

# Simulations Part 1

# **Types of Probabilities**

1. Theoretical Probabilities
2. Experimental Probabilities

# Theoretical Probabilities

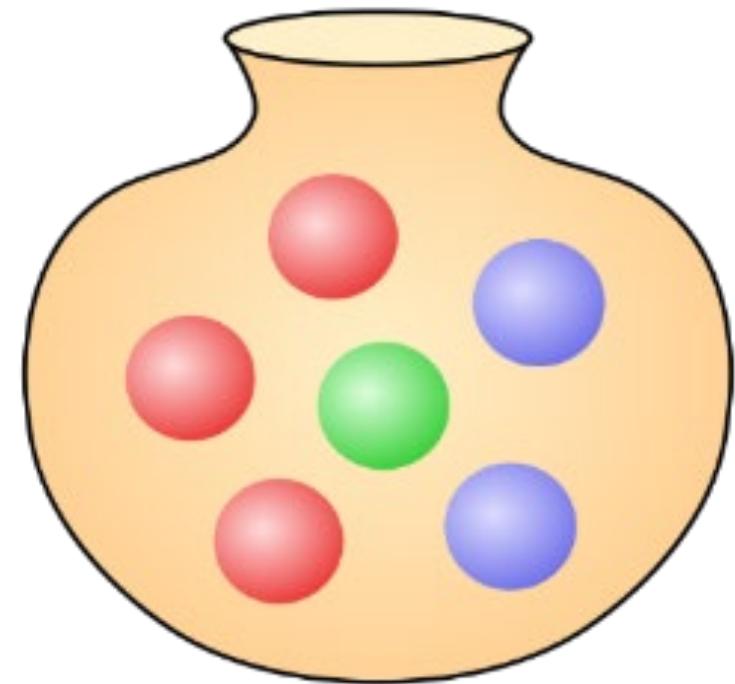
Example: What is the probability of getting a head when flipping a coin?

$$\text{prob.} = \frac{1}{2} = \boxed{0.50}$$



**Example:** Suppose you have an urn with 6 marbles: 3 are red, 2 are blue, and 1 is green. Suppose you draw one marble at random from the urn, what is the probability that the marble is red?

$$\text{prob} = \frac{3}{6} = 0.50$$



**Example:** If you roll a fair six-sided die once, what is the probability that you get a 6?

possible outcomes:

1 2 3 4 5 6

$$\text{prob} = \frac{1}{6} = 0.167$$



**Example:** If you roll a fair six-sided die once, what is the probability that you get an even number?

possible outcomes:

1 2 3 4 5 6

$$\text{prob} = \frac{3}{6} = 0.50$$

## How do we compute Theoretical Probabilities?

Theoretical Prob. = count the # of elements that meet the criteria  
count total # of all possible elements

# Experimental Probabilities

**Example:** Flip a coin 100 times and observe 32 heads. Find the probability of getting a head in a coin flip.

$$\text{experimental prob.} = \frac{32}{100} = 0.32$$

# Coin Experiment

**Experiment:** Flip a coin 20 time and record your observations in every flip. Record your observations below, then compute the experimental probability of getting a head.

Flip	Outcome	Is it a Head? TRUE/FALSE
1	Tails	FALSE
2	Tails	FALSE
3	Tails	FALSE
4	Tails	FALSE
5	Heads	TRUE
6	Heads	TRUE
7	Heads	TRUE
8	Tails	FALSE
9	Heads	TRUE
10	Tails	FALSE
11	Tails	FALSE
12	Tails	FALSE
13	Tails	FALSE
14	Tails	FALSE
15	Heads	TRUE
16	Tails	FALSE
17	Heads	TRUE
18	Heads	TRUE
19	Tails	FALSE
20	Heads	TRUE

experimental  
prob of getting heads =  $\frac{8}{20} = 0.40$

# Law of Large Numbers

*Law of Large Numbers:* In the long run, as the number of trials increases and increases, the proportion of the outcomes get closer to the theoretical probability values.

<b>Number of Tosses</b>	<b>Number of Observed Heads</b>	<b>Percent of Observed Heads</b>	<b>Expected Percent of Heads</b>
10	6	60%	50%
100	48	48%	50%
500	271	54.2%	50%
1000	461	46.1%	50%
5000	2533	50.66%	50%
10,000	5081	50.81%	50%

# Sample Function

All possible elements

`sample(vector, n)`



`c("T", "H")`

how many do you want to sample at the same time?  
In our case, we want to set  $n=1$ ; meaning "one flip"