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**Customer behavioral Segmentation Using RFM analysis: a
Machine learning approach**

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This Project report has been submitted in fulfillment of the requirements for the
Degree of Bachelor of Science in Software Engineering.

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APPROVAL

This **thesis** entitled on Customer behavioral Segmentation Using RFM analysis: a Machine learning approach, submitted by **Md Emran (ID: 181-35-312)** to the Department of Software Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Science in Software Engineering and approval as to its style and contents.

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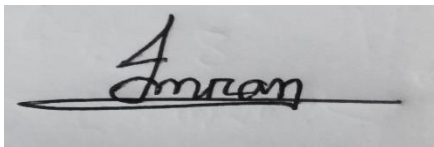
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A photograph of a handwritten signature in black ink on a light-colored background. The signature appears to be 'Emran' with a long horizontal stroke underneath.

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ABSTRACT

Most of the companies faced a problem to find out which is most potential customers of that company. It is very essential to conduct this communication for business incoming enhancement. The relationship between a business organization and its customers is called Customer Relation Management (CRM). This research main aims to find out who is most valuable customers and divide the customer into different subgroup by using their similar behavior, demographic and geographic characteristics, like: age, region, country, social, lifestyle, etc. Furthermore, the organization be able to categorize customer's behavior, attitude, characteristics. Moreover, companies can understand which customers are most important and which are not by their wisdom. The method of dividing the customer based on their behavior in the different segments is called customer behavioral segmentation.

Keywords: K-Mean Algorithm, Customer Relationship Management, RFM, Profiling customer, Profiling Customers, Customer Behavioural Segmentation

CHAPTER 1

INTRODUCTION

1.1 Background

In e-commerce companies like online retailers, customer segmentation is necessary in order to understand customer's behaviors. It leverages acquired customer data like the one we have in our case, transactions data in order to divide customers into groups. The communication between a business organization and its customers is called Customer Relationship Management. In recent years, overall, every company focuses on (CRM) to give the best services to their customer compared to other competitors [3]. Customer relationship management plays a vital role in this sector.

1.2 Motivation of the Research

The customer segmentation is an effective method that enables to get better known clients and to better correspond, their various needs. Almost every company that sells products or services stores data of shopping. This type of data can be used to execute customer segmentation thus, the results of the analysis can be translated into marketing campaigns to increase sales. One of the most widely used techniques is RFM analysis, which allows to create personalized special offers to improve sales.

Recency, Frequency, Monetary (RFM) Value and it is the technique of customer segmentation based on their transaction history. The RFM analysis is based on three criteria's, which measure different customer characteristics. From this research, we analysis previous customers data then identify the different customer behaviour and characteristics. After, divided the overall customers in different subgroup based on Demographic (size of the family, Occupation, income, age, region and more) Geographic (Region, country, population, Climate) Behavioural: (Brand Loyalty, User Status, Usage Rates) Psychographic (Social, lifestyle, interest and more)

Hopefully, this research would be helpful for the companies for stimulant high-quality and long-term client-business organization relationships that increase customer relation and also profits and help marketing experts to achieve this goal.

1.3 Problem Statement

There are lot of small and medium enterprise company have not proper knowledge about the customers characteristic, attitude, interaction and behavior. So, they don't provide their service to their valuable customers properly. To find out the best machine learning model which can be used for understanding about customer behaviour.

1.4 Research Questions

Question 1: When did the last time client made a buy and how much did they spend?

Question 2: How many times customers did the purchase?

Question 3: How can a machine learning-based model be effective in understanding customer behavior?

1.5 Research Objectives

The Customer segmentation process has many Scope to it.

- Help to develop better quality product
- Improve the quality of previous product
- Better relation with client,
- The most successful economies,
- Improve product quality and productivity,
- Lead to advancing costs
- Further develop appropriation channel

CHAPTER 2

LITERATURE REVIEW

A great amount of literature has been examined in relation to consumer segmentation in a several areas. A wide range of approaches, as well as aims, have been identified. Methods for producing segmentation predictions appear to be based on the support of several technologies. The related study for customer behavioral segmentation within K-mean clustering is shown here.

Many researchers are using the customer segmentation method to improve customer behavioral segmentation and take it into consideration in the design and distribution of new goods in many domains such as business, finance, banking and telecommunications. In this paper, introduce the loyalty program, which comprises the issuing of several sorts of cards for these clients [3].

The Author [1] uses the k-mean algorithm to segment the customers during the segmentation procedure. Determine the six groups based on the annual income and spending score in this paper. Also, based on the two main components, identify six clusters. The researcher of this paper, cannot find out RFM score based on customer's monetary and spending values.

The author of the research paper [2] compares various unsupervised techniques utilizing the algorithms K-Means clustering, Fuzzy C-Means, and Possibilistic C-Means. Fuzzy C-Means predicts improved customer segmentation by grouping similar types of customers together in a cluster. They discovered that the Hybrid model in k-mean and decision tree had good accuracy. Fuzzy C-Means clustering for hybrid models is lacking in this research, resulting in low precision.

Different clustering has been presented in this research [3], such as k-mean clustering, Hierarchical clustering, Density Based Clustering, and Affinity Propagation Algorithm, with the conclusion that k-means generate medium accuracy. In the absence of that research, hierarchical clustering results in low clustering accuracy.

Segmentation is done using RFM analysis and then extended to other algorithms including K –Means clustering, Fuzzy C – Means, and a new method RM K-Means by making a minor modification to the current K – Means clustering, according to the author of the publications [4]. The effectiveness of these approaches is investigated. Due to the lack of this research, consumer performance in each category, such as products purchased frequently by members of each group, has suffered.

