NAG 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

```
FUNCTION G01MBF (X)
REAL (KIND=nag_wp) G01MBF
REAL (KIND=nag_wp) 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,

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

The calculation is based on a Chebyshev expansion as described in S15AGF.

4 References

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

5 Parameters

1: X – REAL (KIND=nag_wp) *Input*

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

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 S15AGF for further discussion.

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, $\lambda\left(x;\mu,\sigma^2\right)$, is given by

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

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

```
    Program g01mbfe

!     G01MBF Example Program Text

!     Mark 24 Release. NAG Copyright 2012.

!     .. Use Statements ..
      Use nag_library, Only: a00acf, g01mbf, nag_wp
!     .. Implicit None Statement ..
      Implicit None
!     .. Parameters ..
      Integer, Parameter               :: nin = 5, nout = 6
!     .. Local Scalars ..
      Real (Kind=nag_wp)               :: rm, x, xmu, xsig, z
      Integer                          :: ifail
!     .. Executable Statements ..
      Write (nout,*) 'G01MBF Example Program Results '
      Write (nout,*)

!     Check for valid licence prior to calling G01MBF
      If (.Not. a00acf()) Then
        Write (nout,*) ' ** A valid licence key was not found'

      Else
!       Skip heading in data file
        Read (nin,*)

!       Display titles
        Write (nout,*) ' Mean     Sigma    X        Reciprocal'
        Write (nout,*) '                            Mills Ratio'
        Write (nout,*)

d_lp:   Do
          Read (nin,*,Iostat=ifail) x, xmu, xsig
          If (ifail/=0) Then
            Exit d_lp
          End If

          z = (x-xmu)/xsig
          rm = g01mbf(z)/xsig

!         Display results
          Write (nout,99999) xmu, xsig, x, rm
        End Do d_lp
      End If

99999 Format (1X,4(F7.4,2X))
    End Program g01mbfe
```

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
```