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

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

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 $\nu$ of the function.
   Constraint: $1 \leq \text{abs(nu)} \leq 3$.

3: fail – NagError *
   Input/Output
   The NAG error parameter (see the Essential Introduction).

5 Error Indicators and Warnings
NE_REAL_INT
   On entry, $x = \langle\text{value}\rangle$, $\nu = \langle\text{value}\rangle$.
   Constraint: $x > 0.0$ when $\nu < 0$.
   On entry, $x = \langle\text{value}\rangle$, $\nu = \langle\text{value}\rangle$.
   Constraint: $x \geq 0.0$ when $\nu > 0$.

NE_INT
   On entry, $\nu = \langle\text{value}\rangle$.
   Constraint: $1 \leq \text{abs(nu)} \leq 3$. 

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NE_OVERFLOWLIKELY

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


7 See Also

None.

8 Example

The example program reads values of the arguments \( x \) and \( \nu \) 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_stdbib.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("%12.4f %6ld %12.4e\n", x, nu, y);
        else
        {
            Vprintf("Error from s18ecc.\n\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

<table>
<thead>
<tr>
<th>x</th>
<th>nu</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.9</td>
<td>-3</td>
<td>1.9272e-01</td>
</tr>
<tr>
<td>1.4</td>
<td>-2</td>
<td>3.5767e-01</td>
</tr>
<tr>
<td>8.2</td>
<td>-1</td>
<td>1.4103e-01</td>
</tr>
<tr>
<td>6.7</td>
<td>1</td>
<td>1.5649e-01</td>
</tr>
<tr>
<td>0.5</td>
<td>2</td>
<td>3.5664e-01</td>
</tr>
<tr>
<td>2.3</td>
<td>3</td>
<td>2.3748e-01</td>
</tr>
</tbody>
</table>