

NAG Library

NAG C Library News, Mark 9

1 Introduction

At Mark 9 of the NAG C Library new functionality has been introduced in addition to improvements in existing areas. The Library now contains 1159 user-callable functions, all of which are documented, of which 153 are new at this mark.

Two new chapters have been introduced on wavelet transforms and global optimization; a new sub-chapter has also been introduced on option pricing formulae; and extensions have been included in the areas of statistics, optimization, linear algebra, ordinary differential equations, regression, random numbers, searching, and special functions.

The new Chapter c09 (Wavelet Transforms) has functions for performing one-dimensional discrete, single-level and multi-level, wavelet transforms and their inverses.

The new Chapter e05 (Global Optimization of a Function) has a function for performing global optimization on a problem with simple bounds using a multi-level coordinate search, which is complemented by a number of support functions for initializing the data and setting optional arguments.

Chapter c05 (Roots of One or More Transcendental Equations) has a new function to evaluate real values of Lambert's W function.

Chapter d02 (Ordinary Differential Equations) has extended its functionality to include functions that use the integration method of DASSL; thus, implicit differential algebraic equations of index 2 can now be solved.

Chapter e04 (Minimizing or Maximizing a Function) has added a replacement function for applying the simplex algorithm which should perform significantly faster than the original.

Chapter f01 (Matrix Factorizations) contains a new function for computing the matrix exponential of a real-valued matrix.

Chapter f02 (Eigenvalues and Eigenvectors) contains a new function for obtaining leading terms in the singular value decomposition of a real general matrix.

Chapter f16 (NAG Interface to BLAS) contains various useful level-1 functions from the BLAS Technical Forum (BLAST).

Chapter g01 (Simple Calculations on Statistical Data) contains a new function for finding quantiles of an unordered vector.

Chapter g02 (Correlation and Regression Analysis) contains new functions for: computing the nearest correlation matrix to a real square matrix; computing predicted value and error from a generalized linear model; ridge regression; and partial least squares.

Chapter g03 (Multivariate Methods) contains a new function for performing ProMax rotations.

Chapter g05 (Random Number Generators) has been overhauled to provide a consistent set of functions for: initializing pseudorandom, quasirandom and scrambled quasirandom base generators; generating vectors from distributions; generating matrices from Copula and multivariate distributions; and generating realizations from (V)ARMA models and GARCH processes. The base generators now include the Mersenne Twister and ACORN generators.

Chapter g13 (Time Series Analysis) contain a new function for exponential smoothing of a univariate time series.

Chapter m01 (Sorting and Searching) is renamed from 'Sorting' and contains functions for searching arrays of real-valued, integer or character data.

Chapter s (Approximations of Special Functions) now includes a suite of functions for evaluating various option pricing formulae. This chapter also contains new functions for computing the scaled complement of

the error function (erfcx), a scaled gamma function and computing elliptic integrals in the classical Legendre form.

Plots of example program results have been added to many function documents. In some cases the example program has been modified slightly to produce a larger set of results giving a more representative plot of the solution profile produced.

2 New Functions

The 153 new user-callable functions included in the NAG C Library at Mark 9 are as follows.

