NAG Fortran Library Routine Document

G01MBF

Note: before using this routine, please read the Users' Note for your implementation to check the interpretation of ***bold italicised*** terms and other implementation-dependent details.

1 Purpose

G01MBF returns the reciprocal of Mills' Ratio, via the routine name.

2 Specification

real `FUNCTION G01MBF(X)`
real `X`

3 Description

G01MBF 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 S15ADF; 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 – ***real*** *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 (X02AMF), then 0.0 is returned, which is close to the true value.

The relative accuracy is bounded by the effective ***machine precision***. See S15ADF 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, G01MBF 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

Note: the listing of the example program presented below uses ***bold italicised*** terms to denote precision-dependent details. Please read the Users' Note for your implementation to check the interpretation of these terms. As explained in the Essential Introduction to this manual, the results produced may not be identical for all implementations.

```
*     G01MBF Example Program Text
*     Mark 15 Release. NAG Copyright 1991.
*     .. Parameters ..
      INTEGER          NIN, NOUT
      PARAMETER        (NIN=5,NOUT=6)
*     .. Local Scalars ..
      real             RM, X, XMU, XSIG, Z
      INTEGER          I
*     .. External Functions ..
      real             G01MBF
      EXTERNAL         G01MBF
*     .. Executable Statements ..
      WRITE (NOUT,*) 'G01MBF Example Program Results '
*     Skip heading in data file
      READ (NIN,*)
      WRITE (NOUT,*)
      WRITE (NOUT,99999)
      DO 20 I = 1, 3
         READ (NIN,*) X, XMU, XSIG
         Z = (X-XMU)/XSIG
         RM = G01MBF(Z)/XSIG
         WRITE (NOUT,99998) XMU, XSIG, X, RM
   20 CONTINUE
      STOP
*
99999 FORMAT (2X,'Mean',5X,'Sigma',4X,'X',8X,'Reciprocal',/'          ',
     +       '                   Mills Ratio',/)
99998 FORMAT (1X,4(F7.4,2X))
      END
```

9.2 Program Data

```
G01MBF 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

```
 G01MBF 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
```