The author of this paper[5] tries to segment tourists using online ratings and reviews in social networking sites to anticipate their chosen preferences. The algorithm was created using both supervised and unsupervised algorithms. Using the SOM clustering technique, six segments were found from the customers' online ratings. Multiple platform data is missing, and some crucial data is lost during the dimensionality reduction procedure.

The researcher used a year dataset with 15405 raw customer data in this research [7]. The pre-processing stage reduces the amount of data to 3,721 data, which is then turned into a dataset for the RFM analysis modeling process utilizing the Elbow method and the K-Means algorithm. Following that, they use the K-means clustering algorithm. Due to the lack of this document, Decision Tree accuracy is only 65%.

The main goal of this paper [8] is to analysis an e-commerce store previous 2 years data. The analysis is performed on each dataset using clustering and k-means algorithm. After they find out the cluster of k-means they use RapidMiner tools for the result analysis. Finally they find, maximum activity comes from a single region and age range 25-34. Lack: Different age activity and Different years revenue.

This research [9] aims to determine the main clusters of turkey customers in retail stores in order to aid in customer classification and the development of more efficient customer strategies. They classified customers into three categories based on their RFM values, particularly their spending: Bronze, Gold, and Premium are the three levels of quality.

The author discusses in this paper [10] is how big data analytics can be used in consumer segmentation as a proof of concept. Using the TIC CRM dataset, they study various data analytics methods, particularly K-means and SOM. For a period of time, a customer's behavior features were lacking.

CHAPTER 3

RESEARCH METHODOLOGY

The proposed method of this studies is based on clustering and machine learning approach. The proposed methodology covers three major step. The first step of the research is related to preprocessing which is data cleaning and data pre-analysis part. Second step is, data analysis by using RFM analyzed approach, k-means clustering. Finally the full result Analysis and presented by using different graph and numeric values. The proposed research proposal of customer segmentation is “consumer classification by using the Grid Hill economic theory approach” [20]. Figure 1 depicts the entire study methodological procedure step by step.

The data was gathered from the machine learning repository at UC Irvine. The data is collection of different types of customer transaction in UK-based registered online retail. The company sells different types of product like, decoration accessories, cream, alarm clock and many occasional gifts.

3.1 Data Collection and Dataset

Data taken from the “Online Retail Data Set” in the UCI Machine Learning Repository. This database is related to customer transaction history, for one year in a UK-based and registered non-store online retail. The company mainly sells unique all-occasion gifts. Many customers of the company are wholesalers. The data must pass the data preprocessing stage before it can be utilized as a dataset.

3.2 Data Preprocessing

Check for null values in the data pre-processing step and remove null value from the dataset. And also, string value are converted into numerical format as clustering algorithm and only support features in numerical form. Furthermore, as part of the clustering technique, string values are transformed to numerical format, and only numerical features are supported. It's also crucial to spot outliers in the data. Then, as part of the Data Preprocessing stage, eliminate all null values and outliers. Data preprocessing is most significant step as it minimizes noise from data, that making the data more balanced.

3.3 RFM analysis

Recency, frequency and monetary (RFM) analysis is an effective and identified approach that permits entrepreneurs to take a tactical decision. Customers are ranked using the RFM based on their previous purchasing history. Using this analysis technique, every company has more usable data to properly classify their clients based on their competencies. RFM analysis is used in a variety of applications with a high number of customers, such as online shopping, retailing, and so on. This technique divides clients into three dimensions: recency (R), frequency (F), and monetary value (M).

According to “Pareto’s 80/20 rule, a small percentage of customers make the major contribution to a company’s revenue. Thus, it is better to retain those customers who spend the most or have stayed with the company the longest than to acquire new customers. But how does one retain valuable customers?”[20]

The RFM model is founded on three quantitative variables.

3.3.1 Recency

Recency –When did the last time client made a purchase?

The number of days a customer waits between two purchases is referred to as the recency value. A lower recency value can be used to remind recent customers to return to the business soon to continue meeting their purchasing needs. Similarly, a higher value indicates that the customer is less likely to visit the company in the near future.

3.3.2 Frequency

Frequency –How regularly a customer makes a purchase?

Frequency is defined as the number of purchases made by a customer in a given period of time. The higher the value of frequency, the more loyal the company's customers are. The customer transaction frequency may be affected by some factors such as, product, replacement.

3.3.3 Monetary

Monetary – How much money does a customer spend on purchases in total?

Monetary is defined as the amount of money spent by a customer during a specific time period. The greater the amount of money spent, the greater the revenue generated for the company.

Each customer receives three different scores for the variables of recency, frequency, and monetary value. Scoring is done in the scale from 5 to 1. The top quintile is given a score of 5, and the others are given 4, 3, 2 and 1.

3.4 Choosing several clusters

Clustering technique has vastly using in data mining like customer segmentation, market analysis, image segmentation, etc. The method categorizes data objects based on their similarities. A cluster contains data points with the shortest distance. Various formulas, such as the Euclidean distance and the Manhattan distance, are used to calculate the distances between two data points. [3].

Usually, Fuzzy clustering, model-based clustering, partitional clustering, density-based clustering, hierarchical clustering, K-mean clustering, and grid-based clustering are all types of clustering.. In this paper, using k-means clustering techniques.

3.4.1 K-Means Cluster:

Stuart Lloyd proposed the K-Means algorithm in 1957, based on partitional based clustering techniques. It consists of several steps. In the first step, a sample element is chosen at random as the initial cluster center, and the number of clusters that must be generated is determined. Then, at random, choose k objects to be the initial clusters. During training, each object is assigned to the cluster with the closest centroid, which is usually Euclidean distance. The number of clusters K should be specified at the outset, and the initial centroids are chosen at random.

