INTELLIGENT COOPERATIVE AGENTS FOR RELATIONSHIP MANAGEMENT IN DATA MINING ENVIRONMENTS

Fábio Henrique Frazão Mendes
Edson Nascimento,Ph.D.
Universidade Federal do Maranhão
São Luis - MA, Brazil

ABSTRACT

We already live in a technological innovation era, where consumers can have in their hands plenty of information they demand in real time. With regard to this new era, put in those terms, it is necessary to replace the mass-like marketing practice with a relationship marketing type, that is, to serve each customer according to their needs, offering a product or service specific for each of them. Data mining will be the way to obtain the knowledge that could help understand the customers' wishes through an analysis of data stored within a data base. This short paper provides an overview of intelligent software agent in customer relationship management (CRM) with knowledge of data mining, helping the involved company's staff in CRM decision making, aiming to conquer and carefully keep the customer, thus obtaining his loyalty.

KEYWORDS

Intelligent agents, Data Mining, CRM.

1. INTRODUCTION

The current worldwide conjuncture, in addition to the changes that are occurring in customer behavior, with respect to his/her desires, needs, and expectations, has also demanded a new approach to Marketing. This new way to achieve Relationship Marketing should be by means of information technology, which provides the company with more efficient and integrated means to offer services, recognize and take care of customers in real time, to transform data into information and, once spread out throughout the organization, make the customers known and taken care of by everybody.

The strategy is to get their loyalty, provide personalized services, to acquire a better knowledge of the customers and become charmingly different from the competitors. In this new paradigm of relationship, a new business strategy emerges, aiming to develop an organization focused in the customer, called Customer Relationship Management, which is not a mere computerization of the central service bureau or a sales tool; rather than that, CRM involves an in-depth analysis of the characteristics and behaviors of clients, so as to permit a knowledge about their habits and needs(Perppers, 2001).

The data obtained from the contact with clients can be stored in a database or a data warehouse focused in the client, in order to assist the company with internal and external historical information, by means of which it is possible to integrate data from different systems to aid in the decision-making process (Chaudhurl, 1996). The use of Data Mining technology has been suggested to make knowledge extraction possible. It is a process that involves several techniques that allow information to be retrieved from large databases, where it is apparently camouflaged or hidden, thus enabling decision-making to be speedier.

The remainder of this short paper is organized in the form of customer relationship management, which is the reality of business today. The few concepts about the involved technology, data mining, and intelligent agents that support CRM tasks, are meant to allow the companies to better discriminate and more efficiently allocate resources to their most-desirable customers.

2. BACKGROUND

In our research, we are especially interested in development of relationship management agents in data mining environments, where the agents transform data into information that could be understood and used in the company to improve the relationships with customers. Specifically, the multi-agent system supports CRM by performing tasks that can help marketing and sales clerks involved with CRM. Those tasks are obtained by the intelligent agents through mutual cooperation, provided the agents: i) only know data mining techniques; ii) can login themselves to the database and; iii) interact with the user.

The purpose of CRM is to get to know the customer in depth, taking care of him/her in accordance with their needs. Some tasks that agents will be able to perform to support personnel involved in CRM are:

- ✓ Knowing the customers life cycles (single adults, couples, young and established families, mature and separated adults), classifying the customers according to their daily life purchases, and trying to offer services or products for a given group;
- ✓ Knowing the purchasing behavior within the company (new, regular, potential, to be regained or recovered), to find out customers with respect to their purchases within the company, taking the proper measures to turn them into potential customers;
- ✓ Applying Cross-selling/Up-selling, to verify which customers could be offered a certain service/product, in comparisons with other customers purchases;
- ✓ Discovering the best-selling products in a period of time (month, weekend or holiday);
- ✓ Launching of a new product, to discover who are the possible customers that could buy the product;
- ✓ Clustering, to group customers that do not belong to any predefined class;
- ✓ Searching for profitable customers, to find customers that are highly profitable for the company.

In this short paper, emphasis is placed on agents that work at the back-office level, to supply the company with the necessary information, so that the customers characteristics and behavior can be analyzed. Consequently, they support the staff involved in CRM, providing the customer with real-time, precise, individualized, and especially personalized (customized) service.

