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MAA: A NOVEL DESIGN AND DEVELOPMENT OF ALGORITHM FOR IDENTIFYING OPTIMAL CUSTOMERS USING ASSOCIATION RULE MINING AND PARTICLE SWARM OPTIMIZATION

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ABSTRACT

Identifying customers which are more likely potential for a product and service offering is an important issue. In customers identification data mining has been used extensively to predict potential customers for a product and service. Modern companies and organizations efficiently implement a CRM strategy for managing a company interactions and relationships with customers. CRM systems have been developed and designed to support the areas of marketing, service process and sales. Many literature studies are available to preserve the customer relationship but small drawbacks occur in the existing methods. One method to maintain the customer relationship is frequency based method i.e., The Company will give declination to the customer based on the historical data that is the customers how many times come to that company. These methods are not effective. Because the customers give revenue to that company is less. So the company revenue is affected. In the data mining field, association rules have been researched for more than ten years ; however, the degree to which the support threshold effectively discovers interesting association rules has received little attention. Most of the research effort in the scope of association rules has been oriented to simplify the rule set and to improve performance of the algorithm. But these are not the only problems that can be found and when rules are generated and applied in different domains. Troubleshooting for them should also take into consideration the purpose of association model and the data they come from. Some of drawbacks like non interesting rules, low algorithm performance arts are

found in the algorithm. Several past studies addressed the problem of mining association rules with different Supports will not be appropriate in large dataset and they cannot generate more useful rules. This paper suggests a new framework of algorithm that overcomes the limitations associated with existing methods and enables the finding of association rules based on Apriori Algorithm among the presence and/or absence of a set of items without a preset minimum support threshold and Minimizing Candidate Generation. The proposed work is an efficient algorithm for generating frequent itemsets and is optimized to takes less time compare to the existing algorithms. The main aim of this algorithm is to reduce execution time and memory utilization as compared to the existing algorithms. The framework has been tested on several datasets.. The result obtained shows that the proposed algorithm takes 25% less time compared to the Apriori algorithm in all instances. If the threshold of minimum support values the both algorithm execution time is less. The performance of the algorithm is influenced by the dimensions of the data set and support factor and it is compared with performance of FP-growth and DynFP-Growth algorithms. The algorithm used to discover coherent rules which has been used in CRM model .Then, the mined information is used to calculate the company profit and frequency (the number of times the particular customer visit the company). By using association rule mining, the profit and frequency value of each customer is computed. Based on the mining result, the companies provide offers to customer using swarm intelligence technique known as particle swarm optimization.. This offer does not affect the company revenues as well as satisfying the customers. This process will make a good relationship between the customers and organizations and to satisfy the customers forever with company's rules.

Keywords: CRM, PSO, Data Mining, Association Rule Mining, Algorithm, DynFP-Growth

1. Introduction

This research is concerned with study and analyzes the data mining technique and particle swarm optimization in order to improve the efficiency and effectiveness of customer relationship management system. The advent of computing technology has significantly influenced our lives and two major impacts of the effect are business data processing and scientific computing. During the initial years of the development of computer techniques for business, computer professional were concerned with designing files to store the data so that information could be efficiently retrieved. The advent of computer technology has significantly influenced our lives and two major impacts of this effect are Business Data Processing and Scientific Computing. During the initial years of the development of computer technology for business, computer professionals were concerned with designing files to store the data to store the data so that information could be efficiently retrieved. There were restrictions on storage size for storing data and on the speed of accessing the data. Needlessly to say the activity was restricted to a very few, highly qualified professionals. Then came an era when the task was simplified by a DBMS. The responsibilities of intricate tasks, such as declarative aspects of the programs were passed on to the data base administrator and user could pose his query in simpler languages such as query languages. Thus, almost any business – small, medium or large scale - began using computers for day-to-day activities. Every organization is now accumulating a large volume of daily transaction data and storing them as archival files. As a result, masses and masses of data – megabytes, gigabytes, and terabytes – are piling up in the electronic vaults of companies, governments and research institutions. A question that naturally arose is whether the enormous data that is generated and stored as archives can be used for improving the efficiency of business performance. Early 1990's, the answer to this was 'not much'. No one was really interested in utilizing data which was accumulated during the process of daily activities. Once the transaction process is over, these dada were dumped into archival files. Such a collection of data, whether their origin is business enterprise or scientific experiment, has recently spurred a tremendous interest in the areas of knowledge discovery and data mining. As a result, a new discipline in computer science, Data Mining, gradually evolved. Data is the exploration and analysis of large data set, in order to discover meaningful patterns and rules. The key idea is to find effective ways to combine the computer's power to process data with the human eye's ability to detect patterns. The techniques of data mining are

