import numpy as np

import pandas as pd

from sklearn.cluster import KMeans

from sklearn.preprocessing import StandardScaler

import matplotlib.pyplot as plt

import seaborn as sns

# Step 1: Generate Simulated Customer Data

np.random.seed(42)

n\_customers = 1000

age = np.random.randint(18, 70, size=n\_customers) # Age between 18 and 70

annual\_income = np.random.randint(30000, 120000, size=n\_customers) # Income between 30k and 120k

spending\_score = np.random.randint(1, 100, size=n\_customers) # Spending score between 1 and 100

# Create a DataFrame

df = pd.DataFrame({

'Age': age,

'Annual Income (k$)': annual\_income / 1000, # In thousands for simplicity

'Spending Score': spending\_score

})

# Step 2: Scale the data

scaler = StandardScaler()

df\_scaled = scaler.fit\_transform(df[['Age', 'Annual Income (k$)', 'Spending Score']])

# Step 3: Apply K-Means Clustering

kmeans = KMeans(n\_clusters=4, random\_state=42) # Let's assume 4 segments

df['Segment'] = kmeans.fit\_predict(df\_scaled)

# Step 4: Visualize the Segments

plt.figure(figsize=(10, 6))

sns.scatterplot(x='Age', y='Annual Income (k$)', hue='Segment', data=df, palette='Set1', s=100, alpha=0.7, edgecolor='black')

plt.title('Customer Segmentation based on Age and Annual Income')

plt.xlabel('Age')

plt.ylabel('Annual Income (k$)')

plt.legend(title='Segment')

plt.show()

# Step 5: Analyze the Segments

print(df.groupby('Segment').agg({

'Age': ['mean', 'std'],

'Annual Income (k$)': ['mean', 'std'],

'Spending Score': ['mean', 'std']

}))

# Step 6: Personalization Based on Segments

def personalize\_offer(segment):

if segment == 0:

return "Offer: 10% discount on premium products"

elif segment == 1:

return "Offer: 15% discount on basic products"

elif segment == 2:

return "Offer: Free shipping on all orders"

elif segment == 3:

return "Offer: 20% discount on high-end electronics"

else:

return "Offer: Special loyalty points for your next purchase"

# Example: Personalize an offer for a customer from each segment

df['Personalized Offer'] = df['Segment'].apply(personalize\_offer)

# Show the personalized offers for a few customers

print(df[['Age', 'Annual Income (k$)', 'Spending Score', 'Segment', 'Personalized Offer']].head(10))