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: $0.0 <$ **rlamda** $\leq 10^6$.

2: **k** – Integer *Input*

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

Constraint: **k** ≥ 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, 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_BAD_PARAM

On entry, argument ⟨*value*⟩ had an illegal value.

NE_INT_ARG_LT

On entry, **k** = ⟨*value*⟩.
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.

NE_REAL_ARG_GT

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

NE_REAL_ARG_LE

On entry, **rlamda** = ⟨*value*⟩.
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 1996 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 */
  scanf("%*[^\n] ");
  printf("\n    rlamda     k     plek      pgtk      peqk\n\n");
  while ((scanf("%lf %ld%*[^\n] ", &rlamda, &k)) != EOF)
    {
      /* 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%6ld%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
```