

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,

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

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

4 References

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

5 Arguments

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 argument (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 Parallelism and Performance

G01MBF is not threaded in any implementation.

9 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

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

10 Example

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

10.1 Program Text

```

Program g01mbfe

!      G01MBF Example Program Text

!      Mark 26 Release. NAG Copyright 2016.

!      .. 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,*) '
  Write (nout,*) ' Mills Ratio'

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

```

10.2 Program Data

G01MBF Example Program Data
0.0 0.0 1.0
-2.0 1.0 2.5
10.3 9.0 1.6

10.3 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 |
