Programming I

Introduction

- Important Reading to Consider
  - Chapters 15-17 in R4DS
  - Chapters 14-18 in RP4DS
  - Chapter 7 in AoRP
  - Chapter 4 in FCSPR
- Programming Steps
  - Understand the Problem
  - Inputs and Outputs
  - Create Code
  - Test the Code (Simple Case)
  - Generalize the Code
  - Test Problematic Cases
  - Edit Code to Handle Issues
  - Consider Efficiency

Setup for Lecture

- Open Tutorial 9
- Packages Required:
  - Tidyverse
  - Ecdat
- Knit Document As You Go
- Read Introduction
- Prepare Your Minds for the Matrix

Part 1: If-Else

- General Construction:
  - “If”

```
if (CONDITION) {
        ACTION
}
```

  - “If-Else”

```
if (CONDITION) {
        ACTION 1
} else {
        ACTION 2
}
```

  - ifelse()

```
ifelse(CONDITION,ACTION1,ACTION2)
```

Part 1: If-Else

- Run Chunk 1
  - Check if Larger than 0
  - If True, Take Log
  - Result When x = 3?
  - Result When x = -3?
- Run Chunk 2
  - Notice the Difference
  - If-Else to Handle Errors
- Run Chunk 3
  - Situation Not Considered
  - Replace *BLANK* to Lead to Potential Problem

Part 1: If-Else

- Run Chunk 4
  - Replace BLANK with Different Options and Check
  - How Would You Explain this Code to Your Granny?
- Run Chunk 5
  - What is the Difference Between y1 and y2?
  - Always Look for a Vectorized Solution for Efficiency
- Run Chunk 6
  - Nested ifelse() Statements
  - How Would You Explain this to your Mother?

Part 2: Loops

- General Construction
  - “for” Loop

```
for (INDEX in VECTOR)  {
        ACTION FOR EACH INDEX
}
```

  - “while” Loop

```
while (CONDITION)  {
      ACTION UNTIL CONDITION = FALSE
}
```

  - Nested “for” Loops

```
for (INDEX1 in VECTOR1)  {
      for (INDEX2 in VECTOR2) {
            ACTION
      }
}
```

Part 2: Loops

- Mental Process
  - I Want to Do _____
    for Every _____
    until _____
  - What Type of Object Do You Want Returned?
  - Initiate a Starting Point Based on the Desired Output
  - Try R Code on Single Instance
  - Create the Loop

Part 2: Loops

- Geometric Series

$$\sum_{k=0}^{\infty} ar^k = \frac{a}{1-r}, \text{ for } |r| < 1$$

- Run Chunk 1
  - What *a* did you choose?
  - What *r* did you choose?
  - What is the theoretical limit?
  - What pattern exists?

- Run Chunk 2
  - Choose *a* and *r* that work?
  - Choose *a* and *r* that don't work?
  - Modify: `if(k>100) break`

Part 2: Loops

- Geometric Series (Cont.)

$$\sum_{k=0}^{\infty} ar^k = \frac{a}{1-r}, \text{ for } |r| < 1$$

- Run Chunk 3
  - Suppose We Want to Save at Every Step
  - Why? Picture to Examine the Path of the Summation
  - Choose Small K<15
  - Choose Large K>50
  - What do You Observe?
  - How Would You Explain This Code to Your Stranged Brother ?

Part 2: Loops

- Correlation Matrix
  - Definition: Matrix Which Shows the Correlation Between Every Pair of Numeric Variables
  - Used to Understand Strength of Linear Relationships Between Numeric Variables
  - Helpful in Measuring Collinearity

- Run Chunk 4
  - Inspect the Variables in Cigar
  - Inspect the Correlation Matrix
  - Which Variable(s) is Inappropriate for a Correlation Analysis? Why?

Part 2: Loops

- Run Chunk 5
  - Run First Half – Loops through Every Combination of Columns and Computes Correlation
  - Examine Second Half – Loops Through Every Combination of Columns Excluding the First Column
  - Fill in Blanks with Appropriate Indices so Second Loop Works
  - Run Second Half
- Run Chunk 6
  - Inspect the Variables in HI
  - Uncomment to Print Correlation Matrix
  - What is the Problem?

Part 2: Loops

- Run Chunk 7
  - Observe the Difference Between the Printed Tibbles
  - What is the Difference?
  - How Would You Explain the First Loop to a Toddler?
  - What is cat() doing?
  - How Would You Explain the Second Loop to an Infant?
  - Remember: There Are an Infinite Number of Ways to Do the Same Thing.

Part 3: SRS

- Important For Simulation Studies
- Known Distributions

Distribution	Density/pmf	cdf	Quantiles	Random Numbers
Normal	dnorm()	pnorm()	qnorm()	rnorm()
Chi square	dchisq()	pchisq()	qchisq()	rchisq()
Binomial	dbinom()	pbinom()	qbinom()	rbinom()

- "d" -> Useful for Plotting Density Curve for Continuous Variables or Probability Mass Function for Discrete Variables
- "p" -> Finds the Probability Less Than Or Equal to a Given Number
- "q" -> Finds Cutoff Points
- "r" -> Generates a Random Sample from the Distribution

Part 3: SRS

- For SRS, Use “r”
- Run Chunk 1
  - Scenario for x1: You Ask BLANK Number of Students There Grades where Grades Follow a Normal Distribution with Mean=82 and SD=2
  - Scenario for x2: You Ask BLANK Number of Students to Roll a Fair Die 10 Times and Tell You the Number of 6’s that Appeared.
  - Try Small and Large for BLANK

Part 3: SRS

- Sampling From Finite Set of Possible Outcomes

- Run Chunk 2
  - Scenario: Flip k Coins
    - P(Heads) = BLANK
    - P(Tails) = 1-BLANK
  - How would You Explain What the Figure is Showing to a Politician?

Closing

Disperse and Make Reasonable Decisions