Intermediate R Programming

POS6933: Computational Social Science

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Overview

- **Today's Goal**: Improve Effectiveness w/ `R` Programming
- Random Number Generation in `R`
- Loops and Iteration
- Visualizing Data and Relationships Using `ggplot::()`

Coin Flips

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What about 1000 times?

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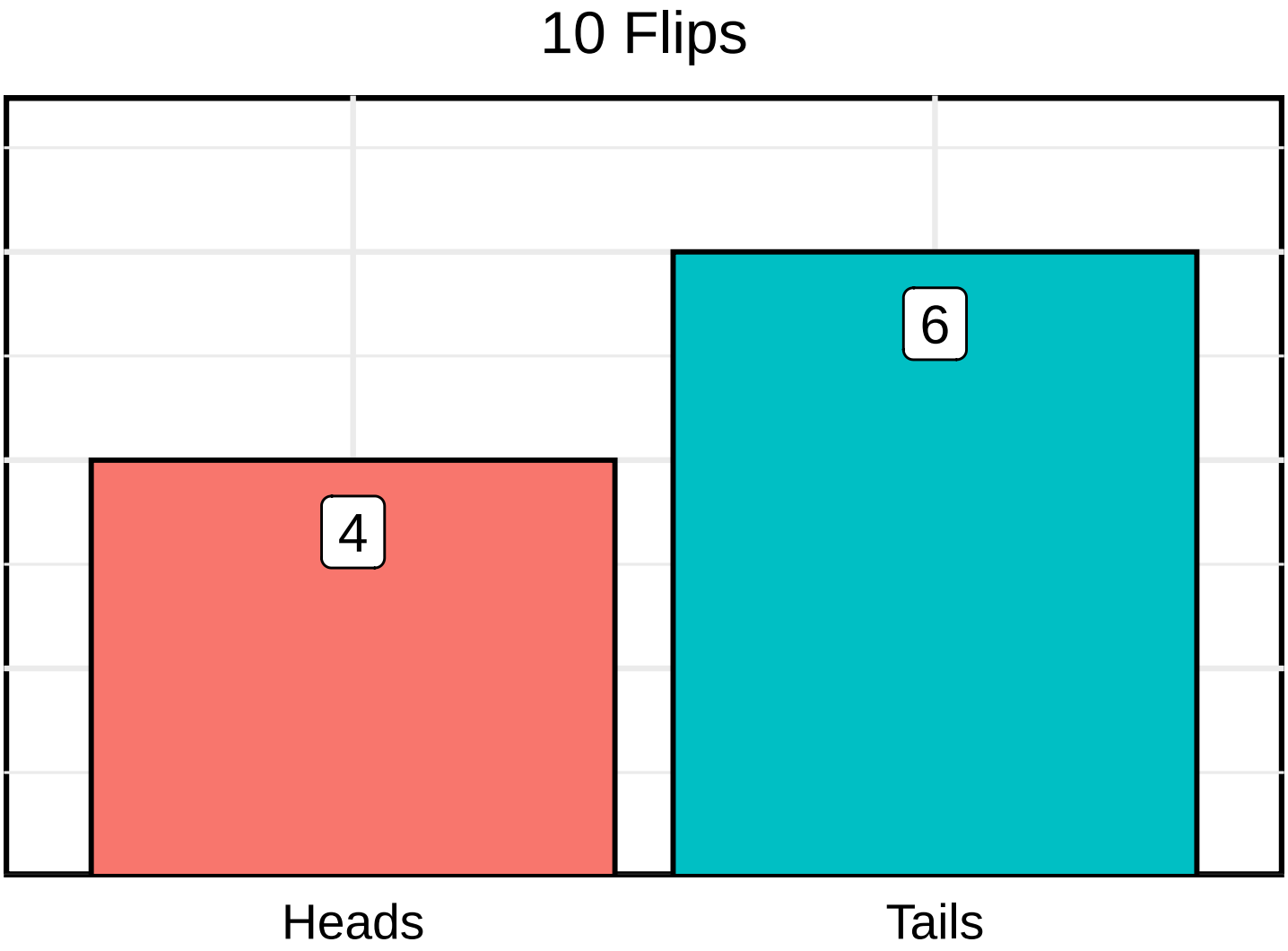
Does this change if I flip 50 times?

