Customer classification to generate appropriate promotion codes based on product category using machine learning models

MSc in Data Analytics
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Saigirish Palavarapu
17170401

School of Computing
National College of Ireland

Lecturer: Noel Cosgrave

Contents

Abstract

In the retail industry, it is necessary to understand customers needs and maintain the customer relationship especially in todays current trend. Providing offers and additional value to your products has become a common practice in order to better customer satisfaction and also due to the increase in competition, the problem thus arise on how to better suggest the most suitable promotion code to the customer or a category of customers. In this paper, we propose a solution that looks to solve this issue by using machine learning methods like k-means, clustering, mean-shift clustering, DBSCAN and SVM for segmentation to generate the right cluster group of customers and products to better generate promotion codes using CLV and RFM features. An integration of a Customer Relationship Management (CRM) system here will enable a complete flow of the data and allow the company to maintain and suggest the customers along with the respective marketing or promotion strategy required.

Keywords: Retail, classification, clustering, promotion codes, CLV, machine learning, CRM

1. Introduction

Today's retail markets analyse all sorts of data in order to obtain maximum details and information about their customers. Companies are also looking very deep into data to better understand their customers, detect similarities, differences, behaviours, opportunities, etc to further provide the right product or solution for them. Providing value to a customer has always been a part of an organizations goal and have always included it in their sales and promotion strategy. Some of which include promotion codes, coupons, loyalty programs, sales, discounts, price drop announcements, limited period offers, etc. In this research, the aim is to classify customers based on the customer lifetime value (CLV) and other attributes like price, products, purchases, etc. and suggest the appropriate promotion code to the customers for the respective product category. The analysis for this research is based on classification models that would consider customer, product and segment data including quantity, price and category for the which the appropriate promotion code is generated for the right customer and category. This would benefit the company and the customer as they are offering more value to the customer for the product and its category. The company offers accurate promotions to the customer making it a better shopping environment for the customer and indirectly increasing the opportunities for sales and promotions. This will not only help the existing customers but also look at cross selling to customers and providing offers to product categories that they would normally not be interested in and might also look at obtaining new customers by possible feedback means of promotion categories, coupons, advertisements, etc.

This research proposal has been designed to answer modern-day retail scenarios of customer engagement, sales promotion offers and product value giving the right attention to detail along with the right value for their products. The research has been designed to first, work on modern methods and models and second, on various customer data and analyse the data using different machine learning algorithms. This research looks at CLV as one of the parameters along with customer data pertaining to purchase, price, etc using the RFM (Recency, Frequency and

Monetary) method to provide the right customer segments and groups. Then, comparison of customer segments and products along with various promotions in order to understand the RFM values for their respective cluster sizes.

In this research, there is a section that focuses on the literature review which is section 2 where the market enhancement, product segments, customer category, purchase, price, promotion, machine learning algorithms used, etc have been discussed. In the next section, we have also discussed the research methodology where the design workflow and implementation of the research is discussed in detail along with the plan for the research implementation. There is also a small section for ethics, mentioning the ethical boundaries of the data in use for this research.

Research Question

Can a model with clustering of customers and products into meaningful segments help in generating appropriate promotion codes for companies and marketing teams in the retail industry?

This research looks at answering the research question using machine learning and data mining methodologies. This research will not only look at getting detailed results for big data pertaining to the retail industry but will also enable the decision makers to make better informed decisions on marketing and promotion related decisions based on customer and product category segments with the promotion type implemented and planned.

