# Generating Normal Pseudo-random Numbers

**Box-Muller Method:**

How to simulate two independent Normal random variables with mean $\mu$ and variance $\sigma^2$?

Generating $U, V$ independent $UNIF(0,1)$ random values.

Then

$$W = cos(2\pi U)\sqrt{-2ln(V)} \quad \text{and} \quad X = sin(2\pi U)\sqrt{-2ln(V)}$$

are such that $W$ and $X$ are independent $Normal(0,1)$ values.

To get $Y$ and $Z$ independent $N(\mu, \sigma^2)$ calculate

$$Y = \mu + \sigma W \quad \text{and} \quad Z = \mu + \sigma X$$

The following Pascal code implements the Box-Muller Method.

```
FUNCTION Random2 : Real;
{ This function checks if the random number we take the natural log  }
{ of is very small.  If so, then we set it equal to something small. }
VAR
      x : Real;
BEGIN
      x := Random;
      IF x <= 0.0001 THEN
            Random2 := 0.0001
      ELSE
            Random2 := x;
END;

PROCEDURE Normal(VAR W, X : REAL);
VAR
      T1, T2 : REAL;
BEGIN
      T1 := 2*Pi*Random;
      T2 := sqrt(-2.0*ln(Random2));
      W := cos(T1)*T2;              { Note W and X are independent }
      X := sin(T1)*T2;              { standard Normals.           }

END;
```