Function

Name	Purpose
a00adc	Library identification, details of implementation, major and minor marks
c05agc	Zero of continuous function, Brent algorithm, from given starting value, binary search for interval
c05avc	Binary search for interval containing zero of continuous function (reverse communication)
c05axc	Zero of continuous function by continuation method, from given starting value (reverse communication)
c05azc	Zero in given interval of continuous function by Brent algorithm (reverse communication)
c05bac	Real values of Lambert's W function, $W(x)$
c09aac	Wavelet filter initialization
c09cac	one-dimensional discrete wavelet transform
c09cbc	one-dimensional inverse discrete wavelet transform
c09ccc	one-dimensional multi-level discrete wavelet transform
c09cdc	one-dimensional inverse multi-level discrete wavelet transform
d02mcc	DASSL method continuation resetting function
d02mwc	Implicit ordinary differential equations/DAEs, initial value problem, setup for nag_dae_ivp_dassl_gen (d02nec)
d02nec	Implicit ordinary differential equations/DAEs, initial value problem, DASSL method integrator
d02npc	Implicit ordinary differential equations/DAEs, initial value problem linear algebra setup routine for nag_dae_ivp_dassl_gen (d02nec)
e04cbc	Unconstrained minimization using simplex algorithm, function of several variables using function values only
e05jac	Initialization function for nag_glopt_bnd_mcs_solve (e05jbc)
e05jbc	Global optimization by multi-level coordinate search, simple bounds, using function values only
e05jcc	Supply optional argument values for nag_glopt_bnd_mcs_solve (e05jbc) from external file
e05jdc	Set a single optional argument for nag_glopt_bnd_mcs_solve (e05jbc) from a character string
e05jec	Set a single optional argument for nag_glopt_bnd_mcs_solve (e05jbc) from an 'ON'/'OFF'-valued character argument
e05jfc	Set a single optional argument for nag_glopt_bnd_mcs_solve (e05jbc) from an integer argument
e05jgc	Set a single optional argument for nag_glopt_bnd_mcs_solve (e05jbc) from a real argument
e05jhc	Determine whether an optional argument for nag_glopt_bnd_mcs_solve (e05jbc) has been set by you or not

e05jkc	Get the setting of an Integer valued optional argument of nag_glopt_bnd_mcs_solve (e05jbc)
e05jlc	Get the setting of a real valued optional argument of nag_glopt_bnd_mcs_solve (e05jbc)
f01ecc	Real matrix exponential
f01edc	Real symmetric matrix exponential
f02wgc	Computes leading terms in the singular value decomposition of a real general matrix; also computes corresponding left and right singular vectors
f08vac	Computes the generalized singular value decomposition of a real matrix pair
f08vnc	Computes the generalized singular value decomposition of a complex matrix pair
f08zac	Solves the real linear equality-constrained least-squares (LSE) problem
f08zbc	Solves a real general Gauss–Markov linear model (GLM) problem
f08znc	Solves the complex linear equality-constrained least-squares (LSE) problem
f08zpc	Solves a complex general Gauss–Markov linear model (GLM) problem
f16dlc	Sum elements of integer vector
f16dnc	Maximum value and location, integer vector
f16dpc	Minimum value and location, integer vector
f16dqc	Maximum absolute value and location, integer vector
f16drc	Minimum absolute value and location, integer vector
f16ehc	Real scaled vector addition preserving input
f16elc	Sum elements of real vector
f16ghc	Complex scaled vector addition preserving input
f16glc	Sum elements of complex vector
f16jnc	Maximum value and location, real vector
f16jpc	Minimum value and location, real vector
f16jqc	Maximum absolute value and location, real vector
f16jrc	Minimum absolute value and location, real vector
f16jsc	Maximum absolute value and location, complex vector
f16jtc	Minimum absolute value and location, complex vector
g01amc	Quantiles of a set of unordered values
g01kac	Calculates the value for the probability density function of the Normal distribution at a chosen point.
g01kfc	Calculates the value for the probability density function of the γ distribution at a chosen point.
g02aac	Computes the nearest correlation matrix to a real square matrix, using the method of Qi and Sun
g02gpc	Computes a predicted value and its associated standard error based on a previously fitted generalized linear model.
g02jcc	Hierarchical mixed effects regression, initialization
g02jdc	Hierarchical mixed effects regression using restricted maximum likelihood
g02jec	Hierarchical mixed effects regression using maximum likelihood
g02kac	Ridge regression, optimizing a ridge regression parameter
g02kbc	Ridge regression using a number of supplied ridge regression parameters