2. Literature Review
2.1 Introduction

In recent times, businesses and companies have been facing with many complexities and that is where the role of data mining becomes important. Be is in terms of descriptive or predictive in nature, the data model built has many uses to it. There have been many researchers and projects that have tried to solve problems in the retail industry to gain better insights on customer related data and information. It is important to understand customer data and many retail companies look for such valuable information. It is important to understand the benefits of customer segmentation, Ezenkwu, C.P., Oloyede, A., Umana, I.S., Jerome, O. and Ekpo, E (2013) mentions the benefits of customer segmentation considering how the world has become competitive and it is very important to satisfy the needs of the customers, as each customer has a different need and there are many parameters that make it complex to understand and the idea of market segmentation and customer segmentation helps to gain a competitive advantage as well. Another method that has been frequently used in retail industry for understanding customers and products is Market Basket Analysis (MBA) which is also known as association rule mining or affinity analysis which looks at discovering relationships in data sets and some

of the papers, like Kaur, M. and Kang, S (2016) mentions about the approach used where the association rule mining predictor algorithm was used with outliers and association rules as results. Brijs, T., Swinnen, G., Vanhoof, K. and Wets, G (1999) also uses MBA in their analysis where the integrate the frequent items with a model for product selection which helps identify cross-sales potential and better product selection. There also have been many other types of machine learning methods like regression methods that need have been used with respect to customised promotions as well as clustering for online promotions to name a few (Zhang, J. and Wedel, M., 2009; Zhang, J. and Krishnamurthi, L., 2004).

For this research, a detailed literature review on the models, methods and techniques that have been used and implemented in the industry to find and solve various problems has been done to understand the problem in detail and what approaches have been used previously.

2.2 Big Data and Customer Behaviour in Retail

As the current trend in big data analysis and research on customer behaviour is changing the trend especially in retail where customer behaviour and trend change has made most retail companies vulnerable and has become a key aspect to the seller as they have new demanding situations in the current market. In the retail industry maintaining and checking on new customers and to understand their purchase and transactions is the main important thing (Bradlow, E.T., Gangwar, M., Kopalle, P. and Voleti, S., 2017). It is important to understand what customers behaviours and understanding is in order to properly understand the problem. Bradlow, E.T. et al (2017) talks about big data in retailing and mentions how the various channels for marketing and the data available for customers, products, time, location and channel is always helpful to understand customers better where an experiment was conducted to examine the possibilities in retail with big data and the detail predictive analysis with importance to understanding customers and their data using various tools and models and there is a lot involved with the way the data has been collected and how the customers perceive the marketing and offers that have been provided which retailers need to proactively address similar issues.

2.3 Customer and Product Segmentation

It is very important to understand the importance of customer and product segmentation, there is a lot of detail involved with many models and methods with various features and parameters involved. Wu, R.S. and Chou, P.H (2011) basically developed a clustering approach that uses latent mixed-class membership approach which is basically derived from the Latent Dirichlet Allocation (LDA) and proposed a hard-clustering approach for better results which basically resulted in a method of segmenting customers across multiple categories that is also computationally feasible. Brito, P.Q., Soares, C., Almeida, S., Monte, A. and Byvoet, M (2015) also looks at investigating customer segmentation using clustering and subgroup discovery methods to better understand customer preferences in the fashion and e-retailer industry helping both marketing and product development teams understand and better improve their

products and effectively understand and respond to customer requests and preferences. You can also look at real time system developments even when considering a retail supermarket, it helps to understand and predict the sales and in this particular case where the clustering was done using k-means and was classified using the nearest mean value added to which an ANOVA was carried out to check the stability of the clusters (Kashwan, K.R. and Velu, C.M, 2013). Aziz, A (2017) also looks at customer segmentation based on behaviour where a personal feed was constructed for each customer where the user groups was from where the items were derived where he also uses Principal Component Analysis (PCA) for dimensionality reduction. Hossain, A.S (2017) looks at customer segmentation by applying density based algorithms along with k-means and primarily looks at applying Density-Based Spatial Clustering of Applications with Noise (DBSCAN) in order to get better results in customer segmentation. Ozan, S (2018) segmented the customer data based on customer groups and promoting a certain group of customers as premium and the other customers as standard making it easy to classify the other payment related data that was used as input and added feature scaling to normalize the data and to segment the customers appropriately in order to find the best classification method for the companies promotion strategy.

