REPORT

Abstract

We live in a world where large and vast amount of data is collected daily. Analysing such data is an important need. In the modern era of innovation, where there is a large competition to be better then everyone, the business strategy needs to be according to the modern conditions. The business done today runs on the basis of innovative ideas as there are large number of potential customers who are confounded to what to buy and what not to buy. The companies doing the business are also not able to diagnose the target potential customers. This is where the machine learning comes into picture, the various algorithms are applied to identify the hidden patterns in the data for better decision making. The concept of which customer segment to target is done using the customer segmentation process using the clustering technique. In this paper, the clustering algorithm used is K-means algorithm which is the partitioning
algorithm, to segment the customers according to the similar characteristics. To determine the optimal clusters, elbow method is used.

Introduction

Over the years, the competition amongst businesses is increased and the large historical data that is available has resulted in the widespread use of data mining techniques in extracting the meaningful and strategic information from the database of the organisation. Data mining is the process where methods are applied to extract data patterns in order to present it in the human readable format which can be used for the purpose of decision support. According to,[4] Clustering techniques consider data tuples as objects. They partition the data objects into groups or clusters so that objects within a cluster are similar to one another and dissimilar to objects in other clusters. Customer Segmentation is the process of division of customer base into several groups called as customer segments such that each customer segment consists of customers who have similar characteristics. The segmentation is based on the similarity in different ways that are relevant to marketing such as gender, age, interests, and miscellaneous spending habits.

The customer segmentation has the importance as it includes, the ability to modify the programs of market so that it is suitable to each of the customer segment, support in business decision; identification of products associated with each customer segment and to mange the demand and supply of that product; identifying and targeting the potential customer base, and predicting customer defection, providing directions in finding the solutions.

The thrust of this paper is to identify customer segments using the data mining approach, using the partitioning algorithm called as K-means clustering algorithm. The elbow method determines the optimal clusters.

Customer Segmentation

Over the years, as there is very strong competition in the business world, the organizations have to enhance their profits and business by satisfying the demands of their customers and attract new customers according to their needs. The identification of customers and satisfying the demands of each customer is a very complex and tedious task. This is because customers may be different according to their demands, tastes, preferences and so on. Instead of "one-size-fits-all" approach, customer segmentation clusters the customers into groups sharing the same properties or behavioural characteristics. According to customer segmentation is a strategy of dividing the market into homogenous groups. The data used in customer segmentation technique that divides the customers into groups depends on various factors like, data geographical conditions, economic conditions, demographical conditions as well as behavioural patterns. The customer segmentation technique allows the business to make better use of their marketing budgets, gain a competitive edge over their rival companies, demonstrating the better knowledge of the needs of the customer. It also helps an organization in, increasing their marketing efficiency, determining new market opportunities, making better brand strategy, identifying customers retention.

Clustering and K-Means Algorithm

Clustering algorithms generates clusters such that within the clusters are similar based on some characteristics. Similarity is defined in terms of how close the objects are in space. K-means algorithm in one of the most popular centroid based algorithm. Suppose data set, D, contains n objects in space. Partitioning methods distribute the objects in D into k clusters, C1,...,Ck , that is, $C_i \subset D$ and $C_i \cap C_j = \emptyset$ for $(1 \leq i, j \leq k)$. A centroid-based partitioning technique uses the centroid of a cluster, Ci , to represent that cluster. Conceptually, the centroid of a cluster is its center point. The difference between an object $p \in C_i$ and ci , the representative of the cluster, is measured by dist(p,ci), where dist(x,y) is the Euclidean distance between two points x and y.

Algorithm: The k-means algorithm for partitioning, where each cluster's center is represented by the mean value of the objects in the cluster.
Input: k: the number of clusters, D: a data set containing n objects.
Output: A set of k clusters. *Method:* (1) arbitrarily choose k objects from D as the initial cluster

centers; (2) repeat (3) (re)assign each object to the cluster to which the object is the most similar, based on the mean value of the objects in the cluster; (4) update the cluster means, that is, calculate the mean value of the objects for each cluster; (5) until no change.

How is Clustering an Unsupervised Learning Problem?

Let's say you are working on a project where you need to predict the sales of a big mall:

Outlet_Size	Outlet_Location_Type	Outlet_Type	Item_Outlet_Sales
Medium	Tier 1	Supermarket Type1	3735.1380
Medium	Tier 3	Supermarket Type2	443.4228
Medium	Tier 1	Supermarket Type1	2097.2700
NaN	Tier 3	Grocery Store	732.3800
High	Tier 3	Supermarket Type1	994.7052

In the sales prediction problem, we have to predict the *Item_Outlet_Sales* based on *outlet_size*, *outlet_location_type*, etc

So, when we have a target variable to predict based on a given set of predictors or independent variables, such problems are called supervised learning problems.

