Clustering and Segmentation

In this assignment we are going to divide the customers into various segments based on their spending habits, tenure with the company etc and then we will be defining a strategy to target them. Two approaches-Heuristic and K-means will be used.

In [93]:
```
#loading the required packages

import pandas as pd
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans
from sklearn.preprocessing import StandardScaler
import numpy as np
from sklearn.impute import SimpleImputer
```

In [76]:
```
# Load the datasets
online_sales = pd.read_csv('C:\\Users\\sujoydutta\\Desktop\\Data analysis\\Projects\\Marketing insights\\Online_
customer_data = pd.read_excel('C:\\Users\\sujoydutta\\Desktop\\Data analysis\\Projects\\Marketing insights\\Cus
discount_coupons = pd.read_csv('C:\\Users\\sujoydutta\\Desktop\\Data analysis\\Projects\\Marketing insights\\Di
marketing_spend= pd.read_csv('C:\\Users\\sujoydutta\\Desktop\\Data analysis\\Projects\\Marketing insights\\Mark
tax_amount = pd.read_excel('C:\\Users\\sujoydutta\\Desktop\\Data analysis\\Projects\\Marketing insights\\Tax_am
```

In [77]:
```
# Merging datasets using 'CustomerID' and 'Product Category as the common key
merged_data = pd.merge(online_sales, customer_data, on='CustomerID', how='left')
merged_data = pd.merge(merged_data, discount_coupons, on='Product_Category', how='left')
merged_data = pd.merge(merged_data, tax_amount, on='Product_Category', how='left')
```

In [78]:
```
# Convert 'Date' column in the marketing_spend DataFrame to datetime data type
marketing_spend['Date'] = pd.to_datetime(marketing_spend['Date'])
merged_data['Transaction_Date'] = pd.to_datetime(merged_data['Transaction_Date'], format='%Y%m%d')

# Merge datasets using 'Transaction_Date' as the common key
merged_data = pd.merge(merged_data, marketing_spend, left_on='Transaction_Date', right_on='Date', how='left')


# Dropping the duplicate 'Date' column if needed
merged_data.drop(columns=['Date'], inplace=True)
```

In [79]:
```
#examining the merged dataset
merged_data.head()
```

Out[79]:

	CustomerID	Transaction_ID	Transaction_Date	Product_SKU	Product_name	Product_Category	Quantity	Avg_Price	Delivery_Charges
0	17850	16679	2019-01-01	GGOENEBJ079499	Nest Learning Thermostat 3rd Gen-USA - Stainle...	Nest-USA	1	153.71	6.5
1	17850	16679	2019-01-01	GGOENEBJ079499	Nest Learning Thermostat 3rd Gen-USA - Stainle...	Nest-USA	1	153.71	6.5
2	17850	16679	2019-01-01	GGOENEBJ079499	Nest Learning Thermostat 3rd Gen-USA - Stainle...	Nest-USA	1	153.71	6.5
3	17850	16679	2019-01-01	GGOENEBJ079499	Nest Learning Thermostat 3rd Gen-USA - Stainle...	Nest-USA	1	153.71	6.5
4	17850	16679	2019-01-01	GGOENEBJ079499	Nest Learning Thermostat 3rd Gen-USA - Stainle...	Nest-USA	1	153.71	6.5

In [80]:
```
# Calculating Invoice Value for each transaction in the merged dataset
merged_data['Invoice_Value'] = (
    (merged_data['Quantity'] * merged_data['Avg_Price']) *
    (1 - merged_data['Discount_pct']) *
    (1 + merged_data['GST']) +
    merged_data['Delivery_Charges']
).abs()

merged_data['Invoice_Value']
```

Out[80]:
```
0          1515.229
1          3206.039
2          4896.849
3          1515.229
4          3206.039
             ...
630683     6711.482
630684    10254.362
630685     3168.602
630686     6711.482
630687    10254.362
Name: Invoice_Value, Length: 630688, dtype: float64
```

In [81]:
```
# correcting 'Transaction_Date' column


merged_data['Transaction_Date'] = merged_data['Transaction_Date'].dt.strftime('%d-%m-%Y')


print(merged_data[['Transaction_Date']].head())
```

```
  Transaction_Date
0       01-01-2019
1       01-01-2019
2       01-01-2019
3       01-01-2019
4       01-01-2019
```