What about 100 times?

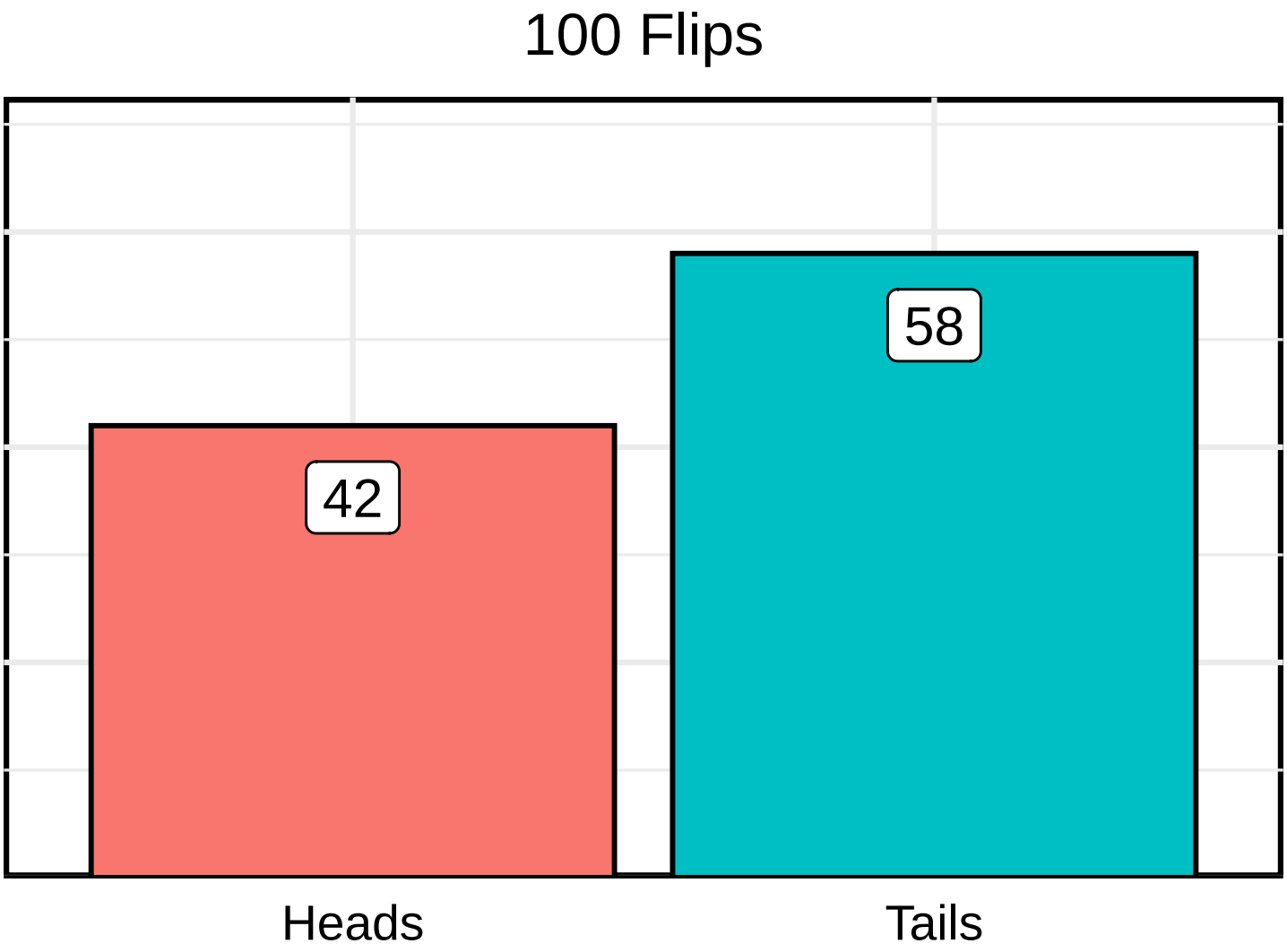
What about 1000 times?

