Lecture 5: Generating random variables – transformations

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Previously

Methods to generate $U \sim \mathit{Uniform}(0, 1)$:

- Linear congruential generator
- Mersenne twister
- lots of other variants and alternatives

Now we want to generate random variables with *other* distributions.

Question: If I have a uniform random variable, how can I get other random variables?

Inverse transform method

Example

Suppose we want to generate $X \sim \mathit{Exponential}(\theta)$

Discrete case

Suppose that we want to generate $X \sim \mathit{Bernoulli}(p)$

Generating a Normal random variable

Suppose we want to simulate $X \sim N(0, 1)$

$$f_X(x) = \frac{1}{\sqrt{2\pi}} \exp\left\{-\frac{1}{2}x^2\right\}$$

$$F_X(t) = \text{?}$$

Box-Muller Transformation

Other Normals

Suppose that $Z \sim N(0, 1)$. How do I get $X \sim N(\mu, \sigma^2)$?

A few other transformations

- If $X \sim N(\mu, \sigma^2)$, then $e^X \sim Lognormal(\mu, \sigma^2)$
- If $Z_1, ..., Z_k \stackrel{iid}{\sim} N(0,1)$, then

$$\sum_{i=1}^{k} Z_i^2 \sim ?$$

- If $V_1 \sim \chi^2_{d_1}$ and $V_2 \sim \chi^2_{d_2}$ are independent, then

$$\frac{V_1/d_1}{V_2/d_2} \sim ?$$