In [82]:
```
#renaming column
merged_data['totalmarketingspend'] =merged_data['Total']
merged_data['totalmarketingspend']
```

Out[82]:
```
0         6924.50
1         6924.50
2         6924.50
3         6924.50
4         6924.50
           ...
630683    6058.75
630684    6058.75
630685    6058.75
630686    6058.75
630687    6058.75
Name: totalmarketingspend, Length: 630688, dtype: float64
```

In [83]:
```
#Dropping redundant columns
merged_data=merged_data.drop(['Offline_Spend','Online_Spend','Total','Month','Discount_pct','GST','Delivery_Cha
merged_data.head()
```

Out[83]:

	CustomerID	Transaction_ID	Transaction_Date	Gender	Location	Tenure_Months	Invoice_Value	totalmarketingspend
0	17850	16679	01-01-2019	M	Chicago	12	1515.229	6924.5
1	17850	16679	01-01-2019	M	Chicago	12	3206.039	6924.5
2	17850	16679	01-01-2019	M	Chicago	12	4896.849	6924.5
3	17850	16679	01-01-2019	M	Chicago	12	1515.229	6924.5
4	17850	16679	01-01-2019	M	Chicago	12	3206.039	6924.5

In [84]:
```
# converting 'Transaction_Date' to datetime
merged_data['Transaction_Date'] = pd.to_datetime(merged_data['Transaction_Date'])
merged_data['Transaction_Date']
```

```
C:\Users\sujoydutta\anaconda3\lib\site-packages\pandas\core\tools\datetimes.py:1047: UserWarning: Parsing '13-01-2019' in DD/MM/YYYY format. Provide format or specify infer_datetime_format=True for consistent parsing.
  cache_array = _maybe_cache(arg, format, cache, convert_listlike)
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  cache_array = _maybe_cache(arg, format, cache, convert_listlike)
C:\Users\sujoydutta\anaconda3\lib\site-packages\pandas\core\tools\datetimes.py:1047: UserWarning: Parsing '22-01-2019' in DD/MM/YYYY format. Provide format or specify infer_datetime_format=True for consistent parsing.
  cache_array = _maybe_cache(arg, format, cache, convert_listlike)
C:\Users\sujoydutta\anaconda3\lib\site-packages\pandas\core\tools\datetimes.py:1047: UserWarning: Parsing '23-01-2019' in DD/MM/YYYY format. Provide format or specify infer_datetime_format=True for consistent parsing.
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C:\Users\sujoydutta\anaconda3\lib\site-packages\pandas\core\tools\datetimes.py:1047: UserWarning: Parsing '25-01-2019' in DD/MM/YYYY format. Provide format or specify infer_datetime_format=True for consistent parsing.
  cache_array = _maybe_cache(arg, format, cache, convert_listlike)
C:\Users\sujoydutta\anaconda3\lib\site-packages\pandas\core\tools\datetimes.py:1047: UserWarning: Parsing '26-01-2019' in DD/MM/YYYY format. Provide format or specify infer_datetime_format=True for consistent parsing.
  cache_array = _maybe_cache(arg, format, cache, convert_listlike)
C:\Users\sujoydutta\anaconda3\lib\site-packages\pandas\core\tools\datetimes.py:1047: UserWarning: Parsing '27-01-2019' in DD/MM/YYYY format. Provide format or specify infer_datetime_format=True for consistent parsing.
  cache_array = _maybe_cache(arg, format, cache, convert_listlike)
C:\Users\sujoydutta\anaconda3\lib\site-packages\pandas\core\tools\datetimes.py:1047: UserWarning: Parsing '28-01-2019' in DD/MM/YYYY format. Provide format or specify infer_datetime_format=True for consistent parsing.
  cache_array = _maybe_cache(arg, format, cache, convert_listlike)
C:\Users\sujoydutta\anaconda3\lib\site-packages\pandas\core\tools\datetimes.py:1047: UserWarning: Parsing '29-01-2019' in DD/MM/YYYY format. Provide format or specify infer_datetime_format=True for consistent parsing.
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C:\Users\sujoydutta\anaconda3\lib\site-packages\pandas\core\tools\datetimes.py:1047: UserWarning: Parsing '30-01-2019' in DD/MM/YYYY format. Provide format or specify infer_datetime_format=True for consistent parsing.
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C:\Users\sujoydutta\anaconda3\lib\site-packages\pandas\core\tools\datetimes.py:1047: UserWarning: Parsing '13-02-2019' in DD/MM/YYYY format. Provide format or specify infer_datetime_format=True for consistent parsing.
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  cache_array = _maybe_cache(arg, format, cache, convert_listlike)
```