What about 10000 times?

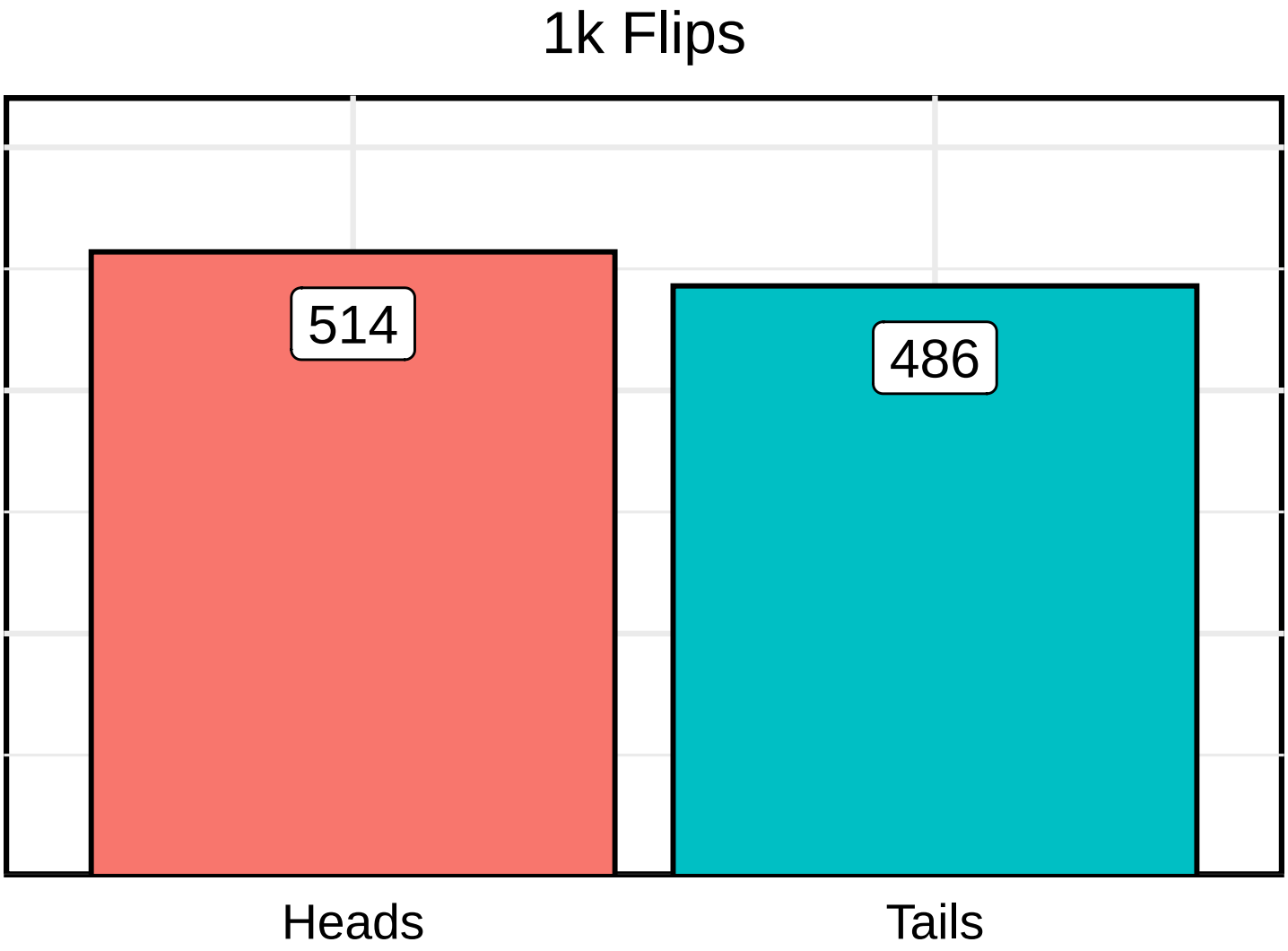
Coin Flips (Cont.)



