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Customer Relationship Management using Artificial Neural Networks

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Abstract: ***Customer Relationship Management has never been as relevant for organizations as it is nowadays. The competitive environment is forcing the companies to adopt customer centered strategies. In addition, the technologic devolvement observed in recent years enabled companies to keep databases with customer related data. This allows the use of data mining techniques to extract knowledge from these databases in order to gain competitive advantage and remain at the leading edge. Data mining is most widely used in all fields because of its purposeful usage in the field where it is applied to. This research deals with providing a solution for Customer Relationship Management with the aid of the available Data Mining Techniques such as Clustering and Classification. These techniques are performed on the data by integrating them with the help of Back propagation Algorithm in Neural Networks. A mobile marketing company has been chosen with a base dataset of customers and a similar number of product entries for this research work. A generic mathematical solution is provided by this study and hence it can be applied to any organization, in which properties of a customer play a major role in selection of products.***

Keywords: Customer Relationship Management, Neural Networks, Clustering, Classification, Indexing, Customer Value.

I. INTRODUCTION

Customer Relationship management is the strongest and the most efficient approach in maintaining and creating relationships with customers. Customer relationship management is not only pure business, but also ideates strong personal bonding within people. Development of this type of bonding drives the business to new levels of success. Once this personal and emotional linkage is built, it is very easy for any organization to identify the actual needs of the customer and help them to serve them in a better way. It is a belief that the more sophisticated strategies involved in implementing the customer relationship management, the more strong and fruitful is the business. Customer relationship management incorporates information acquisition, information storage, and decision support functions to provide customized customer service. It enables customer representatives to analyse data and address customer needs in order to promote greater customer satisfaction and retention. It helps organizations to interact with their customers through a variety of means including phone, web, e-mail, and salesperson. Customer representatives can access data on customer profile, product, logistics and the like to analyze problems and provide online and rapid response to customer queries.

CRM is defined by four elements of simple framework, namely Know, Target, Sell and Service. The concept of CRM defined as "the process of acquiring, retaining and growing profitable customer which requires a clear focus on service attributes that represent value to the customer and creates loyalty". CRM (Customer Relationship Management) is the strategy for building, managing, and strengthening loyal and long lasting customer relationships. CRM has two main objectives: Customer retention through customer satisfaction and Customer development through customer insight [1].

II. PROBLEM DEFINITION

CRM has been initially performed manually by employees of the organization. Due to the increase in online transactions, it becomes better and efficient to automate this process [2], [3]. Today, customers are more highly educated, under higher stress, more specialized, living longer, and more influenced by global culture than those of the 60s and 70s when our view of marketing was formed [4]. With a sharp increase in the competition between the different businesses on over the world and with the accelerated growth of the globalization and the global markets, the companies become to research about new methods and technologies support them to keep their market share and their current customers, and to decrease the attrition rate of their customers into another competitors. In 21st century some of the large companies in various businesses such as telecommunication, retailing and banking and other have adopted data mining technology (DM) as emergent technology to support their marketing and their customer relationship management (CRM) strategy. DM mainly depended on different analytical software that support statistics and machine learning. This technology helps the company to convert the huge volume of the customer data that are stored in the databases into meaningful information and actionable knowledge, this information support the mangers to take effective and critical decisions in terms of designing active marketing programs and building effective CRM activities. A proper mathematical model cannot be proposed in this strategy, since this process becomes unpredictable, as it involves human beings as an important element.

III. METHODOLOGY

The techniques of clustering and classification along with the neural networks approach are used to enhance Customer-Relationship Management.

1. First Phase involves collection of required data and Cluster the data into groups according to the parameter.
2. For further degree of refinement, clustered data are again re-clustered. The information obtained is recorded which forms the basis for Indexing. Clustering and classification is done by using Artificial Neural Network.
3. When new data is added, the first hidden level Perceptron refrain the data according to the system and the Second level of Perceptron progress the cumulative function and the Final Customer value is acquired.
4. The new value is compared with the existing customer value and classified into the prerequisite cluster which is the Classification process.
5. Procurement of properties or information from Indexed database is usually quicker and hoards the time.

