Project Report

"Market Segmentation using machine learning in Python"

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ABSTRACT

Unsupervised learning allows us to approach problems with little or no idea what our results should look like. We can derive structure from data where we don't necessarily know the effect of the variables. We can derive this structure by clustering the data based on relationships among the variables in the data. The market segmentation is also an example of clustering in unsupervised learning. This clustering is done by using K – Means algorithm in Python. The results will help to find out the present and future trend of the customers to make strong decisions. we will be working on market segregation based on buying behaviour using k-clustering algorithm in python. The data set is taken from UCI machine learning repository.

To make our clustering reach its maximum performance we have to determine which hyperparameter fits to the data. To determine which hyperparameter is the best for our model and data, we can use the method to decide.

In concluding we will determine the cluster of customers on the basis of characteristics that exist using python and make suggestions to improve profit for them.

CONTENTS

1. Introduction

Suppose that we have a company that selling some of the product, and you want to know how well does the selling performance of the product we have the data that can we analyse, but what kind of analysis that we can do? Well, we can segment customers based on their buying behaviour on the market.

Keep in mind that the data is really huge, and we cannot analyse it using a bare eye. We have to use machine learning algorithms and the power of computing for it.

This project will show how to cluster customers on segments based on their behaviour using the K-Means algorithm in Python. This project will help on how to do customer segmentation step-by-step from preparing the data to cluster it. We have used here RFM model i.e., recency frequency and monetary model.

2. Data collection

We collected the data first. For this case, we take the data from UCI Machine Learning called Online Retail dataset. The dataset itself is a transactional data that contains transactions from December 1st 2010 until December 9th 2011 for a UK-based online retail. Each row represents the transaction that occurs. It includes the product name, quantity, price, and other columns that represents ID. The size of dataset is (541909,8). In this case, we haven't used all of the rows. Instead, we have sample 10000 rows from the dataset, and we assumed that as the whole transactions that the customers do.

3. Plan of Action (POA)

- Gather the data
- Pre-process the data
- Explore the data
- Cluster the data
- Interpret the result

4. Python Libraries

Following are the some of the libraries which are necessary to run the project code and generate results-

- NumPy
- Pandas
- Matplotlib
- Seaborn

5. Use of Project

Since we are from MTech, this project will help us in our coming placements and will help to target different sectors as we will get in depth knowledge of Python.

6. Code Explanations

- Welcome PYCK Team

```
In [2]: a="Aman"
        b="Deepak"
        c="Dhiraj"
        print(f"Hello team PYCK from {a} {b} and {c}")

        Hello team PYCK from Aman Deepak and Dhiraj
```

- Gathering Data: here we import all the necessary liberaries pandas for data handeling matplotlib and seaborn for data visualisation and sckitlearn for training our data.

```
In [3]: import pandas as pd
        import matplotlib.pyplot as plt
        %matplotlib inline
        import seaborn as sns
        import numpy as np

In [27]: df = pd.read_excel(r'C:\Users\CG-DTE\Downloads\Online Retail.xlsx')

In [3]: df = df[df['CustomerID'].notna()]

In [4]: df_fix = df.sample(10000, random_state = 42)
        df_fix.shape

Out[4]: (10000, 8)
```

- Show data head

```
In [5]: df_fix.head()
```

Out[5]:

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Country
47912	540456	48185	DOORMAT FAIRY CAKE	2	2011-01-07 12:14:00	7.95	13534.0	United Kingdom
342630	566891	23013	GLASS APOTHECARY BOTTLE TONIC	4	2011-09-15 13:51:00	3.95	14894.0	United Kingdom
288183	C562139	21313	GLASS HEART T-LIGHT HOLDER	-4	2011-08-03 10:10:00	0.85	12921.0	United Kingdom
325368	565438	22382	LUNCH BAG SPACEBOY DESIGN	4	2011-09-04 13:56:00	1.65	17229.0	United Kingdom
331450	566016	21212	PACK OF 72 RETROSPOT CAKE CASES	24	2011-09-08 12:20:00	0.55	15144.0	United Kingdom

