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_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.

NE_OVERFLOW

Computation abandoned owing to an internal calculation overflowing.

NE_REAL

On entry, **xstd** $= \langle value \rangle$.
Constraint: **xstd** $\times \sqrt{2.0\pi} >$ nag_real_safe_small_number.

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 2009, 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");
  scanf("%*[^\n] ");
  scanf("%ld%*[^\n] ", &ndata);
  printf("%14s%17s%17s%17s\n\n", "X", "XMEAN", "XSTD", "RESULT");
  for (i = 0; i < ndata; i++)
    {
      scanf("%lf%lf%lf%*[^\n] ", &x, &xmean, &xstd);
      /*
       * 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
```