Homework for Lecture 10

The following homework assignment should be completed as an RMarkdown Document. Only show your working code and place comments/explanations in the "white space" to help me evaluate your work. Please submit both the knitted RMarkdown document (.doc) and the .Rmd file. You may discuss the assignment with your classmates, but your write-up and work should be done independently of your classmates. The use of AI is considered a violation of academic policy for this assignment. When in doubt, ask me what is and is not allowed.

Answer the following questions. When you run code make sure you explain what you are doing and what the output is telling us. This can be done in the RMarkdown document in the "white" section of the document. The "grey" section is where your code will go, when you knit it the output will be present.

1. A smartphone company finds that the probability a customer correctly pairs their phone with a Bluetooth speaker on the first attempt is 0.37.

    - If 2000 customers try this, how many would you expect to succeed on their first try? Simulate it in R several times and compare the simulated counts to the expected value
    - If you split the customers into groups of 20 customers, what is the probability that exactly 8 customers succeed on their first try?

2. A 12-question true/false quiz has two choices per question (one correct). A student guesses on every question.

    - What is the probability the student gets exactly 7 correct? Simulate many students guessing and display a histogram of scores

3. You are monitoring arrivals at the Mount's campus café and find that, on average, 22 students arrive to order coffee each hour. The café has enough staff to comfortably serve up to 25 students per hour.

    - What is the probability that more than 25 students arrive in an hour? Simulate many customers arriving and display a histogram of number of customers
    - What is the probability that exactly 25 students arrive in an hour?

4. You analyze how much change customers receive at a local store. The number of cents returned as change (between \$0.00 and \$0.99) is equally likely, since prices vary randomly throughout the day.

    - Generate a random sample of 100 observations, visualize it, then calculate $P(X < 0.25)$ and $P(0.40 \leq X \leq 0.70)$
    - How do these probabilities behave when the sample size increases to 2,000?

***** MORE QUESTIONS ON PAGE 2 *****

5. A water-pump component has an average lifetime of 50 hours between failures.

   - Using an Exponential distribution with rate = 1/50, generate 100 exponential lifetimes, visualize them, then calculate $P(X < 50 \text{ hours})$, $P(10 \text{ hours} \leq X \leq 30 \text{ hours})$, and $P(X > 200 \text{ hours})$
   - How do values change if the sample size increases to 2,000?

6. You administer a standardized reasoning test that historically is approximately normal with mean 82 and standard deviation 7.

   - Generate 100 samples, visualize the distribution, then compute $P(X < 70)$ and $P(80 < X < 88)$
   - Compare with a 2,000-sample draw

7. Using the 2,000-sample from the normal draw above:

   - What percentage of the data lies within 1, 2, and 3 standard deviations of the mean?
   - What percentage of data is less than 1.5 standard deviations above the mean?
   - Report the empirical percentages from your sample