2.4 Customer Relationship Management (CRM) as a Tool

Over the past few years, many organizations especially in the retail industry are implementing and using CRM tools and software which help them manage the organization and customer details with ease and also helps support the business end and analyse customer and company transaction and purchase details in order to maintain customer relationships with a much more faster and better process. Data mining tools applied to CRM is a global emerging trend and due its customer centric approach CRM is widely used across the world (Ngai, E.W., Xiu, L. and Chau, D.C., 2009). In this paper, Ngai, E.W., Xiu, L. and Chau, D.C (2009) looks at understanding the applications of data mining techniques in CRM systems which basically helps not only in customer relationship but indirectly helps in customer retention to name a few and includes other dimensions of CRM like customer attraction and development as well. Also, some researches look at the long-term impact of customer loyalty programs based on their usage and need to consider consumer idiosyncrasies and cocreation values into the marketing process (Liu, Y., 2007). In a research by Florez-Lopez, R. and Ramon-Jeronimo, J.M (2009) uses CRM and customer profitability into account and proposes a three-stage methodology that has marketing feature selection, customer segmentation and oblique decision making based on different scenarios where the model built was applied and tested on a large insurance marketing data.

2.5 Customer Lifetime Value (CLV)

CLV is one of the many important ways to calculate the value of a customer in terms of loyalty and history of purchase making it easier to understand customers and their purchase patterns as well. CLV is used as a calculation by many researchers across all domains including retail. Cuadros, A.J. and Domínguez, V.E (2014) looks at CLV values and customer segmentation

along with the effectiveness of the customer segmentation and for the lifetime value consider 3 factors namely current value, potential value, and customer loyalty. Khajvand, M. and Tarokh, M.J (2011) also looks at CLV for each segment and mentions that it would be helpful to understand customers and make decisions also considers the customer future value along with CLV based on segmentation. Kim, S.Y., Jung, T.S., Suh, E.H. and Hwang, H.S (2006) also looks at segmentation based on CLV illustrated through case study for a telecommunication company. Kahreh, M.S., Tive, M., Babania, A. and Hesan, M (2014) looks at using CLV for segmentation as well based on descriptive factors of a specific market in the banking sector. Singh, L., Kaur, N. and Chetty, G (2018) looks at a mathematical model framework for CLV to gain the full profit from the customers and segment based on their value and also looks at predicting the same. Gupta, S., Hanssens, D., Hardie, B., Kahn, W., Kumar, V., Lin, N., Ravishanker, N. and Sriram, S (2006) also looks at segmentation using CLV primarily for acquisition, retention and cross selling.

2.6 Recency, Frequency and Monetary (RFM) Model

RFM is a way of expressing the customers in recency, frequency and monetary meaning how recent was their visit, how frequent and the purchase amount (Tanaka, T., Hamaguchi, T., Saigo, T. and Tsuda, K., 2017). The paper by Tanaka, T et al (2017) talks about understanding and classifying supermarket store customers using not only good customers but also customers that generate the higher number of sales using RFM model. Customer segmentation with CLV mainly based on 2 approaches, RFM and an extended RFM model with an additional parameter of item count as well, there is also researches that use CRM data and estimate the CLV based on the RFM model in industries like banking as well (Khajvand, M., Zolfaghar, K., Ashoori, S. and Alizadeh, S., 2011; Khajvand, M. and Tarokh, M.J., 2011). Yoseph, F. and Heikkila, M (2018) looks at retail customer segmentation using an extended RFM model along with a hybrid regression and k-means clustering method to provide better market segments and suggest better marketing strategies. Dogan, O., Ayçin, E. and Bulut, Z.A (2018) also uses the RFM values to identify valuable customers for the company in order to provide promotional activities for which data mining techniques like clustering was used as well.

