NAG Fortran Library Routine Document

G01BKF

Note: before using this routine, please read the Users' Note for your implementation to check the interpretation of ***bold italicised*** terms and other implementation-dependent details.

1 Purpose

G01BKF returns the lower tail, upper tail and point probabilities associated with a Poisson distribution.

2 Specification

```
SUBROUTINE G01BKF(RLAMDA, K, PLEK, PGTK, PEQK, IFAIL)
INTEGER           K, IFAIL
real              RLAMDA, PLEK, PGTK, PEQK
```

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.

This routine computes for given λ and k the probabilities:

$$\begin{aligned}\text{PLEK} &= \text{Prob}\{X \leq k\}\\ \text{PGTK} &= \text{Prob}\{X > k\}\\ \text{PEQK} &= \text{Prob}\{X = k\}.\end{aligned}$$

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 Parameters

1: RLAMDA – ***real*** *Input*

On entry: the parameter λ of the Poisson distribution.

Constraint: $0.0 < \text{RLAMDA} \leq 10^6$.

2: K – INTEGER *Input*

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

Constraint: $\text{K} \geq 0$.

3: PLEK – ***real*** *Output*

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

4: PGTK – ***real*** *Output*

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

5: PEQK – ***real*** *Output*

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

6: IFAIL – INTEGER *Input/Output*

On entry: IFAIL must be set to 0, -1 or 1. Users who are unfamiliar with this parameter should refer to Chapter P01 for details.

On exit: IFAIL $= 0$ unless the routine detects an error (see Section 6).

For environments where it might be inappropriate to halt program execution when an error is detected, the value -1 or 1 is recommended. If the output of error messages is undesirable, then the value 1 is recommended. Otherwise, for users not familiar with this parameter the recommended value is 0. **When the value -1 or 1 is used it is essential to test the value of IFAIL on exit.**

6 Error Indicators and Warnings

If on entry IFAIL $= 0$ or -1, explanatory error messages are output on the current error message unit (as defined by X04AAF).

Errors or warnings detected by the routine:

IFAIL $= 1$

On entry, RLAMDA ≤ 0.0.

IFAIL $= 2$

On entry, K < 0.

IFAIL $= 3$

On entry, RLAMDA $> 10^6$.

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

9 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.

9.1 Program Text

Note: the listing of the example program presented below uses ***bold italicised*** terms to denote precision-dependent details. Please read the Users' Note for your implementation to check the interpretation of these terms. As explained in the Essential Introduction to this manual, the results produced may not be identical for all implementations.

```
*     G01BKF Example Program Text
*     Mark 14 Revised.  NAG Copyright 1989.
*     .. Parameters ..
      INTEGER          NIN, NOUT
      PARAMETER        (NIN=5,NOUT=6)
*     .. Local Scalars ..
```

```
      real              PEQK, PGTK, PLEK, RLAMDA
      INTEGER           IFAIL, K
*     .. External Subroutines ..
      EXTERNAL          G01BKF
*     .. Executable Statements ..
      WRITE (NOUT,*) 'G01BKF Example Program Results'
*     Skip heading in data file
      READ (NIN,*)
      WRITE (NOUT,*)
      WRITE (NOUT,*) '    RLAMDA     K     PLEK      PGTK      PEQK'
      WRITE (NOUT,*)
   20 READ (NIN,*,END=40) RLAMDA, K
      IFAIL = 0
*
      CALL G01BKF(RLAMDA,K,PLEK,PGTK,PEQK,IFAIL)
*
      WRITE (NOUT,99999) RLAMDA, K, PLEK, PGTK, PEQK
      GO TO 20
   40 STOP
*
99999 FORMAT (1X,F10.3,I6,3F10.5)
      END
```

9.2 Program Data

```
G01BKF Example Program Data
  0.75     3     : RLAMDA, K
  9.20    12
 34.00    25
175.00   175
```

9.3 Program Results

```
 G01BKF 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
```