NAG Fortran Library Routine Document

G05EXF

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

G05EXF sets up the reference vector R for a discrete distribution with PDF (probability density function) or CDF (cumulative distribution function) P.

2 Specification

```
SUBROUTINE G05EXF(P, NP, IP, LP, R, NR, IFAIL)
INTEGER           NP, IP, NR, IFAIL
real              P(NP), R(NR)
LOGICAL           LP
```

3 Description

G05EXF sets up a reference vector R for use in G05EYF according to information supplied by the user in P. This may either be the PDF or CDF of the distribution. The reference vector contains the CDF of the distribution in its higher elements, preceded by an index of the form:

R(1) = the number of elements of index, k

R(2) = the value of IP – the (possibly non-positive) subscript in R of the element of the CDF corresponding to P(1) [i.e., R(2) $\leq$ IP $-$ $(k+3)$].

R$(i+2) = \min\{j|\text{CDF}(j) > (i-1)/k\}$, for $i = 1, 2, \ldots, k$

R(i), for $i = k+3, \ldots,$ NR, the CDF.

4 References

Knuth D E (1981) *The Art of Computer Programming (Volume 2)* (2nd Edition) Addison-Wesley

Kendall M G and Stuart A (1969) *The Advanced Theory of Statistics (Volume 1)* (3rd Edition) Griffin

5 Parameters

1: P(NP) – ***real*** array *Input*

On entry: the PDF or CDF of the distribution.

2: NP – INTEGER *Input*

On entry: the dimension of the array P as declared in the (sub)program from which G05EXF is called.

Constraint: NP > 0.

3: IP – INTEGER *Input*

On entry: the value of the variate, assumed to be a whole number, to which the probability in P(1) corresponds.

4: LP – LOGICAL *Input*

On entry: indicates the type of information contained in P. If LP is .TRUE., P contains a cumulative distribution function (CDF); if LP is .FALSE., P contains a probability density function (PDF).

5: R(NR) – ***real*** array *Output*

On exit: the reference vector R (see Section 3).

6: NR – INTEGER *Input*

On entry: the dimension of the array R as declared in the (sub)program from which G05EXF is called.

Suggested value: NR $= 5 + 1.4 \times$ NP approximately (for optimum efficiency in G05EYF).

Constraint: NR $>$ NP $+ 2$.

7: 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, NP < 1.

IFAIL $= 2$

On entry, NR $\leq$ NP $+ 2$.

IFAIL $= 3$

If LP is .TRUE. on entry, then the values in P are not all in non-descending order, as required by a CDF. If LP is .FALSE., then at least one of the probabilities in P is negative, or all the probabilities are zero.

IFAIL $= 4$

The total probability is not 1. In this case, R is set up correctly since the error may be due to larger rounding errors than expected.

7 Accuracy

None.

8 Further Comments

None.

9 Example

The example program sets up a reference vector for a distribution whose CDF, $f(n)$, is defined as follows:

n	$f(n)$
0	0.0
1	0.1
2	0.2
3	0.4
4	0.5
5	0.6
6	0.8
7	0.9
8	1.0
9	1.0

It then prints the first five pseudo-random numbers generated by G05EXF, 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.

```
*     G05EXF Example Program Text
*     Mark 20 Revised. NAG Copyright 2001.
*     .. Parameters ..
      INTEGER          NP, NR
      PARAMETER        (NP=10,NR=19)
      INTEGER          NOUT
      PARAMETER        (NOUT=6)
*     .. Local Scalars ..
      INTEGER          I, IFAIL, IX
*     .. Local Arrays ..
      real             P(NP), R(NR)
*     .. External Functions ..
      INTEGER          G05EYF
      EXTERNAL         G05EYF
*     .. External Subroutines ..
      EXTERNAL         G05CBF, G05EXF, G05ZAF
*     .. Data statements ..
      DATA             P/0.0e0, 0.1e0, 0.2e0, 0.4e0, 0.5e0, 0.6e0,
     +                 0.8e0, 0.9e0, 1.0e0, 1.0e0/
*     .. Executable Statements ..
      CALL G05ZAF('O')
      WRITE (NOUT,*) 'G05EXF Example Program Results'
      WRITE (NOUT,*)
      CALL G05CBF(0)
      IFAIL = 0
*
      CALL G05EXF(P,NP,0,.TRUE.,R,NR,IFAIL)
*
      DO 20 I = 1, 5
         IX = G05EYF(R,NR)
         WRITE (NOUT,99999) IX
   20 CONTINUE
      STOP
*
99999 FORMAT (1X,I5)
      END
```

9.2 Program Data

None.

9.3 Program Results

```
 G05EXF Example Program Results

     6
     3
     3
     3
     7
```