do\_print\_tree, 356
- duplicate, 336
- ensure\_if\_modifiable, 355
- eval, 336
- eval\_indexed, 337
- eval\_integ, 337
- eval\_ncmul, 337
- evalf, 336
- evalm, 336
- ex, 357
- expand, 344
- flags, 358
- get\_free\_indices, 347
- gethash, 354
- has, 341
- hashvalue, 358
- hold, 354
- imag\_part, 350
- info, 339
- integer\_content, 346
- is\_equal, 353
- is\_equal\_same\_type, 350
- is\_polynomial, 343
- ldegree, 343
- let\_op, 340
- map, 342
- match, 341
- match\_same\_type, 341
- max\_coefficient, 347
- nops, 339
- normal, 345
- op, 339
- operator=, 336
- operator[], 340, 341
- precedence, 338
- print, 337
- print\_dispatch, 351
- read\_archive, 352
- real\_part, 350
- return\_type, 349
- return\_type\_tinfo, 349
- scalar\_mul\_indexed, 348
- series, 345
- setflag, 355
- smod, 346
- subs, 342
- subs\_one\_level, 352
- to\_polynomial, 346
- to\_rational, 346
- GiNaC::basic\_log\_kernel, 359
- do\_print, 364
- series\_coeff\_impl, 364
- GiNaC::basic\_multi\_iterator< T >, 364
  - ~basic\_multi\_iterator, 367
  - B, 370
  - basic\_multi\_iterator, 366, 367
  - flag\_overflow, 370
  - get\_vector, 368
  - init, 369
  - N, 370
  - operator<<, 369
  - operator(), 368
  - operator++, 369
  - operator[], 368
  - overflow, 367
  - size, 367
  - v, 370
- GiNaC::basic\_partition\_generator, 371
  - basic\_partition\_generator, 372
  - mpgen, 373
- GiNaC::basic\_partition\_generator::mpartition2, 803
  - m, 803
  - mpartition2, 803
  - n, 803
  - next\_partition, 803
  - x, 803
- GiNaC::class\_info< OPT >, 373
  - class\_info, 374
  - dump\_hierarchy, 375
  - dump\_tree, 375
  - find, 375
  - first, 376
  - get\_parent, 375
  - identify\_parents, 375
  - next, 376
  - options, 376
  - parent, 376
  - parents\_identified, 376
- GiNaC::class\_info< OPT >::tree\_node, 1168
  - add\_child, 1169
  - children, 1169
  - info, 1169
  - tree\_node, 1169
- GiNaC::clifford, 377
  - archive, 386
  - clifford, 385, 386
  - commutator\_sign, 391
  - do\_print\_dflt, 390
  - do\_print\_latex, 390
  - do\_print\_tree, 391
  - eval\_ncmul, 387
  - get\_commutator\_sign, 389
  - get\_metric, 388, 389
  - get\_representation\_label, 388
  - let\_op, 390
  - match\_same\_type, 387
  - metric, 391
  - nops, 389



- op, 389
- precedence, 386
- read\_archive, 386
- representation\_label, 391
- return\_type, 388
- return\_type\_tinfo, 388
- same\_metric, 389
- subs, 390
- thiscontainer, 387, 388
- GiNaC::cliffordunit, 392
  - contract\_with, 397
  - do\_print, 397
  - do\_print\_latex, 397
- GiNaC::color, 397
  - archive, 407
  - color, 406
  - eval\_ncmul, 407
  - get\_representation\_label, 409
  - match\_same\_type, 407
  - read\_archive, 407
  - representation\_label, 409
  - return\_type, 408
  - return\_type\_tinfo, 408
  - thiscontainer, 408
- GiNaC::compare\_all\_equal< T >, 409
  - ~compare\_all\_equal, 410
  - struct\_compare, 410
  - struct\_is\_equal, 410
- GiNaC::compare\_bitwise< T >, 410
  - ~compare\_bitwise, 411
  - struct\_compare, 411
  - struct\_is\_equal, 411
- GiNaC::compare\_std\_less< T >, 411
  - ~compare\_std\_less, 412
  - struct\_compare, 412
  - struct\_is\_equal, 412
- GiNaC::composition\_generator, 413
  - atend, 414
  - cmgen, 414
  - composition, 415
  - composition\_generator, 414
  - current\_updated, 415
  - get, 414
  - next, 414
  - trivial, 414
- GiNaC::composition\_generator::coolmulti, 457
  - ~coolmulti, 457
  - after\_i, 458
  - coolmulti, 457
  - finished, 458
  - head, 458
  - i, 458
  - next\_permutation, 458
- GiNaC::composition\_generator::coolmulti::element, 517
  - ~element, 518
  - element, 518
  - next, 518
  - value, 518
- GiNaC::const\_iterator, 415
  - const\_iterator, 417
  - const\_postorder\_iterator, 420
  - const\_preorder\_iterator, 420
  - difference\_type, 417
  - e, 421
  - ex, 420
  - i, 421
  - iterator\_category, 416
  - operator!=, 419
  - operator<, 419
  - operator<=, 419
  - operator>, 419
  - operator>=, 419
  - operator+, 418, 420
  - operator++, 418
  - operator+=, 418
  - operator-, 419, 420
  - operator->, 417
  - operator--, 418
  - operator-=, 418
  - operator==, 419
  - operator[], 417
  - operator\*, 417
  - pointer, 417
  - reference, 417
  - value\_type, 416
- GiNaC::const\_postorder\_iterator, 421
  - const\_postorder\_iterator, 422
  - descend, 423
  - difference\_type, 422
  - increment, 423
  - iterator\_category, 422
  - operator!=, 423
  - operator++, 423
  - operator->, 423
  - operator==, 423
  - operator\*, 423
  - pointer, 422
  - reference, 422
  - s, 424
  - value\_type, 422
- GiNaC::const\_preorder\_iterator, 424
  - const\_preorder\_iterator, 425
  - difference\_type, 425
  - increment, 426
  - iterator\_category, 425
  - operator!=, 426
  - operator++, 426
  - operator->, 426
  - operator==, 426
  - operator\*, 426
  - pointer, 425
  - reference, 425
  - s, 427
  - value\_type, 425
- GiNaC::constant, 427
  - archive, 434

- calchash, 435
- conjugate, 433
- constant, 432
- derivative, 434
- do\_print, 435
- do\_print\_latex, 436
- do\_print\_python\_repr, 436
- do\_print\_tree, 435
- domain, 437
- ef, 436
- evalf, 433
- imag\_part, 434
- info, 433
- is\_equal\_same\_type, 435
- is\_polynomial, 433
- name, 436
- next\_serial, 437
- number, 437
- read\_archive, 434
- real\_part, 433
- serial, 437
- TeX\_name, 436
- GiNaC::container< C >, 438
  - append, 450
  - archive, 447
  - begin, 451
  - conjugate, 447
  - const\_iterator, 444
  - const\_reverse\_iterator, 444
  - container, 444
  - do\_print, 452
  - do\_print\_python, 452
  - do\_print\_python\_repr, 452
  - do\_print\_tree, 452
  - end, 451
  - get\_close\_delim, 445
  - get\_default\_flags, 445
  - get\_open\_delim, 445
  - imag\_part, 448
  - info, 445
  - is\_equal\_same\_type, 448
  - let\_op, 446
  - nops, 445
  - op, 446
  - precedence, 445
  - prepend, 450
  - printseq, 449
  - rbegin, 452
  - read\_archive, 447
  - real\_part, 448
  - remove\_all, 451
  - remove\_first, 450
  - remove\_last, 450
  - rend, 452
  - sort, 451
  - sort\_, 449
  - STLT, 444
  - subs, 446
  - subschildren, 453
  - thiscontainer, 448, 449
  - unique, 451
  - unique\_, 450, 453
- GiNaC::container\_storage< C >, 453
  - ~container\_storage, 455
  - container\_storage, 454, 455
  - reserve, 455
  - seq, 456
  - STLT, 454
- GiNaC::derivative\_map\_function, 459
  - derivative\_map\_function, 460
  - operator(), 460
  - s, 460
- GiNaC::determinant\_algo, 461
  - automatic, 461
  - bareiss, 461
  - divfree, 461
  - gauss, 461
  - laplace, 461
- GiNaC::diracgamma, 462
  - contract\_with, 467
  - do\_print, 467
  - do\_print\_latex, 467
- GiNaC::diracgamma5, 468
  - conjugate, 472
  - do\_print, 472
  - do\_print\_latex, 472
- GiNaC::diracgammaL, 473
  - conjugate, 477
  - do\_print, 477
  - do\_print\_latex, 477
- GiNaC::diracgammaR, 478
  - conjugate, 482
  - do\_print, 482
  - do\_print\_latex, 482
- GiNaC::diracone, 483
  - do\_print, 487
  - do\_print\_latex, 487
- GiNaC::do\_taylor, 488
- GiNaC::domain, 488
  - complex, 488
  - positive, 488
  - real, 488
- GiNaC::dunno, 489
- GiNaC::Ebar\_kernel, 489
  - do\_print, 496
  - Ebar\_kernel, 495
  - get\_numerical\_value, 496
  - is\_numeric, 495
  - let\_op, 495
  - m, 497
  - n, 497
  - nops, 495
  - op, 495
  - series\_coeff\_impl, 496
  - x, 497
  - y, 497

- GiNaC::Eisenstein\_h\_kernel, [497](#)
  - C\_norm, [507](#)
  - coefficient\_a0, [506](#)
  - coefficient\_an, [506](#)
  - do\_print, [506](#)
  - Eisenstein\_h\_kernel, [504](#)
  - get\_numerical\_value, [505](#)
  - is\_numeric, [505](#)
  - k, [507](#)
  - Laurent\_series, [505](#)
  - let\_op, [504](#)
  - N, [507](#)
  - nops, [504](#)
  - op, [504](#)
  - q\_expansion\_modular\_form, [506](#)
  - r, [507](#)
  - s, [507](#)
  - series, [504](#)
  - uses\_Laurent\_series, [505](#)
- GiNaC::Eisenstein\_kernel, [508](#)
  - a, [517](#)
  - b, [517](#)
  - C\_norm, [517](#)
  - do\_print, [516](#)
  - Eisenstein\_kernel, [514](#)
  - get\_numerical\_value, [515](#)
  - is\_numeric, [515](#)
  - K, [517](#)
  - k, [516](#)
  - Laurent\_series, [515](#)
  - let\_op, [515](#)
  - N, [516](#)
  - nops, [514](#)
  - op, [515](#)
  - q\_expansion\_modular\_form, [516](#)
  - series, [514](#)
  - uses\_Laurent\_series, [516](#)
- GiNaC::ELi\_kernel, [519](#)
  - do\_print, [526](#)
  - ELi\_kernel, [525](#)
  - get\_numerical\_value, [526](#)
  - is\_numeric, [525](#)
  - let\_op, [525](#)
  - m, [526](#)
  - n, [526](#)
  - nops, [525](#)
  - op, [525](#)
  - series\_coeff\_impl, [526](#)
  - x, [527](#)
  - y, [527](#)
- GiNaC::error\_and\_integral, [528](#)
  - error, [529](#)
  - error\_and\_integral, [528](#)
  - integral, [529](#)
- GiNaC::error\_and\_integral\_is\_less, [529](#)
  - operator(), [529](#)
- GiNaC::eval\_integ\_map\_function, [530](#)
  - operator(), [531](#)
- GiNaC::evalf\_map\_function, [531](#)
  - operator(), [532](#)
- GiNaC::evalm\_map\_function, [533](#)
  - operator(), [534](#)
- GiNaC::ex, [534](#)
  - accept, [548](#)
  - antisymmetrize, [560](#)
  - archive\_node, [564](#)
  - are\_ex\_trivially\_equal, [564](#)
  - begin, [540](#)
  - bp, [566](#)
  - coeff, [549](#)
  - collect, [550](#)
  - compare, [558](#)
  - conjugate, [545](#)
  - construct\_from\_basic, [561](#)
  - construct\_from\_double, [563](#)
  - construct\_from\_int, [561](#)
  - construct\_from\_long, [562](#)
  - construct\_from\_longlong, [562](#)
  - construct\_from\_string\_and\_lst, [563](#)
  - construct\_from\_uint, [562](#)
  - construct\_from\_ulong, [562](#)
  - construct\_from\_ulonglong, [563](#)
  - content, [554](#)
  - dbgprint, [542](#)
  - dbgprinttree, [542](#)
  - degree, [549](#)
  - denom, [553](#)
  - diff, [550](#)
  - end, [540](#)
  - eval, [541](#)
  - eval\_integ, [541](#)
  - eval\_ncmul, [541](#)
  - evalf, [541](#)
  - evalm, [541](#)
  - ex, [538](#), [539](#)
  - ex\_to, [564](#)
  - expand, [550](#)
  - find, [546](#)
  - get\_free\_indices, [557](#)
  - gethash, [561](#)
  - has, [546](#)
  - imag\_part, [546](#)
  - info, [542](#)
  - integer\_content, [555](#)
  - is\_a, [565](#)
  - is\_equal, [558](#)
  - is\_exactly\_a, [565](#)
  - is\_polynomial, [549](#)
  - is\_zero, [559](#)
  - is\_zero\_matrix, [559](#)
  - lcoeff, [549](#)
  - ldegree, [549](#)
  - let\_op, [544](#)
  - lhs, [545](#)
  - makewritable, [563](#)
  - map, [547](#), [548](#)

- match, 546
- max\_coefficient, 557
- nops, 543
- normal, 551
- numer, 552
- numer\_denom, 553
- op, 543
- operator[], 544, 545
- postorder\_begin, 541
- postorder\_end, 541
- preorder\_begin, 540
- preorder\_end, 540
- primpart, 555
- print, 542
- real\_part, 545
- return\_type, 561
- return\_type\_tinfo, 561
- rhs, 545
- series, 551
- share, 563
- simplify\_indexed, 557, 558
- smod, 556
- subs, 547
- swap, 540
- symmetrize, 559, 560
- symmetrize\_cyclic, 560
- tcoeff, 550
- to\_polynomial, 552
- to\_rational, 552
- traverse, 548
- traverse\_postorder, 548
- traverse\_preorder, 548
- unit, 554
- unitcontprim, 556
- GiNaC::ex\_base\_is\_less, 566
- operator(), 566
- GiNaC::ex\_is\_equal, 566
- operator(), 567
- GiNaC::ex\_is\_less, 567
- operator(), 567
- GiNaC::ex\_swap, 567
- operator(), 568
- GiNaC::expair, 568
- coeff, 571
- compare, 570
- conjugate, 571
- expair, 569
- is\_canonical\_numeric, 570
- is\_equal, 570
- is\_less, 570
- print, 570
- rest, 571
- swap, 570
- GiNaC::expair\_is\_less, 572
- operator(), 572
- GiNaC::expair\_rest\_is\_less, 572
- operator(), 573
- GiNaC::expair\_swap, 573
- operator(), 573
- GiNaC::expairseq, 574
- archive, 583
- calchash, 584
- can\_make\_flat, 587
- canonicalize, 589
- combine\_ex\_with\_coeff\_to\_pair, 586
- combine\_overall\_coeff, 587
- combine\_pair\_with\_coeff\_to\_pair, 586
- combine\_same\_terms\_sorted\_seq, 590
- conjugate, 582
- construct\_from\_2\_ex, 588
- construct\_from\_2\_expairseq, 588
- construct\_from\_epvector, 589
- construct\_from\_expairseq\_ex, 588
- construct\_from\_exvector, 588
- default\_overall\_coeff, 587
- do\_print, 587
- do\_print\_tree, 588
- eval, 581
- evalchildren, 590
- expair\_needs\_further\_processing, 586
- expairseq, 579, 580
- expand, 584
- expandchildren, 590
- info, 580
- is\_canonical, 590
- is\_equal\_same\_type, 583
- make\_flat, 589
- map, 581
- match, 582
- nops, 580
- op, 581
- overall\_coeff, 591
- precedence, 580
- printpair, 585
- printseq, 585
- read\_archive, 583
- recombine\_pair\_to\_ex, 586
- return\_type, 584
- seq, 591
- split\_ex\_to\_pair, 585
- subs, 582
- subschilren, 591
- thisexpairseq, 584, 585
- to\_polynomial, 582
- to\_rational, 581
- GiNaC::expand\_map\_function, 592
- expand\_map\_function, 593
- operator(), 594
- options, 594
- GiNaC::expand\_options, 594
- expand\_function\_args, 595
- expand\_indexed, 595
- expand\_rename\_idx, 595
- expand\_transcendental, 595
- GiNaC::factor\_options, 595
- all, 595

- polynomial, 595
- GiNaC::fail, 596
  - do\_print, 600
  - return\_type, 600
- GiNaC::fderivative, 600
  - archive, 611
  - derivative, 612
  - derivatives, 613
  - do\_print, 613
  - do\_print\_csrc, 614
  - do\_print\_latex, 613
  - do\_print\_tree, 614
  - eval, 610
  - fderivative, 609, 610
  - is\_equal\_same\_type, 612
  - match\_same\_type, 612
  - parameter\_set, 614
  - print, 610
  - read\_archive, 611
  - series, 610
  - thiscontainer, 611
- GiNaC::function, 615
  - archive, 631
  - calchash, 629
  - conjugate, 630
  - current\_serial, 635
  - derivative, 631
  - eval, 628
  - eval\_ncmul, 629
  - evalf, 628
  - expand, 628
  - expl\_derivative, 633
  - find\_function, 634
  - function, 623–627
  - get\_name, 635
  - get\_registered\_functions, 634
  - get\_serial, 635
  - imag\_part, 630
  - info, 631
  - is\_equal\_same\_type, 632
  - lookup\_remember\_table, 633
  - match\_same\_type, 632
  - pderivative, 633
  - power, 634
  - precedence, 628
  - print, 627
  - read\_archive, 631
  - real\_part, 630
  - register\_new, 634
  - registered\_functions, 633
  - remember\_table\_entry, 635
  - return\_type, 632
  - return\_type\_tinfo, 633
  - serial, 635
  - series, 629
  - store\_remember\_table, 634
  - thiscontainer, 629, 630
- GiNaC::function\_options, 636
  - ~function\_options, 643
  - conjugate\_f, 673
  - conjugate\_func, 648–650, 666
  - conjugate\_use\_exvector\_args, 676
  - derivative\_f, 674
  - derivative\_func, 656–658, 667
  - derivative\_use\_exvector\_args, 677
  - do\_not\_evalf\_params, 670
  - dummy, 643
  - eval\_f, 673
  - eval\_func, 644–646, 666
  - eval\_use\_exvector\_args, 676
  - evalf\_f, 673
  - evalf\_func, 646–648, 666
  - evalf\_params\_first, 675
  - evalf\_use\_exvector\_args, 676
  - expand\_f, 674
  - expand\_func, 654–656, 667
  - expand\_use\_exvector\_args, 677
  - expl\_derivative\_f, 674
  - expl\_derivative\_func, 658–660, 667
  - expl\_derivative\_use\_exvector\_args, 677
  - fderivative, 672
  - function, 672
  - function\_options, 642, 643
  - functions\_with\_same\_name, 678
  - get\_name, 671
  - get\_nparams, 671
  - has\_derivative, 671
  - has\_power, 671
  - imag\_part\_f, 674
  - imag\_part\_func, 652–654, 667
  - imag\_part\_use\_exvector\_args, 677
  - info\_f, 675
  - info\_func, 664–667
  - info\_use\_exvector\_args, 677
  - initialize, 643
  - latex\_name, 644
  - name, 673
  - nparams, 673
  - overloaded, 671
  - power\_f, 674
  - power\_func, 660–662, 667
  - power\_use\_exvector\_args, 677
  - print\_dispatch\_table, 675
  - print\_func, 668–670
  - print\_use\_exvector\_args, 677
  - real\_part\_f, 674
  - real\_part\_func, 650–652, 666
  - real\_part\_use\_exvector\_args, 676
  - remember, 670
  - remember\_assoc\_size, 676
  - remember\_size, 676
  - remember\_strategy, 676
  - return\_type, 675
  - return\_type\_tinfo, 675
  - series\_f, 675
  - series\_func, 662–664, 667