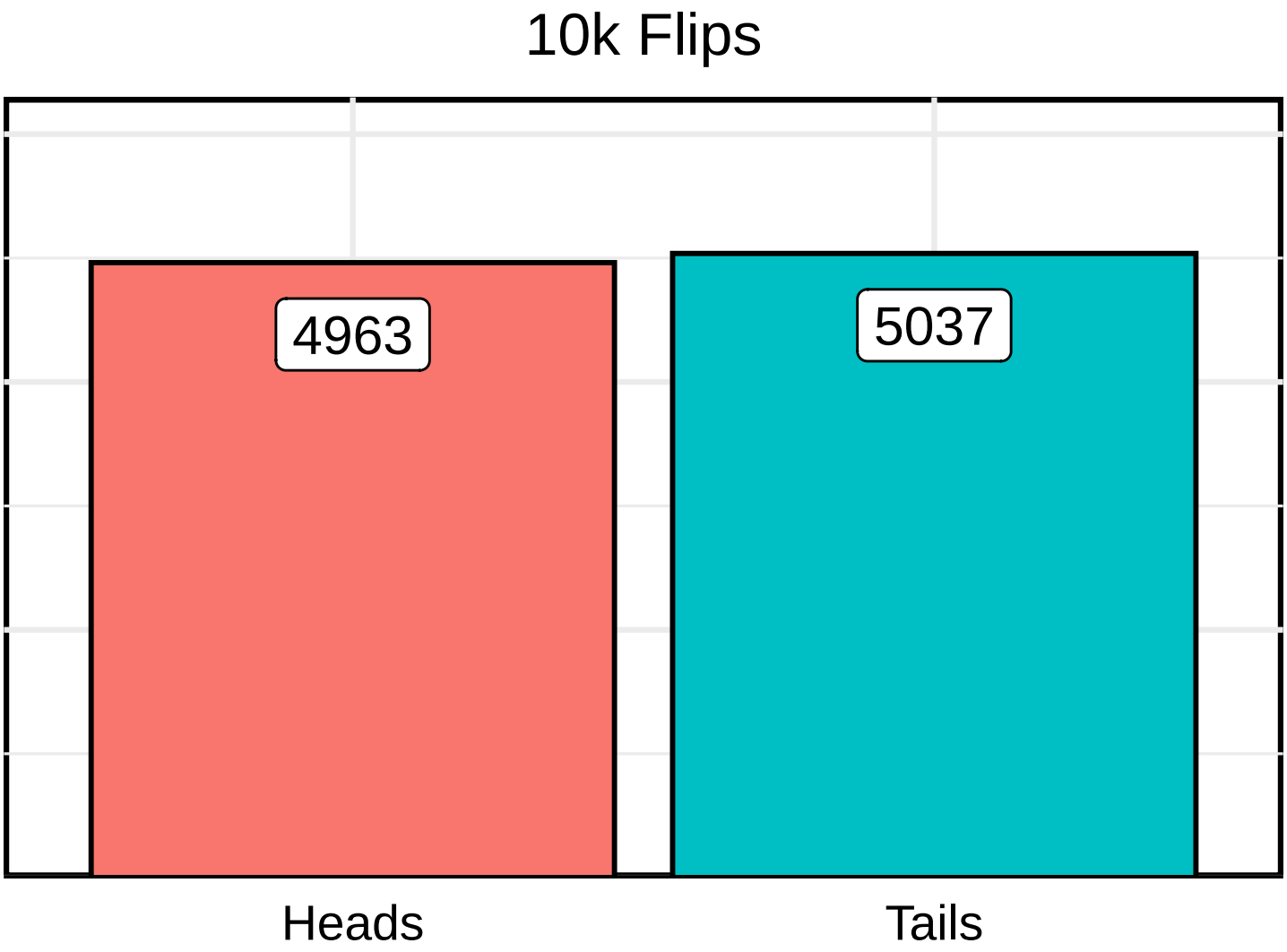
Coin Flips (Cont.)



