

Random Number Generators

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Introduction

The physical description of many interesting systems found in nature usually involves the evaluation of integrals of very high dimensions. Very often, these integrals may be intractable by ordinary numerical methods. The Monte Carlo technique gives a way out of these difficulties. A Monte Carlo technique is any technique that makes use of random numbers to solve a problem. Hence a reliable source of random numbers is an essential building block for any sort of stochastic modeling or Monte Carlo computer work.

A sequence of truly random numbers has individual values which are unpredictable and unreproducible. Such a sequence can only be obtained by a random physical process, as in the decay of a radiation from atoms and its interaction with matter, etc. However, the construction of random number generators utilizing these processes is quite difficult in practice because of speed and accuracy problems. So far, there is only one such sequence of truly random numbers that has been tested and used in large calculations. A list of 2.5 million truly random numbers obtained by Frigerio *et al.* (1978) using a radioactive particle source and a high resolution counter is stored at the Argonne National Laboratory Code Center, Chicago, USA.

The random numbers used in large-scale calculations today are those that are computer-generated in place of the truly random ones. It may not seem obvious how to use a deterministic computer to produce "random" numbers since any computer program produces predictable and reproducible results. However, there is a class of random numbers which are generated according to a strict mathematical formula and therefore lends itself to programming. Known as pseudo-random, this sequence of numbers are predictable, reproducible and are not random in the strict mathematical sense. But they have many of the properties of true random numbers sequences and are indistinguishable from them. If one does not know the formula used in generating the pseudo-random sequence, one will not be able to recognize that a formula was used instead of a random physical process.



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