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A Survey on Data Mining Techniques for Customer Relationship Management

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Abstract: CRM is basic need for any organizations for retaining and attracting the most valuable customers. In Corporate world, "Customer Retention" strategy in CRM is an increasingly pressed issue. For better CRM, Data mining techniques play a vital role by extracting the information of customer from the database. Data mining can help service sector like banking, insurance, and telecommunication to make crucial business decisions. The aim of the paper is to give a summary on the applications of data mining in the customer relationship management domain. This review paper explores how data mining techniques such as K-means, SVM, Decision tree, Neural Network etc which has been developed to support for customer relationship management process.
Keyword: Data Mining, Data Mining Applications, Customer Relationship Management, Review, CRM.

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I.   Introduction

In the present era marketing strategy changed from product oriented to customer oriented concept. Customer expectations are always increasingly and business services must increase along with their expectations. CRM used as a business tool to identify, select, acquire and develop its profitable customers. Today organizations are faced with the challenge of how to collect, analyze and manage such large volume of data. We need new technologies to manage this complication Customer relationship management is a process of managing interactions between a company and its customers and its help us to increase the business revenues.. Data mining is a suitable tool of one such technology which can help the business to make better decisions. By the use of data mining techniques, organizations can extract the hidden information of the customers. So easily can determine the values of customers and predict the future behaviors and requirements . With the significance in mind, this focuses on surveying how data mining techniques applied in customer relationship management through a literature review.

 For article filtering we search the keyword "data mining" and "CRM". The article is carefully reviewed to eliminate those articles that are not related to application of data mining in customer relationship management. The purpose of the paper is to review literature related to the application of data mining techniques for customer relationship management in various academic journals. We organize this paper as follows, first briefly describes about the data mining, CRM and its tasks. Secondly, how data mining techniques used for CRM are summarized, Third, the literature survey are discussed, fourth about the benefits of CRM and finally the conclusion of the study are described .

A.   Data Mining

Data mining refers to extracting or "mining" knowledge from large amount of data. Data mining as a synonym for another popularly used term, knowledge discovery from data or "KDD" The goal of this technique is to find pattern that was previously unknown data [3]. Data mining is an essential step in the knowledge discovery in databases (KDD) process. The process of discovering useful knowledge from a huge data is called Knowledge discovery in database.

Selection: Selecting data relevant to the analysis task from the database.

Preprocessing: Removing noise and inconsistent data, combining multiple data sources.

Transformation: Transforming data into appropriate forms to perform data mining

Data mining: Choosing a data mining algorithm which is appropriate to pattern in the data; extracting data patterns.

Interpretation/ Evaluation: Interpreting the patterns into knowledge by removing redundant or irrelevant patterns. Translating the useful patterns into terms that human understandable.

A.1. Challenges of Data Mining

There are many challenges faced by data mining as follows and these challenges of data mining are pointed as follows [27] Scalability, Complex & heterogeneous data, Data Quality, Data ownership and Distribution, Dimensionality, Privacy presentation, Streaming Data.

A.2. Trends in Data mining

Some of the trends in data mining that reflect the pursuit of these challenges [28] Application exploration, Scalable and interactive data mining methods, Integration of data mining with database systems,

Standardization of data mining language, Visual data mining, New methods for mining complex types of data, Biological data mining, Data mining and software engineering, Web mining, Distributed Data mining, Real time or time-critical data mining, Graph mining, link analysis and social network analysis, Multi-relational and multi-database data mining, and Privacy protection and information security in data mining

A.3. Pros and cons of Data Mining

Data mining has a lot of pros and cons depend on which specific industry used. The below are listed pros and cons of data mining. [38]

Pros of Data Mining:

Finance/Banking: Data mining supports for financial activities in banking such as maintain the loan information of customers and credit card reporting.

Marketing/ Retail: It helps marketing companies to build the model based on the historical data such as online marketing, direct mail etc. Same as marketing ,data mining bring lot of benefits in retail industry.

Manufacturing: By applying data mining techniques, manufacturers detect faulty equipments and determine optimal control parameters.

Government: Data mining helps government agency by digging and analyzing records of financial transactions to build patterns that detect money laundering or criminal activity.

Cons of Data Mining

Privacy Issues: Because of the privacy issues, people are afraid of their personal information is collected and used in unethical way.