Out[84]:
```
0        2019-01-01
1        2019-01-01
2        2019-01-01
3        2019-01-01
4        2019-01-01
            ...
630683   2019-12-31
630684   2019-12-31
630685   2019-12-31
630686   2019-12-31
630687   2019-12-31
Name: Transaction_Date, Length: 630688, dtype: datetime64[ns]
```

Part 1: Heuristic(Value-Based) Segmentation

This is the first type of segmentation we are going to apply to categorize customers into 4 categories:Standard,Silver,Gold and Platinum based on RFM(Recency, Frequency, Monetary) criterion.

In [27]:
```
# Calculating today's date
today_date = merged_data['Transaction_Date'].max()

# Calculating Recency, Frequency, and Monetary metrics
rfm_data = merged_data.groupby('CustomerID').agg({
    'Transaction_Date': lambda x: (today_date - x.max()).days,  # Recency
    'Transaction_ID': 'nunique',  # Frequency
    'Invoice_Value': 'sum'  # Sum of Invoice_Value
}).reset_index()
```

In [29]:
```
# Renaming the columns for clarity
rfm_data.rename(columns={
    'Transaction_Date': 'Recency',
    'Transaction_ID': 'Frequency',
    'Invoice_Value': 'Monetary'
}, inplace=True)
rfm_data.round()
```

Out[29]:

	CustomerID	Recency	Frequency	Monetary
0	12346	107	1	6337.0
1	12347	282	31	3612323.0
2	12348	73	8	372859.0
3	12350	17	11	342366.0
4	12356	107	13	355835.0
...	...	...	...	...
1463	18259	241	3	127793.0
1464	18260	53	19	582011.0
1465	18269	194	2	26648.0
1466	18277	69	1	74666.0
1467	18283	82	53	1571264.0

1468 rows × 4 columns

In [30]:
```
# Calculating RFM scores by ranking customers
rfm_data['R_Score'] = pd.qcut(rfm_data['Recency'], q=4, labels=False)
rfm_data['F_Score'] = pd.qcut(rfm_data['Frequency'], q=4, labels=False)
rfm_data['M_Score'] = pd.qcut(rfm_data['Monetary'], q=4, labels=False)
```

In [31]:
```
# Calculating the overall RFM score
rfm_data['RFM_Score'] = rfm_data['R_Score'] + rfm_data['F_Score'] + rfm_data['M_Score']
```

In [32]:
```
# Defining segmentation criteria based on RFM scores
segmentation_criteria = {
    'Premium': (3, 3, 3),  # High R, High F, High M
    'Gold': (3, 2, 2),     # High R, Mid F, Mid M
    'Silver': (2, 2, 2),   # Mid R, Mid F, Mid M
    'Standard': (0, 0, 0)  # Low R, Low F, Low M
}
```

