NAG Fortran Library Routine Document

G05DRF

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

G05DRF returns a pseudo-random integer variate from a Poisson distribution with mean λ.

2 Specification

```
INTEGER FUNCTION G05DRF(ALAMDA, IFAIL)
INTEGER                 IFAIL
real                    ALAMDA
```

3 Description

The distribution of a Poisson random variable X is given by

$$P(X = x) = \frac{\lambda^x e^{-\lambda}}{x!} \quad \text{if } x = 0, 1, 2, \ldots$$

$$P(X = x) = 0 \qquad \text{otherwise.}$$

The methods used by G05DRF have low set up times and are designed for efficient use when the value of the parameter λ changes during the simulation. For large samples from a distribution with fixed λ using G05ECF to set up a reference vector for subsequent use by G05EYF may be more efficient.

When $\lambda < 7.5$ the product of uniforms method is used, see for example Dagpunar (1988). For larger values of λ an envelope rejection method is used with a target distribution:

$$f(x) = \tfrac{1}{3} \qquad \text{if} \quad |x| \leq 1$$

$$f(x) = \tfrac{1}{3}|x|^{-3} \quad \text{otherwise.}$$

This distribution is generated using a ratio of uniforms method. A similar approach has also been suggested by Ahrens and Dieter (1989). The basic method is combined with quick acceptance and rejection tests given by Maclaren (1990). For values of $\lambda \geq 87$ Stirling's approximation is used in the computation of the Poisson distribution function, otherwise tables of factorials are used as suggested by Maclaren (1990).

4 References

Ahrens J H and Dieter U (1989) A convenient sampling method with bounded computation times for Poisson distributions *Amer. J. Math. Management Sci.* 1–13

Dagpunar J (1988) *Principles of Random Variate Generation* Oxford University Press

Maclaren N M (1990) A Poisson random number generator *Personal Communication*

5 Parameters

1: ALAMDA – ***real*** *Input*

On entry: the parameter, λ, of the distribution.

Constraint: ALAMDA > 0.0 and $2 \times$ ALAMDA $\leq$ MAXINT, where MAXINT is the largest integer representable on the machine (see X02BBF).

2: 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, ALAMDA ≤ 0.0.

IFAIL $= 2$

On entry, $2 \times$ ALAMDA $>$ MAXINT.

7 Accuracy

Not applicable.

8 Further Comments

The methods used by G05DRF have low set up times and are designed for efficient use when the value of the parameter λ changes during the simulation. For large samples from a distribution with fixed λ using G05ECF to set up a reference vector for subsequent use by G05EYF may be more efficient.

9 Example

The example program prints five pseudo-random variates from Poisson distributions with parameters 1, 5, 15, 50 and 100 respectively, generated by G05DRF after initialisation by G05CBF.

The generator mechanism used is selected by an initial call to G05ZAF.

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.

```
*     G05DRF Example Program Text
*     Mark 20 Revised. NAG Copyright 2001.
*     .. Parameters ..
      INTEGER          NIN, NOUT
      PARAMETER        (NIN=5,NOUT=6)
*     .. Local Scalars ..
      real             A
      INTEGER          IFAIL, X
*     .. External Functions ..
      INTEGER          G05DRF
      EXTERNAL         G05DRF
*     .. External Subroutines ..
      EXTERNAL         G05CBF, G05ZAF
*     .. Executable Statements ..
      CALL G05ZAF('O')
```

```
      WRITE (NOUT,*) 'G05DRF Example Program Results'
      WRITE (NOUT,*)
*     Skip heading in data file
      READ (NIN,*)
      IFAIL = 0
      CALL G05CBF(0)
   20 CONTINUE
      READ (NIN,*,END=40,ERR=40) A
*
      IF (A.LE.0.0e0) GO TO 40
      X = G05DRF(A,IFAIL)
*
      WRITE (NOUT,99999) X
      GO TO 20
   40 CONTINUE
      STOP
*
99999 FORMAT (1X,I10)
      END
```

9.2 Program Data

```
G05DRF Example Program Data
1.0
5.0
15.0
50.0
100.0
```

9.3 Program Results

```
 G05DRF Example Program Results

          1
          3
         14
         51
        121
```