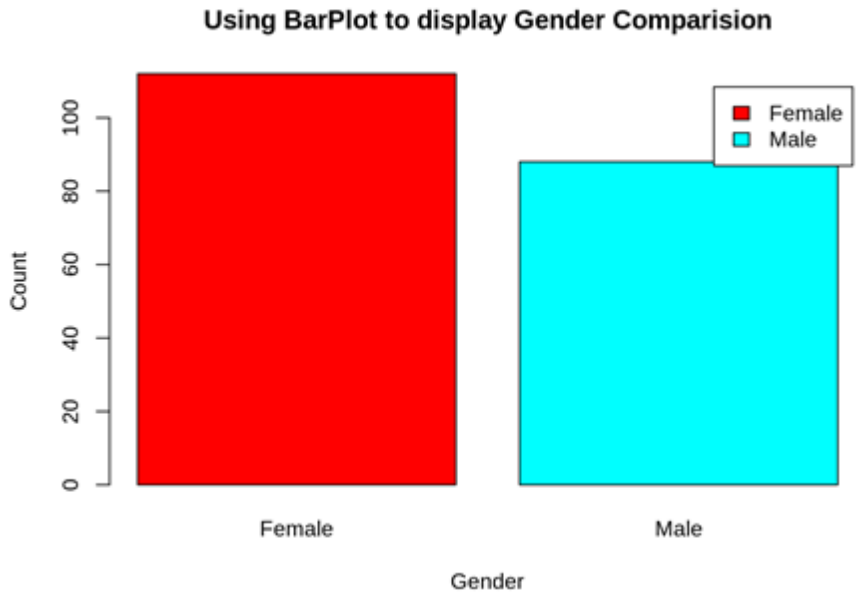
In clustering, we do not have a target to predict. We look at the data and then try to club similar observations and form different groups. Hence it is an unsupervised learning problem.

Methodology

The data set used to implement clustering and K-means algorithm was collected from a store of shopping mall. The data set contains 5 attributes and has 200 tuples, representing the data of 200 customers. The attributes in the data set has CustomerId, gender, age, annual income(k$), spending score on the scale of (1-100).

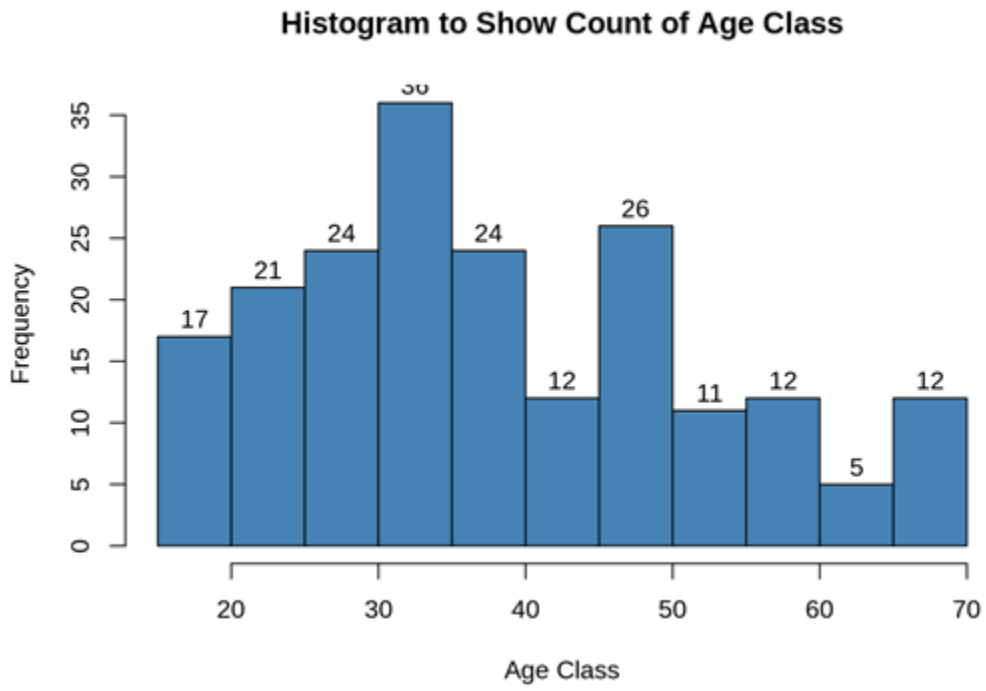
- **Visualize the gender of customers**

```
a=table(customer_data$Gender)
barplot(a,main="Using BarPlot to display Gender Comparision",
        ylab="Count",
        xlab="Gender",
        col=rainbow(2),
        legend=rownames(a))
```



- **Visualize age of customers**

```
hist(customer_data$Age,
     col="blue",
     main="Histogram to Show Count of Age Class",
     xlab="Age Class",
     ylab="Frequency",
     labels=TRUE)
```



- **Elbow Method:**

The elbow method is based on the observation that increasing the number of clusters can help to reduce the sum of within-cluster variance of each cluster. This is because having more clusters allows one to capture finer groups of data objects that are more similar to each other.

