

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>On entry:</i> x , the value at which the PDF is to be evaluated. | <i>Input</i> |
| 2: | XMEAN – REAL (KIND=nag_wp)
<i>On entry:</i> μ , the mean of the Normal distribution. | <i>Input</i> |
| 3: | XSTD – REAL (KIND=nag_wp)
<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. | <i>Input</i> |
| 4: | IFAIL – INTEGER
<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. | <i>Input/Output</i> |

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.

$IFAIL = 1$

On entry, $XSTD = \langle value \rangle$.

Constraint: $XSTD \times \sqrt{2.0\pi} > U$, where U is the safe range parameter as defined by $X02AMF$.

$IFAIL = 2$

Computation abandoned owing to underflow of $\frac{1}{(\sigma \times \sqrt{2\pi})}$.

$IFAIL = 3$

Computation abandoned owing to an internal calculation overflowing.

This rarely occurs, and is the result of extreme values of the parameters X , $XMEAN$ or $XSTD$.

$IFAIL = -99$

An unexpected error has been triggered by this routine. Please contact NAG.

See Section 3.8 in the Essential Introduction for further information.

$IFAIL = -399$

Your licence key may have expired or may not have been installed correctly.

See Section 3.7 in the Essential Introduction for further information.

$IFAIL = -999$

Dynamic memory allocation failed.

See Section 3.6 in the Essential Introduction for further information.

7 Accuracy

Not applicable.

8 Parallelism and Performance

Not applicable.

9 Further Comments

None.

10 Example

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

10.1 Program Text

```

Program g01kafe

!      G01KAF Example Program Text

!      Mark 25 Release. NAG Copyright 2014.

!      .. 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

```

10.2 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

```

10.3 Program Results

```

G01KAF Example Program Results

      X                MEAN                STANDARD                RESULT
      DEVIATION

      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

```

Example Program
Plots of the Gaussian Function (or Normal Distribution).