2.7 Clustering and Segmentation with k-means, DBSCAN and SVM

One of the most widely used clustering algorithm is the k-means clustering. Clustering basically is grouping objects based on similarity on characteristics or parameters or features. K-means algorithm requires you to mention the number of clusters, basically describing your k number for the k-clusters. Kashwan, K.R. and Velu, C.M (2013) looks at a complete report on the k-means clustering technique for a super market in order to predict the sales. Aziz, A (2017) also looked at a customer segmentation approach using k-means clustering along with cosine similarity as a measure. Ezenkwu, C.P et al (2013) looks at k-means clustering for efficient customer segmentation for targeted and customised services and marketing programs. 25. Yoseph, F. and Heikkila, M (2018) looks at k-means for their clustering approach for market segmentation along with the expectation maximization. Liu, R.Q., Lee, Y.C. and Mu,

H.L (2018) looks at customer segmentation using k-means clustering along with association rules for an online shopping mall. Clustering methods like Density-Based Spatial Clustering of Applications with Noise (DBSCAN) have also been used for various retail and customer clustering by many researches and projects and basically look at grouping according to various consumer preferences or logic which can be used for information retrieval as well (Hossain, A.S., 2017; Rajagopal, D., 2011). Sheshasaayee, A. and Logeshwari, L., (2018) also looked at customer segmentation using SVM based on RFM features. We also have Support Vector Machine (SVM) which is one of the most commonly used algorithms for segmentation and Yao, Z., Eklund, T. and Back, B (2010) also looked at mass customer segmentation by combining SVM, neural networks and decision tree models.

3. Research Method and Specification
3.1 Methodology

There has been a lot of work done in the field of retailing and data mining is one of the most primarily used approaches when dealing with customer data. Classification and clustering of data is necessary when we work with customer data especially in retail to understand what kind of data is at hand. In this research, the aim is to check and see if the clustering model built can provide meaningful clusters or segments that can be mapped with appropriate clusters or segments from the marketing promotion campaign in order to provide better promotion codes to its customers. For this we look at clustering using various machine learning algorithms like k-means and Support Vector Machine (SVM) to check and see which model suits and works the best in terms of accuracy. The methodology approach for research is CRISP-DM (CRoss Industry Standard Process for Data Mining) as the approach requires a step by step flow like a hierarchy which can be defined to specific tasks and processes (Wirth, R. and Hipp, J., 2000). When we understand the phases in the CRISP-DM methodology and put it to our research, we have the business understanding where the retail sector is our target business and stakeholders look for answers specific to marketing and promotions for the customer end and this research provides a process to answer this problem (Wirth, R. and Hipp, J., 2000). The next phase is the data understanding phase where the data involves collection, transformation and identification of the customer data that would be used for further analysis. Then we have the data preparation where the extraction of our customer data involving cleaning and getting the data to the right format for applying to the models that would be created. In the Modeling phase is where the models are built and tested and checked for the performance and assessment moving which the evaluation of the results and models are done in the next phase and finally deployment of the entire project and plan in terms of maintenance and constant review in case new data or new customer information has been added into the system for further analysis of the same. The figure below shows the CRISP-DM process flow (Wirth, R. and Hipp, J., 2000)
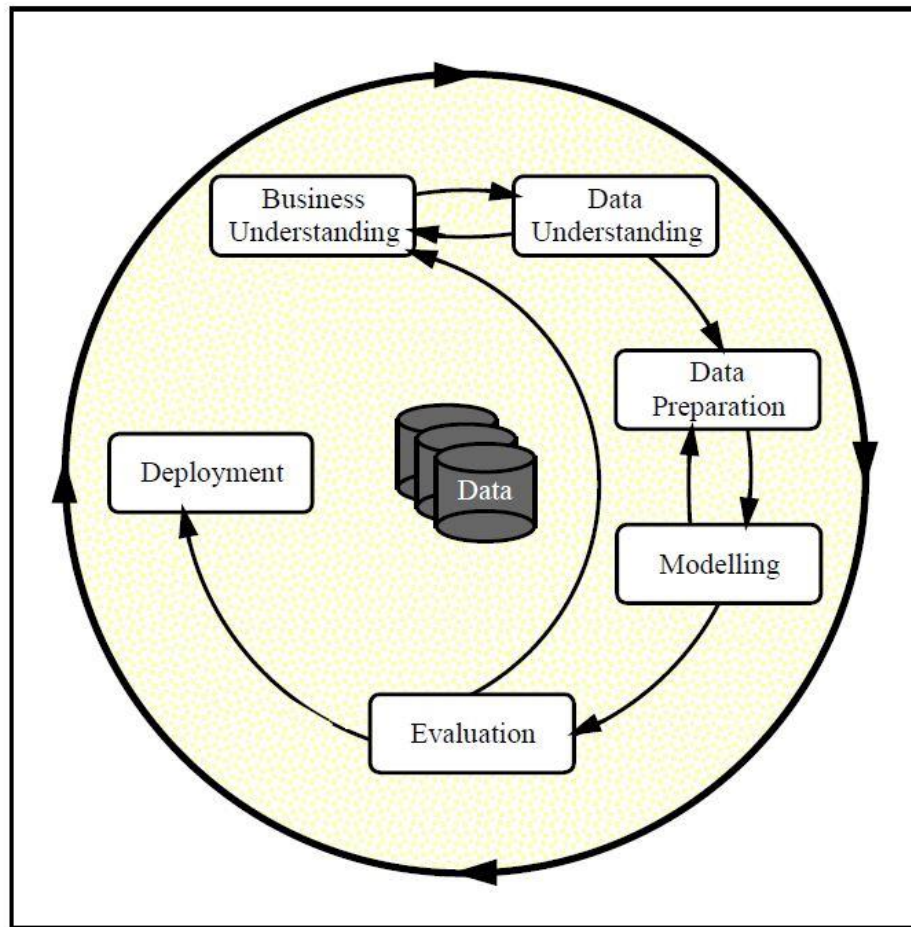
Figure 1: CRISP-DM Process (Wirth, R. and Hipp, J., 2000)

