Customer Segmentation using K-Means Clustering

> Indented block

In [3]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import datetime as dt
from sklearn.preprocessing import MinMaxScaler
from sklearn.cluster import KMeans
from sklearn.metrics import silhouette_score,calinski_harabasz_score
```

In [30]:

```
from google.colab import drive
drive.mount("/content/gdrive")
```

```
Drive already mounted at /content/gdrive; to attempt to forcibly remount, call driv
e.mount("/content/gdrive", force_remount=True).
```

In [31]:

```
import pandas as pd
dataset = pd.read_excel('/content/gdrive/MyDrive/online_retail.xlsx')
```

Data Set Information:

This Online Retail II data set contains all the transactions occurring for a UK-based and registered, non-store online retail between 01/12/2009 and 09/12/2011.The company mainly sells unique all-occasion gift-ware. Many customers of the company are wholesalers.

Attribute Information:

InvoiceNo: Invoice number. Nominal. A 6-digit integral number uniquely assigned to each transaction. If this code starts with the letter 'c', it indicates a cancellation.
StockCode: Product (item) code. Nominal. A 5-digit integral number uniquely assigned to each distinct product.
Description: Product (item) name. Nominal.
Quantity: The quantities of each product (item) per transaction. Numeric.
InvoiceDate: Invice date and time. Numeric. The day and time when a transaction was generated.
UnitPrice: Unit price. Numeric. Product price per unit in sterling (Â£).(1 Pound sterling equals 96.22 Indian Rupee)
CustomerID: Customer number. Nominal. A 5-digit integral number uniquely assigned to each customer.
Country: Country name. Nominal. The name of the country where a customer resides.

In [ ]:

```
dataset.columns
```

Out[ ]:

```
Index(['Invoice', 'StockCode', 'Description', 'Quantity', 'InvoiceDate',
       'Price', 'Customer ID', 'Country', 'month_year'],
      dtype='object')
```

In [ ]:

```
dataset.shape
```

Out[ ]:

```
(525461, 8)
```

In [ ]:

```
dataset.head(10)
```

Out[ ]:

	Invoice	StockCode	Description	Quantity	InvoiceDate	Price	Customer ID	Country
0	489434	85048	15CM CHRISTMAS GLASS BALL 20 LIGHTS	12	2009-12-01 07:45:00	6.95	13085.0	United Kingdom
1	489434	79323P	PINK CHERRY LIGHTS	12	2009-12-01 07:45:00	6.75	13085.0	United Kingdom
2	489434	79323W	WHITE CHERRY LIGHTS	12	2009-12-01 07:45:00	6.75	13085.0	United Kingdom
3	489434	22041	RECORD FRAME 7" SINGLE SIZE	48	2009-12-01 07:45:00	2.10	13085.0	United Kingdom
4	489434	21232	STRAWBERRY CERAMIC TRINKET BOX	24	2009-12-01 07:45:00	1.25	13085.0	United Kingdom
5	489434	22064	PINK DOUGHNUT TRINKET POT	24	2009-12-01 07:45:00	1.65	13085.0	United Kingdom
6	489434	21871	SAVE THE PLANET MUG	24	2009-12-01 07:45:00	1.25	13085.0	United Kingdom
7	489434	21523	FANCY FONT HOME SWEET HOME DOORMAT	10	2009-12-01 07:45:00	5.95	13085.0	United Kingdom
8	489435	22350	CAT BOWL	12	2009-12-01 07:46:00	2.55	13085.0	United Kingdom
9	489435	22349	DOG BOWL , CHASING BALL DESIGN	12	2009-12-01 07:46:00	3.75	13085.0	United Kingdom

In [10]:

```
print("Number of customers are ",len(dataset["Customer ID"].value_counts()))
```

```
Number of customers are  4314
```

In [32]:

```
print(dataset.isnull().sum())
dataset = dataset.dropna()
print(dataset.isnull().sum())
print(dataset.shape)
```

```
Invoice             0
StockCode           0
Description      2928
Quantity            0
InvoiceDate         0
Price               0
Customer ID    107927
Country             0
dtype: int64
Invoice        0
StockCode      0
```

```
Description    0
Quantity       0
InvoiceDate    0
Price          0
Customer ID    0
Country        0
dtype: int64
(417534, 8)
```

In [33]:

```
dataset = dataset[(dataset['Quantity']>0)]
```

In [34]:

```
dataset.describe()
```

Out[34]:

	Quantity	Price	Customer ID
count	407695.000000	407695.000000	407695.000000
mean	13.586686	3.294188	15368.504107
std	96.842229	34.756655	1679.795700
min	1.000000	0.000000	12346.000000
25%	2.000000	1.250000	13997.000000
50%	5.000000	1.950000	15321.000000
75%	12.000000	3.750000	16812.000000
max	19152.000000	10953.500000	18287.000000

In [35]:

```
Country_quantity = dataset["Country"].value_counts()
Country_quantity
```

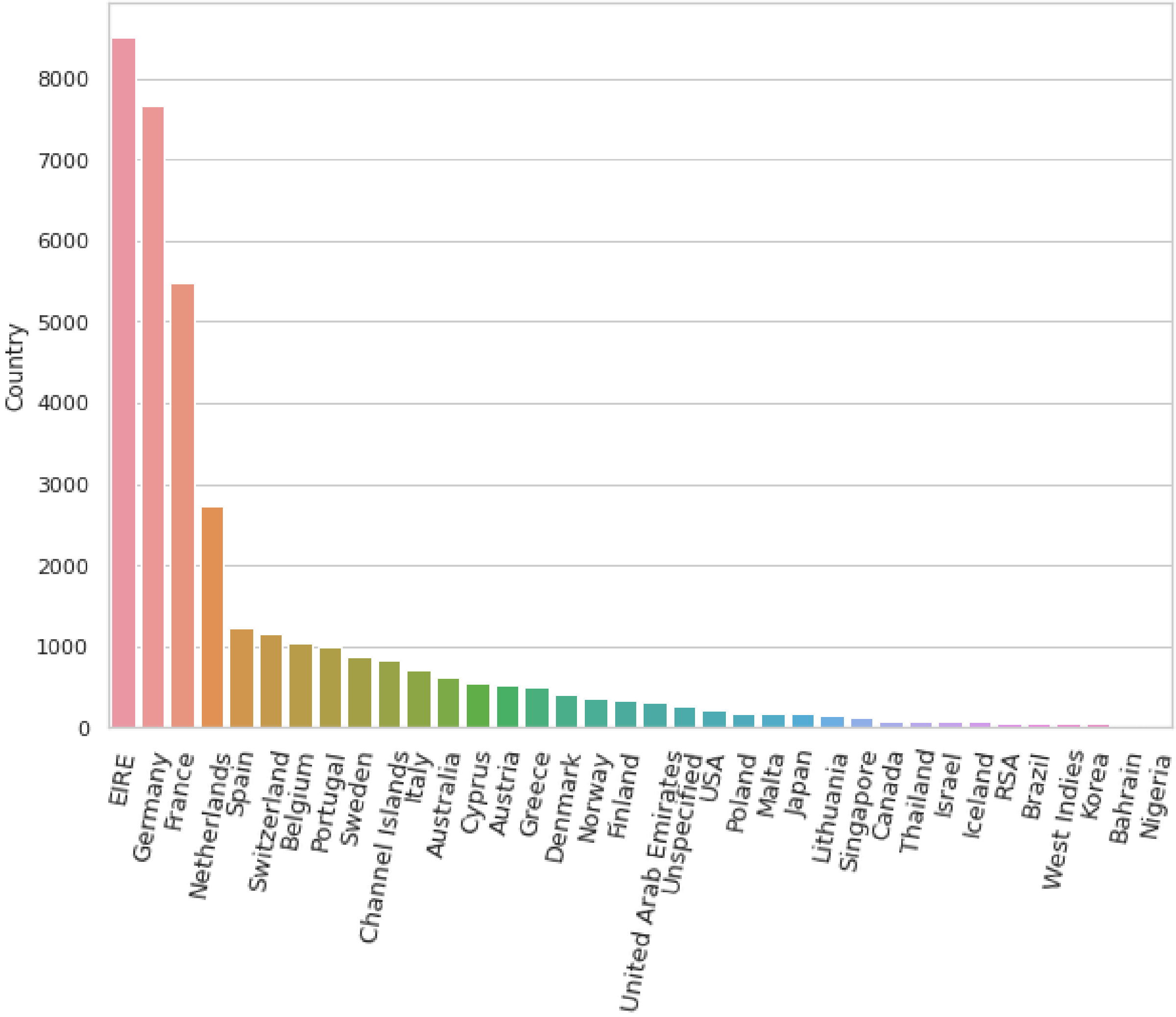
Out[35]:

```
United Kingdom          370951
EIRE                      8507
Germany                   7661
France                    5470
Netherlands               2730
Spain                     1235
Switzerland               1170
Belgium                   1038
Portugal                   984
Sweden                     868
Channel Islands            821
Italy                      710
Australia                  630
Cyprus                     541
Austria                    524
Greece                     512
Denmark                    418
Norway                     365
Finland                    347
United Arab Emirates       315
Unspecified                277
USA                        230
Poland                     182
Malta                      170
Japan                      164
Lithuania                  154
Singapore                  117
Canada                      77
```

```
Thailand                    76
Israel                      74
Iceland                     71
RSA                         65
Brazil                      62
West Indies                 54
Korea                       53
Bahrain                     42
Nigeria                     30
Name: Country, dtype: int64
```

In [36]:

```
import seaborn as sns
import matplotlib.pyplot as plt
plt.figure(figsize = (10,7))
sns.set_theme(style="whitegrid")
plt.xticks(rotation=80,size=13)
sns.barplot(x=Country_quantity.index[1:], y=Country_quantity[1:])
plt.show()
```

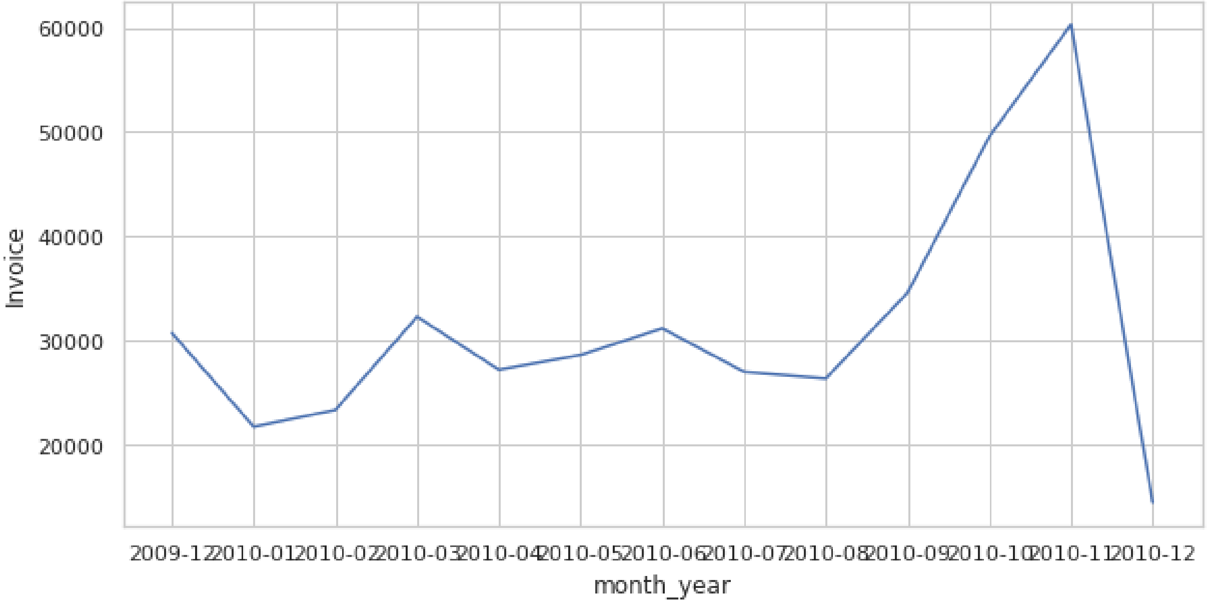


In [37]:

```
import datetime as dt
# month_info = pd.DataFrame(dataset['InvoiceDate'].dt.month)
# year_info = pd.DataFrame(dataset['InvoiceDate'].dt.year)
# new = pd.concat([month_info,year_info],axis=1)
#temp = pd.to_datetime(month_info,year_info.assign(Day=1))
#temp= pd.to_datetime(dataset[['year', 'month']].assign(Day=1))
# dataset['revenue'] = dataset['Price'] * dataset['Quantity']
temp = list(map(lambda x: x.strftime("%Y-%m"),dataset["InvoiceDate"].copy()))
#temp = pd.to_datetime(dataset["InvoiceDate"].copy(),format="%Y-%m-%d")
dataset["month_year"] = temp
```

In [ ]:

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

plot = pd.DataFrame(dataset.groupby(['month_year'])['Invoice'].count()).reset_index(
plt.figure(figsize=(10,5))
ax = sns.lineplot(x="month_year", y="Invoice", data = plot)
plt.show()
```



In [23]:

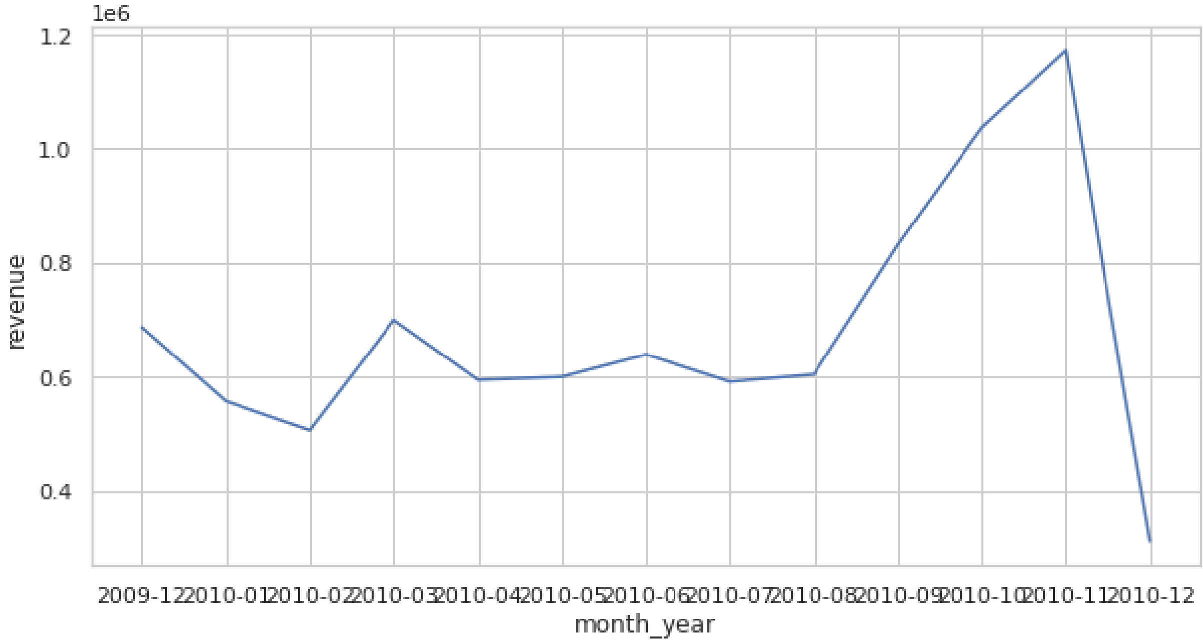
```
dataset["revenue"] = dataset["Price"]*dataset["Quantity"]
dataset["revenue"]
```

Out[23]:

```
0          83.40
1          81.00
2          81.00
3         100.80
4          30.00
           ...  
525456      5.90
525457      3.75
525458      3.75
525459      7.50
525460      3.90
Name: revenue, Length: 407695, dtype: float64
```

