

A Web Application to Support Customer Churn Management for Retail Grocery Stores

Mallawarachchi S.N.¹, Rodrigo M.N.D.², Gunaratne M.A.S.N.³, Gamage M.P.⁴, and Qamra N.N.⁵

^{1,2,3,4,5}Faculty of Computing, Sri Lankan Institute of Information Technology, Malabe, Sri Lanka
Email: ¹it18185126@my.sliit.lk, ²it18112474@my.sliit.lk, ³it18183450@my.sliit.lk, ⁴manori.g@sliit.lk, and ⁵it18156898@my.sliit.lk

Abstract— In the business world ‘Customer Churn’ is a principal issue. The retail grocery business holds a peak point in churning customers due to various reasons. Churn means gradually breaking every connection with the business by the customers. According to the experts, retaining the existing customers cost less, than attracting new customers. Therefore, a web-based prediction model; “CRetention” with some additional features is proposed as a solution. The main features in the proposed system are to analyze data and predict customers who are about to churn, manage the storage of inventory items, provide marketing strategies by market basket analysis, and offer personalized marketing recommendations to retain customers. Machine Learning and Deep Learning technologies are used to implement the solution. The main advantage and novelty of the product are that a definition for churn adjusted to a retail business is created and churners and results are obtained are based on a real scenario. It is clear that the retail grocery store owners highly recommend and appreciate the proposed system from a survey conducted.

Keywords— Customer-Churn, Machine-learning, Recommendation-system, Market-basket, Product-analysis.

INTRODUCTION

A regular customer base is one of the essential factors for the business's survival. Customers are the most important factor of the business. Efficient customer service is very important because of the business' dependency on customer satisfaction. A company is going to stop the customer service and products selling in a selected place at a specified time period is called customer churn. As for the solution, retention was introduced to the modern business world. Holding customers without letting them loose from the organization is called retention. A grocery store is a place people can buy everything under one roof. From a google survey, we found that most time products are not available on the shelf. A grocery store is placing more products with a large number of brands available but still, customers are willing to buy quality products and also customers are looking through the price of the product as well. Another problem that we found through the survey is that new products are refused to buy because of the unfamiliar feelings towards the products. When the products are stuck in stock, the storage space of the store will be not enough to store the new stocks of items. Michael N. Katehakis, Jian Yang, and Tingting Zhou [1] has found the same problem in their research study and addressed the issue as follows in their study “nonperishable are filled with stock without going it will be a problem to stock other demand product to a stock issue is occurring on the space that you have to stock the items. Nonperishable items have to be sold up with offers and promotion.” [1]As we further inspect the product-based issues related to the retail grocery business, unrelated promotion items and item sets were

mentioned by a fair amount of the survey contestants. To address this issue market basket analysis is proposed in our research study to identify relative items, item sets, and relationships between item sets to obtain buying habits and patterns. Market basket analysis is a business intelligent technique; businesses can enhance revenue by better understanding customer buying patterns. It uses to devise effective market strategies. Market basket analysis assists in marketing strategies regarding the placement of products and marketing services. In the retail business, some customers stay whereas some stop purchasing at a specific store after a certain period of time. Identifying customers who have decided to purchase from other stores and finding customers who are inactive at the moment is a tough task for a business. Customer churn which means the tendency of customers discontinuing the interactions with the business holds back the growth. Therefore, a proper settled method is needed to calculate customer churn for a specified time period. Personalized marketing is the implementation of a technique by which organizations deliver personalized content to recipients through data collection, analysis, and also the use of automation technology. In the research study, we focused on implementing a recommendation system to approach the customer with a wide comprehension of their purchasing behaviors. Machine learning-based mostly consumers personalization provides a more accurate and right manner to achieve a unique consumer experience for individual users.

As a solution for the specific retail grocer stores' issues we have identified, actual data sets of transaction,

inventory, and customer are used to estimate accuracy and the performance of proposed machine learning models. The datasets are analyzed using supervised and unsupervised data mining techniques. As the final product, a web-based application was developed using frameworks and back-end programming language. The machine learning models are developed using Python language to generate the predictions for respective research components. The mentioned digitalized solution is purposed to the management of the selected retail grocery store, to apply a solution to existing problems and increase the efficiency and effectiveness of a satisfying customer journey.

A. Objectives

The main objectives of this study are mentioned below.

- Analyze the historical patterns of sales of the customers and suggest the Stock-In items/item quantities for specific time periods.
- Analyzing customer purchasing behavior and identifying item sets that occur frequently.
- Analyzing the number of active days of customers and predicting customers to be dropped out so that necessary actions can be taken
- Analyzing individual consumer profiles and providing consumer personalized marketing promotions for the consumers.

