INFO 2950 Fall 2023 Midterm Questions

Instructions

Some students are taking the exam late due to scheduling constraints. Do not discuss the exam unless you are certain that everyone you are talking to has taken it.

You have 70 minutes to complete this exam. Time will be announced and marked on the board. You may use only a writing utensil and paper. If you use any electronic device (including a calculator) for any purpose we will immediately confiscate your exam paper. All calculations have been constructed so that you will not need a calculator.

Write answers only in the assigned space on the answer sheet. ONLY your answer sheet, and not your question sheet, will be graded. The exam will be graded out of 100 total points.

Make sure your name and netid are clearly written on every page of the answer sheet, as we will remove staples to scan it. If you do not write your answers clearly, they will not be scanned well and may be graded incorrectly.

The answer sheet is intended to provide more than enough space; don't worry if you don't fill it. Showing your work may allow us to give you partial credit. Do not spend more than 10 minutes on a problem. If you get stuck, move on and come back later.

Raise your hand if you would like to ask a clarifying question.
Good luck!

$$var(X) = \frac{\sum_i (X_i - \bar{X})^2}{N}$$

$$cov(X, Y) = \frac{\sum_i (X_i - \bar{X})(Y_i - \bar{Y})}{N}$$

$$corr(X, Y) = \frac{cov(X,Y)}{\sigma_X \sigma_Y}$$

$\sigma(t) = \frac{e^t}{e^t+1} = \frac{1}{1+e^{-t}}$ (not the same σ!)

$\sigma(t)$ is less than 0.5 when t is negative, and greater than 0.5 when t is positive.

if $Y_i = \alpha + \beta X_i + \epsilon_i$, $\beta = \frac{cov(X,Y)}{var(X)}$

I. Programming with Data: Multiple Choice (8 points)

1. *(2 points)* What will be the following expression's output?

```
type("29.50")
```

A. An error (`.dtype` should be used)
B. `float`
C. `string`
D. `NaN`

2. *(2 points)* Which of the following is not necessary when analyzing meaningful time series data?

A. Having regularly spaced and chronological time labels
B. Having corresponding data per time step
C. Converting the time label to a string
D. Having unique time labels
E. Dealing with missing values

3. *(2 points)* Which of the following would convert the `Date` column to a datetime object, and replace the original column with the new series?

A. `df[Date] = pd.to_datetime(df["Date"])`
B. `df = pd.to_datetime(df["Date"])`
C. `df["Date"] = pd.to_datetime(df["Date"])`
D. `df["Date_New"] = pd.to_datetime(df["Date"])`

4. *(2 points)* Both correlation and covariance are indicators of X and Y relationship directions that are between -1 and 1. True or False?

II. Programming with Data: Short Answer (20 points)

1. *(2 points)* Given `arr = np.array([[3,2,1], [6,5,4], [9,8,7]])`, how would you index for the value `4` using numpy? Fill in the blank: `arr[___]`

2. *(2 points)* What is the output of df.shape?

```
df = pd.DataFrame({"a": [1,2], "b": [3,4], "c": [5,6]})
```

3. *(4 points)* In your answer sheet, circle the four cells that would require cleaning in the following dataframe.

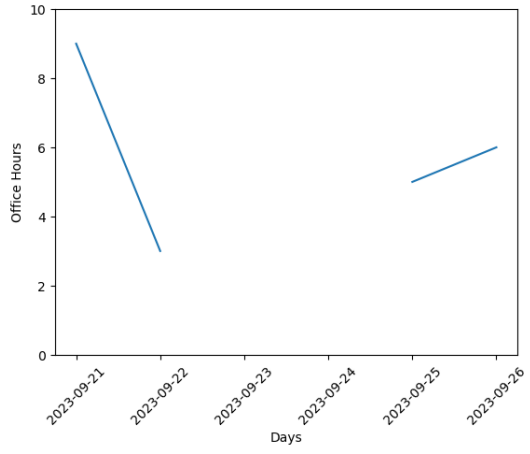
Name	Major	Graduation Year	Credits Taken	Graduated Already?
Jules		2022	85	1
Kiki	Information Science	TwentyTwentyFour	105	0
Jon	Information Science	2021	-5	1
Leo	Animal Science	2025	15	0
Bella	Philosophy	2026	30	0
Toffi	Food Science	2026	45	2

4. *(4 points)* Given the dataframe `office_hours`, which graph would be the output when we execute the following code: `office_hours.plot("date", "num_hours")`? Circle whether graph A or B would be output, and explain why in a few words.