designed for, and work best with large data sets. Several factors have contributed to bring data mining to the forefront. To identify a few of these factors:

- The untapped value of large database.
- The concept of data warehousing.
- The dramatic drop in the cost/performance ratio of hardware systems.

2. DATA MINING – AN OVERVIEW

2.1 Definition

"Data mining" is defined as a sophisticated data search capability that uses statistical algorithms to discover patterns and correlations in data [2]. The term is an analogy to gold or coal mining; data mining finds and extracts knowledge ("datanuggets") buried in corporate data warehouses, or information that visitors have dropped on a website, most of which can lead to improvements in the understanding and use of the data. The data mining approach is complementary to other data analysis techniques such as statistics, on-line analytical processing (OLAP), spreadsheets, and basic data access.

2.2. The evolution of data mining

Data mining techniques are the result of a long research and product development process. The origin of data mining lies with the first storage of data on computers, continues with improvements in data access, until today's technology allows users to navigate through data in real time. In the evolution of business data into useful information, each step builds on the previous ones. Table 1 shows the evolutionary stages from the perspective of the user. In the first stage, Data Collection, individual sites collected data used to make simple calculations such as summations or averages. Information generated in this step answered business questions related to figures derived from data collection sites, such as total revenue or average total revenue over a period of time. Specific application programs were created for collecting data and calculations.

The second step, Data Access, used databases to store data in a structured format. At this stage, company-wide policies for data collection and reporting of management information were established. Because every business unit conformed to specific requirements or formats, businesses could query the information system regarding branch sales during any specified time period. Once individual figures were known, questions that probed the performance of aggregated sites could be asked. For example, regional sales for a specified period could be calculated. Thanks to multi-dimensional databases, a business could obtain either a global view or drill down to a particular site for comparisons with its peers (Data Navigation). Finally, on-line analysis tools provided real-time feedback and information exchange with collaborating business units (Data Mining). This capability is useful when sales representatives or customer service persons need to retrieve customer information on-line and respond to questions on a real-time basis.

Information systems can query past data up to and including the current level of business. Often businesses need to make strategic decisions or implement new policies that better serve their customers. For example, grocery stores redesign their layout to promote more impulse purchasing. Telephone companies establish new price structures to entice customers into placing more calls. Both tasks require an understanding of past customer consumption behavior data in order to identify patterns for making those strategic decisions—and data mining is particularly suited to this purpose. With the application of advanced algorithms, data mining uncovers knowledge in a vast amount of data and points out possible relationships among the data. Data mining helps businesses address questions such as, "What is likely to happen to Boston unit sales next month, and why?" Each of the four stages were Revolutionary because they allowed new business questions to be answered accurately and quickly [4].

The core components of data mining technology have been developing for decades in research areas such as statistics, artificial intelligence, and machine learning. Today, these technologies are mature, and when coupled with relational database systems and a culture of data integration, they create a business environment that can capitalize on knowledge formerly buried within the systems.

2.3 Applications of data mining

Data mining tools take data and construct a representation of reality in the form of a model. The resulting model describes patterns and relationships present in the data. From a process orientation, data mining activities fall into three general categories (see Figure 2.1):

Discovery—the process of looking in a database to find hidden patterns without a predetermined idea or hypothesis about what the patterns may be Predictive.

Modeling—the process of taking patterns discovered from the database and using them to predict the future.

