| Name (Last, First): | Student ID: |
|---|---|
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# Assignment 9

*METCS544A3A4_F2024*

**Instructions:**

4. For answering programming questions, please use Adobe Acrobat to edit the pdf file in two steps **[See Appendix: Example Question and Answer]**:
    a. Copy and paste your R code as text in the box provided (so that your teaching team can run your code);
    b. Screenshot your R console outputs, save them as a .PNG image file, and paste/insert them in the box provided.
    c. Show all work—credit will not be given for code without showing it in action, including a screenshot of R console outputs.
5. To answer non-programming questions, please type or handwrite your final answers clearly in the boxes. Show all work - credit will not be given for numerical solutions that appear without explanation in the space above the boxes. **You're encouraged to use R to graph/plot the data and produce numerical summaries; please append your code and screenshot of the outputs at the end of your PDF submission.**
6. **[Total 105 pts = 90 pts + 15 Extra Credit pts]**

**Grading Rubric**

Each question is worth 3 points and will be graded as follows:

3 points: Correct answer with work shown

2 points: Incorrect answer but attempt shows some understanding (work shown)

1 point: Incorrect answer but an attempt was made (work shown), or **correct answer without explanation (work not shown)**

0 points: Left blank or made little to no effort/work not shown

**Reflective Journal [3 pts]**

(Copy and paste the link to your live Google doc in the box below)

https://drive.google.com/drive/folders/1_8qcBjQVMfZggF42UYJuHQzMoBcyAy0Q?usp=drive_link

## Part I. The Addition Rule (18 pts)

A standard deck of cards has 52 cards. Each deck has 4 different suits: Clubs (black), Spades (black), Diamonds (red), and Hearts (red). Each suit contains the following cards: Ace, 2, 3, 4, 5, 6, 7, 8, 9, 10, Jack, Queen, and a King.

1) Consider the events listed below and a fair deck of cards.

C = draw a heart D = draw a face card E = draw an ace

Which of the following are mutually exclusive? Explain.

a) C and D

Not mutually exclusive because you can draw a heart that is a face card

b) C and E

Not mutually exclusive because you can draw a heart of aces

c) D and E

Mutually exclusive because you cannot draw a face card that is an ace

2) One six-sided die is rolled. What is the probability that the die will be?

a) Factor of 12 *or* Factor of 9

Factors of 12: 1, 2,
3 ,4 6
Factors of 9: 3,1
3 and 1 is repeated
6/6 which is 0.83333

b) Less than 3 *or* Greater than 5

1,2,6
3/6 which is 0..5

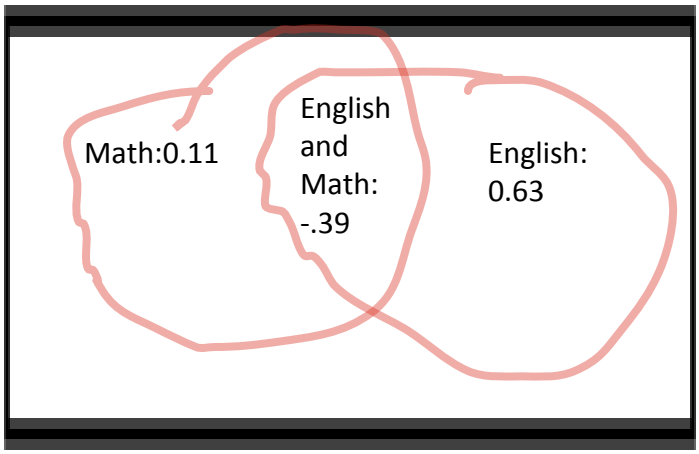
3) The probability that a student owns a car is 0.65, and the probability that a student owns a computer is 0.82. If the probability that a student owns both is 0.55, what is the probability that a randomly selected student owns a car or computer?

0.92

## Part II. Venn Diagrams, Unions, and Intersections (15 pts)

1) At a liberal arts college in the Midwest, 39% of first-year students are enrolled in a math course and an English course, 11% are enrolled in a math course but not an English course, and 63% are enrolled in an English course.

a) Construct a Venn diagram to illustrate this situation. Be sure to label all sets.




b) What is the probability that a first-year student selected at random is taking an English course but not a mathematics course?

.
0.24

c) What is the probability a student is not enrolled in either course?

0.26

2) Create a table to display all data that is described.

M = Male F = Female D = owns a desktop

L = owns a laptop B = owns both N = owns neither

$P(F \cap D) = \frac{21}{235}$ $P(M) = \frac{153}{235}$ $P(L) = \frac{106}{235}$ $P(M \cap L) = \frac{52}{235}$

$P(F \cap N) = \frac{6}{235}$ $P(N) = \frac{10}{235}$ $P(F \cup D) = \frac{86}{235}$

| | Desktop | Laptop | Both | Neither | Total |
|---|---|---|---|---|---|
| **Female** | 21/235 | 54/235 | | 6/235 | |
| **Male** | | 52/235 | | | 153/235 |
| **Total** | | 106/235 | | 10/235 | |

3) The probability of rain on Saturday or Sunday is given as 0.5. The probability of rain on Saturday is 0.2, and the probability of rain on Sunday is 0.4. What is the probability that it will rain on both Saturday and Sunday?

