NAG Toolbox

nag_interp_1d_monotonic_intg (e01bh)

1   Purpose

nag_interp_1d_monotonic_intg (e01bh) evaluates the definite integral of a piecewise cubic Hermite interpolant over the interval $[a, b]$.

2   Syntax

```
[pint, ifail] = nag_interp_1d_monotonic_intg(x, f, d, a, b, 'n', n)
```

```
[pint, ifail] = e01bh(x, f, d, a, b, 'n', n)
```

3   Description

nag_interp_1d_monotonic_intg (e01bh) evaluates the definite integral of a piecewise cubic Hermite interpolant, as computed by nag_interp_1d_monotonic (e01be), over the interval $[a, b]$.

If either a or b lies outside the interval from $\mathbf{x}(1)$ to $\mathbf{x}(\mathbf{n})$ computation of the integral involves extrapolation and a warning is returned.

The function is derived from function PCHIA in Fritsch (1982).

4   References

Fritsch F N (1982) PCHIP final specifications *Report UCID-30194* Lawrence Livermore National Laboratory

5   Parameters

5.1   Compulsory Input Parameters

1:    $\mathbf{x}(\mathbf{n})$ – REAL (KIND=nag_wp) array
2:    $\mathbf{f}(\mathbf{n})$ – REAL (KIND=nag_wp) array
3:    $\mathbf{d}(\mathbf{n})$ – REAL (KIND=nag_wp) array

   $\mathbf{n}$, $\mathbf{x}$, $\mathbf{f}$ and $\mathbf{d}$ must be unchanged from the previous call of nag_interp_1d_monotonic (e01be).

4:    $\mathbf{a}$ – REAL (KIND=nag_wp)
5:    $\mathbf{b}$ – REAL (KIND=nag_wp)

   The interval $[a, b]$ over which integration is to be performed.

5.2   Optional Input Parameters

1:    $\mathbf{n}$ – INTEGER

   Default: the dimension of the arrays $\mathbf{x}$, $\mathbf{f}$, $\mathbf{d}$. (An error is raised if these dimensions are not equal.)

   $\mathbf{n}$, $\mathbf{x}$, $\mathbf{f}$ and $\mathbf{d}$ must be unchanged from the previous call of nag_interp_1d_monotonic (e01be).

5.3   Output Parameters

1:    $\mathbf{pint}$ – REAL (KIND=nag_wp)

   The value of the definite integral of the interpolant over the interval $[a, b]$.

2: **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 $= 1$

   On entry, $\mathbf{n} < 2$.

ifail $= 2$

   The values of $\mathbf{x}(r)$, for $r = 1, 2, \ldots, \mathbf{n}$, are not in strictly increasing order.

ifail $= 3$ (*warning*)

   On entry, at least one of $\mathbf{a}$ or $\mathbf{b}$ lies outside the interval $[\mathbf{x}(1), \mathbf{x}(\mathbf{n})]$, and extrapolation was performed to compute the integral. The value returned is therefore unreliable.

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 computational error in the value returned for **pint** should be negligible in most practical situations.

8   Further Comments

The time taken by nag_interp_1d_monotonic_intg (e01bh) is approximately proportional to the number of data points included within the interval $[a, b]$.

9   Example

This example reads in values of **n**, **x**, **f** and **d**. It then reads in pairs of values for **a** and **b**, and evaluates the definite integral of the interpolant over the interval $[\mathbf{a}, \mathbf{b}]$ until end-of-file is reached.

9.1   Program Text

```
    function e01bh_example

fprintf('e01bh example results\n\n');

x = [7.99 8.09    8.19    8.7     9.2     10      12      15      20];
f = [0 2.7643e-05 0.04375 0.16918 0.46943 0.94374 0.99864 0.99992 0.99999];

% Theses are as returned by e01be(x,f)
d = [0;
     0.00055251;
     0.33587;
     0.34944;
     0.59696;
     0.060326;
     0.000898335;
```

```
      2.93954e-05;
      0];

m = 11;
dx = (x(end)-x(1))/(m-1);
px = [x(1):dx:x(end)];

ia = [1 6 7 8];
ib = [9 7 6 8];
fprintf('                              Integral\n');
fprintf('            a            b     over (a,b)\n');

for i = 1:4
  a = x(ia(i));
  b = x(ib(i));
  [pint, ifail] = e01bh( ...
                         x, f, d, a, b);
  fprintf('%13.4f%13.4f%13.4f\n', a, b, pint);
end
```

9.2 Program Results

```
    e01bh example results

                        Integral
         a           b   over (a,b)
      7.9900     20.0000     10.7648
     10.0000     12.0000      1.9622
     12.0000     10.0000     -1.9622
     15.0000     15.0000      0.0000
```