

NAG Library Routine Document

G01KAF

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

G01KAF returns the value of the probability density function (PDF) for the Normal (Gaussian) distribution with mean μ and variance σ^2 at a point x .

2 Specification

```
FUNCTION G01KAF (X, XMEAN, XSTD, IFAIL)
REAL (KIND=nag_wp) G01KAF
INTEGER IFAIL
REAL (KIND=nag_wp) X, XMEAN, XSTD
```

3 Description

The Normal distribution has probability density function (PDF)

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/2\sigma^2}, \quad \sigma > 0.$$

4 References

None.

5 Parameters

- | | | |
|----|--|---------------------|
| 1: | X – REAL (KIND=nag_wp) | <i>Input</i> |
| | <i>On entry:</i> x , the value at which the PDF is to be evaluated. | |
| 2: | XMEAN – REAL (KIND=nag_wp) | <i>Input</i> |
| | <i>On entry:</i> μ , the mean of the Normal distribution. | |
| 3: | XSTD – REAL (KIND=nag_wp) | <i>Input</i> |
| | <i>On entry:</i> σ , the standard deviation of the Normal distribution. | |
| | <i>Constraint:</i> $z < XSTD\sqrt{2\pi} < 1.0/z$, where $z = X02AMF()$, the safe range parameter. | |
| 4: | IFAIL – INTEGER | <i>Input/Output</i> |
| | <i>On entry:</i> IFAIL must be set to 0, –1 or 1. If you are unfamiliar with this parameter you should refer to Section 3.3 in the Essential Introduction for details. | |

For environments where it might be inappropriate to halt program execution when an error is detected, the value –1 or 1 is recommended. If the output of error messages is undesirable, then the value 1 is recommended. Otherwise, if you are not familiar with this parameter, the recommended value is 0. **When the value –1 or 1 is used it is essential to test the value of IFAIL on exit.**

On exit: IFAIL = 0 unless the routine detects an error or a warning has been flagged (see Section 6).

6 Error Indicators and Warnings

If on entry $IFAIL = 0$ or -1 , explanatory error messages are output on the current error message unit (as defined by X04AAF).

Errors or warnings detected by the routine:

If $IFAIL \neq 0$, then G01KAF returns 0.0.

$IFAIL = 1$

$XSTD\sqrt{2.0\pi} \leq z$, where $z = X02AMF()$, the safe range parameter.

$IFAIL = 2$

$XSTD\sqrt{2.0\pi} \geq 1/z$, where $z = X02AMF()$, the safe range parameter.

$IFAIL = 3$

An internal calculation would overflow. This rarely occurs, and is the result of extreme values of the parameters X, XMEAN or XSTD.

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

This example prints the value of the Normal distribution PDF at four different points X with differing XMEAN and XSTD.

9.1 Program Text

```

Program g01kafe

!      G01KAF Example Program Text

!      Mark 24 Release. NAG Copyright 2012.

!      .. Use Statements ..
      Use nag_library, Only: g01kaf, nag_wp
!      .. Implicit None Statement ..
      Implicit None
!      .. Parameters ..
      Integer, Parameter          :: nin = 5, nout = 6
!      .. Local Scalars ..
      Real (Kind=nag_wp)          :: f, x, xmean, xstd
      Integer                      :: ifail
!      .. Executable Statements ..
      Write (nout,*) 'G01KAF Example Program Results'
      Write (nout,*)

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

!      Display titles
      Write (nout,*) '      X              MEAN          STANDARD          RESULT '
      Write (nout,*) '              DEVIATION'
      Write (nout,*)

d_lp: Do

```

```

      Read (nin,*,Iostat=ifail) x, xmean, xstd
      If (ifail/=0) Then
        Exit d_lp
      End If

      ifail = 0
      f = g01kaf(x,xmean,xstd,ifail)

!      Display results
      Write (nout,99999) x, xmean, xstd, f
      End Do d_lp

99999 Format (1X,1P,4(1X,E13.5))
      End Program g01kafe

```

9.2 Program Data

G01KAF Example Program Data

```

1.0E0  0.0E0  1.0E0
4.0E0  2.0E0  1.0E0
1.0E-1 0.0E0  1.0E-2
1.0E0  0.0E0  1.0E1

```

: X, XMEAN, XSTD

9.3 Program Results

G01KAF Example Program Results

X	MEAN	STANDARD DEVIATION	RESULT
1.00000E+00	0.00000E+00	1.00000E+00	2.41971E-01
4.00000E+00	2.00000E+00	1.00000E+00	5.39910E-02
1.00000E-01	0.00000E+00	1.00000E-02	7.69460E-21
1.00000E+00	0.00000E+00	1.00000E+01	3.96953E-02