0.1

## Part III. The Multiplication Rule (39 pts)

*Round all answers to three decimal places when needed.*

Directions: Determine if the events are independent or dependent, then find the probabilities.

1) Roll a 7 on an 8-sided die and a 1 on a 6-sided die.

7/8*1/6 = 0.146
Indepedent

2) Flip tails on a fair coin and pull a king from a standard deck.

1/2 * 4/52
0.038
Independent

3) You pull a black card, keep it, and then pull another black card.

0.245
dependent

4) You do not roll a six on a 6-sided die and pull a heart from a standard deck.

5/6 * 13/52
0.208
independent

5) You pick to play shortstop on the baseball field, and then your friend picks an outfield position.

0.417
Independent

6) All students attending a homecoming assembly complete a digital survey as they arrive at their seats. The survey asked them what they most looked forward to for the homecoming events. Assume all students in attendance participated and remained at the assembly for its entirety. Write probabilities as decimals rounded to hundredths.

| ---------- | **Bonfire** | **Football Game** | **Dance** | **Total** |
|---|---|---|---|---|
| **Freshmen** | 200 | 98 | 202 | 500 |
| **Sophomores** | 125 | 184 | 231 | 540 |
| **Juniors** | 81 | 294 | 123 | 498 |
| **Seniors** | 92 | 198 | 222 | 512 |
| **Total** | 498 | 774 | 778 | **2050** |

*Teachers take turns randomly choosing students to participate in the pep assembly games. Students can get selected for multiple games.*

a) What is the probability that a teacher chooses a sophomore and another sophomore for the first assembly game?

540/2050 *
539/2049
0.0693

b) What is the probability a teacher chooses a student who prefers the bonfire for the second game and then a student who prefers the dance for the third game?

497/2049 * 776/2048
0.0919

c) What is the probability of choosing four students for the last game who are all looking forward to the football game?

774/2050
0.376

7) Given that $P(A) = 0.6,\ P(B) = 0.3$, and $P(B|A) = 0.5$

a) Find P(A and B)

0.18

b) Find P(A or B)

0.72

c) Are events A and B independent?

They have to be in order for this to work.

8) At Portillo's in Rockford, the distribution of ages and what shift they work on a Saturday is below. Fill in the table with the missing information.

| Age | Open - 1 pm | 1 pm - 7 pm | 7 pm - Close | Total |
|---|---|---|---|---|
| Under 18 | 6 | 2 | 21 | 29 |
| 18 to 49 | 4 | 5 | 2 | 11 |
| 40 and over | 10 | 5 | 25 | 40 |
| Total | 20 | 12 | 48 | 80 |

Are the events "Open - 1 pm" and "40 and over" independent? Show your work.

They are not independent because they rely on each other

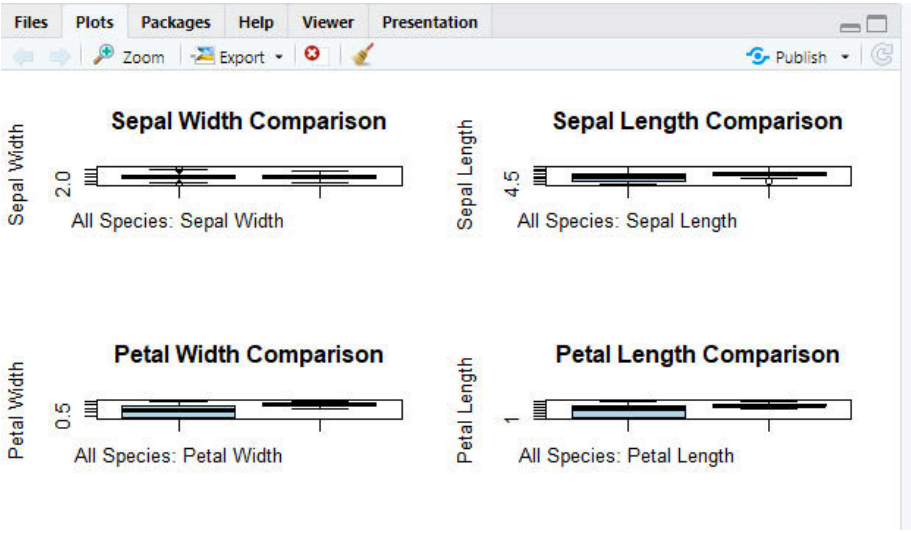
## Part IV. Statistical Programming (18 pts + 12 Extra Credit pts)

1. **(6 pts)** Using the iris data set, produce boxplots of the sepal width, sepal length, petal width, and petal length. Slice the iris data set to contain only flowers of the 'virginica' species. Produce boxplots of the virginica sepal width, sepal length, petal width, and petal length. Show the R commands.