3. ARCHITECTURE OF THE MULTIAGENT SYSTEM FOR CRM

In this new relationship paradigm, a new business strategy arises with the objective of developing an organization centered in the consumer, known as Customer Relationship Management, which is not a mere informatization of the help desk or a sales tool. It is a defined model, based on consumer relationship policies, with the objective of winning and maintaining the customer.The detailed daily knowledge of the customers through the database related with transactions and payments, is not only what the successful companies use to maintain lucrative customers. The transformation of raw data into information that can be consulted for decision-making will be the primordial factor to obtain a CRM environment.

Actually, data mining is a form of knowledge discovery that can be understood as a set of standards bound to be transformed into certain information, in a form that enables right decisions to be made. Many companies gather hundreds of gigabytes of data from and about their customers without learning anything. Data is gathered because it is needed for some operational purpose, such as inventory control or billing. And, once it has served that purpose, it languishes on tape or is discarded (Berry and Gordon, 2001). Data Mining mentions the extraction or knowledge mining from large data bases, and must be seen as a step in the process of knowledge discovering; only six forms of data analysis are generally used (Parr, 2001): classification, estimation, prediction, affinity grouping, clustering, and description. For each form of data analysis, several techniques of AI can be used: Analysis of Market Basket, Memory-Based Reasoning, Cluster, Link Analysis, Decision Tree, Genetic Algorithms, and Neural Networks.

Multi-agent systems estimate the coordination between agents so that they can make decisions about some problems, thus assuring coherent team work, so that their objectives are achieved by the community as a whole, summarizing only one solution for the problem. Such systems agree to model the behavior of a set of intelligent agents, organized according to social laws, distributing them with a certain autonomy immersed in an environment with which they need to interact (Ferber, 1999).

They give support to the marketing and sales sectors, thus being capable of performing the following tasks: to identify who are the possible customers likely to leave the company; to identify cross-selling

products and up-selling opportunities; to identify which customers may increase their purchases; to gather customers according to their purchases within a certain profile (Clustering); to develop awareness of the customers' habits in order to plan Marketing campaigns, such as catalog creation, or yet, to discover products that will be purchased together, adding to sales (Market Basket), and to identify customers eager to purchase new products. The architercture supports four types of agents: system management agent, results agent, data mining agent, and data warehouse agent (Figure 1).

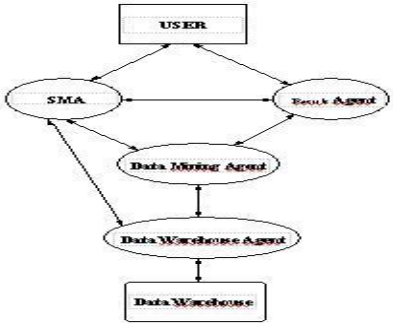

Figure 1. MultiAgent System Architecture

The system management agent's (SMA) role is to interact with the user to obtain a description of the problem, and to model it into tasks that could be performed by the other agents. Another function is the coordination of all tasks that should be distributed among the agents, thus ensuring coherent team work, so the objectives can be achieved by the community as a whole, formulating a single solution for the problem. To that effect, it is necessary that the system management agent has a knowledge of all actions performed by the system's agents. The Results Agent is responsible for showing the results of the problem to the user, which could be done by means of reports, visualization, or a file. The Data Mining Agent is responsible for using, one or more data mining techniques (Market Basket Analysis, Memory-Based Reasoning, Cluster, Link Analysis, Decision Tree, Genetic Algorithm, Fuzzy Logic, and Neural Networks), to obtain the final result. The techniques contained in the data mining agents has been developed by employees involved with CRM, and implemented by a data mining analyst. The Data Warehouse Agent is responsible for accessing the database (data are stored in the form of tables) or the data warehouse (data are stored so as to allow the identification of indicators and the evolutions of values along time), to provide data that could be utilized by the data mining agents.For a better understanding of the proposed architecture, the multi-agent system's operation is explained by means of a sequence diagram, shown in Figure 2.

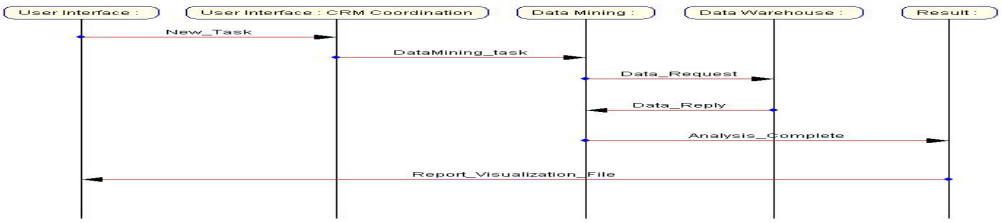

Figure 2. Sequence Diagram of the proposed CRM (Deloach, 2001)