3.2 Implementation

For this research project there are 3 different stages or phases that need to be executed in order to achieve the results required to answer the research question. We need to understand the data first, which is basically customer transactional data for an online retail store where the dataset contains information like invoice number, stock code, product description, quantity, date of purchase, price, customer id, etc and has been taken from the UCI repository website. The information available is specific to customer of that retail company and we need to analyse the data in order to understand the data properly as it contains customer transaction and purchase information and since it is an open source and free dataset without any personal information of the customer, there should be no GDPR issues as well.

To completely understand the project and its implementation, a process flow diagram (Figure 2) has been created. We first gather the data and information from the dataset and then we move to the data pre-processing and preparation step where we look to understand the data and prepare the data for the next phase of feature extraction where we look at similarities and patterns in the data to create our clusters, then we look at understanding the data and identifying

customers lifetime value by calculating the CLV of the customer, which is basically prepared using the RFM model and then we prepare our model and again run a CLV for each individual cluster using the RFM model. Now before the models is being prepared, we look at splitting the data into train and test for validation and data processing and training of the data correction takes place for training the model. We perform the clustering of the data based on RFM parameters and check the best clustering model for the data set using the k-means, mean-shift and DBSCAN algorithms in order to check the best suitable model for the research along with providing the most accurate information for analysing, clustering and segmenting the customers and products in order to generate the appropriate promotion codes for them. DBSCAN looks at eh minimum distance between the points and the minimum number of points based on how dense the region is and determines the clusters so we can check the clusters classes to check if they are appropriate. With k-means algorithm, the number of clusters (k clusters) along with the threshold and iterations are decided by us and we check to see the best cluster or classification output based on the number of k and we can evaluate the clusters based on its class labels as well.

Training our SVM model to segment product data is also important which is the block "A" shown in figure 2. The idea is to segment the products as well so we have a category of products that can be easily mapped to the customer clusters in order to check which group of customers or clusters have what category products. For product segmentation, we will check our support vectors using not only linear SVM but also using Radial Bias Function (RBF) kernel as well. We use a confusion matrix to test the model performance once we get our support vectors, we can classify them into training and testing, and we would know the labels in order to calculate the true positive, false negative and false positive from which accuracy can be calculated. We can also calculate using the F-measure statistic where we check the false negatives and check the precision and recall.

Also shown in block "B" of figure 2 is the segmentation of promotion codes, where we understand what categories of promotion codes are available so that the promotion codes, products and customer clusters can be mapped easily. Then we look at results comparison and evaluate all the models built and check the model performances in order to get the best performing model for this project.

