

nag_monotonic_intg (e01bhc)

1. Purpose

nag_monotonic_intg (e01bhc) evaluates the definite integral of a piecewise cubic Hermite interpolant over the interval $[a, b]$.

2. Specification

```
#include <nag.h>
#include <nage01.h>

void nag_monotonic_intg(Integer n, double x[], double f[], double d[],
                        double a, double b, double *integral, NagError *fail)
```

3. Description

This function evaluates the definite integral of a piecewise cubic Hermite interpolant, as computed by **nag_monotonic_interpolant (e01bec)**, over the interval $[a, b]$.

If either a or b lies outside the interval from $x[0]$ to $x[n-1]$, computation of the integral involves extrapolation and a warning is returned.

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

4. Parameters

n

x[n]

f[n]

d[n]

Input: **n**, **x**, **f** and **d** must be unchanged from the previous call of **nag_monotonic_interpolant (e01bec)**.

a

b

Input: the interval $[a, b]$ over which integration is to be performed.

integral

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

fail

The NAG error parameter, see the Essential Introduction to the NAG C Library.

5. Error Indications and Warnings

NE_INT_ARG_LT

On entry, **n** must not be less than 2: **n** = $\langle value \rangle$.

NE_NOT_MONOTONIC

On entry, $x[r-1] \geq x[r]$ for $r = \langle value \rangle$: $x[r-1] = \langle value \rangle$, $x[r] = \langle value \rangle$.

The values of $x[r]$, for $r = 0, 1, \dots, n-1$ are not in strictly increasing order.

NW_INTERVAL_EXTRAPOLATE

On entry, limits **a**, **b** must not be outside interval $[x[0], x[n-1]]$, **a** = $\langle value \rangle$, **b** = $\langle value \rangle$, $x[0] = \langle value \rangle$, $x[\langle value \rangle] = \langle value \rangle$. Extrapolation was performed to compute the integral. The value returned is therefore unreliable.

6. Further Comments

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

6.1. Accuracy

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

6.2. References

Fritsch F N (August 1982) *PCHIP Final Specifications* Lawrence Livermore National Laboratory report UCID-30194.

7. See Also

nag_monotonic_interpolant (e01bec)

8. Example

This example program 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 **[a, b]** until end-of-file is reached.

8.1. Program Text

```
/* nag_monotonic_intg(e01bhc) Example Program
 *
 * Copyright 1991 Numerical Algorithms Group.
 *
 * Mark 2, 1991.
 */

#include <nag.h>
#include <stdio.h>
#include <nag_stdlib.h>
#include <nage01.h>

#define NMAX 50

main()
{
    double a, b, integral, d[NMAX], f[NMAX], x[NMAX];
    Integer n, r;

    Vprintf("e01bhc Example Program Results\n");
    Vscanf("%*[^\\n]"); /* Skip heading in data file */
    Vscanf("%ld",&n);
    if (n>0 && n<=NMAX)
    {
        for (r=0; r<n; r++)
            Vscanf("%lf%lf%lf",&x[r], &f[r], &d[r]);
        Vprintf("                                Integral\n");
        Vprintf("          a                                b          over (a,b)\n");
        /* Read a, b pairs until end of file and compute
         * definite integrals.
         */
        while(scanf("%lf%lf",&a,&b) !=EOF)
        {
            e01bhc(n, x, f, d, a, b, &integral, NAGERR_DEFAULT);
            Vprintf("%13.4f          %13.4f          %13.4f\n",a,b,integral);
        }
        exit(EXIT_SUCCESS);
    }
    else
    {
        Vfprintf(stderr,"n is out of range : n = %ld\n",n);
        exit(EXIT_FAILURE);
    }
}
```

8.2. Program Data

```
e01bhc Example Program Data
9
7.990  0.00000E+0  0.00000E+0
8.090  0.27643E-4  5.52510E-4
8.190  0.43749E-1  0.33587E+0
8.700  0.16918E+0  0.34944E+0
9.200  0.46943E+0  0.59696E+0
10.00  0.94374E+0  6.03260E-2
12.00  0.99864E+0  8.98335E-4
15.00  0.99992E+0  2.93954E-5
20.00  0.99999E+0  0.00000E+0
7.99      20.0
10.0      12.0
12.0      10.0
15.0      15.0
```

8.3. Program Results

```
e01bhc Example Program Results

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