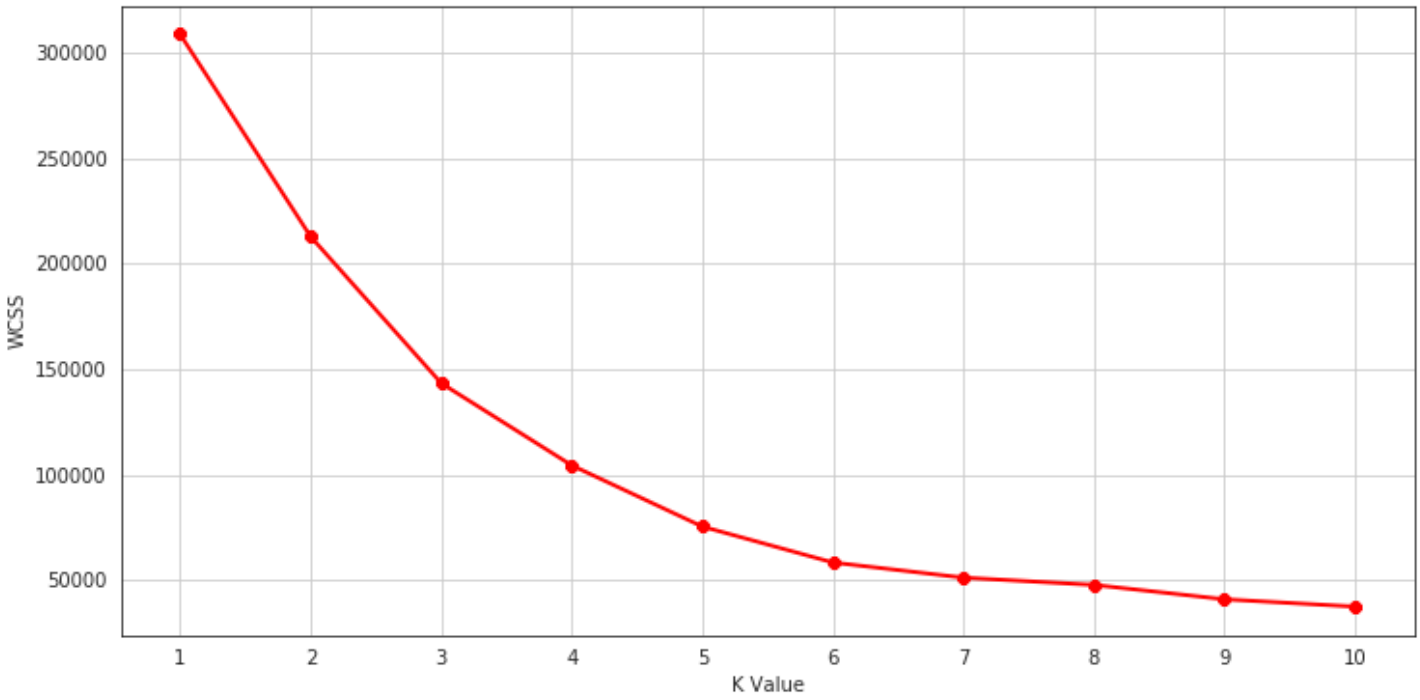
To define the optimal clusters, Firstly, we use the clustering algorithm for various values of k. This is done by ranging k from 1 to 10 clusters. Then we calculate the total intra-cluster sum of square. Then, we proceed to plot intra-cluster sum of square based on the number of clusters. The plot denotes the approximate number of clusters required in our model. The optimum clusters can be found from the graph where there is a bend in the graph.

```
library(purrr)
set.seed(123)
# function to calculate total intra-cluster sum of square
iss <- function(k) {
  kmeans(customer_data[,3:5],k,iter.max=100,nstart=100,algorithm="Lloyd" )$tot.withins
s
}

k.values <- 1:10


iss_values <- map_dbl(k.values, iss)

plot(k.values, iss_values,
     type="b", pch = 19, frame = FALSE,
     xlab="Number of clusters K",
     ylab="Total intra-clusters sum of squares")
```



Marketing strategies for the customer segments

Based on the 6 clusters, we could formulate marketing strategies relevant to each cluster:

- A typical strategy would focus certain promotional efforts for the high value customers of Cluster 6 & Cluster 3.

