

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 100 times?

What about 1000 times?

Coin Flips

What is the probability that any independent coin flip will land on heads?

Does this change if I flip 50 times?

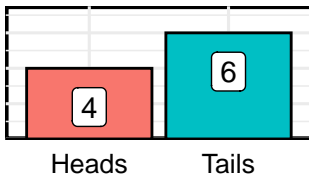
What about 100 times?

What about 1000 times?

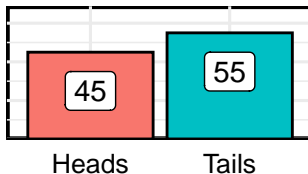
What about 10000 times?

Coin Flips (Cont.)

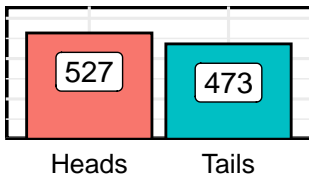
10 Flips



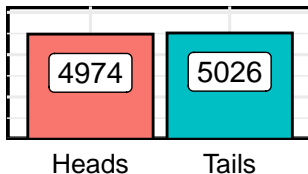
100 Flips



1k Flips



10k Flips



Coin Flips (Cont.)

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

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

```
[1] "Heads"
```

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: 1

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:

9 of Clubs

Q of Clubs

6 of Clubs

2 of Diamonds

6 of Hearts

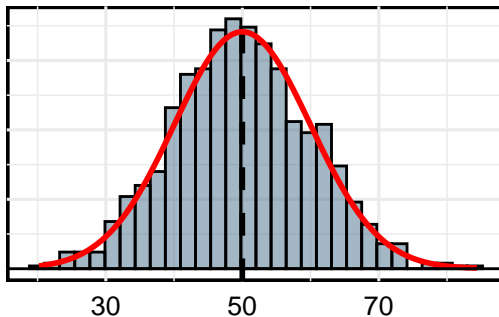
Generating Distributions

- 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)
```

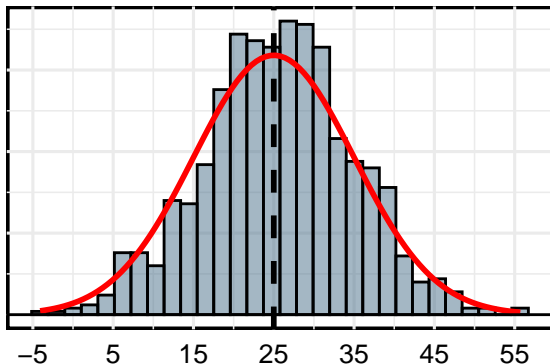


Generating Distributions (Standard Normal)

- **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)
```

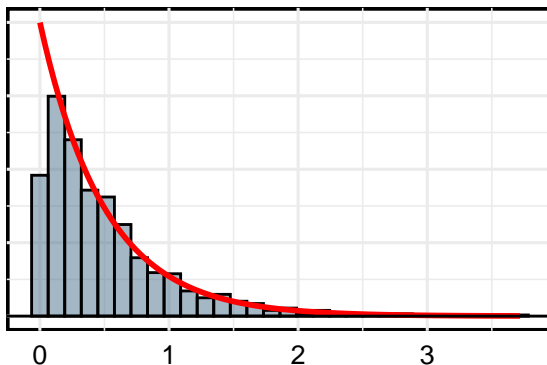


Generating Distributions (Exponential – Ex)

- **Your Turn:** Generate 1000 draws from an exponential distribution where $\text{rate} = 2$

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)

```
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] 6 6 1 4 3 4 3 1 6 3
```

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] 12 14 9 16 13 9 15 13 8 14
```

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.)

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

Hint: Use a loop!

Blackjack Exercise (Cont.)

- ➊ 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.
- ➋ What if I start with \$1000 but don't replace the money every day. . . How much will I have after 10 days? 50 days?
- ➌ 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::()