The main aim of this approach is to provide a clear cut frame work to provide customer satisfaction and to employ the Data Mining work and Neural Network in Customer Relationship Management.

IV. CRM USING DATA MINING TECHNIQUES

A Rule based Data Mining technique has been used to generate new rules and patterns by using sales, marketing, IT and customer's data. Customer's data are clustered by using several characteristics of customers to recognize and understand the customer [8]. Data Mining is used to extract knowledge from these databases and evaluate it for future purpose. Association, Clustering and Classification techniques are used for making data in manipulated form. Whenever a query is raised, the reply will be given with the help of mined data and this will be saved in a database for future augmentation. Association rules have been used to discover regularities between products in large scale transaction data recorded by point-of-sale (POS) systems [9]. Classification and prediction aim to build a model to predict future customer behaviors through classifying database records into a number of predefined classed based on certain criteria [9].

Clustering is used to classify the similar customers and divide the dissimilar customers into different groups. By using cluster analysis, the enterprise can find a customer group of different characteristics by purchase mode, for making more

efficient marketing strategy. Classification methods can be used to classify the potential customers in the existing categories [7]. Customers will be abandoned, if they are found to not fit for bringing profit to customers. Back propagation learning algorithm which is a generalization of Windrow-Hoff error correction rule is used [10]. The range of the output is within 0 to 1. The input-output data are normalized before the initiation of training of Neural Network. The input variable is made to fall in range [-1, 1]. Neural Network based integrated evaluation method is used for simulation. Matlab can be used as a tool. The test results are given as in Table 1. The results of simulation are found to be satisfactory.

Table 1: Test Results and Categorization

order	1	2	3
Test results	0.4508	0.8366	0.6615
Results from experts	0.4600	0.8170	0.6300
Errors / %	1.68	2.37	4.74
Categorized by simulation	Poor	Good	Medium
Categorized by experts	Poor	Good	Medium

A new method based on Neural Network is used for integrating decisions between CRM and Enterprise Resource Planning activity production. It has two phases. First phase is collection of data and passing it to Neural Network [5]. The output customer value is provided by analyzing the properties and combining it with weight values. Product value is provided by analyzing the data relating to the product which is the second phase.

A new customer data is presented to the system in third phase. Multi layer feed forward Neural Network is trained by using Back Propagation Learning Algorithm. The : Structure of an artificial neural network is shown in the Fig 1. The historical purchase data [11] that is available for the organization under study is taken as the training data for the neural networks. [6] Each property of the customer is fed into a perceptron.

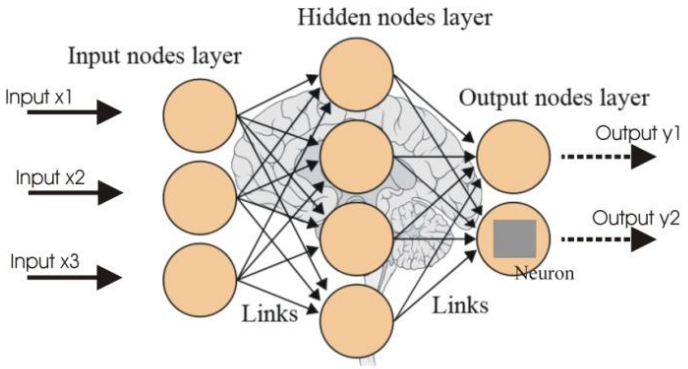

Fig 1: Structure of an artificial neural network

An ANN is typically defined by three types of parameters:

1. The interconnection pattern between different layers of neurons
2. The learning process for updating the weights of the interconnections
3. The activation function that converts a neuron's weighted input to its output activation.

