We do 4 things in this class

1. Build models
   * counting when all elements of discrete sample space are equally likely
   * conditional events
   * any $g(x) \geq 0$ that is piecewise continuous with finite integral.
   * common pdfs and pmfs

2. Compute probabilities for a given model
   * Axioms of probability
   * pmf, pdf, cdf

3. Learn
   * Bayes Rule

4. compute summary statistics
   - expected value, variance, moments

Commonly used probability models (Chapter 3.5 and 4.4)

There are some pmf's and pdf's (for discrete and continuous RVs) that appear over and over. To make it easier to communicate about them, they're given a name. Many are also easily described by one or two parameters, so specifying the entire probability model only requires specifying the name and the parameter(s).

These RVs appear over and over because they are reasonably accurate models for many physical phenomenon.

Discrete pmfs

- Bernoulli (p)
- Binomial (n, p)
- Geometric (p)
- Uniform (a, b)
- Poisson (α)
- Zipf
- negative binomial
- ⋮

Continuous pdfs

- Gaussian (μ, σ)
- Exponential (λ)
- Uniform (a, b)
- Rayleigh
- Cauchy
- ⋮

These can be looked up, BUT you'll need to know <u>how</u> they arise (what physical phenomenon) and how to <u>interpret</u> and <u>apply</u> what you find

Bernoulli random variable (Section 2.6.2 and 3.5.1)

(a building block for many experiments.)

perform one experiment, once.

Event of interest: A.

Event A either happened in this experiment, or it didn't.

If A happened, we call it a "success"

Assign $p = P(A)$ = probability of success.

Examples
- flip a coin and get a heads
- draw an ace from a deck of cards
- a single bit is flipped (or not during transmission
- a component is tested and is <u>bad</u>

Be careful! "success" may be something negative in the context of the experiment!

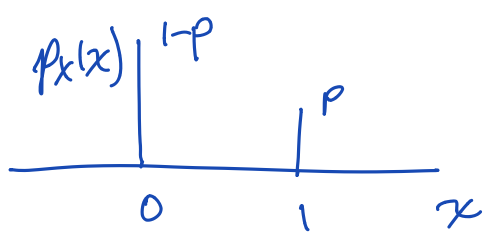
Always define your event A!

Define an indicator variable

$$X_A = \begin{cases} 0 & \text{event } A \text{ did NOT happen} \\ 1 & \text{event } A \text{ happened} \end{cases}$$

X_A is a random variable.

$$p_X(x) = \begin{cases} 1-p & \text{if } x=0 \\ p & \text{if } x=1 \\ 0 & \text{else} \end{cases}$$



$$E(X) = \sum x \, p_X(x) = (0)(1-p) + (1)\,p = p$$

Applications (and distinctions) for Bernoulli, Binomial, Geometric, and Poisson RVs.

Bernoulli

- send a packet, is the packet received
- does a chip have a defect?

Binomial

- send N packets. How many packets received?
- out of N chips, how many have defects?

Geometric

- send a packet repeatedly until it's received. How many times do you send the packet?
- test chips until you find a defective one. How many chips do you test?

Poisson

- send many (N) packets with a small chance of loss. How many packets received?
- out of many (N) chips with a small p chance of defect, how many have a defect?

(also use fn to measure things in a time period or in a spatial region)

In all cases, think carefully about the underlying event A and the meaning of $p = P(A)$, and of the variable X