These previous two steps are completed iteratively in this manner. This process terminates when the centroid remains constant, the data points assigned to the specific centroid remain constant, and the fixed number of iterations is reached [13]. The four main steps in the k-mean are summarized below: Choose initial centroids at random,

assign each object to the cluster with the closest centroid, compute each centroid as the mean of the objects assigned to it, and repeat the previous two steps until no change is observed.

3.4.2 Elbow method

Elbow Method: The elbow measure is a method for determining the best K in the K-means clustering technique. Determined the number of clusters (k) that can be used as input for this elbow method using k-means. The square number of intra-clusters is then calculated. The distance between each data point and the corresponding centroid in each cluster center is defined as intra-cluster distance. Here, the square number of intra-clusters must be measured for each cluster(k) determined as input at the start [8]. Following the measurement of all values, a plot of those values based on the k values can be created. In this plot, the point with the curvature represents the optimal number of clusters [16].

Algorithm 1. Working Steps of K-Means Clustering

Input:

Entire customer dataset D containing 'n' samples.

K number of cluster.

Output: The customers data is partition to K clusters group.

Step 1: Initially, depending on the value of k, k random points are chosen as initial centroids.

Step 2: Find distance measure from each object to chosen K cluster center.

Step 3: Similar object are grouped based on their minimum distance

Step 4: Update the cluster means and take as new cluster centers (C_i), $\{i = 1 \dots k\}$

Step 5: No change in the cluster center then the algorithm stop, or go to step 2.

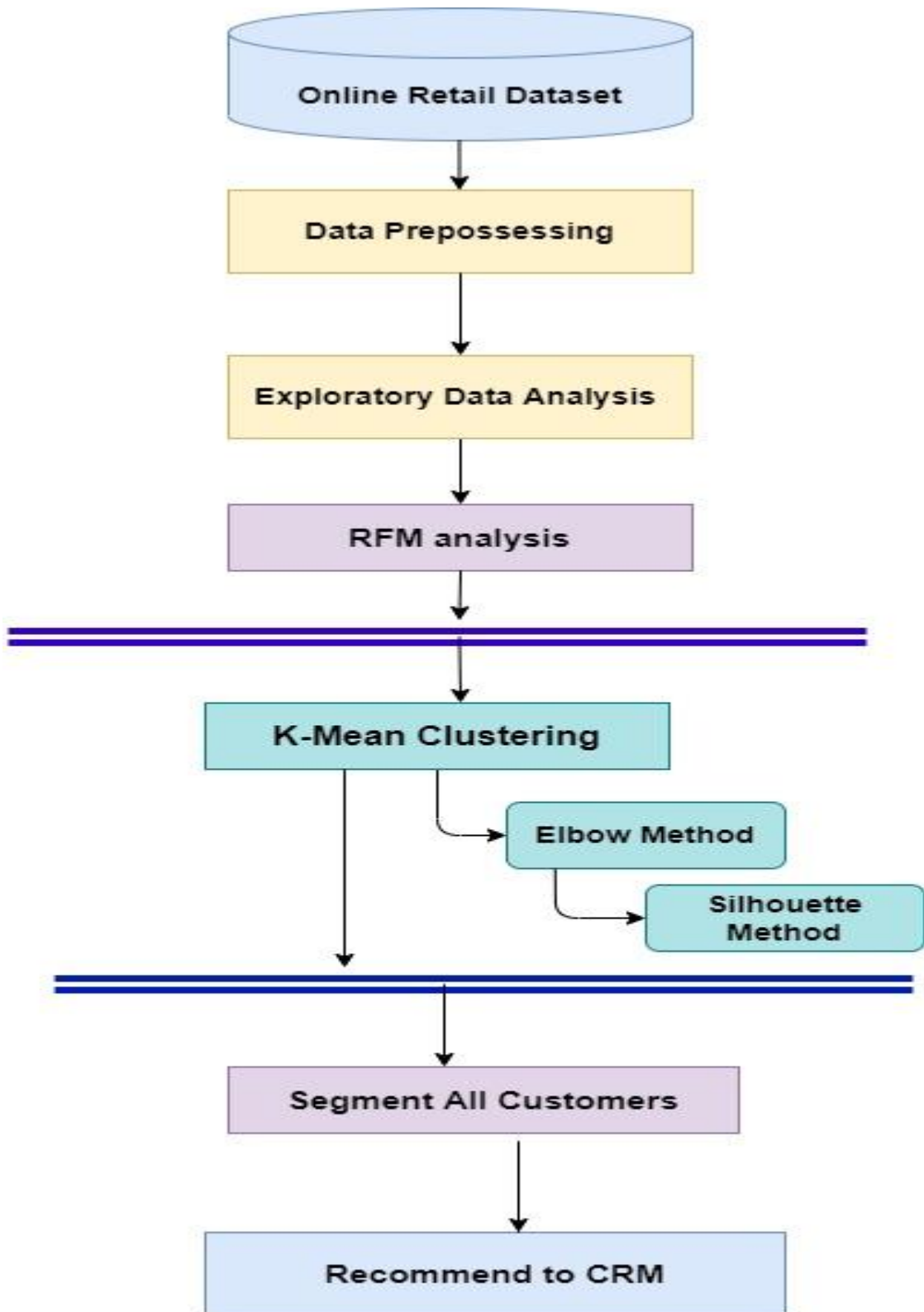


Figure 1: Proposed Method For Customer behavioral Segmentation

CHAPTER 4

RESULTS AND DISCUSSION

The proposed methodology's performance is evaluated by working on a one-year transactional data set of customers from an online retail store obtained from the University of California Irwin (UCI) repository. This section outlines the step-by-step process of customer segmentation. The dataset has eight attributes, which include the customer ID, product code, and product.

