NAG Library Function Document

nag_dsyr2 (f16prc)

1 Purpose

nag_dsyr2 (f16prc) performs a rank-2 update on a real symmetric matrix.

2 Specification

```
#include <nag.h>
#include <nagf16.h>
void nag_dsyr2 (Nag_OrderType order, Nag_UploType uplo, Integer n,
      double alpha, const double x[], Integer incx, const double y[],
      Integer incy, double beta, double a[], Integer pda, NagError *fail)
```

3 Description

nag_dsyr2 (f16prc) performs the symmetric rank-2 update operation

$$A \leftarrow \alpha xy^{\mathrm{T}} + \alpha yx^{\mathrm{T}} + \beta A,$$

where A is an n by n real symmetric matrix, x and y are n-element real vectors, while α and β are real scalars.

4 References

Basic Linear Algebra Subprograms Technical (BLAST) Forum (2001) *Basic Linear Algebra Subprograms Technical (BLAST) Forum Standard* University of Tennessee, Knoxville, Tennessee http://www.netlib.org/blas/blast-forum/blas-report.pdf

5 Arguments

1:    **order** – Nag_OrderType   *Input*

On entry: the **order** argument specifies the two-dimensional storage scheme being used, i.e., row-major ordering or column-major ordering. C language defined storage is specified by **order** = Nag_RowMajor. See Section 3.2.1.3 in the Essential Introduction for a more detailed explanation of the use of this argument.

Constraint: **order** = Nag_RowMajor or Nag_ColMajor.

2:    **uplo** – Nag_UploType   *Input*

On entry: specifies whether the upper or lower triangular part of A is stored.

uplo = Nag_Upper
        The upper triangular part of A is stored.

uplo = Nag_Lower
        The lower triangular part of A is stored.

Constraint: **uplo** = Nag_Upper or Nag_Lower.

3:    **n** – Integer   *Input*

On entry: n, the order of the matrix A.

Constraint: **n** ≥ 0.

4:    **alpha** – double   *Input*

    On entry: the scalar α.

5:    **x**[*dim*] – const double   *Input*

    Note: the dimension, *dim*, of the array **x** must be at least $\max(1, 1 + (\mathbf{n} - 1)|\mathbf{incx}|)$.

    On entry: the vector x.

6:    **incx** – Integer   *Input*

    On entry: the increment in the subscripts of **x** between successive elements of x.

    Constraint: $\mathbf{incx} \neq 0$.

7:    **y**[*dim*] – const double   *Input*

    Note: the dimension, *dim*, of the array **y** must be at least $\max(1, 1 + (\mathbf{n} - 1)|\mathbf{incy}|)$.

    On entry: the vector y.

8:    **incy** – Integer   *Input*

    On entry: the increment in the subscripts of **y** between successive elements of y.

    Constraint: $\mathbf{incy} \neq 0$.

9:    **beta** – double   *Input*

    On entry: the scalar β.

10:   **a**[*dim*] – double   *Input/Output*

    Note: the dimension, *dim*, of the array **a** must be at least $\max(1, \mathbf{pda} \times \mathbf{n})$.

    On entry: the n by n symmetric matrix A.

    If **order** = Nag_ColMajor, A_{ij} is stored in $\mathbf{a}[(j - 1) \times \mathbf{pda} + i - 1]$.

    If **order** = Nag_RowMajor, A_{ij} is stored in $\mathbf{a}[(i - 1) \times \mathbf{pda} + j - 1]$.

    If **uplo** = Nag_Upper, the upper triangular part of A must be stored and the elements of the array below the diagonal are not referenced.

    If **uplo** = Nag_Lower, the lower triangular part of A must be stored and the elements of the array above the diagonal are not referenced.

    On exit: the updated matrix A.

11:   **pda** – Integer   *Input*

    On entry: the stride separating row or column elements (depending on the value of **order**) of the matrix A in the array **a**.

    Constraint: $\mathbf{pda} \geq \max(1, \mathbf{n})$.

12:   **fail** – NagError *   *Input/Output*

    The NAG error argument (see Section 3.6 in the Essential Introduction).

6   Error Indicators and Warnings

NE_ALLOC_FAIL

    Dynamic memory allocation failed.
    See Section 3.2.1.2 in the Essential Introduction for further information.

