23CY305 - APPLIED STATISTICS USING PYTHON

1. Write a Python program to compute the Mode of a List of Scores

```
import statistics
scores=eval(input("Enter the scores as a list : "))
modes=statistics.multimode(scores)

if len(scores)==len(modes):
    print ("No mode")
elif len(modes)==1:
    print("single mode :",modes[0])
else:
    print("Multimodes :",modes)
```

2. Use the tips dataset to create a boxplot comparing the distribution of total bills across different days of the week. What can you infer about the variability and median total bill on different days?

```
import seaborn as sns
import matplotlib.pyplot as plt
tips=sns.load_dataset("tips")
sns.boxplot(x="day",y="total_bill",data=tips)
plt.show()
```

3. **Create a Histogram and KDE Plot**
   Using the tips dataset from Seaborn, create a histogram and

kernel density estimate (KDE) plot to visualize the distribution of the total bill amount. Interpret what the shape of the distribution tells you about the data.

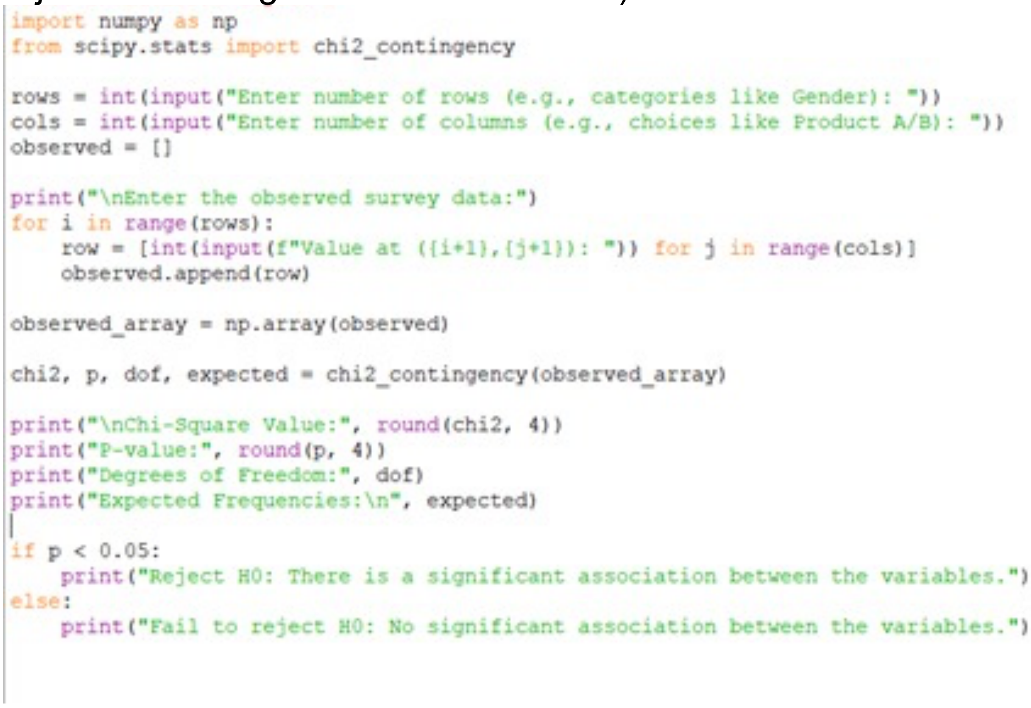
```
import seaborn as sns

import matplotlib.pyplot as plt

tips=sns.load_dataset("tips")

sns.histplot(tips.total_bill,kde=True)

plt.show()
```

4. Write a Python program to find the GCD of 123456 and 7890 using Euclidean Algorithm.

```
def gcd(a,b):

    while b!=0:

        a,b=b,a%b

    return a

x=int(input("Enter num1 : "))

y=int(input("Enter num1 : "))

print("Gcd of",x,y,"is",gcd(x,y))
```

5. Use your chi-square program to analyze real-world data such as survey responses.

```
import numpy as np
from scipy.stats import chi2_contingency

rows = int(input("Enter number of rows: "))
cols = int(input("Enter number of columns: "))

observed = np.array([[int(input(f"Value at ({i+1},{j+1}): ")) for j in range(cols)] for i in range(rows)])

chi2, p, dof, expected = chi2_contingency(observed)

print(f"\nChi-Square Value: {chi2:.4f}")
print(f"P-value: {p:.4f}")
print(f"Degrees of Freedom: {dof}")
print("Expected Frequencies:\n", expected)

print("\nReject H0: Significant association." if p < 0.05 else "\nFail to reject H0: No significant association.")
```

