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 $\lambda \ (> 0)$. 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 $\lambda$.

nag_poisson_dist (g01bkc) computes for given $\lambda$ and $k$ the probabilities:

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

The method is described in Knüsel (1986).

4 References

5 Arguments
1: $r\lambda mda$ – double
   
   On entry: the parameter $\lambda$ of the Poisson distribution.
   
   Constraint: $0.0 < r\lambda mda \leq 10^6$.

2: $k$ – Integer
   
   On entry: the integer $k$ which defines the required probabilities.
   
   Constraint: $k \geq 0$.

3: $\text{plek}$ – double *
   
   On exit: the lower tail probability, Prob$\{X \leq k\}$.

4: $\text{pgtk}$ – double *
   
   On exit: the upper tail probability, Prob$\{X > k\}$.
5:    
peqk – double *  

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

6:    
fail – NagError *

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 \( \langle \text{value} \rangle \) had an illegal value.

**NE_INT_ARG_LT**
On entry, \( k = \langle \text{value} \rangle \).
Constraint: \( k \geq 0 \).

**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, \( \text{rlamda} = \langle \text{value} \rangle \).
Constraint: \( \text{rlamda} \leq 10^6 \).

**NE_REAL_ARG_LE**
On entry, \( \text{rlamda} = \langle \text{value} \rangle \).
Constraint: \( \text{rlamda} > 0.0 \).

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 \text{g01bkc} (g01bkc) depends on \( \lambda \) and \( k \). For given \( \lambda \), the time is greatest when \( k \approx \lambda \), and is then approximately proportional to \( \sqrt{\lambda} \).
10 Example

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

10.1 Program Text

```c
/* 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 */
    ifndef _WIN32
        scanf_s("%*[\n] ");
    else
        scanf("%*[\n] ");
    endif
    printf("\n rlamda k plek pgtk peqk
");

    ifndef _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
", rlamda, k, plek, pgtk, peqk);
    }

END:
    return exit_status;
}
```

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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

<table>
<thead>
<tr>
<th>rlamda</th>
<th>k</th>
<th>plek</th>
<th>pgtk</th>
<th>peqk</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.750</td>
<td>3</td>
<td>0.99271</td>
<td>0.00729</td>
<td>0.03321</td>
</tr>
<tr>
<td>9.200</td>
<td>12</td>
<td>0.86074</td>
<td>0.13926</td>
<td>0.07755</td>
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<tr>
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<td>25</td>
<td>0.06736</td>
<td>0.93264</td>
<td>0.02140</td>
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<tr>
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<td>175</td>
<td>0.52009</td>
<td>0.47991</td>
<td>0.03014</td>
</tr>
</tbody>
</table>