The Additive Congruential Random Number (ACORN) Generator - pseudo-random sequences that are well distributed in k-dimensions.

Roy S Wikramaratna, REAMC Limited

University of Oxford Numerical Analysis Group Internal Seminar, 11th June 2019

Abstract. ACORN generators represents an approach to generating uniformly distributed pseudo-random numbers which is straightforward to implement for arbitrarily large order k and modulus M=2^{30t} (integer t). They give long period sequences which can be proven theoretically to approximate to uniformity in up to k dimensions, while empirical statistical testing demonstrates that (with a few very simple constraints on the choice of parameters and the initialisation) the resulting sequences can be expected to pass all the current standard tests .

The standard TestU01 Crush and BigCrush Statistical Test Suites are used to demonstrate for ACORN generators with order $8 \le k \le 25$ that the statistical performance improves as the modulus increases from 2^{60} to 2^{120}. With M=2^{120} and $k \ge 9$, it appears that ACORN generators pass all the current TestU01 tests over a wide range of initialisations; results are presented that demonstrate the remarkable consistency of these results, and explore the limits of this behaviour.

This contrasts with corresponding results obtained for the widely-used Mersenne Twister MT19937 generator, which consistently failed on two of the tests in both the Crush and BigCrush test suites.

There are other pseudo-random number generators available which will also pass all the TestU01 tests. However, for the ACORN generators it is possible to go further: we assert that an ACORN generator might also be expected to pass any more demanding tests for p-dimensional uniformity that may be required in the future, simply by choosing the order k>p, the modulus M=2^{30t} for sufficiently large t, together with any odd value for the seed and an arbitrary set of initial values. We note that there will be M/2 possible odd values for the seed, with each such choice of seed giving rise to a different k-th order ACORN sequence satisfying all the required tests.

This talk builds on and extends results presented at the recent discussion meeting on “Numerical algorithms for high-performance computational science” at the Royal Society London, 8-9 April 2019, see download link at bottom of web page http://acorn.wikramaratna.org/references.html.