- **Data processing**

Create RFM Table: here we due some feature engineering in which we try to extract three features namely recency(how recently products are bought) frequency(how often products are bought) and monetary value(what is the value spent by each customer)

In [6]:
```
# Convert to show date only
from datetime import datetime
df_fix["InvoiceDate"] = df_fix["InvoiceDate"].dt.date

# Create TotalSum columnn
df_fix["TotalSum"] = df_fix["Quantity"] * df_fix["UnitPrice"] #total sum is the product of unit price and no of units

# Create date variable that records recency
import datetime
snapshot_date = max(df_fix.InvoiceDate) + datetime.timedelta(days=1)

# Aggregate data by each customer
customers = df_fix.groupby(['CustomerID']).agg({
    'InvoiceDate': lambda x: (snapshot_date - x.max()).days,
    'InvoiceNo': 'count',
    'TotalSum': 'sum'})

# Rename columns
customers.rename(columns = {'InvoiceDate': 'Recency',
                            'InvoiceNo': 'Frequency',
                            'TotalSum': 'MonetaryValue'}, inplace=True)
```

- Show customers data head

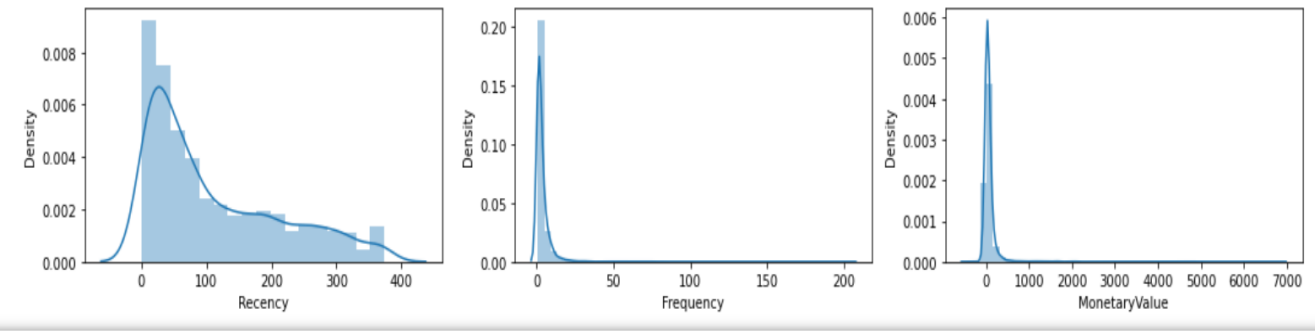
In [7]:
```
customers.head()
```

Out[7]:

CustomerID	Recency	Frequency	MonetaryValue
12347.0	40	5	133.20
12348.0	249	2	120.88
12349.0	19	2	312.75
12352.0	73	5	80.85
12354.0	233	2	33.30

- Manage Skewness:we convert the given data into a non skewed data by using box-cox transformation

```
In [8]: fig, ax = plt.subplots(1, 3, figsize=(15,3))
        sns.distplot(customers['Recency'], ax=ax[0])
        sns.distplot(customers['Frequency'], ax=ax[1])
        sns.distplot(customers['MonetaryValue'], ax=ax[2])
        plt.tight_layout()
        plt.show()
```