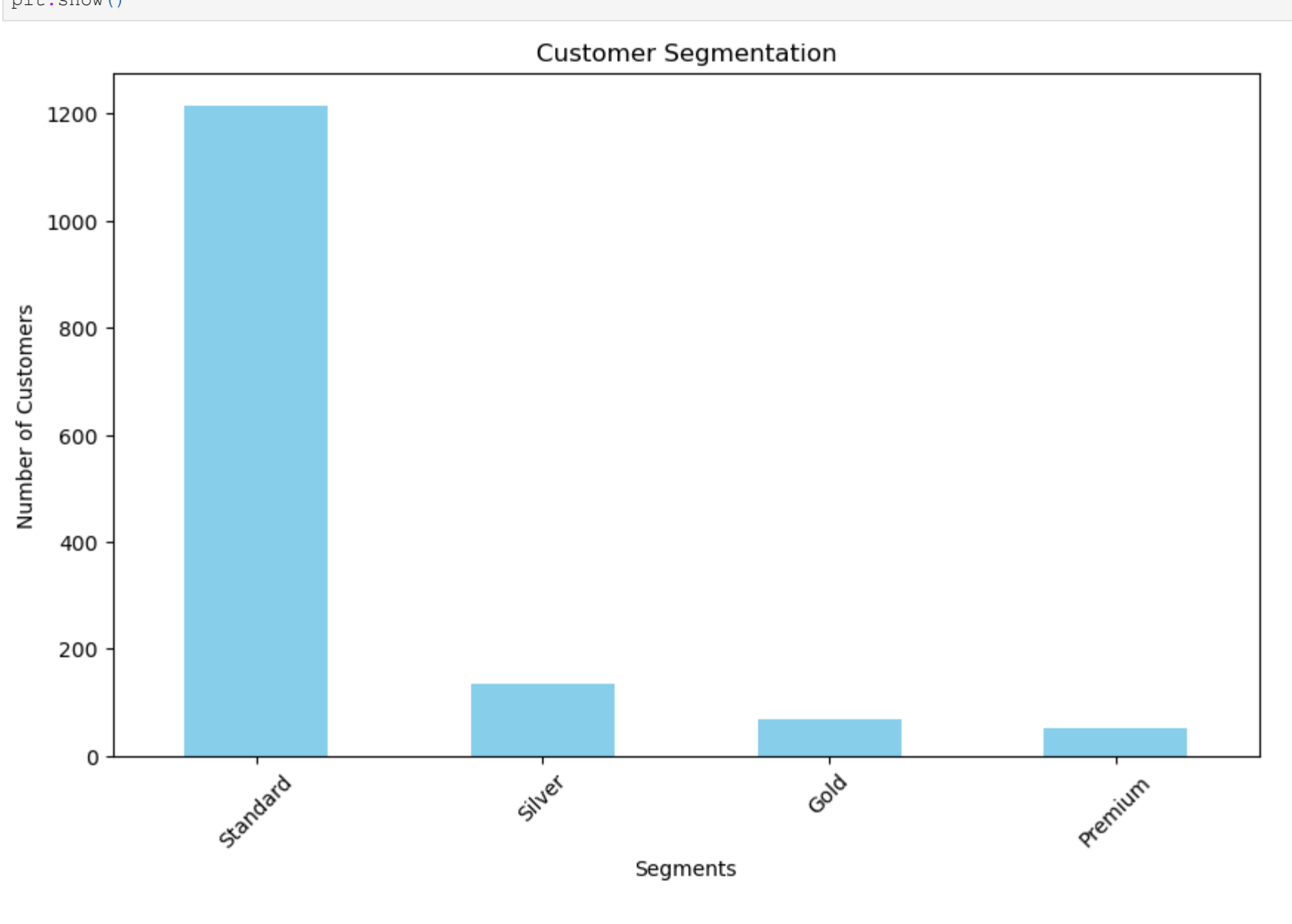
In [33]:
```
# Creating a function to assign segments based on criteria
def assign_segment(row):
    for segment, criteria in segmentation_criteria.items():
        if all(row[['R_Score', 'F_Score', 'M_Score']] >= criteria):
            return segment
    return 'Other'
```

In [34]:
```
# Applying the segmentation function to each customer
rfm_data['Segment'] = rfm_data.apply(assign_segment, axis=1)
```

In [35]:
```
# Counting the number of customers in each segment
segment_counts = rfm_data['Segment'].value_counts()
segment_counts
```

Out[35]:
```
Standard    1215
Silver       134
Gold          68
Premium       51
Name: Segment, dtype: int64
```

In [36]:
```
# Creating a bar plot to visualize the distribution of segments
plt.figure(figsize=(10, 6))
segment_counts.plot(kind='bar', color='skyblue')
plt.title('Customer Segmentation')
plt.xlabel('Segments')
plt.ylabel('Number of Customers')
plt.xticks(rotation=45)
plt.show()
```



Strategy for each segment

'Premium': We must focus on retaining these high-value customers with personalized offers and excellent service. Encourage them to refer friends and family and give them discounts in return.

