NAG Library Function Document

nag_1d_ratnl_eval (e01rbc)

1 Purpose

nag_1d_ratnl_eval (e01rbc) evaluates continued fractions of the form produced by nag_1d_ratnl_interp (e01rac).

2 Specification

```
#include <nag.h>
#include <nage01.h>
void nag_1d_ratnl_eval (Integer m, const double a[], const double u[],
     double x, double *f, NagError *fail)
```

3 Description

nag_1d_ratnl_eval (e01rbc) evaluates the continued fraction

$$R(x) = a_1 + R_m(x)$$

where

$$R_i(x) = \frac{a_{m-i+2}(x - u_{m-i+1})}{1 + R_{i-1}(x)}, \qquad \text{for } i = m, m-1, \ldots, 2.$$

and

$$R_1(x) = 0$$

for a prescribed value of x. nag_1d_ratnl_eval (e01rbc) is intended to be used to evaluate the continued fraction representation (of an interpolatory rational function) produced by nag_1d_ratnl_interp (e01rac).

4 References

Graves–Morris P R and Hopkins T R (1981) Reliable rational interpolation *Numer. Math.* **36** 111–128

5 Arguments

1: **m** – Integer *Input*

On entry: m, the number of terms in the continued fraction.

Constraint: **m** ≥ 1.

2: **a**[**m**] – const double *Input*

On entry: **a**$[j-1]$ must be set to the value of the parameter a_j in the continued fraction, for $j = 1, 2, \ldots, m$.

3: **u**[**m**] – const double *Input*

On entry: **u**$[j-1]$ must be set to the value of the parameter u_j in the continued fraction, for $j = 1, 2, \ldots, m-1$. (The element **u**$[m-1]$ is not used).

4: **x** – double *Input*

On entry: the value of x at which the continued fraction is to be evaluated.

5: **f** – double * *Output*

On exit: the value of the continued fraction corresponding to the value of x.

6: **fail** – NagError * *Input/Output*

The NAG error argument (see Section 3.6 in the Essential Introduction).

6 Error Indicators and Warnings

NE_BAD_PARAM

On entry, argument ⟨*value*⟩ had an illegal value.

NE_INTERNAL_ERROR

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please contact NAG for assistance.

NE_POLE_PRESENT

x corresponds to a pole of $R(x)$, or is very close. $\mathbf{x} = \langle value \rangle$.

7 Accuracy

See Section 7 in nag_1d_ratnl_interp (e01rac).

8 Parallelism and Performance

Not applicable.

9 Further Comments

The time taken by nag_1d_ratnl_eval (e01rbc) is approximately proportional to m.

10 Example

This example reads in the arguments a_j and u_j of a continued fraction (as determined by the example for nag_1d_ratnl_interp (e01rac)) and evaluates the continued fraction at a point x.

10.1 Program Text

```
/* nag_1d_ratnl_eval (e01rbc) Example Program.
 *
 * Copyright 2001 Numerical Algorithms Group.
 *
 * Mark 7, 2001.
 */

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

int main(void)
{
  /* Scalars */
  double   f, x;
  Integer  exit_status, i, m;
  NagError fail;

  /* Arrays */
  double   *a = 0, *u = 0;
```

```
  exit_status = 0;

  INIT_FAIL(fail);

  printf("nag_1d_ratnl_eval (e01rbc) Example Program Results\n");

  /* Skip heading in data file */
  scanf("%*[^\n] ");
  m = 4;

  /* Allocate memory */
  if (!(a = NAG_ALLOC(m, double)) ||
      !(u = NAG_ALLOC(m, double)))
    {
      printf("Allocation failure\n");
      exit_status = -1;
      goto END;
    }

  for (i = 1; i <= m; ++i)
    scanf("%lf", &a[i-1]);
  scanf("%*[^\n] ");

  for (i = 1; i <= m - 1; ++i)
    scanf("%lf", &u[i-1]);
  scanf("%*[^\n] ");
  scanf("%lf%*[^\n] ", &x);

  printf("\n");
  printf("x = %13.4e\n", x);

  /* nag_1d_ratnl_eval (e01rbc).
   * Interpolated values, evaluate rational interpolant
   * computed by nag_1d_ratnl_interp (e01rac), one variable
   */
  nag_1d_ratnl_eval(m, a, u, x, &f, &fail);
  if (fail.code == NE_NOERROR)
    {
      printf("\n");
      printf("The value of R(x) is %13.4e\n", f);
    }
  else
    {
      printf("Error from nag_1d_ratnl_eval (e01rbc).\n%s\n",
              fail.message);
      exit_status = 1;
    }
 END:
  NAG_FREE(a);
  NAG_FREE(u);

  return exit_status;
}
```

10.2 Program Data

```
nag_1d_ratnl_eval (e01rbc) Example Program Data
   4.000   1.000   0.750  -1.000
   0.000   3.000   1.000
   6.000
```

10.3 Program Results

```
nag_1d_ratnl_eval (e01rbc) Example Program Results

x =  6.0000e+00

The value of R(x) is   1.7714e+01
```