Security Issue: Security is a big issue. In Business industry, how the information is taken care is a big question.

Misuse of information: The information may be exploited by other persons and used for decision making. It will cause serious problems.

B.   Customer Relationship Management

In the era of cut throat competition, the customer is considered as the King. Data mining can be helpful in all the phases of Customer relationship cycle such as Customer Acquisition, Increasing Value of the Customer and Customer Retention.[23]. CRM consists of three words Customer, Relationship, and Management [32]

Customer: Customers are those engines without which business cannot run. So, customer's become very important.

Relationship: That attachment which organizations have to make with their customers is called relationship.

Management: It involves all those activities which requires to plan organize motivate and control relations with customers.

B.1. Definition of CRM

CRM defined "the process of acquiring, retaining and growing profitable customer which requires a clear focus on service attribute that represent value to the customer and creates loyalty" [1]. CRM is relationship marketing, which aims are improving the long-term profitability of customers through moving away from product-centric marketing to customer-centric [6]. CRM is defined as an opportunity to increase profit, attracting and retaining economically valuable customers through removing "economically invaluable" ones.[4]

B.2. CRM Dimensions

According [1] CRM consists of four dimensions: Customer Identification, Customer Attraction, Customer Retention and Customer Development. These four steps can be considered as closed loops.

Customer Identification: CRM begins with customer identification which is referred to as customer acquisition. This phase involves targeting the population who are most likely to be a customer or profitable to the company. Elements of customer identification include target customer analysis and customer segmentation.

Customer Attraction: This is the following phase after the customer identification. It attracts the target customers. After identifying the segments of potential of customers, organizations can direct effort and resources into attracting the target customers. Elements of customer attraction are Direct Marketing.

 Customer Retention: This is the central concern for CRM. Customer satisfaction which refers to the comparison of customer expectations, it is the essential condition for retaining customer's .Elements of customer retention includes one-to-one marketing, loyalty programs and complaint management.

Customer development: This involves consistent expansion of transaction value and individual customer profitability. Elements of customer development include customer lifetime value analysis, up/cross selling and market basket analysis. Market analysis goal is to maximizing customer transactions and reveal trends in customer's behaviors.

II.   Data mining techniques for CRM

Each of the CRM elements can be supported by different data mining models, which generally include classification, association, clustering, regression, sequence discovery and visualization. [1]

Classification: Classification is a supervised learning approach. It not only enables the study and examination of the existing sample but also enable to predict future customer behavior through classifying database records into a number of predefined classes based on criteria. Classification builds up and utilizes a model to predict the

categorical label of unknown objects. Common classification technique is neural network, the naïve Bayes technique, decision tree and support vector machines.

Association: Association aims to establishing relationships between items which exist together in a given record .Market basket analysis and cross selling programs are typical examples for which association modeling is usually adopted. For analyzing the customer data the association rules are used.

Clustering: Clustering techniques identify meaningful natural groupings of records and group customers into distinct segments with internal cohesion. Simply it is grouping similar objects. Clustering is an essential task in data mining.

Regression: Regression is a kind of statistical estimation technique used to map each data object to real value to provide prediction value. The regression technique is typically undertaken mathematical models [35]. Regression is a powerful tool for summering the nature of the relationship between variables and for making prediction of likely values of the dependent variables. Common tools for regression include linear regression and logistic regression common tools for sequence discovery are statistics and set theory.

Forecasting: Forecasting estimates the future value based on a record patterns. Prediction estimates numeric and ordered future values based on the future values base on patterns of data set.[36]. Time series data can be used for business gain if the data is converted into information and then into knowledge.

Sequence discovery: Sequence discovery is the identification of associations over times or pattern over time. Sequential pattern mining has become the challenging task in data mining due to complexity. Most common tools are statistics and set theory.

Visualization: Visualization refers the presentation of data so that users can view complex patterns. Visualization involves mapping of the data into some types of drawing or graphical objects. The visualization also helps in acquiring knowledge more comprehensively and most important, very quickly. [37] Data can be presented in visual form ,such as curves, surfaces like graphs. Data in a database can be viewed at different combinations of attributes.

A. *Applications of data mining for CRM*

The applications of data mining are divided into following various categories [3]. Some of the few applications domains and discussed how data mining tools should be developed for the such applications.