B. Deliverables

The product deliverables of our study are as follows.

- A system that can manage the storage and reduce product wastage of a grocery retail store.
- A system that can display the most popular related itemset purchased by the customers.
- A system that can label a customer as a churn or not.
- A web application that can predict if a customer is churning or not.
- A system that can provide personalized marketing offers.

RELATED WORK

The literature survey for this study was done mainly on one area of the subject customer churn prediction in retail businesses. Increasingly, the research community is turning to introduce predictive models to achieve forecasting outcomes using predictive models in the marketing field. Most of the studies to date also support the general classification, clustering, statistical methods.

According to the author Alex Mari in [2], the impact of machine learning (ML) could help to develop more efficient and human marketing strategies. The author provides a model for the definition of AI-driven strategies within the marketing context. And it explores the critical elements of what, how, and why to infuse AI into the sequential steps of a marketing process. Transcripts of semi-structured interviews were conducted physically and virtually over a period of 6 weeks until January 2019 it was used analyze were analyzed by adopting an inductive line-by-line coding approach. Machine learning and artificial intelligence in personalized marketing using machine learning algorithms to predict customer buying behaviors and habits could improve customer satisfaction is theoretically proved in this paper. The author had carefully described the benefits of novel technological marketing strategies with clever practical explanations to prove his theories. The paper contains the importance of the study explained in automation, optimization, and augmentation aspects. The study helped our research to understand the constant theoretical factors of marketing and how machine learning, artificial intelligence concepts are used to obtain more accurate results. Overall, the author highlighted that “implementing an AI strategy is less about developing algorithms and more about building relationships that balance the strategic goals, processes, and benefits of AI-driven marketing”. [2] The authors Akshat Gupta, Milan Desai, Wusheng Liang, Magesh Kannan have described an exploration of multiple approaches to applying action recognition to a production application using a non-standardized dataset. The methods of classifying the non-standardized dataset that is presented in their study have been referred for inventory data management. [3]

As the author, Deepshikha Wadikar explains in her study, the most popular supervised machine learning methods are Logistic Regression, Random Forest, Support Vector Machine (SVM), and Neural Network. The author has done a comparative study of all mentioned methods applying to an imbalanced dataset and results were evaluated. The study helped to understand the process of building and evaluating the churn prediction models. [4] The author Yüksel Akay Ünvan describes market basket analysis conducted using association rule mining. The study was conducted for a supermarket and with a dataset that contains 225 items. We referred to the mentioned process and the steps to achieve successful market basket analysis to our selected dataset. [5] Past researchers and studies, there are few machine learning models of personalized recommendation. Those are content-based modeling, collaborative filtering modeling, and hybrid modeling.

According to the study of authors Baptiste Rocca and Joseph Rocca, categorizing the recommendation implementation methods has three main components. Those are content-based, collaborative filtering, and hybrid method. And collaborative filtering is again categorized into two models as memory-based and model-based. [6]

METHODOLOGY

The dataset used in this study to develop the proposed web application includes real transaction, inventory, and customer data of five months from a retail grocery store in Dehiwala.

A. Apparatus

The proposed system is a web application that assists to retain customers by providing marketing strategies before being dropped out from the business. Python language and Flask framework are used to implement. Html, CSS, and bootstrap are used to implement the frontend of the web application.

B. Research

1. Inventory Management using machine algorithms

A grocery store is a place where the process of buying and selling happens. Products that are sold to the customers should be bought from sellers stored in advance to establish an on-hand supply of products. In order to have efficient and benefit able stock of the company, inventory should be managed in the right manner. This research component was focused on observing many research studies. To reduce all the trouble in inventory management and have a profitable storage controller, we propose a system that contains machine learning-based methods. While analyzing the dataset, the best machine learning algorithm to develop the predictive analysis was studied using past researches.

In machine learning, there are three approaches. Those are supervised unsupervised and reinforcement. Supervised learning is using already labeled data. Which trains data to understand the pattern in this data. But according to the storage dataset, it is not perfect to use because there will be no patterns in the considered inventory data. Sometimes suddenly a lot of products need to be in store and sometimes no need lot of products. So, it is hard to maintain a pattern in the inventory data. Unsupervised learning data allows the data to act without any labeling. Mostly unsupervised learning is used in researches.