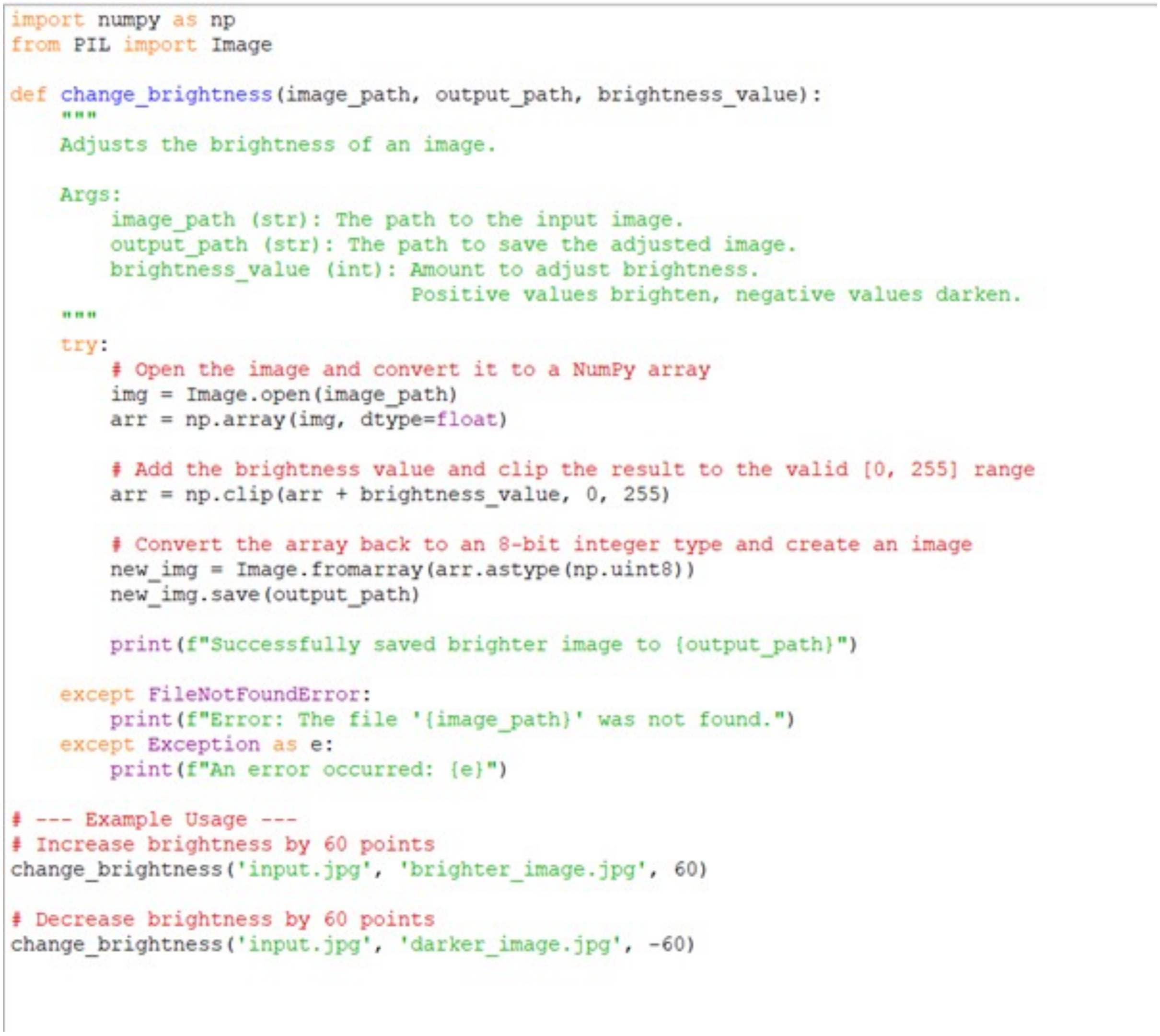


```
import numpy as np
from scipy.stats import chi2_contingency

rows = int(input("Enter number of rows (e.g., categories like Gender): "))
cols = int(input("Enter number of columns (e.g., choices like Product A/B): "))
observed = []

print("\nEnter the observed survey data:")
for i in range(rows):
    row = [int(input(f"Value at ({i+1},{j+1}): ")) for j in range(cols)]
    observed.append(row)

observed_array = np.array(observed)

chi2, p, dof, expected = chi2_contingency(observed_array)

print("\nChi-Square Value:", round(chi2, 4))
print("P-value:", round(p, 4))
print("Degrees of Freedom:", dof)
print("Expected Frequencies:\n", expected)

if p < 0.05:
    print("Reject H0: There is a significant association between the variables.")
else:
    print("Fail to reject H0: No significant association between the variables.")
```

6. **Scatterplot with Regression Line**
   Generate a scatterplot with a regression line (lmplot) to explore the relationship between total bill and tip amount in the tips dataset. Describe the trend and strength of the relationship based on the plot.

```
import seaborn as sns, matplotlib.pyplot as plt

tips = sns.load_dataset("tips")



sns.lmplot(x="total_bill", y="tip", data=tips)

plt.show()
```

7. Write Python program to Image Brightness Adjustment using NumPy.



```
import numpy as np
from PIL import Image

def change_brightness(image_path, output_path, brightness_value):
    """
    Adjusts the brightness of an image.

    Args:
        image_path (str): The path to the input image.
        output_path (str): The path to save the adjusted image.
        brightness_value (int): Amount to adjust brightness.
                                Positive values brighten, negative values darken.
    """
    try:
        # Open the image and convert it to a NumPy array
        img = Image.open(image_path)
        arr = np.array(img, dtype=float)

        # Add the brightness value and clip the result to the valid [0, 255] range
        arr = np.clip(arr + brightness_value, 0, 255)

        # Convert the array back to an 8-bit integer type and create an image
        new_img = Image.fromarray(arr.astype(np.uint8))
        new_img.save(output_path)

        print(f"Successfully saved brighter image to {output_path}")

    except FileNotFoundError:
        print(f"Error: The file '{image_path}' was not found.")
    except Exception as e:
        print(f"An error occurred: {e}")

# --- Example Usage ---
# Increase brightness by 60 points
change_brightness('input.jpg', 'brighter_image.jpg', 60)

# Decrease brightness by 60 points
change_brightness('input.jpg', 'darker_image.jpg', -60)
```