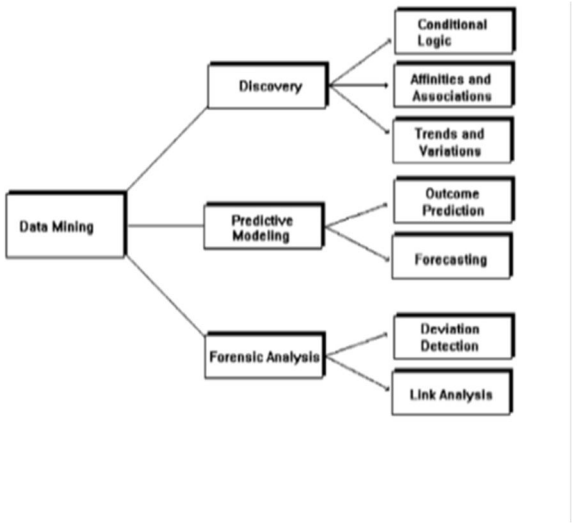

Figure 2.1. Breakdown of data mining from a process orientation.

Forensic Analysis—the process of applying the extracted patterns to find anomalous or unusual data elements.

Data mining is used to construct six types of models aimed at solving business problems: classification, regression, time series, clustering, association analysis, and sequence discovery [3]. The first two, classification and regression, are used to make predictions, while association and sequence discovery are used to describe behavior. Clustering can be used for either forecasting or description. Companies in various industries can gain a competitive edge by mining their expanding databases of valuable, detailed transaction information. Examples of such uses are provided below.

Each of the four applications below makes use of the first two activities of data mining: discovery and predictive modeling. The discovery process, while not mentioned explicitly in the examples (except in the retail description), is used to identify customer segments. This is done through conditional logic, analysis of affinities and associations, and trends and variations. Each of the application categories described below describes some sort of predictive modeling. Each business is interested in predicting the behavior of its customers through the knowledge gained in data mining [5].

2.4. Retail

Through the use of store-branded credit cards and point-of-sale systems, retailers can keep detailed records of every shopping transaction. This enables them to better understand their various customer segments. Some retail applications include [5]: Performing basket analysis—Also known as affinity analysis, basket analysis reveals which items customers tend to purchase together. This knowledge can improve stocking, store layout strategies, and promotions.

Sales forecasting—Examining time-based patterns help retailers make stocking decisions. If a customer purchases an item today, when are they likely to purchase a complementary item?

Database marketing—Retailers can develop profiles of customers with certain behaviors, for example, those who purchase designer label clothing or those who attend sales. This information can be used to focus cost–effective promotions.

Merchandise planning and allocation—When retailers add new stores, they can improve merchandise planning and allocation by examining patterns in stores with similar demographic characteristics. Retailers can also use data mining to determine the ideal layout for a specific store.

2.5. Banking

Banks can utilize knowledge discovery for various applications, including [5]:

Card marketing—By identifying customer segments, card issuers and acquire can improve profitability with more effective acquisition and retention programs, targeted product development, and customized pricing.

Cardholder pricing and profitability—Card issuers can take advantage of data mining technology to price their products so as to maximize

profit and minimize loss of customers. Includes risk-based pricing.

Fraud detection—Fraud is enormously costly. By analyzing past transactions that were later determined to be fraudulent, banks can identify patterns.

Predictive life-cycle management—Data mining helps banks predict each customer's Lifetime value and to service each segment appropriately (for example, offering special deals and discounts

Telecommunications

Telecommunication companies around the world face escalating competition which is forcing them to aggressively market special pricing programs aimed at retaining existing customers and attracting new ones. Knowledge discovery in telecommunications includes the following [5]:

Call detail record analysis—Telecommunication companies accumulate detailed call records. By identifying customer segments with similar use patterns, the companies can develop attractive pricing and feature promotions.

Customer loyalty—Some customers repeatedly switch providers, or "churn", to take advantage of attractive incentives from competing companies. The companies can use data mining to identify the characteristics of customers who are likely to remain loyal once they switch, thus enabling the companies to target their spending on customers who will produce the most profit.

