NAG Fortran Library Routine Document

F07UJF (STPTRI/DTPTRI)

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

F07UJF (STPTRI/DTPTRI) computes the inverse of a real triangular matrix, using packed storage.

2 Specification

```
SUBROUTINE F07UJF(UPLO, DIAG, N, AP, INFO)
ENTRY      stptri  (UPLO, DIAG, N, AP, INFO)
INTEGER            N, INFO
real               AP(*)
CHARACTER*1        UPLO, DIAG
```

The ENTRY statement enables the routine to be called by its LAPACK name.

3 Description

This routine forms the inverse of a real triangular matrix A using packed storage. Note that the inverse of an upper (lower) triangular matrix is also upper (lower) triangular.

4 References

Du Croz J J and Higham N J (1992) Stability of methods for matrix inversion *IMA J. Numer. Anal.* **12** 1–19

5 Parameters

1: UPLO – CHARACTER*1 *Input*

On entry: indicates whether A is upper or lower triangular as follows:

if UPLO = 'U', A is upper triangular;

if UPLO = 'L', A is lower triangular.

Constraint: UPLO = 'U' or 'L'.

2: DIAG – CHARACTER*1 *Input*

On entry: indicates whether A is a non-unit or unit triangular matrix as follows:

if DIAG = 'N', A is a non-unit triangular matrix;

if DIAG = 'U', A is a unit triangular matrix; the diagonal elements are not referenced and are assumed to be 1.

Constraint: DIAG = 'N' or 'U'.

3: N – INTEGER *Input*

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

Constraint: N $\geq$ 0.

4: AP(∗) – ***real*** array *Input/Output*

Note: the dimension of the array AP must be at least $\max(1, \mathrm{N} * (\mathrm{N}+1)/2)$.

On entry: the n by n triangular matrix A, packed by columns. More precisely, if UPLO = 'U', the upper triangle of A must be stored with element a_{ij} in $\mathrm{AP}(i+j(j-1)/2)$ for $i \leq j$; if UPLO = 'L', the lower triangle of A must be stored with element a_{ij} in $\mathrm{AP}(i+(2n-j)(j-1)/2)$ for $i \geq j$. If DIAG = 'U', the diagonal elements of the matrix are not referenced and are assumed to be 1; the same storage scheme is used whether DIAG = 'N' or 'U'.

On exit: A is overwritten by A^{-1}, using the same storage format as described above.

5: INFO – INTEGER *Output*

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

6 Error Indicators and Warnings

Errors or warnings detected by the routine:

INFO < 0

If INFO $= -i$, the ith parameter had an illegal value. An explanatory message is output, and execution of the program is terminated.

INFO > 0

If INFO $= i$, a_{ii} is zero and the matrix A is singular.

7 Accuracy

The computed inverse X satisfies

$$|XA - I| \leq c(n)\epsilon |X|\,|A|,$$

where $c(n)$ is a modest linear function of n, and ϵ is the ***machine precision***.

Note that a similar bound for $|AX - I|$ cannot be guaranteed, although it is almost always satisfied.

The computed inverse satisfies the forward error bound

$$|X - A^{-1}| \leq c(n)\epsilon |A^{-1}|\,|A|\,|X|.$$

See Du Croz and Higham (1992).

8 Further Comments

The total number of floating-point operations is approximately $\frac{1}{3}n^3$.

The complex analogue of this routine is F07UWF (CTPTRI/ZTPTRI).

9 Example

To compute the inverse of the matrix A, where

$$A = \begin{pmatrix} 4.30 & 0.00 & 0.00 & 0.00 \\ -3.96 & -4.87 & 0.00 & 0.00 \\ 0.40 & 0.31 & -8.02 & 0.00 \\ -0.27 & 0.07 & -5.95 & 0.12 \end{pmatrix},$$

using packed storage.

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.

```
*     F07UJF Example Program Text
*     Mark 15 Release. NAG Copyright 1991.
*     .. Parameters ..
      INTEGER          NIN, NOUT
      PARAMETER        (NIN=5,NOUT=6)
      INTEGER          NMAX
      PARAMETER        (NMAX=8)
      CHARACTER        DIAG
      PARAMETER        (DIAG='N')
*     .. Local Scalars ..
      INTEGER          I, IFAIL, INFO, J, N
      CHARACTER        UPLO
*     .. Local Arrays ..
      real             AP(NMAX*(NMAX+1)/2)
*     .. External Subroutines ..
      EXTERNAL         stptri, X04CCF
*     .. Executable Statements ..
      WRITE (NOUT,*) 'F07UJF Example Program Results'
*     Skip heading in data file
      READ (NIN,*)
      READ (NIN,*) N
      IF (N.LE.NMAX) THEN
*
*        Read A from data file
*
         READ (NIN,*) UPLO
         IF (UPLO.EQ.'U') THEN
            READ (NIN,*) ((AP(I+J*(J-1)/2),J=I,N),I=1,N)
         ELSE IF (UPLO.EQ.'L') THEN
            READ (NIN,*) ((AP(I+(2*N-J)*(J-1)/2),J=1,I),I=1,N)
         END IF
*
*        Compute inverse of A
*
         CALL stptri(UPLO,DIAG,N,AP,INFO)
*
*        Print inverse
*
         WRITE (NOUT,*)
         IFAIL = 0
         CALL X04CCF(UPLO,DIAG,N,AP,'Inverse',IFAIL)
      END IF
      STOP
*
      END
```

9.2 Program Data

```
F07UJF Example Program Data
  4                           :Value of N
  'L'                         :Value of UPLO
  4.30
 -3.96  -4.87
  0.40   0.31  -8.02
 -0.27   0.07  -5.95   0.12   :End of matrix A
```

9.3 Program Results

```
 F07UJF Example Program Results

 Inverse
              1          2          3          4
 1       0.2326
 2      -0.1891    -0.2053
 3       0.0043    -0.0079    -0.1247
 4       0.8463    -0.2738    -6.1825     8.3333
```