

## NAG Toolbox

### **nag\_stat\_mills\_ratio (g01mb)**

## 1 Purpose

nag\_stat\_mills\_ratio (g01mb) returns the reciprocal of Mills' Ratio.

## 2 Syntax

```
[result] = nag_stat_mills_ratio(x)
[result] = g01mb(x)
```

## 3 Description

nag\_stat\_mills\_ratio (g01mb) calculates the reciprocal of Mills' Ratio, the hazard rate,  $\lambda(x)$ , for the standard Normal distribution. It is defined as the ratio of the ordinate to the upper tail area of the standard Normal distribution, that is,

$$\lambda(x) = \frac{Z(x)}{Q(x)} = \frac{\frac{1}{\sqrt{2\pi}}e^{-(x^2/2)}}{\frac{1}{\sqrt{2\pi}} \int_x^\infty e^{-(t^2/2)} dt}.$$

The calculation is based on a Chebyshev expansion as described in nag\_specfun\_erfcx\_real (s15ag).

## 4 References

Gross A J and Clark V A (1975) *Survival Distributions: Reliability Applications in the Biomedical Sciences* Wiley

## 5 Parameters

### 5.1 Compulsory Input Parameters

1: **x** – REAL (KIND=nag\_wp)  
*x*, the argument of the reciprocal of Mills' Ratio.

### 5.2 Optional Input Parameters

None.

### 5.3 Output Parameters

1: **result**  
The result of the function.

## 6 Error Indicators and Warnings

None.

## 7 Accuracy

In the left-hand tail,  $x < 0.0$ , if  $\frac{1}{2}e^{-(1/2)x^2} \leq$  the safe range argument (nag\_machine\_real\_safe (x02am)), then 0.0 is returned, which is close to the true value.

The relative accuracy is bounded by the effective ***machine precision***. See nag\_specfun\_erfcx\_real (s15ag) for further discussion.

## 8 Further Comments

If, before entry,  $x$  is not a standard Normal variable, it has to be standardized, and on exit, nag\_stat\_mills\_ratio (g01mb) has to be divided by the standard deviation. That is, if the Normal distribution has mean  $\mu$  and variance  $\sigma^2$ , then its hazard rate,  $\lambda(x; \mu, \sigma^2)$ , is given by

$$\lambda(x; \mu, \sigma^2) = \lambda((x - \mu)/\sigma)/\sigma.$$

## 9 Example

The hazard rate is evaluated at different values of  $x$  for Normal distributions with different means and variances. The results are then printed.

### 9.1 Program Text

```
function g01mb_example

fprintf('g01mb example results\n\n');

x      = [ 0.0; -2.0; 10.3];
xmu   = [ 0.0;  1.0;  9.0];
xsig  = [ 1.0;  2.5;  1.6];

fprintf('  mean      sigma      x      reciprocal\n');
fprintf('                                Mills ratio\n\n');

for j = 1:numel(x)
    z  = (x(j)-xmu(j))/xsig(j);

    rm = g01mb(z);

    rm = rm/xsig(j);
    fprintf('%7.4f%9.4f%9.4f%11.4f\n', xmu(j), xsig(j), x(j), rm);
end
```

### 9.2 Program Results

g01mb example results

mean	sigma	x	reciprocal
Mills ratio			
0.0000	1.0000	0.0000	0.7979
1.0000	2.5000	-2.0000	0.0878
9.0000	1.6000	10.3000	0.8607

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