NAG Library Function Document

nag_normal_pdf (g01kac)

1 Purpose

nag_normal_pdf (g01kac) 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

```
#include <nag.h>
#include <nagg01.h>
double nag_normal_pdf (double x, double xmean, double xstd, NagError *fail)
```

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** – double *Input*

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

2: **xmean** – double *Input*

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

3: **xstd** – double *Input*

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

Constraint: $z < \mathbf{xstd}\sqrt{2\pi} < 1.0/z$, where $z =$ nag_real_safe_small_number, the safe range parameter.

4: **fail** – NagError * *Input/Output*

The NAG error argument (see Section 3.6 in the Essential Introduction).

6 Error Indicators and Warnings

NE_ALLOC_FAIL

Dynamic memory allocation failed.
See Section 3.2.1.2 in the Essential Introduction for further information.

NE_INTERNAL_ERROR

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please contact NAG for assistance.

An unexpected error has been triggered by this function. Please contact NAG.
See Section 3.6.6 in the Essential Introduction for further information.

NE_NO_LICENCE

Your licence key may have expired or may not have been installed correctly.
See Section 3.6.5 in the Essential Introduction for further information.

NE_OVERFLOW

Computation abandoned owing to an internal calculation overflowing.

NE_REAL

On entry, **xstd** $= \langle value \rangle$.
Constraint: **xstd** $\times \sqrt{2.0\pi} > U$, where U is the safe range parameter as defined by nag_real_safe_small_number (X02AMC).

NE_UNDERFLOW

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

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

```
/* nag_normal_pdf (g01kac) Example Program.
 *
 * Copyright 2014 Numerical Algorithms Group.
 *
 * Mark 9, 2009.
 */

/* Pre-processor includes */
#include <stdio.h>
#include <math.h>
#include <string.h>
#include <nag.h>
#include <nag_stdlib.h>
#include <nagg01.h>

int main(void)
{
```

```
  /*Integer scalar and array declarations */
  Integer  exit_status = 0;
  Integer  i, ndata;
  /*Double scalar and array declarations */
  double   xmean, xstd, f, x;
  /* Nag Types */
  NagError fail;

  INIT_FAIL(fail);

  printf("nag_normal_pdf (g01kac) Example Program Results\n\n");
#ifdef _WIN32
  scanf_s("%*[^\n] ");
#else
  scanf("%*[^\n] ");
#endif
#ifdef _WIN32
  scanf_s("%"NAG_IFMT"%*[^\n] ", &ndata);
#else
  scanf("%"NAG_IFMT"%*[^\n] ", &ndata);
#endif
  printf("%14s%17s%17s%17s\n\n", "X", "XMEAN", "XSTD", "RESULT");
  for (i = 0; i < ndata; i++)
    {
#ifdef _WIN32
      scanf_s("%lf%lf%lf%*[^\n] ", &x, &xmean, &xstd);
#else
      scanf("%lf%lf%lf%*[^\n] ", &x, &xmean, &xstd);
#endif
      /*
       * nag_normal_pdf (g01kac)
       * Calculates the value for the probability density function of
       * the normal distribution at a chosen point.
       */
      f = nag_normal_pdf(x, xmean, xstd, &fail);
      if (fail.code != NE_NOERROR)
        {
          printf("Error from nag_normal_pdf (g01kac).\n%s\n",
                  fail.message);
          exit_status = 1;
          goto END;
        }
      printf("%18.5e%17.5e%17.5e%17.5e\n", x, xmean, xstd, f);
    }

 END:

  return exit_status;
}
```

10.2 Program Data

```
nag_normal_pdf (g01kac) Example Program Data
4                     : ndata
1.0E0 0.0E0 1.0E0
4.0E0 2.0E0 1.0E0
1.0E-1 0.0E0 0.1E-1
1.0E0 0.0E0 1.0E1     : x, xmean, xstd
```

10.3 Program Results

```
nag_normal_pdf (g01kac) Example Program Results

             X            XMEAN             XSTD           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
```

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