

NAG Library Routine Document

F07AJF (DGETRI)

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

F07AJF (DGETRI) computes the inverse of a real matrix A , where A has been factorized by F07ADF (DGETRF).

2 Specification

```
SUBROUTINE F07AJF(N, A, LDA, IPIV, WORK, LWORK, INFO)
  INTEGER          N, LDA, IPIV(*), LWORK, INFO
  double precision A(LDA,*), WORK(max(1,LWORK))
```

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

3 Description

F07AJF (DGETRI) is used to compute the inverse of a real matrix A , the routine must be preceded by a call to F07ADF (DGETRF), which computes the LU factorization of A as $A = PLU$. The inverse of A is computed by forming U^{-1} and then solving the equation $XP L = U^{-1}$ for X .

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: N – INTEGER *Input*
On entry: n , the order of the matrix A .
Constraint: $N \geq 0$.
- 2: $A(LDA,*)$ – ***double precision*** array *Input/Output*
Note: the second dimension of the array A must be at least $\max(1, N)$.
On entry: the LU factorization of A , as returned by F07ADF (DGETRF).
On exit: the factorization is overwritten by the n by n matrix A^{-1} .
- 3: LDA – INTEGER *Input*
On entry: the first dimension of the array A as declared in the (sub)program from which F07AJF (DGETRI) is called.
Constraint: $LDA \geq \max(1, N)$.
- 4: $IPIV(*)$ – INTEGER array *Input*
Note: the dimension of the array $IPIV$ must be at least $\max(1, N)$.
On entry: the pivot indices, as returned by F07ADF (DGETRF).

- 5: WORK(max(1,LWORK)) – *double precision* array *Workspace*
On exit: if INFO = 0, WORK(1) contains the minimum value of LWORK required for optimum performance.
- 6: LWORK – INTEGER *Input*
On entry: the dimension of the array WORK as declared in the (sub)program from which F07AJF (DGETRI) is called, unless LWORK = -1, in which case a workspace query is assumed and the routine only calculates the optimal dimension of WORK (using the formula given below).
Suggested value: for optimum performance LWORK should be at least $N \times nb$, where nb is the **blocksize**.
Constraint: LWORK $\geq \max(1, N)$ or LWORK = -1.
- 7: 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 *i*th parameter had an illegal value. An explanatory message is output, and execution of the program is terminated.

INFO > 0

If INFO = *i*, the *i*th diagonal element of the factor *U* is zero, *U* is singular, and the inverse of *A* cannot be computed.

7 Accuracy

The computed inverse *X* satisfies a bound of the form:

$$|XA - I| \leq c(n)\epsilon|X|P|L||U|,$$

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. See Du Croz and Higham (1992).

8 Further Comments

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

The complex analogue of this routine is F07AWF (ZGETRI).

9 Example

This example computes the inverse of the matrix *A*, where

$$A = \begin{pmatrix} 1.80 & 2.88 & 2.05 & -0.89 \\ 5.25 & -2.95 & -0.95 & -3.80 \\ 1.58 & -2.69 & -2.90 & -1.04 \\ -1.11 & -0.66 & -0.59 & 0.80 \end{pmatrix}.$$

Here *A* is nonsymmetric and must first be factorized by F07ADF (DGETRF).

9.1 Program Text

```

*      F07AJF Example Program Text
*      Mark 15 Release. NAG Copyright 1991.
*      .. Parameters ..
      INTEGER          NIN, NOUT
      PARAMETER        (NIN=5,NOUT=6)
      INTEGER          NMAX, LDA, LWORK
      PARAMETER        (NMAX=8,LDA=NMAX,LWORK=64*NMAX)
*      .. Local Scalars ..
      INTEGER          I, IFAIL, INFO, J, N
*      .. Local Arrays ..
      DOUBLE PRECISION A(LDA,NMAX), WORK(LWORK)
      INTEGER          IPIV(NMAX)
*      .. External Subroutines ..
      EXTERNAL         DGETRF, DGETRI, X04CAF
*      .. Executable Statements ..
      WRITE (NOUT,*) 'F07AJF 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,*) ((A(I,J),J=1,N),I=1,N)
*
*          Factorize A
*
*          CALL DGETRF(N,N,A,LDA,IPIV,INFO)
*
*          WRITE (NOUT,*)
*          IF (INFO.EQ.0) THEN
*
*              Compute inverse of A
*
*              CALL DGETRI(N,A,LDA,IPIV,WORK,LWORK,INFO)
*
*              Print inverse
*
*              IFAIL = 0
*              CALL X04CAF('General',' ',N,N,A,LDA,'Inverse',IFAIL)
*          ELSE
*              WRITE (NOUT,*) 'The factor U is singular'
*          END IF
*      END IF
*
      END

```

9.2 Program Data

```

F07AJF Example Program Data
4                               :Value of N
1.80   2.88   2.05  -0.89
5.25  -2.95  -0.95  -3.80
1.58  -2.69  -2.90  -1.04
-1.11  -0.66  -0.59   0.80   :End of matrix A

```

9.3 Program Results

F07AJF Example Program Results

Inverse	1	2	3	4
1	1.7720	0.5757	0.0843	4.8155
2	-0.1175	-0.4456	0.4114	-1.7126
3	0.1799	0.4527	-0.6676	1.4824
4	2.4944	0.7650	-0.0360	7.6119