NAG C Library Function Document

nag_bessel_i_nu_scaled (s18ecc)

1 Purpose

nag_bessel_i_nu_scaled (s18ecc) returns the value of the scaled modified Bessel function $e^{-x}I_{\nu/4}(x)$ for real $x > 0$.

2 Specification

```
double nag_bessel_i_nu_scaled (double x, Integer nu, NagError *fail)
```

3 Description

This routine evaluates an approximation to the scaled modified Bessel function of the first kind $e^{-x}I_{\nu/4}(x)$, where the order $\nu = -3, -2, -1, 1, 2$ or 3 and x is real and positive. For positive orders it may also be called with $x = 0$, since $I_{\nu/4}(0) = 0$ when $\nu > 0$. For negative orders the formula

$$I_{-\nu/4}(x) = I_{\nu/4}(x) + \tfrac{2}{\pi}\sin(\tfrac{\pi\nu}{4})K_{\nu/4}(x)$$

is used prior to multiplication by the scale factor e^{-x}.

4 Parameters

1: **x** – double *Input*

On entry: the argument x of the function.

Constraints:

x $>$ 0.0 when **nu** $<$ 0,

x $\geq$ 0.0 when **nu** $>$ 0.

2: **nu** – Integer *Input*

On entry: the argument ν of the function.

Constraint: $1 \leq$ abs(**nu**) ≤ 3.

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

The NAG error parameter (see the Essential Introduction).

5 Error Indicators and Warnings

NE_REAL_INT

On entry, **x** = <*value*>, **nu** = <*value*>.
Constraint: **x** $>$ 0.0 when **nu** $<$ 0.

On entry, **x** = <*value*>, **nu** = <*value*>.
Constraint: **x** $\geq$ 0.0 when **nu** $>$ 0.

NE_INT

On entry, **nu** = <*value*>.
Constraint: $1 \leq$ abs(**nu**) ≤ 3.

NE_OVERFLOW_LIKELY

The evaluation has been abandoned due to the likelihood of overflow. The result is returned as zero.

NW_SOME_PRECISION_LOSS

The evaluation has been completed but some precision has been lost.

NE_TOTAL_PRECISION_LOSS

The evaluation has been abandoned due to total loss of precision. The result is returned as zero.

NE_TERMINATION_FAILURE

The evaluation has been abandoned due to failure to satisfy the termination condition. The result is returned as zero.

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 consult NAG for assistance.

6 Further Comments

6.1 Accuracy

All constants in the underlying functions are specified to approximately 18 digits of precision. If t denotes the number of digits of precision in the floating-point arithmetic being used, then clearly the maximum number of correct digits in the results obtained is limited by $p = \min(t, 18)$. Because of errors in argument reduction when computing elementary functions inside the underlying functions, the actual number of correct digits is limited, in general, by $p - s$, where $s \approx \max(1, |\log_{10} x|)$ represents the number of digits lost due to the argument reduction. Thus the larger the value of x, the less the precision in the result.

6.2 References

Abramowitz M and Stegun I A (1972) *Handbook of Mathematical Functions* Dover Publications (3rd Edition)

7 See Also

None.

8 Example

The example program reads values of the arguments x and ν from a file, evaluates the function and prints the results.

8.1 Program Text

```
/* nag_bessel_i_nu_scaled (s18ecc) Example Program.
 *
 * Copyright 2000 Numerical Algorithms Group.
 *
 * NAG C Library
 *
 * Mark 6, 2000.
 */

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

```
#include <nags.h>

int main(void)
{
  double x;
  double y;
  Integer exit_status=0;
  Integer nu;
  NagError fail;

  INIT_FAIL(fail);
  Vprintf("s18ecc Example Program Results\n\n");
  /*  Skip heading in data file */
  Vscanf("%*[^\n]");
  Vprintf("\n  x      nu        y\n\n");
  while (scanf("%lf %ld%*[^\n]", &x, &nu) != EOF)
    {
      y = s18ecc  (x, nu, &fail);
      if (fail.code == NE_NOERROR)
        Vprintf("%4.1f %6ld %12.4e\n", x, nu, y);
      else
        {
          Vprintf("Error from s18ecc.\n%s\n", fail.message);
          exit_status = 1;
          goto END;
        }
    }
 END:
  return exit_status;
}
```

8.2 Program Data

```
s18ecc Example Program Data
 3.9  -3
 1.4  -2
 8.2  -1
 6.7   1
 0.5   2
 2.3   3  : Values of x and nu
```

8.3 Program Results

```
s18ecc Example Program Results


  x      nu        y

 3.9     -3   1.9272e-01
 1.4     -2   3.5767e-01
 8.2     -1   1.4103e-01
 6.7      1   1.5649e-01
 0.5      2   3.5664e-01
 2.3      3   2.3748e-01
```