NAG Library Routine Document

F07WKF (DTFTRI)

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

F07WKF (DTFTRI) computes the inverse of a real triangular matrix, stored in Rectangular Full Packed (RFP) format. The RFP storage format is described in Section 3.3.3 in the F07 Chapter Introduction.

2 Specification

```
SUBROUTINE F07WKF (TRANSR, UPLO, DIAG, N, A, INFO)

INTEGER            N, INFO
REAL (KIND=nag_wp) A(N*(N+1)/2)
CHARACTER(1)       TRANSR, UPLO, DIAG
```

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

3 Description

F07WKF (DTFTRI) forms the inverse of a real triangular matrix A, stored using RFP format. 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

Gustavson F G, Waśniewski J, Dongarra J J and Langou J (2010) Rectangular full packed format for Cholesky's algorithm: factorization, solution, and inversion *ACM Trans. Math. Software* **37, 2**

5 Parameters

1: TRANSR – CHARACTER(1) *Input*

On entry: specifies whether the RFP representation of A is normal or transposed.

TRANSR = 'N'
The matrix A is stored in normal RFP format.

TRANSR = 'T'
The matrix A is stored in transposed RFP format.

Constraint: TRANSR = 'N' or 'T'.

2: 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'.

3: 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'.

4: N – INTEGER *Input*

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

Constraint: N ≥ 0.

5: A(N $\times$ (N + 1)/2) – REAL (KIND=nag_wp) array *Input/Output*

On entry: the n by n triangular matrix A, stored in RFP format.

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

6: 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 floating point operations is approximately $\frac{1}{3}n^3$.

The complex analogue of this routine is F07WXF (ZTFTRI).

9 Example

This example computes the inverse of the matrix A, where

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

and is stored using RFP format.

9.1 Program Text

```
    Program f07wkfe

!     F07WKF Example Program Text

!     Mark 24 Release. NAG Copyright 2012.

!     .. Use Statements ..
      Use nag_library, Only: dtftri, dtfttr, nag_wp, x04caf
!     .. Implicit None Statement ..
      Implicit None
!     .. Parameters ..
      Integer, Parameter               :: nin = 5, nout = 6
!     .. Local Scalars ..
      Integer                          :: ifail, info, ldf, lena, n
      Character (1)                    :: diag, transr, uplo
!     .. Local Arrays ..
      Real (Kind=nag_wp), Allocatable  :: a(:), f(:,:)
!     .. Executable Statements ..
      Write (nout,*) 'F07WKF Example Program Results'
!     Skip heading in data file
      Read (nin,*)
      Read (nin,*) n, uplo, transr, diag

      lena = n*(n+1)/2
      ldf = n
      Allocate (a(lena),f(ldf,n))

!     Read A from data file
      Read (nin,*) a(1:lena)

!     Compute inverse of A
!     The NAG name equivalent of dtftri is f07wkf
      Call dtftri(transr,uplo,diag,n,a,info)

      Write (nout,*)
      Flush (nout)
      If (info==0) Then

!       Convert inverse to full array form, and print it
!       The NAG name equivalent of dtfttr is f01vgf
        Call dtfttr(transr,uplo,n,a,f,ldf,info)
        ifail = 0
        Call x04caf(uplo,'Nonunit',n,n,f,ldf,'Inverse',ifail)
      Else
        Write (nout,*) 'A is singular'
      End If

    End Program f07wkfe
```

9.2 Program Data

```
F07WKF Example Program Data
  4 'L' 'N' 'N'                 : n, uplo, transr, diag
 -8.02  4.30 -3.96  0.40 -0.27
 -5.95  0.12 -4.87  0.31  0.07 : A in RFP storage.
```

9.3 Program Results

```
 F07WKF 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
```