g02lac	Partial least-squares (PLS) regression using singular value decomposition
g02lbc	Partial least-squares (PLS) regression using Wold's iterative method
g02lcc	PLS parameter estimates following partial least-squares regression by nag_pls_orth_scores_svd (g02lac) or nag_pls_orth_scores_wold (g02lbc)
g02ldc	PLS predictions based on parameter estimates from nag_pls_orth_scores_fit (g02lcc)
g03bdc	ProMax rotations
g05kfc	Initializes a pseudorandom number generator to give a repeatable sequence
g05kgc	Initializes a pseudorandom number generator to give a non-repeatable sequence
g05khc	Primes a pseudorandom number generator for generating multiple streams using leap-frog
g05kjc	Primes a pseudorandom number generator for generating multiple streams using skip-ahead
g05ncc	Pseudorandom permutation of an integer vector
g05ndc	Pseudorandom sample from an integer vector
g05pdc	Generates a realization of a time series from a GARCH process with asymmetry of the form $(\epsilon_{t-1} + \gamma)^2$
g05pec	Generates a realization of a time series from a GARCH process with asymmetry of the form $(\epsilon_{t-1} + \gamma\epsilon_{t-1})^2$
g05pfc	Generates a realization of a time series from an asymmetric Glosten, Jagannathan and Runkle (GJR) GARCH process
g05pgc	Generates a realization of a time series from an exponential GARCH (EGARCH) process
g05phc	Generates a realization of a time series from an ARMA model
g05pjc	Generates a realization of a multivariate time series from a VARMA model
g05pmc	Generates a realization of a time series from an exponential smoothing model
g05pxc	Generates a random orthogonal matrix
g05pyc	Generates a random correlation matrix
g05pzc	Generates a random two-way table
g05rcc	Generates a matrix of pseudorandom numbers from a Student's t -copula
g05rdc	Generates a matrix of pseudorandom numbers from a Gaussian copula
g05rec	Generates a matrix of pseudorandom numbers from a bivariate Clayton/Cook–Johnson copula
g05rfc	Generates a matrix of pseudorandom numbers from a bivariate Frank copula
g05rgc	Generates a matrix of pseudorandom numbers from a bivariate Plackett copula
g05rhc	Generates a matrix of pseudorandom numbers from a multivariate Clayton/Cook–Johnson copula
g05rjc	Generates a matrix of pseudorandom numbers from a multivariate Frank copula
g05rkc	Generates a matrix of pseudorandom numbers from a Gumbel–Hougaard copula
g05ryc	Generates a matrix of pseudorandom numbers from a multivariate Student's t -distribution
g05rzc	Generates a matrix of pseudorandom numbers from a multivariate Normal distribution
g05sac	Generates a vector of pseudorandom numbers from a uniform distribution over $(0, 1]$
g05sbc	Generates a vector of pseudorandom numbers from a beta distribution
g05scc	Generates a vector of pseudorandom numbers from a Cauchy distribution
g05sdc	Generates a vector of pseudorandom numbers from a χ^2 distribution