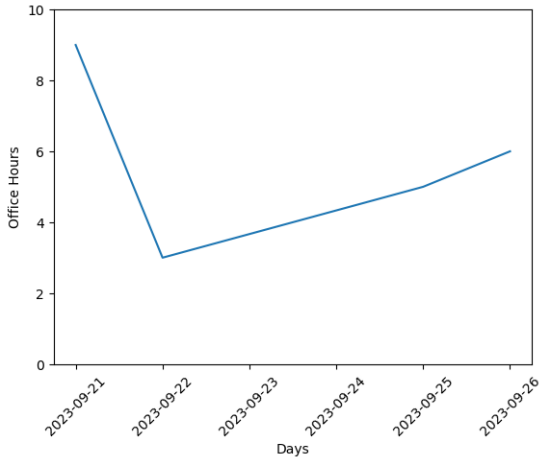
`office_hours:`

	date	num_hours
0	2023-09-21	9
1	2023-09-22	3
2	2023-09-25	5
3	2023-09-26	6

A.



B.



5. *(8 points)* There are four syntax errors in the following program involving a dataframe with columns `temp_value` and `temp_class`. Write the line number and the reason for each error. There may be multiple errors or no errors in each line.

```
import pandas as pd
import duckdb

df = pandas.read_csv(dataframe.csv) # LINE 1
print(df[temp_value].median()) # LINE 2
print(df["temp_value"].mean()) # LINE 3
high_df = duckdb.sql("SELECT * WHERE temp_class = 'high'").df() # LINE 4
```

III. Programming with Data: SQL (15 points)

You are given the following dataframes **df1** and **df2** regarding the INFO2950 pets, their descriptors, and costs from different purchases at the pet store.

df1

Pet	Age	Species
Libby	7	Cat
Juno	2	Cat
Pluto	NaN	Plant

df2

PetStoreVisit	PetStoreCost	PetStoreCategory	Pet
2023-03-15	30	Food	Libby
2023-03-15	20	Litter	Libby
2023-03-20	10	Toy	Juno
2023-07-08	20	Food	Juno
2023-07-15	20	Litter	Juno
2023-07-15	10	Toy	Libby

1. *(5 points)* Write the SQL statement that fills in the blank to generate **df3** (using **df2** and/or **df1**).

```
df3 = duckdb.sql("_____").df()
```

df3

Pet	TotalCost
Libby	60
Juno	50

2. *(5 points)* Write the SQL statement that fills in the blank to generate **df4** (using **df3,** and either **df1** or **df2**).

```
df4 = duckdb.sql("_____").df()
```

df4

Pet	Age	Species	TotalCost
Libby	7	Cat	60
Juno	2	Cat	50

3. *(5 points)* Fill in the table with the headings and data that would result from the following SQL expression.

```
df5 = duckdb.sql("SELECT PetStoreCategory, AVG(PetStoreCost) AS AverageCost
FROM df2 GROUP BY PetStoreCategory ORDER BY AverageCost DESC").df()
```

