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Assignment 6

NEU_COE_INFO6105_Fall2024

Instructions:

1. 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 or python code as text in the box provided (so that your teaching team can run your code);
   b. Screenshot your R or python 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 the code in action by including the screenshot of R or python console outputs.
2. 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 or python 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.**
3. **[Total 111 pts = 36 + 18 + 15 + 39 pts + 3 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://docs.google.com/document/d/1ptEhnYHniNtT1yxDPcvXK7LpJaPGzi80BCSGZZhom7Y/edit?usp=sharing

Part I. Probability Basics (36 pts)

Write all probabilities as decimals and round to the nearest three decimal places when needed.

1) You pick 1 marble from a bag that contains 8 marbles (2 blue, 3 red, and 3 yellow). Find the following probabilities.

2=Blue , Red = 3, Yellow = 3, Green = 0 Total = 8 marbles.

a) P(Blue)

$P(Blue) = \frac{\text{No of Blue Marbles}}{\text{Total marbles}}$

$= \frac{2}{8} = 0.250$

b) P(Yellow)

$P(Yellow) = \frac{\text{No of Yellow Marbles}}{\text{Total Marbles}}$

$= \frac{3}{8} = 0.375$

c) P(Green)

$P(Green) = \frac{\text{No of Green Marbles}}{\text{Total Marbles}}$

$= \frac{0}{8} = 0$

d) P(Blue or Yellow)

$P(\text{Blue or Yellow}) = P(Blue) + P(Yellow)$

$= 0.250 + 0.375$

$= 0.625$

e) P(not Blue)

$P(\text{Not Blue}) = 1 - P(Blue)$

$= 1 - 0.250$

$= 0.750$

f) P(Red, Blue, or Yellow)

$P(\text{Red, Blue, or Yellow})$

$= P(Red) + P(Blue) + P(Yellow)$

$= \frac{3}{8} + \frac{2}{8} + \frac{3}{8}$

$= 0.375 + 0.250 + 0.375$

$= 1.000$

2) Below are the probabilities of pulling out a particular color from an M&M bag.

a) What is the probability of pulling a blue M&M?

b) Describe the likelihood of this event.

Brown	Red	Yellow	Green	Orange	Blue
0.30	0.20	0.20	0.10	0.10	?

Answer: a) Total probability of all event = 1

$P(Blue) = 1 - (P(Brown) + P(Red) + P(Yellow) + P(Green) + P(Orange))$

$= 1 - (0.30 + 0.20 + 0.20 + 0.10 + 0.10)$

$= 1 - 0.90$

$\therefore P(Blue) = 0.10$

Probability of pulling a blue M&M = 0.10

b. The likelihood of pulling blue M&M is 10% (0.10)

This is an unlikely event but not impossible.

This has a low probability.

3) A survey of 324 people asked what their favorite food was. The results are shown below.

	Pizza	Burgers	Fried Chicken	Other	Total
Less than 18	60	23	5	34	122
18 and older	45	33	20	104	202
Total	105	56	25	138	324

If we randomly select a person from this sample,

a) What is the probability that a person likes fried chicken?

$$\boxed{P(\text{Fried Chicken}) = \frac{\text{Total who liked Fried Chicken}}{\text{Total people}} = \frac{25}{324} = 0.077}$$

b) What is the probability that a person is less than 18 years old and likes burgers?

No of people less than 18 years & like burgers = 23

$$P(\text{Less Than 18years \& likes burger}) = \frac{23}{324} = 0.071$$

c) What is the probability that a person likes pizza or burgers?

Number of people who like pizza = 105

Number of people who like burgers = 56

$$P(\text{Pizza or Burgers}) = P(\text{Pizza}) + P(\text{Burgers})$$

$$= \frac{105}{324} + \frac{56}{324}$$

$$= \frac{105+56}{324}$$

$$= 0.497$$

d) What is the probability that a person is less than 18 or 18 and older?

$$P(\text{Less than 18 or 18 and older}) = P(\text{Less than 18}) + P(\text{18 and older})$$

$$= \frac{122}{324} + \frac{202}{324}$$

$$= \frac{324}{324} = 1$$

or

$P(\text{Less than 18 OR 18 and older}) = 1$ (i.e. $\frac{324}{324}$)

– As everybody in the sample are either less than 18 or 18 and older.

Part II. 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.

