NAG Toolbox

nag_det_complex_gen (f03bn)

1 Purpose

nag_det_complex_gen (f03bn) computes the determinant of a complex n by n matrix A. nag_lapack_zgetrf (f07ar) must be called first to supply the matrix A in factorized form.

2 Syntax

```
[d, id, ifail] = nag_det_complex_gen(a, ipiv, 'n', n)
[d, id, ifail] = f03bn(a, ipiv, 'n', n)
```

3 Description

nag_det_complex_gen (f03bn) computes the determinant of a complex n by n matrix A that has been factorized by a call to nag_lapack_zgetrf (f07ar). The determinant of A is the product of the diagonal elements of U 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: **a**$(lda,:)$ – COMPLEX (KIND=nag_wp) array

The first dimension of the array **a** must be at least **n**.

The second dimension of the array **a** must be at least **n**.

The n by n matrix A in factorized form as returned by nag_lapack_zgetrf (f07ar).

2: **ipiv**(**n**) – INTEGER array

The row interchanges used to factorize matrix A as returned by nag_lapack_zgetrf (f07ar).

5.2 Optional Input Parameters

1: **n** – INTEGER

Default: the first dimension of the array **a** and the dimension of the array **ipiv**. (An error is raised if these dimensions are not equal.)

n, the order of the matrix A.

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

5.3 Output Parameters

1: **d** – COMPLEX (KIND=nag_wp)

The mantissa of the real and imaginary parts of the determinant.

2: **id**(**2**) – INTEGER array

The exponents for the real and imaginary parts of the determinant. The determinant, $d = (d_r, d_i)$, is returned as $d_r = D_r \times 2^j$ and $d_i = D_i \times 2^k$, where $\mathbf{d} = (D_r, D_i)$ and j and k are stored in the first and second elements respectively of the array **id** on successful exit.

3: **ifail** – INTEGER

ifail $= 0$ unless the function detects an error (see Section 5).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail $= 1$

Constraint: **n** ≥ 1.

ifail $= 3$

Constraint: $lda \geq$ **n**.

ifail $= 4$

The matrix A is approximately singular.

ifail $= -99$

An unexpected error has been triggered by this routine. Please contact NAG.

ifail $= -399$

Your licence key may have expired or may not have been installed correctly.

ifail $= -999$

Dynamic memory allocation failed.

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 nag_det_complex_gen (f03bn) is approximately proportional to n.

9 Example

This example calculates the determinant of the complex matrix

$$\begin{pmatrix} 1 & 1+2i & 2+10i \\ 1+i & 3i & -5+14i \\ 1+i & 5i & -8+20i \end{pmatrix}.$$

9.1 Program Text

```
     function f03bn_example

fprintf('f03bn example results\n\n');

a = [1,   1+2i, 2+10i;
     1+i, 3i,  -5+14i;
     1+i, 5i,  -8+20i];
% LU factorisation of a
[a, ipiv, info] = f07ar(a);

fprintf('\n');
[ifail] = x04da('g', 'n', a, 'Array a after factorization');

fprintf('\nPivots:\n');
fprintf(' %d', ipiv);
fprintf('\n\n');

[d, id, ifail] = f03bn(a, ipiv);

fprintf('\nd = %13.5f id = (%d, %d)\n', d, id);
fprintf('Value of determinant = (%13.5e, %13.5e)\n', ...
        real(d)*2^id(1),imag(d)*2^id(2));
```

9.2 Program Results

```
     f03bn example results

 Array a after factorization
              1          2          3
 1      1.0000     0.0000    -5.0000
        1.0000     3.0000    14.0000

 2      1.0000     0.0000    -3.0000
        0.0000     2.0000     6.0000

 3      0.5000     0.2500    -0.2500
       -0.5000     0.2500    -0.2500

Pivots:
 2 3 3

d =       0.06250 id = (4, 0)
Value of determinant = (  1.00000e+00,   0.00000e+00)
```