Generating values from normal distribution

In computer simulations, especially in applications of the Monte-Carlo method, it is often desirable to generate values that are normally distributed. The algorithms listed below all generate the standard normal deviates, since a $N(\mu, \sigma 2)$ can be generated as $X = \mu + \sigma Z$, where Z is standard normal. All these algorithms rely on the availability of a random number generator U capable of producing uniform random variates.

- The Box–Muller method uses two independent random numbers U and V distributed uniformly on (0,1). Then the two random variables X and Y

  $$X = \sqrt{-2\ln U}\, \cos(2\pi V),$$
  $$Y = \sqrt{-2\ln U}\, \sin(2\pi V).$$

  will both have the standard normal distribution, and will be independent. This formulation arises because for a bivariate normal random vector (X Y) the squared norm $X^2 + Y^2$ will have the chi-square distribution with two degrees of freedom, which is an easily generated exponential random variable corresponding to the quantity −2ln(U) in these equations; and the angle is distributed uniformly around the circle, chosen by the random variable V.
- Marsaglia polar method is a modification of the Box–Muller method algorithm, which does not require computation of functions `sin()` and `cos()`. In this method $U$and V are drawn from the uniform (−1,1) distribution, and then $S = U^2 + V^2$ is computed. If S is greater or equal to one then the method starts over, otherwise two quantities

  $$X = U\sqrt{\frac{-2\ln S}{S}}, \qquad Y = V\sqrt{\frac{-2\ln S}{S}}$$

  are returned. Again, X and Y will be independent and standard normally distributed.