Score: __________ / **30**

PSTAT 5A / **FINAL EXAM** / Sum. Sess. A 2023 Instructor: **Ethan Marzban**

Name:____ **UCSB NetID:**____________________

First, then Last *NOT your Perm Number!*

Circle Your Section: Olivier 12:30 - 1:20pm Mengrui 2 - 2:50pm Mengrui 3 - 3:50pm

MULTIPLE CHOICE QUESTIONS VERSION B

Instructions:

- You will have **160 minutes** to complete the entire exam
  - Do not begin working on the exam until instructed to do so.
  - During the final 10 minutes of the exam, we will ask everyone to remain seated until the exam concludes.
- This exam comes in **TWO PARTS**: this is the **MULTIPLE CHOICE** part of the exam.
  - There is a separate booklet containing Free-Response questions that should have been distributed to you at the same time as this booklet.
- Fill in the bubble corresponding to your answer **on the provided scantron**; **Absolutely NOTHING** written directly on this exam booklet will be graded. Partial credit will **not** be awarded.
  - Unless explicitly instructed otherwise, mark only one answer per question. If you mark multiple answers for the same question, you will receive 0 points for the question even if one of your choices is correct.
- The use of calculators is permitted; the use of any other aids (including notes, laptops, phones, etc.) is strictly prohibited. A list of formulae, as well as a collection of tables, is included with this exam.
- **PLEASE DO NOT DETACH ANY PAGES FROM THIS EXAM.**
- Good Luck!!!

Problems 1 - 3 refer to the following situation: Karla wants to know whether regular exercise has an effect on overall mental health.

Problem 1. Which of the following schemes describes how Karla could conduct an **observational study** to achieve her goal? [1pts.]

A. Take a sample of 100 volunteers and divide them into two groups. To one group, prescribe regular exercise and to the other prescribe no exercise. Instruct groups to continue for a period of several weeks, and then record mental health at the end of the several weeks.

B. Take a sample of 100 volunteers, 50 of which already regularly exercise and 50 of which do not regularly exercise. Observe these 100 individuals over a period of a few weeks and then record the mental health of each group at the end of the several weeks.

C. Take a sample of 100 volunteers that do not regularly exercise, and start by recording the initial mental health of these 100 volunteers. Then, prescribe regular exercise to these volunteers for a period of several weeks, and then record the post-treatment mental health of the volunteers.

Problem 2. Suppose Karla has performed her observational study, and found that there is a statistically significant relationship between exercise and mental health; specifically, it seems that more regular exercise is associated with improved mental health. Can Karla then conclude that exercising regularly causes an improvement in mental health? [1pts.]

A. Yes, Karla is justified in making a causal assertion.

B. No, because it is not possible to make causal assertions using an observational study.

C. No, because there may be confounding variables Karla has not controlled for.

D. Both choices (B) and (C).

E. None of the above.

Problem 3. Suppose Karla has performed her study in the following way: [1pts.]

> Take a sample of 100 volunteers that do not regularly exercise, and start by recording the initial mental health of these 100 volunteers. Then, prescribe regular exercise to these volunteers for a period of several weeks, and then record the post-treatment mental health of the volunteers.

Has Karla performed a longitudinal study or a cross-sectional study?

A. Longitudinal

B. Cross-Sectional

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Problems 4 - 8 refer to the following stiutation: At the *GauchoCinema*, it is found that 60% of people are going to watch *Barbie* and 50% are going to watch *Oppenheimer*. Additionally, of those watching *Barbie* it is found that 50% are going to watch *Oppenheimer* as well. A person is selected at random, and the movie/s they are going to watch is recorded.

Problem 4. What is the probability that the randomly-selected person is going to watch both *Barbie* and *Oppenheimer*? [1pts.]

A. 0.1
B. 0.3
C. 0.5
D. 0.6
E. None of the above.

Problem 5. Given that the person is going to watch *Oppenheimer*, what is the probability that they also watch *Barbie*? [1pts.]

A. 0.1
B. 0.3
C. 0.5
D. 0.6
E. None of the above.

Problem 6. What is the probability that the randomly-selected person watches *Barbie* but not *Oppenheimer*? Assume that the probability of watching both *Barbie* and *Oppenheimer* is 0.3 (which isn't to say this is the correct answer to Problem 5 above!). [1pts.]

A. 0.1
B. 0.3
C. 0.5
D. 0.6
E. None of the above.

Problem 7. Let B denote the event "the person watches *Barbie* " and O denote the event "the person watches *Oppenheimer*." Are B and O independent? [1pts.]