g05sec	Generates a vector of pseudorandom numbers from a Dirichlet distribution
g05sfc	Generates a vector of pseudorandom numbers from an exponential distribution
g05sgc	Generates a vector of pseudorandom numbers from an exponential mix distribution
g05shc	Generates a vector of pseudorandom numbers from an F -distribution
g05sjc	Generates a vector of pseudorandom numbers from a gamma distribution
g05skc	Generates a vector of pseudorandom numbers from a Normal distribution
g05slc	Generates a vector of pseudorandom numbers from a logistic distribution
g05smc	Generates a vector of pseudorandom numbers from a log-normal distribution
g05snc	Generates a vector of pseudorandom numbers from a Student's t -distribution
g05spc	Generates a vector of pseudorandom numbers from a triangular distribution
g05sqc	Generates a vector of pseudorandom numbers from a uniform distribution over $[a, b]$
g05src	Generates a vector of pseudorandom numbers from a von Mises distribution
g05ssc	Generates a vector of pseudorandom numbers from a Weibull distribution
g05tac	Generates a vector of pseudorandom integers from a binomial distribution
g05tbc	Generates a vector of pseudorandom logical values
g05tcc	Generates a vector of pseudorandom integers from a geometric distribution
g05tdc	Generates a vector of pseudorandom integers from a general discrete distribution
g05tec	Generates a vector of pseudorandom integers from a hypergeometric distribution
g05tfc	Generates a vector of pseudorandom integers from a logarithmic distribution
g05tgc	Generates a vector of pseudorandom integers from a multinomial distribution
g05thc	Generates a vector of pseudorandom integers from a negative binomial distribution
g05tjc	Generates a vector of pseudorandom integers from a Poisson distribution
g05tkc	Generates a vector of pseudorandom integers from a Poisson distribution with varying mean
g05tlc	Generates a vector of pseudorandom integers from a uniform distribution
g05yjc	Generates a Normal quasi-random number sequence
g05ykc	Generates a log-normal quasi-random number sequence
g05ylc	Initializes a quasi-random number generator
g05ymc	Generates a uniform quasi-random number sequence
g05ync	Initializes a scrambled quasi-random number generator
g07bfc	Estimates parameter values of the generalized Pareto distribution
g13amc	Univariate time series, exponential smoothing
m01nac	Binary search in set of real numbers
m01nbc	Binary search in set of integer numbers
m01ncc	Binary search in set of character data
s14ahc	Scaled log gamma function $\ln G(x)$, where $G(x) = \gamma(x+1)/(x/e)$
s15agc	Scaled complement of error function, $\operatorname{erfcx}(x)$
s21bec	Elliptic integral of 1st kind, Legendre form, $F(\phi m)$
s21bfc	Elliptic integral of 2nd kind, Legendre form, $E(\phi m)$
s21bgc	Elliptic integral of 3rd kind, Legendre form, $\Pi(n; \phi m)$

s21bhc	Complete elliptic integral of 1st kind, Legendre form, $K(m)$
s21bjc	Complete elliptic integral of 2nd kind, Legendre form, $E(m)$
s30aac	Black–Scholes–Merton option pricing formula
s30abc	Black–Scholes–Merton option pricing formula with Greeks
s30bac	Floating-strike lookback option pricing formula
s30bbc	Floating-strike lookback option pricing formula with Greeks
s30cac	Binary option: cash-or-nothing pricing formula
s30cbc	Binary option: cash-or-nothing pricing formula with Greeks
s30ccc	Binary option: asset-or-nothing pricing formula
s30cdc	Binary option: asset-or-nothing pricing formula with Greeks
s30fac	Standard barrier option pricing formula
s30jac	Jump-diffusion, Merton’s model, option pricing formula
s30jbc	Jump-diffusion, Merton’s model, option pricing formula with Greeks
s30nac	Heston’s model option pricing formula
s30qcc	American option: Bjerksund and Stensland pricing formula
s30sac	Asian option: geometric continuous average rate pricing formula
s30sbc	Asian option: geometric continuous average rate pricing formula with Greeks
x04aec	Open file mentioned on command line and return associated file pointer
x04ndc	Returns the string error name corresponding to a C Library exit error code

3 Functions Scheduled for Withdrawal

The functions listed below are scheduled for withdrawal from the NAG C Library, because improved functions have now been included in the Library. You are advised to stop using functions which are scheduled for withdrawal and to use recommended replacement functions instead. See the document ‘Advice on Replacement Calls for Withdrawn/Superseded Functions’ for more detailed guidance, including advice on how to change a call to the old function into a call to its recommended replacement.

The following functions will be withdrawn at Mark 10.

