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Random Number



A random number is a number chosen as if by chance from some specified distribution such that selection of a large set of these numbers reproduces the underlying distribution. Almost always, such numbers are also required to be independent, so that there are no correlations between successive numbers. Computer-generated random numbers are sometimes called **pseudorandom numbers**, while the term "random" is reserved for the output of unpredictable physical processes. When used without qualification, the word "random" usually means "random with a **uniform distribution**." Other distributions are of course possible. For example, the **Box-Muller transformation** allows pairs of uniform random numbers to be transformed to corresponding random numbers having a two-dimensional **normal distribution**.

It is impossible to produce an arbitrarily long string of random digits and prove it is random. Strangely, it is also very difficult for humans to produce a string of random digits, and computer programs can be written which, on average, actually predict some of the digits humans will write down based on previous ones.

There are a number of common methods used for generating **pseudorandom numbers**, the simplest of which is the **linear congruence method**. Another simple and elegant method is **elementary cellular automaton rule 30**, whose central column is given by 1, 1, 0, 1, 1, 1, 0, 0, 1, 1, 0, 0, 0, 1, ... (OEIS [A051023](#)), and which provides the random number generator used for large integers in the **Wolfram Language**. Most random number generators require specification of an initial number used as the starting point, which is known as a "**seed**." The goodness of random numbers generated by a given **algorithm** can be analyzed by examining its **noise sphere**.

When generating random numbers over some specified boundary, it is often necessary to normalize the distributions so that each differential area is equally populated. For example, picking θ and ϕ from uniform distributions *does not* give a uniform distribution for **sphere point picking**.

In order to generate a power-law distribution $P(x)$ from a uniform distribution $P(y)$, write $P(x) = Cx^n$ for $x \in [x_0, x_1]$. Then normalization gives

$$\int_{x_0}^{x_1} P(x) dx = C \frac{[x^{n+1}]_{x_0}^{x_1}}{n+1} = 1, \quad (1)$$

so

$$C = \frac{n+1}{x_1^{n+1} - x_0^{n+1}}. \quad (2)$$

Let \mathcal{Y} be a uniformly distributed variate on $[0, 1]$. Then

$$D(x) = \int_{x_0}^x P(x') dx' \quad (3)$$

$$= C \int_{x_0}^x x'^n dx' \quad (4)$$

$$= \frac{C}{n+1} (x^{n+1} - x_0^{n+1}) \quad (5)$$

$$\equiv y, \quad (6)$$

and the variate given by

$$X = \left(\frac{n+1}{C} y + x_0^{n+1} \right)^{1/(n+1)} \quad (7)$$

$$= \left[(x_1^{n+1} - x_0^{n+1}) y + x_0^{n+1} \right]^{1/(n+1)} \quad (8)$$

is distributed as $P(x)$.

SEE ALSO:

Bays' Shuffle, Box-Muller Transformation, Cliff Random Number Generator, Quasirandom Sequence, Random Variable, Schrage's Algorithm, Stochastic, Uniform Distribution

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random number 1-100



THINGS TO TRY:

- = random number 1-100
- = random number between 1 and 10
- = random number generator

Interactive knowledge apps from
Wolfram Demonstrations Project

The Method of Inverse Transforms
Ryan Carroll



Poor Statistical Qualities for the RANDU Random Number Generator
Paul Savory



Mersenne Twister and Friends
Ed Pegg Jr



Using Rule 30 to Generate Pseudorandom Real Numbers
Chris Boucher

Check Your Answers
(and the steps)

100%

1. $\int \tan^2(x) \sec^2(x) dx = \frac{\tan^2(x)}{3} + C$
2. $\int_{-1}^1 \sqrt{9t^4 + 4t^2} dt = \frac{2}{27} (13\sqrt{13} - 8)$
- 3.

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Marsaglia, G. "DIEHARD: A Battery of Tests for Random Number Generators." <http://stat.fsu.edu/~geo/diehard.html>.
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