

Index

- access, 2
- access paths, 155
- `__add__()`, 113
- adjoint, 93
- ANSI C, 37, 184
- Arnoldi method, 47, 177

- back substitution, 135
- backward compatibility, 187
- band matrix, 27, 120, 121, 124
- `band2mat()`, 120
- bandwidth, 27
- `bd_copy()`, 59
- `bd_get()`, 70
- `bdLDLfactor()`, 121
- `bdLDLsolve()`, 121
- `bdLUfactor()`, 124
- `bdLUsolve()`, 124
- `bd_resize()`, 77
- `bd_transp()`, 93
- `bisvd()`, 143
- `BKPfactor()`, 116, 169
- `BKPsolve()`, 116, 169
- BSD Unix, 184
- Bunch–Kaufmann–Parlett factorisation,
 - 116
 - sparse, 169

- C, 189
- C++, 195, 218
- `calloc()`, 197
- `catch()`, 51
- `catchall()`, 51, 204
- `catch_FPE()`, 51
- CGS, 47, 173
- `CHfactor()`, 41, 118
- Cholesky factorisation, 18, 41, 118
 - band, 121
 - incomplete, 21
 - modified, 118
 - sparse, 165
- `CHsolve()`, 41, 118
- columns, 31, 72, 101
- comment, 3, 63, 202
- compact form, 15
- companion matrix, 215
- compatibility, 187
- compilation, 12, 17
- complex
 - conjugate, 38
 - data type, 25
 - matrix, 27
 - number, 111
 - vector, 25
- componentwise operations, 104
- condition number, 40, 42, 44, 47, 128
 - estimator, 40, 122
 - least squares, 42
- conjugate, 38
- conjugate gradients, 173
 - pre-conditioner, 166
- contiguous allocation, 27
- copy, 196
- copy routines, 59
- copying, 199
 - sparse matrices, 151
- copyright, 187
- core routines, 113
- create object, 70

- data structures, 1, 23, 65, 195, 206
- debugging, 65, 203, 215, 216
- deep copy, 199

- dimension, 2
- d_save()**, 91
- Dsolve()**, 135
- efficiency, 203
- eigenvalues, 20, 44, 139, 142, 177
- eigenvectors, 20, 44, 139, 142, 215
- entries, 2
 - band matrix, 27
 - sparse matrix, 153
- ERRABORT()**, 57
- ERREXIT()**, 57
- err_is_list_attached()**, 53
- err_list_attach()**, 53
- err_list_free()**, 53
- error()**, 51, 53, 215
- error handling, 13, 51, 53, 57, 204
- ev_err()**, 53, 204
- exponential, 145
- factorisation, 4
 - BKP, 116
 - sparse, 169
 - Bunch–Kaufman–Parlett, 116
 - Cholesky, 18, 33, 41, 118, 165
 - band, 27, 121
 - incomplete, 21, 48
 - incomplete, 33, 165
 - indefinite, 116
 - LDL, 137
 - LU, 20, 122
 - band, 27, 124
 - incomplete, 48
 - sparse, 167
 - modified, 33
 - positive definite, 118
 - QR, 20, 41, 43, 126, 129, 133, 137
 - Schur, 139
 - sparse, 33
 - SVD, 143
 - symbolic, 33, 165
 - symmetric, 116, 118, 137
- Fast Fourier Transform, 147
- fft()**, 147
- files, 3, 62, 65, 91
- fill-in, 27, 29, 33, 46, 165, 167
- finput()**, 67
- floating point
 - precision, 80
- forward substitution, 135
- fprompter()**, 67
- functional representation, 21, 47, 171, 211
- Gauss–Seidel, 47
- Gaussian elimination, 122, 167
- get object, 70
- get_col()**, 72
- get_row()**, 72
- givens()**, 130
- Givens’ rotations, 43, 130
- GMRES, 47, 173
- GNU, 183, 215, 217
- Hadamard product, 104
- hhtrcols()**, 43, 133
- hhtrrows()**, 43, 133
- hhtrvec()**, 43, 133
- hhvec()**, 43, 133
- Householder transformations, 43, 126, 133
- identity matrix, 73
- ifft()**, 147
- ill conditioning, 37
- ill-conditioned problem, 39, 214
- incremental testing, 213, 216
- indexing, 2
- initialisation, 3, 18, 73, 157
- inner product, 75
- in_prod()**, 75
- input()**, 67
- input routines, 62
- input/output, 3, 12, 13, 65, 67, 198, 200
 - interactive, 200
 - sparse, 158, 160
- integer vectors, 25
- inverse
 - matrix, 122, 215