Functions Scheduled for Withdrawal	Replacement Function(s)
e01sac	nag_2d_shep_interp (e01sgc) or nag_2d_triang_interp (e01sjc)
e01sbc	nag_2d_shep_eval (e01shc) or nag_2d_triang_eval (e01skc)
e01szc	No replacement routine required
e04hcc	No longer required
e04hdc	No longer required
e04jbc	nag_opt_nlp_solve (e04wdc)
e04kbc	nag_opt_nlp_solve (e04wdc)
f06pac	nag_dgemv (f16pac)
f06pbc	nag_dgbmv (f16pbc)
f06pcc	nag_dsymv (f16pcc)
f06pdc	nag_dsbbmv (f16pdc)

f06pec	nag_dspmv (f16pec)
f06pfc	nag_dtrmv (f16pfc)
f06pgc	nag_dtbmv (f16pgc)
f06phc	nag_dtpmv (f16phc)
f06pjc	nag_dtrsv (f16pjc)
f06pkc	nag_dtbsv (f16pkc)
f06plc	nag_dtpsv (f16plc)
f06pmc	nag_dger (f16pmc)
f06ppc	nag_dsyr (f16ppc)
f06pqc	nag_dspr (f16pqc)
f06pre	nag_dsyr2 (f16pre)
f06psc	nag_dspr2 (f16psc)
f06sac	nag_zgemv (f16sac)
f06sbc	nag_zgbmv (f16sbc)
f06scc	nag_zhemv (f16scc)
f06sdc	nag_zhbm (f16sdc)
f06sec	nag_zhpmv (f16sec)
f06sfc	nag_ztrmv (f16sfc)
f06sgc	nag_ztbmv (f16sgc)
f06shc	nag_ztpmv (f16shc)
f06sjc	nag_ztrsv (f16sjc)
f06skc	nag_ztbsv (f16skc)
f06slc	nag_ztpsv (f16slc)
f06smc	nag_zger (f16smc)
f06snc	nag_zger (f16snc)
f06spc	nag_zher (f16spc)
f06sqc	nag_zhpr (f16sqc)
f06src	nag_zher2 (f16src)
f06ssc	nag_zhpr2 (f16ssc)
f06yac	nag_dgemm (f16yac)
f06ycc	nag_dsymm (f16ycc)
f06yfc	nag_dtrmm (f16yfc)
f06yjc	nag_dtrsm (f16yjc)
f06ypc	nag_dsyrk (f16ypc)
f06yrc	nag_dsyr2k (f16yrc)
f06zac	nag_zgemm (f16zac)
f06zcc	nag_zhemm (f16zcc)
f06zfc	nag_ztrmm (f16zfc)
f06zjc	nag_ztrsm (f16zjc)

f06zpc	nag_zherk (f16zpc)
f06zrc	nag_zher2k (f16zrc)
f06ztc	nag_zsymm (f16ztc)
f06zuc	nag_zsyrk (f16zuc)
f06zwc	nag_zsyr2k (f16zwc)

The following functions have been superseded, but will not be withdrawn from the Library until Mark 11 at the earliest.

Superseded

Function	Replacement Function(s)
c05adc	nag_zero_cont_func_bd_1 (c05sdc)
c05nbc	nag_zero_nonlin_eqns_1 (c05tbc)
c05pbc	nag_zero_nonlin_eqns_deriv_1 (c05ubc)
c05zbc	nag_check_deriv_1 (c05zcc)
d01ajc	nag_1d_quad_gen_1 (d01sjc)
d01akc	nag_1d_quad_osc_1 (d01skc)
d01alc	nag_1d_quad_brkpts_1 (d01slc)
d01amc	nag_1d_quad_inf_1 (d01smc)
d01apc	nag_1d_quad_wt_alglog_1 (d01spc)
d01aqc	nag_1d_quad_wt_cauchy_1 (d01sqc)
d01asc	nag_1d_quad_inf_wt_trig_1 (d01ssc)
d01bac	nag_1d_quad_gauss_1 (d01tac)
d01fcc	nag_multid_quad_adapt_1 (d01wcc)
d01gbc	nag_multid_quad_monte_carlo_1 (d01xbc)
e04ccc	nag_opt_simplex_easy (e04cbc)
g01cec	nag_deviates_normal (g01fac)
g05cac	nag_rand_basic (g05sac)
g05cbc	nag_rand_init_repeatabe (g05kfc)
g05ccc	nag_rand_init_nonrepeatabe (g05kgc)
g05cfc	No replacement routine required
g05cgc	No replacement routine required
g05dac	nag_rand_uniform (g05sqc)
g05dbc	nag_rand_exp (g05sfc)
g05ddc	nag_rand_normal (g05skc)
g05dyc	nag_rand_discrete_uniform (g05tlc)
g05eac	nag_rand_matrix_multi_normal (g05rzc)
g05ecc	nag_rand_poisson (g05tjc)
g05edc	nag_rand_binomial (g05tac)
g05ehc	nag_rand_permute (g05ncc)
g05ejc	nag_rand_sample (g05ndc)