- series\_use\_exvector\_args, 677
- set\_name, 644
- set\_print\_func, 672
- set\_return\_type, 670
- set\_symmetry, 671
- symtree, 678
- test\_and\_set\_nparams, 671
- TeX\_name, 673
- use\_remember, 676
- use\_return\_type, 675
- GiNaC::G2\_SERIAL, 678
  - serial, 678
- GiNaC::G3\_SERIAL, 679
  - serial, 679
- GiNaC::gcd\_options, 679
  - no\_heur\_gcd, 680
  - no\_part\_factored, 680
  - use\_sr\_gcd, 680
- GiNaC::gcdheu\_failed, 680
- GiNaC::has\_distance< T >, 680
  - no\_type, 681
  - test, 681
  - value, 681
  - yes\_type, 681
- GiNaC::has\_options, 682
  - algebraic, 682
- GiNaC::idx, 683
  - archive, 689
  - calchash, 691
  - derivative, 690
  - dim, 694
  - do\_print, 693
  - do\_print\_csrc, 693
  - do\_print\_latex, 694
  - do\_print\_tree, 694
  - evalf, 689
  - get\_dim, 692
  - get\_value, 691
  - idx, 688
  - info, 688
  - is\_dim\_numeric, 692
  - is\_dim\_symbolic, 692
  - is\_dummy\_pair\_same\_type, 691
  - is\_numeric, 692
  - is\_symbolic, 692
  - map, 689
  - match\_same\_type, 690
  - minimal\_dim, 693
  - nops, 688
  - op, 689
  - print\_index, 693
  - read\_archive, 690
  - replace\_dim, 693
  - subs, 689
  - value, 694
- GiNaC::idx\_is\_equal\_ignore\_dim, 695
  - operator(), 695
- GiNaC::indexed, 695
  - all\_index\_values\_are, 710
  - archive, 708
  - derivative, 708
  - do\_print, 711
  - do\_print\_latex, 712
  - do\_print\_tree, 712
  - eval, 707
  - expand, 710
  - get\_dummy\_indices, 710
  - get\_free\_indices, 708
  - get\_indices, 710
  - get\_symmetry, 711
  - has\_dummy\_index\_for, 711
  - imag\_part, 707
  - indexed, 702–706
  - info, 707
  - precedence, 707
  - print\_indexed, 711
  - printindices, 711
  - read\_archive, 708
  - real\_part, 707
  - reposition\_dummy\_indices, 713
  - return\_type, 709
  - return\_type\_tinfo, 709
  - simplify\_indexed, 713
  - simplify\_indexed\_product, 713
  - symtree, 714
  - thiscontainer, 709
  - validate, 712
- GiNaC::info\_flags, 714
  - cinteger, 715
  - cinteger\_polynomial, 715
  - crational, 715
  - crational\_polynomial, 715
  - even, 715
  - expanded, 715
  - exprseq, 715
  - has\_indices, 715
  - idx, 715
  - indefinite, 715
  - indexed, 715
  - integer, 715
  - integer\_polynomial, 715
  - list, 715
  - negative, 715
  - negint, 715
  - nonnegative, 715
  - nonnegint, 715
  - numeric, 715
  - odd, 715
  - polynomial, 715
  - posint, 715
  - positive, 715
  - prime, 715
  - rational, 715
  - rational\_function, 715
  - rational\_polynomial, 715
  - real, 715

- relation, 715
- relation\_equal, 715
- relation\_greater, 715
- relation\_greater\_or\_equal, 715
- relation\_less, 715
- relation\_less\_or\_equal, 715
- relation\_not\_equal, 715
- symbol, 715
- GiNaC::integral, 715
  - a, 726
  - archive, 724
  - b, 726
  - conjugate, 723
  - degree, 721
  - derivative, 724
  - do\_print, 725
  - do\_print\_latex, 725
  - eval, 721
  - eval\_integ, 724
  - eval\_ncmul, 722
  - evalf, 721
  - expand, 723
  - f, 726
  - get\_free\_indices, 723
  - integral, 721
  - ldegree, 722
  - let\_op, 722
  - max\_integration\_level, 726
  - nops, 722
  - op, 722
  - precedence, 721
  - read\_archive, 724
  - relative\_integration\_error, 726
  - return\_type, 723
  - return\_type\_tinfo, 723
  - series, 725
  - x, 726
- GiNaC::integration\_kernel, 727
  - cache\_step\_size, 736
  - do\_print, 735
  - get\_cache\_size, 734
  - get\_numerical\_value, 733
  - get\_numerical\_value\_impl, 735
  - get\_series\_coeff, 734
  - has\_trailing\_zero, 732
  - is\_numeric, 732
  - Laurent\_series, 733
  - series, 732
  - series\_coeff, 735
  - series\_coeff\_impl, 734
  - series\_vec, 736
  - set\_cache\_step, 734
  - uses\_Laurent\_series, 733
- GiNaC::internal, 287
- GiNaC::internal::\_iter\_rep, 289
  - \_iter\_rep, 290
  - e, 290
  - i, 290
  - i\_end, 291
  - operator!=, 290
  - operator==, 290
- GiNaC::is\_not\_a\_clifford, 736
  - operator(), 736
- GiNaC::is\_summation\_idx, 737
  - operator(), 737
- GiNaC::iterated\_integral2\_SERIAL, 737
  - serial, 737
- GiNaC::iterated\_integral3\_SERIAL, 738
  - serial, 738
- GiNaC::Kronecker\_dtau\_kernel, 738
  - C\_norm, 747
  - do\_print, 746
  - get\_numerical\_value, 746
  - is\_numeric, 745
  - K, 747
  - Kronecker\_dtau\_kernel, 745
  - let\_op, 745
  - n, 747
  - nops, 745
  - op, 745
  - series\_coeff\_impl, 746
  - z, 747
- GiNaC::Kronecker\_dz\_kernel, 748
  - C\_norm, 756
  - do\_print, 755
  - get\_numerical\_value, 755
  - is\_numeric, 754
  - K, 756
  - Kronecker\_dz\_kernel, 754
  - let\_op, 754
  - n, 756
  - nops, 754
  - op, 754
  - series\_coeff\_impl, 755
  - tau, 756
  - z\_j, 756
- GiNaC::lanczos\_coeffs, 756
  - calc\_lanczos\_A, 757
  - coeffs, 758
  - current\_vector, 758
  - get\_order, 757
  - lanczos\_coeffs, 757
  - sufficiently\_accurate, 757
- GiNaC::library\_init, 759
  - ~library\_init, 759
  - count, 760
  - init\_unarchivers, 760
  - library\_init, 759
- GiNaC::make\_flat\_inserter, 760
  - combine\_indices, 761
  - do\_renaming, 762
  - handle\_factor, 761
  - make\_flat\_inserter, 761
  - used\_indices, 762
- GiNaC::map\_function, 762
  - ~map\_function, 764

- argument\_type, 764
- operator(), 764
- result\_type, 764
- GiNaC::matrix, 765
  - add, 776
  - add\_indexed, 773
  - archive, 774
  - charpoly, 780
  - col, 786
  - cols, 775
  - conjugate, 774
  - contract\_with, 773
  - determinant, 778
  - determinant\_minor, 782
  - division\_free\_elimination, 783
  - do\_print, 785
  - do\_print\_latex, 785
  - do\_print\_python\_repr, 785
  - echelon\_form, 782
  - eval\_indexed, 773
  - evalm, 772
  - fraction\_free\_elimination, 783
  - gauss\_elimination, 783
  - imag\_part, 774
  - inverse, 780
  - is\_zero\_matrix, 782
  - let\_op, 772
  - m, 786
  - markowitz\_elimination, 784
  - match\_same\_type, 775
  - matrix, 770, 771
  - mul, 776, 777
  - mul\_scalar, 777
  - nops, 772
  - op, 772
  - operator(), 777, 778
  - pivot, 784
  - pow, 777
  - print\_elements, 785
  - rank, 781, 782
  - read\_archive, 774
  - real\_part, 774
  - return\_type, 775
  - row, 786
  - rows, 775
  - scalar\_mul\_indexed, 773
  - set, 778
  - solve, 781
  - sub, 776
  - subs, 772
  - trace, 779
  - transpose, 778
- GiNaC::minkmetric, 787
  - archive, 793
  - do\_print, 793
  - do\_print\_latex, 793
  - eval\_indexed, 792
  - info, 792
  - minkmetric, 792
  - pos\_sig, 794
  - read\_archive, 793
  - return\_type, 793
- GiNaC::modular\_form\_kernel, 794
  - C\_norm, 802
  - do\_print, 802
  - get\_numerical\_value, 801
  - is\_numeric, 800
  - k, 802
  - Laurent\_series, 801
  - let\_op, 800
  - modular\_form\_kernel, 799
  - nops, 800
  - op, 800
  - P, 802
  - q\_expansion\_modular\_form, 801
  - series, 800
  - uses\_Laurent\_series, 801
- GiNaC::mul, 804
  - add, 822
  - algebraic\_subs\_mul, 820
  - can\_be\_further\_expanded, 821
  - can\_make\_flat, 819
  - coeff, 812
  - combine\_ex\_with\_coeff\_to\_pair, 818
  - combine\_overall\_coeff, 819
  - combine\_pair\_with\_coeff\_to\_pair, 818
  - conjugate, 816
  - default\_overall\_coeff, 819
  - degree, 812
  - derivative, 816
  - do\_print, 820
  - do\_print\_csrc, 821
  - do\_print\_latex, 821
  - do\_print\_python\_repr, 821
  - eval, 813
  - eval\_ncmul, 816
  - evalf, 813
  - evalm, 814
  - expair\_needs\_further\_processing, 818
  - expand, 819
  - expandchildren, 821
  - find\_real\_imag, 820
  - get\_free\_indices, 816
  - has, 813
  - imag\_part, 814
  - info, 811
  - integer\_content, 815
  - is\_polynomial, 812
  - ldegree, 812
  - max\_coefficient, 815
  - mul, 810, 811
  - ncmul, 822
  - normal, 814
  - power, 822
  - precedence, 811
  - print\_overall\_coeff, 820



- real\_part, 814
- recombine\_pair\_to\_ex, 818
- return\_type, 817
- return\_type\_tinfo, 817
- series, 814
- smod, 815
- split\_ex\_to\_pair, 817
- thisexpairseq, 817
- GiNaC::multi\_iterator\_counter< T >, 823
  - init, 825
  - multi\_iterator\_counter, 825
  - operator<<, 826
  - operator++, 825
- GiNaC::multi\_iterator\_counter\_indv< T >, 826
  - init, 829
  - multi\_iterator\_counter\_indv, 828
  - Nv, 830
  - operator<<, 830
  - operator++, 829
- GiNaC::multi\_iterator\_ordered< T >, 830
  - init, 833
  - multi\_iterator\_ordered, 832
  - operator<<, 834
  - operator++, 833
- GiNaC::multi\_iterator\_ordered\_eq< T >, 834
  - init, 837
  - multi\_iterator\_ordered\_eq, 836
  - operator<<, 837
  - operator++, 837
- GiNaC::multi\_iterator\_ordered\_eq\_indv< T >, 838
  - init, 840
  - multi\_iterator\_ordered\_eq\_indv, 840
  - Nv, 841
  - operator<<, 841
  - operator++, 840
- GiNaC::multi\_iterator\_permutation< T >, 842
  - get\_sign, 845
  - init, 844
  - multi\_iterator\_permutation, 844
  - operator<<, 845
  - operator++, 844
- GiNaC::multi\_iterator\_shuffle< T >, 846
  - init, 848
  - multi\_iterator\_shuffle, 848
  - N\_internal, 849
  - operator<<, 849
  - operator++, 848
  - v\_internal, 849
  - v\_orig, 849
- GiNaC::multi\_iterator\_shuffle\_prime< T >, 850
  - init, 853
  - multi\_iterator\_shuffle\_prime, 852
  - operator<<, 853
- GiNaC::multiple\_polylog\_kernel, 853
  - do\_print, 860
  - is\_numeric, 860
  - let\_op, 860
  - multiple\_polylog\_kernel, 859
  - nops, 860
  - op, 860
  - series\_coeff\_impl, 860
  - z, 861
- GiNaC::ncmul, 861
  - append\_factors, 874
  - coeff, 870
  - conjugate, 872
  - count\_factors, 874
  - degree, 870
  - derivative, 873
  - do\_print, 873
  - do\_print\_csrc, 874
  - eval, 871
  - evalm, 871
  - expand, 870
  - expandchildren, 874
  - get\_factors, 874
  - get\_free\_indices, 871
  - hold\_ncmul, 875
  - imag\_part, 872
  - info, 869
  - ldegree, 870
  - ncmul, 868, 869
  - power, 875
  - precedence, 869
  - real\_part, 872
  - reeval\_ncmul, 875
  - return\_type, 873
  - return\_type\_tinfo, 873
  - thiscontainer, 872
- GiNaC::normal\_map\_function, 876
  - operator(), 877
- GiNaC::numeric, 877
  - add, 891
  - add\_dyn, 893
  - archive, 890
  - calchash, 891
  - coeff, 886
  - compare, 896
  - conjugate, 890
  - csgn, 896
  - degree, 886
  - denom, 903
  - derivative, 891
  - div, 892
  - div\_dyn, 894
  - do\_print, 903
  - do\_print\_csrc, 904
  - do\_print\_csrc\_cl\_N, 904
  - do\_print\_latex, 904
  - do\_print\_python\_repr, 904
  - do\_print\_tree, 904
  - eval, 887
  - evalf, 887
  - has, 887
  - imag, 902
  - imag\_part, 890

- info, 885
- int\_length, 903
- integer\_content, 889
- inverse, 895
- is\_cinteger, 899
- is\_crational, 899
- is\_equal, 896
- is\_equal\_same\_type, 891
- is\_even, 898
- is\_integer, 897
- is\_negative, 897
- is\_nonneg\_integer, 898
- is\_odd, 898
- is\_polynomial, 886
- is\_pos\_integer, 898
- is\_positive, 897
- is\_prime, 898
- is\_rational, 899
- is\_real, 899
- is\_zero, 897
- ldegree, 886
- max\_coefficient, 889
- mul, 892
- mul\_dyn, 893
- normal, 888
- numer, 902
- numeric, 883–885
- operator!=, 900
- operator<, 900
- operator<=, 900
- operator>, 900
- operator>=, 901
- operator=, 894, 895
- operator==, 900
- power, 893
- power\_dyn, 894
- precedence, 885
- print\_numeric, 903
- read\_archive, 890
- real, 902
- real\_part, 890
- smod, 889
- step, 895
- sub, 892
- sub\_dyn, 893
- subs, 887
- to\_cl\_N, 902
- to\_double, 901
- to\_int, 901
- to\_long, 901
- to\_polynomial, 888
- to\_rational, 888
- value, 905
- GiNaC::op0\_is\_equal, 905
- operator(), 905
- GiNaC::partition\_generator, 906
- current\_updated, 908
- get, 907
- next, 907
- partition, 908
- partition\_generator, 907
- GiNaC::partition\_with\_zero\_parts\_generator, 908
- current\_updated, 910
- get, 910
- m, 910
- next, 910
- partition, 910
- partition\_with\_zero\_parts\_generator, 910
- GiNaC::pointer\_to\_map\_function, 911
- operator(), 913
- pointer\_to\_map\_function, 913
- ptr, 913
- GiNaC::pointer\_to\_map\_function\_1arg< T1 >, 913
- arg1, 915
- operator(), 915
- pointer\_to\_map\_function\_1arg, 915
- ptr, 915
- GiNaC::pointer\_to\_map\_function\_2args< T1, T2 >, 916
- arg1, 918
- arg2, 918
- operator(), 917
- pointer\_to\_map\_function\_2args, 917
- ptr, 918
- GiNaC::pointer\_to\_map\_function\_3args< T1, T2, T3 >, 918
- arg1, 920
- arg2, 920
- arg3, 920
- operator(), 920
- pointer\_to\_map\_function\_3args, 920
- ptr, 920
- GiNaC::pointer\_to\_member\_to\_map\_function< C >, 921
- c, 923
- operator(), 923
- pointer\_to\_member\_to\_map\_function, 923
- ptr, 923
- GiNaC::pointer\_to\_member\_to\_map\_function\_1arg< C, T1 >, 924
- arg1, 926
- c, 926
- operator(), 925
- pointer\_to\_member\_to\_map\_function\_1arg, 925
- ptr, 926
- GiNaC::pointer\_to\_member\_to\_map\_function\_2args< C, T1, T2 >, 926
- arg1, 928
- arg2, 928
- c, 928
- operator(), 928
- pointer\_to\_member\_to\_map\_function\_2args, 928
- ptr, 928
- GiNaC::pointer\_to\_member\_to\_map\_function\_3args< C, T1, T2, T3 >, 929
- arg1, 931

