

Optimization of Store Layout using Market Basket Analysis

Tom Joe, Sreejith R, Kannan Sekar

Abstract— Store layout is a crucial factor for attracting customers in a retail store. Use of appropriate store layout results in an increase in sales of the store. Grid layout, free flow layout, spine layout is a few commonly used store layouts in the retail store. The grid layout is used for supermarkets but the placement of different products as per the preference of the customer is quite an arduous task there. Purchase history of a supermarket can be utilized to predict the preferences of the customers and can be utilized as an aid for designing a better store layout. Market basket analysis is employed to get insights from the POS data of the supermarket. Market basket analysis (MBA) helps to extract the various association rules from the purchase data of the shoppers. A customer can pick different items identified with the items that the person has just put in his or her shopping basket or cart which frames an association rule. The extraction of such rules can help in the appropriate product placement in the store as per the shopper's preference.

Index Terms: Association rules, MBA, POS data

I. INTRODUCTION

Market basket analysis (MBA) is a tool under marketing analytics to study the buying behaviour of customers. It is utilized to determine what items are mostly bought together or placed in the same basket by customers. [1] It uses this purchase history to utilize the advantages of sales and marketing. MBA searches for a group of items that as often as possible happen in purchases and has been productively utilized since the deployment of electronic POS systems that have enabled the collection of enormous amounts of data. Using the rack space is an arduous task for the retailer since there are a variety of merchandises which should be organized as per the quickly changing needs of the consumers.

MBA can be employed to know the exact purchasing pattern of modern consumers to design an effective and efficient shelf layout to enhance their shopping experience. This can contribute to fast shopping that can be an added advantage for the time, conscious shopper, to finish the shopping within a flash of time.

II. COMPUTERIZED CHECKOUTS AND SCANNER DATA

Computerized checkouts in grocery stores have created new possibilities for retailers to use more and exact and timely information for decisions regarding assortment, shelf space, advertising or general store policy. The scanner data generated from these computerized checkouts can be utilized to study the purchasing patterns of the consumers and can organize the merchandises in the store as per the consumer preferences. [1]. 5147 customer transactions have been taken as a sample for the research.

III. STORE LAYOUT AND ENVIRONMENT

The store layout is an essential factor which can influence the shopper's view of a store and which results in approaching or ignoring the store. Retail store layout designing is a troublesome task. The principal task is to increase sales with consumer loyalty and limiting the overall costs. Numerous elements influence the store layout like the entry sequence of customers, building configuration, service level, product assortment, and a lot more. Store atmospheric characteristics (ambience, music, salespeople and a lot more) comprise the general setting within which customers settle on making choices on store selection. [2]

IV. CONSUMER BEHAVIOUR IN RETAIL STORES

Demographic factors like age, sex, financial and educational status, religion can both impact purchasing and consumption behaviour [7]. Significance of each of these characteristics is varies greatly as per the type of the problem [3]. Therefore, studying the consumer behaviour in retail stores can be addressed as behaviour patterns which can be categorized in relation to place of purchase, items purchased, time and frequency of purchase, mode of purchase and response to sales promotion devices [8].

V. MARKET BASKET ANALYSIS (MBA)

MBA is performed by mining the association rules from a complex dataset. Association rules comprise of a collection of rules which give association between groups of elements in a dataset or it may also be utilized to find patterns in a transaction database or any alternative information source.

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In retailing, extraction of association rules gives the idea about what kind of items are purchased together by a customer and could predict the future purchases of that particular customer [4]. Retailers can manipulate the association rules to change the store layout as per the changing trends. Bundling offers, catalogue design, tailor-made offers for specific customers via emails or messages could be done effectively by performing association rule mining on the customer transaction data or the POS data. The coding for MBA is done in R language. Figure 1 illustrates the basic steps followed in MBA. The input scanner data has to be processed in a definite form in which every customer transaction arranged in rows. It should only have the product categories arranged in a row format [9].

