NAG C Library Function Document

nag_mills_ratio (g01mbc)

1 Purpose

nag_mills_ratio (g01mbc) returns the reciprocal of Mills' Ratio.

2 Specification

```
double nag_mills_ratio (double x)
```

3 Description

nag_mills_ratio (g01mbc) 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,

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

If $x \leq 9.0$, then the calculation is based on a Chebyshev expansion as described in nag_erfc (s15adc); otherwise, the method due to Swan (1969) is used.

4 References

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

Swan A V (1969) Algorithm AS17. The reciprocal of Mills's ratio *Appl. Statist.* **18** 115

5 Parameters

1: **x** – double *Input*

On entry: the argument of the reciprocal of Mills' Ratio, x.

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 parameter (nag_real_safe_small_number (X02AMC)), then 0.0 is returned, which is close to the true value.

The relative accuracy is bounded by the effective ***machine precision***. See nag_erfc (s15adc) for further discussion for the case $x \leq 9.0$.

8 Further Comments

If, before entry, x is not a standard Normal variable, it has to be standardized, and on exit, nag_mills_ratio (g01mbc) has to be divided by the standard deviation. That is, if the Normal distribution has mean μ and variance σ^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

```
/* nag_mills_ratio (g01mbc) Example Program.
 *
 * Copyright 2001 Numerical Algorithms Group.
 *
 * Mark 7, 2001.
 */

#include <stdio.h>
#include <nag.h>
#include <nag_stdlib.h>
#include <nagg01.h>

int main(void)
{
  /* Scalars */
  double rm, x, xmu, xsig, z__;
  Integer exit_status, i;

  exit_status = 0;
  Vprintf("g01mbc Example Program Results\n");

/* Skip heading in data file */
  Vscanf("%*[^\n] ");

  Vprintf("\n%2sMean%5sSigma%4sX%8sReciprocal",   "",  "",  "",  "");
  Vprintf("\n                                Mills Ratio\n\n");
  for (i = 1; i <= 3; ++i)
    {

      Vscanf("%lf%lf%lf%*[^\n] ",   &x,  &xmu,  &xsig);
      z__ = (x - xmu) / xsig;
      rm = g01mbc(z__) / xsig;
       Vprintf("%7.4f%2s%7.4f%2s%7.4f%2s%7.4f",   xmu,  "",  xsig,  "",  x,  "",
rm);
      Vprintf("\n");
    }
  return exit_status;
}
```

9.2 Program Data

```
g01mbc Example Program Data
0.0 0.0 1.0
-2.0 1.0 2.5
10.3 9.0 1.6
```

9.3 Program Results

```
g01mbc Example Program 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
```