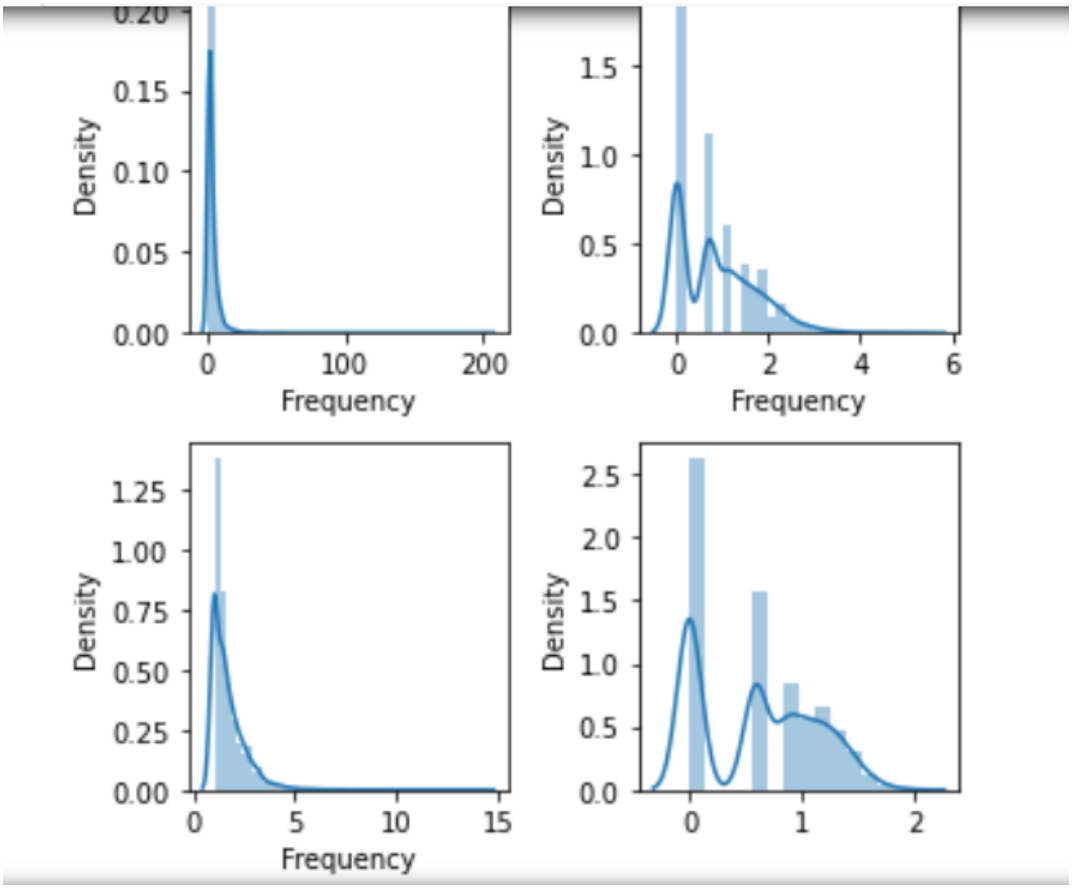
- Import and data ararngement

```
In [9]: from scipy import stats
        def analyze_skewness(x):
            fig, ax = plt.subplots(2, 2, figsize=(5,5))
            sns.distplot(customers[x], ax=ax[0,0])
            sns.distplot(np.log(customers[x]), ax=ax[0,1])
            sns.distplot(np.sqrt(customers[x]), ax=ax[1,0])
            sns.distplot(stats.boxcox(customers[x])[0], ax=ax[1,1])
            plt.tight_layout()
            plt.show()

            print(customers[x].skew().round(2))
            print(np.log(customers[x]).skew().round(2))
            print(np.sqrt(customers[x]).skew().round(2))
            print(pd.Series(stats.boxcox(customers[x])[0]).skew().round(2))
```