Dataset available at <https://archive.ics.uci.edu/ml/datasets/online+retail>

In this segment, we clarify the prediction of ML Algorithms result, the assessment of code review comments

4.1 Dataset Description:

Table 1: Online Retail Dataset

S.N	Full Name	Attribute name	Attribute description	Type
1	Invoice number	InvoiceNo	Each transaction assigned Six-digit unique number	Nominal
2	Product Code	StockCode	Each distinct product has been assigned five-digit unique number.	Nominal
3	Product name	Description	Name of the product	Nominal
4	Product Quantity	Quantity	The quantities of product per transaction	Numeric
5	Invoice Date and Time	InvoiceDate	Date and time of each transaction	Number
6	Unit Price	UnitPrice	Per unit product price	Number
7	Customer Number	CustomerID	Each customer assigned by five-digit unique number.	Nominal
8	Country Name	Country	The country name	Nominal

4.2 Data Visualization

Visualizing the dataset using several types of plots and graph. First of all, shows the total sales by country use to be pareto plot. Figure 2 visualize that the total price is greater in United Kingdom than other country respectively.

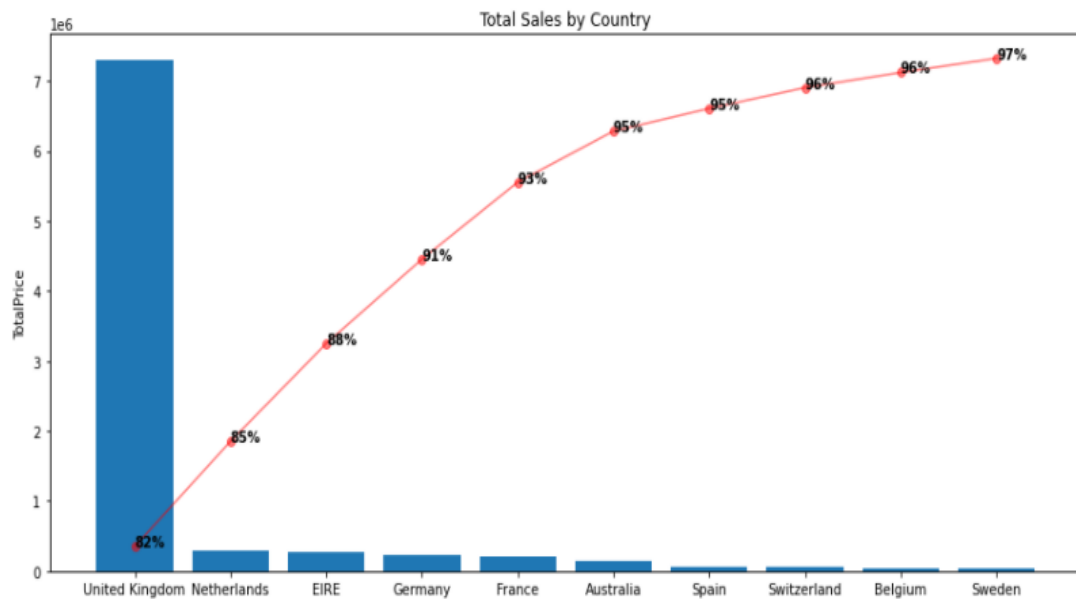


Figure 2: Country wise total sales

Then visualize top 10 customer with their total spending which is monetary value by use the below bar plot. The figure of 3 has shows the highest spending customerId has been 14646.

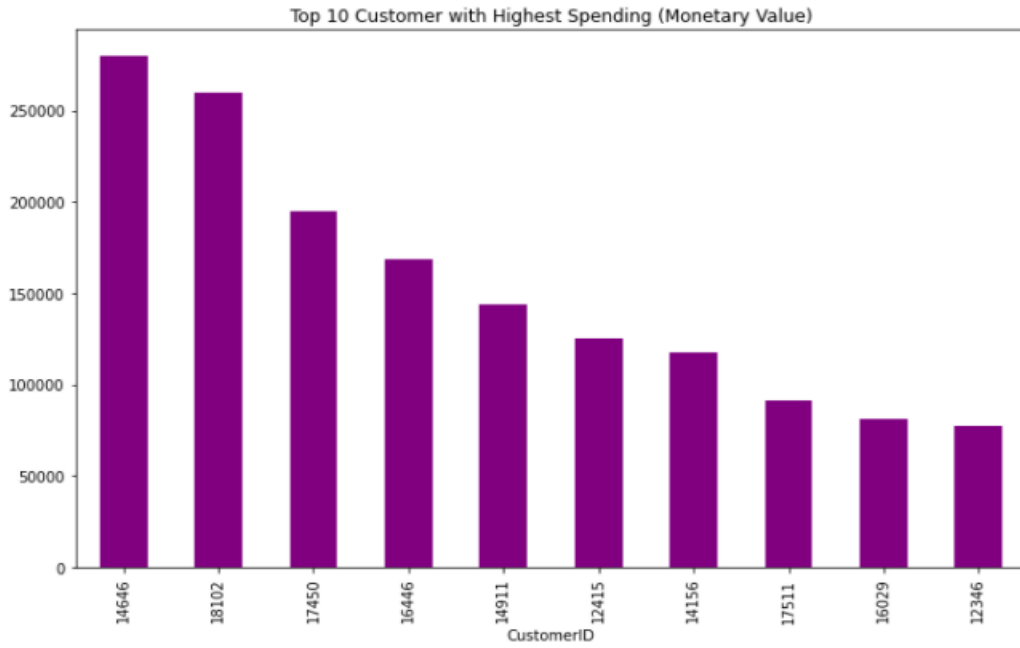


Figure 3: Top ten customer with their Spending

After then visualize top 10 items which contribute to Overall sales with their description using the bar plot. Figure 4 shows the highest contributing product.