NE_BAD_PARAM

On entry, argument $\langle value \rangle$ had an illegal value.

NE_INT

On entry, **incx** $= \langle value \rangle$.
Constraint: **incx** $\neq 0$.

On entry, **incy** $= \langle value \rangle$.
Constraint: **incy** $\neq 0$.

On entry, **n** $= \langle value \rangle$.
Constraint: **n** ≥ 0.

NE_INT_2

On entry, **pda** $= \langle value \rangle$, **n** $= \langle value \rangle$.
Constraint: **pda** $\geq \max(1, \mathbf{n})$.

NE_INTERNAL_ERROR

An unexpected error has been triggered by this function. Please contact NAG.
See Section 3.6.6 in the Essential Introduction for further information.

NE_NO_LICENCE

Your licence key may have expired or may not have been installed correctly.
See Section 3.6.5 in the Essential Introduction for further information.

7 Accuracy

The BLAS standard requires accurate implementations which avoid unnecessary over/underflow (see Section 2.7 of Basic Linear Algebra Subprograms Technical (BLAST) Forum (2001)).

8 Parallelism and Performance

Not applicable.

9 Further Comments

None.

10 Example

Perform rank-2 update of real symmetric matrix A using vectors x and y:

$$A \leftarrow A - xy^{\mathrm{T}} - yx^{\mathrm{T}},$$

where A is the 4 by 4 matrix given by

$$A = \begin{pmatrix} 4.30 & 4.00 & 0.40 & -0.28 \\ 4.00 & -4.87 & 0.31 & 0.07 \\ 0.40 & 0.31 & -8.02 & -5.95 \\ -0.28 & 0.07 & -5.95 & 0.12 \end{pmatrix},$$

$$x = (2.0, 2.0, 0.2, -0.14)^{\mathrm{T}} \quad \text{and} \quad y = (1.0, 1.0, 0.1, -0.07)^{\mathrm{T}}.$$

The vector y is stored in every second element of the array **y** (**incy** $= 2$).

