NAG Toolbox for MATLAB

f04ad

1 Purpose

f04ad calculates the approximate solution of a set of complex linear equations with multiple right-hand sides, using an LU factorization with partial pivoting.

2 Syntax

```
[a, c, ifail] = f04ad(a, b, 'n', n, 'm', m)
```

3 Description

Given a set of complex linear equations $AX = B$, the function first computes an LU factorization of A with partial pivoting, $PA = LU$, where P is a permutation matrix, L is lower triangular and U is unit upper triangular. The columns x of the solution X are found by forward and backward substitution in $Ly = Pb$ and $Ux = y$, where b is a column of the right-hand side matrix B.

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: **a**(**lda**,$*$) – **complex 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.

2: **b**(**ldb**,$*$) – **complex array**

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

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

The n by m right-hand side matrix B. See also Section 8.

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

2: **m – int32 scalar**

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

m, the number of right-hand sides.

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

5.3 Input Parameters Omitted from the MATLAB Interface

lda, ldb, ldc, wkspce

5.4 Output Parameters

1: **a**(**lda**,∗) – **complex 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 array 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: **c**(**ldc**,∗) – **complex array**

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

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

The n by m solution matrix X. See also Section 8.

3: **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.

ifail $= 2$

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

7 Accuracy

The accuracy of the computed solution depends on the conditioning of the original matrix. For a detailed error analysis see page 106 of Wilkinson and Reinsch 1971.

8 Further Comments

The time taken by f04ad is approximately proportional to n^3.

9 Example

```
a = [complex(1, +0), complex(1, +2), complex(2, +10);
     complex(1, +1), complex(0, +3), complex(-5, +14);
     complex(1, +1), complex(0, +5), complex(-8, +20)];
b = [complex(1, +0);
     complex(0, +0);
     complex(0, +0)];
[aOut, c, ifail] = f04ad(a, b)
```

```
aOut =
   1.0000             1.0000 + 2.0000i   2.0000 +10.0000i
   1.0000 + 1.0000i   1.0000 + 2.0000i   3.2000 + 1.6000i
   1.0000 + 1.0000i   1.0000            -0.2000 + 0.4000i
c =
  10.0000 + 1.0000i
   9.0000 - 3.0000i
  -2.0000 + 2.0000i
ifail =
           0
```