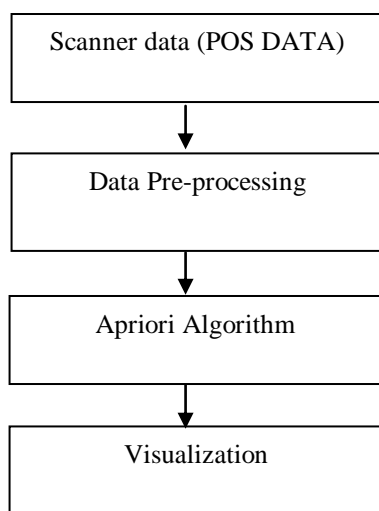


Fig 1: Steps in Market Basket Analysis

Then apriori algorithm is used to mine the association rules which is further visualized to perform analysis.

VI. APRIORI ALGORITHM

MBA employs Apriori algorithm to perform association rule mining. The algorithm uses the concept of support, lift and confidence for getting the data patterns. The percentage of transactions which comprise item A or item B set is the *support*. The ratio of the percentage of transactions which have items A and B to the percentage of transactions which have item A is the *confidence*. An association rule is good or said to be strong if it has minimum support and minimum confidence [5]. The third parameter, *lift* is the ratio of observed support to that expected if A and B were independent.

$$lift(A \rightarrow B) = \frac{support(A \& B)}{support(A) \times support(B)}$$

If the parameter lift is greater than 1, then the rule of association is strong which signifies strong link between the two items [10].

VII. DATA VISUALIZATION

Simplification of the mined association rules can be done via appropriate visualization techniques [6]. Analysis can be done through data visualization techniques like item

frequency plots, interactive plots and two-key plot which are available in the packages arulesViz, ggplot2 and RColorBrewer in R language.

VIII. ANALYSIS

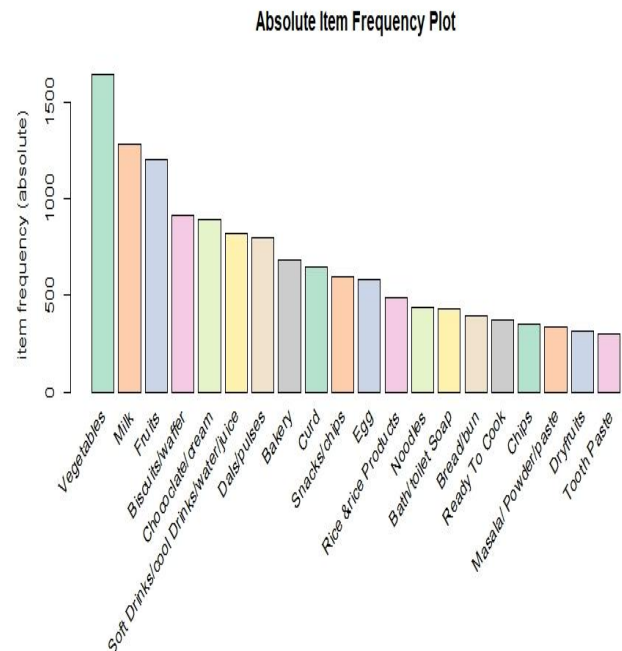


Fig 2: Item Frequency Plot

An item frequency plot is shown in Fig 2 which shows the most frequent items purchased in the supermarket. Majority of the buyers purchase from the vegetable section, fruits section, biscuit and wafers and chocolate sections.

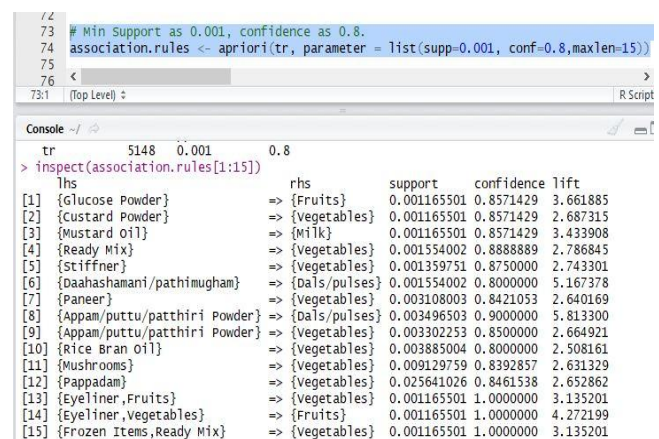


Fig 3 : Association Rules Mining

Fig 3 shows the first fifteen association rules which satisfies the conditions which satisfies the threshold support and 85% confidence. The above rules are randomly organized according to the basic conditions. It can be inferred that, 100% people who purchased frozen items and ready mix items also purchase from the vegetables section.