Financial data analysis: Financial data collected in the banking and financial industry are often relatively complete, reliable and of high quality which facilities systematic data analysis and data mining. Some examples cases such as Design and construction of data warehouses for multidimensional data analysis and data mining, Loan payment prediction and customer credit policy analysis, Classification and clustering of customers of targeting marketing, Detection of money laundering and other financial crimes.

Retail Industry: It is the major application area of data mining because to identify customer buying behavior, achieve good customer retention. Retails data mining can help identify customer buying behaviors and achieve better customer retention and satisfaction. Some examples of retail industry are Design and construction of data warehouses based on the benefits of data mining, , Multidimensional analysis of sales, customers , products , time and region, Analysis of the effectiveness of sales campaigns, Customer retention .

Health Care and Insurance Industry: The growth of insurance industry entirely depends on the ability of converting data into the knowledge information or intelligence about customer's competitors and its markets. Data mining also applied in claims analysis such as identify which medical procedures are claimed together. The techniques which are used for fraud detection in insurance. In insurance, four categories such as home insurance, life insurance, motor insurance, medical insurance. Among the four, the motor and medical insurance have much more fraud problems. The data mining techniques which are more helpful for detecting the fraud in the insurance sector.

Telecommunication industry: Telecommunication market is rapidly expanding and highly competitive. It creates a demand for data mining in order to understand the business, identify the telecommunications patterns and improve the quality of service. The scenarios for which data mining may improve telecommunications services as such as Multidimensional analysis of telecommunications data, Fraudulent pattern analysis and the identification of unusual patterns, Mobile telecommunications, use of visualization tools in telecommunications data analysis.

III. Literature Survey

Keshav Dahal et al., [5] proposed a new set of features for enhanced the classification data mining models such as Naïve bayes. Naïve Bayesian classifier is a statistical classifier based on Bayes Theorem and maximum posteriori hypothesis .This classifier is so common and easy to implement and fast. The experiment were conducted using the various classification algorithms and compare the performance among then classifiers such as decision tree, neural network etc. and they found that Naïve Bayes classifiers had helped in large deal to solve many complex problems. He improved the lot of changes to enhance the performance and accuracy better. It considers for making classification useable is to identify a similar group of data from the whole training set of data and then training each group of similar data. For better results, K-means clustering used to split the training data and then train each group with Naïve Bayes Classification algorithm. The results proved that the proposed

models (ECNBDMM-I and ECNBDMM-II) provide better result in terms of classification accuracy than conventional Naïve Bayes classifier. It has shown better results than the other classifier (Decision tree. Neural network etc). The experiment analysis was tested with the help of thyroid benchmark dataset.. It also tested proposed model with other benchmark dataset and attained higher classification accuracy than the naïve bayes classifier. This achieves better results for a data mixing up with supervised and unsupervised learning

Narender Kumar et al., [6] used K-means method to develop a model to find the relationship in a customer database. Cluster analysis (K-means) find the group of persons belongs which criteria. The customer data of LIC have taken for the experiment. Only the age and three premium policy are used for analysis. Cluster analysis using K-means to find the distance between the three customers. K-means is suitable technique for cluster analysis. It may set a path and make a good relationship between the customer and insurance policy organization. This method is to find the cluster (C1) have the three customers (S1,S2,S10) which satisfied with all the benefits terms and conditions of cluster same as the S1,S2,S10 then allocated the cluster C1. Cluster C2, C3 allocated as the cluster C1.It will increase the profit of the organization. Clustering optimization method is used to find the appropriate or local optimal solution.

Indranil Bose et al., [7] projected on two-stage hybrid models to combine unsupervised learning technique with supervised learning technique. It developed a model for the prediction of customer churn. The important decision in customer churn management is the separation of churners from non-churners. Decision tree model are very popular in prediction of churn. It used multiple variables for clustering and examines different approaches of hybridization for utilizing the results of clustering in order to build supervised learning models for prediction of churn. In the hybrid method, clustering used as a first stage and decision tree used as a second stage. C5.0 decision tree model is found be efficient compared to other C4.5 algorithm. C5.0 decision tree models with boosting improved the performance of models in term of top decile lift. Three customers churn dataset used in this paper.

