Chapter 21
Random Number Generation

1 Scope of the Chapter

This chapter provides procedures for generating random numbers from common statistical distributions.

2 Available Modules

Module 21.1: `nag_rand_util` — **Utilities for random number generation**

This module provides a procedure for setting the *seed* of the basic random number generator that is used by all the procedures in the chapter.

Module 21.2: `nag_rand_contin` — **Random numbers from continuous distributions**

This module contains procedures for generating random variates from the following continuous distributions:

- uniform distribution;
- Normal distribution;
- multivariate Normal distribution;
- negative exponential distribution;
- gamma distribution;
- beta distribution.

Module 21.3: `nag_rand_discrete` — **Random numbers from discrete distributions**

This module contains procedures for generating random variates from the following discrete distributions:

- binomial distribution;
- negative binomial distribution;
- hypergeometric distribution;
- user-supplied discrete distribution.

3 Background

3.1 The Basic Generator

The procedures produce a sequence of random numbers (or more correctly pseudo-random numbers) that is generated in a systematic way such that the statistical properties exhibited are those that would be expected of a true random sequence. The basic random number generator used by the routines in this chapter is a multiplicative congruential algorithm defined by

$$n_i = (a \times n_{i-1}) \bmod(m).$$

The integers n_i are divided by m to give uniformly distributed random numbers lying in the range (0,1).

The generator uses the values $a = 13^{13}$ and $m = 2^{59}$. This gives it a cycle length of 2^{57}. The generator has been examined using the Spectral Test (see Knuth [1]) and it returned a good result.

3.2 Other Distributions

Some other distributions, not currently available in this chapter, can easily be generated using the results from the procedures in the modules `nag_rand_contin` (21.2) and `nag_rand_discrete` (21.3). Some distributions are special cases of one of the above distributions (e.g., the χ^2-distribution is a special case of the gamma distribution) while other distributions can be easily generated from one or more of the above distributions (e.g., the F-distribution can be derived from the beta distribution, and the t-distribution from the Normal distribution and the gamma distribution).

4 References

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