NAG Toolbox for MATLAB

e01ab

1 Purpose

e01ab interpolates at a given point x from a table of function values evaluated at equidistant points, by Everett's formula.

2 Syntax

```
[a, g, ifail] = e01ab(n, p, a, n2, 'n1', n1)
```

3 Description

e01ab interpolates at a given point

$$x = x_0 + ph, \qquad \text{where} \qquad -1 < p < 1$$

from a table of values $(x_0 + mh)$ and y_m where $m = -(n-1), -(n-2), \ldots, -1, 0, 1, \ldots, n$. The formula used is that of Fröberg 1970, neglecting the remainder term:

$$y_p = \sum_{r=0}^{n-1} \binom{1-p+r}{2r+1} \delta^{2r} y_0 + \sum_{r=0}^{n-1} \binom{p+r}{2r+1} \delta^{2r} y_1.$$

The values of $\delta^{2r} y_0$ and $\delta^{2r} y_1$ are stored on exit from the function in addition to the interpolated function value y_p.

4 References

Fröberg C E 1970 *Introduction to Numerical Analysis* Addison–Wesley

5 Parameters

5.1 Compulsory Input Parameters

1: **n – int32 scalar**

n, half the number of points to be used in the interpolation.

2: **p – double scalar**

The point p at which the interpolated function value is required, i.e., $p = (x - x_0)/h$ with $-1.0 < p < 1.0$.

Constraint: $-1.0 < \mathbf{p} < 1.0$.

3: **a(n1) – double array**

$\mathbf{a}(i)$ must be set to the function value y_{i-n} for $i = 1, 2, \ldots, 2n$.

4: **n2 – int32 scalar**

the value $2n + 1$, that is, **n2** is one more than the number of data points.

5.2 Optional Input Parameters

1: **n1 – int32 scalar**

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

the value $2n$, that is, **n1** is equal to the number of data points.

5.3 Input Parameters Omitted from the MATLAB Interface

None.

5.4 Output Parameters

1: **a(n1) – double array**

The contents of **a** are unspecified.

2: **g(n2) – double array**

The array contains

y_0 in $\mathbf{g}(1)$

y_1 in $\mathbf{g}(2)$

$\delta^{2r}y_0$ in $\mathbf{g}(2r+1)$

$\delta^{2r}y_1$ in $\mathbf{g}(2r+2)$ for $r = 1, 2, \ldots, n-1$.

The interpolated function value y_p is stored in $\mathbf{g}(2n+1)$.

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 $= 1$

On entry, $\mathbf{p} \leq -1.0$,
or $\mathbf{p} \geq 1.0$.

7 Accuracy

In general, increasing n improves the accuracy of the result until full attainable accuracy is reached, after which it might deteriorate. If x lies in the central interval of the data (i.e., $0.0 \leq p \leq 1.0$), as is desirable, an upper bound on the contribution of the highest order differences (which is usually an upper bound on the error of the result) is given approximately in terms of the elements of the array **g** by $a \times (|\mathbf{g}(2n-1)| + |\mathbf{g}(2n)|)$, where $a = 0.1$, 0.02, 0.005, 0.001, 0.0002 for $n = 1, 2, 3, 4, 5$ respectively, thereafter decreasing roughly by a factor of 4 each time.

8 Further Comments

The computation time increases as the order of n increases.

9 Example

```
n = int32(3);
p = 0.5600000000000001;
a = [0;
     -0.53;
     -1;
     -0.46;
```

```
     2;
     11.09];
n2 = int32(7);
[aOut, g, ifail] = e01ab(n, p, a, n2)
```

```
aOut =
   -0.0400
    3.8000
  -20.4300
   15.7200
   -9.0900
   11.0900
g =
   -1.0000
   -0.4600
    1.0100
    1.9200
   -0.0400
    3.8000
   -0.8359
ifail =
           0
```