Yaya Xie et al., [8] developed the standard random forests approach in effectively for predicting the customer churn. In this study, proposed a improved balanced random forests method (IBRF) . The experimented were conducted with the help of real bank customer churn dataset. The dataset extracted from the bank's data warehouse. IBRF proved that better prediction results among the random forests such as balanced random forests and weighted random forests. The proposed method combines the two random forests such as balanced random forest and weighted random forest. IBRF is better than that of ANN, DT and SVM. This method to be proven that better accuracy, faster training speeds.

S. Balaji et al., [11] focused on Naïve Bayesian Classification algorithm for customer classification and prediction on Life Insurance of customers and used Naïve Bayes classification for classifying the customers from the huge dataset. It also examines the challenges of using data mining technology for predicting the customer behavior. In this analysis, they have experimented on 10.000 sample of Life Insurance of customers the raw data can be converted into meaningful information and then into knowledge for which predictive data mining techniques are used. They experimented with classification technique namely Naïve Bayes Classification and Data collected from IRDA Dataset of Life Insurance Corporation of India. For experimental analysis, we eliminate some attributes because too many attributes used it is difficult to interpret. In depth discussion, finally 7 attributes only taken, predicting the class label using naïve bayes classification. In this paper, posteriori classification process applied for the data. It clearly proved that the naïve bayes classifier is more better than other classifier to conduct the policy preferences towards the customers. This technique helps us to increase the revenue of the organization

Prabha Dhandayudam et al,. [12] attempted to improve clustering algorithm for segmenting the customer using RFM (Recency, Frequency, Monetary) values. Then the performance of the algorithm compared with other traditional techniques such as K-means, single link and complete link.RFM is very effective method for customer segmentation. For segmenting the customers, the attribute R, F and M are used as three in clustering techniques. For finding the distance between from each object to all other object, here Manhattan distance used and store it in distance matrix. It experimented with real data set of the customer transaction details are used for clustering. In each iteration the pair of each cluster of same distance is merged in parallel instead of merging only one pair of cluster at a time. The parallel merging of clusters pairs improves the quality of clustering algorithm. It will improve the performance the clustering algorithm better than the other traditional clustering algorithm. The performance of the clustering algorithms were measured in term of four criteria (MSE, Intra cluster distance, Inter Cluster distance, Intra cluster distance divided by inter cluster distance .In this paper, the cluster technique used for customer segmentation.

P. Isakki alias Devi et al., [13] developed a method to design retail promotions, informed by product associations observed in the same groups of customers. It used the Clustering and association rule find to identify customer behavior. It can easily predict the sales. The customer with similar purchasing behavior are first grouped by means of clustering techniques such as K-means method and for each cluster an association rule (Apriori algorithm) to identify the products that are brought together by the customers. Association rules are adopted to discover the relationship and knowledge of the database. It proved that apriori algorithm is the

most well known association rule mining algorithm because it is easily found the frequent item datasets from the database. Data analysis done by the open source data mining tool such as WEKA. Analysis of customer behavior aims to improve the overall performance of the enterprise. This paper focused on getting more customer satisfaction.

Bart Baesens et al., [15] focused on introducing a measure of a customer future spending evolution . It improves marketing decision making. Bayesian network classifier used for customer life cycle slope estimation problem. They concluded that Bayesian network classifiers are performed well in predicting the future customer evolution. It augmented that loyal customers be always a regarded as a homogeneous group of profitable customers of a company, In this study,. Bayesian network classifiers have a good performance. This major focused the predictability of the sign of the slope and compare the performance of Bayesian network with other artificial intelligence technique .In this study , they tried to acknowledge the heterogeneity in the long-life customer and it is proved that possible to predict the slope of customer life cycle of long life customers. (TAN) Tree Augumented Naïve Bayes Classifiers were presented extension of naïve bayes classifier.To measure the performance of classifier , the (PCC) performance of correctly classified used .In this paper, clearly stated that bayesian network classifier is suitable for the customer lifecycle estimation problem and Markov blanket concept effective for attribute selection.