Similarly, 100% people who purchased eyeliner and vegetables also purchase fruits which is shown in the 14th association rule. Moreover, this rule is the strongest among the extracted fifteen rules since the lift parameter is highest.

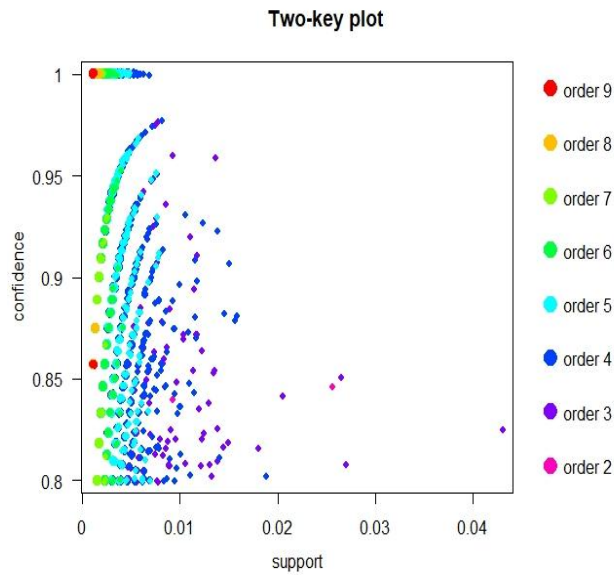


Fig. 4: Two-Key Plot

A Two-key plot of mined association rules is shown in fig 4: which illustrates the order of the rules as per the confidence and support parameters. The rules have orders ranging from 2 to 9 which is nothing but the number of items in customer transactions. Association rules which have order 4 and 5 have the highest confidence and support. That is; rules which have 4 and 5 number of items are the strongest. Therefore, the retailer can bundle 4 or 5 items which have stronger associations in the promotional rack to increase the sales. Fig 5a and Fig 5b are the interactive plots which plot the association rules with minimum confidence 50% and minimum support parameter. The plot is arranged so as to map the rules which have higher confidence, support and lift. Customers who purchase colour/crayons/sketch pencil and eraser also purchase pencils which is the 54th rule is the strongest association rule which has their highest lift and 100% confidence. Customers who purchase Bath/toilet soap, Dals/pulses and spices and condiments also purchase Salt.

