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 Arguments

1:    X – REAL (KIND=nag_wp) *Input*

   On entry: x, the value at which the PDF is to be evaluated.

2:    XMEAN – REAL (KIND=nag_wp) *Input*

   On entry: μ, the mean of the Normal distribution.

3:    XSTD – REAL (KIND=nag_wp) *Input*

   On entry: σ, the standard deviation of the Normal distribution.

   Constraint: $z < \text{XSTD}\sqrt{2\pi} < 1.0/z$, where $z = \text{X02AMF}()$, the safe range parameter.

4:    IFAIL – INTEGER *Input/Output*

   On entry: IFAIL must be set to 0, -1 or 1. If you are unfamiliar with this argument you should refer to Section 3.4 in How to Use the NAG Library and its Documentation 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 argument, 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 arguments X, XMEAN or XSTD.

IFAIL $= -99$

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

See Section 3.9 in How to Use the NAG Library and its Documentation for further information.

IFAIL $= -399$

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

See Section 3.8 in How to Use the NAG Library and its Documentation for further information.

IFAIL $= -999$

Dynamic memory allocation failed.

See Section 3.7 in How to Use the NAG Library and its Documentation for further information.

7   Accuracy

Not applicable.

8   Parallelism and Performance

G01KAF is not threaded in any implementation.

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 26 Release. NAG Copyright 2016.

!     .. 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).