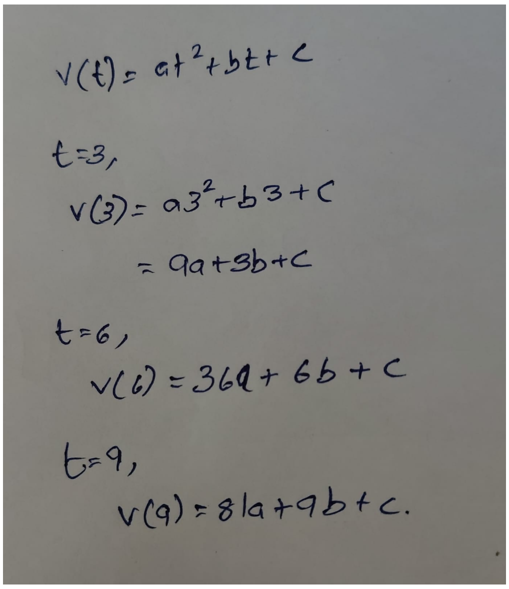
8. Find the count of prime numbers between two given numbers.

```
def is_prime(n):
    if n<=1:
        return False
    for i in range(2,int(n**0.5)+1):
        if n%i==0:
            return False
    return True
a=int(input("Enter starting no: "))
b=int(input("Enter ending no: "))

c=0

for i in range(a,b+1):
    if is_prime(i):
        c+=1
print(f"The number of primes from {a} to {b} is {c}")
```

9. Write a python program to display the names of students (input names separately) with their scores and grades.

```
import statistics
scores=eval(input("Enter the marks : "))
name=input("Enter the names of students seperated by space(the no of marks and names should be equal : ").split()
grades=[]
n=len(scores)
for i in scores:
    if i>=90:
        grades.append("A")
    elif i>=80:
        grades.append("B")
    elif i>=70:
        grades.append("C")
    elif i>=60:
        grades.append("D")
    else:
        grades.append("F")
print("\n Student Details\n")
for i in range(n):
    print(f"Student Name : {name[i]} \n Score : {scores[i]} \n Grade : {grades[i]} \n")
```

10. The upward speed *v*(*t*) of a rocket at time t is approximated by $v(t) = at^2 + bt + c$, $0 \le t \le 100$ where a, b, and c are constants. It has been found that the speed at times t = 3, t = 6 , and t = 9 seconds are respectively, 64, 133, and 208 miles per second respectively. Find the speed at time t = 15 seconds.



