Midterm 1: Practice Problems

PSTAT 5A: Spring 2023, with Ethan P. Marzban

! Disclaimer

- This is not meant to be comprehensive, nor is this meant to directly emulate the format of the actual exam.
  - Rather, these problems are designed to *supplement* your already-existing notes, lecture examples, homeworks, labs, and quiz.

Multiple Choice Questions

1. Given two events A and B with $\mathbb{P}(A) = 0.5$, $\mathbb{P}(B) = 0.7$, is it possible for A and B to be disjoint?
   a. Yes
   b. No
   c. Not enough information to determine

2. In what module is the function `make_array()` found?
   a. `numpy`
   b. `math`
   c. `datascience`
   d. `python_arrays`
   e. None of the above

3. What do we call the verbal description of a function included in the definition of a function, often enclosed in three quotation marks?
   a. functional description
   b. docstring
   c. user guide
   d. vignette
   e. None of the above

4. Which of the following expressions will, when run, return a value of `True`?
   a. `1 > 4`
   b. `2 + 2`
   c. `'a' < 'b'`
   d. `'b' < 'b'`
   e. None of the above

5. Masha records the weight (in grams) of 294 different baby goats. What is the correct classification of the variable containing the weights of these goats?
    a. discrete
    b. continuous
    c. nominal
    d. ordinal
    e. None of the above

6. Morgan collects 78 pieces of fruit and records both the type of fruit (`apple`, `orange`, etc.), along with its weight (in grams). What is the correct type of visualization Morgan should generate if they want to determine the relationship between fruit type and fruit weight?
    a. Boxplot
    b. Histogram
    c. Bargraph
    d. Side-by-side Boxplot
    e. Scatterplot
    f. None of the above

7. Given two events E and F, which of the following statements must be true?
    a. $\mathbb{P}(E \cap F) = \mathbb{P}(E \mid F) \cdot \mathbb{P}(F)$
    b. $\mathbb{P}(E \cap F) = \mathbb{P}(E) \cdot \mathbb{P}(F)$
    c. $\mathbb{P}(E \cup F) = \mathbb{P}(E) + \mathbb{P}(F)$
    d. $\mathbb{P}(E \cup F) = 1 - \mathbb{P}(E^C \cup F^C)$
    e. None of the above.

8. If E and F are two events such that $\mathbb{P}(E) = 0.3$, $\mathbb{P}(F) = 0.2$, and $\mathbb{P}(E \cap F) = 0.1$, which of the statements is true?
    a. E and F are disjoint, but not independent
    b. E and F are independent, but not disjoint
    c. E and F are independent and disjoint
    d. E and F are neither independent nor disjoint

9. How do we add multi-line comments to a Jupyter notebook code cell?
    a. Using a hashtag (#)
    b. Using three qutoation marks (""")
    c. Using a percent sign (%)
    d. Using a backslash (\)
    e. None of the above

Free Response Questions

Problem 1: Political Opinions

A group of political scientists have surveyed several individuals in downtown Santa Barbara and asked participants their political affiliation (Democrat, Republican, Independent) and whether or not they support an upcoming Bill. The results of the survey are included in the contingency table below:

	Affiliation		
Support	Democrat	Independent	Republican
Oppose	10	3	7
Support	10	5	15

a. If a person from the survey is selected at random, what is the probability that they are a Democrat?

b. If a person from the survey is selected at random, what is the probability that they oppose the bill?

c. If a person from the survey is selected at random, what is the probability that they are an Independent that supports the bill?

d. If a person from the survey is selected at random, what is the probability that they are either an Independent or they oppose the bill (or both)?

e. A person is selected at random, and it is noted that they oppose the bill. What is the probability that this individual is a Republican?

f. Are 'being a Democrat' and 'supporting the bill' independent events? Justify your answer **mathematically**.

Problem 2: Descriptive Statistics

Consider the set of numbers $X = \{-3, -1, 0, 4, 8\}$.

a. Compute $\overline{x}$, the mean of X.

b. Compute median(X), the median of X.

c. Compute range(X), the range of X.

d. Compute s_X, the standard deviation of X.

Problem 3: Transformations

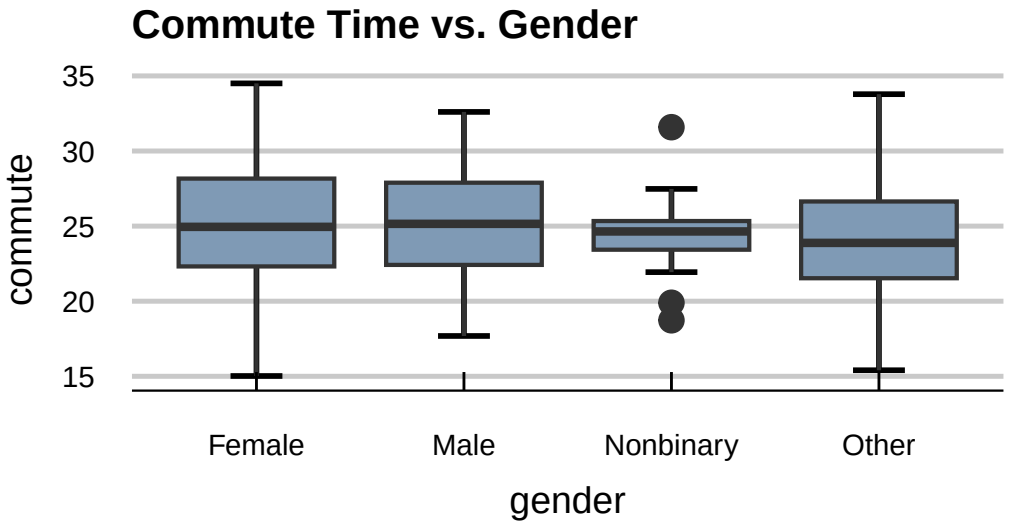
Consider a set $X = \{x_i\}_{i=1}^n$, and define $Y = \{x_i + a\}_{i=1}^n$ for some fixed constant a.

a. Show that $\overline{y} = \overline{x} + a$. (For extra practice, show this from scratch as opposed to citing previously-derived results).

b. How does s_Y^2 compare with s_X^2?

Problem 4: Interpreting Plots

A sample of 135 UCSB students was taken and their gender (Male, Female, Nonbinary, Other) along with their commute time to campus (in minutes). The results of this study are summarized in the following graph:



a. Provide the five-number summary of commute times among Female respondents.

b. Provide the range of commute times among Nonbinary respondents.

c. Does there appear to a difference in commute times across genders?

Problem 5: Picking Numbers

Suppose we pick three numbers from the set $\{0, 2\}$, replacing the number after each draw, and record the selected numbers.

a. Write down the outcome space of this experiment.

b. How many elements are in Ω?

c. Let A be the event "the sum of the three numbers is 2". Write down the mathematical formulation of A; i.e. identify the outcomes that comprise A.

d. Are we justified in using the Classical Approach to probability? Why or why not.

Problem 6: Events

Let E and F be two events with $\mathbb{P}(E) = 0.6$, $\mathbb{P}(F) = 0.5$, and $\mathbb{P}(E \cap F) = 0.12$.

a. What is the probability that either E or F occur?

b. What is the probability that neither E nor F occur?

c. What is $\mathbb{P}(E \mid F)$?

d. What is $\mathbb{P}(F \mid E)$?