2.6. Other applications

Knowledge discovery applications are emerging in a variety of industries [5]:

Customer segmentation—All industries can take advantage of data mining to discover Discrete segments in their customer bases by considering additional variables beyond traditional analysis.

Manufacturing—Through choice boards, manufacturers are beginning to customize products for customers; therefore they must be able to predict which features should be bundled to meet customer demand.

Warranties—Manufacturers need to predict the number of customers who will submit warranty claims and the average cost of those claims.

Frequent flier incentives—Airlines can identify groups of customers that can be given incentives to fly more. In the application examples discussed above, the use of forensic analysis was not as common. The banking example is the only one that was looking for deviations in the data. Banks and other financial institutions use data mining for fraud detection, which was not alluded to in the other examples even though there are similar uses of deviation detection in the other industries.

3. Literature Survey

Crosby (2002) argues that, by using customer information wisely to deliver what the customer needs, companies will create long-term, collaborative relationships with the customers. He further states that, this will bring many benefits since long-term customers are less costly to serve and smooth-running relationships are less resource intensive (Ibid). A survey of more than 500 executives in six industries, communication, chemicals, pharmaceuticals, electronics/high-tech, forest products and retail, believes that 10% improvement of overall CRM capabilities can add up to$35 million benefits to a $1 billion business unit. **(Gray and Byun 2001)**. CRM is a very big tool that contributes so much to profit indicated by **Newell (2000)**. Furthermore he stated that, if organizations could transform the customer data into knowledge and then use that knowledge to build relationships it would then create loyalty and thereby creating profit (Ibid). Turban et al. (2000) suggest that increasing customer satisfaction increases customer loyalty. **Swift (2001 pp. 28)** argues that organizations can get a lot of benefits from CRM initiatives. He goes on to say that,these benefits could be found in these areas:

• Higher customer retention and loyalty:

The customer retention will increase when customers stay longer, buy more and buy more frequently. The customers take more initiatives that increase bounding relationship, and as a result the customer loyalty increases.

• Increased customer profitability:

The customer profitability will increase when the customer wallet-share increases, the up-selling goes up as well as cross-selling and follow up sales and also more referrals come with higher customer satisfaction among existing customers.

• Evaluation of Customer profitability:

When the organization gets to know which customers are profitable and which ones that might become profitable in the future, that is the potential

profitable customers and those who will never become profitable. This is a very important area because the key to any successful business is to acquire and focus on those customers who bring profit, when you get them, you do not want to leave them.

• Reduced cost of sales:

The costs regarding selling are reduced due to the fact that existing customers are usually more responsive. In addition, with better knowledge of channels and distributors, the relationships become more effective, as well as costs for marketing campaigns are reduced.

• Lower cost of recruiting customers:

When the cost of recruiting new customers reduces or go down, there will be savings to be made on marketing, mailing, contact, follow-up, fulfilling, service and many more.

• No need to recruit so many customers to preserve a steady volume of business:

When the number of long-term customers increases and consequently the need to recruit many new customers will decrease (Ibid).

Bose (2002) argues that, most organizations can use CRM, however he goes on to say that, there are some organizations that are more likely to get more benefits from CRM than others. Furthermore he states that, those are the companies that accumulate a huge customer data when doing business and whose customer needs are differentiated. On the other hand, Bose (2002) says that, companies that rarely have any contact with their customers have a higher customer turn over and identifying customer needs are likely to get less benefit from CRM (Ibid). According to **Newell (2002)** organizations should under take CRM initiatives where they will get the best possible return and benefits. He goes on to indicate that, companies should then focus on customers who are already profitable and those who will become the company's most profitable customers in the future (Ibid).

Newell (2000) divides customers into three types according to the benefits organizations derive from them as follows:

• **The top group:** These consist of the top 10% and these are the customers with excellent loyalty and of high profitability for the organization.

• **The middle group:** these consist of the 40%-50% of the company's customers and they are the ones delivering good profits and also show a very good potential for future growth and loyalty.