$v(t) = at^2+bt+c$

$t=3,$

$v(3) = a3^2+b3+C$

$= 9a+3b+C$

$t=6,$

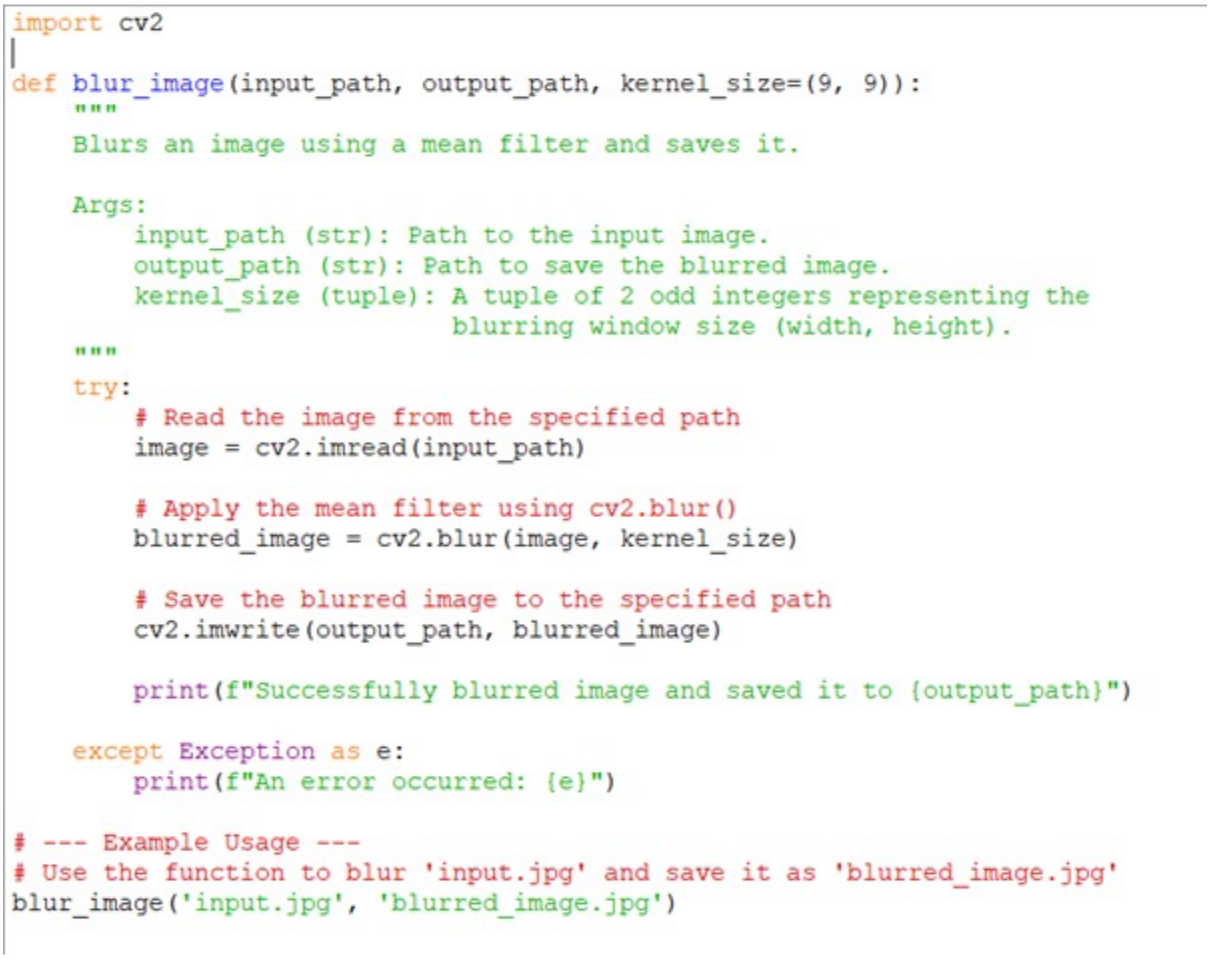
$v(6) = 36a+6b+c$

$t=9,$

$v(9) = 81a+9b+c.$

```
import numpy as np
A = np.array([[9, 3, 1], [36, 6, 1], [81, 9, 1]])
B = np.array([64, 133, 208])
X = np.linalg.solve(A, B)
a,b,c=X
a=round(a,2)
b=round(b,2)
c=round(c,2)
print("a = ",round(a,2))
print("b = ",round(b,2))
print("c = ",round(c,2))
t=15
y=a*(t**2)+(b*t)+c
print("Speed of the rocket at time t=15 is ",y,"miles per second")
```

11. Construct a Python program to Image Blurring using a Mean Filter.



```
import cv2

def blur_image(input_path, output_path, kernel_size=(9, 9)):
    """
    Blurs an image using a mean filter and saves it.

    Args:
        input_path (str): Path to the input image.
        output_path (str): Path to save the blurred image.
        kernel_size (tuple): A tuple of 2 odd integers representing the
                             blurring window size (width, height).
    """
    try:
        # Read the image from the specified path
        image = cv2.imread(input_path)

        # Apply the mean filter using cv2.blur()
        blurred_image = cv2.blur(image, kernel_size)

        # Save the blurred image to the specified path
        cv2.imwrite(output_path, blurred_image)

        print(f"Successfully blurred image and saved it to {output_path}")

    except Exception as e:
        print(f"An error occurred: {e}")

# --- Example Usage ---
# Use the function to blur 'input.jpg' and save it as 'blurred_image.jpg'
blur_image('input.jpg', 'blurred_image.jpg')
```

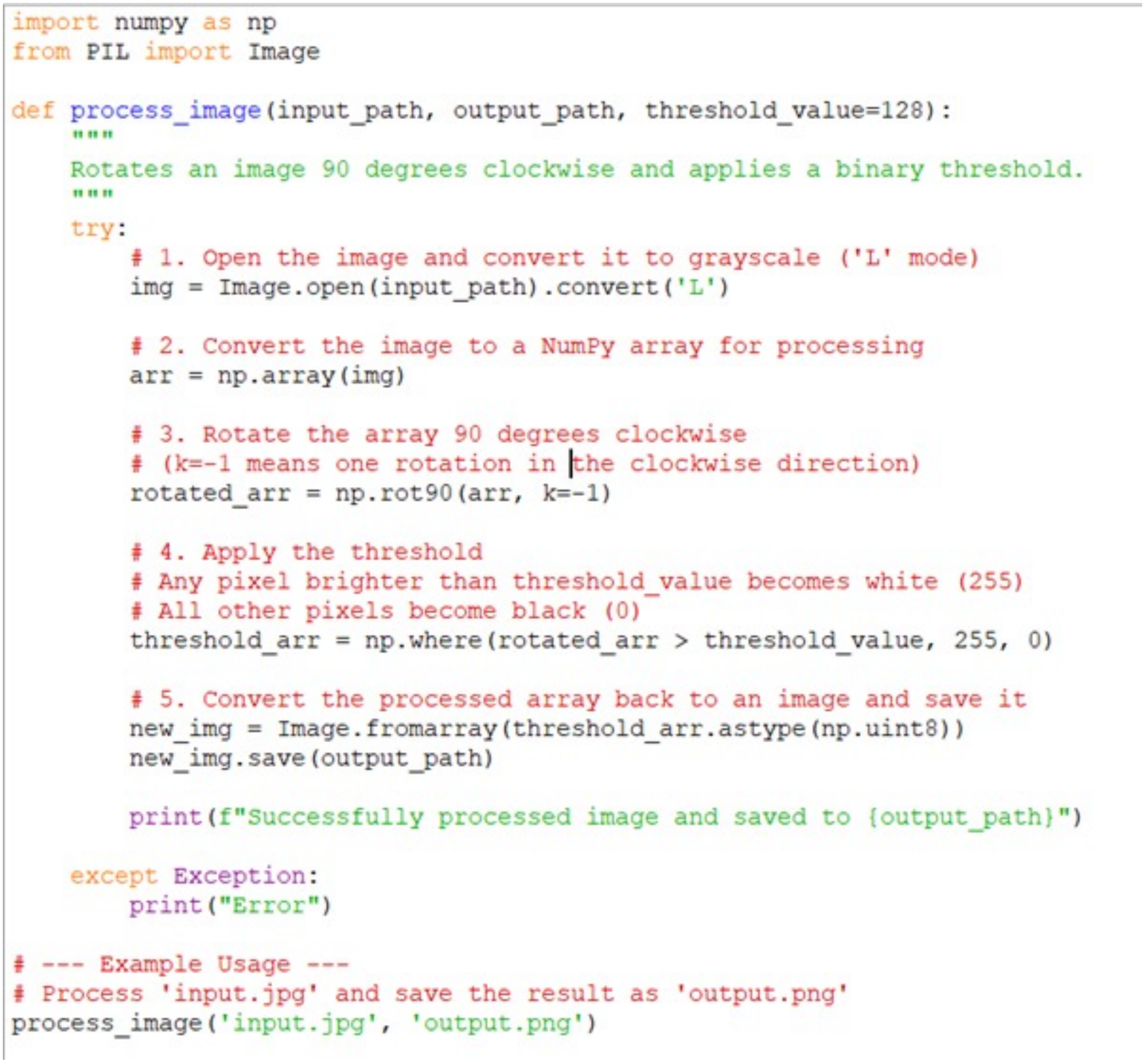
12. Write a Python program to group the sales data by Salesperson. For each salesperson, calculate their total sales (sum of Total Sales).

```
import pandas as pd

df = pd.read_csv("sales_data.csv")
print(df.groupby("Salesperson")["Total_Amount"].sum())
```

the CSV file needs at least these columns:

- **Salesperson**
- **Total_Amount**

13. Construct a Python program to write a Code for Thresholding using NumPy at 90° clockwise rotation.



```python
import numpy as np
from PIL import Image

def process_image(input_path, output_path, threshold_value=128):
    """
    Rotates an image 90 degrees clockwise and applies a binary threshold.
    """
    try:
        # 1. Open the image and convert it to grayscale ('L' mode)
        img = Image.open(input_path).convert('L')

        # 2. Convert the image to a NumPy array for processing
        arr = np.array(img)

        # 3. Rotate the array 90 degrees clockwise
        # (k=-1 means one rotation in the clockwise direction)
        rotated_arr = np.rot90(arr, k=-1)

        # 4. Apply the threshold
        # Any pixel brighter than threshold_value becomes white (255)
        # All other pixels become black (0)
        threshold_arr = np.where(rotated_arr > threshold_value, 255, 0)

        # 5. Convert the processed array back to an image and save it
        new_img = Image.fromarray(threshold_arr.astype(np.uint8))
        new_img.save(output_path)

        print(f"Successfully processed image and saved to {output_path}")

    except Exception:
        print("Error")

# --- Example Usage ---
# Process 'input.jpg' and save the result as 'output.png'
process_image('input.jpg', 'output.png')
```

14. **Heatmap of Correlation Matrix**

Calculate the correlation matrix for the numerical variables in the iris dataset. Visualize this correlation matrix using a heatmap. Which pairs of variables show the strongest positive and negative correlations?

```
import seaborn as sns, matplotlib.pyplot as plt

iris = sns.load_dataset("iris")



sns.heatmap(iris.corr(numeric_only=True), annot=True,
cmap="coolwarm", center=0)

plt.show()
```

15. Given a dataset weather_data.csv with columns Date, City, Temperature, Humidity, Rainfall, filter the data for a city (e.g., "Delhi"), and plot the monthly average temperature trend over a year using a line chart.

```
import pandas as pd, matplotlib.pyplot as plt



df = pd.read_csv("weather_data.csv", parse_dates=["Date"])

df[df.City=="Delhi"].set_index("Date").Temperature.resample("M").
mean().plot(marker="o", color="red")

plt.show()
```

16. I
In a T20 match, Chennai Super Kings needed just 6 runs to win with 1 ball left to go in the last over. The last ball was bowled and the batsman at the crease hit it high up. The ball traversed along a path in a vertical plane and the equation of the path is $y = ax^2 + bx + c$ with respect to a *xy* - coordinate system in the vertical plane and the ball traversed through the points (10,8), (20,16), (30,18) , can you conclude that Chennai Super Kings won the match?

```
import numpy as np
A = np.array([[100, 10, 1], [400, 20, 1], [900, 30, 1]])
B = np.array([8, 16, 18])
X = np.linalg.solve(A, B)
a, b, c = X
x = -b / (2 * a)
y = a * x**2 + b * x + c
print("Maximum height:", round(y, 2))
if y >= 15:
    print("Conclusion: Chennai Super Kings WON the match.")
else:
    print("Conclusion: Chennai Super Kings did NOT win the match.")
```

17. Write a Python program to load the dataset using Pandas and display the first 5 rows.

```
import pandas as pd

df = pd.read_csv("students.csv")
```

```
# Display first 5 rows
print(df.head(5))
```

18. Write a Python program to count and display how many students received each grade.

```
import statistics
scores=eval(input("Enter the marks : "))
a,b,c,d,e=0,0,0,0,0
for i in scores:
    if i>=90:
        a+=1
    elif i>=80:
        b+=1
    elif i>=70:
        c+=1
    elif i>=60:
        d+=1
    else:
        e+=1
print("\n--- Grade Counts ---")
print(f"A: {a}")
print(f"B: {b}")
print(f"C: {c}")
print(f"D: {d}")
print(f"F: {e}")
```

19. Write a Python program that takes two numbers as user input and then prints their LCM. Extend the program to find the LCM of three numbers.

```
import math
a=int(input("Enter a number 1 : "))
b=int(input("Enter a number 2 : "))
result=math.lcm(a,b)
print("lcm is ",result)


import math
a=int(input("Enter a number 1 : "))
b=int(input("Enter a number 2 : "))
c=int(input("Enter a number 3 : "))
result=math.lcm(a,b,c)
print("lcm is ",result)
```

20. Implement a one-sample t-test to check if the sample mean is significantly different from a given value.

```
from scipy.stats import ttest_1samp


# Input sample data

n = int(input("Enter number of elements in sample: "))

data = [float(input(f"Value {i+1}: ")) for i in range(n)]


# Input hypothesized mean

mu = float(input("\nEnter the hypothesized mean: "))
```

```
# One-sample t-test
t, p = ttest_1samp(data, mu)

print(f"\nSample mean = {sum(data)/len(data):.2f}")
print(f"T-statistic = {t:.4f}")
print(f"P-value     = {p:.4f}")

if p < 0.05:
    print("Reject H0: The sample mean is significantly different from the hypothesized mean.")
else:
    print("Fail to reject H0: No significant difference from the hypothesized mean.")
```

