NAG Library Routine Document

F07UWF (ZTPTRI)

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

F07UWF (ZTPTRI) computes the inverse of a complex triangular matrix, using packed storage.

2 Specification

```
SUBROUTINE F07UWF (UPLO, DIAG, N, AP, INFO)

INTEGER                 N, INFO
COMPLEX (KIND=nag_wp) AP(*)
CHARACTER(1)            UPLO, DIAG
```

The routine may be called by its LAPACK name ***ztptri***.

3 Description

F07UWF (ZTPTRI) forms the inverse of a complex 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: specifies whether A is upper or lower triangular.

UPLO = 'U'
A is upper triangular.

UPLO = 'L'
A is lower triangular.

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

2: DIAG – CHARACTER(1) *Input*

On entry: indicates whether A is a nonunit or unit triangular matrix.

DIAG = 'N'
A is a nonunit triangular matrix.

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: $\mathrm{N} \geq 0$.

4: AP$(*)$ – COMPLEX (KIND=nag_wp) array *Input/Output*

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

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 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 AP$(i+(2n-j)(j-1)/2)$ for $i \geq j$.

If DIAG = 'U', the diagonal elements of A are assumed to be 1, and are not referenced; 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 $= i$, $a(i,i)$ is exactly zero; A is singular and its inverse cannot be computed.

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

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

See Du Croz and Higham (1992).

8 Further Comments

The total number of real floating point operations is approximately $\frac{4}{3}n^3$.

The real analogue of this routine is F07UJF (DTPTRI).

9 Example

This example computes the inverse of the matrix A, where

$$A = \begin{pmatrix} 4.78 + 4.56i & 0.00 + 0.00i & 0.00 + 0.00i & 0.00 + 0.00i \\ 2.00 - 0.30i & -4.11 + 1.25i & 0.00 + 0.00i & 0.00 + 0.00i \\ 2.89 - 1.34i & 2.36 - 4.25i & 4.15 + 0.80i & 0.00 + 0.00i \\ -1.89 + 1.15i & 0.04 - 3.69i & -0.02 + 0.46i & 0.33 - 0.26i \end{pmatrix},$$

using packed storage.

9.1 Program Text

```
    Program f07uwfe

!     F07UWF Example Program Text

!     Mark 24 Release. NAG Copyright 2012.

!     .. Use Statements ..
      Use nag_library, Only: nag_wp, x04ddf, ztptri
!     .. Implicit None Statement ..
      Implicit None
!     .. Parameters ..
      Integer, Parameter               :: nin = 5, nout = 6
      Character (1), Parameter         :: diag = 'N'
!     .. Local Scalars ..
      Integer                          :: i, ifail, info, j, n
      Character (1)                    :: uplo
!     .. Local Arrays ..
      Complex (Kind=nag_wp), Allocatable :: ap(:)
      Character (1)                    :: clabs(1), rlabs(1)
!     .. Executable Statements ..
      Write (nout,*) 'F07UWF Example Program Results'
!     Skip heading in data file
      Read (nin,*)
      Read (nin,*) n

      Allocate (ap(n*(n+1)/2))

!     Read A from data file

      Read (nin,*) uplo
      If (uplo=='U') Then
        Read (nin,*)((ap(i+j*(j-1)/2),j=i,n),i=1,n)
      Else If (uplo=='L') Then
        Read (nin,*)((ap(i+(2*n-j)*(j-1)/2),j=1,i),i=1,n)
      End If

!     Compute inverse of A
!     The NAG name equivalent of ztptri is f07uwf
      Call ztptri(uplo,diag,n,ap,info)

!     Print inverse

      Write (nout,*)
      Flush (nout)

!     ifail: behaviour on error exit
!             =0 for hard exit, =1 for quiet-soft, =-1 for noisy-soft
      ifail = 0
      Call x04ddf(uplo,diag,n,ap,'Bracketed','F7.4','Inverse','Integer',rlabs, &
        'Integer',clabs,80,0,ifail)

    End Program f07uwfe
```

9.2 Program Data

```
F07UWF Example Program Data
  4                                                          :Value of N
  'L'                                                        :Value of UPLO
 ( 4.78, 4.56)
 ( 2.00,-0.30) (-4.11, 1.25)
 ( 2.89,-1.34) ( 2.36,-4.25) ( 4.15, 0.80)
 (-1.89, 1.15) ( 0.04,-3.69) (-0.02, 0.46) ( 0.33,-0.26)  :End of matrix A
```

9.3 Program Results

```
 F07UWF Example Program Results

 Inverse
                     1                 2                 3                 4
 1  ( 0.1095,-0.1045)
 2  ( 0.0582,-0.0411) (-0.2227,-0.0677)
 3  ( 0.0032, 0.1905) ( 0.1538,-0.2192) ( 0.2323,-0.0448)
 4  ( 0.7602, 0.2814) ( 1.6184,-1.4346) ( 0.1289,-0.2250) ( 1.8697, 1.4731)
```