Coin Flips (Cont.)



Coin Flips (Cont.)



Coin Flips (Cont.)

- We can use `sample()` to randomly select elements from a vector
- In this case, a coin flip where $p(heads) = p(tails) = 0.5$

```
sides <- c("Heads", "Tails")  # Flip Options
single_flip <- sample(sides, size = 1)  # Single Draw
print(single_flip)
```

```
[1] "Tails"
```

6-Sided Die

- We can use the same approach to "roll" a six-sided die.

```
sides <- c(1:6)  # 1, 2, 3, 4, 5, 6
single_roll <- sample(sides, size = 1)  # Single Roll
message("Result of Single Roll: ", single_roll)
```

```
Result of Single Roll: 2
```

Poker Hands

- We can even use it to do more complex operations like simulate a random draw from 5-card Poker

```
cards <- as.character(c(2:10, "J", "Q", "K", "A"))
# All Card Values
suits <- c("Hearts", "Diamonds", "Spades", "Clubs")
# Suits

deck <- expand.grid(value = cards, suit = suits) |>
    mutate(card = paste(value, "of", suit)) |>
    pull(card)  # Create a Full Deck

random_draw <- sample(deck, size = 5, replace = F)
# Random 5-Card Draw w/out Replacement
```

Poker Hands (Cont.)

```
Hand:
3 of Diamonds
5 of Hearts
10 of Diamonds
2 of Diamonds
Q of Diamonds
```

Generating Distributions

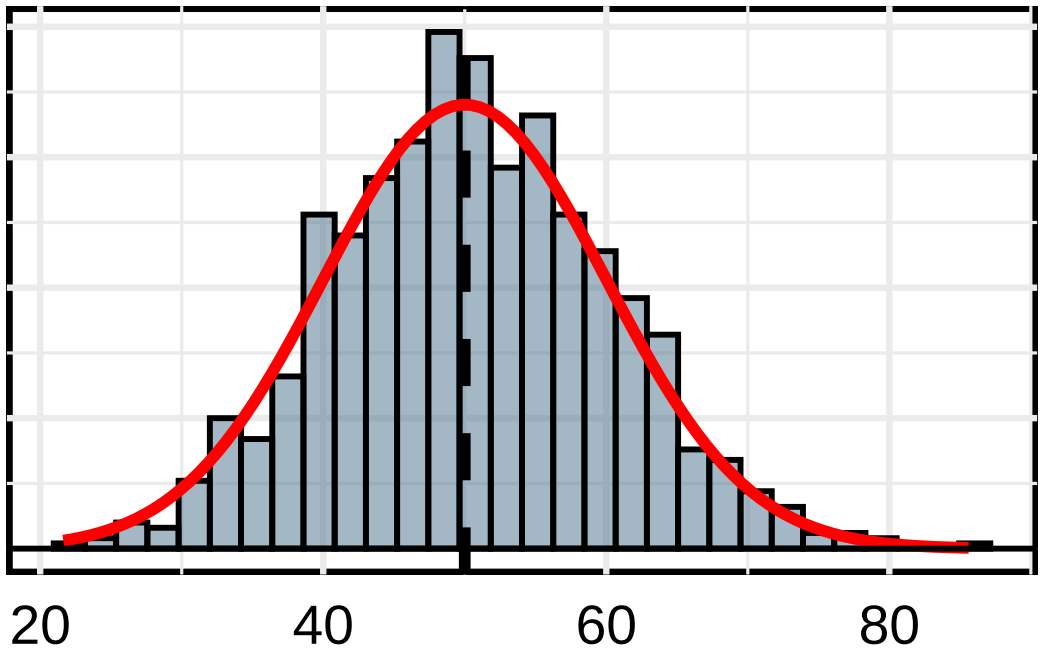
- What if we wanted to move beyond random selection where each draw or iteration exists with equal probability or within a uniform distribution?

