NAG Fortran Library Routine Document

F11MLF

Note: before using this routine, please read the Users' Note for your implementation to check the interpretation of ***bold italicised*** terms and other implementation-dependent details.

1 Purpose

F11MLF computes the 1-norm, the ∞-norm or the maximum absolute value of the elements of a real, square, sparse matrix which is held in compressed column (Harwell–Boeing) format.

2 Specification

```
SUBROUTINE F11MLF (NORM, ANORM, N, ICOLZP, IROWIX, A, IFAIL)
INTEGER            N, ICOLZP(*), IROWIX(*), IFAIL
double precision   ANORM, A(*)
CHARACTER*1        NORM
```

3 Description

F11MLF computes various quantities relating to norms of a real, sparse n by n matrix A presented in compressed column (Harwell–Boeing) format.

4 References

None.

5 Parameters

1: NORM – CHARACTER*1 *Input*

On entry: specifies the value to be returned in ANORM:

if NORM = '1' or 'O', the 1-norm $\|A\|_1$ of the matrix is computed, that is $\max\limits_{1\le j\le n}\sum\limits_{i=1}^{n}\left|A_{ij}\right|$;

if NORM = 'I', the ∞-norm $\|A\|_\infty$ of the matrix is computed, that is $\max\limits_{1\le i\le n}\sum\limits_{j=1}^{n}\left|A_{ij}\right|$;

if NORM = 'M', the value $\max\limits_{1\le i,j\le n}\left|A_{ij}\right|$ (not a norm).

Constraint: NORM = '1', 'O', 'I' or 'M'.

2: ANORM – ***double precision*** *Output*

On exit: the computed quantity relating the matrix.

3: N – INTEGER *Input*

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

Constraint: N $\geq$ 0.

4: ICOLZP($*$) – INTEGER array *Input*

On entry: ICOLZP(i) contains the index in A of the start of a new column. See Section 2.1.3 in the F11 Chapter Introduction.

5: IROWIX(∗) – INTEGER array *Input*

Note: the dimension of the array IROWIX must be at least ICOLZP(N + 1) − 1, the number of non-zeros of the sparse matrix A.

On entry: the row index array of the sparse matrix A.

6: A(∗) – ***double precision*** array *Input*

Note: the dimension of the array A must be at least ICOLZP(N + 1) − 1, the number of non-zeros of the sparse matrix A.

On entry: the array of non-zero values in the sparse matrix A.

7: IFAIL – INTEGER *Input/Output*

On entry: IFAIL must be set to 0, −1 or 1. Users who are unfamiliar with this parameter should refer to Chapter P01 for details.

On exit: IFAIL = 0 unless the routine detects an error (see Section 6).

For environments where it might be inappropriate to halt program execution when an error is detected, the value −1 or 1 is recommended. If the output of error messages is undesirable, then the value 1 is recommended. Otherwise, for users not familiar with this parameter the recommended value is 0. **When the value −1 or 1 is used it is essential to test the value of IFAIL on exit.**

6 Error Indicators and Warnings

If on entry IFAIL = 0 or −1, explanatory error messages are output on the current error message unit (as defined by X04AAF).

Errors or warnings detected by the routine:

IFAIL = 1

On entry, NORM ≠ '1', 'O', 'I' or 'M',
or N < 0.

IFAIL = 301

Unable to allocate required internal workspace.

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

To compute norms and maximum absolute value of the matrix A, where

$$A = \begin{pmatrix} 2.00 & 1.00 & 0 & 0 & 0 \\ 0 & 0 & 1.00 & -1.00 & 0 \\ 4.00 & 0 & 1.00 & 0 & 1.00 \\ 0 & 0 & 0 & 1.00 & 2.00 \\ 0 & -2.00 & 0 & 0 & 3.00 \end{pmatrix}.$$

9.1 Program Text

Note: the listing of the example program presented below uses ***bold italicised*** terms to denote precision-dependent details. Please read the Users' Note for your implementation to check the interpretation of these terms. As explained in the Essential Introduction to this manual, the results produced may not be identical for all implementations.

```
*     F11MLF Example Program Text
*     Mark 21 Release. NAG Copyright 2004.
*     .. Parameters ..
      INTEGER          NIN, NOUT
      PARAMETER        (NIN=5,NOUT=6)
      INTEGER          LA, NMAX
      PARAMETER        (LA=10000,NMAX=1000)
*     .. Local Scalars ..
      DOUBLE PRECISION ANORM
      INTEGER          I, IFAIL, N, NNZ
      CHARACTER        NORM
*     .. Local Arrays ..
      DOUBLE PRECISION A(LA)
      INTEGER          ICOLZP(NMAX+1), IROWIX(LA)
*     .. External Subroutines ..
      EXTERNAL         F11MLF
*     .. Executable Statements ..
      WRITE (NOUT,*) 'F11MLF Example Program Results'
*     Skip heading in data file
      READ (NIN,*)
*
*     Read order of matrix and number of right hand sides
*
      READ (NIN,*) N
      IF (N.LE.NMAX) THEN
*
*        Read the matrix A
*
         DO 20 I = 1, N + 1
            READ (NIN,*) ICOLZP(I)
   20    CONTINUE
         NNZ = ICOLZP(N+1) - 1
         DO 40 I = 1, NNZ
            READ (NIN,*) A(I), IROWIX(I)
   40    CONTINUE
*
*        Calculate 1-norm
*
         NORM = '1'
         IFAIL = 0
         CALL F11MLF(NORM,ANORM,N,ICOLZP,IROWIX,A,IFAIL)
*
*        Output norm
*
         WRITE (NOUT,*)
         WRITE (NOUT,*) 'One-norm'
         WRITE (NOUT,'(F7.3)') ANORM
*
*        Calculate M-norm
*
         NORM = 'M'
         IFAIL = 0
         CALL F11MLF(NORM,ANORM,N,ICOLZP,IROWIX,A,IFAIL)
*
*        Output norm
*
         WRITE (NOUT,*)
         WRITE (NOUT,*) 'Max'
         WRITE (NOUT,'(F7.3)') ANORM
*
*        Calculate I-norm
*
         NORM = 'I'
         IFAIL = 0
         CALL F11MLF(NORM,ANORM,N,ICOLZP,IROWIX,A,IFAIL)
```

```
*
*        Output norm
*
         WRITE (NOUT,*)
         WRITE (NOUT,*) 'Infinity-norm'
         WRITE (NOUT,'(F7.3)') ANORM
*
      END IF
      END
```

9.2 Program Data

```
F11MLF Example Program Data
  5  N
 1
 3
 5
 7
 9
 12   ICOLZP(I) I=1,..,N+1
  2.   1
  4.   3
  1.   1
 -2.   5
  1.   2
  1.   3
 -1.   2
  1.   4
  1.   3
  2.   4
  3.   5    A(I), IROWIX(I) I=1,NNZ
```

9.3 Program Results

```
 F11MLF Example Program Results

 One-norm
  6.000

 Max
  4.000

 Infinity-norm
  6.000
```