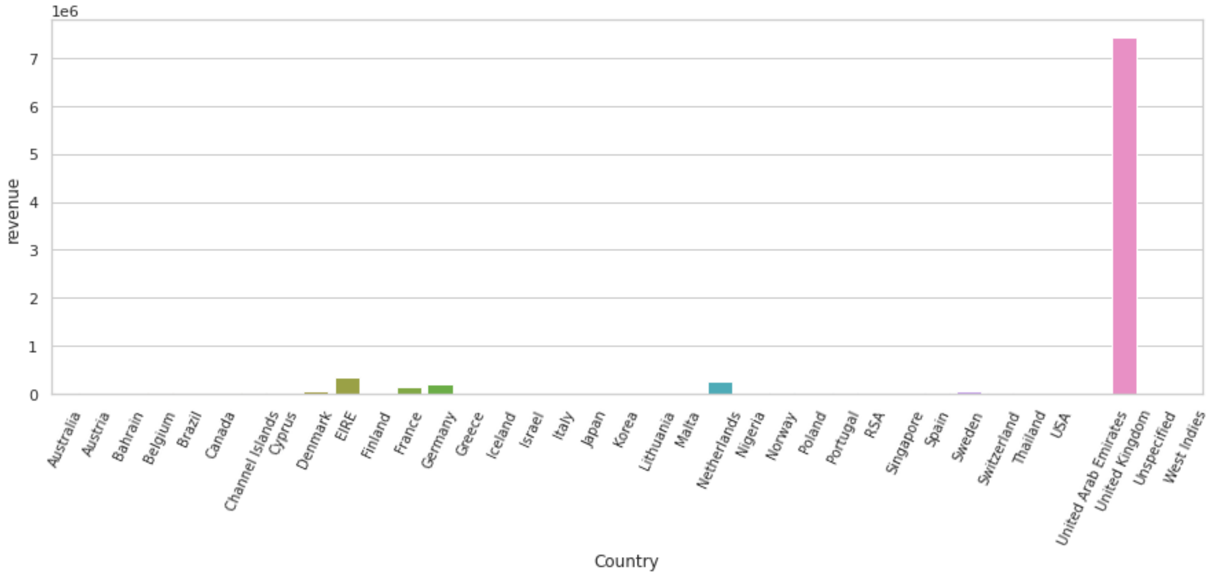
In [ ]:

```
data_temp = pd.DataFrame(dataset.groupby(['month_year'])['revenue'].sum()).reset_ind
plt.figure(figsize=(10,5))
ax = sns.lineplot(x = 'month_year', y='revenue', data = data_temp)
```



In [ ]:

```
data_temp2 = pd.DataFrame(dataset.groupby(['Country'])['revenue'].sum()).reset_index
plt.figure(figsize=(15,5))
ax=sns.barplot(x='Country', y='revenue',data=data_temp2)
plt.xticks(rotation=65,size=10)
plt.show()
```



In [ ]:

```
dataset.columns
```

Out[ ]:

```
Index(['Invoice', 'StockCode', 'Description', 'Quantity', 'InvoiceDate',
       'Price', 'Customer ID', 'Country', 'month', 'year', 'month_year',
       'revenue'],
      dtype='object')
```

RFM Analysis:

- R (Recency) - most recent purchase
- F (Frequency) - how frequent is the purchase
- M (Monetary) - amount spent in each purchase

In [26]:

```
dataset['Customer ID'] = dataset['Customer ID'].astype(str)
dataset['Amount'] = dataset['Quantity']*dataset['Price']
rfm_dataset_monetary = dataset.groupby('Customer ID')['Amount'].sum()
rfm_dataset_monetary.reset_index()
rfm_dataset_monetary.columns = ['Customer ID', 'Amount']
print(rfm_dataset_monetary)
```

```
Customer ID
12346.0     372.86
12347.0    1323.32
12348.0     222.16
12349.0    2671.14
12351.0     300.93
             ...
18283.0     641.77
18284.0     461.68
18285.0     427.00
18286.0    1296.43
18287.0    2345.71
Name: Amount, Length: 4314, dtype: float64
```

In [ ]:

```
rfm_dataset_frequency =  dataset[['Customer ID','Invoice']].groupby(['Customer ID','
rfm_dataset_frequency = rfm_dataset_frequency.reset_index().groupby(["Customer ID"])
rfm_dataset_frequency.columns = ['Customer ID', 'Frequency']
print(rfm_dataset_frequency)
```

```
     Customer ID  Frequency
0        12346.0         11
1        12347.0          2
2        12348.0          1
3        12349.0          3
4        12351.0          1
...          ...        ...
4309     18283.0          6
4310     18284.0          1
4311     18285.0          1
4312     18286.0          2
4313     18287.0          4

[4314 rows x 2 columns]
```

In [38]:

```
dataset['InvoiceDate'] = pd.to_datetime(dataset['InvoiceDate'],format='%d-%m-%Y %H:%
max_date = max(dataset['InvoiceDate'])
dataset['Diff'] = max_date - dataset['InvoiceDate']
rfm_dataset_recency = dataset.groupby('Customer ID')['Diff'].min()
rfm_dataset_recency = rfm_dataset_recency.reset_index()
rfm_dataset_recency.columns = ['Customer ID','Diff']
rfm_dataset_recency['Diff'] = rfm_dataset_recency['Diff'].dt.days
print(rfm_dataset_recency)
```

```
      Customer ID  Diff
0         12346.0   164
1         12347.0     2
2         12348.0    73
3         12349.0    42
4         12351.0    10
...           ...   ...
4309      18283.0    17
4310      18284.0    66
4311      18285.0   295
4312      18286.0   111
4313      18287.0    17
```

```
[4314 rows x 2 columns]
```

