NAG Library Function Document

nag_poisson_dist (g01bkc)

1 Purpose

nag_poisson_dist (g01bkc) returns the lower tail, upper tail and point probabilities associated with a Poisson distribution.

2 Specification

```
#include <nag.h>
#include <nagg01.h>
```

```
void nag_poisson_dist (double rlamda, Integer k, double *plek, double *pgtk,
     double *peqk, NagError *fail)
```

3 Description

Let X denote a random variable having a Poisson distribution with parameter λ (> 0). Then

$$\text{Prob}\{X = k\} = e^{-\lambda}\frac{\lambda^k}{k!}, \quad k = 0, 1, 2, \ldots$$

The mean and variance of the distribution are both equal to λ.

nag_poisson_dist (g01bkc) computes for given λ and k the probabilities:

$$\begin{aligned} \textbf{plek} &= \text{Prob}\{X \leq k\} \\ \textbf{pgtk} &= \text{Prob}\{X > k\} \\ \textbf{peqk} &= \text{Prob}\{X = k\}. \end{aligned}$$

The method is described in Knüsel (1986).

4 References

Knüsel L (1986) Computation of the chi-square and Poisson distribution *SIAM J. Sci. Statist. Comput.* **7** 1022–1036

5 Arguments

1: **rlamda** – double *Input*

On entry: the parameter λ of the Poisson distribution.

Constraint: $0.0 < \textbf{rlamda} \leq 10^6$.

2: **k** – Integer *Input*

On entry: the integer k which defines the required probabilities.

Constraint: $\textbf{k} \geq 0$.

3: **plek** – double * *Output*

On exit: the lower tail probability, $\text{Prob}\{X \leq k\}$.

4: **pgtk** – double * *Output*

On exit: the upper tail probability, $\text{Prob}\{X > k\}$.

5: **peqk** – double * *Output*

On exit: the point probability, $\text{Prob}\{X = k\}$.

6: **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_BAD_PARAM

On entry, argument $\langle value \rangle$ had an illegal value.

NE_INT_ARG_LT

On entry, **k** $= \langle value \rangle$.
Constraint: **k** ≥ 0.

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_REAL_ARG_GT

On entry, **rlamda** $= \langle value \rangle$.
Constraint: **rlamda** $\leq 10^6$.

NE_REAL_ARG_LE

On entry, **rlamda** $= \langle value \rangle$.
Constraint: **rlamda** > 0.0.

7 Accuracy

Results are correct to a relative accuracy of at least 10^{-6} on machines with a precision of 9 or more decimal digits, and to a relative accuracy of at least 10^{-3} on machines of lower precision (provided that the results do not underflow to zero).

8 Parallelism and Performance

Not applicable.

9 Further Comments

The time taken by nag_poisson_dist (g01bkc) depends on λ and k. For given λ, the time is greatest when $k \approx \lambda$, and is then approximately proportional to $\sqrt{\lambda}$.

10 Example

This example reads values of λ and k from a data file until end-of-file is reached, and prints the corresponding probabilities.

10.1 Program Text

```
/* nag_poisson_dist (g01bkc) Example Program.
 *
 * Copyright 2014 Numerical Algorithms Group.
 *
 * Mark 4, 1996.
 *
 */

#include <nag.h>
#include <nag_stdlib.h>
#include <stdio.h>
#include <nagg01.h>

int main(void)
{
  Integer  exit_status = 0;
  Integer  k;
  double   plek, peqk, pgtk;
  double   rlamda;
  NagError fail;

  INIT_FAIL(fail);

  printf("nag_poisson_dist (g01bkc) Example Program Results\n");

  /* Skip heading in data file */
#ifdef _WIN32
  scanf_s("%*[^\n] ");
#else
  scanf("%*[^\n] ");
#endif
  printf("\n    rlamda     k     plek      pgtk      peqk\n\n");

#ifdef _WIN32
  while ((scanf_s("%lf %"NAG_IFMT"%*[^\n] ", &rlamda, &k)) != EOF)
#else
  while ((scanf("%lf %"NAG_IFMT"%*[^\n] ", &rlamda, &k)) != EOF)
#endif
    {
      /* nag_poisson_dist (g01bkc).
       * Poisson distribution function
       */
      nag_poisson_dist(rlamda, k, &plek, &pgtk, &peqk, &fail);
      if (fail.code != NE_NOERROR)
        {
          printf("Error from nag_poisson_dist (g01bkc).\n%s\n",
                 fail.message);
          exit_status = 1;
          goto END;
        }
      printf(" %10.3f%6"NAG_IFMT"%10.5f%10.5f%10.5f\n", rlamda, k, plek,
             pgtk, peqk);
    }

 END:
  return exit_status;
}
```

10.2 Program Data

```
nag_poisson_dist (g01bkc) Example Program Data
0.75      3      : rlamda, k
9.20     12
34.00     25
175.00   175
```

10.3 Program Results

```
nag_poisson_dist (g01bkc) Example Program Results

    rlamda      k      plek       pgtk       peqk

      0.750     3    0.99271    0.00729    0.03321
      9.200    12    0.86074    0.13926    0.07755
     34.000    25    0.06736    0.93264    0.02140
    175.000   175    0.52009    0.47991    0.03014
```