- Analyze skewness(‘Frequency')

```
In [11]: analyze_skewness('Frequency')
```



Output values- of skewness-

14.77

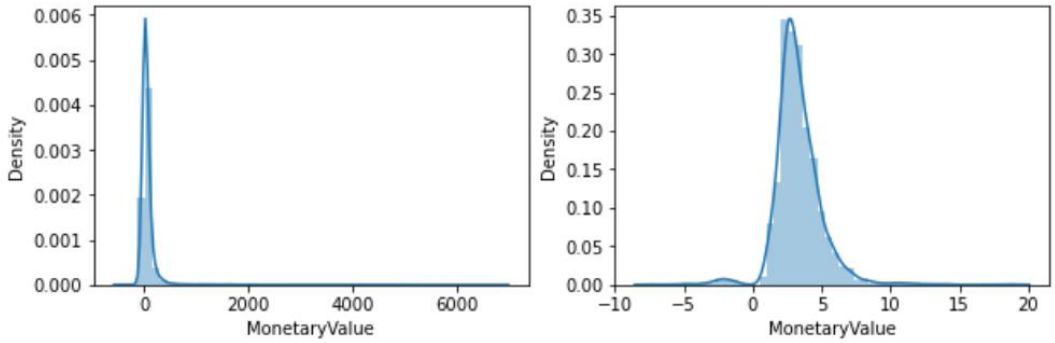
0.85

3.67

0.16

- Standardization

In [12]:
```
fig, ax = plt.subplots(1, 2, figsize=(10,3))
sns.distplot(customers['MonetaryValue'], ax=ax[0])
sns.distplot(np.cbrt(customers['MonetaryValue']), ax=ax[1])
plt.show()
print(customers['MonetaryValue'].skew().round(2))
print(np.cbrt(customers['MonetaryValue']).skew().round(2))
```




```
16.63
1.16
```

In [13]:
```
pd.Series(np.cbrt(customers['MonetaryValue'])).values
```

Out[13]:
```
array([ 5.10702607,  4.94445183,  6.78785317, ..., -1.66910753,
        4.27320639,  4.0872497 ])
```

- Set the Numbers

In [14]:
```
# Set the Numbers
customers_fix = pd.DataFrame()
customers_fix["Recency"] = stats.boxcox(customers['Recency'])[0]
customers_fix["Frequency"] = stats.boxcox(customers['Frequency'])[0]
customers_fix["MonetaryValue"] = pd.Series(np.cbrt(customers['MonetaryValue'])).values
customers_fix.tail()
```

Out[14]:

	Recency	Frequency	MonetaryValue
2685	7.832068	0.591193	3.408514
2686	1.269495	1.435599	5.907565
2687	4.288385	0.591193	-1.669108
2688	1.665555	1.615329	4.273206
2689	6.340700	1.017445	4.087250

- Centring and Scaling Variables: we convert the data to have the same mean and variance. We have to normalize it. To normalize, we can use StandardScaler object from scikit-learn library to do it. The code will look like this.

In [15]:
```
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
scaler.fit(customers_fix)
customers_normalized = scaler.transform(customers_fix)
print(customers_normalized.mean(axis = 0).round(2))
print(customers_normalized.std(axis = 0).round(2))
```

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

In [16]:
```
pd.DataFrame(customers_normalized).head()
```

Out[16]:

	0	1	2
0	-0.493794	1.012426	1.017503
1	1.232949	-0.017412	0.925115
2	-0.994917	-0.017412	1.972690
3	-0.012582	1.012426	0.572565
4	1.155005	-0.017412	-0.056441