In [ ]:

```
rfm_dataset_final = pd.merge(rfm_dataset_monetary,rfm_dataset_frequency,on='Customer
rfm_dataset_final = pd.merge(rfm_dataset_final,rfm_dataset_recency,on='Customer ID',
rfm_dataset_final.columns = ['Customer ID', 'Amount', 'Frequency', 'Recency']
print(rfm_dataset_final)
```

```
      Customer ID   Amount  Frequency  Recency
0         12346.0   372.86         11      164
1         12347.0  1323.32          2        2
2         12348.0   222.16          1       73
3         12349.0  2671.14          3       42
4         12351.0   300.93          1       10
...           ...      ...        ...      ...
4309      18283.0   641.77          6       17
4310      18284.0   461.68          1       66
4311      18285.0   427.00          1      295
4312      18286.0  1296.43          2      111
4313      18287.0  2345.71          4       17

[4314 rows x 4 columns]
```

In [ ]:

```
rfm_dataset_final.shape
```

Out[ ]:

```
(4314, 4)
```

In [ ]:

```
Q1 = rfm_dataset_final.Amount.quantile(0.05)
Q3 = rfm_dataset_final.Amount.quantile(0.95)
IQR = Q3 - Q1
rfm_dataset_final = rfm_dataset_final[(rfm_dataset_final.Amount >= Q1 - 1.5*IQR) & (

Q1 = rfm_dataset_final.Recency.quantile(0.05)
Q3 = rfm_dataset_final.Recency.quantile(0.95)
IQR = Q3 - Q1
rfm_dataset_final = rfm_dataset_final[(rfm_dataset_final.Recency >= Q1 - 1.5*IQR) &

Q1 = rfm_dataset_final.Frequency.quantile(0.05)
Q3 = rfm_dataset_final.Frequency.quantile(0.95)
IQR = Q3 - Q1
rfm_dataset_final = rfm_dataset_final[(rfm_dataset_final.Frequency >= Q1 - 1.5*IQR)
```

In [ ]:

```
X = rfm_dataset_final[['Amount', 'Frequency', 'Recency']]
scaler = MinMaxScaler()
rfm_dataset_scaled = scaler.fit_transform(X)
```

In [ ]:

```
rfm_dataset_scaled = pd.DataFrame(rfm_dataset_scaled)
rfm_dataset_scaled.columns = ['Amount', 'Frequency', 'Recency']
rfm_dataset_scaled.head()
```

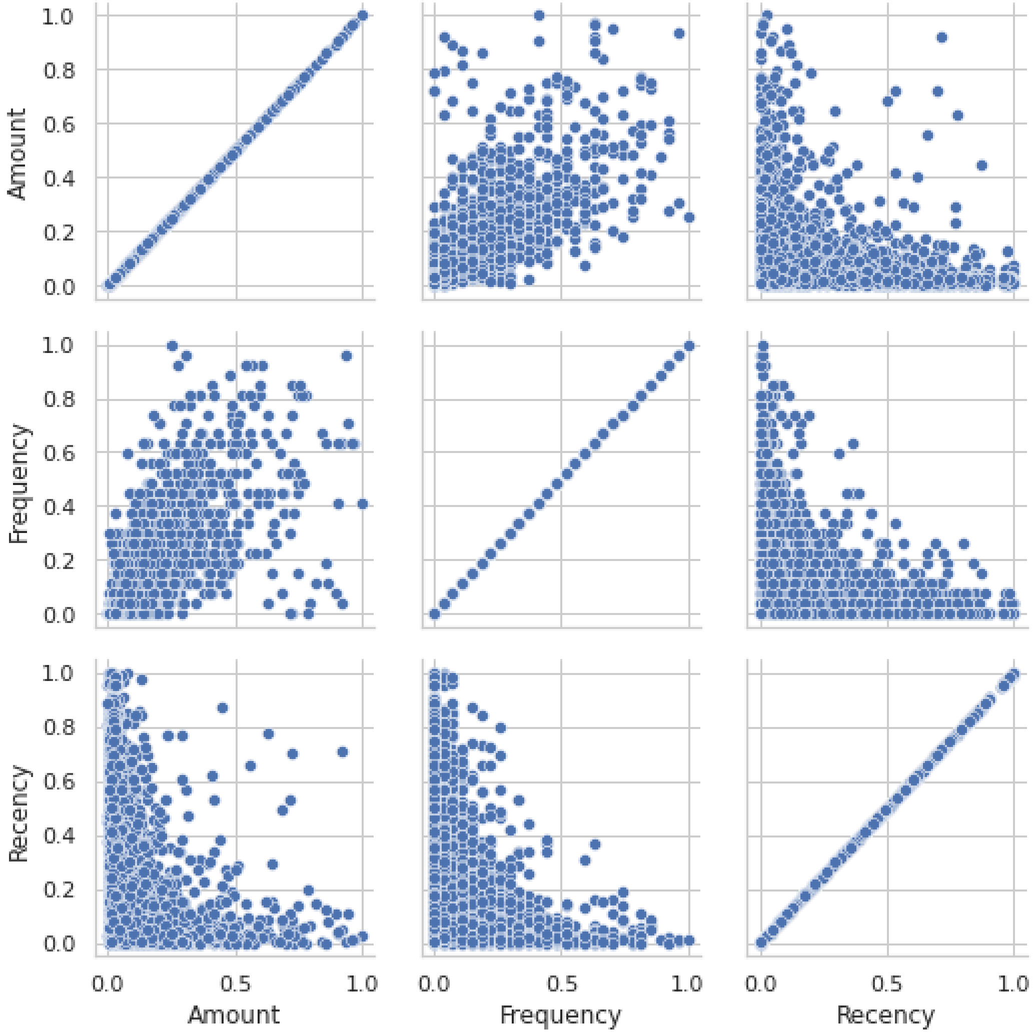
Out[ ]:

	Amount	Frequency	Recency
0	0.024629	0.370370	0.439678
1	0.087409	0.037037	0.005362
2	0.014674	0.000000	0.195710
3	0.176437	0.074074	0.112601

	Amount	Frequency	Recency
4	0.019877	0.000000	0.026810

In [ ]:

```
g = sns.PairGrid(rfm_dataset_scaled)
g.map(sns.scatterplot);
```



Segmentation based on Amount,Recency and Frequency

In [ ]:

```
within_sum_square = []
range_n_clusters = [i for i in range(2,11)]
for num_clusters in range_n_clusters:
    kmeans = KMeans(n_clusters=num_clusters, init ='k-means++', max_iter=300,random_
    within_sum_square.append(kmeans.inertia_)
    cluster_labels = kmeans.labels_
    silhouette_avg = silhouette_score(rfm_dataset_scaled, cluster_labels)
    # c_avg = calinski_harabasz_score(rfm_dataset_scaled, cluster_labels)
    print("For n_clusters={0}, the silhouette score is {1}".format(num_clusters, sil
```

```
For n_clusters=2, the silhouette score is 0.5661945492047095
For n_clusters=3, the silhouette score is 0.5477575520199691
For n_clusters=4, the silhouette score is 0.4743336103129437
For n_clusters=5, the silhouette score is 0.4377793045333027
For n_clusters=6, the silhouette score is 0.3880489018428877
For n_clusters=7, the silhouette score is 0.381351139040909
For n_clusters=8, the silhouette score is 0.387409124390399
For n_clusters=9, the silhouette score is 0.37027024047295526
For n_clusters=10, the silhouette score is 0.35262500025185517
```

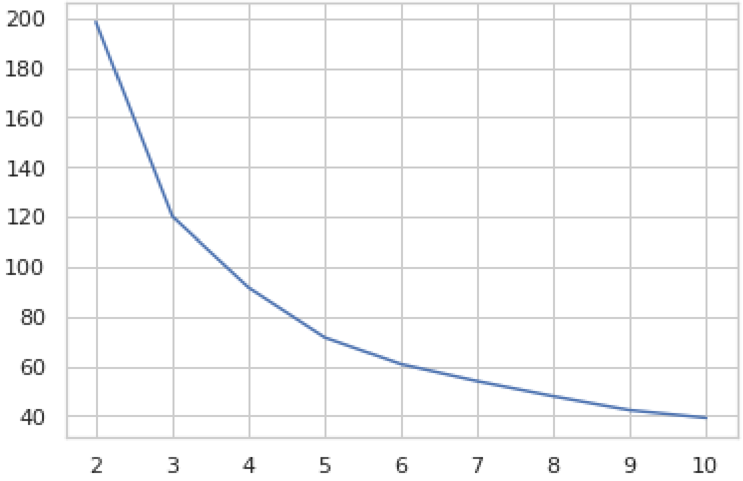
In [ ]:

```
kmeans = KMeans(n_clusters=3, max_iter=300,init="k-means++",random_state=42)
kmeans.fit(rfm_dataset_scaled)
lbs = kmeans.labels_
print(kmeans.labels_)
```

```
[1 0 0 ... 1 0 0]
```

In [ ]:

```
plt.plot(range_n_clusters,within_sum_square)
plt.show()
```



In [ ]:

```
rfm_dataset_final['Cluster_Id'] = lbs
rfm_dataset_final.head()
```

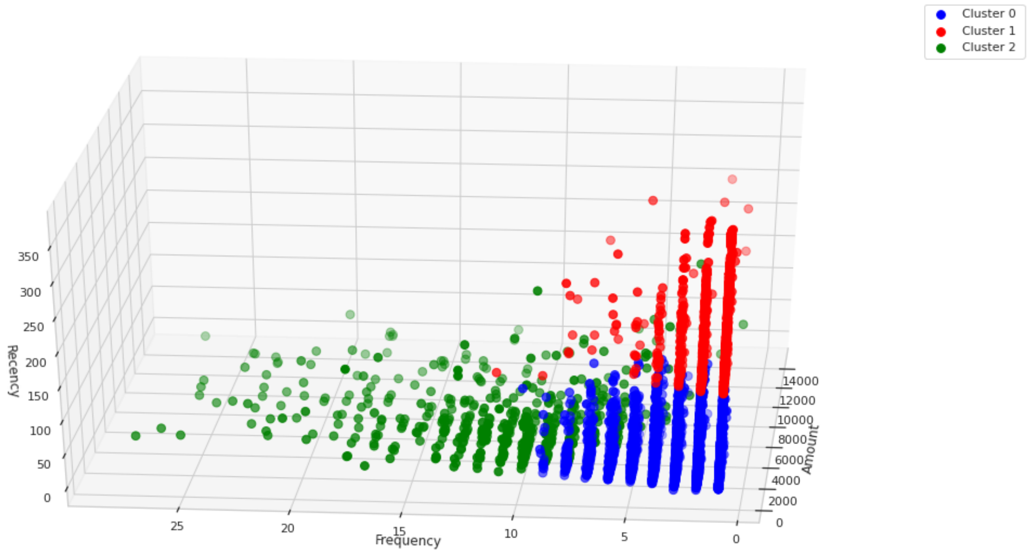
Out[ ]:

	Customer ID	Amount	Frequency	Recency	Cluster_Id
0	12346.0	372.86	11	164	1
1	12347.0	1323.32	2	2	0
2	12348.0	222.16	1	73	0
3	12349.0	2671.14	3	42	0
4	12351.0	300.93	1	10	0

In [ ]:

```
from mpl_toolkits.mplot3d import Axes3D
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd

fig = plt.figure(figsize=(20,10))
ax = fig.add_subplot(111, projection='3d')
ax.scatter(rfm_dataset_final["Amount"][rfm_dataset_final.Cluster_Id == 0], rfm_datas
ax.scatter(rfm_dataset_final["Amount"][rfm_dataset_final.Cluster_Id == 1], rfm_datas
ax.scatter(rfm_dataset_final["Amount"][rfm_dataset_final.Cluster_Id == 2], rfm_datas
ax.view_init(30, 185)
plt.legend(("Cluster 0 ","Cluster 1","Cluster 2"))
plt.xlabel("Amount")
plt.ylabel("Frequency")
```

```
ax.set_zlabel('Recency')
plt.show()
```



Segmentation based on Amount and Frequency

In [ ]:

```
rfm_dataset_af = rfm_dataset_scaled[["Amount","Frequency"]].copy()
rfm_dataset_af
```

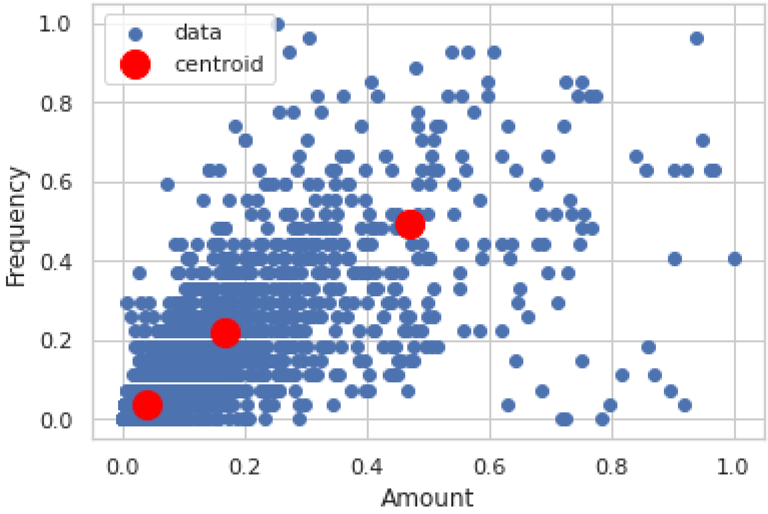
Out[ ]:

	Amount	Frequency
0	0.024629	0.370370
1	0.087409	0.037037
2	0.014674	0.000000
3	0.176437	0.074074
4	0.019877	0.000000
...	...	...
4232	0.042391	0.185185
4233	0.030495	0.000000
4234	0.028205	0.000000
4235	0.085633	0.037037
4236	0.154941	0.111111

4237 rows × 2 columns

In [ ]:

```
d2kmeans = KMeans(n_clusters = 3,                    # Set amount of clusters
                  init = 'k-means++',              # Initialization method for kmeans
                  max_iter = 100)               # Maximum number of iterations

pred_y =d2kmeans.fit_predict(rfm_dataset_af)


# Plot the data
plt.scatter(rfm_dataset_scaled["Amount"],
            rfm_dataset_scaled["Frequency"])

# Plot the clusters
plt.scatter(d2kmeans.cluster_centers_[:, 0],
            d2kmeans.cluster_centers_[:, 1],
            s=200,                              # Set centroid size
            c='red')
plt.legend(["data","centroid"])
plt.xlabel("Amount")
plt.ylabel("Frequency")                  # Set centroid color
plt.show()
```



In [ ]:

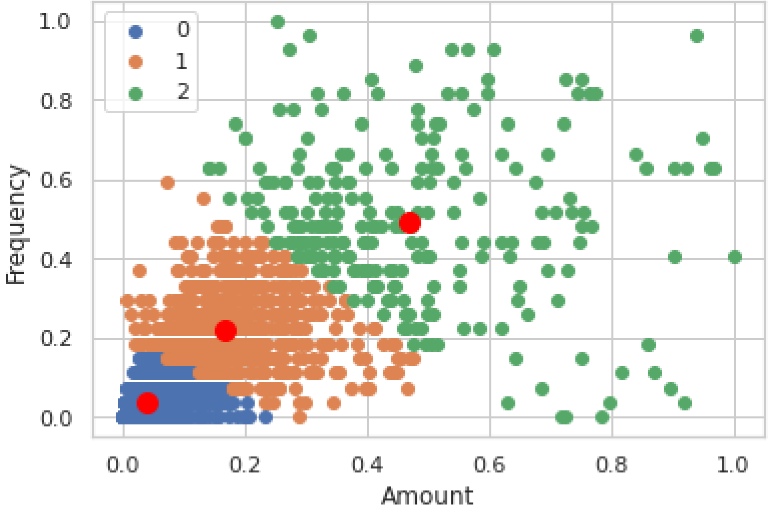
```
#pred_y
rfm_copy = rfm_dataset_af.copy()
rfm_copy["Cluster_Id"]= pred_y
rfm_copy.head()
```

