

nag_bessel_i0 (s18aec)**1. Purpose**

nag_bessel_i0 (s18aec) returns the value of the modified Bessel function $I_0(x)$.

2. Specification

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

double nag_bessel_i0(double x, NagError *fail)
```

3. Description

This function evaluates an approximation to the modified Bessel function of the first kind, $I_0(x)$.

The function is based on Chebyshev expansions.

For large x , the function must fail because of the danger of overflow in calculating e^x .

4. Parameters

x

Input: the argument x of the function.

fail

The NAG error parameter, see the Essential Introduction to the NAG C Library.

5. Error Indications and Warnings**NE_REAL_ARG_GT**

On entry, $|x|$ must not be greater than $\langle value \rangle$: $x = \langle value \rangle$.

$|x|$ is too large and the function returns the approximate value of $I_0(x)$ at the nearest valid argument.

6. Further Comments**6.1. Accuracy**

Let δ and ϵ be the relative errors in the argument and result respectively.

If δ is somewhat larger than the **machine precision** (i.e., if δ is due to data errors etc.), then ϵ and δ are approximately related by $\epsilon \simeq |xI_1(x)/I_0(x)| \delta$.

However, if δ is of the same order as **machine precision**, then rounding errors could make ϵ slightly larger than the above relation predicts.

For small x the amplification factor is approximately $x^2/2$, which implies strong attenuation of the error, but in general ϵ can never be less than the **machine precision**.

For large x , $\epsilon \simeq x\delta$ and we have strong amplification of errors. However, the function must fail for quite moderate values of x , because $I_0(x)$ would overflow; hence in practice the loss of accuracy for large x is not excessive. Note that for large x the errors will be dominated by those of the **math library** function exp.

6.2. References

Abramowitz M and Stegun I A (1968) *Handbook of Mathematical Functions* Dover Publications, New York ch 9 p 374.

7. See Also

nag_bessel_i1 (s18afc)

8. Example

The following program reads values of the argument x from a file, evaluates the function at each value of x and prints the results.

8.1. Program Text

```

/* nag_bessel_i0(s18aec) Example Program
 *
 * Copyright 1990 Numerical Algorithms Group.
 *
 * Mark 2 revised, 1992.
 */

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

main()
{
    double x, y;

    /* Skip heading in data file */
    Vscanf("%*[^\\n]");
    Vprintf("s18aec Example Program Results\\n");
    Vprintf("      x          y\\n");
    while (scanf("%lf", &x) != EOF)
    {
        y = s18aec(x, NAGERR_DEFAULT);
        Vprintf("%12.3e%12.3e\\n", x, y);
    }
    exit(EXIT_SUCCESS);
}

```

8.2. Program Data

```

s18aec Example Program Data
      0.0
      0.5
      1.0
      3.0
      6.0
      8.0
     10.0
     15.0
     20.0
     -1.0

```

8.3. Program Results

```

s18aec Example Program Results
      x          y
  0.000e+00  1.000e+00
  5.000e-01  1.063e+00
  1.000e+00  1.266e+00
  3.000e+00  4.881e+00
  6.000e+00  6.723e+01
  8.000e+00  4.276e+02
  1.000e+01  2.816e+03
  1.500e+01  3.396e+05
  2.000e+01  4.356e+07
 -1.000e+00  1.266e+00

```