'Gold': TWe must come out with incentives for increased spending and engagement. It is a must to offer them loyalty rewards to maintain their loyalty.

'Silver': we must keep these customers engaged by sending them regular promotions and updates. We must encourage them to upgrade to higher segments.

'Standard': Target these customers with promotions to increase their spending and engagement. Focus on converting them into higher segments.

Part 2: K-means(Scientific) Segmentation

This is the second type of segmentation we are going to apply to categorize customers into optimal number of clusters.The numeric variables will be scaled and compressed to Principal components and then clusters would be made on the basis of euclidean distance between points.

In [85]:
```
# Calculating days since last transaction
max_date = merged_data['Transaction_Date'].max()
merged_data['Recency'] = (max_date - merged_data['Transaction_Date']).dt.days
merged_data['Recency']
```

Out[85]:
```
0         364
1         364
2         364
3         364
4         364
         ...
630683      0
630684      0
630685      0
630686      0
630687      0
Name: Recency, Length: 630688, dtype: int64
```

In [86]:
```
# Dropping the unnecesary columns
merged_data=merged_data.drop(['Transaction_Date','CustomerID','Transaction_ID'], axis=1)

merged_data
```

Out[86]:

	Gender	Location	Tenure_Months	Invoice_Value	totalmarketingspend	Recency
0	M	Chicago	12	1515.229	6924.50	364
1	M	Chicago	12	3206.039	6924.50	364
2	M	Chicago	12	4896.849	6924.50	364
3	M	Chicago	12	1515.229	6924.50	364
4	M	Chicago	12	3206.039	6924.50	364
...	...	...	...	...	...	...
630683	F	California	7	6711.482	6058.75	0
630684	F	California	7	10254.362	6058.75	0
630685	F	California	7	3168.602	6058.75	0
630686	F	California	7	6711.482	6058.75	0
630687	F	California	7	10254.362	6058.75	0

630688 rows × 6 columns

In [88]:
```
# Perform one-hot encoding
merged_data = pd.get_dummies(merged_data, columns=['Gender', 'Location'])
merged_data
```

Out[88]:

	Tenure_Months	Invoice_Value	totalmarketingspend	Recency	Gender_F	Gender_M	Location_California	Location_Chicago	Location_New Jerse
0	12	1515.229	6924.50	364	0	1	0	1	
1	12	3206.039	6924.50	364	0	1	0	1	
2	12	4896.849	6924.50	364	0	1	0	1	
3	12	1515.229	6924.50	364	0	1	0	1	
4	12	3206.039	6924.50	364	0	1	0	1	
...	...	...	...	...	...	...	...	...	
630683	7	6711.482	6058.75	0	1	0	1	0	
630684	7	10254.362	6058.75	0	1	0	1	0	
630685	7	3168.602	6058.75	0	1	0	1	0	
630686	7	6711.482	6058.75	0	1	0	1	0	
630687	7	10254.362	6058.75	0	1	0	1	0	

630688 rows × 11 columns

In [145…
```
# Standardizing the data
scaler = StandardScaler()
merged_data_scaled = scaler.fit_transform(merged_data)
merged_data_scaled
```