• **The lower group:** these consist of the lower 40%-50% of the company's bottom customers and are those who are only marginally profitable and these may become potential future profitable customers.

Xu, Yen, Lin, and Chou (2002) argue that CRM initiatives do not only improve customer loyalty, but it also improves the internal processes, which in turn increases as well. Again they indicated that, one of the benefits of CRM is that, it identifies and targets best customers based on recent purchase or behavior, frequency and monetary scoring. Furthermore they stated that, it helps to manage marketing campaigns with clear goals and measurable or quantifiable objectives.

More over XU, et al (2002) state that one of the benefits of CRM initiatives is that it creates and manages solid sales leads for field and Telesales representatives. They further add the following as some of the benefits that organizations derive from their CRM initiatives and solutions:

• It increases marketing and cross selling opportunities

• It enables tight and accurate targeting and one-to-one marketing

• It helps increases return on marketing investment

• It adds more valuable knowledge already gained from direct customer interaction and this knowledge in turn helps improve product development processes (Ibid).

Xu, et al, (2002) summarizes the following as the benefits of CRM initiatives from the sales perspective:

• It improves Telesales, field sales, and sales management through real time information sharing among multiple employees.

• It increases sales efficiency through the wire and Internet-based order entry.

• It improves territory management with real time account information updates

• It improves the entire sales force by capturing, distributing and leveraging the success and expertise of the highest performers.

• It increases revenue per call by focusing on growing the best accounts (Ibid).

According to Xu, et al (2002) the following summarize the benefits of CRM initiatives and solutions from the field service perspective:

• It ensures customer satisfaction and retention by solving customer problems quickly.

• It integrates the management of people and materials within the service organization smoothly.

• It again ensures customer satisfaction by allocating, scheduling and dispatching the right people, with the right parts at the right time (Ibid).

Xu, et al, (2002) summarizes the benefits of CRM initiatives and solutions from the perspective of the customer support as follows:

• Shared relationships with personalized customer care based on specific customer history and preferences are strengthened.

• Through automated scripting based on known solutions, call center efficiency and help desk support's quality are improved

• Support and service costs are reduced when Web-based support functionality is extended directly to the customer and this increases customer satisfaction.

• All customer contact for sales, support, field service and marketing are centralized.

Ching-Hsue Cheng *et al.* their study has proposed a procedure for successfully extracting meaning rules to improve these drawbacks by combining quantitative value of RFM attributes and K-means algorithm into rough set theory (RS theory). The proposed method has first obtained quantitative value as input features by utilizing the RFM model. Then, customer values have been clustered using K-means algorithm; and in the end, classification rules that assist enterprises driving an outstanding CRM have been mined by employing a rough set (the LEM2 algorithm). The proposed procedure proved to surpass the methods listed in terms of precision rate irrespective of 3, 5 and 7 classes on output, and produce comprehensible decision rules by analyzing the experimental results**[20]**.

Abdullah *et al.* have presented the most excellent combination of ERP with Customer Relationship Management (CRM). The three main parts present in their model have been outer view-CRM, inner view-ERP and knowledge discovery view. The CRM EPR and knowledge discovery have been used for the purpose of gathering the queries of customers, evaluate and combine the data and provide forecasts and recommendations for the improvement of an organization respectively. They have utilized MADAR data and implemented Apriori Algorithm on it for the practical implementation of the presented model**[21]**.

4. Experimental Result

The synthesis of data mining tools outlined and implemented in this paper allows for a far more holistic approach to data mining in MATLAB than has been available previously. This work ensures that data mining becomes an increasingly straight forward task, as the appropriate tools for a given analysis become apparent. The proposed CRM system is implemented in the working platform of MATLAB (version 7.10). The model has been designed so as to allow for both straightforward mining in the form of rule extraction and as a means of analyzing the knowledge extracted during a separate data mining session. The first step of the algorithm is executed using the algorithms *apriori*from the customer database D, consisting of N transactions, m items and thresholds defined by *minsupport and minconf* input parameter. The function takes the list of customer transactions as the main input and finds sets of items that occur in the database more often than a certain threshold.