Face Card = Jack, Queen, King

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

12 cards total → 3 for each suit

Which of the following are mutually exclusive? Explain. - Mutually exclusive events are events that cannot happen at the same time.

a) C and D

C = Drawing a heart (13 cards)

D = Drawing a face card (12 cards)

There are 3 face cards in hearts, it's possible to draw both a heart & face card at same time. ∴ Not mutually exclusive.

b) C and E

C = Drawing a heart

E = Drawing an ace

There is an ace in hearts, it's possible to draw both a heart and an ace at the same time.

∴ Not mutually exclusive

c) D and E

D = Drawing a face card

E = Drawing an ace.

Face card are Jack, Queen & King, while aces are seperate from these categories. It's impossible to draw both a face card & an ace at the same time

∴ Mutually exclusive

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

a) Factor of 12 *or* Factor of 9

Factor of 12 in six-sided die = 1, 2, 3, 4 & 6.

Factor of 9 in six-sided die = 1 and 9.

P(Factor of 12 or Factor of 9) = P(Factor of 12) + P(Factor of 9) - P(Factor of 12 and Factor of 9)

P(Factor of 12) = $\frac{5}{6}$ (1, 2, 3, 4, 6)

P(Factor of 9) = $\frac{2}{6}$ (1, 2)

P(Factor of 12 or Factor of 9) = $\frac{2}{6}$ (1, 2) [To remove duplicate]

P(Factor of 12 or Factor of 9) = $\frac{5}{6} + \frac{2}{6} - \frac{2}{6} = \frac{5}{6} \approx 0.833$

b) Less than 3 *or* Greater than 5

Less Than 3 = 1, 2 Greater Than 5 = only 6.

P(Less than 3 or Greater than 5) = P(Less than 3) + P(Greater than 5)

P(Less Than 3) = $\frac{2}{6}$ (1, 2)

P(Greater than 5) = $\frac{1}{6}$ (6)

P(Less than 3 or Greater than 5) = $\frac{2}{6} + \frac{1}{6} = \frac{3}{6}$

= 0.500

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?

P(Owner a Car) = 0.65 P(Owns a Computer) = 0.82 P(Owns both) = 0.55

P(Owns a car or Computer) = P(Owns a Car) + P(Owns a computer) - P(Owns both)

P(Owns a Car or Computer) = 0.65 + 0.82 - 0.55

= 0.92

Part III. 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.

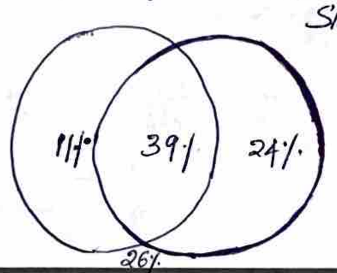
$P(E) = 63\% = 0.63$ $P(E \cap M) = 0.39$ $P(M \cap E^c) = 0.11$

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

Total English = 63%, Math & English = 39%, Math but Not English = 11%

Total Math = 39% + 11% = 50%, English not Math = 24% (63% - 39%)

Student in neith course = 26%



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

$P(E \cap M^c) = P(E) - P(E \cap M)$

$= 0.63 - 0.39$

$= 0.24$

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

$P(E \cap M^c) = 0.24$, $P(E \cap M) = 0.39$ $P(M \cap E^c) = 0.11$

Total = 100 = 1.00

$1.00 - (P(E \cap M^c) + P(E \cap M) = 0.39 + P(M \cap E^c))$

$1.00 - (0.24 + 0.39 + 0.11)$

$= 0.26$

Probability a student is not enrolled in either course = 0.26 (ie 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

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

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

$P(D) = ?$ $P(F \cup D) = P(F) + P(D) - P(F \cap D)$

$\frac{86}{235} = \frac{82}{235} + P(D) - \frac{21}{235}$

$P(D) = \frac{86}{235} - \frac{82 + 21}{235 \quad 235}$

$= \frac{25}{235}$

	Desktop	Laptop	Both	Neither	Total
Female	21	54	1	6	82
Male	4	52	93	4	153
Total	25	106	94	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?

$P(Sat \cup Sun) = 0.5$ (Probability of rain on Saturday & Sunday)

$P(Sat) = 0.2$ (Probability of rain on Saturday)

$P(Sun) = 0.4$ (Probability of rain on Sunday)

$P(Sat \cup Sun) = P(Sat) + P(Sun) - P(Sat \cap Sun)$

$0.5 = 0.2 + 0.4 - P(Sat \cap Sun)$

$P(Sat \cap Sun) = 0.6 - 0.5 = 0.1$

Probability of rain on both Saturday and Sunday is 0.1 (or 10%)

Part IV. 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.