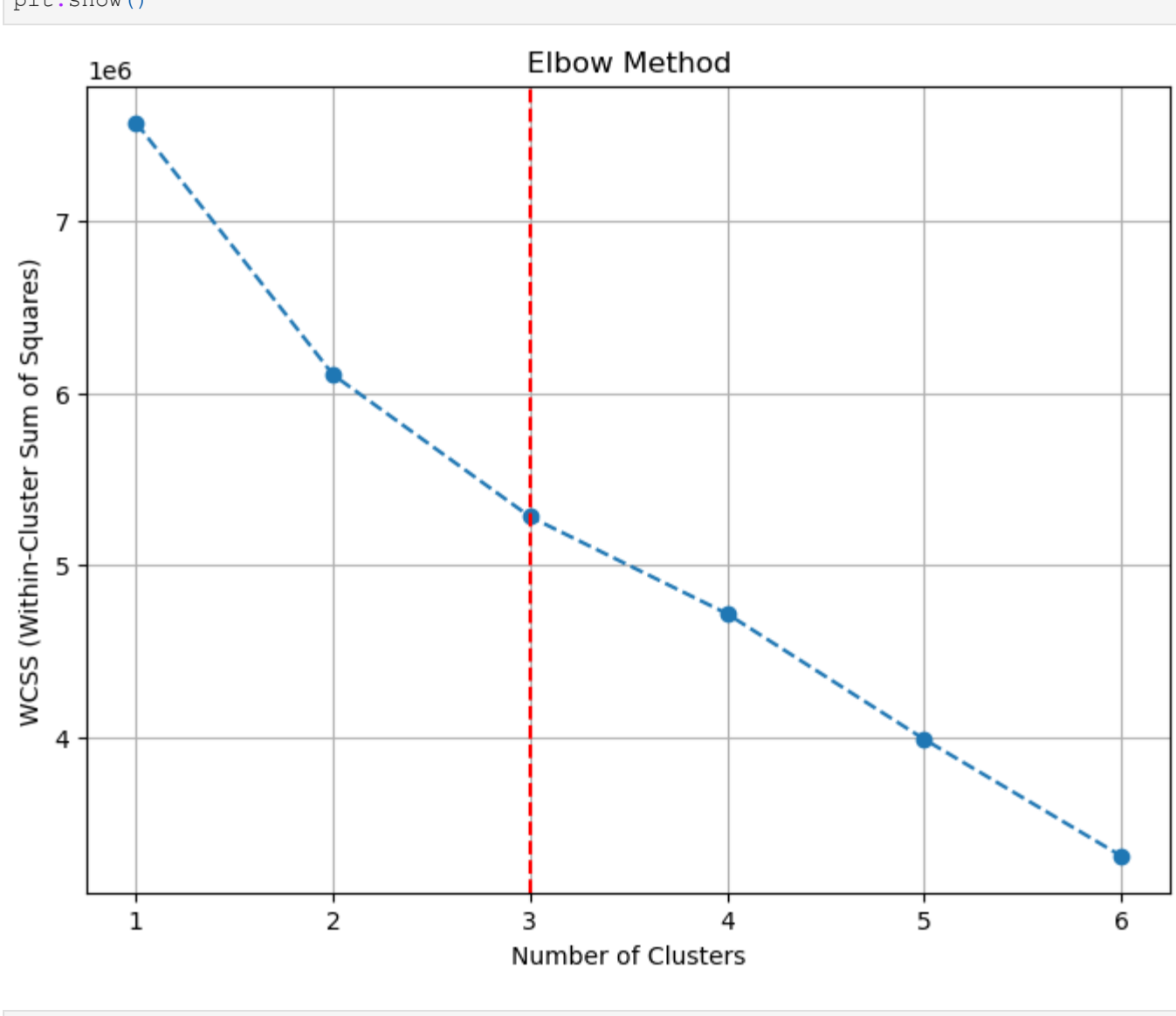
Out[145]:
```
array([[-1.04939813, -0.08891677,  1.54086686, ..., -0.51753946,
        -0.23320675, -0.77371162],
       [-1.04939813,  0.35434271,  1.54086686, ..., -0.51753946,
        -0.23320675, -0.77371162],
       [-1.04939813,  0.79760219,  1.54086686, ..., -0.51753946,
        -0.23320675, -0.77371162],
       ...,
       [-1.42048942,  0.3445283 ,  0.93396959, ..., -0.51753946,
        -0.23320675,  1.7131431 ],
       [-1.42048942,  1.27332287,  0.93396959, ..., -0.51753946,
        -0.23320675,  1.7131431 ],
       [-1.42048942,  2.20211744,  0.93396959, ..., -0.51753946,
        -0.23320675,  1.7131431 ]])
```

In [146…
```
# Create an imputer object
imputer = SimpleImputer(strategy='mean')

# Fit and transform the imputer on your data
merged_data_scaled = imputer.fit_transform(merged_data_scaled)
merged_data_scaled
```