- R is very flexible and capable of illustrating sampling distributions against expected outcomes

Generating Distributions (Standard Normal)

- Let's start with 1000 samples from a standard normal distribution where $\mu = 50$ and $\sigma = 10$

```
normal <- rnorm(1000, mean = 50, sd = 10)
```

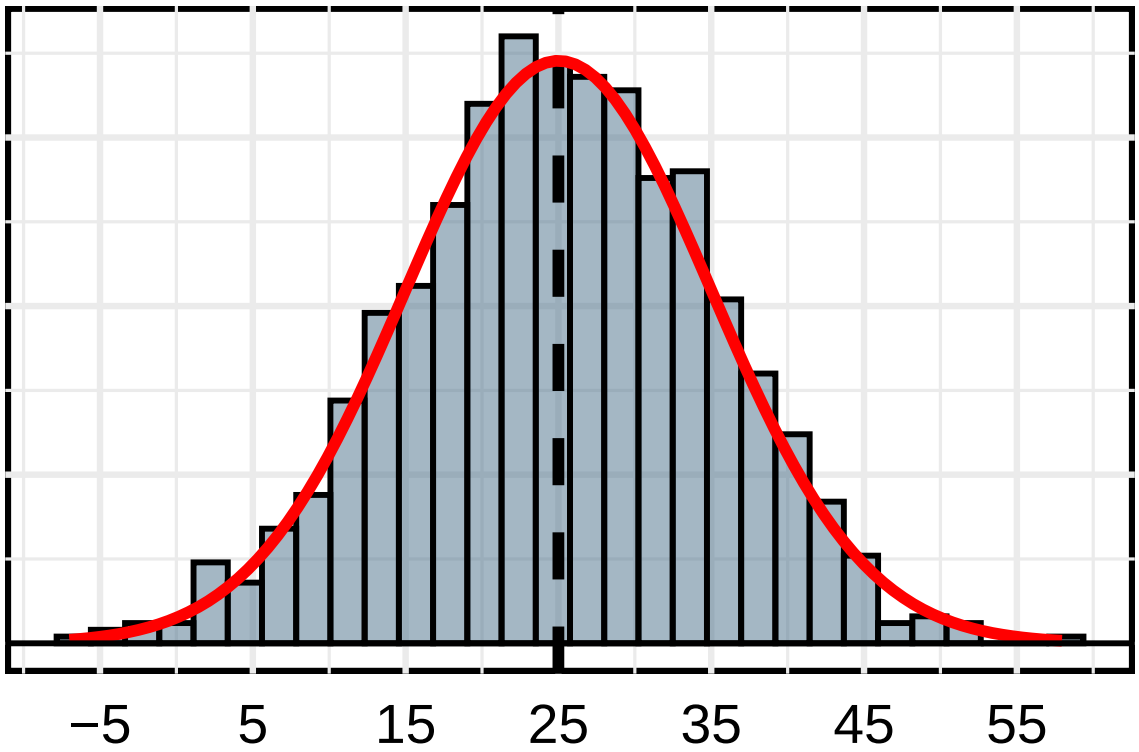


Generating Distributions (Standard Normal)

- **Your Turn**: Generate 1000 draws from a standard normal distribution where $\mu = 25$ and $\sigma = 10$.