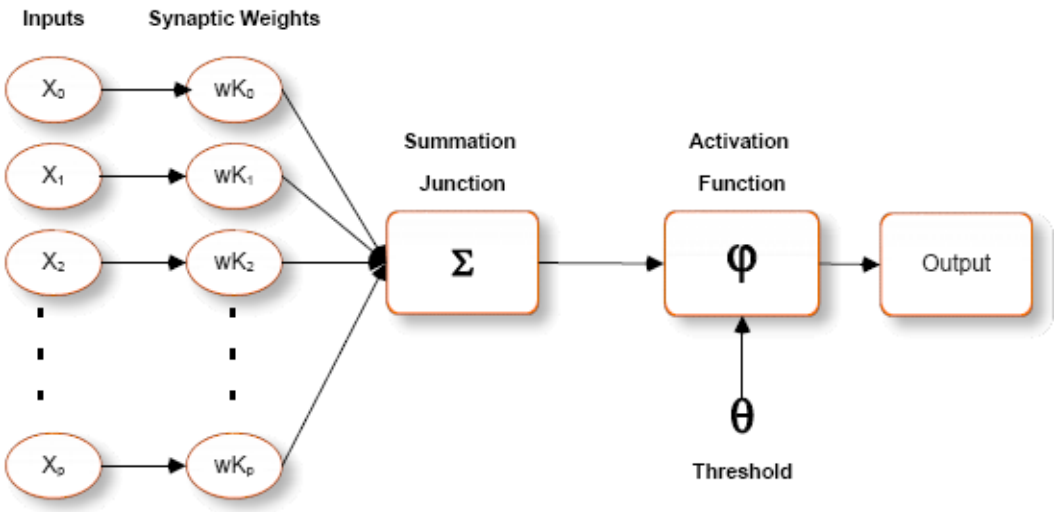

Fig 2: Mathematical Model of a Neural Network

The perceptrons are already provided with weight-age values that correspond to the property represented by it. Figure 2 describes the Customer Value obtained from the training data by using weight-age values. Since this phase also acts as a training phase or learning phase for the neural networks system, user has the facility to adjust these weight-age values until they arrive at a satisfactory result. As every property is fed into the perceptrons or neurons, these property values are operated with their corresponding weight-age values and a result is obtained by each perceptron. This acts as the first hidden layer in the system. The second hidden layer consists of one perceptron that inputs all the values provided by the first layer. All these properties are processed and a final value called the Customer Value [12] is obtained from the system. Every data related to customer is present to the system and goes through the same processing. Hence we obtain a customer value for each customer who had performed a transaction with the organization.

A similar process is carried out for all the products that are being sold by the organization and a product value is obtained for each product. The minimum and maximum customer values are obtained from the result and a median value is calculated. This value acts as the base for Clustering. A boundary is defined by the user, with the obtained median value taken as the centroid. All the customer values that come under this boundary are added to the cluster. Similarly a second centroid value is calculated and boundaries are defined for it for obtaining the next cluster. This process is repeated until all the customers are added to a cluster. Each cluster is examined and similar properties are extracted out of each cluster and are considered as the properties belonging to the cluster.

This property directly corresponds to the purchase capacity of the customer, or we can also say that these properties reflect the type of products that a customer most likely purchases. A similar process is carried out for the products cluster and product properties are obtained. Figure 3 represents how the data is clustered according to the salary and purchase category of the training data customers. Each color in the Figure 3 and 4 represents each cluster according to their salary and purchase.

4.1 CRM process in Two Phases

The CRM process is carried out in two different phases. The first phase deals with processing of the data for the first time, and further processing are carried out according to the rules mentioned in the second phase.

The first phase involves gathering the required data from the user and performing the operation of Clustering on the obtained data. This results in producing clusters of similar types of data, as described in [13]. We further refine this process by performing clustering operation on the already clustered data, which provides us a further degree of refinement [14].