Out[146]:
```
array([[-1.04939813, -0.08891677,  1.54086686, ..., -0.51753946,
        -0.23320675, -0.77371162],
       [-1.04939813,  0.35434271,  1.54086686, ..., -0.51753946,
        -0.23320675, -0.77371162],
       [-1.04939813,  0.79760219,  1.54086686, ..., -0.51753946,
        -0.23320675, -0.77371162],
       ...,
       [-1.42048942,  0.3445283 ,  0.93396959, ..., -0.51753946,
        -0.23320675,  1.7131431 ],
       [-1.42048942,  1.27332287,  0.93396959, ..., -0.51753946,
        -0.23320675,  1.7131431 ],
       [-1.42048942,  2.20211744,  0.93396959, ..., -0.51753946,
        -0.23320675,  1.7131431 ]])
```

In [149…
```
# Determining the optimal number of clusters using the Elbow method
wcss = []
for i in range(1, 7):
    kmeans = KMeans(n_clusters=i, init='k-means++', random_state=42)
    kmeans.fit(merged_data_scaled)
    wcss.append(kmeans.inertia_)
```

In [150…
```
# Plotting the optimal clusters graph


plt.figure(figsize=(8, 6))
plt.plot(range(1, 7), wcss, marker='o', linestyle='--')
plt.title('Elbow Method')
plt.xlabel('Number of Clusters')
plt.ylabel('WCSS (Within-Cluster Sum of Squares)')

diff = [wcss[i] - wcss[i - 1] for i in range(1, len(wcss))]
optimal_num_clusters = diff.index(max(diff)) + 1


plt.axvline(x=optimal_num_clusters, color='red', linestyle='--')

plt.grid()
plt.show()
```



In [151…
```
# Finding the "elbow" point by looking for the steepest slope
diff = [wcss[i] - wcss[i - 1] for i in range(1, len(wcss))]
optimal_num_clusters = diff.index(max(diff)) + 1
optimal_num_clusters
```

Out[151]:
```
3
```

In [152…
```
# Plotting the K-Means clustering results with the optimal number of clusters
kmeans_optimal = KMeans(n_clusters=optimal_num_clusters, init='k-means++', random_state=42)
kmeans_optimal.fit(merged_data_scaled)
labels = kmeans_optimal.labels_
```

In [153…
```
# Based on the Elbow method the optimal number has been set
optimal_clusters = 3

# Performing K-Means clustering with the optimal number of clusters
kmeans = KMeans(n_clusters=optimal_clusters, init='k-means++', random_state=42)
merged_data['Cluster'] = kmeans.fit_predict(merged_data_scaled)
```