A. Yes
B. No
C. Not enough information to determine.

Problem 8. Let B and O be defined as in Problem 7 above. Are B and O disjoint? [1pts.]

A. Yes
B. No
C. Not enough information to determine.

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Problems 9 - 12 refer to the following stiuation: The **geometric mean** of a list of numbers $\{y_i\}_{i=1}^n$ is defined to be

$$\overline{y}_{\text{geom}} = (y_1 \times y_2 \times \cdots \times y_n)^{\frac{1}{n}}$$

i.e. the geometric mean is computed by first computing the product of the numbers, and then raising the product to the power $(1/n)$ where n is the number of observations. João would like to write a Python function called `geom_mean()` that takes in a single input `y = [y1, ..., yn]` and outputs the geometric mean of `y`. To that end, he has written the following code, and has nothing written above it:

```
def geom_mean(y):

    """
    return the geometric mean of y
    """

    n = len(y)

    prod_y = 1

    for k in __Blank 1__:

        prod_y __Blank 2__ k

    return (prod_y) __Blank 3__ (1/n)
```

Problem 9. What should go in Blank 1? [1pts.]

- **A.** `k`
- **B.** `y`
- **C.** `geom_mean`
- **D.** **`len`**
- **E.** None of the above

Problem 10. What should go in Blank 2? [1pts.]

- **A.** `*=`
- **B.** `+=`
- **C.** `=*`
- **D.** `=+`
- **E.** None of the above

Problem 11. What should go in Blank 3? [1pts.]

A. `^`

B. `^^`

C. `*`

D. `**`

E. None of the above

Problem 12. Assuming all blanks are filled in correctly, what would be the output of running `geom_mean(1, 2, 3)`? [1pts.]

A. `0.5503`

B. `1.8171`

C. `2.0000`

D. An Error

E. None of the above

Problems 13 - 18 refer to the following situation: Consider the following data matrix:

`grade`	`sleep`	`major`	`fav_color`
A+	7.8	PSTAT	Green
B	6.9	PSYCH	Gold
A-	7.0	SOC	Red
B	5.5	PSTAT	Gold
C+	6.7	PSTAT	Purple

We are also provided with the following data dictionary:

- **`grade`**: letter grade
- **`sleep`**: amount of sleep (in hours)
- **`major`**: major
- **`fav_color`**: favorite color

Problem 13. What is the best type of visualization to visualize the relationship between **`sleep`** and **`fav_color`**? [1pts.]

A. Histogram

B. Barplot

C. Scatterplot

D. Side-by-side Boxplot

E. None of the above

Problem 14. Which of the variables below is ordinal? (There is only one correct answer choice.) [1pts.]

A. **`grade`**

B. **`sleep`**

C. **`major`**

D. **`fav_color`**

Problem 15. Suppose Ayesha wants to model the relationship between **`sleep`** and **`grade`**, using **`grade`** as the response variable and **`sleep`** as the explanatory variable. Is this a regression problem or a classification problem? [1pts.]

A. Regression

B. Classification

For Problems 16 - 18: Suppose the above data matrix has been imported into Python as a `datascience` table called `students`. Also assume the `datascience` module has been imported, and that it has been imported without any nickname.

Problem 16. What would be the result of running the code [1pts.]

```
students.column(2).item(3)
```

A. 7.0

B. 5.5

C. SOC

D. PSTAT

E. None of the above.

Problem 17. Which of the answer choices below best describes what the following code is doing: [1pts.]

```
students.row(students.column(3)== "Gold")[0]
```

A. It returns the favorite colors of students whose favorite color was Gold.

B. It returns the grades of students whose favorite color was Gold.

C. It returns the number of students whose favorite color was Gold.

D. It returns an error.

E. None of the above.

Problem 18. What does the output of **`len`**`(students.labels)` represent? [1pts.]

A. The number of variables

B. The number of observational units

C. The number of explanatory variables.

D. The total number of elements in the table

E. None of the above.

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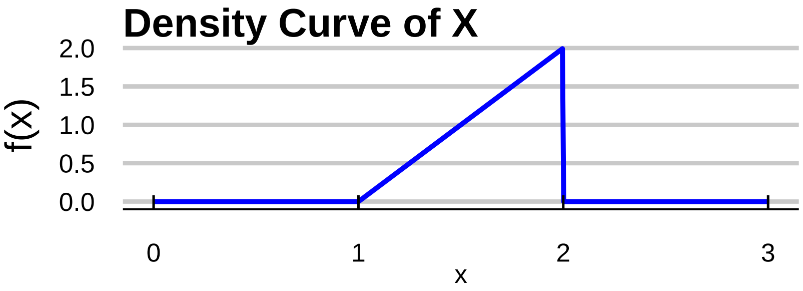
Problems 19 - 21 refer to the following situation: The random variable X has the following density curve (if the picture is difficult to read, the density curve is zero up to 1, a straight line from the point $(1, 0)$ to $(2, 2)$, and then zero from 2 onwards):



Problem 19. What is the state space of X? [1pts.]