- arg2, [932](#)
- arg3, [932](#)
- c, [931](#)
- operator(), [931](#)
- pointer\_to\_member\_to\_map\_function\_3args, [931](#)
- ptr, [931](#)
- GiNaC::pole\_error, [932](#)
  - deg, [934](#)
  - degree, [933](#)
  - pole\_error, [933](#)
- GiNaC::possymbol, [934](#)
  - duplicate, [940](#)
  - get\_domain, [940](#)
  - possymbol, [939](#)
- GiNaC::power, [940](#)
  - archive, [951](#)
  - basis, [956](#)
  - coeff, [947](#)
  - conjugate, [951](#)
  - degree, [947](#)
  - derivative, [952](#)
  - do\_print\_csrc, [954](#)
  - do\_print\_csrc\_cl\_N, [954](#)
  - do\_print\_dflt, [953](#)
  - do\_print\_latex, [953](#)
  - do\_print\_python, [954](#)
  - do\_print\_python\_repr, [954](#)
  - eval, [947](#)
  - eval\_ncmul, [952](#)
  - evalf, [948](#)
  - evalm, [948](#)
  - expand, [953](#)
  - expand\_add, [954](#)
  - expand\_add\_2, [955](#)
  - expand\_mul, [955](#)
  - exponent, [956](#)
  - has, [949](#)
  - imag\_part, [951](#)
  - info, [945](#)
  - is\_polynomial, [946](#)
  - ldegree, [947](#)
  - map, [946](#)
  - mul, [956](#)
  - nops, [946](#)
  - normal, [950](#)
  - op, [946](#)
  - power, [945](#)
  - precedence, [945](#)
  - print\_power, [953](#)
  - read\_archive, [951](#)
  - real\_part, [951](#)
  - return\_type, [952](#)
  - return\_type\_tinfo, [952](#)
  - series, [949](#)
  - subs, [949](#)
  - to\_polynomial, [950](#)
  - to\_rational, [950](#)
- GiNaC::print\_context, [957](#)
  - ~print\_context, [957](#)
  - options, [958](#)
  - print\_context, [957](#)
  - s, [958](#)
- GiNaC::print\_context\_options, [959](#)
  - get\_id, [960](#)
  - get\_name, [959](#)
  - get\_parent\_name, [959](#)
  - id, [960](#)
  - name, [960](#)
  - parent\_name, [960](#)
  - print\_context\_options, [959](#)
- GiNaC::print\_csrc, [961](#)
  - print\_csrc, [962](#)
- GiNaC::print\_csrc\_cl\_N, [962](#)
  - print\_csrc\_cl\_N, [964](#)
- GiNaC::print\_csrc\_double, [964](#)
  - print\_csrc\_double, [966](#)
- GiNaC::print\_csrc\_float, [966](#)
  - print\_csrc\_float, [968](#)
- GiNaC::print\_dflt, [968](#)
  - print\_dflt, [969](#)
- GiNaC::print\_functor, [969](#)
  - impl, [971](#)
  - is\_valid, [971](#)
  - operator(), [971](#)
  - operator=, [971](#)
  - print\_functor, [970](#), [971](#)
- GiNaC::print\_functor\_impl, [972](#)
  - ~print\_functor\_impl, [972](#)
  - duplicate, [972](#)
  - operator(), [972](#)
- GiNaC::print\_latex, [973](#)
  - print\_latex, [974](#)
- GiNaC::print\_memfun\_handler< T, C >, [975](#)
  - duplicate, [976](#)
  - F, [976](#)
  - f, [977](#)
  - operator(), [976](#)
  - print\_memfun\_handler, [976](#)
- GiNaC::print\_options, [977](#)
  - print\_index\_dimensions, [978](#)
- GiNaC::print\_ptrfun\_handler< T, C >, [978](#)
  - duplicate, [979](#)
  - F, [979](#)
  - f, [980](#)
  - operator(), [979](#)
  - print\_ptrfun\_handler, [979](#)
- GiNaC::print\_python, [980](#)
  - print\_python, [981](#)
- GiNaC::print\_python\_repr, [982](#)
  - print\_python\_repr, [983](#)
- GiNaC::print\_tree, [983](#)
  - delta\_indent, [985](#)
  - print\_tree, [984](#)
- GiNaC::pseries, [988](#)
  - add\_series, [1000](#)
  - archive, [998](#)

- coeff, 995
- coeffop, 1000
- collect, 995
- conjugate, 997
- convert\_to\_poly, 999
- degree, 995
- derivative, 999
- do\_print, 1002
- do\_print\_latex, 1002
- do\_print\_python, 1003
- do\_print\_python\_repr, 1003
- do\_print\_tree, 1002
- eval, 996
- eval\_integ, 998
- evalf, 996
- evalm, 998
- expand, 997
- exponop, 1000
- get\_point, 999
- get\_var, 999
- imag\_part, 998
- is\_compatible\_to, 1000
- is\_terminating, 1000
- is\_zero, 1000
- ldegree, 995
- mul\_const, 1001
- mul\_series, 1001
- nops, 994
- normal, 997
- op, 994
- point, 1003
- power\_const, 1001
- precedence, 994
- print\_series, 1002
- pseries, 993, 994
- read\_archive, 999
- real\_part, 998
- seq, 1003
- series, 996
- shift\_exponents, 1002
- subs, 996
- var, 1003
- GiNaC::psi1\_SERIAL, 1004
  - serial, 1004
- GiNaC::psi2\_SERIAL, 1005
  - serial, 1005
- GiNaC::ptr< T >, 1005
  - ~ptr, 1007
  - get\_pointer, 1009
  - makewritable, 1008
  - operator!=, 1008, 1009
  - operator<<, 1010
  - operator->, 1008
  - operator=, 1007
  - operator==, 1008, 1009
  - operator\*, 1007
  - p, 1010
  - ptr, 1007
  - std::less< ptr< T > >, 1009
  - swap, 1008
- GiNaC::realsymbol, 1010
  - conjugate, 1016
  - duplicate, 1016
  - get\_domain, 1016
  - imag\_part, 1016
  - real\_part, 1016
  - realsymbol, 1015, 1016
- GiNaC::refcounted, 1017
  - add\_reference, 1019
  - get\_refcount, 1019
  - refcount, 1020
  - refcounted, 1019
  - remove\_reference, 1019
  - set\_refcount, 1019
- GiNaC::registered\_class\_options, 1020
  - get\_id, 1021
  - get\_name, 1021
  - get\_parent\_name, 1021
  - get\_print\_dispatch\_table, 1021
  - name, 1022
  - parent\_name, 1022
  - print\_dispatch\_table, 1022
  - print\_func, 1021, 1022
  - registered\_class\_options, 1021
  - set\_print\_func, 1022
  - tinfo\_key, 1022
- GiNaC::relational, 1023
  - archive, 1030
  - calchash, 1032
  - canonical, 1031
  - do\_print, 1032
  - do\_print\_python\_repr, 1032
  - equal, 1028
  - eval\_ncmul, 1031
  - greater, 1028
  - greater\_or\_equal, 1028
  - info, 1029
  - less, 1028
  - less\_or\_equal, 1028
  - lh, 1034
  - lhs, 1032
  - make\_safe\_bool, 1033
  - map, 1030
  - match\_same\_type, 1031
  - nops, 1029
  - not\_equal, 1028
  - o, 1034
  - op, 1029
  - operator safe\_bool, 1033
  - operator!, 1033
  - operators, 1028
  - precedence, 1029
  - read\_archive, 1030
  - relational, 1029
  - return\_type, 1031
  - return\_type\_tinfo, 1032

- rh, [1034](#)
- rhs, [1033](#)
- safe\_bool, [1028](#)
- subs, [1030](#)
- GiNaC::relational::safe\_bool\_helper, [1046](#)
- nonnull, [1046](#)
- GiNaC::remember\_strategies, [1034](#)
  - delete\_cyclic, [1035](#)
  - delete\_lfu, [1035](#)
  - delete\_lru, [1035](#)
  - delete\_never, [1035](#)
- GiNaC::remember\_table, [1035](#)
  - add\_entry, [1037](#)
  - clear\_all\_entries, [1037](#)
  - init\_table, [1037](#)
  - lookup\_entry, [1037](#)
  - max\_assoc\_size, [1038](#)
  - remember\_strategy, [1038](#)
  - remember\_table, [1036](#)
  - remember\_tables, [1037](#)
  - show\_statistics, [1037](#)
  - table\_size, [1038](#)
- GiNaC::remember\_table\_entry, [1039](#)
  - access\_counter, [1041](#)
  - get\_last\_access, [1040](#)
  - get\_result, [1040](#)
  - get\_successful\_hits, [1040](#)
  - hashvalue, [1041](#)
  - is\_equal, [1040](#)
  - last\_access, [1041](#)
  - remember\_table\_entry, [1040](#)
  - result, [1041](#)
  - seq, [1041](#)
  - successful\_hits, [1041](#)
- GiNaC::remember\_table\_list, [1042](#)
  - add\_entry, [1043](#)
  - lookup\_entry, [1043](#)
  - max\_assoc\_size, [1043](#)
  - remember\_strategy, [1043](#)
  - remember\_table\_list, [1043](#)
- GiNaC::return\_type\_t, [1044](#)
  - operator!=, [1044](#)
  - operator<, [1044](#)
  - operator==, [1044](#)
  - rl, [1045](#)
  - tinfo, [1045](#)
- GiNaC::return\_types, [1045](#)
  - commutative, [1046](#)
  - noncommutative, [1046](#)
  - noncommutative\_composite, [1046](#)
- GiNaC::scalar\_products, [1046](#)
  - add, [1047](#)
  - add\_vectors, [1047](#)
  - clear, [1047](#)
  - debugprint, [1048](#)
  - evaluate, [1048](#)
  - is\_defined, [1048](#)
  - spm, [1048](#)
- GiNaC::series\_options, [1049](#)
  - suppress\_branchcut, [1049](#)
- GiNaC::solve\_algo, [1049](#)
  - automatic, [1050](#)
  - bareiss, [1050](#)
  - divfree, [1050](#)
  - gauss, [1050](#)
  - markowitz, [1050](#)
- GiNaC::spinidx, [1050](#)
  - archive, [1058](#)
  - conjugate, [1058](#)
  - do\_print, [1060](#)
  - do\_print\_latex, [1060](#)
  - do\_print\_tree, [1060](#)
  - dotted, [1060](#)
  - is\_dotted, [1059](#)
  - is\_dummy\_pair\_same\_type, [1058](#)
  - is\_undotted, [1059](#)
  - match\_same\_type, [1058](#)
  - read\_archive, [1058](#)
  - spinidx, [1057](#)
  - toggle\_dot, [1059](#)
  - toggle\_variance\_dot, [1059](#)
- GiNaC::spinmetric, [1061](#)
  - contract\_with, [1066](#)
  - do\_print, [1067](#)
  - do\_print\_latex, [1067](#)
  - eval\_indexed, [1066](#)
  - info, [1066](#)
- GiNaC::spmapkey, [1067](#)
  - debugprint, [1069](#)
  - dim, [1069](#)
  - operator<, [1069](#)
  - operator==, [1069](#)
  - spmapkey, [1068](#)
  - v1, [1069](#)
  - v2, [1069](#)
- GiNaC::status\_flags, [1070](#)
  - dynamallocated, [1070](#)
  - evaluated, [1070](#)
  - expanded, [1070](#)
  - has\_indices, [1071](#)
  - has\_no\_indices, [1071](#)
  - hash\_calculated, [1070](#)
  - is\_negative, [1071](#)
  - is\_positive, [1071](#)
  - not\_shareable, [1071](#)
  - purely\_indefinite, [1071](#)
- GiNaC::structure< T, ComparisonPolicy >, [1071](#)
  - add\_indexed, [1084](#)
  - calchash, [1086](#)
  - coeff, [1080](#)
  - collect, [1081](#)
  - contract\_with, [1085](#)
  - degree, [1080](#)
  - derivative, [1081](#)
  - eval, [1076](#)
  - eval\_indexed, [1076](#)

- eval\_ncmul, 1076
- evalm, 1076
- expand, 1081
- get\_class\_name, 1076
- get\_free\_indices, 1084
- get\_struct, 1087
- has, 1079
- info, 1077
- integer\_content, 1083
- is\_equal\_same\_type, 1086
- ldegree, 1080
- let\_op, 1078
- map, 1080
- match, 1079
- match\_same\_type, 1079
- max\_coefficient, 1083
- nops, 1077
- normal, 1082
- obj, 1087
- op, 1077
- operator->, 1086
- operator[], 1078
- precedence, 1077
- print, 1076
- return\_type, 1085
- return\_type\_tinfo, 1086
- scalar\_mul\_indexed, 1084
- series, 1082
- smod, 1083
- structure, 1075
- subs, 1079
- to\_polynomial, 1083
- to\_rational, 1082
- GiNaC::su3d, 1088
  - contract\_with, 1092
  - do\_print, 1093
  - do\_print\_latex, 1093
  - eval\_indexed, 1092
  - return\_type, 1092
- GiNaC::su3f, 1093
  - contract\_with, 1098
  - do\_print, 1098
  - do\_print\_latex, 1098
  - eval\_indexed, 1098
  - return\_type, 1098
- GiNaC::su3one, 1099
  - do\_print, 1103
  - do\_print\_latex, 1103
- GiNaC::su3t, 1104
  - contract\_with, 1108
  - do\_print, 1108
  - do\_print\_latex, 1108
- GiNaC::subs\_options, 1109
  - algebraic, 1109
  - no\_index\_renaming, 1109
  - no\_pattern, 1109
  - pattern\_is\_not\_product, 1109
  - pattern\_is\_product, 1109
  - really\_subs\_idx, 1109
  - subs\_algebraic, 1109
  - subs\_no\_pattern, 1109
- GiNaC::sy\_is\_less, 1110
  - operator(), 1110
  - sy\_is\_less, 1110
  - v, 1110
- GiNaC::sy\_swap, 1110
  - operator(), 1111
  - swapped, 1111
  - sy\_swap, 1111
  - v, 1111
- GiNaC::sym\_desc, 1112
  - deg\_a, 1114
  - deg\_b, 1114
  - ldeg\_a, 1114
  - ldeg\_b, 1114
  - max\_deg, 1114
  - max\_lcnops, 1114
  - operator<, 1113
  - sym, 1114
  - sym\_desc, 1113
- GiNaC::symbol, 1115
  - archive, 1123
  - calchash, 1124
  - conjugate, 1122
  - derivative, 1123
  - do\_print, 1125
  - do\_print\_latex, 1125
  - do\_print\_python\_repr, 1125
  - do\_print\_tree, 1125
  - eval, 1120
  - evalf, 1120
  - get\_domain, 1124
  - get\_name, 1125
  - get\_TeX\_name, 1125
  - imag\_part, 1122
  - info, 1120
  - is\_equal\_same\_type, 1123
  - is\_polynomial, 1122
  - name, 1126
  - next\_serial, 1126
  - normal, 1121
  - read\_archive, 1123
  - real\_part, 1122
  - serial, 1126
  - series, 1121
  - set\_name, 1124
  - set\_TeX\_name, 1124
  - subs, 1121
  - symbol, 1120
  - TeX\_name, 1126
  - to\_polynomial, 1122
  - to\_rational, 1121
- GiNaC::symbolset, 1127
  - has, 1127
  - insert\_symbols, 1127
  - s, 1128

- symbolset, 1127
- GiNaC::symmetry, 1128
  - add, 1135
  - antisymmetric, 1133
  - archive, 1134
  - calchash, 1134
  - canonicalize, 1137
  - children, 1137
  - cyclic, 1133
  - do\_print, 1136
  - do\_print\_tree, 1136
  - get\_type, 1134
  - has\_cyclic, 1136
  - has\_nonsymmetric, 1135
  - has\_symmetry, 1135
  - indices, 1137
  - none, 1133
  - read\_archive, 1134
  - set\_type, 1135
  - sy\_is\_less, 1136
  - sy\_swap, 1136
  - symmetric, 1133
  - symmetry, 1133
  - symmetry\_type, 1133
  - type, 1137
  - validate, 1135
- GiNaC::symminfo, 1138
  - coeff, 1139
  - num, 1140
  - orig, 1140
  - symminfo, 1139
  - symmterm, 1139
- GiNaC::symminfo\_is\_less\_by\_orig, 1140
  - operator(), 1140
- GiNaC::symminfo\_is\_less\_by\_symmterm, 1141
  - operator(), 1141
- GiNaC::tensdelta, 1141
  - contract\_with, 1146
  - do\_print, 1146
  - do\_print\_latex, 1147
  - eval\_indexed, 1146
  - info, 1146
  - return\_type, 1146
- GiNaC::tensepsilon, 1147
  - archive, 1153
  - contract\_with, 1152
  - do\_print, 1153
  - do\_print\_latex, 1154
  - eval\_indexed, 1152
  - info, 1152
  - minkowski, 1154
  - pos\_sig, 1154
  - read\_archive, 1153
  - return\_type, 1153
  - tensepsilon, 1152
- GiNaC::tensmetric, 1155
  - contract\_with, 1160
  - do\_print, 1160
  - eval\_indexed, 1160
  - info, 1160
  - return\_type, 1160
- GiNaC::tensor, 1161
  - replace\_contr\_index, 1165
  - return\_type, 1165
- GiNaC::terminfo, 1166
  - orig, 1167
  - symm, 1167
  - terminfo, 1167
- GiNaC::terminfo\_is\_less, 1168
  - operator(), 1168
- GiNaC::unarchive\_table\_t, 1169
  - ~unarchive\_table\_t, 1170
  - find, 1170
  - insert, 1170
  - unarch\_map, 1171
  - unarchive\_table\_t, 1170
  - usecount, 1171
- GiNaC::user\_defined\_kernel, 1171
  - do\_print, 1178
  - f, 1178
  - is\_numeric, 1177
  - Laurent\_series, 1177
  - let\_op, 1177
  - nops, 1177
  - op, 1177
  - user\_defined\_kernel, 1177
  - uses\_Laurent\_series, 1178
  - x, 1178
- GiNaC::varidx, 1179
  - archive, 1185
  - covariant, 1187
  - do\_print, 1186
  - do\_print\_tree, 1187
  - is\_contravariant, 1186
  - is\_covariant, 1186
  - is\_dummy\_pair\_same\_type, 1185
  - match\_same\_type, 1185
  - read\_archive, 1185
  - toggle\_variance, 1186
  - varidx, 1184
- GiNaC::visitor, 1187
  - ~visitor, 1188
- GiNaC::wildcard, 1188
  - archive, 1193
  - calchash, 1193
  - do\_print, 1194
  - do\_print\_python\_repr, 1194
  - do\_print\_tree, 1194
  - get\_label, 1193
  - label, 1194
  - match, 1193
  - read\_archive, 1193
  - wildcard, 1192
- GiNaC::zeta1\_SERIAL, 1195
  - serial, 1195
- GiNaC::zeta2\_SERIAL, 1195