- permutation, 98
- `__ip__()`, 113
- `iter_cg()`, 21
- `iter_arnoldi()`, 177
- `iter_arnoldi_iref()`, 177
- iterative methods, 47, 173, 177, 187
- iterative routines, 34
 - data structures, 34
- `iter_ATx()`, 171
- `iter_Ax()`, 171
- `iter_Bx()`, 171
- `iter_cg()`, 166, 173
- `iter_cgne()`, 173
- `iter_cgs()`, 173
- `iter_copy()`, 171
- `iter_copy2()`, 171
- `iter_dump()`, 171
- `iter_free()`, 171
- `iter_get()`, 171
- `iter_lanczos()`, 177
- `iter_lanczos2()`, 177
- `iter_lsqr()`, 173
- `iter_mgcr()`, 173
- `iter_resize()`, 171
- `iter_sparnoldi()`, 177
- `iter_sparnoldi_iref()`, 177
- `iter_spcg()`, 21, 173
- `iter_spcgne()`, 173
- `iter_spcgs()`, 173
- `iter_splanczos()`, 177
- `iter_splanczos2()`, 177
- `iter_splsqr()`, 173
- `iter_spmgcr()`, 173
- `iv_add()`, 76
- `iv_copy()`, 59
- `iv_fininput()`, 62
- `IV_FREE()`, 68
- `iv_free()`, 25
- `iv_free_vars()`, 68
- `iv_get()`, 25, 70
- `iv_get_vars()`, 70
- `iv_input()`, 62
- `iv_resize()`, 25, 77
- `iv_resize_vars()`, 77
- `iv_sub()`, 76
- Jordan Normal form, 45
- Krylov subspace, 177
- Lanczos method, 47, 177
- Lanczos routines, 215
- `LDLfactor()`, 118
- `LDLsolve()`, 118
- `LDLupdate()`, 137
- least squares, 20, 41, 126
- linear combinations, 107
- linear equations, 20
- `lint`, 215
- loop unrolling, 185
- `Lsolve()`, 135
- LSQR, 47, 173
- `LTsolve()`, 135
- LU factorisation, 20, 122, 167
 - band, 27, 124
- `LUcondest()`, 40, 122
- `zLUcondest()`, 122
- `LUfactor()`, 20, 122
- `LUsolve()`, 20, 122
- `LUTsolve()`, 122
- M_FREE()**, 6
- MACHEPS**, 37, 43, 80, 167
- machine dependent routines, 113
- machine epsilon, 37, 43, 80, 185, 214
- `m_add()`, 81
- `makeQ()`, 129
- `makeR()`, 129
- Markowitz, 167
- `mat2band()`, 120
- MATLAB, 91
- matrix
 - adjoint, 38
 - band, 27, 120, 121, 124
 - columns, 101
 - complex, 27
 - complex adjoint, 93, 96
 - data structure, 26
 - dense, 46, 120