Generating Distributions (Standard Normal – Ex)

```
normal <- rnorm(1000, mean = 25, sd = 10)
```

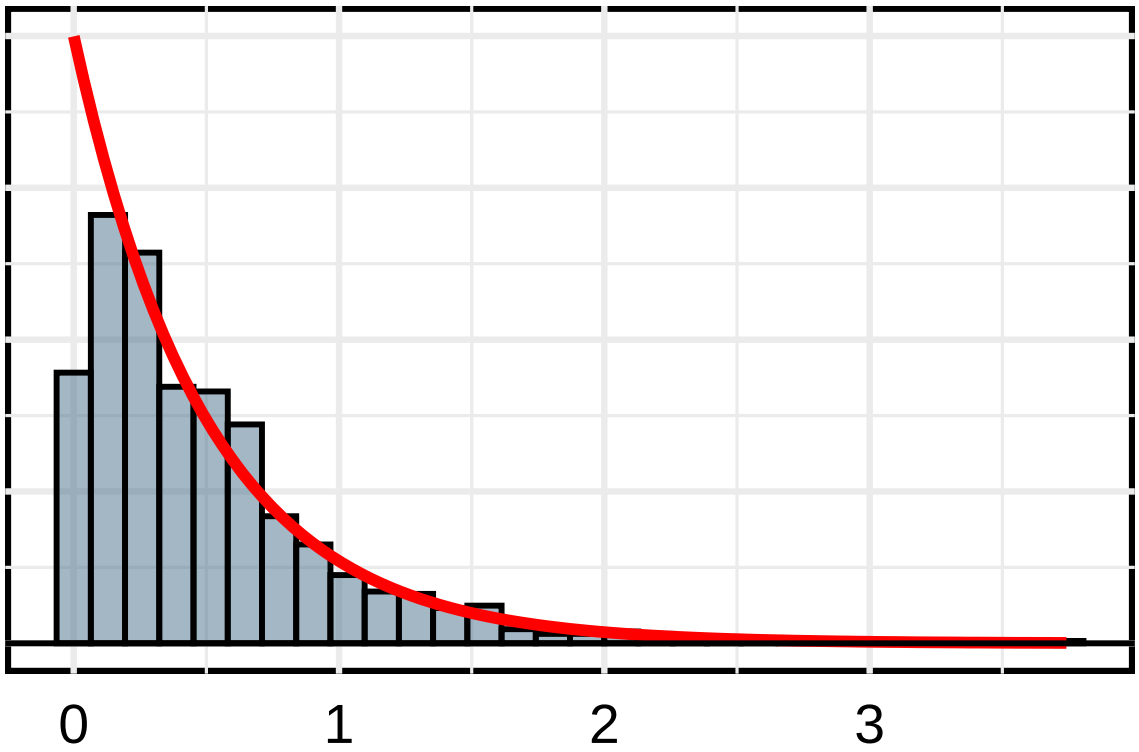


Generating Distributions (Exponential – Ex)

- **Your Turn**: Generate 1000 draws from an exponential distribution where `rate` $= 2$

Generating Distributions (Exponential – Ex)

```
exp <- rexp(1000, rate = 2)
```



Functions (Basics)

- Functions are reusable blocks of code that perform a specific task when called, helping avoid repetition.
- They can take arguments (inputs) and return values (outputs), making them flexible and generalizable.
- They can also be combined, nested, and used within other functions to build complex workflows in a clear, organized way.

Functions (Basic Syntax)

```
function_name <- function(input_1, input_2){

  Code to Assume Input_1 and Input_2

  return(Return Output Value or Object)

}
```

Functions (Example)

```r
add_numbers <- function(x, y) {
    result <- x + y
    return(result)
}

add_numbers(5, 3)
```

Functions (Basics, Cont.)

- Take some time to try your own!
- Try:
  - Random Number Generation
  - Easy Task Completion (e.g., addition, subtraction, etc.)

Loops (Basics)

- In R, a for loop is a control structure used to repeat a block of code a fixed number of times, iterating over a sequence of values. The basic syntax is:

```
for (variable in sequence){
   Repeating Code Routine
  return(Result Value or Object)
}
```

Loops (Basics, Cont.)

