

NAG Toolbox for MATLAB

f03af

1 Purpose

f03af computes an LU factorization of a real matrix, with partial pivoting, and evaluates the determinant.

2 Syntax

```
[a, dl, id, p, ifail] = f03af(eps, a, 'n', n)
```

3 Description

f03af computes an LU factorization of a real matrix A with partial pivoting: $PA = LU$, where $\mathbf{p}$ is a permutation matrix, L is lower triangular and U is unit upper triangular. The determinant of A is the product of the diagonal elements of L with the correct sign determined by the row interchanges.

4 References

Wilkinson J H and Reinsch C 1971 *Handbook for Automatic Computation II, Linear Algebra* Springer-Verlag

5 Parameters

5.1 Compulsory Input Parameters

1: **eps** – double scalar

Must be set to the value of *machine precision*.

2: **a(lda,*)** – double array

The first dimension of the array **a** must be at least $\max(1, \mathbf{n})$

The second dimension of the array must be at least $\max(1, \mathbf{n})$

The n by n matrix A .

5.2 Optional Input Parameters

1: **n** – int32 scalar

Default: The second dimension of the array **a**.

n , the order of the matrix A .

Constraint: $\mathbf{n} \geq 0$.

5.3 Input Parameters Omitted from the MATLAB Interface

lda

5.4 Output Parameters

1: **a(lda,*)** – double array

The first dimension of the array **a** must be at least $\max(1, \mathbf{n})$

The second dimension of the array must be at least $\max(1, \mathbf{n})$

A contains the lower triangular matrix L and the off-diagonal elements of the upper triangular matrix U . The unit diagonal elements of U are not stored.

2: **d1** – double scalar

3: **id** – int32 scalar

The determinant of A is given by $\mathbf{d1} \times 2.0^{\mathbf{id}}$. It is given in this form to avoid overflow or underflow.

4: **p(*)** – double array

Note: the dimension of the array **p** must be at least $\max(1, \mathbf{n})$.

p(i) gives the row index of the i th pivot.

5: **ifail** – int32 scalar

0 unless the function detects an error (see Section 6).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail = 1

The matrix A is singular, possibly due to rounding errors. The factorization could not be completed. **d1** and **id** are set to zero.

ifail = 2

On entry, $\mathbf{n} < 0$,
or $\mathbf{lda} < \max(1, \mathbf{n})$.

7 Accuracy

The accuracy of the determinant depends on the conditioning of the original matrix. For a detailed error analysis, see page 107 of Wilkinson and Reinsch 1971.

8 Further Comments

The time taken by f03af is approximately proportional to n^3 .

9 Example

```
eps = 1.111307226797642e-16;
a = [33, 16, 72;
     -24, -10, -57;
     -8, -4, -17];
[aOut, d1, id, p, ifail] = f03af(eps, a)
```

```
aOut =
    -8.0000    0.5000    2.1250
   -24.0000    2.0000   -3.0000
    33.0000   -0.5000    0.3750
d1 =
    0.3750
id =
         4
p =
         3
```

$$\begin{vmatrix} & & 2 \\ & 3 & \\ \text{ifail} = & & 0 \end{vmatrix}$$