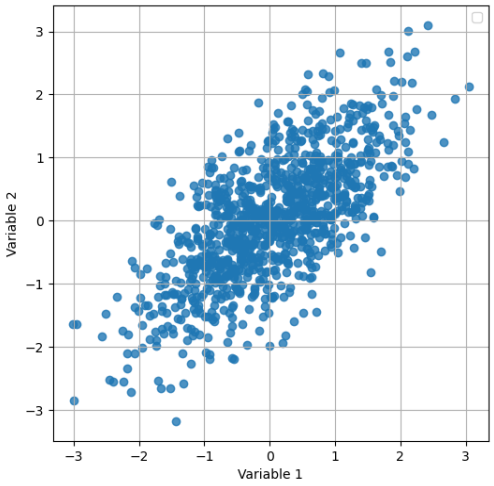
df5

IV. Regression: Multiple Choice (12 points)

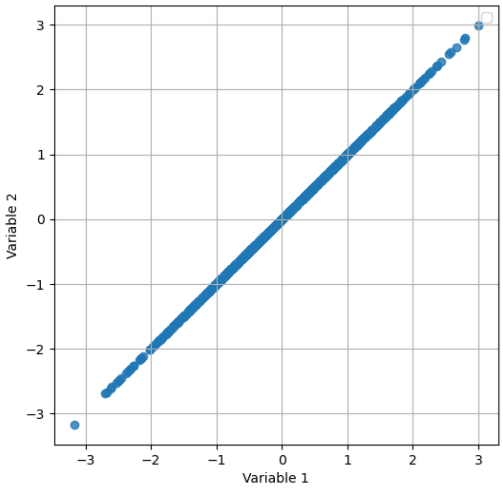
1. *(2 points)* What are possible ways of finding α and β in a regression?
   A. Doing it by hand (with calculus) for a linear regression
   B. Doing it by hand (with calculus) for a logistic regression
   C. Using Python packages
   D. A and C
   E. B and C
   F. All of the above

2. *(2 points)* If you rank the following plots in order from smallest to largest covariance, which of the following is the correct order?

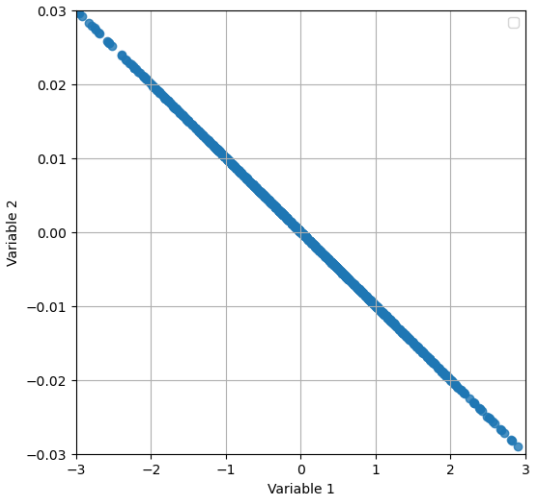
i.



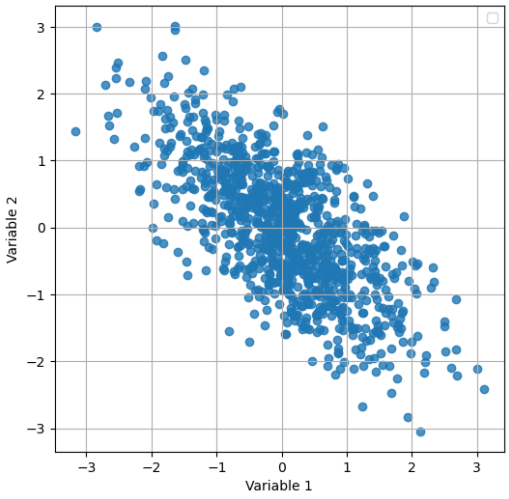
ii.



iii.



iv.



A. iii, iv, i, ii
B. ii, i, iii, iv
C. iv, iii, i, ii
D. ii, i, iv, iii
E. More information is needed to answer this.

3. *(2 points)* Which term represents the "least squares" component that one tries to minimize when using ordinary least squares (OLS) regression?