**Answer: Copy and paste your R code in the box below (not an image but the text).**

```
data(iris)
# Slice the dataset to include only the 'virginica' species
virginica_data <- subset(iris, Species == "virginica")
par(mfrow = c(2, 2))
boxplot(iris$Sepal.Width, virginica_data$Sepal.Width,
      names = c("All Species: Sepal Width", "Virginica: Sepal Width"),
      main = "Sepal Width Comparison",
      col = c("lightblue", "lightgreen"),
      ylab = "Sepal Width")
boxplot(iris$Sepal.Length, virginica_data$Sepal.Length,
      names = c("All Species: Sepal Length", "Virginica: Sepal Length"),
      main = "Sepal Length Comparison",
      col = c("lightblue", "lightgreen"),
      ylab = "Sepal Length")
boxplot(iris$Petal.Width, virginica_data$Petal.Width,
      names = c("All Species: Petal Width", "Virginica: Petal Width"),
      main = "Petal Width Comparison",
      col = c("lightblue", "lightgreen"),
      ylab = "Petal Width")
boxplot(iris$Petal.Length, virginica_data$Petal.Length,
      names = c("All Species: Petal Length", "Virginica: Petal Length"),
      main = "Petal Length Comparison",
      col = c("lightblue", "lightgreen"),
      ylab = "Petal Length")
```

**Take a screenshot of your R console outputs and paste the image in the box below. Also, save the plots from the Plot pane and paste them into the box below.**



2. **(12 pts + 12 Extra Credit pts)** Load the Titanic data set using data ("Titanic"). The following questions will use this data set.
    a. What are the dimensions of the summarized Titanic table?
    b. What are the names of the dimensions of the summarized Titanic table?
    c. Produce margin tables for the Class and Age variables separately and then a joint margin table of both variables. Show the R commands.
    d. Produce a mosaic plot of the Titanic Class and Survived variables. Show the R commands.
    e. **(Extra Credit)** Produce barplots showing the number of passengers that survived broken down by class. Include a legend and label the axes. Try to produce all four plots in one window. Use the par(mfrow) function to do so. Show the R commands.

**Answer: Copy and paste your R code in the box below (not an image but the text).**

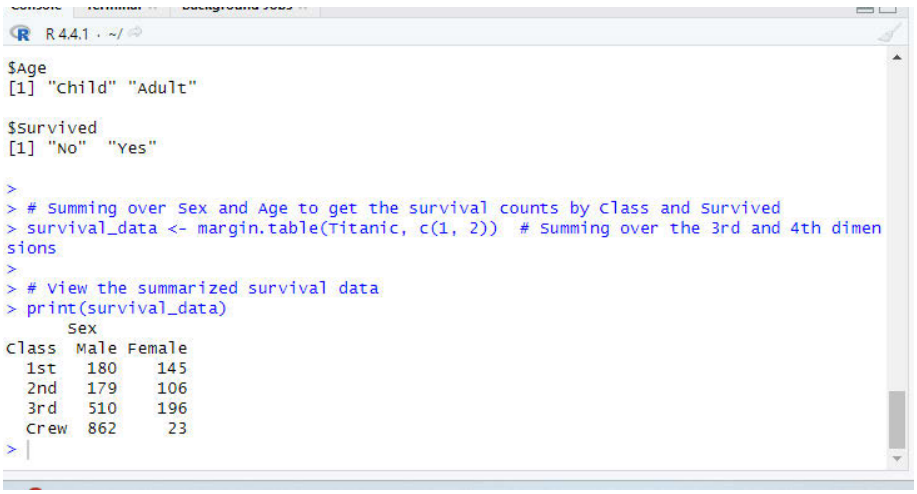
```
data("Titanic")


dim(Titanic)
dimnames(Titanic)


survival_data <- margin.table(Titanic, c(1, 2))  # Summing
over the 3rd and 4th dimensions

print(survival_data)
```

**Take a screenshot of your R console outputs and paste the image in the box below. Also, save the plots from the Plot pane and paste them into the box below.**



## Appendix: Example Question and Answer for R programming questions:

Calculate the sum $\sum_{j=0}^{n} r^j$, where $r$ has been assigned the value 1.08, and compare with $(1-r^{n+1})/(1-r)$, for $n = 10, 20, 30, 40$.

**Answer: Copy and paste your R code in the box below (not an image but the text).**

```
r <- 1.08
n <- c(10, 20, 30, 40)
sum1 <- c()
for(i in n){
  x <- 0:i
  sum1 <- c(sum1, sum(r^x))
}
sum1   # This gives the calculated sums for n = 10, 20, 30, 40.

sum2 <- (1 - r^(n + 1)) / (1 - r)
sum2

sum2 - sum1   # The formula works.
```

**Screenshot of your R console outputs and paste the image in the box below**

```
> r <- 1.08
> n <- c(10, 20, 30, 40)
> sum1 <- c()
> for(i in n){
+   x <- 0:i
+   sum1 <- c(sum1, sum(r^x))
+ }
> sum1   # This gives the calculated sums for n = 10, 20, 30, 40.
[1]  16.64549  50.42292 123.34587 280.78104
> sum2 <- (1 - r^(n + 1)) / (1 - r)
> sum2
[1]  16.64549  50.42292 123.34587 280.78104
> sum2 - sum1   # The formula works.
[1] 0 0 0 0
```

**THE END**