According to exploratory analysis, data is trained to analyze models using the clustering method. Analysis of Johathan Oesterle and Tomas Bauernhasl researcher and

Marcelo Marques researchers' study of development views that k-mean clustering method is suitable to find the quality products and unpopular products lists, higher and lower cost product list report. [7] [8] Analyzed data were used for prediction at last. K-mean technique clustered the minimum data point to the centers. Inventory data cannot cluster in many groups as the end point, so the k-mean algorithm is used to develop the highest and lowest cost product lists. Also, k-mean rule mining is used to identify frequent itemsets. Time series analysis was conducted to identify the products near to expire. Those dates need to be identified before the expiring month and the products listing is a technical need to act towards respective products. According to Japan Gupta development and C.L.Karmaker, P.K Halder and E.Sarkers have been used time series related analysis. [9] [10] There will be 77602 items, millions of units on that, and one item will have one single expiry date. The bottom-up approach was the best approach to handle a large amount of the data and create one unit per item. In bottom-up data will not be lost due to aggregation and it will be an advantage to use the bottom-up time series also lower levels can be noisy. It will be a disadvantage so, bottom-up time series is the best to use in this particular situation. Observing all this we used time series to develop the near to expiry product list report. In both of these methods, it is showing a linear relationship.

After development happened near to expiry product report and quality and unpopular product list report will direct to the market basket analysis as well. Those reports will display on the system not only these reports highest and lowest cost product report also display on the website.

2. Market Basket Analysis.

Market basket analysis is a business intelligence technology to predict future purchase decisions of the customers. It studies customers buying patterns and preferences to predict what they will prefer to purchase along with the existing items in their cart. Market basket analysis assists in marketing strategies regarding placing of items, maintenance of inventory, marketing, communication, etc. The business owners can improve their sales merging and profit merging and give a good service to the customer.

It is mainly based on daily transaction data. Using a function, the data will have sorted invoice vis and move the mane of the items related to one invoice to a single column. That sorted data will be put to the Apriori algorithm. It was proposed to use the apriori method for frequent item-set mining. This algorithm is used to determine the most common thins in a database on a

series of steps. It's also the fastest algorithm for mining association rules (reference [11] [5]). Its produces are repeated iteratively until the most common item set has been identified using this. That processed data put to the Association rule mining. Association rule mining discover interesting relationship between variables in huge databases (reference [12] [13] [14] [15]). That method gets the best support and confidence between related data. Then the system will be displayed the best confidant-related item set. Then the business owner can make some decisions based on the result that the system gave.

The authors, Sachin Sharma and Shaveta Bhatia basically discuss their research papers. They are mainly using data mining, association rules to “get minimum support value by the user may be considered as positive or negative. Frequent item set is the most crucial and expensive task for the industry today. In this paper, they aim to study various techniques to generate the Association rules” It uses to find the buying habits of the customer it will very use full to devise effective market strategies. [12]

According to Annie, Loraine Charlet M.C and Ashok Kumar D research market basket analysis is a very important part of the analytical system in retail organizations to work out the location of goods, coming up with classified ads for various segments to boost customer satisfaction and therefore the profit of the grocery area unit address here mistreatment frequent item-set mining.

The frequent item-set area unit well-mind from the market basket information mistreatment the economical K-Apriori rule the association rule area unite generated. [11]

This research component has two main algorithms that used are Apriori algorithm and the association rule mining algorithm.

- Mainly used Apriori algorithm and association rule mining because
- It is straightforward to understand and express the rules to the end-users (reference [11] [5]).
- This method does not rely on labeled data since it is completely unsupervised (reference [11] [5]).
- A process designed to identify common recurring trends in data in data from a variety of databases, including relational databases, transactional databases, and other repositories (reference [12] [13] [14] [15]).

3. Defining customer churn and churn prediction using machine learning models

The considered retail grocery store does not have a specific definition of churn relative to their own business. Therefore, defining churn is the first step in this component. Then the churn label will be used to churn prediction in supervised machine learning models. Transaction and customer data are used in this component. The main objectives of this component accord with the considered store are,

i. Defining customer churn

According to different businesses and companies, the definition of customer churn varies a lot [16] Churn label is created with the understanding that it should be calculated individually for each customer. Furthermore, an exchange has to be considered between defining churn as early as possible and not defining churn when a customer is in an inactive phase. Churn definition is generated using two equations consisting of the variables DaysFirstPurch (days since first purchase), DaysLastPurch (days since last purchase), and ActiveDays (active days).

$$\text{Wavelength} = \frac{\text{DaysFirstPurch} - \text{DaysLastPurch}}{\text{ActiveDays}}$$

$$\text{FC} = \frac{\text{DaysLastPurch}}{\text{Wavelength}} \quad \square \square \square$$

The first equation computes the average time between purchases, defined as Wavelength. The second equation calculates the Factor of Churn (FC), a measurement that indicates whether a customer is churning or not.

