G05EXF – NAG Fortran Library Routine Document

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., $R(2) \le IP - (k+3)$].

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

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

4 References

[1] Knuth D E (1981) *The Art of Computer Programming (Volume 2)* Addison–Wesley (2nd Edition)

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

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: LP 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. For users not familiar with this parameter (described in Chapter P01) the recommended value is 0.

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

6   Error Indicators and Warnings

Errors 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.

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 14 Revised.  NAG Copyright 1989.
*     .. 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
*     .. 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 ..
      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
```