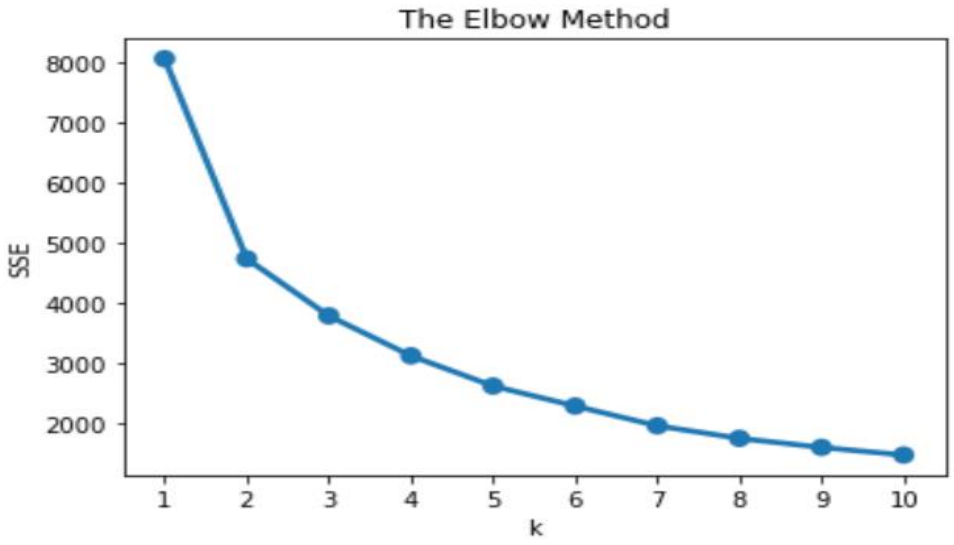
- **Modelling**

Choose k-number: To make segmentation from the data, we can use the K-Means algorithm to do this. K-Means algorithm is an unsupervised learning algorithm that uses the geometrical principle to determine which cluster belongs to the data. By determine each centroid, we calculate the distance to each centroid. Each data belongs to a centroid if it has the smallest distance from the other. It repeats until the next total of the distance doesn't have significant changes than before.

In [17]:
```
from sklearn.cluster import KMeans

sse = {}
for k in range(1, 11):
    kmeans = KMeans(n_clusters=k, random_state=42)
    kmeans.fit(customers_normalized)
    sse[k] = kmeans.inertia_ # SSE to closest cluster centroid

plt.title('The Elbow Method')
plt.xlabel('k')
plt.ylabel('SSE')
sns.pointplot(x=list(sse.keys()), y=list(sse.values()))
plt.show()
```



In [28]:
```
model = KMeans(n_clusters=3, random_state=42)
model.fit(customers_normalized)
model.labels_.shape
```

Out[28]: (2690,)

Based on our observation, the k-value of 3 is the best hyperparameter for our model because the next k-value tend to have a linear trend. Therefore, our best model for the data is K-Means with the number of clusters is 3.

```
In [19]: customers.shape
Out[19]: (2690, 3)
```

- **Cluster Analysis**

Making suitable number of segments based on K value and assigning them their cluster number.

```
In [20]: customers["Cluster"] = model.labels_
         customers.head()
```

Out[20]:

CustomerID	Recency	Frequency	MonetaryValue	Cluster
12347.0	40	5	133.20	2
12348.0	249	2	120.88	1
12349.0	19	2	312.75	2
12352.0	73	5	80.85	2
12354.0	233	2	33.30	1

- Analysis of clustered data by grouping them

```
In [21]: customers.groupby('Cluster').agg({
             'Recency':'mean',
             'Frequency':'mean',
             'MonetaryValue':['mean', 'count']}).round(1)
```

Out[21]:

	Recency	Frequency	MonetaryValue	
	mean	mean	mean	count
Cluster				
0	47.2	1.6	21.6	808
1	226.6	1.6	28.7	960
2	46.3	7.7	166.1	922

- **Snake Plot**

To analyse data by graphically snake plots are used. From snake plot customer segmentation can be easily visualised by using recency, frequency and monetary value.

In [22]:
```
df_normalized = pd.DataFrame(customers_normalized, columns=['Recency', 'Frequency', 'MonetaryValue'])
df_normalized['ID'] = customers.index
df_normalized['Cluster'] = model.labels_
df_normalized.head()
```

Out[22]:

	Recency	Frequency	MonetaryValue	ID	Cluster
0	-0.493794	1.012426	1.017503	12347.0	2
1	1.232949	-0.017412	0.925115	12348.0	1
2	-0.994917	-0.017412	1.972690	12349.0	2
3	-0.012582	1.012426	0.572565	12352.0	2
4	1.155005	-0.017412	-0.056441	12354.0	1