After the successful completion of this process, the obtained clusters are analyzed for common information. This information is recorded along with the common properties used for Clustering process. This forms the basis for Indexing. When a new customer arrives, he/she is classified into any one of the existing clusters. The property of the customer is said to correspond to the properties of the cluster in which they are classified into. Figure 5 shows the Classification Process to identify the customer purchase pattern.

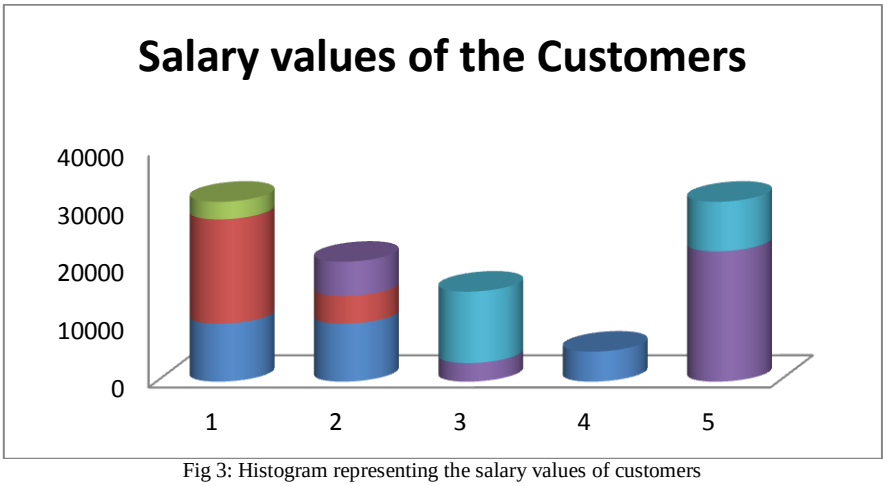

Fig 3: Histogram representing the salary values of customers

The second phase deals with providing the user a faster performance during the clustering process. After a certain period of time, the data present in the data store increases and hence a need for re-clustering arises. This process is usually tedious, since the entire first phase is carried out with a larger amount of data. But in the proposed paper, the data present in the clusters are indexed, since obtaining of properties from an indexed format is usually faster than the normal database, we can save a large amount of time. Only new data present in the system have to be analyzed and stored in the index. This saves a considerable amount of time and processing power. Both, the clustering and the classification phases are performed using the artificial neural networks.

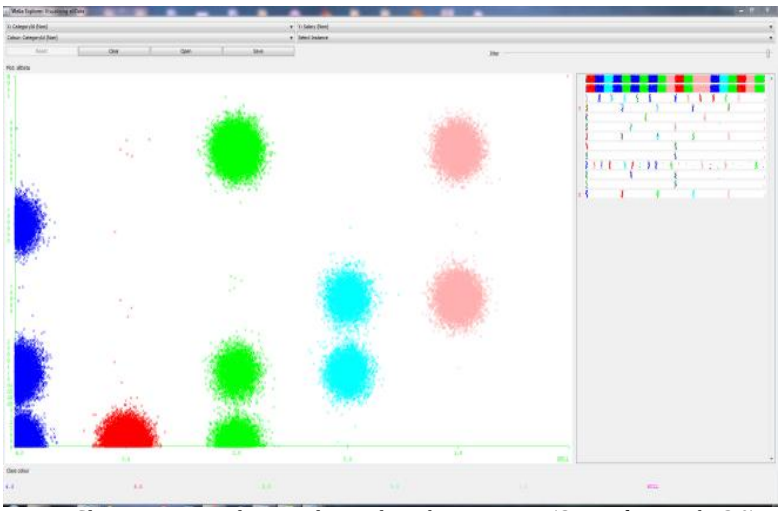

Fig 4: Clusters corresponding to salary and purchase category (Output from Weka 3.0)