10.1 Program Text

```
/* nag_dsyr2 (f16prc) Example Program.
 *
 * Copyright 2014 Numerical Algorithms Group.
 *
 * Mark 8, 2005.
 */

#include <stdio.h>
#include <nag.h>
#include <nag_stdlib.h>
#include <nagf16.h>
#include <nagx04.h>

int main(void)
{

  /* Scalars */
  double        alpha, beta;
  Integer       exit_status, i, incx, incy, j, n, pda, xlen, ylen;

  /* Arrays */
  double        *a = 0, *x = 0, *y = 0;
  char          nag_enum_arg[40];

  /* Nag Types */
  NagError      fail;
  Nag_OrderType  order;
  Nag_UploType   uplo;
  Nag_MatrixType matrix;

#ifdef NAG_COLUMN_MAJOR
#define A(I, J) a[(J-1)*pda + I - 1]
  order = Nag_ColMajor;
#else
#define A(I, J) a[(I-1)*pda + J - 1]
  order = Nag_RowMajor;
#endif

  exit_status = 0;
  INIT_FAIL(fail);

  printf("nag_dsyr2 (f16prc) Example Program Results\n\n");

  /* Skip heading in data file */
#ifdef _WIN32
  scanf_s("%*[^\n] ");
#else
  scanf("%*[^\n] ");
#endif

  /* Read the problem dimension */
#ifdef _WIN32
  scanf_s("%"NAG_IFMT"%*[^\n] ", &n);
#else
  scanf("%"NAG_IFMT"%*[^\n] ", &n);
#endif

  /* Read the uplo storage parameter */
#ifdef _WIN32
  scanf_s("%39s%*[^\n] ", nag_enum_arg, _countof(nag_enum_arg));
#else
  scanf("%39s%*[^\n] ", nag_enum_arg);
#endif
  /* nag_enum_name_to_value (x04nac).
   * Converts NAG enum member name to value
   */
  uplo = (Nag_UploType) nag_enum_name_to_value(nag_enum_arg);

  /* Read scalar parameters */
```

```
#ifdef _WIN32
  scanf_s("%lf%lf%*[^\n] ", &alpha, &beta);
#else
  scanf("%lf%lf%*[^\n] ", &alpha, &beta);
#endif
  /* Read increment parameters */
#ifdef _WIN32
  scanf_s("%"NAG_IFMT"%"NAG_IFMT"%*[^\n] ", &incx, &incy);
#else
  scanf("%"NAG_IFMT"%"NAG_IFMT"%*[^\n] ", &incx, &incy);
#endif

  pda = n;

  xlen = MAX(1, 1 + (n - 1)*ABS(incx));
  ylen = MAX(1, 1 + (n - 1)*ABS(incy));

  if (n > 0)
    {
      /* Allocate memory */
      if (!(a = NAG_ALLOC(pda*n, double)) ||
          !(x = NAG_ALLOC(xlen, double)) ||
          !(y = NAG_ALLOC(ylen, double)))
        {
          printf("Allocation failure\n");
          exit_status = -1;
          goto END;
        }
    }
  else
    {
      printf("Invalid n\n");
      exit_status = 1;
      goto END;
    }

  /* Input matrix A and vector x */

  if (uplo == Nag_Upper)
    {
      for (i = 1; i <= n; ++i)
        {
          for (j = i; j <= n; ++j)
#ifdef _WIN32
            scanf_s("%lf", &A(i, j));
#else
            scanf("%lf", &A(i, j));
#endif
#ifdef _WIN32
          scanf_s("%*[^\n] ");
#else
          scanf("%*[^\n] ");
#endif
        }
    }
  else
    {
      for (i = 1; i <= n; ++i)
        {
          for (j = 1; j <= i; ++j)
#ifdef _WIN32
            scanf_s("%lf", &A(i, j));
#else
            scanf("%lf", &A(i, j));
#endif
#ifdef _WIN32
          scanf_s("%*[^\n] ");
#else
          scanf("%*[^\n] ");
#endif
        }
```

```
    }
  for (i = 0; i < xlen; ++i)
#ifdef _WIN32
    scanf_s("%lf%*[^\n] ", &x[i]);
#else
    scanf("%lf%*[^\n] ", &x[i]);
#endif
  for (i = 0; i < ylen; ++i)
#ifdef _WIN32
    scanf_s("%lf%*[^\n] ", &y[i]);
#else
    scanf("%lf%*[^\n] ", &y[i]);
#endif

  /* nag_dsyr2 (f16prc).
   * Rank two update of real symmetric matrix.
   *
   */
  nag_dsyr2(order, uplo, n, alpha, x, incx, y, incy, beta, a, pda,
            &fail);
  if (fail.code != NE_NOERROR)
    {
      printf("Error from nag_dsyr2 (f16prc).\n%s\n", fail.message);
      exit_status = 1;
      goto END;
    }

  if (uplo == Nag_Upper)
    {
      matrix = Nag_UpperMatrix;
    }
  else
    {
      matrix = Nag_LowerMatrix;
    }
  /* Print updated matrix A */
  /* nag_gen_real_mat_print (x04cac).
   * Print real general matrix (easy-to-use)
   */
  fflush(stdout);
  nag_gen_real_mat_print(order, matrix, Nag_NonUnitDiag, n,
                         n, a, pda, "Updated Matrix A", 0, &fail);
  if (fail.code != NE_NOERROR)
    {
      printf("Error from nag_gen_real_mat_print (x04cac).\n%s\n",
             fail.message);
      exit_status = 1;
      goto END;
    }

 END:
 NAG_FREE(a);
 NAG_FREE(x);
 NAG_FREE(y);

  return exit_status;
}
```

10.2 Program Data

```
nag_dsyr2 (f16prc) Example Program Data
  4                         :Value of n
  Nag_Lower                 :Storage of A
 -1.0    1.0                :Values of alpha and beta
  1  2                      :Values of incx and incy
  4.30
  4.00  -4.87
  0.40   0.31  -8.02
 -0.28   0.07  -5.95   0.12   :End of matrix A
```

```
 2.00
 2.00
 0.20
-0.14                                   :End of vector x
 1.00
 0.00
 1.00
 0.00
 0.10
 0.00
-0.07                                   :End of vector y
```

10.3 Program Results

```
nag_dsyr2 (f16prc) Example Program Results

 Updated Matrix A
             1            2            3            4
 1      0.3000
 2      0.0000     -8.8700
 3      0.0000     -0.0900     -8.0600
 4      0.0000      0.3500     -5.9220      0.1004
```