# Lecture 5: Generating random variables –

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transformations

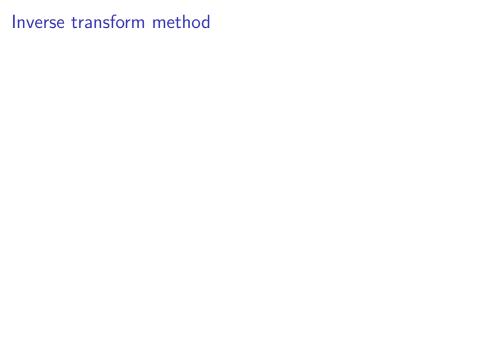
## Previously

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

- ► 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?



## Example

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

#### Discrete case

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

# Generating a Normal random variable

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

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

## 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

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

#### Your turn

Practice questions on the course website:

https://sta379-s25.github.io/practice\_questions/pq\_5.html

- Practice generating random variables
- Start in class. You are welcome to work with others
- Practice questions are to help you practice. They are not submitted and not graded
- Solutions are posted on the course website