Using an algorithm, the labeling is divided into two intervals because the Wavelength differs a lot between different customers. Based on the labeling process on the individual Wavelength of each customer it is feasible to draw closer to accurate labeling. The interval split I and constants, FC1 and FC2 used to compare with the Factor of Churn were selected by evaluating all feasible combinations and tested to see which setting gave the best result. The labels derived from the created churn definition are then compared if a customer purchased again. This comparison is used to determine the best setting for I, FC1, and FC2, as a customer labeled as churn does not want to purchase again. To minimize the probability of getting a biased result for a specific month, the labeling is done for three different months.

ii. Churn prediction using machine learning models

Due to the instability in the purchase frequency, it was decided to consider four months back from the prediction date and do the prediction for the fifth month. Adequate data were required to generate a fair definition

of a customer's behavior; therefore, four months were selected as the observation window.

The labeled dataset is preprocessed, cleaned, identified patterns and inconsistencies, and validated hypotheses that are built. The dataset is split into two, 80% for training and 20% for testing to carry out the model training and testing steps. In this component, six models; Logistic Regression (LR), Neural Network (NN), Random Forest (RF), Decision Tree (DT), Support Vector Machine (SVM), and Extreme Gradient Boosting (XGB) are used and tested. Models are chosen referring to [4] [16] [17] [4] [18] [19]. Metrics such as Feature weights, Confusion matrix, Accuracy score, ROC curve, Precision-Recall-Curve (PRC), AUC (for ROC and PRC), F1 score are used to assess the performance of the selected models [16] Models are optimized in an afterward step by tuning their hyperparameters. Cross-validation is used in hyperparameter tuning with Grid Search and Randomized Search to address a tendency that may result from the precise splitting of data in the train-test-split section. The model with the best performance on the test data is chosen as the best fitting model according to the results.

4. Implementing and defining Customer personalization using recommendation systems.

Customer personalization is one of the key modern business strategies to increase loyal customers. We focused on using machine learning algorithms with data science techniques to design a customer-based recommendation system and provide wide comprehension of the customers to the selected retail store management.

In the study, we have considered collaborative filtering to achieve more accuracy of the results that are individualized to multiple users unlike in content-based where one users' preference is compared with other customers. Three steps of neighborhood-based methods implementation that are described in the study of the author, FLORIAN CARRA have been taken to consideration when implementing the recommendation system. [20]

- Choosing the entity to compare (User/Items).
- Defining the similarity measures for finding nearest neighbors.
- Defining a strategy for generating recommendations.

Choosing 'user/customer' as the entity to compare, a user-based filtering method is used for the recommendations. The user-item matrix is considered a

set of rows. Comparing the similar items and the frequency of purchase, customers have been segmented.

Segmentation of the customers who have a similar purchasing behavior is partitioned using k-means data clustering techniques. RFM analysis means customer behavior segmentation technique. Based on customers' historical transactions, RFM analysis focuses on three main aspects of customers' transactions: recency, frequency, and purchase amount. Understanding these behaviors will allow businesses to cluster different customers into the group. [21] Analyzing customer past interactions with products; transactional data according to purchasing frequency, recency, and amount (Monetary) is considered when segmenting customers.

Regression has been used as the prediction method to recommend new items to the respective groups of customers according to their interests.

$$\hat{r}(x,a) = \frac{\sum_{y \in \text{neighborhood}(x) \cap U} S(x,y) \times r(y,a)}{\sum_{y \in \text{neighborhood}(x) \cap U} |S(x,y)|}$$

The predicted rating relating x to a is described in the mentioned equation.

x, y: Customers a: Product
 r (y, a): Initial implicit rating of y for a.

Both frequency and recency of purchase have been taken to account when considering the equation. As the result of the calculation, a set of customers with an expressed relation with a product was obtained. The nearest-Neighbors Recommender implements the item list and the respectively interested customer list.

Once the list is generated, the shop management can send mail or information through social media to relevant customers to implement a more personalized customer journey.

RESULTS AND DISCUSSION

1. Inventory Management using machine algorithms

Inventory management will help to have profitable stock which makes business benefit able. To succor in this system, we develop the three reports of excel sheets that show the highest and lowest cost product list report, unpopular and quality product list report, and near to expiry product list reports. To develop these reports, we used the machine learning k-mean algorithm rule mining method and the time series bottom-up method. According to these systems, organizations can have these benefits. Those are controlling product wastage zero percentage, the availability the quality product in anytime customer visit to the grocery store and have

enough space to store the products. The space more can be used to stock the demand product and limitedly unpopularly stock can be stored.