- diagonal, 104, 105
- exponential, 145
- Hessenberg, 178
- Hilbert, 40
- inverse, 122, 215
- multiplication, 93
- norm, 38, 94
- operations, 3, 30, 81
- orthogonal, 15, 126, 129, 130, 133, 139, 143
- polynomial, 145
- random, 73
- row, 101
- scalar multiplication, 81
- sparse, 29, 46, 121, 124
- structure, 29
- symmetric, 44, 139
- transpose, 93, 96, 120, 154
- tridiagonal, 139
- unitary, 38, 45, 126, 129, 130, 133, 139
- matrix–vector multiplication, 96, 154
- maximum, 104
- MCHfactor(), 118
- m_copy(), 6, 59
- m_dump(), 65
- mem_attach_list(), 83, 208
- mem_bytes(), 83
- mem_bytes_list(), 83, 208
- MEM_COPY(), 114
- mem_free_list(), 83
- mem_info_bytes(), 83
- mem_info_f(), 216
- mem_info_file(), 83
- mem_info_is_on(), 83
- mem_info_numvar(), 83
- mem_info_on(), 83, 216
- mem_info_type(), 216
- mem_is_list_attached(), 83, 208
- mem_numvar_list(), 208
- memory management, 5, 25, 27, 29, 46, 59, 68, 70, 77, 83, 88, 149, 196, 202, 204, 206, 216
- mem_stat_dump(), 88, 217
- mem_stat_free(), 88
- mem_stat_mark(), 88
- MEM_STAT_REG(), 78, 85, 88, 209, 217
- mem_stat_reg_list(), 88, 209
- mem_stat_reg_vars(), 88
- mem_stat_reg_vars(), 14
- mem_stat_show_mark(), 88
- MEM_ZERO(), 186
- m_exp(), 145
- m_finput(), 62
- m_foutput(), 65
- M_FREE(), 68
- m_free_vars(), 68
- MGCR, 47
- m_get(), 2, 70
- m_get_vars(), 70
- m_ident(), 73, 143
- minimum, 104
- m_input(), 62
- m_inverse(), 122
- zm_inverse(), 122
- m_load(), 91
- __mltadd__(), 113
- m_mlt(), 81
- m_move(), 59
- mmtr_mlt(), 93
- m_norm1(), 39, 94
- m_norm_frob(), 39, 94
- m_norm_inf(), 39, 94
- m_ones(), 73
- m_poly(), 145
- m_pow(), 145
- m_rand(), 73
- mrnd(), 73
- mrndlist(), 73
- m_resize(), 77
- m_resize_vars(), 77
- m_save(), 91
- zm_save(), 91
- mem_stat_free(), 8
- mem_stat_mark(), 8
- MEM_STAT_REG(), 8
- m_sub(), 81

- `m_transp()`, 93
- `mtrm_mlt()`, 41, 93
- `mv_mlt()`, 96
- `mv_mltadd()`, 96
- `m_zero()`, 73
- norm, 38
 - Euclidean, 39
 - Frobenius, 39, 94
 - matrix, 38, 94
 - vector, 109
- normal equations, 41
- NULL, 2, 7, 10, 29, 34, 68, 70, 77, 107, 193, 197, 199, 202, 203
- numerical integration, 211
- `ON_ERROR()`, 57
- ordinary differential equations, 8
- orthogonal matrices, 15, 126, 130, 133, 139
- overdetermined system, 41
- partial pivoting, 33, 122, 167
- permutation
 - data structure, 28
 - identity, 2
 - matrices, 99
 - operations, 3, 98
 - vectors, 99
- perturbation theorem, 40, 44
- pointer, 192
- pointers, 1, 29, 195, 212
- polynomial, 104, 145, 214
- power, 145
- preconditioning, 21, 105
- `prompter()`, 67
- pseudo-inverse, 42
- `px_cols()`, 99
- `px_copy()`, 59
- `px_dump()`, 65
- `px_finput()`, 62
- `px_foutput()`, 65
- `PX_FREE()`, 68
- `px_free_vars()`, 68
- `px_get()`, 2, 70
- `px_get_vars()`, 70
- `px_ident()`, 98
- `px_input()`, 62
- `px_inv()`, 98
- `pxinv_vec()`, 99
- `pxinv_zvec()`, 99
- `px_mlt()`, 98
- `px_resize()`, 77
- `px_resize_vars()`, 77
- `px_rows()`, 99
- `px_sign()`, 98
- `px_transp()`, 98
- `px_vec()`, 99
- `px_zvec()`, 99
- QR factorisation, 20, 41, 43, 126, 129
- `QRCPfactor()`, 126
- `QRCPsolve()`, 126
- `QRfactor()`, 15, 20, 126
- `QRsolve()`, 20, 126
- `QRTsolve()`, 126
- `QRupdate()`, 137
- raise an error, 53
- `rand_mat()`, 185
- random entries, 73
- `rand_vec()`, 185
- rank deficient, 42, 43
- rank estimation, 42, 128, 143
- rational function, 214
- resizing, 149, 211
- resizing data structures, 77
- reverse communication, 213
- `rot_cols()`, 130
- `rot_rows()`, 130
- `rot_vec()`, 130
- `rot_zvec()`, 130
- rotations, 130
- `rot_cols()`, 43
- `rot_vec()`, 43
- roundoff error, 214
- rows, 31, 72, 101
- `row_xpd()`, 153
- Runge–Kutta ODE solver, 8