The customer dataset contains the customer information's such as Date, Number of Transactions, Customer ID and Profit. The dataset is created for 5 years and the customer ID is created randomly. This is randomly generate a number Between 1 to 10, if the generated number is 4, the customer will be provided with new customer ID or the customer will be considered as a regular customer. The date field contains 1825 days per year and profit field contain the profit amount of company. From the dataset , relevant customer information has been extracted using above mentioned querying methods.

The querying method result gives a large data set; the number of customers have been minimized using the proposed apriori algorithm. Using this algorithm, have produced frequent items and association rules are generated for these frequent items. It can be calculated the total profit value for selected customers and original database customers in the querying process. Based on the threshold

value, have selected the eligible customers and again using PSO algorithm the customers are selected from the eligible customers to produce the optimal result. The given tables 1.1 show the result of apriori algorithm for different combination of profit lengths for each customer. Some of the customer's length combination results are given below.

The PSO algorithm is applied to the above table, to select the optimal customers. The optimal customers have selected based on the customer's profit and frequency value. Table 1.1 shows the result of selected optimal customers.

Table 1.1: Selected Optimal Customers

Customer ID	Profit
1444	282
1756	398
1688	194
861	126
774	142

The above table illustrates the customers finally selected for getting offer from the company. Following this procedure it will maintain the customer relationship efficiently. This have designed the comparison result for finally selected customer against the original database customers for five years and the selected customer's profit, frequency are individually compared to their five year data. Following graphs Figure. 4.1: show the comparison results of different customers with profit and frequency of their five years data.

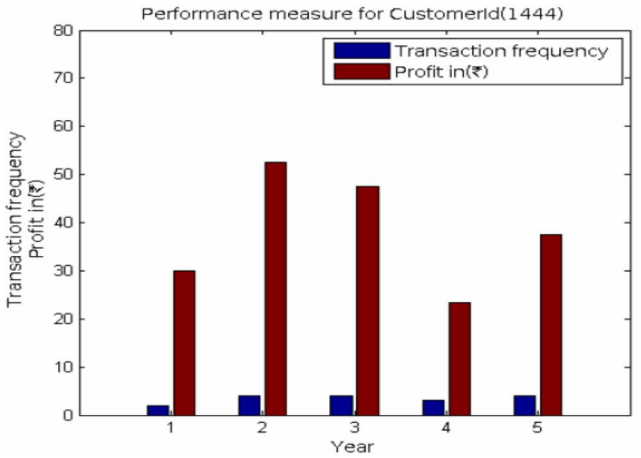

Figure 4.1: Performance of customer ID 1444

The chart shows that the customer ID 1444 transaction increases in profit for each .Similarly , the model has designed the comparison result for finally selected customer against the original database customers for five years and the selected customer's profit, frequency are individually compared to their five year data based on PSO algorithm. Next , the customer ID 1756 was selected for comparison result and was shown in Figure 4.2.

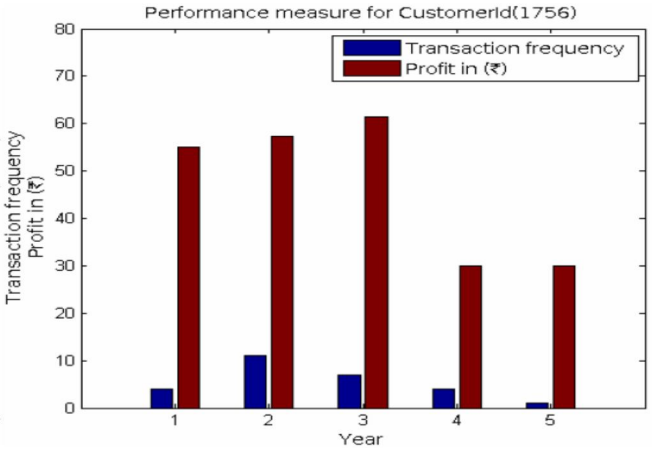

Figure 4.2: Performance of customer ID 1756

The customer IDs 1688, 861,774 were selected in experimental results and the comparison results shown in figure 4.3, 4.4 and 4.5 which shows customer performance over the five years.