g05exc	nag_rand_gen_discrete (g05tdc)
g05eyc	nag_rand_gen_discrete (g05tdc)
g05ezc	nag_rand_matrix_multi_normal (g05rzc)
g05fec	nag_rand_beta (g05sbc)
g05ffc	nag_rand_gamma (g05sjc)
g05hac	nag_rand_arma (g05phc)
g05hkc	nag_rand_agarchI (g05pdc)
g05hlc	nag_rand_agarchII (g05pec)
g05hmc	nag_rand_garchGJR (g05pfc)
g05kac	nag_rand_basic (g05sac)
g05kbc	nag_rand_init_repeatable (g05kfc)
g05kcc	nag_rand_init_nonrepeatable (g05kgc)
g05kec	nag_rand_logical (g05tbc)
g05lac	nag_rand_normal (g05skc)
g05lbc	nag_rand_students_t (g05snc)
g05lcc	nag_rand_chi_sq (g05sdc)
g05ldc	nag_rand_f (g05shc)
g05lec	nag_rand_beta (g05sbc)
g05lfc	nag_rand_gamma (g05sjc)
g05lgc	nag_rand_uniform (g05sqc)
g05lhc	nag_rand_triangular (g05spc)
g05ljc	nag_rand_exp (g05sfc)
g05lkc	nag_rand_lognormal (g05smc)
g05llc	nag_rand_cauchy (g05scc)
g05lmc	nag_rand_weibull (g05ssc)
g05lnc	nag_rand_logistic (g05slc)
g05lpc	nag_rand_von_mises (g05src)
g05lqc	nag_rand_exp_mix (g05sgc)
g05lxc	nag_rand_matrix_multi_students_t (g05ryc)
g05lyc	nag_rand_matrix_multi_normal (g05rzc)
g05lzc	nag_rand_matrix_multi_normal (g05rzc)
g05mac	nag_rand_discrete_uniform (g05tlc)
g05mbc	nag_rand_geom (g05tcc)
g05mcc	nag_rand_neg_bin (g05thc)
g05mdc	nag_rand_logarithmic (g05tfc)
g05mec	nag_rand_compound_poisson (g05tkc)
g05mjc	nag_rand_binomial (g05tac)
g05mkc	nag_rand_poisson (g05tjc)
g05mlc	nag_rand_hypergeometric (g05tec)

g05mrc	nag_rand_gen_multinomial (g05tgc)
g05mzc	nag_rand_gen_discrete (g05tdc)
g05nac	nag_rand_permute (g05ncc)
g05nbc	nag_rand_sample (g05ndc)
g05pac	nag_rand_arma (g05phc)
g05pcc	nag_rand_varma (g05pjc)
g05qac	nag_rand_orthog_matrix (g05pxc)
g05qbc	nag_rand_corr_matrix (g05pyc)
g05qdc	nag_rand_2_way_table (g05pzc)
g05rac	nag_rand_copula_normal (g05rdc)
g05rbc	nag_rand_copula_students_t (g05rcc)
g05yac	nag_quasi_init (g05ylc) and nag_quasi_rand_uniform (g05ymc)
g05ybc	nag_quasi_rand_normal (g05yjc) and nag_quasi_init (g05ylc)
x02dac	No longer required