- Cluster 4 is a unique customer segment, where in spite of their relatively lower annual income, these customers tend to spend more on the site, indicating their loyalty. There could be some discounted pricing based promotional campaigns for this group so as to retain them.

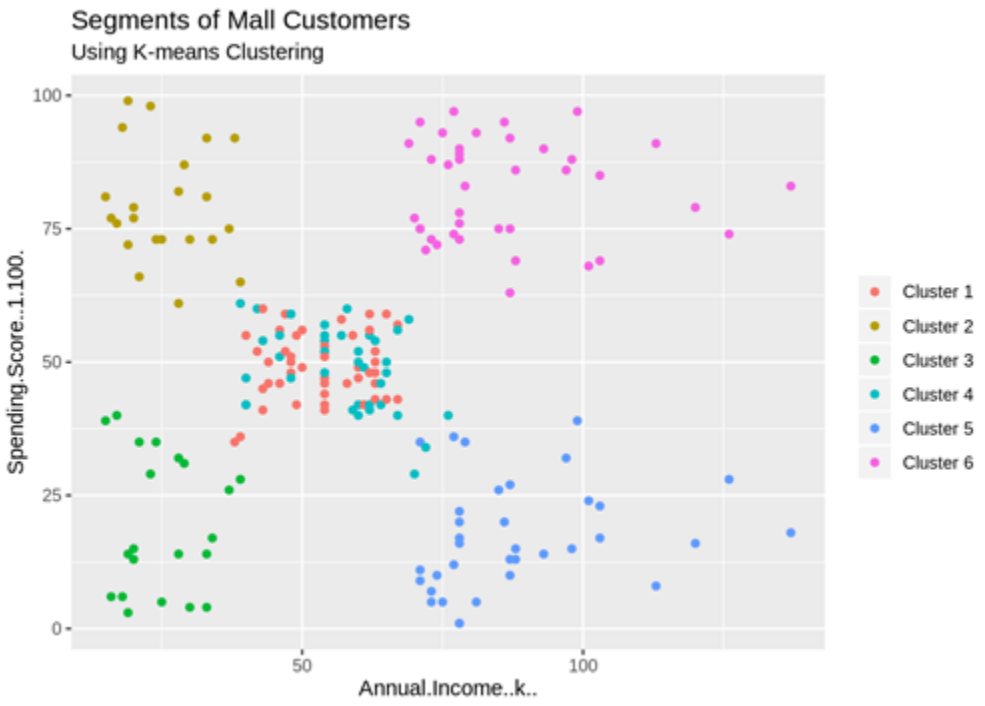
- For Cluster 2 where both the income and annual spend are low, further analysis could be needed to find the reasons for the lower spend and price-sensitive strategies could be introduced to increase the spend from this segment.

- Customers in clusters 1 and 5 are not spending enough on the site in spite of a good annual income — further analysis of these segments could lead to insights on the satisfaction / dissatisfaction of these customers or lesser visibility of the e-commerce site to these customers. Strategies could be evolved accordingly.

We have thus seen, how we could arrive at meaningful insights and recommendations by using clustering algorithms to generate customer segments. For the sake of simplicity, the dataset used only 2 variables — income and spend. In a typical business scenario, there could be several variables which could possibly generate much more realistic and business-specific insights.

- **Visualize the clusters**

```
## VISULIASE THE CLUSTERS
set.seed(1)
ggplot(customer_data, aes(x =Annual.Income..k.., y = Spending.Score..1.100.)) +
    geom_point(stat = "identity", aes(color = as.factor(k6$cluster))) +
    scale_color_discrete(name=" ",
                         breaks=c("1", "2", "3", "4", "5","6"),
                         labels=c("Cluster 1", "Cluster 2", "Cluster 3", "Cluster 4",
"Cluster 5","Cluster 6")) +
    ggtitle("Segments of Mall Customers", subtitle = "Using K-means Clustering")
```



Applications of Clustering in Real-World Scenarios

Clustering is a widely used technique in the industry. It is actually being used in almost every domain, ranging from banking to recommendation engines, document clustering to image segmentation.

Advantages of Customer Segmentation:

- Helps identify least and most profitable customers, thus helping the business to concentrate marketing activities on those most likely to buy your products or services
- Helps build loyal relationships with customers by developing and offering them the products and services they want
- Helps improve customer service
- Helps maximize use of your resources
- Helps improve or tweak products to meet customer requirements
- Helps increase profit by keeping costs down

Conclusion

From the above visualization it can be observed that

Cluster 1 denotes the customer who has high annual income as well as high yearly spend. Cluster 2 represents the cluster having high annual income and low annual spend. Cluster 3 represents customer with low annual income and low annual spend. Cluster 5 denotes the low annual income but high yearly spend. Cluster 4 and cluster 6 denotes the customer with medium income and medium spending score.