4.1.1 Phase I

The historical purchase data [11] that is available for the organization under study is taken as the training data for the neural networks. [15] Each property of the customer is fed into a perceptron. The perceptrons are already provided with weight-age values that correspond to the property represented by it. The second hidden layer consists of one perceptron that inputs all the values provided by the first layer. All these properties are processed and a final value called the Customer Value [12] is obtained from the system. A similar process is carried out for all the products that are being sold by the organization and a product value is obtained for each product. The minimum and maximum customer values are obtained from the result and a

median value is calculated. This value acts as the base for Clustering. A boundary is defined by the user, with the obtained median value taken as the centroid. All the customer values that come under this boundary are added to the cluster.

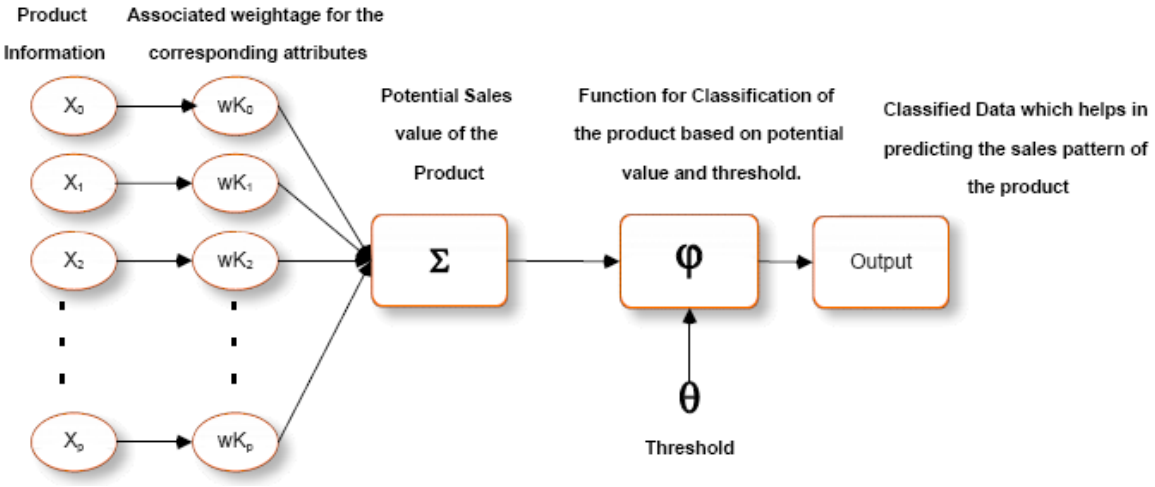

Fig 5: Process of Classification

A second phase Clustering is carried out on each of these obtained clusters as described in [14]. These clusters will correspond to a new property provided by the customer. This provides us with an additional division in each cluster or a second degree of refinement. Each cluster is examined and similar properties are extracted out of each cluster and are considered as the properties belonging to the cluster. This property directly corresponds to the purchase capacity of the customer, or we can also say that these properties reflect the type of products that a customer most likely purchases. A similar process is carried out for the products cluster and product properties are obtained. All these data obtained are recorded in an indexed table. This table contains the customer value, the property values that were used in the clustering process and the cluster under which the current customer is present.

When a new customer data is provided to the system, the customer's properties are passed to the perceptrons and they are passed to the first level hidden layer. This layer contains the final weight-age values that have been tuned in for the particular system. These weight-age values are processes with the corresponding properties and the results are passed to the second level hidden layer. The second level perceptrons processes this cumulative information and the customer's value is obtained. The obtained customer value is compared with the existing clusters and it is classified onto a cluster that has the current customer value within its boundaries. This process is called Classification [3].

The properties of the Cluster, under which the particular customer is classified, are taken as the properties corresponding to the customer. These properties are compared with the properties that have been generated from the product clusters. The two clusters are integrated to provide a solution to the user that contains all the products that the customer has the highest probability of buying.

