Customer Relationship Management using Adaptive Resonance Theory

Manjari Anand
M.Tech.Scholar
Invertis University
Bareilly, Uttar Pradesh, India

Zubair Khan
Associate Professor
Invertis University
Bareilly, Uttar Pradesh, India

Ravi S. Shukla
Associate Professor
Invertis University
Bareilly, Uttar Pradesh, India

ABSTRACT

CRM is a kind of implemented model for managing a company's interactions with their customers. CRM involves the customer classification to understand the behavior of the customer. There is a vital role of the data mining techniques for the classification. This paper presents the concept of one of the data mining technique ART for the customer classification for CRM.

General Terms

Adaptive Resonance Theory

Keywords

Adaptive Resonance Theory (ART), Customer Relationship Management (CRM).

1. INTRODUCTION

CRM is the core business strategy that integrates internal processes and functions of the organization, to create and deliver value to targeted customers at a profit. It is mainly grounded on high quality customer related data and enabled by information technology. CRM is an information industry term that helps an enterprise to manage customer relationships in an organized way and helping the company to provide better services to its customers. CRM is the process of managing all aspects of interaction of the company with its existing customers and the new customers, including prospecting, sales and service. CRM applications try to provide insight into and help in improving the company/customer relationship by combining all these views of customer interaction into one picture.

CRM is an integrated approach to identify, acquire and retain the old customers as well as the new customers. By enabling organizations to manage and coordinated customer interactions across multiple channels, departments, lines of business and various geographies. CRM helps an organization to maximize the value of every customer's interaction and drive superior corporate performance. CRM embraces all aspects of dealing with the prospects and customers of the banks, life-insurance companies, and all other organizations. CRM is an activity in any organization that maximizes the profitability for the organization and the customer satisfaction by organizing around customer segments, fostering behavior that provides customer satisfaction and loyalty.

Types/Variations of CRM:

- **Sales force Automation (SFA):** SFA uses the software to streamline the sales process. SFA is a contact management system for keep tracking and recording every stage in the sales process for each prospective client, from the beginning contact to final disposition. Many of the SFA applications also include opportunities, sales forecasting and work flow automation.

- **Marketing:** CRM system for marketing generally tracks and measures the campaigns over multiple channels, such as email, search in the search engines, social media channel, telephone line channel and direct mail channel. These systems track the customer service and support.

- **Customer Service:** CRM can be used to create, assign and manage requests made by the customers, such as call centre which help direct customers to agents.CRM software can be used to recognize and reward loyal customers over a period of time and help them in retaining.

- **Appointment**: CRM provide suitable appointment time to the customers via e-mail or the web, which are then mainly synchronized with the representative or agent's calendar.

- **Small Business:** For small businesses a CRM may simply consist of a contact manager system which integrates the emails, documents, jobs, faxes, and scheduling for individual accounts. CRM available for specific markets and for professional markets (legal, finance) are frequently touted for their event management and relationship tracking opposed to financial return on investment (ROI).

- **Social media:** Some CRM coordinate with the social networking-websites like Twitter, LinkedIn, Facebook and Google Plus to track and communicate with customers who share opinions and experiences about their company, product and services.

2. Data Mining and CRM

Customer Segmentation is one of the important functions in the CRM. The customer segmentation classifies the customers according to their attributes, behaviors and needs. The customer segmentation helps the manager of the company to understand about the needs of the customers in a better way. If the manager understands his customers then he can able to provide the satisfactory goods and services to his customers. Data mining techniques are used for the classification and regression problem. The classification and regression (prediction) can be used for the customer satisfaction

according to the needs and behaviors of the customers. In the classification problem, we're predicting to what category something fall into. In regression problem, we're predicting a number such as the probability that a person will respond to an offer or not. In the CRM, the data mining is frequently used to identify a set of characteristics (called a profile) that segments customers into groups with similar behaviors, such as buying a similar product. The data warehouse, OLAP and other data analytic tools are applied to the database, for example sale database, marketing database and customer database. It will not only be waste of time but also not ideal. Therefore, it is wise that the data of business database that lead to data warehouse after was cleaned, extracted, transformed; loaded the data of data warehouse will offer the data resource for the application of data mining. The data analysis will become great efficient based on the data warehouse. The architecture of CRM [1] based on Data Mining is as follows:

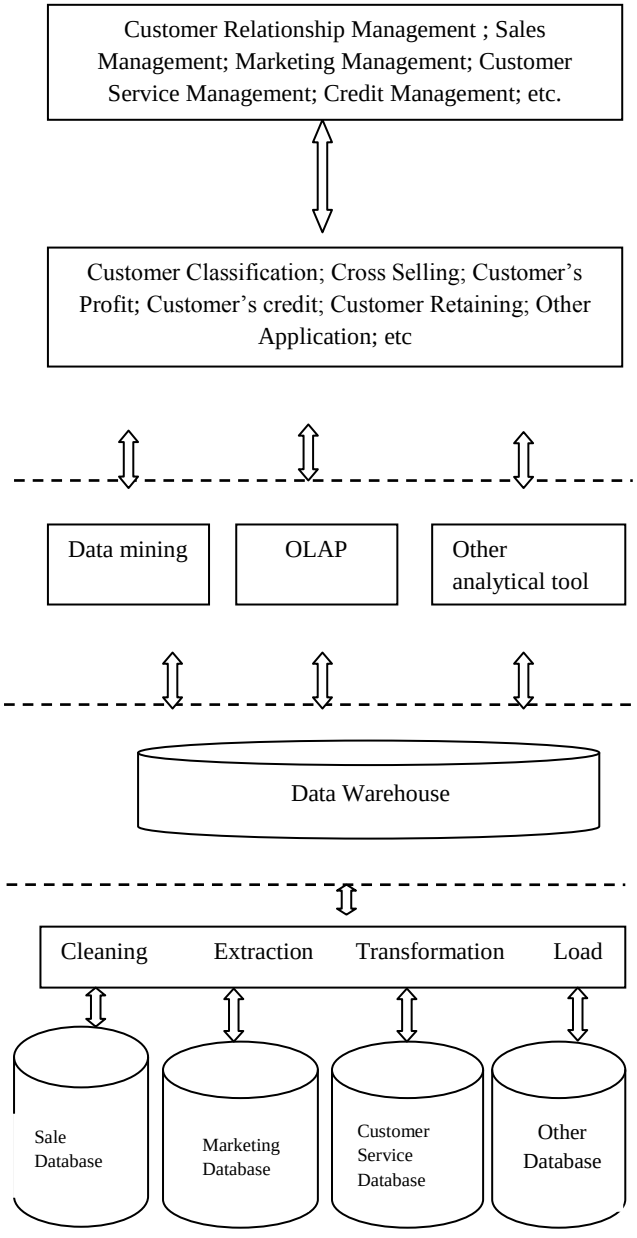

Fig 2: Architecture of CRM based on Data Mining

3. ART

ART is a family of different neural architectures. The concept of ART was given by Carpenter, and Grossberg in 1987 on the concept based that how our brain process the information.

Difference between ART and conventional neural networks:

ART is different from conventional neural networks .The conventional neural networks have failed to solve the ***stability-plasticity dilemma*** but ART is capable of solving stability-plasticity dilemma. The stability-plasticity dilemma addresses how a learning system can preserve its previously learned knowledge while keeping its ability to learn new patterns. The architecture of ART models can self-organize itself in real time producing stable recognition while getting input patterns beyond those originally stored.

Properties of ART:

The four basic properties of an ART system is as follows:

1) The first is the self-scaling computational units. The attentional subsystem is based on competitive learning enhancing pattern features but suppressing noise.
2) The second is self-adjusting memory search. The system can search memory in parallel and adaptively change its search order.
3) Third, already learned patterns directly access their corresponding category.
4) Finally, the system can adaptively modulate attentional vigilance using the environment as a teacher. If the environment disapproves the current recognition of the system, it changes this parameter to be more vigilant.

4. BACKGROUND

Previously many data mining techniques have been applied for the CRM. The classification of the customers into groups by discovering the patterns and trends among the customers using have been done by applying Regency, Frequency and Monetary (RFM) and Rough Set (RS) concept [5]. The customer details segmented using k-means and then Association Rules have also being used customer behavior for CRM [6]. The customer classification and prediction in CRM have been done using Naïve Bayesian Classification [8]. The classification and prediction of the customer in Customer Relationship Management have been done using the back propagation algorithm [1].

5. PROPOSED WORK

5.1 ART1 Algorithm [14]

The parameters used in the algorithm are:

n= Number of components in the input vector

m=Maximum number of clusters that can be formed

b_{ij} =Bottom-up weights (From F1 (b) to F2 unit)

t_{ji} =Top-down weights (From F2 to F1 (b) unit)

ρ=Vigilance parameter

s=Binary input vector

x=Activation vector for interface (F1 (b) layer (binary))

||x||=Norm of vector x (sum of the component $x_{i)}$

Parameter	Range	Typical Value
L	$L > 1$	2
ρ (Vigilance Parameter)	$0 < \rho \leq 1$	0.9
b_{ij} (Bottom-up weights)	$0 < b_{ij} < \frac{L}{L-1+n}$	$\frac{1}{1+n}$
t_{ji} (Top-down weights)	$t_{ji}(0) = 1$	1

Table 1. Typical values of parameters

The training algorithm for ART1 is as follows:

Step 1: Initialize Parameters

$$L > 1 \; and \; 0 < \rho \leq 1$$

Initialize weights

$$0 < b_{ij}(0) < \frac{L}{L-1+n}, \qquad t_{ij}(0) = 1$$

Step 2: While stopping condition is false, perform steps 3-14

Step 3: For each training input, do Steps 4-13

Step 4: Set activations of all F2 units to zero

Set activations of F1 (a) units to input vector s

Step 5: Compute the norm of s:

$$\|s\| = \sum_i S_i$$

Step 6: Send input signal from F1 (a) to F1 (b) layer

$$\boldsymbol{x_i = s_i}$$

Step 7: For each F2 node that is inhibited.