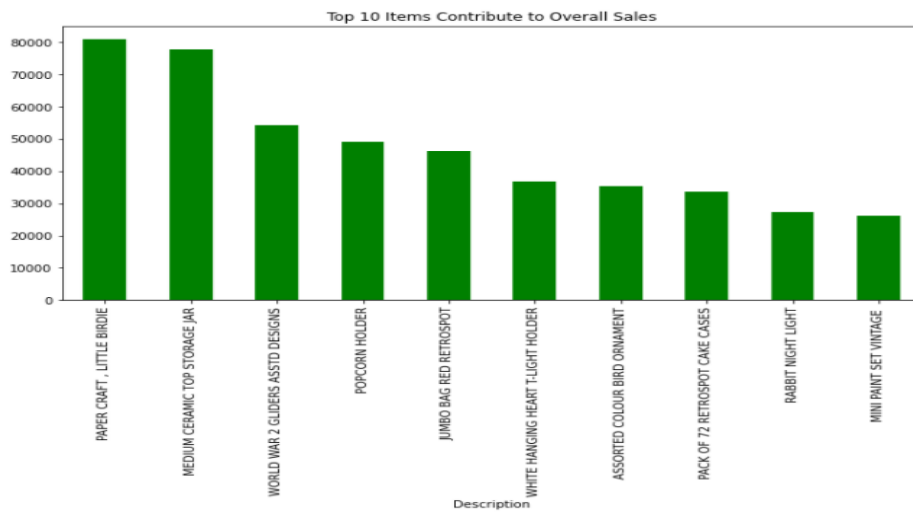


Figure 4: Top 10 items which contribute to overall sales

After then, visualize top 10 sold items with their description using the bar plot. Figure 5 shows the highest sold product.