- serial, [1196](#)
- GINAC\_ASSERT
  - assertion.h, [1202](#)
- GINAC\_BIND\_UNARCHIVER
  - archive.h, [1201](#)
  - GiNaC, [82](#), [87](#), [88](#), [99](#), [100](#), [105](#), [121](#), [122](#), [125](#), [188](#), [190–193](#), [195](#), [200](#), [201](#), [216](#), [247](#), [248](#), [250](#), [251](#), [258](#), [259](#), [268](#), [271](#)
- GINAC\_DECLARE\_PRINT\_CONTEXT
  - print.h, [1289](#)
- GINAC\_DECLARE\_PRINT\_CONTEXT\_BASE
  - print.h, [1289](#)
- GINAC\_DECLARE\_PRINT\_CONTEXT\_COMMON
  - print.h, [1289](#)
- GINAC\_DECLARE\_REGISTERED\_CLASS
  - registrar.h, [1294](#)
- GINAC\_DECLARE\_REGISTERED\_CLASS\_COMMON
  - registrar.h, [1294](#)
- GINAC\_DECLARE\_REGISTERED\_CLASS\_NO\_CTORS
  - registrar.h, [1294](#)
- GINAC\_DECLARE\_UNARCHIVER
  - archive.h, [1200](#)
  - GiNaC, [83](#), [97](#), [98](#), [104](#), [105](#), [120](#), [121](#), [124](#), [130](#), [188](#), [193–195](#), [197](#), [201](#), [232](#), [247](#), [248](#), [250](#), [251](#), [255](#), [262](#), [268](#)
- GINAC\_IMPLEMENT\_PRINT\_CONTEXT
  - print.h, [1290](#)
- GINAC\_IMPLEMENT\_REGISTERED\_CLASS
  - registrar.h, [1295](#)
- GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT
  - GiNaC, [82](#), [84](#), [87](#), [99](#), [105](#), [119–122](#), [125](#), [187](#), [190–193](#), [195](#), [200](#), [201](#), [215](#), [246](#), [248–251](#), [258](#), [267](#)
  - registrar.h, [1295](#)
- GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT\_T
  - registrar.h, [1295](#)
- GINAC\_LT\_AGE
  - version.h, [1312](#)
- GINAC\_LT\_CURRENT
  - version.h, [1312](#)
- GINAC\_LT\_REVISION
  - version.h, [1312](#)
- GINACLIB\_ARCHIVE\_AGE
  - version.h, [1312](#)
- GINACLIB\_ARCHIVE\_VERSION
  - version.h, [1312](#)
- GINACLIB\_MAJOR\_VERSION
  - version.h, [1312](#)
- GINACLIB\_MICRO\_VERSION
  - version.h, [1312](#)
- GINACLIB\_MINOR\_VERSION
  - version.h, [1312](#)
- GINACLIB\_STR
  - version.h, [1312](#)
- GINACLIB\_STR\_HELPER
  - version.h, [1312](#)
- GINACLIB\_VERSION
  - version.h, [1313](#)
- golden\_ratio\_hash
  - GiNaC, [263](#)
- greater
  - GiNaC::relational, [1028](#)
- greater\_or\_equal
  - GiNaC::relational, [1028](#)
- guess\_precision
  - GiNaC, [224](#)
- H\_deriv
  - GiNaC, [164](#)
- H\_eval
  - GiNaC, [164](#)
- H\_evalf
  - GiNaC, [164](#)
- H\_print\_latex
  - GiNaC, [164](#)
- H\_series
  - GiNaC, [164](#)
- handle\_factor
  - GiNaC::make\_flat\_inserter, [761](#)
- has
  - GiNaC, [108](#)
  - GiNaC::basic, [341](#)
  - GiNaC::ex, [546](#)
  - GiNaC::mul, [813](#)
  - GiNaC::numeric, [887](#)
  - GiNaC::power, [949](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1079](#)
  - GiNaC::symbolset, [1127](#)
- has\_cyclic
  - GiNaC::symmetry, [1136](#)
- has\_derivative
  - GiNaC::function\_options, [671](#)
- has\_dummy\_index\_for
  - GiNaC::indexed, [711](#)
- has\_ex
  - GiNaC::archive\_node, [325](#)
- has\_expression
  - GiNaC::archive\_node, [327](#)
- has\_indices
  - GiNaC::info\_flags, [715](#)
  - GiNaC::status\_flags, [1071](#)
- has\_no\_indices
  - GiNaC::status\_flags, [1071](#)
- has\_nonsymmetric
  - GiNaC::symmetry, [1135](#)
- has\_power
  - GiNaC::function\_options, [671](#)
- has\_same\_ex\_as
  - GiNaC::archive\_node, [325](#)
- has\_symmetry
  - GiNaC::symmetry, [1135](#)
- has\_trailing\_zero
  - GiNaC::integration\_kernel, [732](#)
- hash\_calculated
  - GiNaC::status\_flags, [1070](#)
- hash\_map.h, [1243](#)
- hash\_seed.h, [1243](#)



- hashvalue
  - GiNaC::basic, 358
  - GiNaC::remember\_table\_entry, 1041
- hasindex
  - GiNaC, 128
- haswild
  - GiNaC, 268
- head
  - GiNaC::composition\_generator::coolmulti, 458
- heur\_gcd
  - GiNaC, 208
- heur\_gcd\_z
  - GiNaC, 208
- hold
  - GiNaC::basic, 354
- hold\_ncmul
  - GiNaC, 201
  - GiNaC::ncmul, 875
- I
  - GiNaC, 271
- i
  - GiNaC::composition\_generator::coolmulti, 458
  - GiNaC::const\_iterator, 421
  - GiNaC::internal::\_iter\_rep, 290
- i\_end
  - GiNaC::internal::\_iter\_rep, 291
- id
  - GiNaC::print\_context\_options, 960
- identify\_parents
  - GiNaC::class\_info< OPT >, 375
- idx
  - GiNaC, 270
  - GiNaC::idx, 688
  - GiNaC::info\_flags, 715
- idx.cpp, 1244
- idx.h, 1245
- idx\_symmetrization
  - GiNaC, 127
- ifactor
  - GiNaC, 188
- imag
  - GiNaC, 236
  - GiNaC::numeric, 902
- imag\_part
  - GiNaC, 107
  - GiNaC::add, 305
  - GiNaC::basic, 350
  - GiNaC::constant, 434
  - GiNaC::container< C >, 448
  - GiNaC::ex, 546
  - GiNaC::function, 630
  - GiNaC::indexed, 707
  - GiNaC::matrix, 774
  - GiNaC::mul, 814
  - GiNaC::ncmul, 872
  - GiNaC::numeric, 890
  - GiNaC::power, 951
  - GiNaC::pseries, 998
  - GiNaC::realsymbol, 1016
  - GiNaC::symbol, 1122
- imag\_part\_conjugate
  - GiNaC, 134
- imag\_part\_eval
  - GiNaC, 133
- imag\_part\_evalf
  - GiNaC, 133
- imag\_part\_expl\_derivative
  - GiNaC, 134
- imag\_part\_f
  - GiNaC::function\_options, 674
- imag\_part\_func
  - GiNaC::function\_options, 652–654, 667
- imag\_part\_funcp
  - GiNaC, 60
- imag\_part\_funcp\_1
  - GiNaC, 61
- imag\_part\_funcp\_10
  - GiNaC, 73
- imag\_part\_funcp\_11
  - GiNaC, 74
- imag\_part\_funcp\_12
  - GiNaC, 76
- imag\_part\_funcp\_13
  - GiNaC, 77
- imag\_part\_funcp\_14
  - GiNaC, 79
- imag\_part\_funcp\_2
  - GiNaC, 62
- imag\_part\_funcp\_3
  - GiNaC, 64
- imag\_part\_funcp\_4
  - GiNaC, 65
- imag\_part\_funcp\_5
  - GiNaC, 66
- imag\_part\_funcp\_6
  - GiNaC, 67
- imag\_part\_funcp\_7
  - GiNaC, 69
- imag\_part\_funcp\_8
  - GiNaC, 70
- imag\_part\_funcp\_9
  - GiNaC, 71
- imag\_part\_funcp\_exvector
  - GiNaC, 80
- imag\_part\_imag\_part
  - GiNaC, 134
- imag\_part\_print\_latex
  - GiNaC, 134
- imag\_part\_real\_part
  - GiNaC, 134
- imag\_part\_use\_exvector\_args
  - GiNaC::function\_options, 677
- impl
  - GiNaC::print\_functor, 971
- increment
  - GiNaC::const\_postorder\_iterator, 423

- GiNaC::const\_preorder\_iterator, [426](#)
- indefinite
  - GiNaC::info\_flags, [715](#)
- index0
  - GiNaC, [251](#)
- index1
  - GiNaC, [252](#)
- index2
  - GiNaC, [252](#)
- index3
  - GiNaC, [252](#)
- index\_dimensions
  - GiNaC, [246](#)
- indexed
  - GiNaC::indexed, [702–706](#)
  - GiNaC::info\_flags, [715](#)
- indexed.cpp, [1246](#)
- indexed.h, [1248](#)
- indices
  - GiNaC::symmetry, [1137](#)
- indices\_consistent
  - GiNaC, [125](#)
- info
  - GiNaC::add, [301](#)
  - GiNaC::basic, [339](#)
  - GiNaC::class\_info< OPT >::tree\_node, [1169](#)
  - GiNaC::constant, [433](#)
  - GiNaC::container< C >, [445](#)
  - GiNaC::ex, [542](#)
  - GiNaC::expairseq, [580](#)
  - GiNaC::function, [631](#)
  - GiNaC::idx, [688](#)
  - GiNaC::indexed, [707](#)
  - GiNaC::minkmetric, [792](#)
  - GiNaC::mul, [811](#)
  - GiNaC::ncmul, [869](#)
  - GiNaC::numeric, [885](#)
  - GiNaC::power, [945](#)
  - GiNaC::relational, [1029](#)
  - GiNaC::spinmetric, [1066](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1077](#)
  - GiNaC::symbol, [1120](#)
  - GiNaC::tensdelta, [1146](#)
  - GiNaC::tensepsilon, [1152](#)
  - GiNaC::tensmetric, [1160](#)
- info\_f
  - GiNaC::function\_options, [675](#)
- info\_func
  - GiNaC::function\_options, [664–667](#)
- info\_funcp
  - GiNaC, [61](#)
- info\_funcp\_1
  - GiNaC, [62](#)
- info\_funcp\_10
  - GiNaC, [74](#)
- info\_funcp\_11
  - GiNaC, [75](#)
- info\_funcp\_12
  - GiNaC, [76](#)
- info\_funcp\_13
  - GiNaC, [78](#)
- info\_funcp\_14
  - GiNaC, [79](#)
- info\_funcp\_2
  - GiNaC, [63](#)
- info\_funcp\_3
  - GiNaC, [64](#)
- info\_funcp\_4
  - GiNaC, [66](#)
- info\_funcp\_5
  - GiNaC, [67](#)
- info\_funcp\_6
  - GiNaC, [68](#)
- info\_funcp\_7
  - GiNaC, [70](#)
- info\_funcp\_8
  - GiNaC, [71](#)
- info\_funcp\_9
  - GiNaC, [72](#)
- info\_funcp\_exvector
  - GiNaC, [81](#)
- info\_use\_exvector\_args
  - GiNaC::function\_options, [677](#)
- inifcns.cpp, [1249](#)
- inifcns.h, [1252](#)
- inifcns\_elliptic.cpp, [1253](#)
- inifcns\_gamma.cpp, [1255](#)
- inifcns\_nstdsums.cpp, [1256](#)
- inifcns\_trans.cpp, [1258](#)
- init
  - GiNaC::basic\_multi\_iterator< T >, [369](#)
  - GiNaC::multi\_iterator\_counter< T >, [825](#)
  - GiNaC::multi\_iterator\_counter\_indv< T >, [829](#)
  - GiNaC::multi\_iterator\_ordered< T >, [833](#)
  - GiNaC::multi\_iterator\_ordered\_eq< T >, [837](#)
  - GiNaC::multi\_iterator\_ordered\_eq\_indv< T >, [840](#)
  - GiNaC::multi\_iterator\_permutation< T >, [844](#)
  - GiNaC::multi\_iterator\_shuffle< T >, [848](#)
  - GiNaC::multi\_iterator\_shuffle\_prime< T >, [853](#)
- init\_table
  - GiNaC::remember\_table, [1037](#)
- init\_unarchivers
  - GiNaC::library\_init, [760](#)
- initialize
  - GiNaC::function\_options, [643](#)
- insert
  - GiNaC::unarchive\_table\_t, [1170](#)
- insert\_symbols
  - GiNaC::symbolset, [1127](#)
- int\_length
  - GiNaC::numeric, [903](#)
- integer
  - GiNaC::info\_flags, [715](#)
- integer\_content
  - GiNaC::add, [304](#)
  - GiNaC::basic, [346](#)

- GiNaC::ex, 555
  - GiNaC::mul, 815
  - GiNaC::numeric, 889
  - GiNaC::structure< T, ComparisonPolicy >, 1083
- integer\_polynomial
  - GiNaC::info\_flags, 715
- integral
  - GiNaC::error\_and\_integral, 529
  - GiNaC::integral, 721
- integral.cpp, 1261
- integral.h, 1262
- integration\_kernel.cpp, 1262
- integration\_kernel.h, 1264
- interpolate
  - GiNaC, 207
- inv\_at\_cit
  - GiNaC::archive, 312
- inverse
  - GiNaC, 199, 233
  - GiNaC::matrix, 780
  - GiNaC::numeric, 895
- inverse\_atoms
  - GiNaC::archive, 317
- iquo
  - GiNaC, 230
- irem
  - GiNaC, 229
- is\_a
  - GiNaC, 84, 115, 248
  - GiNaC::ex, 565
- is\_canonical
  - GiNaC::expairseq, 590
- is\_canonical\_numeric
  - GiNaC::expair, 570
- is\_cinteger
  - GiNaC, 235
  - GiNaC::numeric, 899
- is\_clifford\_tinfo
  - GiNaC, 98
- is\_color\_tinfo
  - GiNaC, 102
- is\_compatible\_to
  - GiNaC::pseries, 1000
- is\_contravariant
  - GiNaC::varidx, 1186
- is\_covariant
  - GiNaC::varidx, 1186
- is\_crational
  - GiNaC, 235
  - GiNaC::numeric, 899
- is\_defined
  - GiNaC::scalar\_products, 1048
- is\_dim\_numeric
  - GiNaC::idx, 692
- is\_dim\_symbolic
  - GiNaC::idx, 692
- is\_dirac\_slash
  - GiNaC, 88
- is\_discriminant\_of\_quadratic\_number\_field
  - GiNaC, 188
- is\_dotted
  - GiNaC::spinidx, 1059
- is\_dummy\_pair
  - GiNaC, 122, 123
- is\_dummy\_pair\_same\_type
  - GiNaC::idx, 691
  - GiNaC::spinidx, 1058
  - GiNaC::varidx, 1185
- is\_equal
  - GiNaC::basic, 353
  - GiNaC::ex, 558
  - GiNaC::expair, 570
  - GiNaC::numeric, 896
  - GiNaC::remember\_table\_entry, 1040
- is\_equal\_same\_type
  - GiNaC::basic, 350
  - GiNaC::constant, 435
  - GiNaC::container< C >, 448
  - GiNaC::expairseq, 583
  - GiNaC::fderivative, 612
  - GiNaC::function, 632
  - GiNaC::numeric, 891
  - GiNaC::structure< T, ComparisonPolicy >, 1086
  - GiNaC::symbol, 1123
- is\_even
  - GiNaC, 234
  - GiNaC::numeric, 898
- is\_ex\_the\_function
  - function.h, 1241
- is\_exactly\_a
  - GiNaC, 85, 115
  - GiNaC::ex, 565
- is\_integer
  - GiNaC, 234
  - GiNaC::numeric, 897
- is\_less
  - GiNaC::expair, 570
- is\_negative
  - GiNaC, 234
  - GiNaC::numeric, 897
  - GiNaC::status\_flags, 1071
- is\_nonneg\_integer
  - GiNaC, 234
  - GiNaC::numeric, 898
- is\_numeric
  - GiNaC::Ebar\_kernel, 495
  - GiNaC::Eisenstein\_h\_kernel, 505
  - GiNaC::Eisenstein\_kernel, 515
  - GiNaC::ELi\_kernel, 525
  - GiNaC::idx, 692
  - GiNaC::integration\_kernel, 732
  - GiNaC::Kronecker\_dtau\_kernel, 745
  - GiNaC::Kronecker\_dz\_kernel, 754
  - GiNaC::modular\_form\_kernel, 800
  - GiNaC::multiple\_polylog\_kernel, 860
  - GiNaC::user\_defined\_kernel, 1177