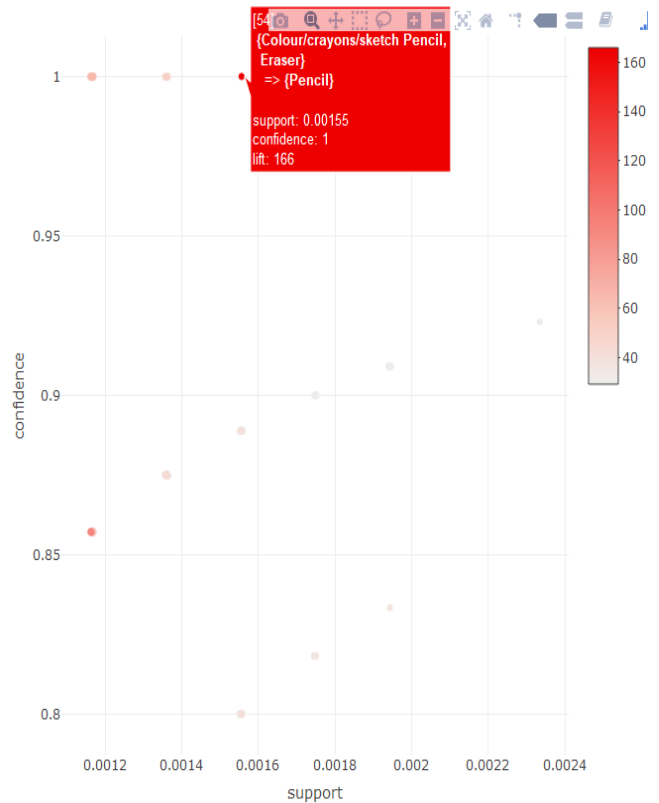


Fig 5a: Interactive Plot 1

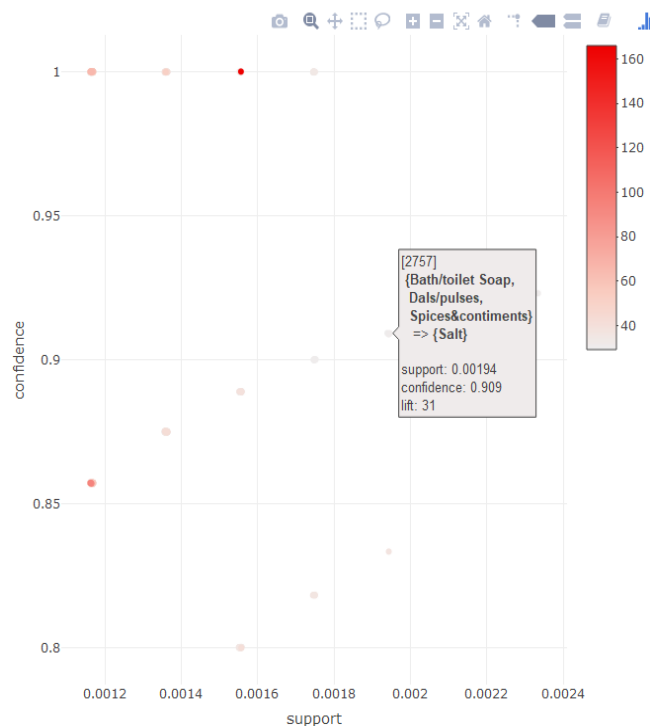


Fig 5b: Interactive Plot 2

This is the 2757th association rule which is strong due to 90% confidence and higher support.