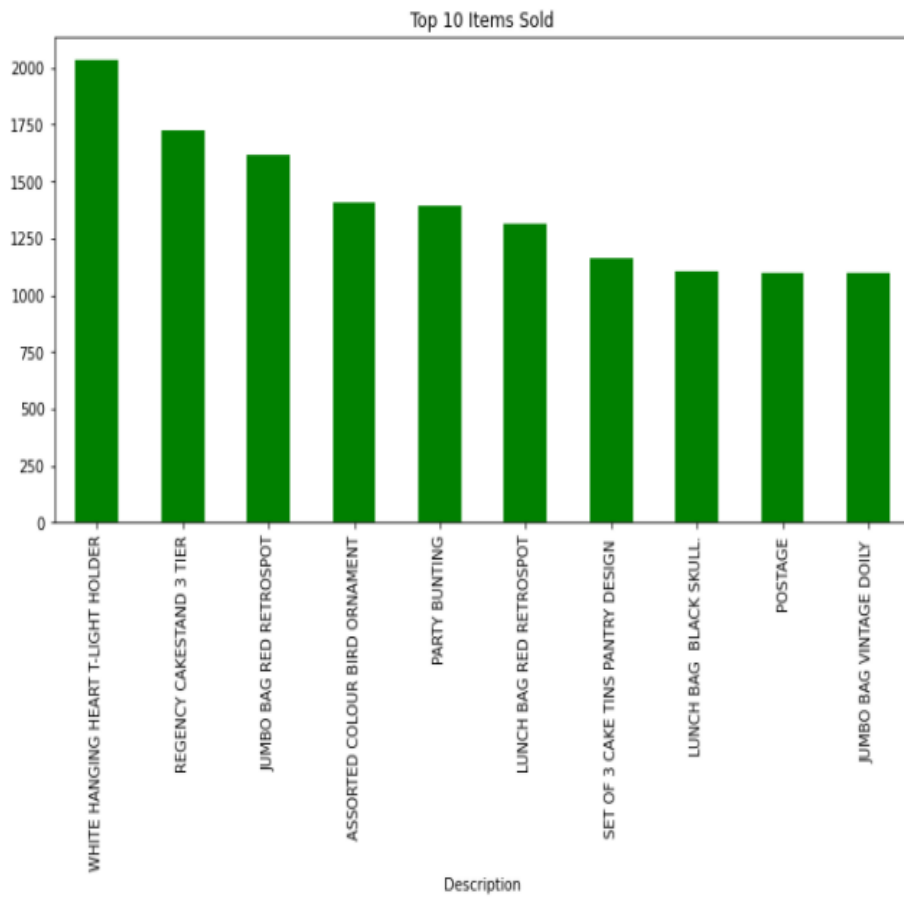


Figure 5: Top 10 sold items

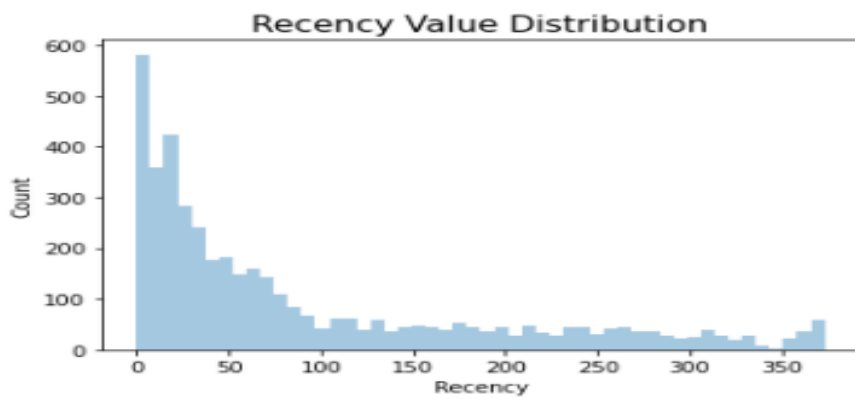


Figure 6: Recency value distribution

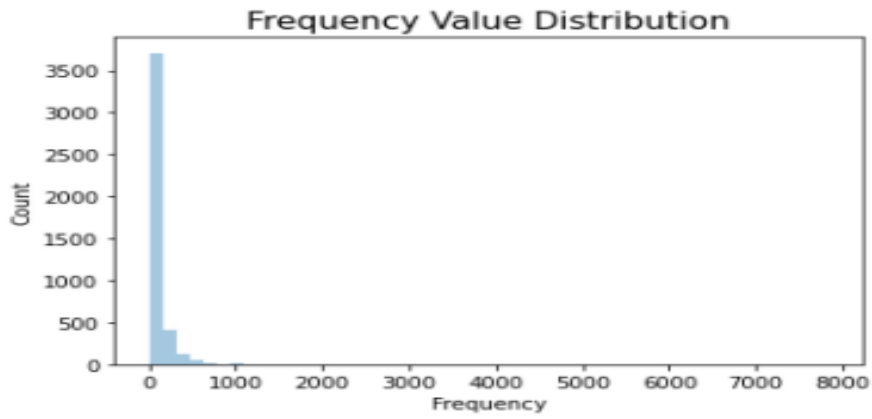


Figure 7: frequency value distribution

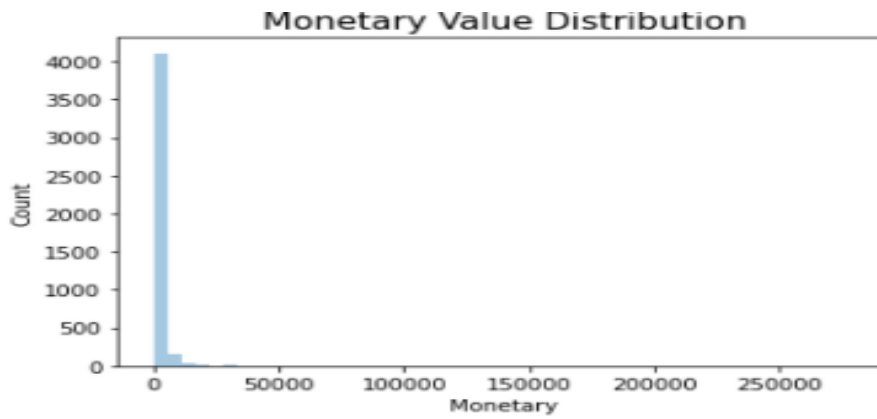


Figure 8: Monetary value distribution

4.3 Optimal cluster analysis:

Now analysis the optimal number of cluster. From this figure 9,find out the optimal cluster taken as 3. Here, I used 1-9 values for K respectively . Now I am building the K Means model using 3 clusters.

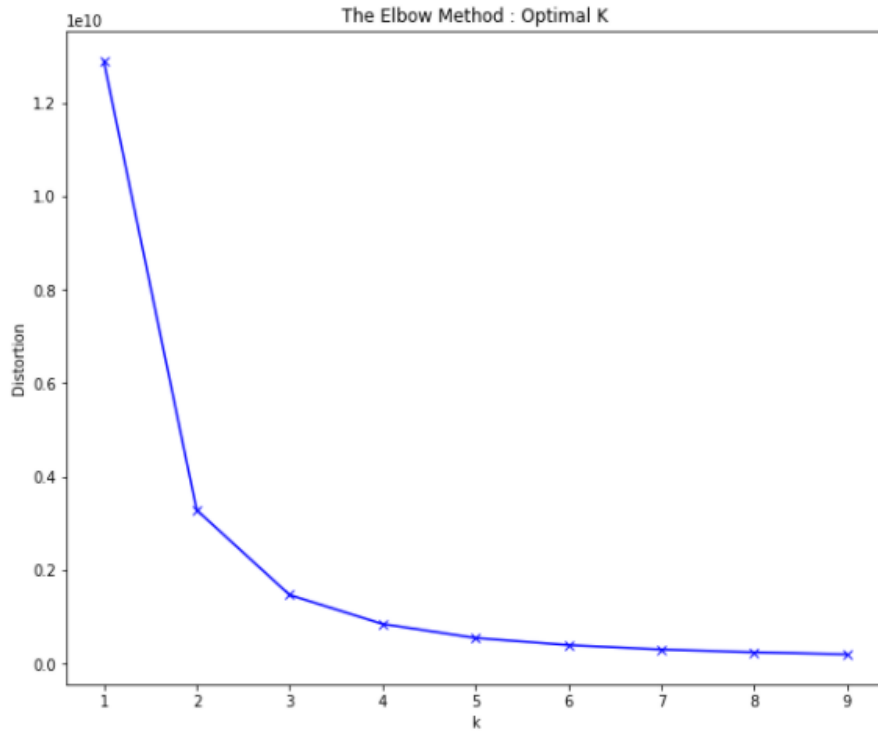


Figure 9: Finding the optimal numbers of Cluster (Elbow method)