- is\_odd
  - GiNaC, [235](#)
  - GiNaC::numeric, [898](#)
- is\_order\_function
  - GiNaC, [151](#)
- is\_polynomial
  - GiNaC, [108](#)
  - GiNaC::add, [302](#)
  - GiNaC::basic, [343](#)
  - GiNaC::constant, [433](#)
  - GiNaC::ex, [549](#)
  - GiNaC::mul, [812](#)
  - GiNaC::numeric, [886](#)
  - GiNaC::power, [946](#)
  - GiNaC::symbol, [1122](#)
- is\_pos\_integer
  - GiNaC, [234](#)
  - GiNaC::numeric, [898](#)
- is\_positive
  - GiNaC, [234](#)
  - GiNaC::numeric, [897](#)
  - GiNaC::status\_flags, [1071](#)
- is\_prime
  - GiNaC, [235](#)
  - GiNaC::numeric, [898](#)
- is\_rational
  - GiNaC, [235](#)
  - GiNaC::numeric, [899](#)
- is\_real
  - GiNaC, [235](#)
  - GiNaC::numeric, [899](#)
- is\_symbolic
  - GiNaC::idx, [692](#)
- is\_terminating
  - GiNaC, [249](#)
  - GiNaC::pseries, [1000](#)
- is\_the\_function
  - GiNaC, [121](#)
- is\_the\_function< G\_SERIAL >
  - GiNaC, [150](#)
- is\_the\_function< iterated\_integral\_SERIAL >
  - GiNaC, [151](#)
- is\_the\_function< psi\_SERIAL >
  - GiNaC, [150](#)
- is\_the\_function< zeta\_SERIAL >
  - GiNaC, [149](#)
- is\_undotted
  - GiNaC::spinidx, [1059](#)
- is\_valid
  - GiNaC::print\_functor, [971](#)
- is\_zero
  - GiNaC, [114](#), [233](#)
  - GiNaC::ex, [559](#)
  - GiNaC::numeric, [897](#)
  - GiNaC::pseries, [1000](#)
- is\_zero\_matrix
  - GiNaC::ex, [559](#)
  - GiNaC::matrix, [782](#)
- isqrt
  - GiNaC, [231](#)
- iterated\_integral
  - GiNaC, [150](#), [151](#)
- iterated\_integral2\_eval
  - GiNaC, [154](#)
- iterated\_integral2\_evalf
  - GiNaC, [154](#)
- iterated\_integral3\_eval
  - GiNaC, [155](#)
- iterated\_integral3\_evalf
  - GiNaC, [154](#)
- iterated\_integral\_evalf\_impl
  - GiNaC, [154](#)
- iterator\_category
  - GiNaC::const\_iterator, [416](#)
  - GiNaC::const\_postorder\_iterator, [422](#)
  - GiNaC::const\_preorder\_iterator, [425](#)
- K
  - GiNaC::Eisenstein\_kernel, [517](#)
  - GiNaC::Kronecker\_dtau\_kernel, [747](#)
  - GiNaC::Kronecker\_dz\_kernel, [756](#)
- k
  - GiNaC::Eisenstein\_h\_kernel, [507](#)
  - GiNaC::Eisenstein\_kernel, [516](#)
  - GiNaC::modular\_form\_kernel, [802](#)
- Kronecker\_dtau\_kernel
  - GiNaC::Kronecker\_dtau\_kernel, [745](#)
- Kronecker\_dz\_kernel
  - GiNaC::Kronecker\_dz\_kernel, [754](#)
- kronecker\_symbol
  - GiNaC, [189](#)
- label
  - GiNaC::wildcard, [1194](#)
- lanczos\_coeffs
  - GiNaC::lanczos\_coeffs, [757](#)
- laplace
  - GiNaC::determinant\_algo, [461](#)
- last\_access
  - GiNaC::remember\_table\_entry, [1041](#)
- latex
  - GiNaC, [245](#)
- latex\_name
  - GiNaC::function\_options, [644](#)
- Laurent\_series
  - GiNaC::Eisenstein\_h\_kernel, [505](#)
  - GiNaC::Eisenstein\_kernel, [515](#)
  - GiNaC::integration\_kernel, [733](#)
  - GiNaC::modular\_form\_kernel, [801](#)
  - GiNaC::user\_defined\_kernel, [1177](#)
- lcm
  - GiNaC, [211](#), [231](#)
- lcm\_of\_coefficients\_denominators
  - GiNaC, [203](#)
- lcmcoeff
  - GiNaC, [202](#)
- lcoeff

- GiNaC::ex, 549
- ldeg\_a
  - GiNaC::sym\_desc, 1114
- ldeg\_b
  - GiNaC::sym\_desc, 1114
- ldegree
  - GiNaC, 108
  - GiNaC::add, 302
  - GiNaC::basic, 343
  - GiNaC::ex, 549
  - GiNaC::integral, 722
  - GiNaC::mul, 812
  - GiNaC::ncmul, 870
  - GiNaC::numeric, 886
  - GiNaC::power, 947
  - GiNaC::pseries, 995
  - GiNaC::structure< T, ComparisonPolicy >, 1080
- less
  - GiNaC::relational, 1028
- less\_or\_equal
  - GiNaC::relational, 1028
- let\_op
  - GiNaC::basic, 340
  - GiNaC::clifford, 390
  - GiNaC::container< C >, 446
  - GiNaC::Ebar\_kernel, 495
  - GiNaC::Eisenstein\_h\_kernel, 504
  - GiNaC::Eisenstein\_kernel, 515
  - GiNaC::ELi\_kernel, 525
  - GiNaC::ex, 544
  - GiNaC::integral, 722
  - GiNaC::Kronecker\_dtau\_kernel, 745
  - GiNaC::Kronecker\_dz\_kernel, 754
  - GiNaC::matrix, 772
  - GiNaC::modular\_form\_kernel, 800
  - GiNaC::multiple\_polylog\_kernel, 860
  - GiNaC::structure< T, ComparisonPolicy >, 1078
  - GiNaC::user\_defined\_kernel, 1177
- lgamma
  - GiNaC, 224, 225
- lgamma\_conjugate
  - GiNaC, 156
- lgamma\_deriv
  - GiNaC, 155
- lgamma\_eval
  - GiNaC, 155
- lgamma\_evalf
  - GiNaC, 155
- lgamma\_series
  - GiNaC, 156
- lh
  - GiNaC::relational, 1034
- lhs
  - GiNaC, 113
  - GiNaC::ex, 545
  - GiNaC::relational, 1032
- Li2
  - GiNaC, 224
- Li2\_
  - GiNaC, 223
- Li2\_conjugate
  - GiNaC, 142
- Li2\_deriv
  - GiNaC, 142
- Li2\_eval
  - GiNaC, 142
- Li2\_evalf
  - GiNaC, 141
- Li2\_projection
  - GiNaC, 223
- Li2\_series
  - GiNaC, 142, 223
- Li3\_eval
  - GiNaC, 143
- Li\_deriv
  - GiNaC, 162
- Li\_eval
  - GiNaC, 161
- Li\_evalf
  - GiNaC, 161
- Li\_print\_latex
  - GiNaC, 162
- Li\_series
  - GiNaC, 161
- library\_init
  - GiNaC::library\_init, 759
- library\_initializer
  - GiNaC, 270
- likely
  - compiler.h, 1214
- link\_ex
  - GiNaC, 118
- list
  - GiNaC::info\_flags, 715
- log
  - GiNaC, 218
- log2
  - GiNaC, 263
- log\_conjugate
  - GiNaC, 170
- log\_deriv
  - GiNaC, 169
- log\_eval
  - GiNaC, 168
- log\_evalf
  - GiNaC, 168
- log\_expand
  - GiNaC, 169
- log\_imag\_part
  - GiNaC, 169
- log\_info
  - GiNaC, 170
- log\_real\_part
  - GiNaC, 169
- log\_series
  - GiNaC, 169

- lookup\_entry
  - GiNaC::remember\_table, [1037](#)
  - GiNaC::remember\_table\_list, [1043](#)
- lookup\_map
  - GiNaC, [81](#)
- lookup\_remember\_table
  - GiNaC::function, [633](#)
- lorentz\_eps
  - GiNaC, [261](#)
- lorentz\_g
  - GiNaC, [260](#)
- lsolve
  - GiNaC, [148](#)
- lst
  - GiNaC, [81](#)
- lst.cpp, [1265](#)
- lst.h, [1266](#)
- lst\_to\_clifford
  - GiNaC, [95](#)
- lst\_to\_matrix
  - GiNaC, [195](#)
- m
  - GiNaC::basic\_partition\_generator::mpartition2, [803](#)
  - GiNaC::Ebar\_kernel, [497](#)
  - GiNaC::ELi\_kernel, [526](#)
  - GiNaC::matrix, [786](#)
  - GiNaC::partition\_with\_zero\_parts\_generator, [910](#)
- make\_flat
  - GiNaC::expairseq, [589](#)
- make\_flat\_inserter
  - GiNaC::make\_flat\_inserter, [761](#)
- make\_hash\_seed
  - GiNaC, [121](#)
- make\_real\_float
  - GiNaC, [215](#)
- make\_return\_type\_t
  - GiNaC, [249](#)
- make\_safe\_bool
  - GiNaC::relational, [1033](#)
- makewritable
  - GiNaC::ptr< T >, [1008](#)
- makewritable
  - GiNaC::ex, [563](#)
- map
  - GiNaC::basic, [342](#)
  - GiNaC::ex, [547](#), [548](#)
  - GiNaC::expairseq, [581](#)
  - GiNaC::idx, [689](#)
  - GiNaC::power, [946](#)
  - GiNaC::relational, [1030](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1080](#)
- map\_eval\_integ
  - GiNaC, [269](#)
- map\_evalm
  - GiNaC, [268](#)
- markowitz
  - GiNaC::solve\_algo, [1050](#)
- markowitz\_elimination
  - GiNaC::matrix, [784](#)
- match
  - GiNaC, [111](#)
  - GiNaC::basic, [341](#)
  - GiNaC::ex, [546](#)
  - GiNaC::expairseq, [582](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1079](#)
  - GiNaC::wildcard, [1193](#)
- match\_same\_type
  - GiNaC::basic, [341](#)
  - GiNaC::clifford, [387](#)
  - GiNaC::color, [407](#)
  - GiNaC::fderivative, [612](#)
  - GiNaC::function, [632](#)
  - GiNaC::idx, [690](#)
  - GiNaC::matrix, [775](#)
  - GiNaC::relational, [1031](#)
  - GiNaC::spinidx, [1058](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1079](#)
  - GiNaC::varidx, [1185](#)
- matrix
  - GiNaC::matrix, [770](#), [771](#)
- matrix.cpp, [1266](#)
- matrix.h, [1267](#)
- max\_assoc\_size
  - GiNaC::remember\_table, [1038](#)
  - GiNaC::remember\_table\_list, [1043](#)
- max\_coefficient
  - GiNaC::add, [305](#)
  - GiNaC::basic, [347](#)
  - GiNaC::ex, [557](#)
  - GiNaC::mul, [815](#)
  - GiNaC::numeric, [889](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1083](#)
- max\_deg
  - GiNaC::sym\_desc, [1114](#)
- max\_integration\_level
  - GiNaC::integral, [726](#)
- max\_lcnops
  - GiNaC::sym\_desc, [1114](#)
- metric
  - GiNaC::clifford, [391](#)
- metric\_tensor
  - GiNaC, [259](#)
- minimal\_dim
  - GiNaC, [123](#)
  - GiNaC::idx, [693](#)
- minkmetric
  - GiNaC::minkmetric, [792](#)
- minkowski
  - GiNaC::tensepsilon, [1154](#)
- mod
  - GiNaC, [228](#)
- modular\_form\_kernel
  - GiNaC::modular\_form\_kernel, [799](#)
- mpartition2

- GiNaC::basic\_partition\_generator::mpartition2, 803
- mpgen
  - GiNaC::basic\_partition\_generator, 373
- mul
  - GiNaC::add, 310
  - GiNaC::matrix, 776, 777
  - GiNaC::mul, 810, 811
  - GiNaC::numeric, 892
  - GiNaC::power, 956
- mul.cpp, 1269
- mul.h, 1269
- mul\_const
  - GiNaC::pseries, 1001
- mul\_dyn
  - GiNaC::numeric, 893
- mul\_scalar
  - GiNaC::matrix, 777
- mul\_series
  - GiNaC::pseries, 1001
- multi\_iterator\_counter
  - GiNaC::multi\_iterator\_counter< T >, 825
- multi\_iterator\_counter\_indv
  - GiNaC::multi\_iterator\_counter\_indv< T >, 828
- multi\_iterator\_ordered
  - GiNaC::multi\_iterator\_ordered< T >, 832
- multi\_iterator\_ordered\_eq
  - GiNaC::multi\_iterator\_ordered\_eq< T >, 836
- multi\_iterator\_ordered\_eq\_indv
  - GiNaC::multi\_iterator\_ordered\_eq\_indv< T >, 840
- multi\_iterator\_permutation
  - GiNaC::multi\_iterator\_permutation< T >, 844
- multi\_iterator\_shuffle
  - GiNaC::multi\_iterator\_shuffle< T >, 848
- multi\_iterator\_shuffle\_prime
  - GiNaC::multi\_iterator\_shuffle\_prime< T >, 852
- multinomial\_coefficient
  - GiNaC, 263
- multiple\_polylog\_kernel
  - GiNaC::multiple\_polylog\_kernel, 859
- multiply\_lcm
  - GiNaC, 203
- my\_ios\_callback
  - GiNaC, 243
- my\_ios\_index
  - GiNaC, 243
- N
  - GiNaC::basic\_multi\_iterator< T >, 370
  - GiNaC::Eisenstein\_h\_kernel, 507
  - GiNaC::Eisenstein\_kernel, 516
- n
  - GiNaC::basic\_partition\_generator::mpartition2, 803
  - GiNaC::Ebar\_kernel, 497
  - GiNaC::ELi\_kernel, 526
  - GiNaC::Kronecker\_dtau\_kernel, 747
  - GiNaC::Kronecker\_dz\_kernel, 756
- N\_internal
  - GiNaC::multi\_iterator\_shuffle< T >, 849
- name
  - GiNaC::archive::archived\_ex, 330
  - GiNaC::archive\_node::property, 986
  - GiNaC::archive\_node::property\_info, 987
  - GiNaC::constant, 436
  - GiNaC::function\_options, 673
  - GiNaC::print\_context\_options, 960
  - GiNaC::registered\_class\_options, 1022
  - GiNaC::symbol, 1126
- ncmul
  - GiNaC::mul, 822
  - GiNaC::ncmul, 868, 869
- ncmul.cpp, 1270
- ncmul.h, 1271
- negative
  - GiNaC::info\_flags, 715
- negint
  - GiNaC::info\_flags, 715
- next
  - GiNaC::class\_info< OPT >, 376
  - GiNaC::composition\_generator, 414
  - GiNaC::composition\_generator::coolmulti::element, 518
  - GiNaC::partition\_generator, 907
  - GiNaC::partition\_with\_zero\_parts\_generator, 910
- next\_partition
  - GiNaC::basic\_partition\_generator::mpartition2, 803
- next\_permutation
  - GiNaC::composition\_generator::coolmulti, 458
- next\_print\_context\_id
  - GiNaC, 271
- next\_serial
  - GiNaC::constant, 437
  - GiNaC::symbol, 1126
- no\_heur\_gcd
  - GiNaC::gcd\_options, 680
- no\_index\_dimensions
  - GiNaC, 246
- no\_index\_renaming
  - GiNaC::subs\_options, 1109
- no\_part\_factored
  - GiNaC::gcd\_options, 680
- no\_pattern
  - GiNaC::subs\_options, 1109
- no\_type
  - GiNaC::has\_distance< T >, 681
- nodes
  - GiNaC::archive, 317
- noncommutative
  - GiNaC::return\_types, 1046
- noncommutative\_composite
  - GiNaC::return\_types, 1046
- none
  - GiNaC::symmetry, 1133
- nonnegative
  - GiNaC::info\_flags, 715

- nonnegint
  - GiNaC::info\_flags, 715
- nonnull
  - GiNaC::relational::safe\_bool\_helper, 1046
- nops
  - GiNaC, 107, 197
  - GiNaC::basic, 339
  - GiNaC::clifford, 389
  - GiNaC::container< C >, 445
  - GiNaC::Ebar\_kernel, 495
  - GiNaC::Eisenstein\_h\_kernel, 504
  - GiNaC::Eisenstein\_kernel, 514
  - GiNaC::ELi\_kernel, 525
  - GiNaC::ex, 543
  - GiNaC::expairseq, 580
  - GiNaC::idx, 688
  - GiNaC::integral, 722
  - GiNaC::Kronecker\_dtau\_kernel, 745
  - GiNaC::Kronecker\_dz\_kernel, 754
  - GiNaC::matrix, 772
  - GiNaC::modular\_form\_kernel, 800
  - GiNaC::multiple\_polylog\_kernel, 860
  - GiNaC::power, 946
  - GiNaC::pseries, 994
  - GiNaC::relational, 1029
  - GiNaC::structure< T, ComparisonPolicy >, 1077
  - GiNaC::user\_defined\_kernel, 1177
- normal
  - GiNaC, 109
  - GiNaC::add, 304
  - GiNaC::basic, 345
  - GiNaC::ex, 551
  - GiNaC::mul, 814
  - GiNaC::numeric, 888
  - GiNaC::power, 950
  - GiNaC::pseries, 997
  - GiNaC::structure< T, ComparisonPolicy >, 1082
  - GiNaC::symbol, 1121
- normal.cpp, 1272
  - FAST\_COMPARE, 1274
  - STATISTICS, 1274
  - USE\_REMEMBER, 1274
  - USE\_TRIAL\_DIVISION, 1274
- normal.h, 1274
- not\_equal
  - GiNaC::relational, 1028
- not\_shareable
  - GiNaC::status\_flags, 1071
- not\_symmetric
  - GiNaC, 252
- nparams
  - GiNaC::function\_options, 673
- num
  - GiNaC::symminfo, 1140
- num\_expressions
  - GiNaC::archive, 314
- number
  - GiNaC::constant, 437
- number\_of\_type
  - GiNaC, 125
- numer
  - GiNaC, 109, 236
  - GiNaC::ex, 552
  - GiNaC::numeric, 902
- numer\_denom
  - GiNaC, 109
  - GiNaC::ex, 553
- numeric
  - GiNaC::info\_flags, 715
  - GiNaC::numeric, 883–885
- numeric.cpp, 1276
- numeric.h, 1279
- Nv
  - GiNaC::multi\_iterator\_counter\_indv< T >, 830
  - GiNaC::multi\_iterator\_ordered\_eq\_indv< T >, 841
- o
  - GiNaC::relational, 1034
- obj
  - GiNaC::structure< T, ComparisonPolicy >, 1087
- odd
  - GiNaC::info\_flags, 715
- op
  - GiNaC, 113
  - GiNaC::basic, 339
  - GiNaC::clifford, 389
  - GiNaC::container< C >, 446
  - GiNaC::Ebar\_kernel, 495
  - GiNaC::Eisenstein\_h\_kernel, 504
  - GiNaC::Eisenstein\_kernel, 515
  - GiNaC::ELi\_kernel, 525
  - GiNaC::ex, 543
  - GiNaC::expairseq, 581
  - GiNaC::idx, 689
  - GiNaC::integral, 722
  - GiNaC::Kronecker\_dtau\_kernel, 745
  - GiNaC::Kronecker\_dz\_kernel, 754
  - GiNaC::matrix, 772
  - GiNaC::modular\_form\_kernel, 800
  - GiNaC::multiple\_polylog\_kernel, 860
  - GiNaC::power, 946
  - GiNaC::pseries, 994
  - GiNaC::relational, 1029
  - GiNaC::structure< T, ComparisonPolicy >, 1077
  - GiNaC::user\_defined\_kernel, 1177
- operator long
  - GiNaC::\_numeric\_digits, 292
- operator safe\_bool
  - GiNaC::relational, 1033
- operator!
  - GiNaC::relational, 1033
- operator!=
  - GiNaC, 242
  - GiNaC::const\_iterator, 419
  - GiNaC::const\_postorder\_iterator, 423
  - GiNaC::const\_preorder\_iterator, 426
  - GiNaC::internal::\_iter\_rep, 290