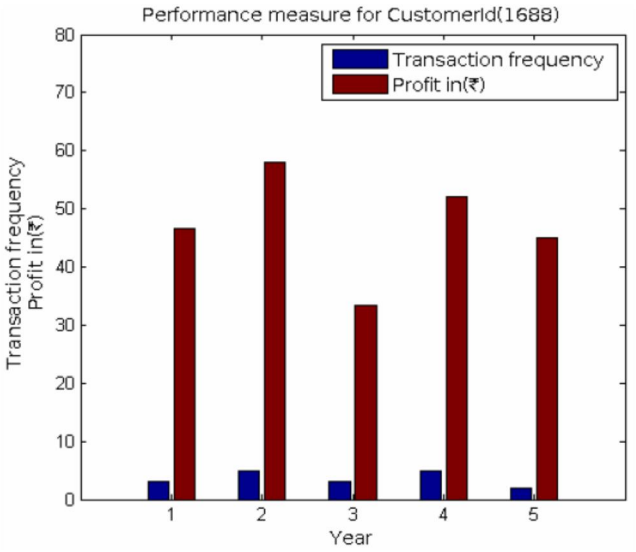

Figure 4.3: Performance of customer ID 1688

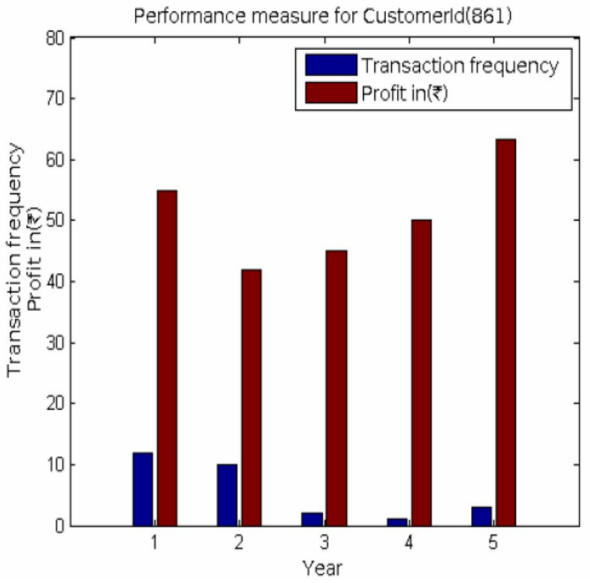

Figure 4.4: : Performance of customer ID 861

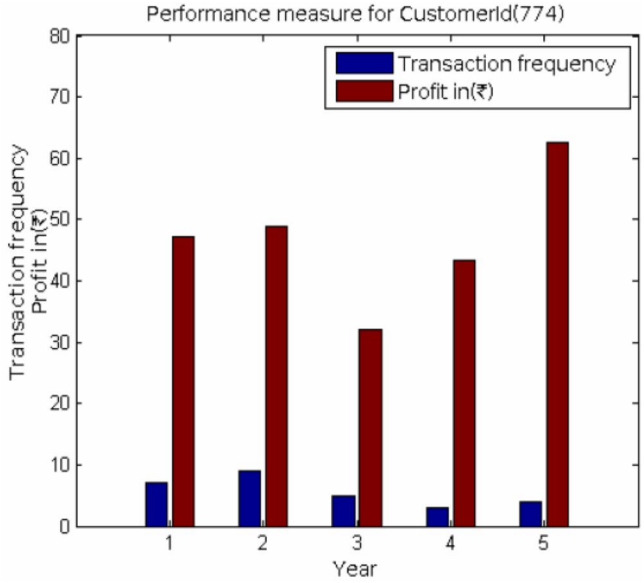

Figure 4.5: Performance of customer ID 774

The above results of the algorithm have highlighted the strength of the effect of transaction of the customer played on the motivation of the several customers to increase in profit of the organization in several years .The following result in figure 4.6 shows that a number of customers are increasing in every year after implementing the proposed CRM model.