The output mapping stage can be done both manually or automated in the sense of using a tool for management or marketing. It can be done using a CRM system like salesforce, Zoho CRM, MS Dynamics, etc as well where the entire customer journey can is captured along with details that can be maintained by the company system where we can include the marketing or emailing campaigns and also look into using the right promotion code to the customer or group of customers that are there integrating it into the system would help in better customer response and customer relations. A CRM system here can also act as a bridge between the data flow and the customer interactions as well.
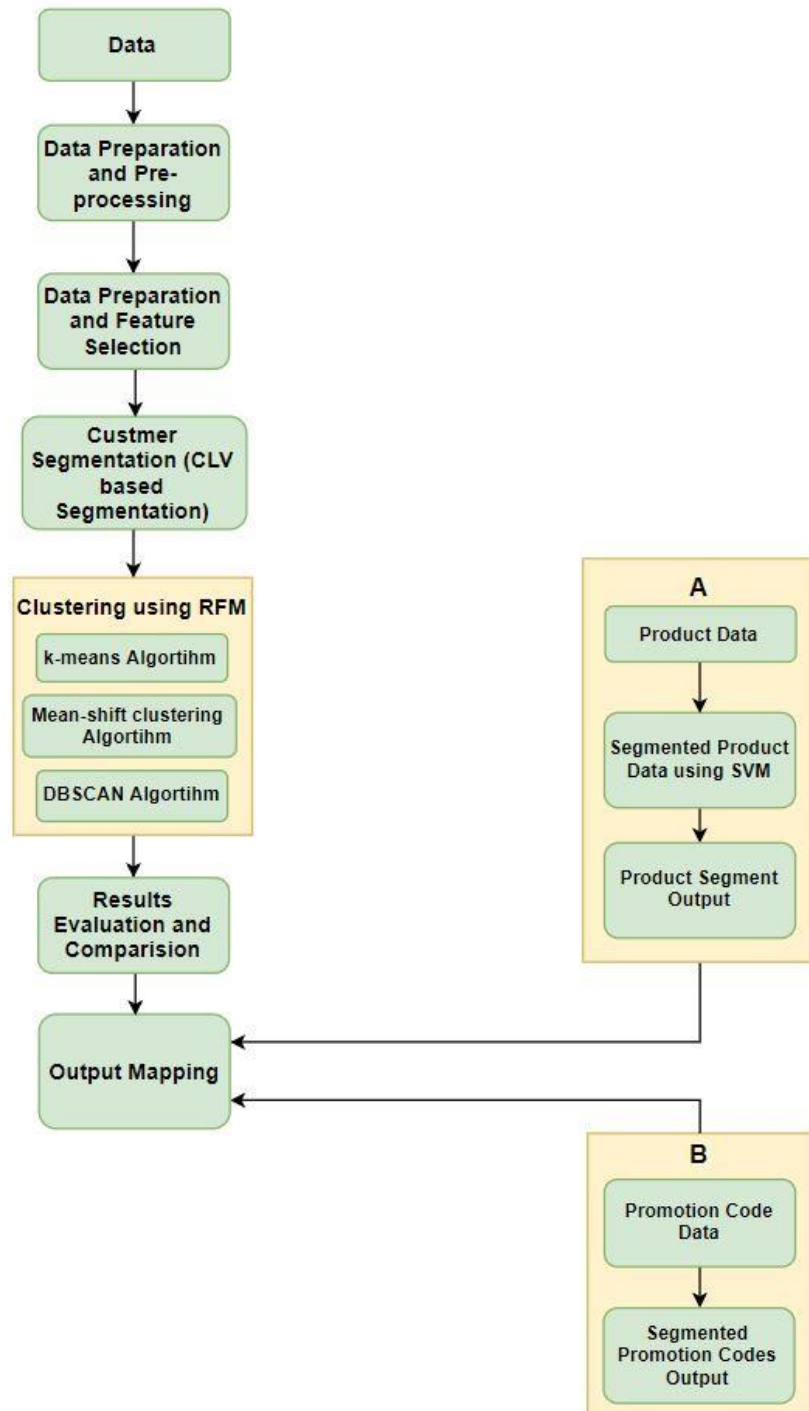
Figure 2: Project Design Flow

4. Ethical Considerations and Project Plan

This research project is not using any private data and the data is a free and an open source available from an online repository and even data from the company customer data consists of only general information without any personal details for the customers profiles which does not hamper any policies of the GDPR (General data protection regulation).