- For example, we can complete basics rolls of six-sided dice:

```
rolls <- c()

for (i in 1:10) {

    temp_roll <- sample(1:6, 1, replace = TRUE, prob = rep(1/6,
        6))

    rolls <- c(rolls, temp_roll)
}

rolls  # Print
```

```
 [1] 4 6 3 1 2 2 3 2 5 5
```

Loops (Basics, Cont.)

- We can also conditionally iterate through different values from the `functions` example

```
add_numbers <- function(x, y) {
    result <- x + y
    return(result)
}

available_values <- c(1:10)
sums <- c()

for (pair in seq(1:10)) {
    temp_pair <- sample(available_values, 2)
    sums <- c(sums, add_numbers(temp_pair[1], temp_pair[2]))
}

sums
```

```
 [1]  9  7  9  9 12 15 19 15  8 13
```

Loops (Basics, Cont.)

- I can also deal 5 hands from a standard 52-card deck for a game of Texas Hold 'Em
- Here's the setup – What's Next?

```
set.seed(1234)  # Seed
cards <- as.character(c(2:10, "J", "Q", "K", "A"))
suits <- c("Hearts", "Diamonds", "Spades", "Clubs")
deck <- expand.grid(value = cards, suit = suits) |>
    mutate(card = paste(value, "of", suit)) |>
    pull(card)  # Create a Full Deck

hands <- lapply(1:5, function(x) x)
```

Loops (Basics, Cont.)

```
for (card in 1:2) {
    for (player in 1:5) {
        temp_player_card <- sample(deck, 1, replace = F)
        deck <- deck[!deck %in% temp_player_card]
        hands[[player]][card] <- temp_player_card
    }  # For All 5 Players
}  # For Both Cards

do.call(cbind, hands)
```

```
     [,1]           [,2]             [,3]
[1,] "3 of Spades" "4 of Diamonds" "J of Diamonds"
[2,] "A of Clubs"  "10 of Hearts"  "6 of Hearts"
     [,4]          [,5]
[1,] "2 of Clubs" "10 of Clubs"
[2,] "6 of Clubs" "7 of Diamonds"
```

Games of Chance: Blackjack

What are the basic rules of Blackjack?

Rules of Blackjack:

- Objective: Beat the dealer by getting closer to 21 without going over
- Card values:
  - Number Cards = Face Value
  - Face Cards = 10 (Aces = 1 *or* 11)
- Dealer Rules: Dealer reveals cards after players act and must hit until *at least* 17
- Gameplay:
  - Go Over 21 = **BUST** (Loss)
  - Tie w/ Dealer = Push (No Win/Loss)
  - Standard Win = **1:1** (Win Bet x2)
  - Blackjack (Ace + 10-Value Card = **3:2**

Blackjack Exercise

Write an R routine to play a round of Blackjack. I will be the Dealer

- *Hint*: Sample from all 52 cards without replacement. . .

Blackjack Exercise (Cont.)

1. What if we play with a four-deck shoe?
2. What if I wanted to repeat this process 1,000 times?

Hint: Use a loop!

Blackjack Exercise (Cont.)

1. Assume I begin with \$1000 every day and bet \$100 each game (though I'll only play 10 hands...). Over 100 days, approximately how much money am I left with? *Note*: If I run out of money on a given day, I'm done – also, each day restarts with \$1000 but previous day's leftover sum is added to aggregate winnings.
2. What if I start with \$1000 but don't replace the money every day... How much will I have after 10 days? 50 days?
3. Take some time then play around with blackjack_simulation.R

Roulette Exercise

- Head over to Course GitHub (Intermediate Programming in `R`)
- Bottom of `Number Generation & Loops`

ggplot::()

```
set.seed(123)

df <- tibble(x = seq(0, 10, length.out = 100), y = 2 *
    x + rnorm(100, sd = 3))

ggplot(df, aes(x = x, y = y)) + geom_point(alpha = 0.6) +
    geom_smooth(method = "lm", se = FALSE) + labs(title = '
    subtitle = "Points + fitted line are separate layers",
    x = "X", y = "Y")
```

```
`geom_smooth()` using formula = 'y ~ x'
```