21.Modify the t-test program to handle unequal sample sizes.

```
from scipy.stats import ttest_ind

n1 = int(input("Enter number of elements in Group 1: "))
g1 = [float(input(f"Group1 value {i+1}: ")) for i in range(n1)]

n2 = int(input("Enter number of elements in Group 2: "))
g2 = [float(input(f"Group2 value {i+1}: ")) for i in range(n2)]

t, p = ttest_ind(g1, g2, equal_var=False)

print(f"\nT-statistic: {t:.4f}\nP-value: {p:.4f}")
print("Reject H0" if p < 0.05 else "Fail to reject H0")
```

22. Write a Python program to group the dataset by the Product column and calculate the total units sold and total sales for each product.

```
import pandas as pd
```

```
df = pd.read_csv("sales_data.csv")
print(df.groupby("Product").agg(Total_Units=("Quantity","sum"), Total_Sales=("Total_Amount","sum")))
```

```
Product,Quantity,Total_Amount
Laptop,5,300000
Mobile,10,250000
Tablet,4,80000
Laptop,3,180000
Mobile,6,150000
Tablet,2,40000
Headphones,15,75000
Laptop,2,120000
Headphones,10,50000
Mobile,8,200000
```

23.Extend the chi-square program to handle goodness-of-fit test.

```
from scipy.stats import chisquare

n = int(input("Enter number of categories: "))

print("\nEnter observed frequencies:")
observed = [int(input(f"Observed value for category {i+1}: ")) for i in range(n)]

print("\nEnter expected frequencies:")
expected = [float(input(f"Expected value for category {i+1}: ")) for i in range(n)]

chi2_stat, p_value = chisquare(f_obs=observed, f_exp=expected)

print("\nChi-Square Value:", round(chi2_stat, 4))
print("P-value:", round(p_value, 4))

if p_value < 0.05:
    print("Reject H0: Observed distribution is significantly different from expected.")
else:
    print("Fail to reject H0: Observed distribution fits the expected distribution.")
```

24. Solve the following system of equations, $2x_1 + 3x_2 + 3x_3 = 5$, $x_1 – 2x_2 + x_3 = -4$, $3x_1 – x_2 – 2x_3 = 3$

```
import numpy as np
A = np.array([[2, 3, 3], [1, -2, 1], [3, -1, -2]])
B = np.array([5, -4, 3])
X = np.linalg.solve(A, B)
print("Solution:", X)
```

25. Write a Python program to check whether 35 and 64 are coprime.

```
def gcd(a,b):
    while b!=0:
        a,b=b,a%b
    return a
x=int(input("Enter num1 : "))
y=int(input("Enter num1 : "))
if gcd(x,y)==1:
    print(f"{x} and {y} are coprime")
```

```
else:

    print(f"{x} and {y} are not coprimes")
```

26. A retail chain wants to classify customers into lifestyle groups using three features: **Age**, **Annual Income**, and **Spending Score**.

The following dataset contains information of 10 customers:

CustomerID	**Age**	**AnnualIncome**	**SpendingScore**
1	19	15000	39
2	21	18000	81
3	20	17000	6
4	23	22000	77
5	31	35000	40
6	35	40000	50
7	40	45000	60
8	52	60000	30
9	58	65000	20
10	63	70000	70

Question:

1. Load the above dataset into a pandas DataFrame (either manually or using CSV).
2. Standardize the features since they are in different ranges.
3. Use the **Elbow Method** to find the best number of clusters.
4. Perform **K-Means clustering**.
5. Visualize the clusters in a **3D scatter plot** (Age vs Income vs Spending Score).
6. Explain the characteristics of the clusters (e.g., young-high income-high spending, old-low income-low spending, etc.).