- GiNaC::numeric, [900](#)
  - GiNaC::ptr< T >, [1008](#), [1009](#)
  - GiNaC::return\_type\_t, [1044](#)
- operator<
  - GiNaC, [243](#)
  - GiNaC::const\_iterator, [419](#)
  - GiNaC::numeric, [900](#)
  - GiNaC::return\_type\_t, [1044](#)
  - GiNaC::spmapkey, [1069](#)
  - GiNaC::sym\_desc, [1113](#)
- operator<<
  - GiNaC, [83](#), [106](#), [232](#), [244](#), [265–267](#)
  - GiNaC::archive, [316](#)
  - GiNaC::archive\_node, [326](#)
  - GiNaC::basic\_multi\_iterator< T >, [369](#)
  - GiNaC::multi\_iterator\_counter< T >, [826](#)
  - GiNaC::multi\_iterator\_counter\_indv< T >, [830](#)
  - GiNaC::multi\_iterator\_ordered< T >, [834](#)
  - GiNaC::multi\_iterator\_ordered\_eq< T >, [837](#)
  - GiNaC::multi\_iterator\_ordered\_eq\_indv< T >, [841](#)
  - GiNaC::multi\_iterator\_permutation< T >, [845](#)
  - GiNaC::multi\_iterator\_shuffle< T >, [849](#)
  - GiNaC::multi\_iterator\_shuffle\_prime< T >, [853](#)
  - GiNaC::ptr< T >, [1010](#)
- operator<=
  - GiNaC, [243](#)
  - GiNaC::const\_iterator, [419](#)
  - GiNaC::numeric, [900](#)
- operator>
  - GiNaC, [243](#)
  - GiNaC::const\_iterator, [419](#)
  - GiNaC::numeric, [900](#)
- operator>>
  - GiNaC, [83](#), [84](#), [245](#)
  - GiNaC::archive, [316](#)
  - GiNaC::archive\_node, [326](#)
- operator>=
  - GiNaC, [243](#)
  - GiNaC::const\_iterator, [419](#)
  - GiNaC::numeric, [901](#)
- operator()
  - GiNaC::basic\_multi\_iterator< T >, [368](#)
  - GiNaC::derivative\_map\_function, [460](#)
  - GiNaC::error\_and\_integral\_is\_less, [529](#)
  - GiNaC::eval\_integ\_map\_function, [531](#)
  - GiNaC::evalf\_map\_function, [532](#)
  - GiNaC::evalm\_map\_function, [534](#)
  - GiNaC::ex\_base\_is\_less, [566](#)
  - GiNaC::ex\_is\_equal, [567](#)
  - GiNaC::ex\_is\_less, [567](#)
  - GiNaC::ex\_swap, [568](#)
  - GiNaC::expair\_is\_less, [572](#)
  - GiNaC::expair\_rest\_is\_less, [573](#)
  - GiNaC::expair\_swap, [573](#)
  - GiNaC::expand\_map\_function, [594](#)
  - GiNaC::idx\_is\_equal\_ignore\_dim, [695](#)
  - GiNaC::is\_not\_a\_clifford, [736](#)
  - GiNaC::is\_summation\_idx, [737](#)
  - GiNaC::map\_function, [764](#)
  - GiNaC::matrix, [777](#), [778](#)
  - GiNaC::normal\_map\_function, [877](#)
  - GiNaC::op0\_is\_equal, [905](#)
  - GiNaC::pointer\_to\_map\_function, [913](#)
  - GiNaC::pointer\_to\_map\_function\_1arg< T1 >, [915](#)
  - GiNaC::pointer\_to\_map\_function\_2args< T1, T2 >, [917](#)
  - GiNaC::pointer\_to\_map\_function\_3args< T1, T2, T3 >, [920](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function< C >, [923](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function\_1arg< C, T1 >, [925](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function\_2args< C, T1, T2 >, [928](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function\_3args< C, T1, T2, T3 >, [931](#)
  - GiNaC::print\_functor, [971](#)
  - GiNaC::print\_functor\_impl, [972](#)
  - GiNaC::print\_memfun\_handler< T, C >, [976](#)
  - GiNaC::print\_ptrfun\_handler< T, C >, [979](#)
  - GiNaC::sy\_is\_less, [1110](#)
  - GiNaC::sy\_swap, [1111](#)
  - GiNaC::symminfo\_is\_less\_by\_orig, [1140](#)
  - GiNaC::symminfo\_is\_less\_by\_symmterm, [1141](#)
  - GiNaC::terminfo\_is\_less, [1168](#)
  - std::equal\_to< GiNaC::ex >, [527](#)
  - std::hash< GiNaC::ex >, [683](#)
  - std::less< GiNaC::ptr< T > >, [758](#)
- operator+
  - GiNaC, [237](#), [238](#), [240](#)
  - GiNaC::const\_iterator, [418](#), [420](#)
- operator++
  - GiNaC, [241](#), [242](#)
  - GiNaC::basic\_multi\_iterator< T >, [369](#)
  - GiNaC::const\_iterator, [418](#)
  - GiNaC::const\_postorder\_iterator, [423](#)
  - GiNaC::const\_preorder\_iterator, [426](#)
  - GiNaC::multi\_iterator\_counter< T >, [825](#)
  - GiNaC::multi\_iterator\_counter\_indv< T >, [829](#)
  - GiNaC::multi\_iterator\_ordered< T >, [833](#)
  - GiNaC::multi\_iterator\_ordered\_eq< T >, [837](#)
  - GiNaC::multi\_iterator\_ordered\_eq\_indv< T >, [840](#)
  - GiNaC::multi\_iterator\_permutation< T >, [844](#)
  - GiNaC::multi\_iterator\_shuffle< T >, [848](#)
- operator+=
  - GiNaC, [239](#)
  - GiNaC::const\_iterator, [418](#)
- operator-
  - GiNaC, [238](#), [240](#)
  - GiNaC::const\_iterator, [419](#), [420](#)
- operator->
  - GiNaC::const\_iterator, [417](#)
  - GiNaC::const\_postorder\_iterator, [423](#)
  - GiNaC::const\_preorder\_iterator, [426](#)
  - GiNaC::ptr< T >, [1008](#)

- GiNaC::structure< T, ComparisonPolicy >, 1086
- operator--
  - GiNaC, 241, 242
  - GiNaC::const\_iterator, 418
- operator-=
  - GiNaC, 239, 240
  - GiNaC::const\_iterator, 418
- operator/
  - GiNaC, 238, 239
- operator/=
  - GiNaC, 239, 240
- operator=
  - GiNaC::\_numeric\_digits, 292
  - GiNaC::archive\_node, 321
  - GiNaC::basic, 336
  - GiNaC::numeric, 894, 895
  - GiNaC::print\_functor, 971
  - GiNaC::ptr< T >, 1007
- operator==
  - GiNaC, 242
  - GiNaC::const\_iterator, 419
  - GiNaC::const\_postorder\_iterator, 423
  - GiNaC::const\_preorder\_iterator, 426
  - GiNaC::internal::\_iter\_rep, 290
  - GiNaC::numeric, 900
  - GiNaC::ptr< T >, 1008, 1009
  - GiNaC::return\_type\_t, 1044
  - GiNaC::spmapkey, 1069
- operator[]
  - GiNaC::basic, 340, 341
  - GiNaC::basic\_multi\_iterator< T >, 368
  - GiNaC::const\_iterator, 417
  - GiNaC::ex, 544, 545
  - GiNaC::structure< T, ComparisonPolicy >, 1078
- operator\*
  - GiNaC, 238
  - GiNaC::const\_iterator, 417
  - GiNaC::const\_postorder\_iterator, 423
  - GiNaC::const\_preorder\_iterator, 426
  - GiNaC::ptr< T >, 1007
- operator\*=
  - GiNaC, 239, 240
- operators
  - GiNaC::relational, 1028
- operators.cpp, 1282
- operators.h, 1284
- options
  - GiNaC::class\_info< OPT >, 376
  - GiNaC::expand\_map\_function, 594
  - GiNaC::print\_context, 958
- Order\_conjugate
  - GiNaC, 147
- Order\_eval
  - GiNaC, 146
- Order\_expl\_derivative
  - GiNaC, 147
- Order\_imag\_part
  - GiNaC, 147
- Order\_power
  - GiNaC, 147
- Order\_real\_part
  - GiNaC, 147
- Order\_series
  - GiNaC, 147
- orig
  - GiNaC::symminfo, 1140
  - GiNaC::terminfo, 1167
- overall\_coeff
  - GiNaC::expairseq, 591
- overflow
  - GiNaC::basic\_multi\_iterator< T >, 367
- overloaded
  - GiNaC::function\_options, 671
- P
  - GiNaC::modular\_form\_kernel, 802
- p
  - GiNaC::ptr< T >, 1010
- parameter\_set
  - GiNaC::fderivative, 614
- paramset
  - GiNaC, 60
- parent
  - GiNaC::class\_info< OPT >, 376
- parent\_name
  - GiNaC::print\_context\_options, 960
  - GiNaC::registered\_class\_options, 1022
- parents\_identified
  - GiNaC::class\_info< OPT >, 376
- partition
  - GiNaC::partition\_generator, 908
  - GiNaC::partition\_with\_zero\_parts\_generator, 910
- partition\_generator
  - GiNaC::partition\_generator, 907
- partition\_with\_zero\_parts\_generator
  - GiNaC::partition\_with\_zero\_parts\_generator, 910
- pattern\_is\_not\_product
  - GiNaC::subs\_options, 1109
- pattern\_is\_product
  - GiNaC::subs\_options, 1109
- pderivative
  - GiNaC::function, 633
- permutation\_sign
  - GiNaC, 264
- permute\_free\_index\_to\_front
  - GiNaC, 100
- Pi
  - GiNaC, 269
- PIEvalf
  - GiNaC, 232
- pivot
  - GiNaC::matrix, 784
- point
  - GiNaC::pseries, 1003
- pointer
  - GiNaC::const\_iterator, 417
  - GiNaC::const\_postorder\_iterator, 422

- GiNaC::const\_preorder\_iterator, 425
- pointer\_to\_map\_function
  - GiNaC::pointer\_to\_map\_function, 913
- pointer\_to\_map\_function\_1arg
  - GiNaC::pointer\_to\_map\_function\_1arg< T1 >, 915
- pointer\_to\_map\_function\_2args
  - GiNaC::pointer\_to\_map\_function\_2args< T1, T2 >, 917
- pointer\_to\_map\_function\_3args
  - GiNaC::pointer\_to\_map\_function\_3args< T1, T2, T3 >, 920
- pointer\_to\_member\_to\_map\_function
  - GiNaC::pointer\_to\_member\_to\_map\_function< C >, 923
- pointer\_to\_member\_to\_map\_function\_1arg
  - GiNaC::pointer\_to\_member\_to\_map\_function\_1arg< C, T1 >, 925
- pointer\_to\_member\_to\_map\_function\_2args
  - GiNaC::pointer\_to\_member\_to\_map\_function\_2args< C, T1, T2 >, 928
- pointer\_to\_member\_to\_map\_function\_3args
  - GiNaC::pointer\_to\_member\_to\_map\_function\_3args< C, T1, T2, T3 >, 931
- pole\_error
  - GiNaC::pole\_error, 933
- polynomial
  - GiNaC::factor\_options, 595
  - GiNaC::info\_flags, 715
- pos\_sig
  - GiNaC::minkmetric, 794
  - GiNaC::tensepsilon, 1154
- posint
  - GiNaC::info\_flags, 715
- positive
  - GiNaC::domain, 488
  - GiNaC::info\_flags, 715
- possymbol
  - GiNaC::possymbol, 939
- postorder\_begin
  - GiNaC::ex, 541
- postorder\_end
  - GiNaC::ex, 541
- pow
  - GiNaC, 232, 247
  - GiNaC::matrix, 777
- power
  - GiNaC::add, 310
  - GiNaC::function, 634
  - GiNaC::mul, 822
  - GiNaC::ncmul, 875
  - GiNaC::numeric, 893
  - GiNaC::power, 945
- power.cpp, 1285
- power.h, 1286
- power\_const
  - GiNaC::pseries, 1001
- power\_dyn
  - GiNaC::numeric, 894
- power\_f
  - GiNaC::function\_options, 674
- power\_func
  - GiNaC::function\_options, 660–662, 667
- power\_funcp
  - GiNaC, 60
- power\_funcp\_1
  - GiNaC, 62
- power\_funcp\_10
  - GiNaC, 73
- power\_funcp\_11
  - GiNaC, 75
- power\_funcp\_12
  - GiNaC, 76
- power\_funcp\_13
  - GiNaC, 78
- power\_funcp\_14
  - GiNaC, 79
- power\_funcp\_2
  - GiNaC, 63
- power\_funcp\_3
  - GiNaC, 64
- power\_funcp\_4
  - GiNaC, 65
- power\_funcp\_5
  - GiNaC, 67
- power\_funcp\_6
  - GiNaC, 68
- power\_funcp\_7
  - GiNaC, 69
- power\_funcp\_8
  - GiNaC, 71
- power\_funcp\_9
  - GiNaC, 72
- power\_funcp\_exvector
  - GiNaC, 80
- power\_use\_exvector\_args
  - GiNaC::function\_options, 677
- precedence
  - GiNaC::add, 301
  - GiNaC::basic, 338
  - GiNaC::clifford, 386
  - GiNaC::container< C >, 445
  - GiNaC::expairseq, 580
  - GiNaC::function, 628
  - GiNaC::indexed, 707
  - GiNaC::integral, 721
  - GiNaC::mul, 811
  - GiNaC::ncmul, 869
  - GiNaC::numeric, 885
  - GiNaC::power, 945
  - GiNaC::pseries, 994
  - GiNaC::relational, 1029
  - GiNaC::structure< T, ComparisonPolicy >, 1077
- prem
  - GiNaC, 205
- preorder\_begin

- GiNaC::ex, 540
- preorder\_end
  - GiNaC::ex, 540
- prepend
  - GiNaC::container< C >, 450
- prime
  - GiNaC::info\_flags, 715
- primitive\_dirichlet\_character
  - GiNaC, 189
- primpart
  - GiNaC::ex, 555
- print
  - GiNaC::\_numeric\_digits, 292
  - GiNaC::basic, 337
  - GiNaC::ex, 542
  - GiNaC::expair, 570
  - GiNaC::fderivative, 610
  - GiNaC::function, 627
  - GiNaC::structure< T, ComparisonPolicy >, 1076
- print.cpp, 1287
- print.h, 1287
  - GINAC\_DECLARE\_PRINT\_CONTEXT, 1289
  - GINAC\_DECLARE\_PRINT\_CONTEXT\_BASE, 1289
  - GINAC\_DECLARE\_PRINT\_CONTEXT\_COMMON, 1289
  - GINAC\_IMPLEMENT\_PRINT\_CONTEXT, 1290
- print\_add
  - GiNaC::add, 308
- print\_context
  - GiNaC::print\_context, 957
- print\_context\_class\_info
  - GiNaC, 82
- print\_context\_options
  - GiNaC::print\_context\_options, 959
- print\_csrc
  - GiNaC::print\_csrc, 962
- print\_csrc\_cl\_N
  - GiNaC::print\_csrc\_cl\_N, 964
- print\_csrc\_double
  - GiNaC::print\_csrc\_double, 966
- print\_csrc\_float
  - GiNaC::print\_csrc\_float, 968
- print\_dflt
  - GiNaC::print\_dflt, 969
- print\_dispatch
  - GiNaC::basic, 351
- print\_dispatch\_table
  - GiNaC::function\_options, 675
  - GiNaC::registered\_class\_options, 1022
- print\_elements
  - GiNaC::matrix, 785
- print\_func
  - GiNaC::function\_options, 668–670
  - GiNaC::registered\_class\_options, 1021, 1022
- print\_func< print\_context >
  - GiNaC, 122
- print\_func< print\_dflt >
  - GiNaC, 87, 99, 258
- print\_funcp
  - GiNaC, 61
- print\_funcp\_1
  - GiNaC, 62
- print\_funcp\_10
  - GiNaC, 73
- print\_funcp\_11
  - GiNaC, 75
- print\_funcp\_12
  - GiNaC, 76
- print\_funcp\_13
  - GiNaC, 78
- print\_funcp\_14
  - GiNaC, 79
- print\_funcp\_2
  - GiNaC, 63
- print\_funcp\_3
  - GiNaC, 64
- print\_funcp\_4
  - GiNaC, 65
- print\_funcp\_5
  - GiNaC, 67
- print\_funcp\_6
  - GiNaC, 68
- print\_funcp\_7
  - GiNaC, 69
- print\_funcp\_8
  - GiNaC, 71
- print\_funcp\_9
  - GiNaC, 72
- print\_funcp\_exvector
  - GiNaC, 81
- print\_functor
  - GiNaC::print\_functor, 970, 971
- print\_index
  - GiNaC::idx, 693
- print\_index\_dimensions
  - GiNaC::print\_options, 978
- print\_indexed
  - GiNaC::indexed, 711
- print\_integer\_csrc
  - GiNaC, 216
- print\_latex
  - GiNaC::print\_latex, 974
- print\_memfun\_handler
  - GiNaC::print\_memfun\_handler< T, C >, 976
- print\_numeric
  - GiNaC::numeric, 903
- print\_operator
  - GiNaC, 250
- print\_overall\_coeff
  - GiNaC::mul, 820
- print\_power
  - GiNaC::power, 953
- print\_ptrfun\_handler
  - GiNaC::print\_ptrfun\_handler< T, C >, 979
- print\_python

