

NAG Toolbox

nag_stat_prob_poisson (g01bk)

1 Purpose

nag_stat_prob_poisson (g01bk) returns the lower tail, upper tail and point probabilities associated with a Poisson distribution.

2 Syntax

```
[plek, pgtk, peqk, ifail] = nag_stat_prob_poisson(rlamda, k)
[plek, pgtk, peqk, ifail] = g01bk(rlamda, k)
```

3 Description

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

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

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

nag_stat_prob_poisson (g01bk) computes for given λ and k the probabilities:

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

The method is described in Knísel (1986).

4 References

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

5 Parameters

5.1 Compulsory Input Parameters

1: **rlamda** – REAL (KIND=nag_wp)

The parameter λ of the Poisson distribution.

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

2: **k** – INTEGER

The integer k which defines the required probabilities.

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

5.2 Optional Input Parameters

None.

5.3 Output Parameters

- 1: **plek** – REAL (KIND=nag_wp)
The lower tail probability, $\text{Prob}\{X \leq k\}$.
- 2: **pgtk** – REAL (KIND=nag_wp)
The upper tail probability, $\text{Prob}\{X > k\}$.
- 3: **peqk** – REAL (KIND=nag_wp)
The point probability, $\text{Prob}\{X = k\}$.
- 4: **ifail** – INTEGER
ifail = 0 unless the function detects an error (see Section 5).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail = 1

On entry, **rlamda** \leq 0.0.

ifail = 2

On entry, **k** < 0.

ifail = 3

On entry, **rlamda** > 10^6 .

ifail = -99

An unexpected error has been triggered by this routine. Please contact NAG.

ifail = -399

Your licence key may have expired or may not have been installed correctly.

ifail = -999

Dynamic memory allocation failed.

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 Further Comments

The time taken by nag_stat_prob_poisson (g01bk) depends on λ and k . For given λ , the time is greatest when $k \approx \lambda$, and is then approximately proportional to $\sqrt{\lambda}$.

9 Example

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

9.1 Program Text

```
function g01bk_example
fprintf('g01bk example results\n\n');
rlamda = [0.75 9.2 34 175];
k = nag_int([3 12 25 175]);
fprintf(' rlamda      k      plek      pgtk      peqk\n');
for i=1:4
    [plek, pgtk, peqk, ifail] = ...
    g01bk(rlamda(i), k(i));
    fprintf('%8.3f%6d%10.5f%10.5f%10.5f\n', rlamda(i), k(i), plek, pgtk, peqk);
end
```

9.2 Program Results

```
g01bk example 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
