1 Purpose

nag_cumul_normal_complem (s15acc) returns the value of the complement of the cumulative Normal distribution function, $Q(x)$.

2 Specification

```c
#include <nag.h>
#include <nags.h>
double nag_cumul_normal_complem (double x)
```

3 Description

nag_cumul_normal_complem (s15acc) evaluates an approximate value for the complement of the cumulative Normal distribution function

$$Q(x) = \frac{1}{\sqrt{2\pi}} \int_x^\infty e^{-u^2/2} du.$$ 

The function is based on the fact that

$$Q(x) = \frac{1}{2} \text{erfc}\left(\frac{x}{\sqrt{2}}\right)$$

and it calls nag_erfc (s15adc) to obtain the necessary value of $\text{erfc}$, the complementary error function.

4 References


5 Arguments

1: x – double

*Input*

*On entry*: the argument $x$ of the function.

6 Error Indicators and Warnings

None.

7 Accuracy

Because of its close relationship with $\text{erfc}$ the accuracy of this function is very similar to that in nag_erfc (s15adc). If $\epsilon$ and $\delta$ are the relative errors in result and argument, respectively, then in principle they are related by

$$|\epsilon| \approx \left| \frac{x e^{-x^2/2}}{\sqrt{2\pi}Q(x)} \right| \delta.$$
For $x$ negative or small positive this factor is always less than one and accuracy is mainly limited by machine precision. For large positive $x$ we find $\epsilon \sim x^2\delta$ and hence to a certain extent relative accuracy is unavoidably lost. However the absolute error in the result, $E$, is given by

$$|E| \approx \left| \frac{xe^{-x^2/2}}{\sqrt{2\pi} \delta} \right|$$

and since this factor is always less than one absolute accuracy can be guaranteed for all $x$.

8 Parallelism and Performance

Not applicable.

9 Further Comments

None.

10 Example

This example reads values of the argument $x$ from a file, evaluates the function at each value of $x$ and prints the results.

10.1 Program Text

/* nag_cumul_normal_complem (s15acc) Example Program. */
/* Copyright 2014 Numerical Algorithms Group. */
/* Mark 1, 1990. */
/* Mark 3 revised, 1994. */
*/
#include <nag.h>
#include <stdio.h>
#include <nag_stdlib.h>
#include <nags.h>

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

    /* Skip heading in data file */
    #ifdef _WIN32
    scanf_s("%*[\n]");
    #else
    scanf("%*[\n]");
    #endif
    printf("nag_cumul_normal_complem (s15acc) Example Program Results\n");
    printf(" x y\n");
    #ifdef _WIN32
    while (scanf_s("%lf", &x) != EOF)
    #else
    while (scanf("%lf", &x) != EOF)
    #endif
    { /* nag_cumul_normal_complem (s15acc).
        * Complement of cumulative Normal distribution function
        * $Q(x)$ */
        y = nag_cumul_normal_complem(x);
    }
}

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printf("%12.3e%12.3e\n", x, y);
}
return exit_status;
}

10.2 Program Data

nag_cumul_normal_complem (s15acc) Example Program Data

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-20.0</td>
<td>1.0000e+00</td>
</tr>
<tr>
<td>-1.0</td>
<td>8.413e-01</td>
</tr>
<tr>
<td>0.0</td>
<td>5.000e-01</td>
</tr>
<tr>
<td>1.0</td>
<td>1.587e-01</td>
</tr>
<tr>
<td>2.0</td>
<td>2.275e-02</td>
</tr>
<tr>
<td>20.0</td>
<td>2.754e-89</td>
</tr>
</tbody>
</table>

10.3 Program Results

nag_cumul_normal_complem (s15acc) Example Program Results

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