

# Lecture 2

# Agenda

- HW 1 released on course website, due next Friday
- Continuing intro to probability simulations
- Time permitting: start HW 1 in class

## Warm-up question

- A roulette wheel has 38 slots numbered 00, 0, and 1–36. Two are green, 18 are red, and 18 are black.
- If a gambler bets based on color, the return on a \$1 bet is \$2
- A gambler has \$50, and will continuously bet \$1 on red until they double their money (have \$100) or lose the money they came with
- What is the probability the gambler doubles their money?

**Question:** Without calculating probabilities, how could you design an experiment to estimate this probability?

# Designing an experiment

# Step 1: representing the roulette wheel

```
1 wheel <- c(rep("green", 2), rep("black", 18), rep("red", 18))  
2  
3 wheel
```

```
[1] "green" "green" "black" "black" "black" "black" "black" "black"  
"black"  
[10] "black" "black" "black" "black" "black" "black" "black" "black"  
"black"  
[19] "black" "black" "red"   "red"   "red"   "red"   "red"   "red"  
"red"  
[28] "red"   "red"   "red"   "red"   "red"   "red"   "red"   "red"  
"red"  
[37] "red"   "red"
```

- `rep` repeats a value a specified number of times
- `c()` combines vectors into a single vector

## Step 2: spin the wheel!

```
1 spin <- sample(wheel, size = 1)
2
3 spin
```

```
[1] "black"
```

## Step 3: change in money

```
1 money <- 50
2 spin <- sample(wheel, size = 1)
3
4 if(spin == "red"){
5   money <- money + 1
6 } else {
7   money <- money - 1
8 }
9
10 spin
```

```
[1] "red"
```

```
1 money
```

```
[1] 51
```

- if the result was red, gain a dollar
- otherwise, lose a dollar

## Step 3: change in money

Another way of writing the conditional statement:

```
1 money <- 50
2 spin <- sample(wheel, size = 1)
3
4 money <- ifelse(spin == "red", money + 1, money - 1)
5
6 spin
```

```
[1] "black"
```

```
1 money
```

```
[1] 49
```



## Step 4: keep spinning

The gambler continues to bet until they have \$0 or \$100.

**Question:** Is a `for` loop appropriate for iterating the betting process?

## Step 4: keep spinning

```
1 money <- 50 # starting money
2
3 while(money > 0 & money < 100){
4   spin <- sample(wheel, size = 1)
5   money <- ifelse(spin == "red", money + 1, money - 1)
6 }
7
8 money
```

[1] 0

- `while` loop: repeat the process until the condition is true

## Step 5: repeat the process

```
1  set.seed(279)
2
3  nsim <- 1000
4  results <- rep(NA, nsim)
5
6  for(i in 1:nsim){
7    money <- 50 # starting money
8
9    while(money > 0 & money < 100){
10     spin <- sample(wheel, size = 1)
11     money <- ifelse(spin == "red", money + 1, money - 1)
12   }
13
14   results[i] <- ...
15 }
```

- What should I check at each iteration?

## Step 5: repeat the process

```
1  set.seed(279)
2
3  nsim <- 1000
4  results <- rep(NA, nsim)
5
6  for(i in 1:nsim){
7    money <- 50 # starting money
8
9    while(money > 0 & money < 100){
10     spin <- sample(wheel, size = 1)
11     money <- ifelse(spin == "red", money + 1, money - 1)
12   }
13
14   results[i] <- money == 100
15 }
16
17 mean(results)
```

```
[1] 0.008
```

