

## NAG 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

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

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

#### 3 Description

nag\_bessel\_i\_nu\_scaled (s18ecc) 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 References

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

#### 5 Arguments

- 1: **x** – double *Input*  
*On entry:* the argument  $x$  of the function.  
*Constraints:*  
     if **nu** < 0, **x** > 0.0;  
     if **nu** > 0, **x** ≥ 0.0.
- 2: **nu** – Integer *Input*  
*On entry:* the argument  $\nu$  of the function.  
*Constraint:*  $1 \leq \text{abs}(\mathbf{nu}) \leq 3$ .
- 3: **fail** – NagError \* *Input/Output*  
 The NAG error argument (see Section 2.7 in How to Use the NAG Library and its Documentation).

## 6 Error Indicators and Warnings

### NE\_INT

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

### 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\_OVERFLOW\_LIKELY

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

### NE\_REAL\_INT

On entry,  $\mathbf{x} = \langle \text{value} \rangle$ ,  $\mathbf{nu} = \langle \text{value} \rangle$ .  
 Constraint:  $\mathbf{x} > 0.0$  when  $\mathbf{nu} < 0$ .

On entry,  $\mathbf{x} = \langle \text{value} \rangle$ ,  $\mathbf{nu} = \langle \text{value} \rangle$ .  
 Constraint:  $\mathbf{x} \geq 0.0$  when  $\mathbf{nu} > 0$ .

### NE\_TERMINATION\_FAILURE

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

### NE\_TOTAL\_PRECISION\_LOSS

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

### NW\_SOME\_PRECISION\_LOSS

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

## 7 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.

## 8 Parallelism and Performance

`nag_bessel_i_nu_scaled (s18ecc)` is not threaded in any implementation.

## 9 Further Comments

None.

## 10 Example

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

## 10.1 Program Text

```

/* nag_bessel_i_nu_scaled (s18ecc) Example Program.
 *
 * NAGPRODCODE Version.
 *
 * Copyright 2016 Numerical Algorithms Group.
 *
 * NAG C Library
 *
 * Mark 26, 2016.
 */

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

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

    INIT_FAIL(fail);

    /* Skip heading in data file */
#ifdef _WIN32
    scanf_s("%*[\n]");
#else
    scanf("%*[\n]");
#endif
    printf("nag_bessel_i_nu_scaled (s18ecc) Example Program Results\n");
    printf(" x      nu      y\n");
#ifdef _WIN32
    while (scanf_s("%lf %" NAG_IFMT "%*[\n]", &x, &nu) != EOF)
#else
    while (scanf("%lf %" NAG_IFMT "%*[\n]", &x, &nu) != EOF)
#endif
    {
        /* nag_bessel_i_nu_scaled (s18ecc).
         * Scaled modified Bessel function exp(-x) I_(nu/4)(x)
         */
        y = nag_bessel_i_nu_scaled(x, nu, &fail);
        if (fail.code != NE_NOERROR) {
            printf("Error from nag_bessel_i_nu_scaled (s18ecc).\n%s\n",
                fail.message);
            exit_status = 1;
            goto END;
        }
        printf("%4.1f %6" NAG_IFMT " %13.4e\n", x, nu, y);
    }
END:
    return exit_status;
}

```

## 10.2 Program Data

```

nag_bessel_i_nu_scaled (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

```

### 10.3 Program Results

nag\_bessel\_i\_nu\_scaled (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

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