Out[ ]:

	Amount	Frequency	Cluster_Id
0	0.024629	0.370370	1
1	0.087409	0.037037	0
2	0.014674	0.000000	0
3	0.176437	0.074074	0
4	0.019877	0.000000	0

In [ ]:

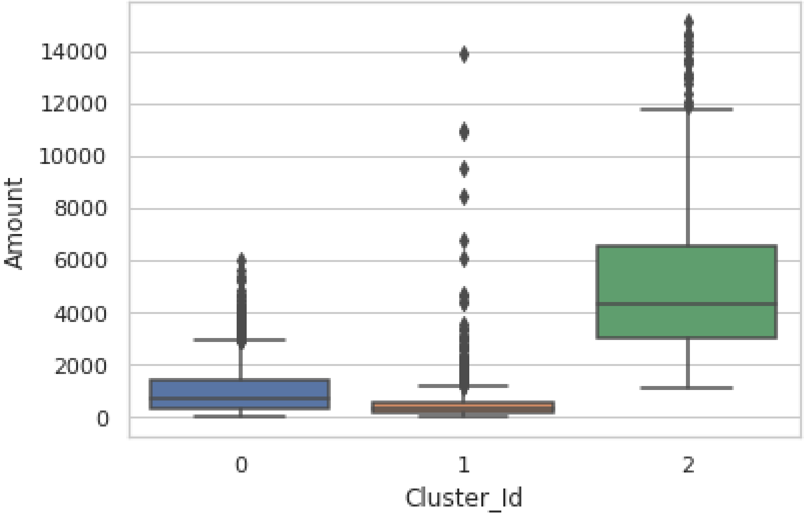
```
u_labels = np.unique(pred_y)

#plotting the results:

for i in u_labels:
    plt.scatter(rfm_copy[pred_y == i]['Amount'] ,rfm_copy[pred_y==i]['Frequency'],la
plt.scatter(d2kmeans.cluster_centers_[:, 0],
            d2kmeans.cluster_centers_[:, 1],
            s=100,                              # Set centroid size
            c='red')
plt.legend()
plt.xlabel("Amount")
plt.ylabel("Frequency")
plt.show()
```



Plots that summarize the Output

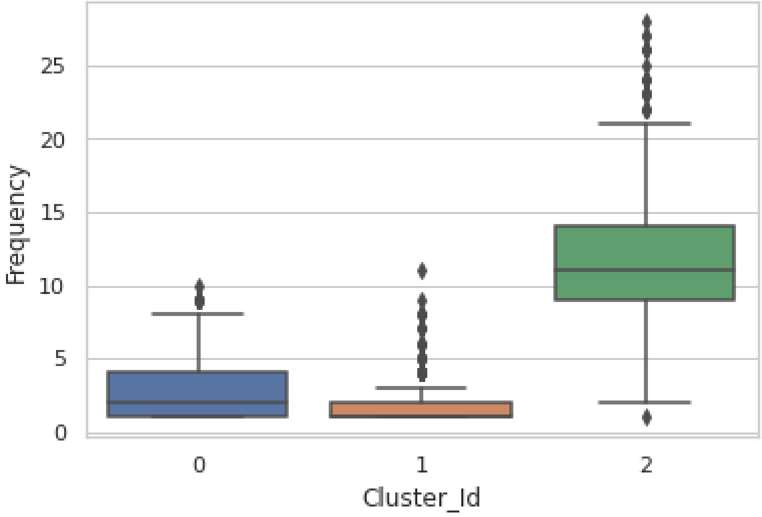
In [ ]:

```
sns.boxplot(x='Cluster_Id', y='Amount', data=rfm_dataset_final)
plt.show()
```

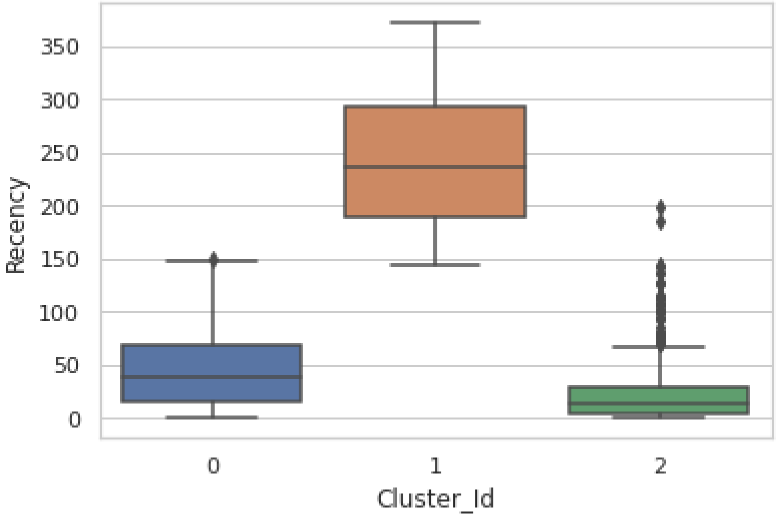


In [ ]:

```
sns.boxplot(x='Cluster_Id', y='Frequency', data=rfm_dataset_final)
plt.show()
```



In [ ]:
```
sns.boxplot(x='Cluster_Id', y='Recency', data=rfm_dataset_final)
plt.show()
```


Recency
Cluster_Id