Table 2: RFM score

	CustomerID	Recency	RecencyCluster	Frequency	FrequencyCluster	Monetary	MonetaryCluster	RFMScore
0	12346	325	0	1	0	77183.60	1	1
1	12350	309	0	17	0	334.40	0	0
2	12354	231	0	58	0	1079.40	0	0
3	12361	286	0	10	0	189.90	0	0
4	12365	290	0	22	0	641.38	0	0

Table 3: RFM membership

CustomerID	Recency	RecencyCluster	Frequency	FrequencyCluster	Monetary	MonetaryCluster	RFMScore	Membership	
0	12346	325	0	1	0	77183.60	1	1	Silver
1	12350	309	0	17	0	334.40	0	0	Bronze
2	12354	231	0	58	0	1079.40	0	0	Bronze
3	12361	286	0	10	0	189.90	0	0	Bronze
4	12365	290	0	22	0	641.38	0	0	Bronze

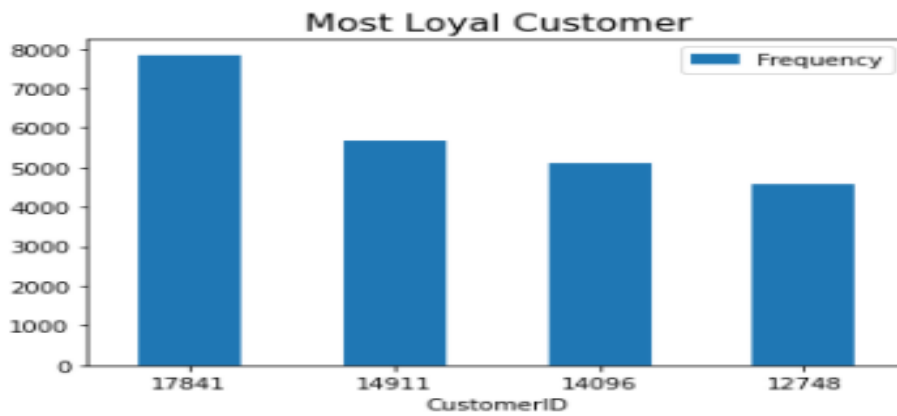


Figure 10: Loyal customers based on customerid



Figure 11: Loyal customer based on Membership



Figure 12: Highest Paying customer based on monetary customer id

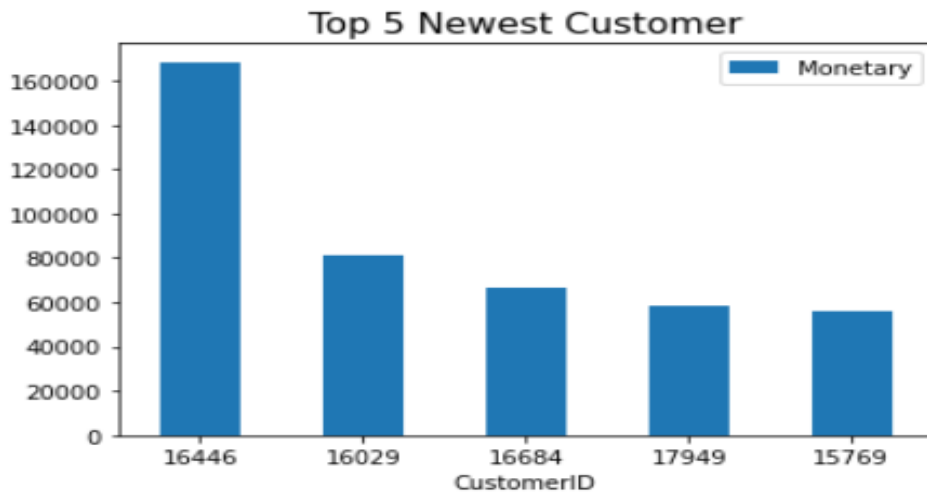


Figure 13 : Newest customers

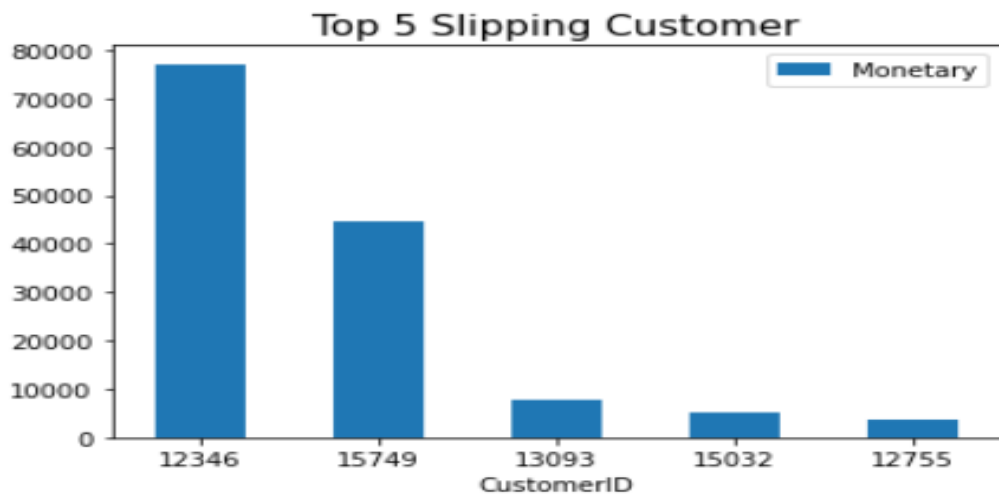


Figure 14: Once loyal, now gone

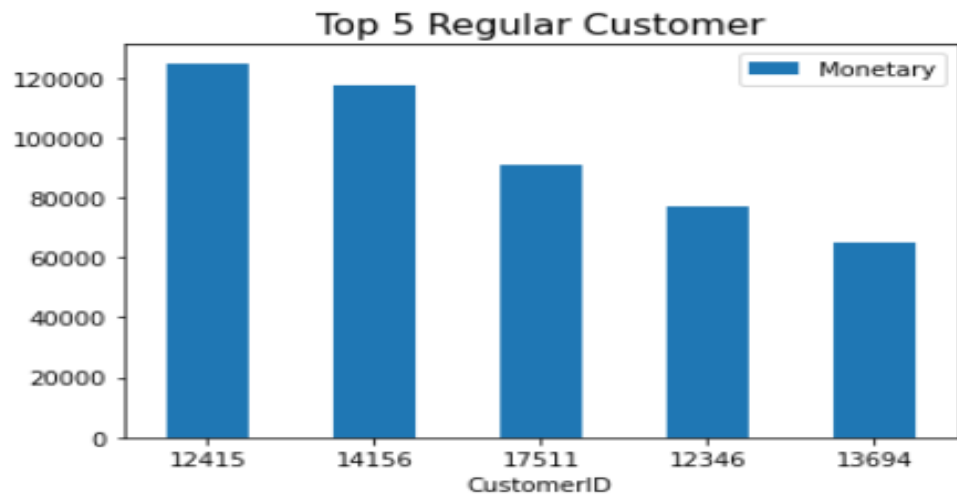


Figure 15: Regular customer

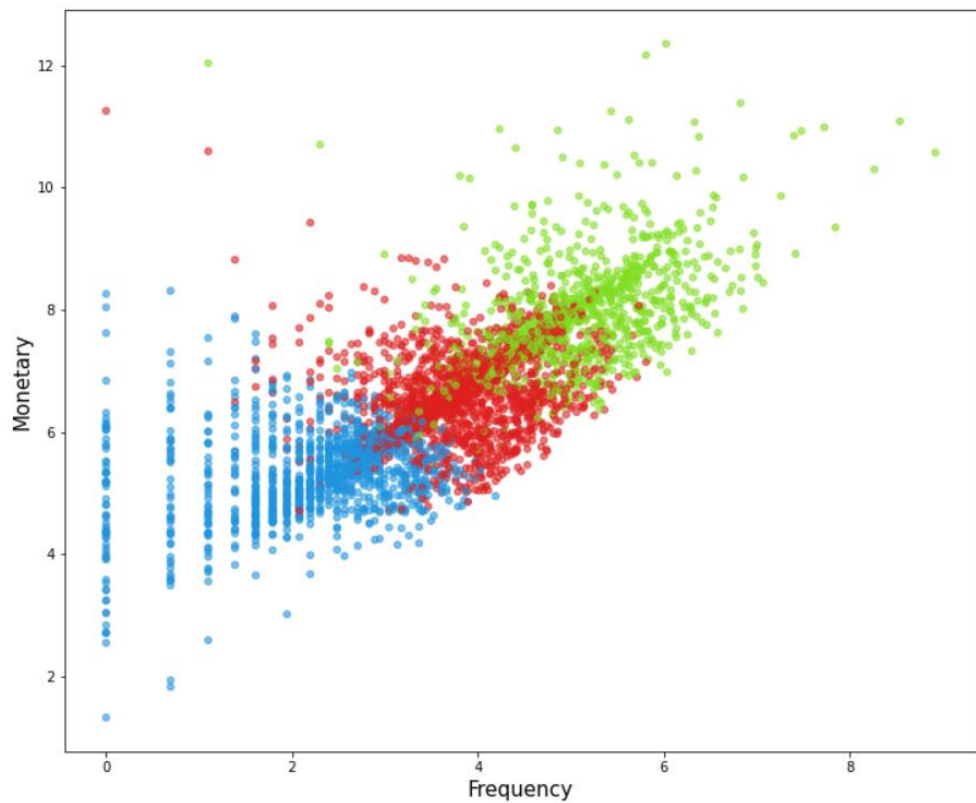


Figure 16: Customer in different cluster based on monetary and frequency value.

The above plot, Figure 16, that clearly show that green cluster is high value customer (Cluster 1) and blue cluster is Low value customer cohort (Cluster 2) while red cluster is average value customer cohort (Cluster 0)

- High Value :- Frequently purchasing customers with high monetary value of transactions and had transacted recently
- Low Value :- Least frequency customer and monetary spending and made purchase long time ago. These customers might be, lost from the customer base.
- Average Value :- Customers who made their transactions sometime with less frequency and monetary value. These customers could become high risk and company could aggressively market towards them with great deals so we don't lose them forever.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Findings and Contributions

Done of this research paper ,It conclude as pursue: Data cleaning and then analysis exploratory data. After than modeling data by using RFM factors. Choosing optimal number of cluster by using k-means algorithm based on elbow method. Simplify the business organization to building a better decisions by using customer different membership like, Gold, silver, bronze. Customers in the gold category purchase frequently, while customers in the bronze category purchase infrequently and may be dropped from the customer base. On the other hand, the silver customer purchase the product in average frequently. Therefore, would be nice to the organization to identify the customer in different group . So, the companies take a proper decision for the risk customer who maybe lost. The customer behavior segmentation help the organization to taking good relation with the customers and implementing different marketing strategies.

5.2 Future Work

In this paper, deep learning approaches have not explored with this dataset so it can be used with adding some other features and improve algorithm to get better acquires and performance.

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