NAG Library Function Document

nag_dgemv (f16pac)

1 Purpose

nag_dgemv (f16pac) performs matrix-vector multiplication for a real general matrix.

2 Specification

```
#include <nag.h>
#include <nagf16.h>
```

```
void nag_dgemv (Nag_OrderType order, Nag_TransType trans, Integer m,
     Integer n, double alpha, const double a[], Integer pda,
     const double x[], Integer incx, double beta, double y[], Integer incy,
     NagError *fail)
```

3 Description

nag_dgemv (f16pac) performs one of the matrix-vector operations

$$y \leftarrow \alpha A x + \beta y, \qquad \text{or} \qquad y \leftarrow \alpha A^{\mathrm{T}} x + \beta y,$$

where A is an m by n real matrix, x and y are real vectors, and α and β are real scalars.

If $m = 0$ or $n = 0$, no operation is performed.

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: **trans** – Nag_TransType *Input*

On entry: specifies the operation to be performed.

trans = Nag_NoTrans
$y \leftarrow \alpha A x + \beta y.$

trans = Nag_Trans or Nag_ConjTrans
$y \leftarrow \alpha A^{\mathrm{T}} x + \beta y.$

Constraint: **trans** = Nag_NoTrans, Nag_Trans or Nag_ConjTrans.

3: **m** – Integer *Input*

On entry: m, the number of rows of the matrix A.

Constraint: $\mathbf{m} \geq 0$.

4: **n** – Integer *Input*

On entry: n, the number of columns of the matrix A.

Constraint: $\mathbf{n} \geq 0$.

5: **alpha** – double *Input*

On entry: the scalar α.

6: **a**[*dim*] – const double *Input*

Note: the dimension, *dim*, of the array **a** must be at least

$\max(1, \mathbf{pda} \times \mathbf{n})$ when **order** = Nag_ColMajor;
$\max(1, \mathbf{m} \times \mathbf{pda})$ when **order** = Nag_RowMajor.

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 $\mathbf{a}[(i-1) \times \mathbf{pda} + j - 1]$.

On entry: the m by n matrix A.

7: **pda** – Integer *Input*

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

Constraints:

if **order** = Nag_ColMajor, $\mathbf{pda} \geq \max(1, \mathbf{m})$;
if **order** = Nag_RowMajor, $\mathbf{pda} \geq \mathbf{n}$.

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

Note: the dimension, *dim*, of the array **x** must be at least

$\max(1, 1 + (\mathbf{n} - 1)|\mathbf{incx}|)$ when **trans** = Nag_NoTrans;
$\max(1, 1 + (\mathbf{m} - 1)|\mathbf{incx}|)$ when **trans** = Nag_Trans or Nag_ConjTrans.

On entry: the vector x.

9: **incx** – Integer *Input*

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

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

10: **beta** – double *Input*

On entry: the scalar β.

11: **y**[*dim*] – double *Input/Output*

Note: the dimension, *dim*, of the array **y** must be at least

$\max(1, 1 + (\mathbf{m} - 1)|\mathbf{incy}|)$ when **trans** = Nag_NoTrans;
$\max(1, 1 + (\mathbf{n} - 1)|\mathbf{incy}|)$ when **trans** = Nag_Trans or Nag_ConjTrans.

On entry: the vector y.

If $\mathbf{beta} = 0$, **y** need not be set.

On exit: the updated vector y.

12: **incy** – Integer *Input*

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

Constraint: **incy** $\neq 0$.

13: **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 ⟨*value*⟩ had an illegal value.

NE_INT

On entry, **incx** = ⟨*value*⟩.
Constraint: **incx** $\neq 0$.

On entry, **incy** = ⟨*value*⟩.
Constraint: **incy** $\neq 0$.

On entry, **m** = ⟨*value*⟩.
Constraint: **m** ≥ 0.

On entry, **n** = ⟨*value*⟩.
Constraint: **n** ≥ 0.

NE_INT_2

On entry, **pda** = ⟨*value*⟩, **m** = ⟨*value*⟩.
Constraint: **pda** $\geq \max(1, \mathbf{m})$.

On entry, **pda** = ⟨*value*⟩ and **n** = ⟨*value*⟩.
Constraint: **pda** $\geq$ **n**.

NE_INTERNAL_ERROR

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please contact NAG for assistance.

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

This example computes the matrix-vector product

$$y = \alpha Ax + \beta y$$

where

$$A = \begin{pmatrix} 1.0 & 2.0 \\ 3.0 & 4.0 \\ 5.0 & 6.0 \end{pmatrix},$$

$$x = \begin{pmatrix} -1.0 \\ 2.0 \end{pmatrix},$$

$$y = \begin{pmatrix} 1.0 \\ 2.0 \\ 3.0 \end{pmatrix},$$

$$\alpha = 1.5 \text{ and } \beta = 1.0.$$

10.1 Program Text

```
/* nag_dgemv (f16pac) Example Program.
 *
 * Copyright 2014 Numerical Algorithms Group.
 *
 * Mark 8, 2005.
 */

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

int main(void)
{

  /* Scalars */
  double        alpha, beta;
  Integer       exit_status, i, incx, incy, j, m, 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_TransType trans;

#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_dgemv (f16pac) Example Program Results\n\n");

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

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

  /* Read the transpose 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
   */
  trans = (Nag_TransType) 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

#ifdef NAG_COLUMN_MAJOR
  pda = m;
#else
  pda = n;
#endif

  if (trans == Nag_NoTrans)
    {
      xlen = MAX(1, 1 + (n - 1)*ABS(incx));
      ylen = MAX(1, 1 + (m - 1)*ABS(incy));
    }
  else
    {
      xlen = MAX(1, 1 + (m - 1)*ABS(incx));
      ylen = MAX(1, 1 + (n - 1)*ABS(incy));
    }

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

  /* Input matrix A and vectors x and y */

  for (i = 1; i <= m; ++i)
    {
      for (j = 1; 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
    }
  for (i = 1; i <= xlen; ++i)
#ifdef _WIN32
    scanf_s("%lf%*[^\n] ", &x[i - 1]);
#else
    scanf("%lf%*[^\n] ", &x[i - 1]);
#endif
  for (i = 1; i <= ylen; ++i)
#ifdef _WIN32
    scanf_s("%lf%*[^\n] ", &y[i - 1]);
#else
    scanf("%lf%*[^\n] ", &y[i - 1]);
#endif

  /* nag_dgemv (f16pac).
   * Matrix-vector multiply.
   *
   */
  nag_dgemv(order, trans, m, n, alpha, a, pda, x, incx,
            beta, y, incy, &fail);
  if (fail.code != NE_NOERROR)
    {
      printf("Error from nag_dgemv.\n%s\n", fail.message);
      exit_status = 1;
      goto END;
    }

  /* Print output vector y */
  printf("%s\n", "  y");
  for (i = 1; i <= ylen; ++i)
    {
      printf("%11f\n", y[i-1]);
    }

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

  return exit_status;
}
```

10.2 Program Data

```
nag_dgemv (f16pac) Example Program Data
  3 2                  : m, n the dimensions of matrix A
  Nag_NoTrans          : trans
  1.5 1.0              : alpha, beta
  1 1                  : incx, incy
  1.0 2.0
  3.0 4.0
  5.0 6.0              : the end of matrix A
   -1.0
    2.0                : the end of vector x
    1.0
    2.0
    3.0                : the end of vector y
```

10.3 Program Results

```
nag_dgemv (f16pac) Example Program Results

  y
   5.500000
   9.500000
  13.500000
```