A. $S_X = \{0, 1, 2\}$

B. $S_X = [0, 2]$

C. $S_X = \{1, 2\}$

D. $S_X = [1, 2]$

E. None of the above

Problem 20. What is $\mathbb{P}(X = 1.5)$? [1pts.]

- **A.** 0.00
- **B.** 0.25
- **C.** 0.50
- **D.** 0.75
- **E.** None of the above.

Problem 21. What is $\mathbb{P}(X \geq 1.5)$? [1pts.]

- **A.** 0.00
- **B.** 0.25
- **C.** 0.50
- **D.** 0.75
- **E.** None of the above.

Problems 22 - 23 refer to the following situation: Suppose Nitin has imported the `scipy.stats` module with the nickname `sps`, and has also run the following code:

```
a = sps.t.ppf(0.3, 27)
b = sps.t.ppf(0.7, 27)

c = sps.t.cdf(-1.31, 27)
```

Problem 22. What is the correct relationship between `a` and `b`? [1pts.]

- **A.** `a = b`
- **B.** `a = -b`
- **C.** `a = 1 - b`
- **D.** `b = 1 - a`
- **E.** None of the above.

Problem 23. What is the value of `c`? [1pts.]

- **A.** -1.31
- **B.** 0.10
- **C.** 0.20
- **D.** 1.31
- **E.** None of the above.

Problems 24 - 30 are unrelated.

Problem 24. Which of the options below gives the correct LaTeX syntax for rendering the following equation (pay attention to the parentheses and exponents!) [1pts.]

$$f_X(x) = \left(\frac{\pi}{x} \right)^{-4}$$

A. `$$ f_X(x) = \left( \frac{\pi}{x} \right)^{-4} $$`

B. `$$ f_X(x) = ( \frac{\pi}{x} )^{-4} $$`

C. `$$ f_X(x) = \left( \frac{\pi}{x} \right)^-4 $$`

D. `$$ f_X(x) = ( \frac{\pi}{x} )^-4 $$`

E. None of the above.

Problem 25. Consider the function `g()`, defined as follows: [1pts.]

```
def g(x):

    """
    return negative one times x
    """

    -1 * x
```

What will be returned by calling `g(-1)`?

A. -1

B. 1

C. An Error

D. Nothing

E. None of the above.

Problem 26. When running the code `y = y - 2`, which side of the equality does Python evaluate first? [1pts.]

A. Left

B. Right

Problem 27. Let π_p denote the p^{th} percentile of the <u>standard normal distribution</u> for an arbitrary (but fixed) value of p that is strictly greater than 50%. Which of the following must be true? [1pts.]

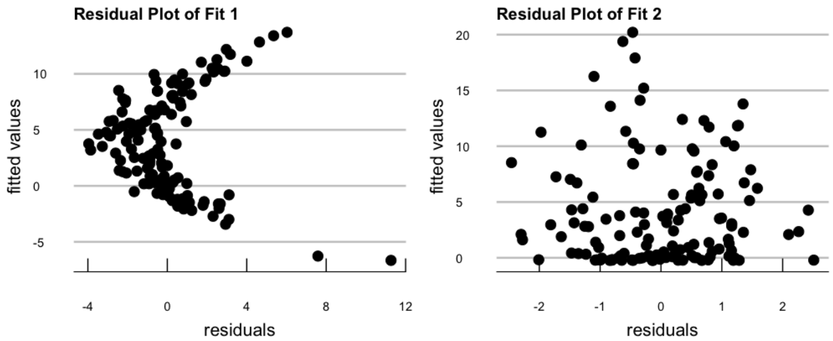
A. $\pi_p < 0$

B. $\pi_p = 0$

C. $\pi_p > 0$

D. None of the above.

Problem 28. A variable y is regressed onto another variable x. Two different fits are generated, called Fit 1 and Fit 2 respectively; the residual plots are displayed below. Which model is performing "better" (i.e. fitting the data better)? [1pts.]



A. Fit 1

B. Fit 2

Problem 29. **True or False:** The right endpoint of the right whisker on a boxplot will always be the maximum value in the dataset. [1pts.]

A. True

B. False

Problem 30. **True or False:** Variance is a measure of central tendency. [1pts.]

A. True

B. False