If y_j, then

$Y_j = \sum b_{ij} * x_i$

Step 8: While reset is true, do 9- 12

Step 9: Find J such that $y_J > y_j$ for all node j

If $y = -1$, then all nodes are inhibited and this pattern cannot be clustered.

Step 10: Re-compute activation x of F1 (b)

$$X_i = s_i * t_{ji}$$

Step 11: Compute the norm of vector x

$$\|x\| = \sum_i x_i$$

Step 12: Test for reset

If $|\frac{\|x\|}{\|s\|} < \rho$, then

$Y_j = -1$(Inhibited node J)

If $\frac{\|x\|}{\|s\|} \geq \rho$, then

Proceed to step 13

Step 13: Updates the weights for node j

$$b_{ij}(new) = (L * x_i)/(L - 1 + \|x\|)$$

$$t_{ji}(new) = x_i$$

Step 14: Test for stopping condition.

5.2 Implementation Detail

In this section we analyze the performance of this new approach of ART1 algorithm for the classification of the customer on the basis of their choices. In the proposed work the database of the customers of the company dealing with the selling of the vehicles was used. The database of the company contains the proposal number, order of their choice and the other details of the customers. The performance of the ART1 algorithm was compared with the back propagation algorithm in the classification for CRM. The algorithm was implemented in MATLAB 7.0.

5.3 Experimental Results

The following figures shows the results of ART1 algorithm used for the customer classification for CRM. The figure shows the clusters of customers obtained who were dealing with the purchase of Hero Activa and Star City.

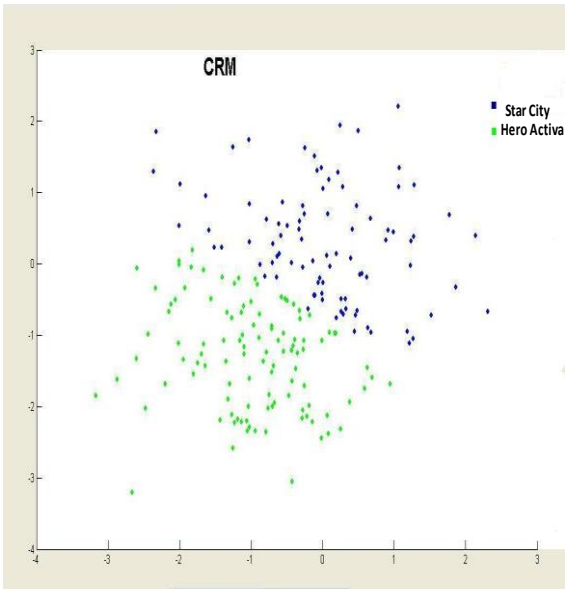

Fig 2: Customer classification by clustering of customers of Hero Activa and Star City

Table 2. Comparison of execution time of ART1 and Back propagation for customer classification for CRM

No. of records , N	Execution Time of ART1 (in seconds)	Execution Time of Back- Propagation (in seconds)
5	5	10
10	13.01	20
15	22.15	30
20	32.04	40
25	42.47	50
30	53.34	60
35	64.57	70
40	76.12	80
45	82.94	90

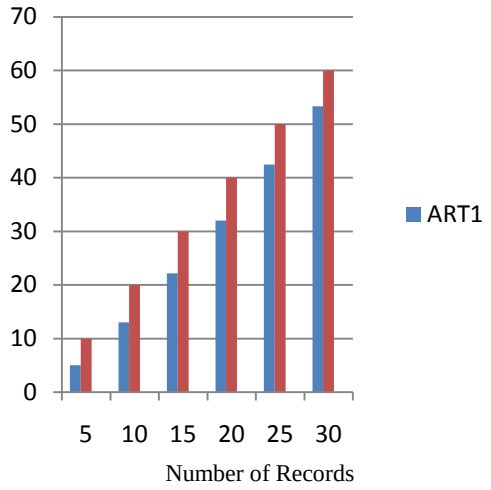

Fig 3: Graph showing the comparison of execution time of ART1 and Back propagation algorithm

6. CONCLUSION AND FUTURE WORK

Adaptive Resonance Theory (ART) is the best approach to deal with the large volume of data of the customers and to provide the customer classification in CRM. Customer classification allows understanding the needs and behaviors of customer to the company's manager who can satisfy its customers by providing the good services to them. ART1 algorithm takes less time to provide the customer classification as ART1 has the self learning capability. The time complexity of ART1 is less than the Back propagation algorithm. Hence ART1 is more efficient to use for the customer classification in CRM.

There are so many variant of ART that can be used for better results than this. One can pick any of the variant and can compare their performance. In future, ART can also be implemented with hybrid information filtering, fuzzy immunity clonal selection neural network and fuzzy multi-set to build the multi-pass ART and provide more efficient result.

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