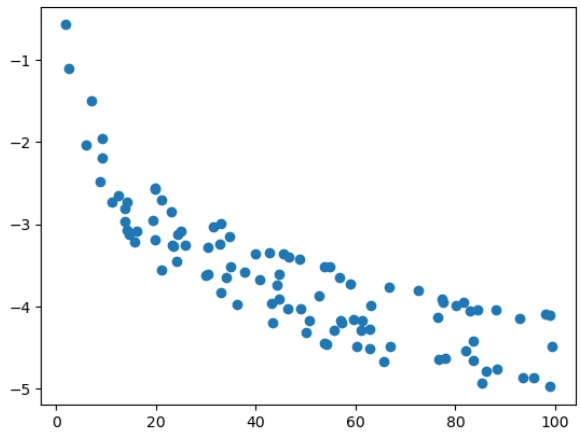
A. $\sum\left(x_i - \hat{x}_i\right)^2$ **B.** $\sum |y_i - \hat{y}_i|$ **C.** $\sum \hat{\varepsilon}_i$

D. $\sum\left(y_i - \hat{y}_i\right)^2$ **E.** $\frac{cov(y,\, x)}{var(x)}$

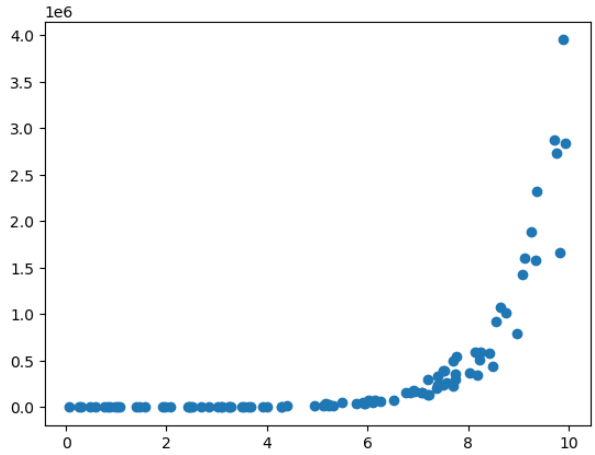
4. *(3 points)* Each of the following plots would be best modeled by one of the three following equations. Each equation was used once. Select the answer that matches the plots to the equations correctly.

1) $y_i=\alpha+\beta x_i+\epsilon_i$ **2)** $y_i=\alpha+\beta\log(x_i)+\epsilon_i$ **3)** $\log(y_i)=\alpha+\beta x_i+\epsilon_i$

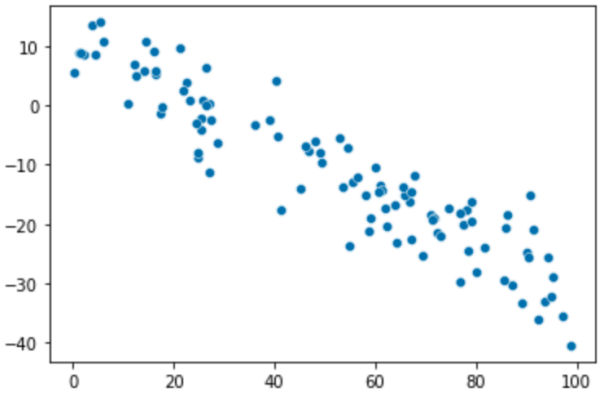
i.



ii.



iii.



Options:

A. 1=iii, 2=ii, 3=i

B. 1=iii, 2=i, 3=ii

C. 1=ii, 2=iii, 3=i

D. 1=i, 2=iii, 3=ii

5. *(3 points)* Which of the following components should you include in your interpretation of $y \sim x_1 + x_2 + x_3$ when summarizing the relationship between variables? y represents the cost of a product, and x_1 represents the weight of the product. The product can be one of three items: rock, paper, and scissors. The dummy variables are as follows: x_2 represents being a rock product, and x_3 represents being a paper product.