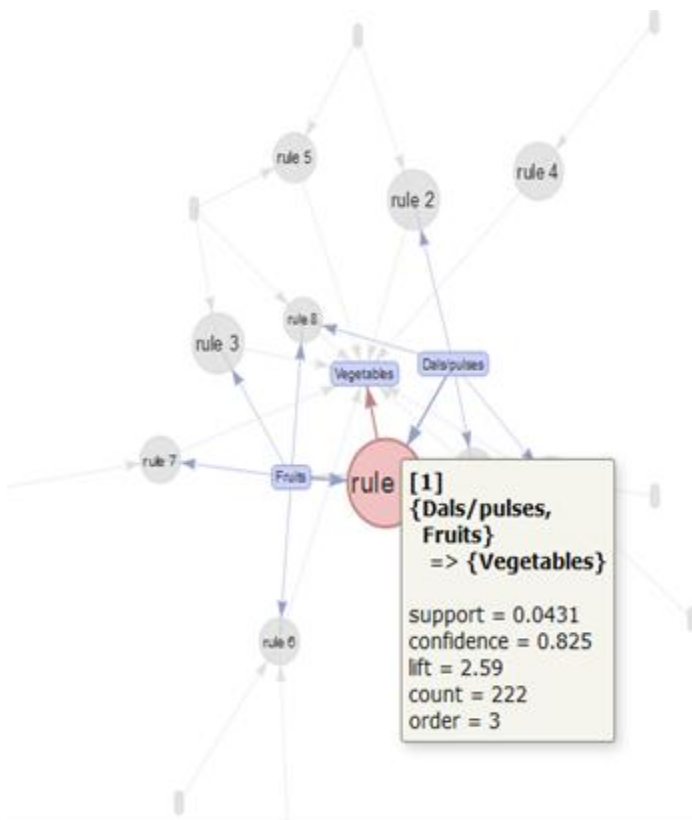


Fig 6a: Interactive Network –Rule 1

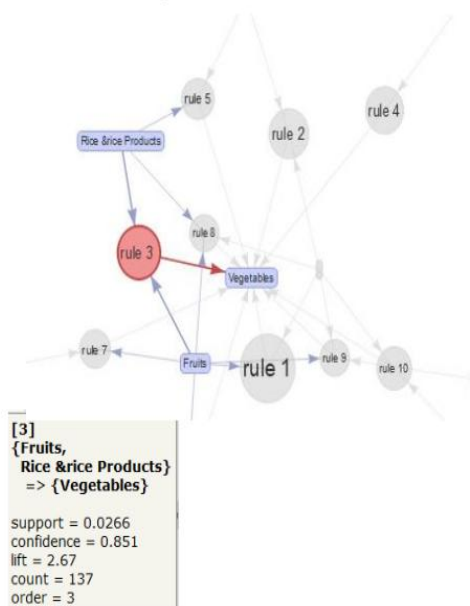


Fig 6b: Interactive Network – Rule 3

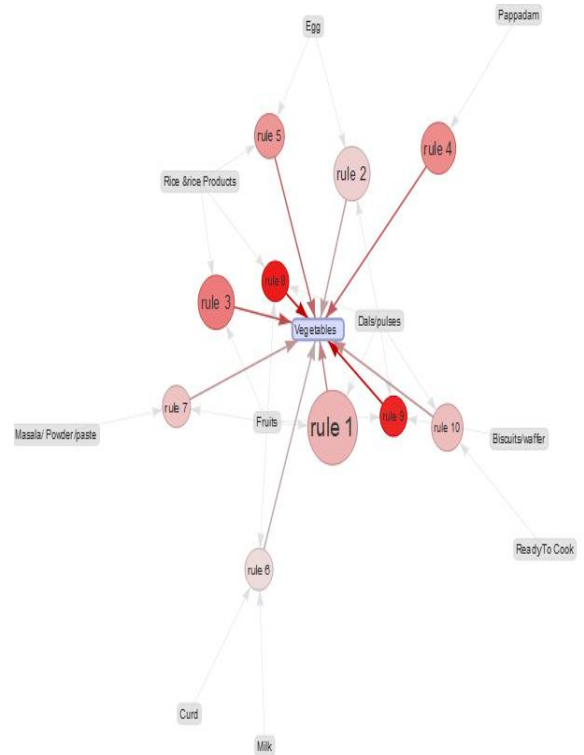


Fig 6c: Interactive Network

Figures 6a, 6b and 6c illustrate various interactive network plots. The interactive network shows the top ten association rules as per the count of customers purchased certain products. Rule 1 shows that 222 customers purchased Dals/pulses, Fruits in connection with vegetables. Rule 3 shows that 137 customers who purchase Fruits and Rice & rice also purchase vegetables and this rule satisfies 85% confidence hence it is a stronger association rule. Fig 6c shows that top ten rules are related to vegetables. So the retailer can have changes in the layout of the store in such a manner that he can shelf certain high margin products closer to the vegetable section.

IX. CONCLUSION

Store layout design is definitely a complicated task to implement. Arranging the merchandises as per the changing trends is another hard task. Employing analytics techniques to predict the shoppers' purchases is obvious in the modern scenario. Market basket analysis has been successfully employed on a week's POS data to map the customer's purchasing pattern. As per the analysis, it is seen that the majority of the purchases are linked with the vegetable section. The retailer can have alterations in the layout of the store in such a manner that a customer can access to other sections in a better way. The retailer can bundle certain products with vegetables in the promotions rack like "fruits and vegetables", "spices and condiments with vegetables and "rice products and vegetables" or these sections can be arranged nearby if the retailer does not need a promotions rack arrangement.

But certain products like floor cleaners, toilet cleaners cannot be placed near to the vegetable sections. In such situations retailers can put promotional windows near the section where the customer traffic is more, here it is in the vegetable section. The retailer can also use bundling offers displays in high traffic sections in the store.

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