- scalar multiplication, 81, 102
- `schur()`, 20, 45, 139, 142
- Schur decomposition, 20, 44, 139, 142
 - real, 44
- `schur_evals()`, 20, 142
- `schur_vals()`, 45
- `schur_vecs()`, 20, 45, 142
- `setbuf()`, 215
- `set_col()`, 101
- `set_err_flag()`, 53
- `set_row()`, 101
- shallow copy, 196
- Singular Value Decomposition, 143
- singular values, 42, 143
- singular vectors, 42
- size, 2
- SmallTalk, 195
- `__smlt__()`, 113
- `sm_mlt()`, 81
- `smrand()`, 73
- solving equations, 135
- SOR, 47
- sorting, 104
- sparse
 - eigenvalues, 177
 - linear equations, 173
 - matrix, 21, 46
 - rows, 162
- `spBKPfactor()`, 169
- `spBKPsolve()`, 169
- `spCHfactor()`, 33, 165
- `spCHsolve()`, 33, 165
- `spCHsymb()`, 33, 151, 165
- `sp_col_access()`, 31, 155
- `sp_compact()`, 149
- `sp_copy()`, 151
- `sp_copy2()`, 151
- `sp_copy()`, 19
- `sp_diag_access()`, 155
- `sp_dump()`, 30
- `sp_finput()`, 158
- `sp_finput()`, 160
- `sp_foutput()`, 158
- `SP_FREE()`, 149
- `sp_free()`, 149
- `sp_free_vars()`, 149
- `sp_get()`, 18, 149
- `sp_get_val()`, 153
- `sp_get_vars()`, 149
- `spICHfactor()`, 19, 21, 151, 165
- `sp_input()`, 160
- `spLUfactor()`, 33, 167
- `spLUsolve()`, 167
- `spLUTsolve()`, 167
- `sp_mv_mlt()`, 154
- `sp_output()`, 158
- `sp_pccg()`, 19
- `sp_resize()`, 149
- `sp_resize_vars()`, 149
- `sprow_add()`, 162
- `sprow_foutput()`, 162
- `sprow_get()`, 162
- `sprow_get_idx()`, 162
- `sprow_merge()`, 162
- `sprow_mltadd()`, 162
- `sprow_set_val()`, 162
- `sprow_smlt()`, 162
- `sprow_sub()`, 162
- `sprow_xpd()`, 162
- `sp_set_val()`, 18, 153
- `sp_vm_mlt()`, 154
- `sp_zero()`, 157
- stability, 37
 - backward, 37
 - forward, 37
- `__sub__()`, 113
- SVD, 39, 41, 42, 143
- `svd()`, 143
- `sv_mlt()`, 102
- `symmeig()`, 20, 44, 139
- `tracecatch()`, 51, 204
- transpose, 93, 96, 154
- triangular matrices, 135
- `trieig()`, 139
- unit roundoff, 37, 80, 185
- unitary matrices, 45, 126, 130, 133, 139