The project plan for this research is spread on a 15 weeks timeline and involves mainly the research methodology and report as mentioned in the following

Research Methodology:

1. Data Extraction
2. Data Cleaning
3. Transformation of Data
4. Feature Extraction
5. Building Models and Implementation
6. Evaluate Results

Report:

1. Rough document draft
2. Proofreading
3. Collate
4. Final Report

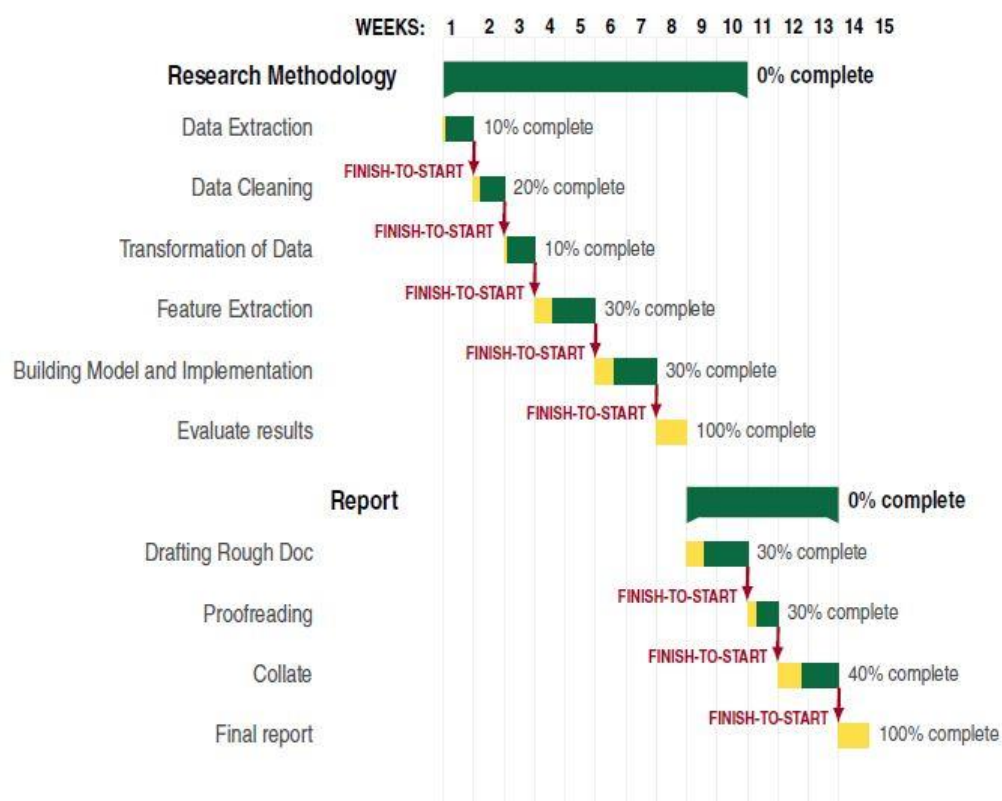Details and timelines are shown in the Gantt chart below (Figure 3)

Figure 3: Gantt chart for project plan

5. Conclusion

In this project we look to understand what kind of customers does the retail organisation have and understand what product categories are primarily being bought and used and look at generating the right promotion codes to the right segment of customers based on the product category in order to possibly better engage with the customer and improve customer

understanding and indirectly increase sales, customer loyalty and brand along with improving the relationships with the customer and eventually increase or build trust as well. This project looks to build the respective models uses machine learning algorithms in order to achieve the task of clustering and segmenting the customer along with promotion code generation along with evaluation and validation of the results.

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