

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 | <i>Input</i> |
| | <i>On entry:</i> the argument x of the function. | |
| | <i>Constraints:</i> | |
| | $x > 0.0$ when nu < 0, | |
| | $x \geq 0.0$ when nu > 0. | |
| 2: | nu – Integer | <i>Input</i> |
| | <i>On entry:</i> the argument ν of the function. | |
| | <i>Constraint:</i> $1 \leq \text{abs}(\mathbf{nu}) \leq 3$. | |
| 3: | fail – NagError * | <i>Input/Output</i> |
| | 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: $1 \leq \text{abs}(\mathbf{nu}) \leq 3$.

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