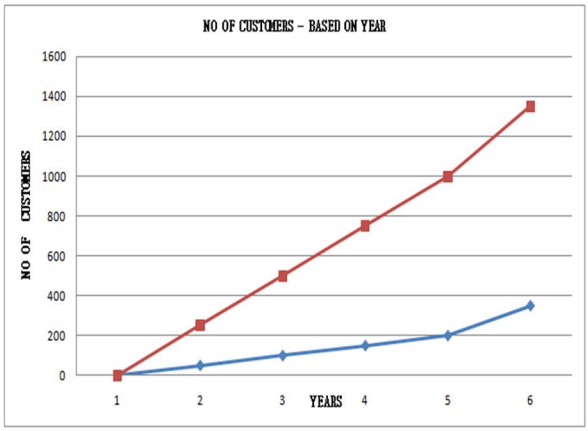

Figure 4.6: Performance of Increase number of customer over year

It is optimize the selected customer's result, so the result of selected customers is compared with the remaining customers in the database. First this is compare the frequency value of selected customers in opposition to frequency value of remaining customers in an original customer database and another one comparison have made on profit value of the selected customers against the profit value of remaining customers in a database. The comparison result shows the higher performance of selected customers than remaining customers in both frequency and profit values. From this graph, it is illustrated that selected customers frequency value is higher than the remaining customer's frequency value in each year. The second graph Figure 4.7 shows the results of selected and remaining customers' profit value performance. The profit value performance gives very high result to the selected customer's compared to the remaining customers.

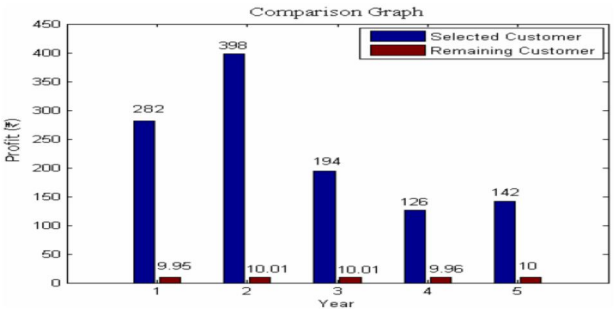

Figure 4.7: Comparison result of selected and remaining customer's profit value

5. Conclusion

There are several ways to improve the database access of Apriori algorithm thereby improving also the efficiency of the execution. The growth of interest in data, information and knowledge management has helped many organizations to digitize and manage their information resource for effective use in the future to predict about their business processes, product and behavior of their customers. Implementation of data mining technologies in CRM helps to optimize pattern for customers relationship between customer and company in order to enhance service delivery and to maximize profit in the organization . Data mining application could be used to increase and classify customers behavior in providing the best service. Then, the data mining technology could help to predict potential customers from the other in taking measures to improve the service delivery and profit generating in the future.

The efficient CRM system using data mining ARM and artificial intelligence PSO techniques was proposed using customer's information dataset in MATLAB tool .The CRM system has provided to select the optimal customers in which they are frequently visited and also have provided high revenue to the company. The finding's result demonstrates that there are patterns relationships between different attributes. Thus, based on discovering patterns, customers can be clustered in different groups according to their revenue to the company . Then, it will be easy to predict and classify customers accordingly. Experimental findings show that there are different options to attract and retain customers, as well as to gain competitive advantage in the industry and also serve customers with optimal satisfaction based on the discovered patterns. These paternal relationships between the data indicate the hidden fact among the dataset. Therefore, the organization could plan and implement strategies for effective and efficient customer service to maximize profit gained through maximum customer satisfaction. Generally, to predict the behavior of customers, and business processes of the organization data mining techniques offers great promise in helping organizations to discover hidden patterns in their data. Thus, using combination of techniques likes ARM with PSO (as done in this research work) will assist to overcome the complexity of problems in business processes.

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