4.1.2 Phase II

After a period of time, the database is prone to expand. When this happens, the user is compelled to carry out the clustering process again. This process keeps getting tedious every time this stage is reached, since every time a larger amount of data is to be handled by the user. This can be solved by using indexing. Instead of referring the entire database, the user can refer to the indexed values alone, which is faster. The new values are added to the table every time this process is carried out. Hence, processing is done only for the newly arrived data.

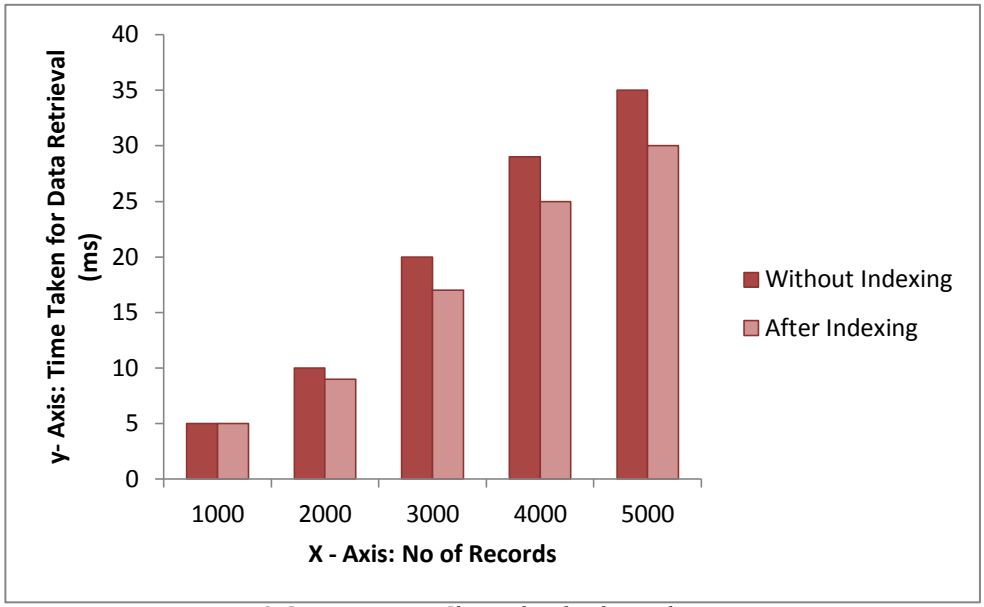

Fig. 6: Comparison Time Chart with and without Indexing

V. Conclusion and Future Enhancement Techniques

The aim of this research is to develop a data mining process framework that enables consultants to determine effectively data analytics tasks for customer relationship management. As a result a unique framework was developed and provides a structured approach for its users to determine effective data analytics tasks. The designed framework provides some advantages over other data mining frameworks and methodologies. Contrary to existing literature the designed data mining process framework structures the whole data mining process, from the business to the engineering phase, at a high level. By structuring the process of selecting relevant business questions and formulating them as data mining tasks the designed framework helps to make data mining more applicable in business. Second, a general applicable framework is very interesting for consultants as it can be applied to different industries and therefore the consultants might use the data mining process framework at different clients within different industries. The possible range of clients where the framework potentially could be applied is quite large, as long as the company has a sufficient amount of data available from their ERP system. The current process can be further extended by including the demographic and psychographic data about the customers. This type of segmentation leads to better analysis of customers and it might prove to be a valuable addition to the project that makes the results more accurate.

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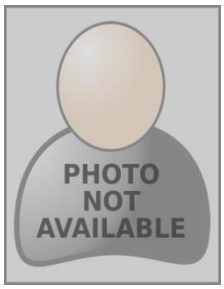

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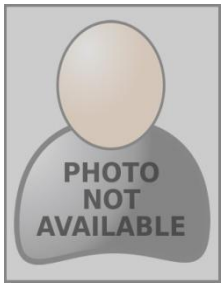

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