- GiNaC::print\_python, [981](#)
- print\_python\_repr
  - GiNaC::print\_python\_repr, [983](#)
- print\_real\_cl\_N
  - GiNaC, [218](#)
- print\_real\_csrc
  - GiNaC, [217](#)
- print\_real\_number
  - GiNaC, [216](#)
- print\_series
  - GiNaC::pseries, [1002](#)
- print\_sym\_pow
  - GiNaC, [247](#)
- print\_tree
  - GiNaC::print\_tree, [984](#)
- print\_use\_exvector\_args
  - GiNaC::function\_options, [677](#)
- printindices
  - GiNaC::indexed, [711](#)
- printpair
  - GiNaC::expairseq, [585](#)
- printraw
  - GiNaC::archive, [315](#)
  - GiNaC::archive\_node, [326](#)
- printseq
  - GiNaC::container< C >, [449](#)
  - GiNaC::expairseq, [585](#)
- product\_to\_exvector
  - GiNaC, [127](#)
- property
  - GiNaC::archive\_node::property, [985](#)
- property\_info
  - GiNaC::archive\_node::property\_info, [987](#)
- property\_type
  - GiNaC::archive\_node, [320](#)
- propinfovector
  - GiNaC::archive\_node, [320](#)
- props
  - GiNaC::archive\_node, [327](#)
- pseries
  - GiNaC::pseries, [993](#), [994](#)
- pseries.cpp, [1290](#)
- pseries.h, [1291](#)
- psi
  - GiNaC, [150](#), [225](#)
- psi1\_deriv
  - GiNaC, [159](#)
- psi1\_eval
  - GiNaC, [159](#)
- psi1\_evalf
  - GiNaC, [158](#)
- psi1\_series
  - GiNaC, [159](#)
- psi2\_deriv
  - GiNaC, [160](#)
- psi2\_eval
  - GiNaC, [159](#)
- psi2\_evalf
  - GiNaC, [159](#)
- psi2\_series
  - GiNaC, [160](#)
- ptr
  - GiNaC::pointer\_to\_map\_function, [913](#)
  - GiNaC::pointer\_to\_map\_function\_1arg< T1 >, [915](#)
  - GiNaC::pointer\_to\_map\_function\_2args< T1, T2 >, [918](#)
  - GiNaC::pointer\_to\_map\_function\_3args< T1, T2, T3 >, [920](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function< C >, [923](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function\_1arg< C, T1 >, [926](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function\_2args< C, T1, T2 >, [928](#)
  - GiNaC::pointer\_to\_member\_to\_map\_function\_3args< C, T1, T2, T3 >, [931](#)
  - GiNaC::ptr< T >, [1007](#)
- ptr.h, [1292](#)
- PTYPE\_BOOL
  - GiNaC::archive\_node, [320](#)
- PTYPE\_NODE
  - GiNaC::archive\_node, [320](#)
- PTYPE\_STRING
  - GiNaC::archive\_node, [320](#)
- PTYPE\_UNSIGNED
  - GiNaC::archive\_node, [320](#)
- purely\_indefinite
  - GiNaC::status\_flags, [1071](#)
- python
  - GiNaC, [245](#)
- python\_repr
  - GiNaC, [245](#)
- q\_expansion\_modular\_form
  - GiNaC::Eisenstein\_h\_kernel, [506](#)
  - GiNaC::Eisenstein\_kernel, [516](#)
  - GiNaC::modular\_form\_kernel, [801](#)
- quo
  - GiNaC, [203](#)
- r
  - GiNaC::Eisenstein\_h\_kernel, [507](#)
- rank
  - GiNaC, [199](#)
  - GiNaC::matrix, [781](#), [782](#)
- rational
  - GiNaC::info\_flags, [715](#)
- rational\_function
  - GiNaC::info\_flags, [715](#)
- rational\_polynomial
  - GiNaC::info\_flags, [715](#)
- rbegin
  - GiNaC::container< C >, [452](#)
- read\_archive
  - GiNaC::basic, [352](#)
  - GiNaC::clifford, [386](#)

- GiNaC::color, [407](#)
  - GiNaC::constant, [434](#)
  - GiNaC::container< C >, [447](#)
  - GiNaC::expairseq, [583](#)
  - GiNaC::fderivative, [611](#)
  - GiNaC::function, [631](#)
  - GiNaC::idx, [690](#)
  - GiNaC::indexed, [708](#)
  - GiNaC::integral, [724](#)
  - GiNaC::matrix, [774](#)
  - GiNaC::minkmetric, [793](#)
  - GiNaC::numeric, [890](#)
  - GiNaC::power, [951](#)
  - GiNaC::pseries, [999](#)
  - GiNaC::relational, [1030](#)
  - GiNaC::spinidx, [1058](#)
  - GiNaC::symbol, [1123](#)
  - GiNaC::symmetry, [1134](#)
  - GiNaC::tensepsilon, [1153](#)
  - GiNaC::varidx, [1185](#)
  - GiNaC::wildcard, [1193](#)
- read\_real\_float
  - GiNaC, [215](#)
- read\_unsigned
  - GiNaC, [83](#)
- real
  - GiNaC, [236](#)
  - GiNaC::domain, [488](#)
  - GiNaC::info\_flags, [715](#)
  - GiNaC::numeric, [902](#)
- real\_part
  - GiNaC, [107](#)
  - GiNaC::add, [305](#)
  - GiNaC::basic, [350](#)
  - GiNaC::constant, [433](#)
  - GiNaC::container< C >, [448](#)
  - GiNaC::ex, [545](#)
  - GiNaC::function, [630](#)
  - GiNaC::indexed, [707](#)
  - GiNaC::matrix, [774](#)
  - GiNaC::mul, [814](#)
  - GiNaC::ncmul, [872](#)
  - GiNaC::numeric, [890](#)
  - GiNaC::power, [951](#)
  - GiNaC::pseries, [998](#)
  - GiNaC::realsymbol, [1016](#)
  - GiNaC::symbol, [1122](#)
- real\_part\_conjugate
  - GiNaC, [132](#)
- real\_part\_eval
  - GiNaC, [132](#)
- real\_part\_evalf
  - GiNaC, [132](#)
- real\_part\_expl\_derivative
  - GiNaC, [133](#)
- real\_part\_f
  - GiNaC::function\_options, [674](#)
- real\_part\_func
  - GiNaC::function\_options, [650–652](#), [666](#)
- real\_part\_funcp
  - GiNaC, [60](#)
- real\_part\_funcp\_1
  - GiNaC, [61](#)
- real\_part\_funcp\_10
  - GiNaC, [73](#)
- real\_part\_funcp\_11
  - GiNaC, [74](#)
- real\_part\_funcp\_12
  - GiNaC, [75](#)
- real\_part\_funcp\_13
  - GiNaC, [77](#)
- real\_part\_funcp\_14
  - GiNaC, [78](#)
- real\_part\_funcp\_2
  - GiNaC, [62](#)
- real\_part\_funcp\_3
  - GiNaC, [64](#)
- real\_part\_funcp\_4
  - GiNaC, [65](#)
- real\_part\_funcp\_5
  - GiNaC, [66](#)
- real\_part\_funcp\_6
  - GiNaC, [67](#)
- real\_part\_funcp\_7
  - GiNaC, [69](#)
- real\_part\_funcp\_8
  - GiNaC, [70](#)
- real\_part\_funcp\_9
  - GiNaC, [71](#)
- real\_part\_funcp\_exvector
  - GiNaC, [80](#)
- real\_part\_imag\_part
  - GiNaC, [133](#)
- real\_part\_print\_latex
  - GiNaC, [132](#)
- real\_part\_real\_part
  - GiNaC, [132](#)
- real\_part\_use\_exvector\_args
  - GiNaC::function\_options, [676](#)
- really\_subs\_idx
  - GiNaC::subs\_options, [1109](#)
- realsymbol
  - GiNaC::realsymbol, [1015](#), [1016](#)
- recombine\_pair\_to\_ex
  - GiNaC::add, [308](#)
  - GiNaC::expairseq, [586](#)
  - GiNaC::mul, [818](#)
- reduced\_matrix
  - GiNaC, [196](#)
- reeval\_ncmul
  - GiNaC, [201](#)
  - GiNaC::ncmul, [875](#)
- refcount
  - GiNaC::refcounted, [1020](#)
- refcounted
  - GiNaC::refcounted, [1019](#)

- reference
  - GiNaC::const\_iterator, [417](#)
  - GiNaC::const\_postorder\_iterator, [422](#)
  - GiNaC::const\_preorder\_iterator, [425](#)
- REGISTER\_FUNCTION
  - function.h, [1241](#)
  - GiNaC, [131](#), [133](#), [134](#), [137](#), [138](#), [140–143](#), [145](#), [146](#), [148](#), [152](#), [154](#), [156–158](#), [162](#), [163](#), [165](#), [168](#), [170](#), [172](#), [173](#), [175–179](#), [181](#), [182](#), [184–187](#)
- register\_new
  - GiNaC::function, [634](#)
- registered\_class\_info
  - GiNaC, [82](#)
- registered\_class\_options
  - GiNaC::registered\_class\_options, [1021](#)
- registered\_functions
  - GiNaC::function, [633](#)
- registrar.cpp, [1292](#)
- registrar.h, [1293](#)
  - GINAC\_DECLARE\_REGISTERED\_CLASS, [1294](#)
  - GINAC\_DECLARE\_REGISTERED\_CLASS\_COMMON, [1294](#)
  - GINAC\_DECLARE\_REGISTERED\_CLASS\_NO\_CTORS, [1294](#)
  - GINAC\_IMPLEMENT\_REGISTERED\_CLASS, [1295](#)
  - GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT, [1295](#)
  - GINAC\_IMPLEMENT\_REGISTERED\_CLASS\_OPT\_T, [1295](#)
- relation
  - GiNaC::info\_flags, [715](#)
- relation\_equal
  - GiNaC::info\_flags, [715](#)
- relation\_greater
  - GiNaC::info\_flags, [715](#)
- relation\_greater\_or\_equal
  - GiNaC::info\_flags, [715](#)
- relation\_less
  - GiNaC::info\_flags, [715](#)
- relation\_less\_or\_equal
  - GiNaC::info\_flags, [715](#)
- relation\_not\_equal
  - GiNaC::info\_flags, [715](#)
- relational
  - GiNaC::relational, [1029](#)
- relational.cpp, [1296](#)
- relational.h, [1296](#)
- relative\_integration\_error
  - GiNaC::integral, [726](#)
- rem
  - GiNaC, [204](#)
- remember
  - GiNaC::function\_options, [670](#)
- remember.cpp, [1297](#)
- remember.h, [1297](#)
- remember\_assoc\_size
  - GiNaC::function\_options, [676](#)
- remember\_size
  - GiNaC::function\_options, [676](#)
- remember\_strategy
  - GiNaC::function\_options, [676](#)
  - GiNaC::remember\_table, [1038](#)
  - GiNaC::remember\_table\_list, [1043](#)
- remember\_table
  - GiNaC::remember\_table, [1036](#)
- remember\_table\_entry
  - GiNaC::function, [635](#)
  - GiNaC::remember\_table\_entry, [1040](#)
- remember\_table\_list
  - GiNaC::remember\_table\_list, [1043](#)
- remember\_tables
  - GiNaC::remember\_table, [1037](#)
- remove\_all
  - GiNaC::container< C >, [451](#)
- remove\_dirac\_ONE
  - GiNaC, [94](#)
- remove\_first
  - GiNaC::container< C >, [450](#)
- remove\_last
  - GiNaC::container< C >, [450](#)
- remove\_reference
  - GiNaC::refcounted, [1019](#)
- rename\_dummy\_indices
  - GiNaC, [126](#)
- rename\_dummy\_indices\_uniquely
  - GiNaC, [128](#), [129](#)
- rend
  - GiNaC::container< C >, [452](#)
- replace\_contr\_index
  - GiNaC::tensor, [1165](#)
- replace\_dim
  - GiNaC::idx, [693](#)
- replace\_with\_symbol
  - GiNaC, [213](#)
- reposition\_dummy\_indices
  - GiNaC, [126](#)
  - GiNaC::indexed, [713](#)
- representation\_label
  - GiNaC::clifford, [391](#)
  - GiNaC::color, [409](#)
- reserve
  - GiNaC::container\_storage< C >, [455](#)
- rest
  - GiNaC::expair, [571](#)
- result
  - GiNaC::remember\_table\_entry, [1041](#)
- result\_type
  - GiNaC::map\_function, [764](#)
- resultant
  - GiNaC, [215](#)
- return\_type
  - GiNaC::add, [306](#)
  - GiNaC::basic, [349](#)
  - GiNaC::clifford, [388](#)



- GiNaC::color, [408](#)
  - GiNaC::ex, [561](#)
  - GiNaC::expairseq, [584](#)
  - GiNaC::fail, [600](#)
  - GiNaC::function, [632](#)
  - GiNaC::function\_options, [675](#)
  - GiNaC::indexed, [709](#)
  - GiNaC::integral, [723](#)
  - GiNaC::matrix, [775](#)
  - GiNaC::minkmetric, [793](#)
  - GiNaC::mul, [817](#)
  - GiNaC::ncmul, [873](#)
  - GiNaC::power, [952](#)
  - GiNaC::relational, [1031](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1085](#)
  - GiNaC::su3d, [1092](#)
  - GiNaC::su3f, [1098](#)
  - GiNaC::tensdelta, [1146](#)
  - GiNaC::tensepsilon, [1153](#)
  - GiNaC::tensmetric, [1160](#)
  - GiNaC::tensor, [1165](#)
- return\_type\_tinfo
  - GiNaC::add, [306](#)
  - GiNaC::basic, [349](#)
  - GiNaC::clifford, [388](#)
  - GiNaC::color, [408](#)
  - GiNaC::ex, [561](#)
  - GiNaC::function, [633](#)
  - GiNaC::function\_options, [675](#)
  - GiNaC::indexed, [709](#)
  - GiNaC::integral, [723](#)
  - GiNaC::mul, [817](#)
  - GiNaC::ncmul, [873](#)
  - GiNaC::power, [952](#)
  - GiNaC::relational, [1032](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1086](#)
- rh
  - GiNaC::relational, [1034](#)
- rhs
  - GiNaC, [113](#)
  - GiNaC::ex, [545](#)
  - GiNaC::relational, [1033](#)
- rl
  - GiNaC::return\_type\_t, [1045](#)
- root
  - GiNaC::archive::archived\_ex, [330](#)
- rotate\_left
  - GiNaC, [263](#)
- row
  - GiNaC::matrix, [786](#)
- rows
  - GiNaC, [198](#)
  - GiNaC::matrix, [775](#)
- s
  - GiNaC::const\_postorder\_iterator, [424](#)
  - GiNaC::const\_preorder\_iterator, [427](#)
  - GiNaC::derivative\_map\_function, [460](#)
  - GiNaC::Eisenstein\_h\_kernel, [507](#)
  - GiNaC::print\_context, [958](#)
  - GiNaC::symbolset, [1128](#)
- S\_deriv
  - GiNaC, [163](#)
- S\_eval
  - GiNaC, [162](#)
- S\_evalf
  - GiNaC, [162](#)
- S\_print\_latex
  - GiNaC, [163](#)
- S\_series
  - GiNaC, [163](#)
- safe\_bool
  - GiNaC::relational, [1028](#)
- same\_metric
  - GiNaC::clifford, [389](#)
- scalar\_mul\_indexed
  - GiNaC::basic, [348](#)
  - GiNaC::matrix, [773](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1084](#)
- seq
  - GiNaC::container\_storage< C >, [456](#)
  - GiNaC::expairseq, [591](#)
  - GiNaC::pseries, [1003](#)
  - GiNaC::remember\_table\_entry, [1041](#)
- serial
  - GiNaC::constant, [437](#)
  - GiNaC::function, [635](#)
  - GiNaC::G2\_SERIAL, [678](#)
  - GiNaC::G3\_SERIAL, [679](#)
  - GiNaC::iterated\_integral2\_SERIAL, [737](#)
  - GiNaC::iterated\_integral3\_SERIAL, [738](#)
  - GiNaC::psi1\_SERIAL, [1004](#)
  - GiNaC::psi2\_SERIAL, [1005](#)
  - GiNaC::symbol, [1126](#)
  - GiNaC::zeta1\_SERIAL, [1195](#)
  - GiNaC::zeta2\_SERIAL, [1196](#)
- series
  - GiNaC, [111](#)
  - GiNaC::add, [303](#)
  - GiNaC::basic, [345](#)
  - GiNaC::Eisenstein\_h\_kernel, [504](#)
  - GiNaC::Eisenstein\_kernel, [514](#)
  - GiNaC::ex, [551](#)
  - GiNaC::fderivative, [610](#)
  - GiNaC::function, [629](#)
  - GiNaC::integral, [725](#)
  - GiNaC::integration\_kernel, [732](#)
  - GiNaC::modular\_form\_kernel, [800](#)
  - GiNaC::mul, [814](#)
  - GiNaC::power, [949](#)
  - GiNaC::pseries, [996](#)
  - GiNaC::structure< T, ComparisonPolicy >, [1082](#)
  - GiNaC::symbol, [1121](#)
- series\_coeff
  - GiNaC::integration\_kernel, [735](#)
- series\_coeff\_impl
  - GiNaC::basic\_log\_kernel, [364](#)