- Unix, 12, 17, 215
 - BSD, 184
- update routines, 137
- Usolve(), 135
- UTsolve(), 135
- v_add(), 102
- v_conv(), 104
- v_copy(), 2, 59
- v_dump(), 65
- vector
 - adjoint, 38
 - complex, 25
 - data structure, 24
 - linear combinations, 107
 - norms, 109
 - operations, 2, 102, 104
 - random, 73
 - sorting, 104
- vector processors, 185
- v_finput(), 62
- v_foutput(), 65
- V_FREE(), 68
- v_free_vars(), 68
- v_get(), 2, 70
- v_get_vars(), 70
- v_input(), 62
- v_lincomb(), 107
- v_linlist(), 14, 107
- v_map(), 104
- v_max(), 104
- v_min(), 104
- v_mltadd(), 10, 102
- vm_mlt(), 96
- zvm_mlt(), 96
- vm_mltadd(), 96
- v_move(), 59
- v_norm1(), 39, 109
- v_norm2(), 39, 109
- v_norm_inf(), 109
- v_norm_inf(), 39
- v_ones(), 73
- v_pconv(), 104
- v_rand(), 73
- v_resize(), 7, 77
- v_resize_vars(), 77
- v_save(), 91
- v_slash(), 104
- v_sort(), 104
- v_star(), 104
- v_sub(), 102
- v_sum(), 104
- v_zero(), 73
- warning(), 53
- workspace, 88, 204
 - registration, 6, 77, 206
- zabs(), 111
- __zadd__(), 113
- zadd(), 111
- __zconj__(), 113
- zconj(), 111
- zdiv(), 111
- __zero__(), 113, 186
- zexp(), 111
- z_foutput(), 65
- zget_col(), 72
- zget_row(), 72
- zgivens(), 130
- zhhtcols(), 133
- zhhtrows(), 133
- zhhtvec(), 133
- zhhvec(), 133
- zin_prod(), 75
- zinv(), 111
- __zip__(), 113
- zLAsolve(), 135
- zlog(), 111
- zLsolve(), 135
- zLUAsolve(), 122
- zLUfactor(), 122
- zLUsolve(), 122
- zm_add(), 81
- zm_adjoint(), 93
- zmake(), 111
- zmakeQ(), 129
- zmakeR(), 129

zmam_mlt(), 93
zm_copy(), 59
zm_dump(), 65
zm_finput(), 62
zm_foutput(), 65
ZM_FREE(), 68
zm_free_vars(), 68
zm_get(), 70
zm_get_vars(), 70
zm_input(), 62
zm_load(), 91
__zmlt__(), 113
zmlt(), 111
__zmltadd__(), 113
zmma_mlt(), 93
zm_mlt(), 81
zm_move(), 59
zm_norm1(), 94
zm_norm_frob(), 94
zm_norm_inf(), 94
zm_ones(), 73
zm_rand(), 73
zm_resize(), 77
zm_resize_vars(), 77
zm_sub(), 81
zmv_mlt(), 96
zmv_mltadd(), 96
zm_zero(), 73
zneg(), 111
zQRAsolve(), 126
QRCPfactor(), 126
QRfactor(), 126
zQRsolve(), 126
zrot_cols(), 130
zrot_rows(), 130
z_save(), 91
zschur(), 45, 139
zset_col(), 101
zset_row(), 101
zsm_mlt(), 81
zsqrt(), 111
__zsub__(), 113
zsub(), 111
zUAsolve(), 135
zUsolve(), 135
zv_add(), 102
zv_copy(), 59
zv_dump(), 65
zv_finput(), 62
zv_foutput(), 65
ZV_FREE(), 68
zv_free_vars(), 68
zv_get(), 70
zv_get_vars(), 70
zv_input(), 62
zv_lincomb(), 107
zv_linlist(), 107
zv_map(), 104
zv_mlt(), 102
zv_mltadd(), 102
zvm_mltadd(), 96
zv_move(), 59
zv_norm1(), 109
zv_norm2(), 109
zv_norm_inf(), 109
zv_ones(), 73
zv_rand(), 73
zv_resize(), 77
zv_resize_vars(), 77
zv_save(), 91
zv_slash(), 104
zv_star(), 104
zv_sub(), 102
zv_sum(), 104
zv_zero(), 73
__zzero__(), 113