Melt the data

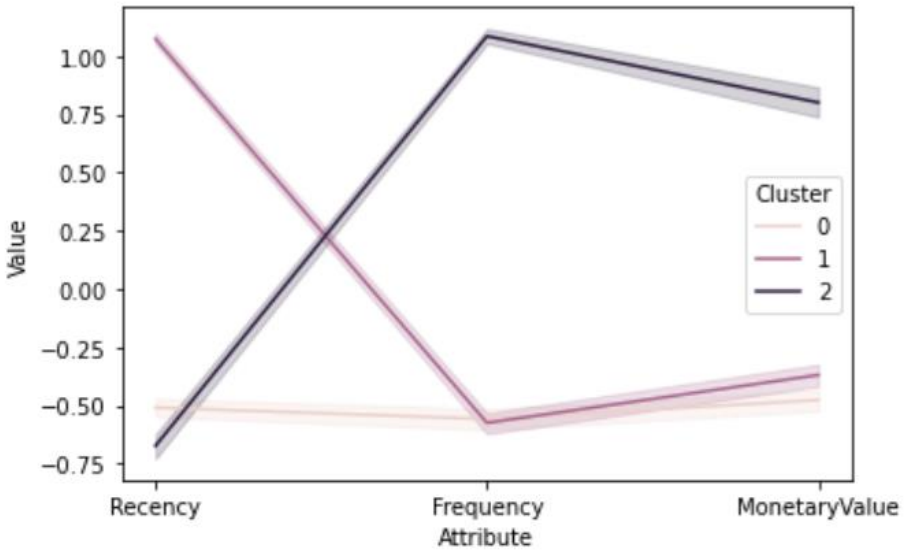
In [23]:
```
# Melt The Data
df_nor_melt = pd.melt(df_normalized.reset_index(),
                      id_vars=['ID', 'Cluster'],
                      value_vars=['Recency','Frequency','MonetaryValue'],
                      var_name='Attribute',
                      value_name='Value')
df_nor_melt.head()
```

Out[23]:

	ID	Cluster	Attribute	Value
0	12347.0	2	Recency	-0.493794
1	12348.0	1	Recency	1.232949
2	12349.0	2	Recency	-0.994917
3	12352.0	2	Recency	-0.012582
4	12354.0	1	Recency	1.155005

In [24]:
```
sns.lineplot('Attribute', 'Value', hue='Cluster', data=df_nor_melt)
```

Out[24]: <AxesSubplot:xlabel='Attribute', ylabel='Value'>



In [29]:
```
customers.groupby('Cluster').agg({
    'Recency':'mean',
    'Frequency':'mean',
    'MonetaryValue':['mean', 'count']}).round(1)
```

Out[29]:

	Recency	Frequency	MonetaryValue	
	mean	mean	mean	count
Cluster				
0	47.2	1.6	21.6	808
1	226.6	1.6	28.7	960
2	46.3	7.7	166.1	922

Cluster 2 is frequent, spend more, and they buy the product recently. Therefore, it could be the cluster of a **loyal customer**. Then, the cluster 0 is less frequent, less to spend, but they buy the product recently. Therefore, it could be the cluster of **new customers**. Finally, the cluster 1 is less frequent, less to spend, and they buy the product at the old time. Therefore, it could be the cluster of **saturated or old customers.**

7. Conclusion

The customer segmentation is really necessary for knowing what characteristics that exist on each customer. Which customer loyal customer, new customer and churned customers is clearly segmented by using K-Means clustering. The project has shown to you how to implement it using Python. We infer that cluster 2 is frequent, spend more, and they buy the product recently. Therefore, it could be the cluster of a loyal customer. Then, the cluster 0 is less frequent, less to spend, but they buy the product recently. Therefore, it could be the cluster of new customers. Finally, the cluster 1 is less frequent, less to spend, and they buy the product at the old time. Therefore, it could be the cluster of churned customers.

SUGGESTIONS: -

1) Since 0 is our new customer segmentation we can try to convert them into loyal customer by providing them the attractive offers and discount to maximize our profit.

2) cluster 1 is our churned-out customer that means either they are saturated or not interested in our shop so there is not much scope for improvement in this segment.

3) cluster 3 is our loyal and most important cluster and keeping and increasing this cluster is the most important thing for the shop.

8. References

1) https://www.geeksforgeeks.org/elbow-method-for-optimal-value-of-k-in-kmeans/ https://www.marketingprofs.com/tutorials/snakeplot.asp reference for snake plot

2) PYCK notes