NAG Library Function Document

nag_bessel_i0_scaled_vector (s18csc)

1 Purpose

nag_bessel_i0_scaled_vector (s18csc) returns an array of values of the scaled modified Bessel function \( e^{-ix}I_0(x) \).

2 Specification

```c
#include <nag.h>
#include <nags.h>
void nag_bessel_i0_scaled_vector (Integer n, const double x[], double f[], NagError *fail)
```

3 Description

nag_bessel_i0_scaled_vector (s18csc) evaluates an approximation to \( e^{-ix}I_0(x_i) \), where \( I_0 \) is a modified Bessel function of the first kind for an array of arguments \( x_i \), for \( i = 1, 2, \ldots, n \). The scaling factor \( e^{-ix} \) removes most of the variation in \( I_0(x) \).

The function uses the same Chebyshev expansions as nag_bessel_i0_vector (s18asc), which returns an array of the unscaled values of \( I_0(x) \).

4 References


5 Arguments

1: \textbf{n} – Integer \hspace{1cm} \textit{Input}

\textit{On entry}: \( n \), the number of points.

\textit{Constraint}: \textbf{n} \geq 0.

2: \textbf{x[n]} – const double \hspace{1cm} \textit{Input}

\textit{On entry}: the argument \( x_i \) of the function, for \( i = 1, 2, \ldots, n \).

3: \textbf{f[n]} – double \hspace{1cm} \textit{Output}

\textit{On exit}: \( e^{-ix}I_0(x_i) \), the function values.

4: \textbf{fail} – NagError * \hspace{1cm} \textit{Input/Output}

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

6 Error Indicators and Warnings

\textbf{NE_ALLOC_FAIL}

Dynamic memory allocation failed.

See Section 3.2.1.2 in the Essential Introduction for further information.
NE_BAD_PARAM
On entry, argument \textit{value} had an illegal value.

NE_INT
On entry, \textit{n} = \textit{value}.
Constraint: \textit{n} \geq 0.

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.
An unexpected error has been triggered by this function. Please contact NAG.
See Section 3.6.6 in the Essential Introduction for further information.

NE_NO_LICENCE
Your licence key may have expired or may not have been installed correctly.
See Section 3.6.5 in the Essential Introduction for further information.

7 Accuracy
Relative errors in the argument are attenuated when propagated into the function value. When the
accuracy of the argument is essentially limited by the \textit{machine precision}, the accuracy of the function
value will be similarly limited by at most a small multiple of the \textit{machine precision}.

8 Parallelism and Performance
Not applicable.

9 Further Comments
None.

10 Example
This example reads values of \(x\) from a file, evaluates the function at each value of \(x_i\) and prints the
results.

10.1 Program Text
/* nag_bessel_i0_scaled_vector (s18csc) Example Program. */
/* Copyright 2014 Numerical Algorithms Group. */
/* Mark 23, 2011. */
#include <nag.h>
#include <stdio.h>
#include <nag_stdlib.h>
#include <nag_stdlib.h>
#include <nags.h>

int main(void)
{
    Integer exit_status = 0;
    Integer i, n;
    double *f = 0, *x = 0;
    NagError fail;

    INIT_FAIL(fail);
    /* Skip heading in data file */
/* Allocate memory */
if (!(x = NAG_ALLOC(n, double)) || !(f = NAG_ALLOC(n, double)))
{
    printf("Allocation failure\n");
    exit_status = -1;
    goto END;
}

for (i=0; i<n; i++)
    scanf("%lf", &x[i]);
#endif
scanf("%*[\n]");
#endif
scanf("%*[\n]");
#endif

/* nag_bessel_i0_scaled_vector (s18csc). Scaled Bessel function I0(x) */
if (fail.code!=NE_NOERROR)
{
    printf("Error from nag_bessel_i0_scaled_vector (s18csc).\n%s\n", fail.message);
    exit_status = 1;
    goto END;
}

for (i=0; i<n; i++)
    printf(" %11.3e %11.3e\n", x[i], f[i]);

END:
NAG_FREE(f);
NAG_FREE(x);
return exit_status;
}
10.2 Program Data

nag_bessel_i0_scaled_vector (s18csc) Example Program Data

8
0.0 0.5 1.0 3.0 6.0 10.0 1000.0 -1.0

10.3 Program Results

nag_bessel_i0_scaled_vector (s18csc) Example Program Results

<table>
<thead>
<tr>
<th>x</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000e+00</td>
<td>1.000e+00</td>
</tr>
<tr>
<td>5.000e-01</td>
<td>6.450e-01</td>
</tr>
<tr>
<td>1.000e+00</td>
<td>4.658e-01</td>
</tr>
<tr>
<td>3.000e+00</td>
<td>2.430e-01</td>
</tr>
<tr>
<td>6.000e+00</td>
<td>1.667e-01</td>
</tr>
<tr>
<td>1.000e+01</td>
<td>1.278e-01</td>
</tr>
<tr>
<td>1.000e+03</td>
<td>1.262e-02</td>
</tr>
<tr>
<td>-1.000e+00</td>
<td>4.658e-01</td>
</tr>
</tbody>
</table>