Table 1: list of articles according to data mining task, techniques and limitations

S.No	References	Data mining task	Data mining Techniques	Limitations
1.	[5]	Classification, Clustering	Naïve Bayes classification algorithm-means	Assumes independence of features.
2.	[6]	Clustering	K-Means	problems occurs when empty clusters, or cluster differing in size and densities
3.	[7]	Clustering, Prediction	Decision tree, C5.0,SOM, FCM BIRCH ,Boosting	Each node in CF tree can hold only a limited no of entries
4.	[8]	Classification	Improved balanced random forests method	It most robust to noise
5 .	[11]	Classification, Prediction	Naïve Bayes classification algorithm	The values of attributes are assumed to conditionally independent of another
6.	[12]	Clustering	K-means, Single link, Complete link	Traditional k-means takes long time compared with improved clustering algorithm
7.	[13]	Clustering. Association, Prediction	K-means Apriori algorithm	Low comprehensibility used algorithms have too many parameters means obtained rules far too many.
8.	[15]	Classification	Bayesian Network classifier	Sometimes, it computationally infeasible
9.	[18]	Clustering	Adaptive resonance Theory 1 algorithm	It is effective only handle the large amount of data.
10.	[19]	Classification, Clustering	Semi supervised learning algorithm	Cannot say too much in terms of convergence

Manjari Anand et al., [18] analyzed the performance of ART (Adaptive Resonance Theory) algorithm for the classification of the customer on the basis of their choices. The experimented were conducted using the database of the customers of the company dealing with selling of the vehicles. For classification of customers using ART algorithm. The performance of this algorithm compared with back propagation algorithm. It proved ART is more efficient algorithm to use for the customer classification in CRM. This algorithm taken only less time to provide the customer classification The time complexity of this algorithm is less than the backpropagation algorithm The algorithm was implemented in MATLAB 7.0.

Siavash Emtiyaz et al., [19] investigated the use of technique such as semi-supervised learning. It is used to predict the category of an unknown customer. Semi- supervised learning (SSL) is a halfway between supervised and unsupervised learning. Self-training is a commonly used technique for semi-supervised learning. For customer behavior modeling, it used self-training algorithm It proposed a model by means of feed forward neural network trained by back propagation algorithm in order to predict the unknown customer. Multi-layer perceptron neural network algorithm in which a back propagation algorithm is used to classifier. Semi-supervised machine learning techniques are used to construct customer behavior modeling to improve accuracy. The performance of the semi-supervised algorithms is compared with other algorithms (SVM, KNN, Naïve Bayes) on the bank data set. This technique can be used with data mining tool Rapid Miner for both labeled and unlabeled data.

IV.   Data mining Challenges & opportunities for CRM

Following are the key data mining challenges and opportunities for better customer relationship management.[25]

* Non-trivial results almost always need a combination DM technique
* There is a strong requirement for data integration before Data mining
* Diverse data types are often encountered, which requires the integrated mining of diverse and heterogeneous data
* Highly and unavoidably noisy data must be dealt with
* Real world validation of results is essential for acceptance.
* Developing deeper models for customer behavior.
* Acquiring data for deeper understanding in an non-intrusive, low cost, high accuracy manner.

A.   *Benefits of CRM for Customers*

According [4] , we summarize benefits of CRM for customers into the following cases i. Improve customer services, ii. Increased personalized service or one to one service, iii. Responsive to customer's needs, iv. Customer segmentation, v. Improve customization of marketing, vi. Multichannel integration, vii. Time saving, viii. Improve customer knowledge

B.   *Advantages of using Data mining in CRM*

 Some of the advantages of using data mining in CRM are [41] Fast and accurate access to information for easy answer to customer questions, Increase customer satisfaction and loyalty, Integrated data and advanced tools to data analysis for reporting, Response to rapidly changing business environments and customer needs, and Attract new customers and increase market share.

V.   Conclusion

In any organization, CRM is an important issue and managing the good relations customer has become a strong demand for development of any CRM. It was further more beneficial. .This survey paper categories and summaries from all published technical and review articles in CRM.. From the literature review it is clearly understood that the data mining techniques is very important for the customer relationship management. And its techniques become mandatory for all the kind of service industry.

This paper has some assumptions as follows

* Publication rates (research on applications of data mining for customer relationship management) will be increase in future.
* The hybridization techniques of classification and clustering in order to solve different CRM problems. So this trend also rises in the future.
* Data mining is an interdisciplinary research area. Thus in the future data mining development may need integration with various technologies.

In this survey paper, we have shown that data mining can be integrated into customer relationship management and enhanced the process of CRM with betterment. In marketing, to retain their customer, CRM is one of the best leading approach. This study shows that data mining techniques in CRM which improve the efficiency of CRM and provide a better prediction ability to the organizations. Data mining will have major impact of customer relationship management and will present challenges for future research.

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