

NAG Toolbox for MATLAB

s15ab

1 Purpose

s15ab returns the value of the cumulative Normal distribution function, $P(x)$, via the function name.

2 Syntax

```
[result, ifail] = s15ab(x)
```

3 Description

s15ab evaluates an approximate value for the cumulative Normal distribution function

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

The function is based on the fact that

$$P(x) = \frac{1}{2} \operatorname{erfc}\left(\frac{-x}{\sqrt{2}}\right)$$

and it calls s15ad to obtain a value of *erfc* for the appropriate argument.

4 References

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

5 Parameters

5.1 Compulsory Input Parameters

1: **x – double scalar**

The argument x of the function.

5.2 Optional Input Parameters

None.

5.3 Input Parameters Omitted from the MATLAB Interface

None.

5.4 Output Parameters

1: **result – double scalar**

The result of the function.

2: **ifail – int32 scalar**

0 unless the function detects an error (see Section 6).

6 Error Indicators and Warnings

There are no failure exits from this function. The parameter **ifail** is included for consistency with other functions in this chapter.

7 Accuracy

Because of its close relationship with *erfc*, the accuracy of this function is very similar to that in s15ad. If ϵ and δ are the relative errors in result and argument, respectively, they are in principle related by

$$|\epsilon| \simeq \left| \frac{xe^{-\frac{1}{2}x^2}}{\sqrt{2\pi}P(x)} \delta \right|$$

so that the relative error in the argument, x , is amplified by a factor, $\frac{xe^{-\frac{1}{2}x^2}}{\sqrt{2\pi}P(x)}$, in the result.

For x small and for x positive this factor is always less than one and accuracy is mainly limited by *machine precision*.

For large negative x the factor behaves like $\sim x^2$ and hence to a certain extent relative accuracy is unavoidably lost.

However the absolute error in the result, E , is given by

$$|E| \simeq \left| \frac{xe^{-\frac{1}{2}x^2}}{\sqrt{2\pi}} \delta \right|$$

so absolute accuracy can be guaranteed for all x .

8 Further Comments

None.

9 Example

```
x = -20;
[result, ifail] = s15ab(x)

result =
    2.7536e-89
ifail =
    0
```