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 parameters λ (> 0). Then

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

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

This routine computes for given λ and k the probabilities:

plek $= \text{Prob}\{X \leq k\}$
pgtk $= \text{Prob}\{X > k\}$
peqk $= \text{Prob}\{X = k\}$.

The method is described in Knüsel (1986).

4. Parameters

rlamda
Input: the parameter λ of the Poisson distribution.
Constraint: $0.0 <$ **rlamda** $\leq 10^6$.

k
Input: the integer k which defines the required probabilities.
Constraint: **k** ≥ 0.

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

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

peqk
Output: the point probability, $\text{Prob}\{X = k\}$.

fail
The NAG error parameter, see the Essential Introduction to the NAG C Library.

5. Error Indications and Warnings

NE_INT_ARG_LT
On entry, **k** must not be less than 0: **k** $= \langle$*value*$\rangle$.

NE_REAL_ARG_LE
On entry, **rlamda** must not be less than or equal to 0.0: **rlamda** $= \langle$*value*$\rangle$.

NE_REAL_ARG_GT
On entry, **rlamda** must not be greater than 10^6: **rlamda** $= \langle$*value*$\rangle$.

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 consult NAG for assistance.

6. Further Comments

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

6.1. 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).

6.2. References

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

7. See Also

nag_binomial_dist (g01bjc)
nag_hypergeom_dist (g01blc)

8. Example

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

8.1. 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>

main()
{

  double plek, peqk, pgtk;
  double rlamda;

  Integer k;

  Vprintf("g01bkc Example Program Results\n");

  /*     Skip heading in data file */
  Vscanf("%*[^\n] ");
  Vprintf("\n    rlamda     k     plek      pgtk      peqk\n\n");

  while((scanf("%lf %ld%*[^\n] ", &rlamda, &k)) != EOF)
    {
      g01bkc(rlamda, k, &plek, &pgtk, &peqk, NAGERR_DEFAULT);
      Vprintf(" %10.3f%6ld%10.5f%10.5f%10.5f\n", rlamda,k,plek,pgtk,peqk);
    }
  exit(EXIT_SUCCESS);
}
```

8.2. Program Data

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

8.3. Program Results

```
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
```