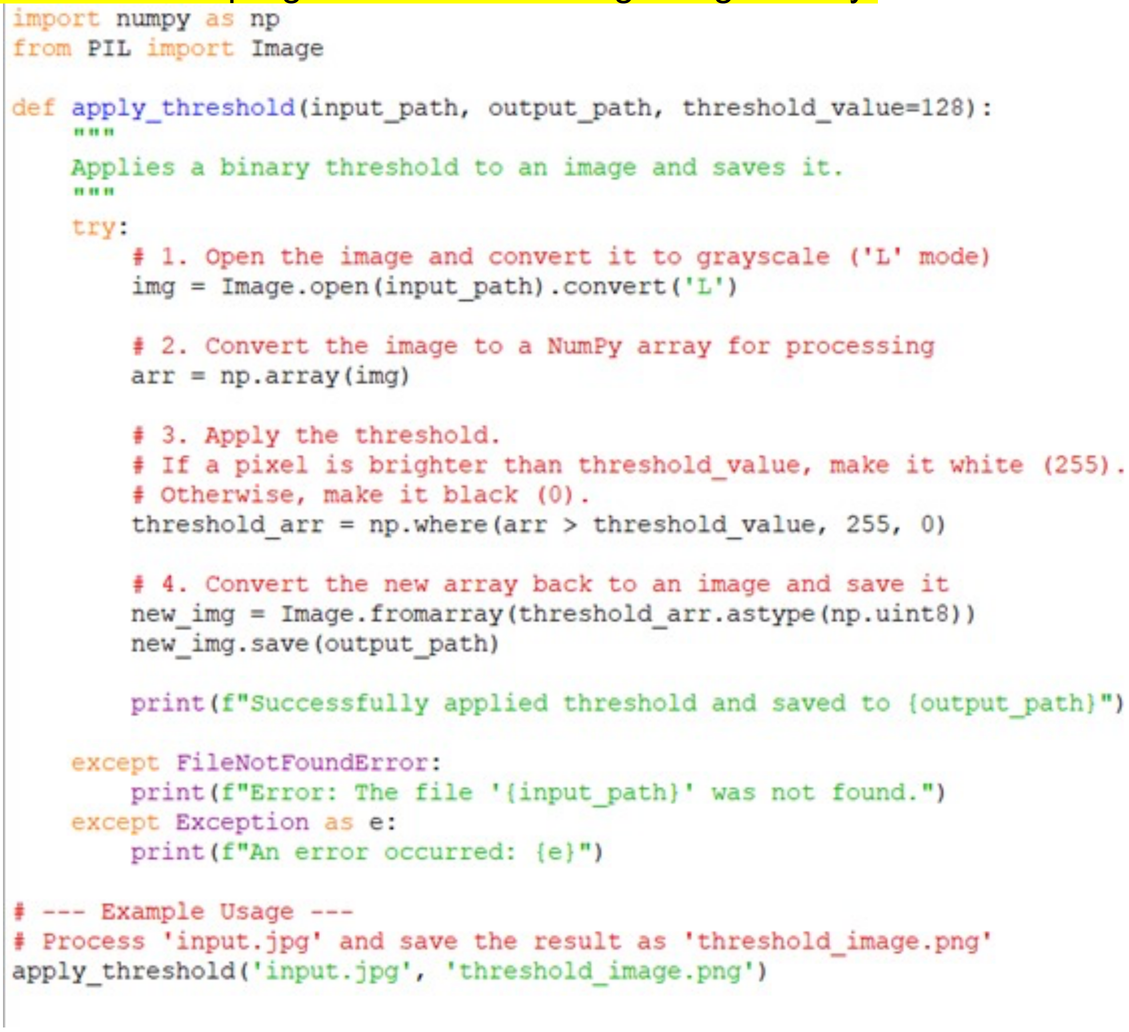
```
import pandas as pd, matplotlib.pyplot as plt, seaborn as sns
```

```
from sklearn.preprocessing import StandardScaler

from sklearn.cluster import KMeans

from mpl_toolkits.mplot3d import Axes3D


# 1 Load

df = pd.read_csv("customers.csv")


# 2 Scale

X = StandardScaler().fit_transform(df[["Age","AnnualIncome","SpendingScore"]])


# 3 Elbow

plt.plot(range(1,7), [KMeans(n_clusters=k,n_init=10).fit(X).inertia_ for k in range(1,7)], 'o-'); plt.show()


# 4 Cluster

kmeans = KMeans(n_clusters=3,n_init=10,random_state=0)

df["Cluster"] = kmeans.fit_predict(X)


# 5 3D Plot

ax = plt.figure().add_subplot(111,projection="3d")

ax.scatter(df.Age, df.AnnualIncome, df.SpendingScore, c=df.Cluster, cmap="viridis", s=80)

ax.set(xlabel="Age", ylabel="Income", zlabel="Score"); plt.show()
```

# 6 Summary

print(df.groupby("Cluster")[["Age","AnnualIncome","SpendingScore"]].mean())

27. Write a program for thresholding using NumPy.



```
import numpy as np
from PIL import Image

def apply_threshold(input_path, output_path, threshold_value=128):
    """
    Applies a binary threshold to an image and saves it.
    """
    try:
        # 1. Open the image and convert it to grayscale ('L' mode)
        img = Image.open(input_path).convert('L')

        # 2. Convert the image to a NumPy array for processing
        arr = np.array(img)

        # 3. Apply the threshold.
        # If a pixel is brighter than threshold_value, make it white (255).
        # Otherwise, make it black (0).
        threshold_arr = np.where(arr > threshold_value, 255, 0)

        # 4. Convert the new array back to an image and save it
        new_img = Image.fromarray(threshold_arr.astype(np.uint8))
        new_img.save(output_path)

        print(f"Successfully applied threshold and saved to {output_path}")

    except FileNotFoundError:
        print(f"Error: The file '{input_path}' was not found.")
    except Exception as e:
        print(f"An error occurred: {e}")

# --- Example Usage ---
# Process 'input.jpg' and save the result as 'threshold_image.png'
apply_threshold('input.jpg', 'threshold_image.png')
```

28. A shopping mall collects customer information containing **Age** and **Annual Income**. The management wants to identify different customer groups for targeted marketing campaigns.

The following dataset contains information of 10 customers:

CustomerID	**Age**	**AnnualIncome**
1	19	15000

CustomerID	Age	AnnualIncome
2	21	18000
3	20	17000
4	23	22000
5	31	35000
6	35	40000
7	40	45000
8	52	60000
9	58	65000
10	63	70000

Question:

I. Load the above dataset into a pandas DataFrame (you can enter manually or save as CSV and load).

II. Apply the **Elbow Method** to determine the optimal number of clusters.

III. Perform **K-Means clustering** to group customers.

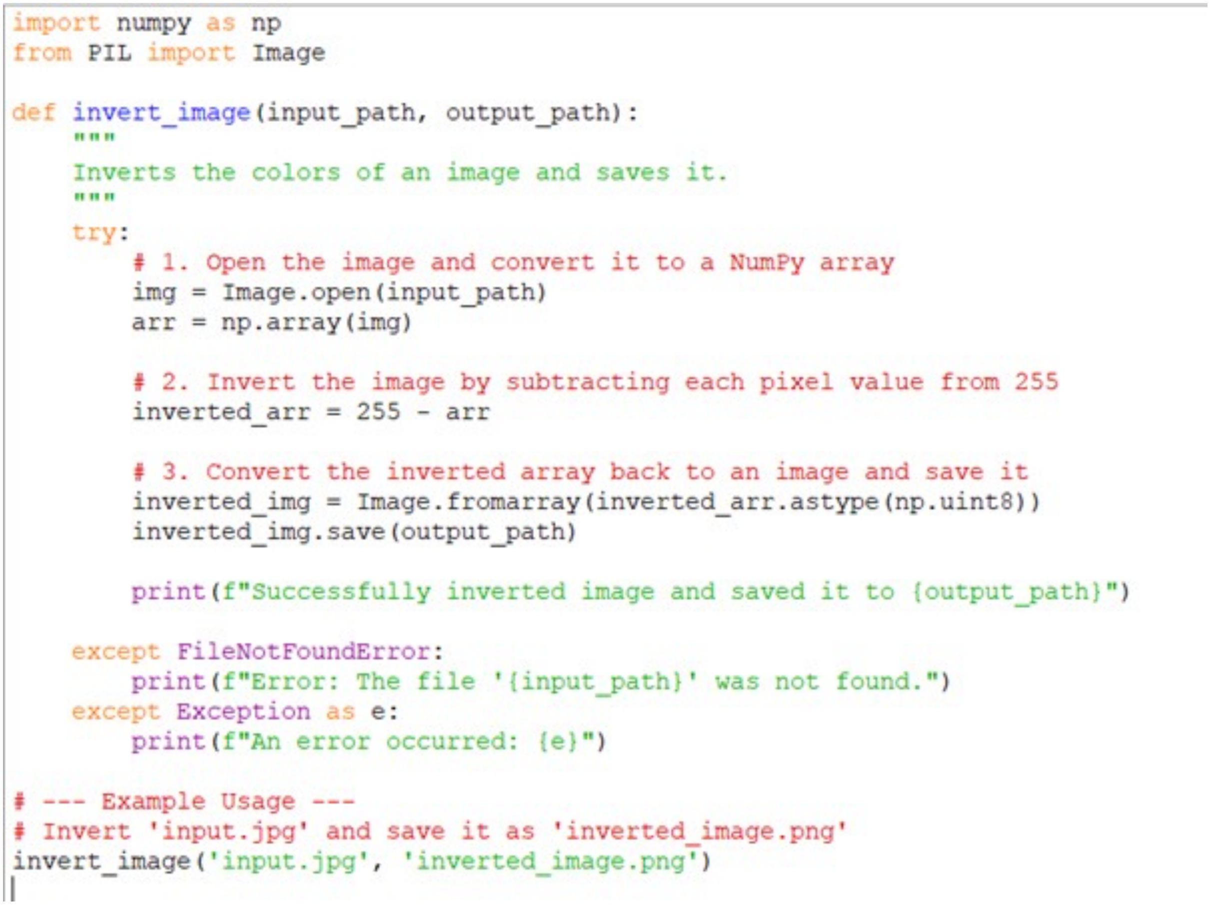
IV. Visualize the clusters in a scatter plot (Age vs Annual Income).

V. Interpret the results (e.g., young-low income, middle-aged-high income, etc.).

```
import pandas as pd

import matplotlib.pyplot as plt

import seaborn as sns

from sklearn.cluster import KMeans



# Load dataset

df = pd.read_csv('customers.csv')
```

```
X = df[['Age', 'AnnualIncome']].values


# Elbow Method

wcss = [KMeans(n_clusters=k, n_init=10,
random_state=42).fit(X).inertia_ for k in range(1, 11)]

plt.plot(range(1, 11), wcss, 'o--')

plt.show()


# K-Means Clustering (assuming optimal clusters = 3)

kmeans = KMeans(n_clusters=3, n_init=10, random_state=42)

df['Cluster'] = kmeans.fit_predict(X)


# Visualize clusters

sns.scatterplot(x='Age', y='AnnualIncome', hue='Cluster', data=df,
s=100)

plt.scatter(kmeans.cluster_centers_[:, 0],
kmeans.cluster_centers_[:, 1], 'rX')  # simplified line

plt.show()
```

29.Write a program for Image Inversion using NumPy



```python
import numpy as np
from PIL import Image

def invert_image(input_path, output_path):
    """
    Inverts the colors of an image and saves it.
    """
    try:
        # 1. Open the image and convert it to a NumPy array
        img = Image.open(input_path)
        arr = np.array(img)

        # 2. Invert the image by subtracting each pixel value from 255
        inverted_arr = 255 - arr

        # 3. Convert the inverted array back to an image and save it
        inverted_img = Image.fromarray(inverted_arr.astype(np.uint8))
        inverted_img.save(output_path)

        print(f"Successfully inverted image and saved it to {output_path}")

    except FileNotFoundError:
        print(f"Error: The file '{input_path}' was not found.")
    except Exception as e:
        print(f"An error occurred: {e}")

# --- Example Usage ---
# Invert 'input.jpg' and save it as 'inverted_image.png'
invert_image('input.jpg', 'inverted_image.png')
```

30. Solve the following system of linear equations, $4x + 3y + 6z = 25$, $x + 5y + 7z = 13$, $2x + 9y + z = 1$.

```python
import numpy as np
A = np.array([[4, 3, 6], [1, 5, 7], [2, 9, 1]])
B = np.array([25, 13, 1])
X = np.linalg.solve(A, B)
print("Solution:", X)
```

31. Load a CSV file containing student data and apply logistic regression.

```python
import pandas as pd

from sklearn.linear_model import LogisticRegression


# Load data

df = pd.read_csv("student.csv")
```

```
# Train model
X = df[["StudyHours","PreviousMarks"]]
y = df["Passed"]
model = LogisticRegression().fit(X, y)

# Predict
print("Prediction:",model.predict([[6,58]]))
```

32. Using Pandas, filter the dataset to show only the sales records where the Region is **"South"** and the Product is **"Laptop"**.

```
import pandas as pd
df = pd.read_csv('sales_data.csv')
filtered_df = df[(df['Region'] == 'South') & (df['Product'] == 'Laptop')]
print("Filtered Records (Region = 'South' AND Product = 'Laptop'):")
print(filtered_df)
```