2. Market Basket Analysis

After processing the raw transaction data have to generate a table using an apriori algorithm.

Table 1: Table Generated Using Apriori Algorithm

	BREAD	MILK	BISCUIT	TEA	BOURNVITA	JAM	MAGGI
0	1	1	1	0	0	0	1
1	1	0	0	0	1	1	0
2	0	1	1	0	1	0	0

After that have to get a mostly buying relationship item-set to do that system wants to get support, confidence, and lift using Association rule mining. Using Association rule mining can get the highest confidence

value of the relationship item-set. The result will display to the business owner to take good dissection about the business and system also can suggest placement of goods.

Table 2: Highest Confidence Value of Item Set

	Antecedents	Consequents	Antecedents support	Consequents support	Support	Confidence
0	BREAD	TEA	0.631579	0.368421	0.21526	0.333333
1	TEA	BREAD	0.368421	0.631579	0.21526	0.571429
2	BREAD	SUGAR	0.631579	0.315789	0.21526	0.333333

3. Defining customer churn and churn prediction using machine learning models

a. Defining customer churn results

After calculating the Wavelength and FC measurements, the following step is to label the customers as churn or not. It is important to conduct the labeling process optimally as this step lays the base for the predictions. Using the algorithm mentioned in the methodology, all the possible values for I, FC1, and FC2 are tested. The best settings when testing this are found to be I=10, FC1=2, FC2=5.

b. Churn prediction using machine learning models results

The final comparison is conducted between the optimized models between LR, NN, RF, DT, SVM, and XGB. XGB model has significantly higher accuracy on the test set. By comparing the F1 score on jointly precision and recall, XGB is chosen as the best performance fitting model which has the highest F1 score.

Table 3: Comparison of Models

Model	Evaluation Metrics				
	Accuracy (Test)	Accuracy (Train)	AUC (ROC)	AUC (PRC)	F1
LR	0.7932	0.8073	0.8262	0.6317	0.5727
NN	0.7988	0.8190	0.8324	0.6373	0.5737
RF	0.7783	0.9977	0.8158	0.6091	0.5385
DT	0.7762	0.8021	0.8137	0.6086	0.5368
SVM	0.7939	0.8027	0.8201	0.6282	0.5809
XGB	0.7996	0.8298	0.8356	0.6429	0.5948

4. Implementing and defining Customer personalization using recommendation systems

Using the existent transactional of a selected retail grocery store, the study has been carried out. Using the historical purchasing data to find similarities of purchasing behaviors of customers to implement a personalized recommendation system is the purpose of this research component. According to the referred past

studies and research, comparatively collaborative filtering has a higher variance and less bias. [20][CR1] User-based filtering is performed to identify the similarities among customers to recommend currently interested items and new items to respective customer groups.

K nearest neighbor clustering method is used to segment the customers according to the RFM analysis and using

regression and a predictive method, we have obtained the customer clusters and predictive analysis of the items that they would be interested in.

5. Results of the survey conducted

A survey was conducted to measure the usefulness and effectiveness of the proposed web application. Fig. 1

168 responses

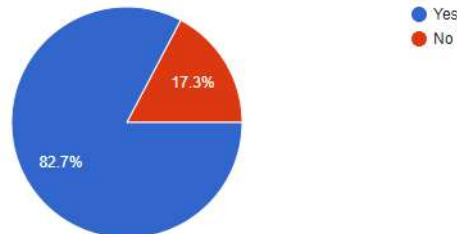


Figure 1: User satisfaction of the purposed application

CONCLUSION

The web application developed using Machine Learning and Deep Learning technologies proved its accuracy in providing stock management in a specific time period which allows making available the timely and expected products of the customers. The product also analyzes customer purchasing behavior and identifies frequently buying item sets accurately by the customers.

The work conducted in this study assists the retail grocery store to define and prevent customer churn that the profit can be increased and to analyze customer profiles individually and provide personalized marketing offers for the customers.

This study is limited to a short time span of data. In future research, data with a long time span can be used. According to the current sales, predicting the sales amount of every product for the upcoming months.

The time series model can be used to predict customer churn in the future. Predicting pricing offers for the products and itemset can be focused on. A hybrid methodology with collaborative and content-based filtering can be used for personalized marketing offers.

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shows the percentage of the retail grocery store owners who recommend the product as useful and effective. According to the results of the conducted survey, most of the respondents (82.7%) recommend the web application proposed

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