

## Simulations - Part 2

### *Side Note*

```
w<-c(TRUE, TRUE, FALSE)
```

```
w
```

**output:**

```
class(w)
```

**output:**

```
as.numeric(w)
```

**output:**

Conclusion: Changing the class of a logical vector into a numeric vector, changes the TRUE for 1 and the FALSE for 0.

## Types of Probabilities

1. Theoretical Probabilities
2. Experimental Probabilities

### 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.

| Number of Tosses | Number of Observed Heads | Proportion of Observed Heads | Expected Proportion of Heads |
|------------------|--------------------------|------------------------------|------------------------------|
| 10               | 6                        | .60                          | .50                          |
| 100              | 48                       | .48                          | .50                          |
| 500              | 271                      | .542                         | .50                          |
| 1000             | 461                      | .461                         | .50                          |
| 5000             | 2533                     | .5066                        | .50                          |
| 10,000           | 5081                     | .5081                        | .50                          |

## Experiment: Flipping a Coin

**Theoretical Probability of Getting Heads:** 0.5

**Experimental Probability of Getting Heads:** We need to flip the coin  $n$  times and see how many times you “see” heads. Divide that number by the number of flips.

| 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                     |

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

## Simulations

**Step 1:** Simulate One Trial (One Flip)

```
coin_flip <- sample(c("H", "T"), 1)
```

**Step 2:** Check the criteria that you are trying to compute the probability on.

Checking if that flip is "Heads" (because that is the one that you wanted to compute the probability on)

```
check_flip <- coin_flip == "H"
```

**Step 3:** Create a Function that performs 1 Trial and checks if it met the criteria.

In our example, the function will flip the coin once and checks if it is Heads

```
coin_function <- function(i) {  
  coin_flip <- sample(c("H", "T"), 1)  
  check_flip <- coin_flip == "H"  
  return(check_flip)  
}
```

**Step 4:** Run the function  $n$  times (i.e., 100000 times)

Means you flip the coin  $n$  times (i.e., 10000 times) and every time you flip you record if it was a heads or not.

```
iterations <- map_dbl(1:100000, coin_function)
```

**Step 5:** To get the experimental probability, sum the number of times the criteria was met, divided by the total number of trials  $n$ .

Sum the number of times you got heads and divide it by the number of times you flipped the coin.

```
experimental_prob <- sum(iterations)/length(iterations)
```

**Step 6:** Theoretical probability

```
theoretical_prob <- 1/2
```

**Step 7:** Theoretical probability vs experimental

```
theoretical_prob - experimental_prob
```

## Full Codes

```
coin_function <- function(i) {  
  coin_flip <- sample(c("H", "T"), 1)  
  check_flip <- coin_flip == "H"  
  return(check_flip)  
}  
iterations <- map_dbl(1:100000, coin_function)  
experimental_prob <- sum(iterations)/length(iterations)  
theoretical_prob <- 1/2  
theoretical_prob - experimental_prob
```