In this proposed architecture, the system management agent (SMA) captures the entire description of the problem, and then models the problem into tasks that could be performed by the agents. Each task could count on one or more agents for its solution. The SMA sends the agents the tasks that will have to be solved, and the agents then undertake to perform those tasks. In this case, the use of three tasks will be necessary: a data mining task, access to the data warehouse to obtain information, and a display of results. These tasks will be executed by the three corresponding agents (Data Mining Agent, Data Warehouse Agent, and Results Agent). The agents will maintain communications among themselves to solve the tasks. The Data Mining Agent will need data to begin its job; it then sends a request to the Data Warehouse agent for the data to be prepared. These data work as input for the techniques that will be utilized, in order to produce some knowledge. After finding the results, the Data Mining Agent notifies the results agent, which in turn will make them available by means of a report, file, and visualization.

4. RESULTS

As an example, it is show the utilization of the market basket technique by the agents. First, the SMA agent is the one responsible for coordinating the tasks, so they are distributed among the agents, ensuring team work in such a way that their objectives are achieved by the community; his also is the role of interacting with the user in order to obtain the information needed for the tasks to be performed by the agents.

Knowing the names of the agents that have the abilities required to achieve the objective, the SMA agent requests their addresses to the Facilitator agent, who answers with a message containing the name and IP address of the machine where the requested agents have been installed. Then, the SMA sends a call for proposal (cfp mensage) to the MarketBasketAgent and DataWarehouseAgent agents, which launch their proposals to be analyzed. In case these proposals fulfill the expectations, a message is then sent to each agent, in order to provide them with a confirmation. The MarketBasketAgent and DataWarehouseAgent agents begin to perform their tasks; since the MarketBasketAgent needs the information collected by the DataWarehouseAgent, they then communicate to be able to achieve the main objective of the SMA agent. The result thus obtained is displayed by the ResultAgent (Figure 3), and a file containing the rules for the market basket is also created; this file could be utilized in the company's home page to offer products in real time or to make a promotion aimed at a bundle sale.

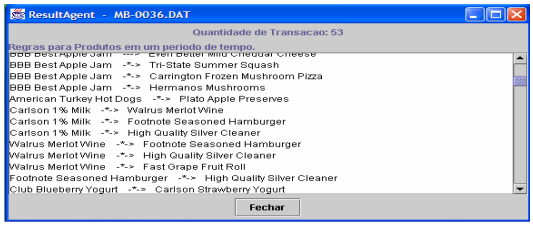

Figure 3. Market Basket Technique Results

5. CONCLUSION

The traditional methods used to attract and retain clients are fast becoming inefficient. The increased competition in areas previously considered as monopolies, the globalization of the economy, and the popularization of the Web are changing the business scenario worldwide. Companies have to change the way they do business in order to maintain their competitivity in an ever more aggressive market. CRM is a synthesis of this change: leaving a product-oriented world and entering a client-oriented world. Thanks to information technology and the Internet, it is possible to avoid the trap of commoditization. Instead of selling to markets, we will be selling to clients. Instead of seeking greater participation in the market, we will seek greater participation in the clients. Instead of offering discounts to increase revenue, we will create stronger relationships with our clients, develop loyalty with our most valuable clients, and thus increase profitability. In this paper we attempted to show how it is possible to utilize intelligent agents in association with data mining knowledge to aid in client relationship management.

REFERENCES

Berry, M. and Gordon L., 2000. *Data Mining Techniques For Marketing, Sales and Customer Support.* Wiley Publishers, Canada.

Chaudhurl, S. and Dayal, U., 1996. *Decision support, Data Warehouse and OLAP*. Tutorials of the Twenty-Second international Conference on Very Large Data Base, Bombay, pages 195-306.

Deloach, S. et al, 2001. *Multiagent systems engineering.* Internacional Journal of Software Engineering and Knowledge Engineering. Ohio, USA, pp. 231-256.

Ferber, J., 1999. *Multi-agent Systems An Introduction to Distributed Artificial Intelligence.* Pearson Education, London, England.

Parr Rud O., 2001. *Data Mining Cookbook – Modeling Data for Marketing, Risk, and Customer Relationship Management*. Wiley Publishers, Canada.

Perppers, D. et al, 2001. *Marketing one to one.* Makron Publishers, Canada.