- GiNaC::Ebar\_kernel, [496](#)
- GiNaC::ELi\_kernel, [526](#)
- GiNaC::integration\_kernel, [734](#)
- GiNaC::Kronecker\_dtau\_kernel, [746](#)
- GiNaC::Kronecker\_dz\_kernel, [755](#)
- GiNaC::multiple\_polylog\_kernel, [860](#)
- series\_f
  - GiNaC::function\_options, [675](#)
- series\_func
  - GiNaC::function\_options, [662–664](#), [667](#)
- series\_funcp
  - GiNaC, [61](#)
- series\_funcp\_1
  - GiNaC, [62](#)
- series\_funcp\_10
  - GiNaC, [73](#)
- series\_funcp\_11
  - GiNaC, [75](#)
- series\_funcp\_12
  - GiNaC, [76](#)
- series\_funcp\_13
  - GiNaC, [78](#)
- series\_funcp\_14
  - GiNaC, [79](#)
- series\_funcp\_2
  - GiNaC, [63](#)
- series\_funcp\_3
  - GiNaC, [64](#)
- series\_funcp\_4
  - GiNaC, [65](#)
- series\_funcp\_5
  - GiNaC, [67](#)
- series\_funcp\_6
  - GiNaC, [68](#)
- series\_funcp\_7
  - GiNaC, [69](#)
- series\_funcp\_8
  - GiNaC, [71](#)
- series\_funcp\_9
  - GiNaC, [72](#)
- series\_funcp\_exvector
  - GiNaC, [80](#)
- series\_to\_poly
  - GiNaC, [248](#)
- series\_use\_exvector\_args
  - GiNaC::function\_options, [677](#)
- series\_vec
  - GiNaC::integration\_kernel, [736](#)
- set
  - GiNaC::matrix, [778](#)
- set\_cache\_step
  - GiNaC::integration\_kernel, [734](#)
- set\_name
  - GiNaC::function\_options, [644](#)
  - GiNaC::symbol, [1124](#)
- set\_print\_context
  - GiNaC, [244](#)
- set\_print\_func
  - GiNaC, [249](#)
  - GiNaC::function\_options, [672](#)
  - GiNaC::registered\_class\_options, [1022](#)
- set\_print\_options
  - GiNaC, [244](#)
- set\_refcount
  - GiNaC::refcounted, [1019](#)
- set\_return\_type
  - GiNaC::function\_options, [670](#)
- set\_symmetry
  - GiNaC::function\_options, [671](#)
- set\_TeX\_name
  - GiNaC::symbol, [1124](#)
- set\_type
  - GiNaC::symmetry, [1135](#)
- setflag
  - GiNaC::basic, [355](#)
- shaker\_sort
  - GiNaC, [264](#)
- share
  - GiNaC::ex, [563](#)
- shift\_exponents
  - GiNaC::pseries, [1002](#)
- show\_statistics
  - GiNaC::remember\_table, [1037](#)
- simplify\_indexed
  - GiNaC, [111](#), [112](#), [127](#)
  - GiNaC::ex, [557](#), [558](#)
  - GiNaC::indexed, [713](#)
- simplify\_indexed\_product
  - GiNaC, [127](#)
  - GiNaC::indexed, [713](#)
- sin
  - GiNaC, [219](#)
- sin\_conjugate
  - GiNaC, [171](#)
- sin\_deriv
  - GiNaC, [171](#)
- sin\_eval
  - GiNaC, [170](#)
- sin\_evalf
  - GiNaC, [170](#)
- sin\_imag\_part
  - GiNaC, [171](#)
- sin\_real\_part
  - GiNaC, [171](#)
- sinh
  - GiNaC, [221](#)
- sinh\_conjugate
  - GiNaC, [180](#)
- sinh\_deriv
  - GiNaC, [180](#)
- sinh\_eval
  - GiNaC, [180](#)
- sinh\_evalf
  - GiNaC, [179](#)
- sinh\_imag\_part
  - GiNaC, [180](#)

- sinh\_real\_part
  - GiNaC, 180
- size
  - GiNaC::basic\_multi\_iterator< T >, 367
- smod
  - GiNaC, 228
  - GiNaC::add, 304
  - GiNaC::basic, 346
  - GiNaC::ex, 556
  - GiNaC::mul, 815
  - GiNaC::numeric, 889
  - GiNaC::structure< T, ComparisonPolicy >, 1083
- solve
  - GiNaC::matrix, 781
- sort
  - GiNaC::container< C >, 451
- sort\_
  - GiNaC::container< C >, 449
- spinidx
  - GiNaC::spinidx, 1057
- spinor\_metric
  - GiNaC, 260
- split\_ex\_to\_pair
  - GiNaC::add, 307
  - GiNaC::expairseq, 585
  - GiNaC::mul, 817
- spm
  - GiNaC::scalar\_products, 1048
- spmap
  - GiNaC, 81
- spmapkey
  - GiNaC::spmapkey, 1068
- sprem
  - GiNaC, 205
- sqrfree
  - GiNaC, 211
- sqrfree\_parfrac
  - GiNaC, 212
- sqrfree\_yun
  - GiNaC, 211
- sqrt
  - GiNaC, 231, 248
- sr\_gcd
  - GiNaC, 207
- STATISTICS
  - normal.cpp, 1274
- std, 287
  - swap, 287
- std::equal\_to< GiNaC::ex >, 527
  - operator(), 527
- std::hash< GiNaC::ex >, 682
  - operator(), 683
- std::less< GiNaC::ptr< T > >, 758
  - operator(), 758
- std::less< ptr< T > >
  - GiNaC::ptr< T >, 1009
- step
  - GiNaC, 233
  - GiNaC::numeric, 895
- step\_conjugate
  - GiNaC, 138
- step\_eval
  - GiNaC, 137
- step\_evalf
  - GiNaC, 137
- step\_imag\_part
  - GiNaC, 138
- step\_real\_part
  - GiNaC, 138
- step\_series
  - GiNaC, 137
- STLT
  - GiNaC::container< C >, 444
  - GiNaC::container\_storage< C >, 454
- store\_remember\_table
  - GiNaC::function, 634
- struct\_compare
  - GiNaC::compare\_all\_equal< T >, 410
  - GiNaC::compare\_bitwise< T >, 411
  - GiNaC::compare\_std\_less< T >, 412
- struct\_is\_equal
  - GiNaC::compare\_all\_equal< T >, 410
  - GiNaC::compare\_bitwise< T >, 411
  - GiNaC::compare\_std\_less< T >, 412
- structure
  - GiNaC::structure< T, ComparisonPolicy >, 1075
- structure< T, CP >::reg\_info
  - GiNaC, 272
- structure.h, 1298
- sub
  - GiNaC::matrix, 776
  - GiNaC::numeric, 892
- sub\_dyn
  - GiNaC::numeric, 893
- sub\_matrix
  - GiNaC, 197
- subs
  - GiNaC, 114
  - GiNaC::basic, 342
  - GiNaC::clifford, 390
  - GiNaC::container< C >, 446
  - GiNaC::ex, 547
  - GiNaC::expairseq, 582
  - GiNaC::idx, 689
  - GiNaC::matrix, 772
  - GiNaC::numeric, 887
  - GiNaC::power, 949
  - GiNaC::pseries, 996
  - GiNaC::relational, 1030
  - GiNaC::structure< T, ComparisonPolicy >, 1079
  - GiNaC::symbol, 1121
- subs\_algebraic
  - GiNaC::subs\_options, 1109
- subs\_no\_pattern
  - GiNaC::subs\_options, 1109
- subs\_one\_level

- GiNaC::basic, 352
- subchildren
  - GiNaC::container< C >, 453
  - GiNaC::expairseq, 591
- subvalue
  - GiNaC, 187
- successful\_hits
  - GiNaC::remember\_table\_entry, 1041
- sufficiently\_accurate
  - GiNaC::lanczos\_coeffs, 757
- suppress\_branchcut
  - GiNaC::series\_options, 1049
- swap
  - GiNaC, 114, 119
  - GiNaC::ex, 540
  - GiNaC::expair, 570
  - GiNaC::ptr< T >, 1008
  - std, 287
- swapped
  - GiNaC::sy\_swap, 1111
- sy\_anti
  - GiNaC, 256, 257
- sy\_cycl
  - GiNaC, 257
- sy\_is\_less
  - GiNaC::sy\_is\_less, 1110
  - GiNaC::symmetry, 1136
- sy\_none
  - GiNaC, 255
- sy\_swap
  - GiNaC::sy\_swap, 1111
  - GiNaC::symmetry, 1136
- sy\_symm
  - GiNaC, 255, 256
- sym
  - GiNaC::sym\_desc, 1114
- sym\_desc
  - GiNaC::sym\_desc, 1113
- sym\_desc\_vec
  - GiNaC, 81
- symbol
  - GiNaC::info\_flags, 715
  - GiNaC::symbol, 1120
- symbol.cpp, 1299
- symbol.h, 1299
- symbolic\_matrix
  - GiNaC, 196, 199
- symbolset
  - GiNaC::symbolset, 1127
- symm
  - GiNaC, 254
  - GiNaC::terminfo, 1167
- symmetric
  - GiNaC::symmetry, 1133
- symmetric2
  - GiNaC, 252
- symmetric3
  - GiNaC, 252
- symmetric4
  - GiNaC, 253
- symmetrize
  - GiNaC, 112, 254, 257
  - GiNaC::ex, 559, 560
- symmetrize\_cyclic
  - GiNaC, 113, 254, 258
  - GiNaC::ex, 560
- symmetry
  - GiNaC::symmetry, 1133
- symmetry.cpp, 1300
- symmetry.h, 1301
- symmetry\_type
  - GiNaC::symmetry, 1133
- symminfo
  - GiNaC::symminfo, 1139
- symmterm
  - GiNaC::symminfo, 1139
- symtree
  - GiNaC::function\_options, 678
  - GiNaC::indexed, 714
- synthesize\_func
  - GiNaC, 58
- table\_size
  - GiNaC::remember\_table, 1038
- tan
  - GiNaC, 219
- tan\_conjugate
  - GiNaC, 174
- tan\_deriv
  - GiNaC, 174
- tan\_eval
  - GiNaC, 173
- tan\_evalf
  - GiNaC, 173
- tan\_imag\_part
  - GiNaC, 174
- tan\_real\_part
  - GiNaC, 174
- tan\_series
  - GiNaC, 174
- tanh
  - GiNaC, 222
- tanh\_conjugate
  - GiNaC, 183
- tanh\_deriv
  - GiNaC, 183
- tanh\_eval
  - GiNaC, 182
- tanh\_evalf
  - GiNaC, 182
- tanh\_imag\_part
  - GiNaC, 183
- tanh\_real\_part
  - GiNaC, 183
- tanh\_series
  - GiNaC, 183
- tau

- GiNaC::Kronecker\_dz\_kernel, 756
- tcoeff
  - GiNaC::ex, 550
- tensepsilon
  - GiNaC::tensepsilon, 1152
- tensor
  - GiNaC, 269
- tensor.cpp, 1303
- tensor.h, 1304
- terminfo
  - GiNaC::terminfo, 1167
- test
  - GiNaC::has\_distance< T >, 681
- test\_and\_set\_nparams
  - GiNaC::function\_options, 671
- TEST\_PERMUTATION
  - color.cpp, 1211
- TeX\_name
  - GiNaC::constant, 436
  - GiNaC::function\_options, 673
  - GiNaC::symbol, 1126
- tgamma
  - GiNaC, 225
- tgamma\_conjugate
  - GiNaC, 157
- tgamma\_deriv
  - GiNaC, 157
- tgamma\_eval
  - GiNaC, 156
- tgamma\_evalf
  - GiNaC, 156
- tgamma\_series
  - GiNaC, 157
- thiscontainer
  - GiNaC::clifford, 387, 388
  - GiNaC::color, 408
  - GiNaC::container< C >, 448, 449
  - GiNaC::fderivative, 611
  - GiNaC::function, 629, 630
  - GiNaC::indexed, 709
  - GiNaC::ncmul, 872
- thisexpairseq
  - GiNaC::add, 307
  - GiNaC::expairseq, 584, 585
  - GiNaC::mul, 817
- tinfo
  - GiNaC::return\_type\_t, 1045
- tinfo\_key
  - GiNaC::registered\_class\_options, 1022
- to\_cl\_N
  - GiNaC::numeric, 902
- to\_double
  - GiNaC, 236
  - GiNaC::numeric, 901
- to\_int
  - GiNaC, 236
  - GiNaC::numeric, 901
- to\_long
  - GiNaC, 236
  - GiNaC::numeric, 901
- to\_polynomial
  - GiNaC, 110
  - GiNaC::basic, 346
  - GiNaC::ex, 552
  - GiNaC::expairseq, 582
  - GiNaC::numeric, 888
  - GiNaC::power, 950
  - GiNaC::structure< T, ComparisonPolicy >, 1083
  - GiNaC::symbol, 1122
- to\_rational
  - GiNaC, 110
  - GiNaC::basic, 346
  - GiNaC::ex, 552
  - GiNaC::expairseq, 581
  - GiNaC::numeric, 888
  - GiNaC::power, 950
  - GiNaC::structure< T, ComparisonPolicy >, 1082
  - GiNaC::symbol, 1121
- toggle\_dot
  - GiNaC::spinidx, 1059
- toggle\_variance
  - GiNaC::varidx, 1186
- toggle\_variance\_dot
  - GiNaC::spinidx, 1059
- too\_late
  - GiNaC::\_numeric\_digits, 293
- trace
  - GiNaC, 198
  - GiNaC::matrix, 779
- trace\_string
  - GiNaC, 92
- transpose
  - GiNaC, 198
  - GiNaC::matrix, 778
- traverse
  - GiNaC::ex, 548
- traverse\_postorder
  - GiNaC::ex, 548
- traverse\_preorder
  - GiNaC::ex, 548
- tree
  - GiNaC, 245
- tree\_node
  - GiNaC::class\_info< OPT >::tree\_node, 1169
- trig\_info
  - GiNaC, 171
- trivial
  - GiNaC::composition\_generator, 414
- tryfactsubs
  - GiNaC, 200
- type
  - GiNaC::archive\_node::property, 986
  - GiNaC::archive\_node::property\_info, 987
  - GiNaC::symmetry, 1137
- uintvector
  - GiNaC, 81

- unarch\_map
  - GiNaC::unarchive\_table\_t, [1171](#)
- unarch\_table\_instance
  - GiNaC, [268](#)
- unarchive
  - GiNaC::archive\_node, [325](#)
- unarchive\_ex
  - GiNaC::archive, [313](#), [314](#)
- unarchive\_map\_t
  - GiNaC, [58](#)
- unarchive\_table\_t
  - GiNaC::unarchive\_table\_t, [1170](#)
- unatomize
  - GiNaC::archive, [316](#)
- unique
  - GiNaC::container< C >, [451](#)
- unique\_
  - GiNaC::container< C >, [450](#), [453](#)
- unit
  - GiNaC::ex, [554](#)
- unit\_matrix
  - GiNaC, [196](#), [199](#)
- unitcontprim
  - GiNaC::ex, [556](#)
- unlikely
  - compiler.h, [1214](#)
- unlink\_ex
  - GiNaC, [119](#)
- unsignedvector
  - GiNaC, [81](#)
- USE\_REMEMBER
  - normal.cpp, [1274](#)
- use\_remember
  - GiNaC::function\_options, [676](#)
- use\_return\_type
  - GiNaC::function\_options, [675](#)
- USE\_SAME\_DEGREE\_FACTOR
  - factor.cpp, [1226](#)
- use\_sr\_gcd
  - GiNaC::gcd\_options, [680](#)
- USE\_TRIAL\_DIVISION
  - normal.cpp, [1274](#)
- usecount
  - GiNaC::unarchive\_table\_t, [1171](#)
- used\_indices
  - GiNaC::make\_flat\_inserter, [762](#)
- user\_defined\_kernel
  - GiNaC::user\_defined\_kernel, [1177](#)
- uses\_Laurent\_series
  - GiNaC::Eisenstein\_h\_kernel, [505](#)
  - GiNaC::Eisenstein\_kernel, [516](#)
  - GiNaC::integration\_kernel, [733](#)
  - GiNaC::modular\_form\_kernel, [801](#)
  - GiNaC::user\_defined\_kernel, [1178](#)
- utils.cpp, [1305](#)
- utils.h, [1307](#)
  - DEFAULT\_COMPARE, [1309](#)
  - DEFAULT\_CTOR, [1309](#)
  - DEFAULT\_PRINT, [1309](#)
  - DEFAULT\_PRINT\_LATEX, [1309](#)
- utils\_multi\_iterator.h, [1309](#)
- v
  - GiNaC::basic\_multi\_iterator< T >, [370](#)
  - GiNaC::sy\_is\_less, [1110](#)
  - GiNaC::sy\_swap, [1111](#)
- v1
  - GiNaC::spmapkey, [1069](#)
- v2
  - GiNaC::spmapkey, [1069](#)
- v\_internal
  - GiNaC::multi\_iterator\_shuffle< T >, [849](#)
- v\_orig
  - GiNaC::multi\_iterator\_shuffle< T >, [849](#)
- validate
  - GiNaC::indexed, [712](#)
  - GiNaC::symmetry, [1135](#)
- value
  - GiNaC::archive\_node::property, [986](#)
  - GiNaC::composition\_generator::coolmulti::element, [518](#)
  - GiNaC::has\_distance< T >, [681](#)
  - GiNaC::idx, [694](#)
  - GiNaC::numeric, [905](#)
- value\_type
  - GiNaC::const\_iterator, [416](#)
  - GiNaC::const\_postorder\_iterator, [422](#)
  - GiNaC::const\_preorder\_iterator, [425](#)
- var
  - GiNaC::pseries, [1003](#)
- varidx
  - GiNaC::varidx, [1184](#)
- version.h, [1311](#)
  - GINAC\_LT\_AGE, [1312](#)
  - GINAC\_LT\_CURRENT, [1312](#)
  - GINAC\_LT\_REVISION, [1312](#)
  - GINACLIB\_ARCHIVE\_AGE, [1312](#)
  - GINACLIB\_ARCHIVE\_VERSION, [1312](#)
  - GINACLIB\_MAJOR\_VERSION, [1312](#)
  - GINACLIB\_MICRO\_VERSION, [1312](#)
  - GINACLIB\_MINOR\_VERSION, [1312](#)
  - GINACLIB\_STR, [1312](#)
  - GINACLIB\_STR\_HELPER, [1312](#)
  - GINACLIB\_VERSION, [1313](#)
- version\_major
  - GiNaC, [272](#)
- version\_micro
  - GiNaC, [272](#)
- version\_minor
  - GiNaC, [272](#)
- wild
  - GiNaC, [268](#)
- wildcard
  - GiNaC::wildcard, [1192](#)
- wildcard.cpp, [1313](#)
- wildcard.h, [1314](#)

write\_real\_float  
    GiNaC, [216](#)  
write\_unsigned  
    GiNaC, [83](#)  
  
x  
    GiNaC::basic\_partition\_generator::mpartition2,  
        [803](#)  
    GiNaC::Ebar\_kernel, [497](#)  
    GiNaC::ELi\_kernel, [527](#)  
    GiNaC::integral, [726](#)  
    GiNaC::user\_defined\_kernel, [1178](#)  
  
y  
    GiNaC::Ebar\_kernel, [497](#)  
    GiNaC::ELi\_kernel, [527](#)  
yes\_type  
    GiNaC::has\_distance< T >, [681](#)  
  
z  
    GiNaC::Kronecker\_dtau\_kernel, [747](#)  
    GiNaC::multiple\_polylog\_kernel, [861](#)  
z\_j  
    GiNaC::Kronecker\_dz\_kernel, [756](#)  
zeta  
    GiNaC, [149](#), [224](#)  
zeta1\_deriv  
    GiNaC, [165](#)  
zeta1\_eval  
    GiNaC, [165](#)  
zeta1\_evalf  
    GiNaC, [165](#)  
zeta1\_print\_latex  
    GiNaC, [165](#)  
zeta2\_deriv  
    GiNaC, [166](#)  
zeta2\_eval  
    GiNaC, [166](#)  
zeta2\_evalf  
    GiNaC, [166](#)  
zeta2\_print\_latex  
    GiNaC, [166](#)  
zetaderiv\_deriv  
    GiNaC, [143](#)  
zetaderiv\_eval  
    GiNaC, [143](#)