Independent event as outcome of rolling one die does not affect the outcome of rolling the other die.

P(7 on 8 sided die) = 1/8

P(1 on 6 sided die) = 1/6

P(7 on 8 sided die and 1 on 6 sided die)

$= \frac{1}{8} \times \frac{1}{6} = \frac{1}{48} \approx 0.021$

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

Independent because flipping the coin does not affect drawing a card from the desk.

P(Tails) = 1/2

P(King) = 4/52 = 1/13

P(Tails and King) $= \frac{1}{2} \times \frac{1}{13} = \frac{1}{26} \approx 0.038$

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

Dependent because you do not replace the first card, which affects the probability of pulling the second black card.

P(First black card) $= \frac{26}{52} = 1/2$ P(Second black card) $= \frac{25}{51}$

P(Both black cards) $= \frac{1}{2} \times \frac{25}{51}$

$= \frac{25}{102} \approx 0.245$

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

Independent because rolling the die does not affect drawing card from the deck

P(Not a six) $= \frac{5}{6}$ P(Heart) $= \frac{13}{52} = 1/4$ P(Not Six and heart) $= \frac{5}{6} \times \frac{1}{4} = \frac{5}{24} \approx 0.208$

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

Dependent - The first choice affects the available choice for the second person.

P(Shortstop) = 1/9 P(outfield or shortstop) $= \frac{3}{8}$

P(Friend picks outfield) $= \frac{1}{9} \times \frac{3}{8} = \frac{1}{24} \approx 0.042$

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?

$P(\text{First Sophomore}) = \frac{540}{2050}$

$P(\text{Second Sophomore}) = \frac{539}{2049}$

$P(\text{Two Sophomores}) = P(\text{First Sophomore}) \times P(\text{Second Sophomore})$

$= \frac{540}{2050} \times \frac{539}{2049} = \frac{291060}{4207450} \approx \cancel{0.069}$

$\approx \underline{0.07}$

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?

$P(\text{Bonfire}) = \frac{498}{2050}$

$P(\text{Dance}) = \frac{778}{2050}$

$P(\text{Bonfire and Dance}) = P(\text{Bonfire}) \times P(\text{Dance})$

$= \frac{498}{2050} \times \frac{778}{2050} = \frac{387756}{4202500} \approx \underline{0.09}$

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

$P(1\ \text{Football}) = \frac{774}{2050}$

$P(4\ \text{Football}) = \frac{771}{2047}$

$P(2\ \text{Football}) = \frac{773}{2049}$

$P(4\ \text{Football}) = \frac{774}{2050} \times \frac{773}{2049} \times \frac{772}{2048} \times \frac{771}{2047}$

$P(3\ \text{Football}) = \frac{772}{2048}$

$= \frac{356{,}116{,}530{,}024}{2050 \times 2049 \times 2048 \times 2047}$

$\approx \underline{0.02}$

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

a) Find P(A and B)

$$P(B|A) = \frac{P(A \text{ and } B)}{P(A)}$$

$$P(A \text{ and } B) = P(B|A) \times P(A)$$

$$= 0.5 \times 0.6 = 0.30$$

b) Find P(A or B)

$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$

$$= 0.6 + 0.3 - 0.3 = 0.6$$

$$P(A \cup B) = 0.60$$

c) Are events A and B independent?

$$P(A \text{ and } B) = P(A) \times P(B)$$

$$= 0.6 \times 0.3 = 0.18$$

Since P(A and B) = 0.30 from ⓐ P(A) x P(B) = 0.18 ∴ A & B are not independent.

i.e 0.30 ≠ 0.18

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.

$$P(\text{Open - 1pm}) = \frac{20}{80} = \frac{2}{8} = 0.25$$

$$P(\text{40 and Over}) = \frac{40}{80} = 1/2 = 0.5$$

$$P(\text{Open - 1pm} \cap \text{40 and Over}) = \frac{10}{80} = \frac{1}{8} = 0.125$$

$$P(\text{Open - 1pm} \cap \text{40 and Over}) = P(\text{Open - 1pm}) \times P(\text{40 and Over})$$

$$= \frac{20}{80} \times \frac{40}{80}$$

$$= \frac{1}{4} \times \frac{1}{2} = \frac{1}{8} = 0.125$$

From table P(Open - 1pm ∩ 40 and over) = 0.125.

THE END

From calculation P(Open - 1pm ∩ 40 and Over) = 0.125.

0.125 = 0.125

∴ They are independent.