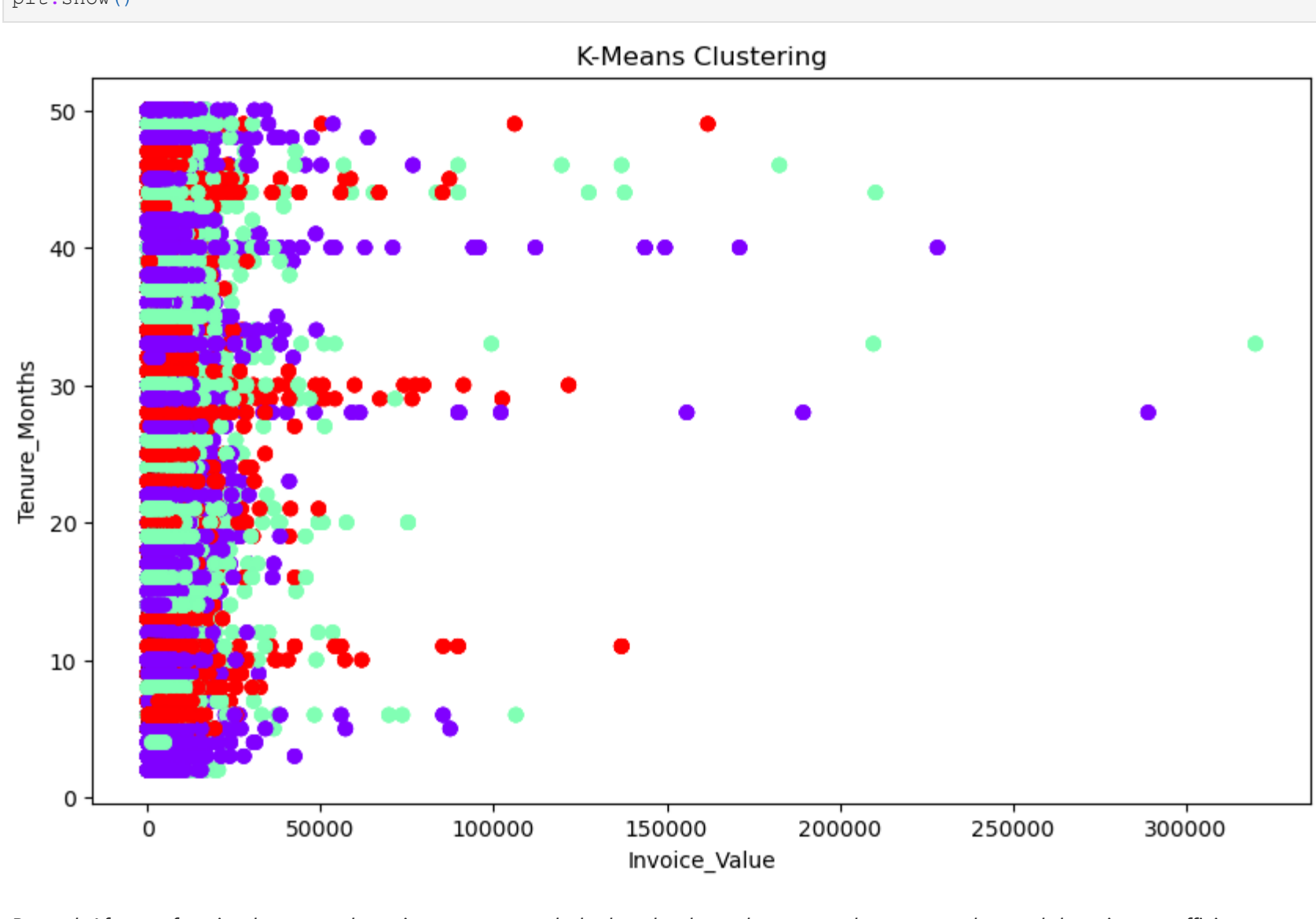
In [157…
```
# Viewing the cluster centers
cluster_centers = pd.DataFrame(
    scaler.inverse_transform(kmeans.cluster_centers_),
    columns=merged_data.columns
)
print(cluster_centers)
```

```
   Tenure_Months  Invoice_Value  totalmarketingspend     Recency  \
0      25.949355    1794.781643          4703.756100  175.987027
1      26.878421    1863.326859          4663.678146  184.980189
2      25.191622    1955.536061          4883.087213  179.271255

       Gender_F      Gender_M  Location_California  Location_Chicago  \
0  1.000000e+00  4.040657e-13        -7.494005e-14      5.250251e-01
1 -6.936673e-13  1.000000e+00         3.141365e-01      3.462553e-01
2  1.000000e+00  1.809664e-13         8.866331e-01      1.394440e-13

   Location_New Jersey  Location_New York  Location_Washington DC   Cluster
0         1.400778e-01       3.348971e-01           -3.868433e-14  1.719844
1         7.230952e-02       1.936108e-01            7.368785e-02  1.075066
2        -4.850287e-14       1.239009e-13            1.133669e-01  3.886633
```

In [158…
```
# Analyzing the results
cluster_counts = merged_data['Cluster'].value_counts().sort_index()
print(cluster_counts)
```

```
0    260698
1    237244
2    132746
Name: Cluster, dtype: int64
```

In [159…
```
# Visualizing the clusters
plt.figure(figsize=(10, 6))
plt.scatter(merged_data['Invoice_Value'], merged_data['Tenure_Months'], c=merged_data['Cluster'], cmap='rainbow
plt.title('K-Means Clustering')
plt.xlabel('Invoice_Value')
plt.ylabel('Tenure_Months')
plt.show()
```



Remark:After performing k-means clustering we can conclude that the three clusters overlap one another and there is not sufficient difference between the three groups and hence heuristic clustering worked better in this case.