A. "All else equal,..."
B. "we expect y to increase/decrease by β_2 if it is a rock product relative to being a scissor product."
C. "we expect y to increase/decrease by β_2 if it is a rock product relative to being not a rock product."
D. A and B
E. A and C

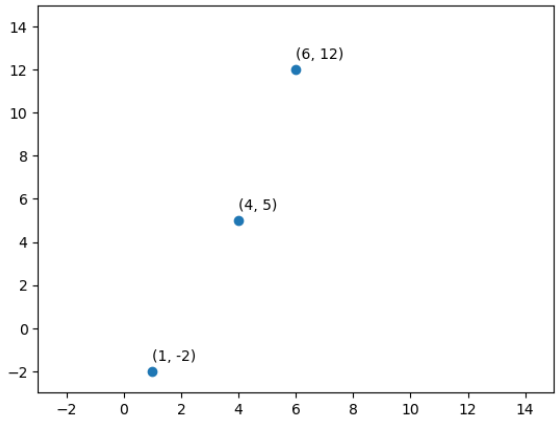
V. Regression: Short Answer (29 points)

1. *(2 points)* Fill in the blanks for a linear model that represents *Gimme! Coffee*'s hot chocolate sales. There are only two types of days that can be represented by x: either it snows (x=1) or it does not snow (x=0). If it does not snow, the model predicts that *Gimme! Coffee* will sell 10 hot chocolates. If it does snow, the model predicts that *Gimme! Coffee* will sell 35 hot chocolates.

y = ___ + ___ x

2. Using the following two linear models and three data points:

Model 1: y = 2x - 3
Model 2: y = 3x - 6



i. *(4 points)* Fill in the table in your answer sheet by computing $\hat{y}$ and epsilon for each x_i.

ii. *(2 points)* Compute the mean squared error for each model. You may leave your answer in unreduced fraction form.

iii. *(2 points)* Which model fits the data better? (Circle your answer).

Model 1: y = 2x - 3 **Model 2: y = 3x - 6**

x	y	ŷ (model 1)	ε (model 1)	ŷ (model 2)	ε (model 2)
1	-2				
4	5				
6	12				

3. For some binary outcome Y:

i. *(4 points)* Fill in the missing values in the table. Express probabilities as fractions.

Row #	Log odds	Probability	Odds
1			**1:1**
2	**-0.30**		**1:2**
3	**2.94**		**19:1**

ii. *(1 point)* Which Row # has the highest Pr(Y=1)/Pr(Y=0)?

4. *(8 points)* Fill in the blanks to derive how a change in x would affect the output *y* for a linear-log model.

Step 1: y = a+b*ln(x)

Step 2: Define new variable $\mathbf{x_{new}}$**= _____**

Step 3: Define new variable y_{new} so that $y_{new} = a+b*\ln(x_{new})$

Step 4: Rewrite the right-hand side to be in terms of x instead of x_{new}

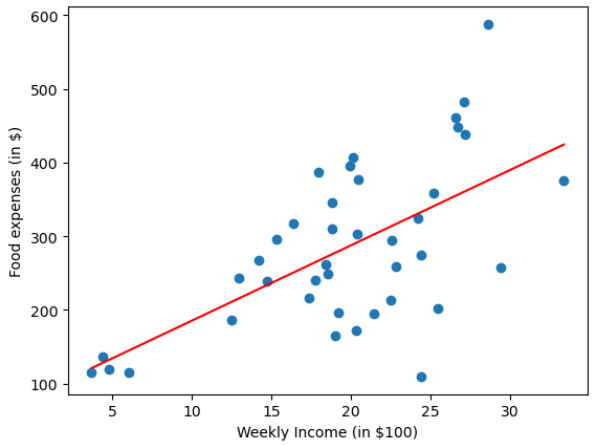
$\mathbf{y_{new}}$ **= _____**

Step 5: Rewrite the right-hand side to be in terms of y instead of x

$\mathbf{y_{new}}$ **= _____**

Step 6: Write the change between y_{new} and y, and **explain in words** how you would interpret this: **_____**

5. The below figure shows data points and a regression line using weekly income to predict food expenditure.

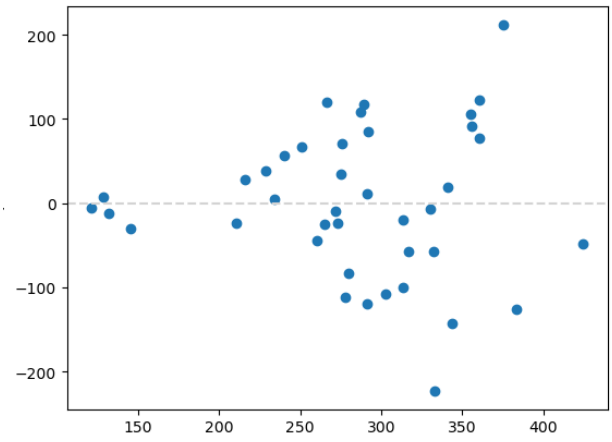


i. *(2 points)* Is Figure A or B the corresponding residual plot?

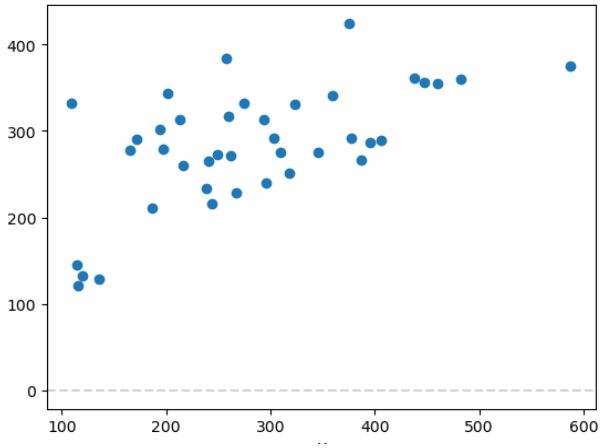
ii. *(2 points)* What do the X and Y axes of a residual plot represent? (Answer in 2 sentences or fewer.)

iii. *(2 points)* Would you trust a regression fit to the data shown in this problem? Why or why not? If not, how would you solve this issue? (Answer in 2 sentences or fewer.)

A:



B:



VI. Regression: Interpretations (16 points)

An exponential lookup table is provided on the following page.

1. Suppose we have the following regression model:

x = number of days since the start of October (i.e. October 1st = day 0, etc.)
y = quantity of Halloween candy sold
$\log_e(y) = x + 2$

Interpret the relationship between days since the start of October and the amount of Halloween candy sold. Make sure to describe using full sentences.

i. *(3 points)* Summarize the relationship between variables.
ii. *(3 points)* Make a prediction for x = 0, and for x = 1.
iii. *(2 points)* Inspect oddities.

2. You build a logistic regression model to predict whether or not it is fall in Ithaca based on the percentage of colorful (non-green) leaves on trees.

x = percentage of colorful leaves *(x = 70 means 70% of leaves are fall colored)*
y = 1 if it is fall; 0 if any other season
$y \sim \sigma(-1 + 3x)$

Interpret the relationship between percentage of colored leaves and the current season being fall. Make sure to describe using full sentences.

i. *(3 points)* Summarize the relationship between variables.

Note: You should only pick one of these phrases to use in your summary:
"If [x] increases by 1 percent…" means going from, e.g., x=50 → x=50.5
"If [x] increases by 1 percentage point…" means, e.g., x=50 → x=51

ii. *(3 points)* Predict the probability of fall when x = 0.
iii. *(2 points)* Inspect oddities.

Extra Credit

(2 points) What is the correct way to tag your homework on Gradescope?

A. Just the problem description.
B. The problem description, the code, and the output.
C. Just the code and the output.

Exponential lookup table (you may use as many or as few of these as needed):

n	**e^n**	**σ(n)**
-3	0.05	0.05
-2	0.14	0.12
-1	0.37	0.27
1	2.72	0.73
2	7.39	0.88
3	20.1	0.95
31	3e13	1.00
32	8e13	1.00
33	2e14	1.00
34	5e14	1.00

SCRATCH PAPER

SCRATCH PAPER