Customer Relationship Management System Developed using Data Mining and Fuzzy Arbiter

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Abstract: **Customer relationship management system is a system which is required for detail analysis of the market, market needs and about the product improvements and about its life cycle. Collecting data about the product sale over a period can help in analyzing various trends of a market this is known as data mining, using this collected data a product lifecycle can be defined and a new product can be developed with some new improvements according to the market trends. Making decisions on the detailed analysis of the product sales figure and on various data analysis is done by the arbiters, Fuzzy arbiters works on a set parameter which can be generic or can be defined for each category separately, though it is always advisable to keep arbiters generic.**

Keywords: **Database, Data Mining, Data Analysis, Machine Learning, Fuzzy Logic, Arbiter.**

1. Introduction

This paper discusses the effects of data mining, machine learning over the commercial market, irrespective of the product nature and their relevance to the technology. Having a customer relationship management system can help a business in many ways, it can reduce the deadlocks, can help a vendor in managing stock numbers which will ultimately improve the profit books, not only that it will reduce wastage of many resources as well, a customer relationship management system can also be used in managing limited natural resources. In this paper we will talk about the sales figure and prediction of sales for a particular category.

Database is a systematic collection of data. Databases support storage and manipulation of data. Databases make data management easy.

Data mining is the process of sorting through large data sets to identify patterns and establish relationships to solve problems through data analysis. Data mining tools allow enterprises to predict future trends.

The process of inspecting, cleaning, transforming, and modeling data with the objective of discovering useful information, arriving at conclusions, and supporting the decision making process is called Data Analysis.

Machine learning (ML) is a category of algorithm that allows software applications to become more accurate in predicting outcomes without being explicitly programmed. The basic premise of machine learning is to build algorithms that can receive input data and use statistical analysis to predict an output while updating outputs as new data becomes available.

Fuzzy logic is an approach to computing based on "degrees of truth" rather than the usual "true or false" (1 or 0) Boolean logic on which the modern computer is based.

The idea of fuzzy logic was first advanced by Dr. Lotfi Zadeh of the University of California at Berkeley in the 1960s. Dr. Zadeh was working on the problem of computer understanding of natural language. Natural language (like most other activities in life and indeed the universe) is not easily translated into the absolute terms of 0 and 1. (Whether everything is ultimately describable in binary terms is a philosophical question worth pursuing, but in practice much data we might want to feed a computer is in some state in between and so, frequently, are the results of computing.) It may help to see fuzzy logic as the way reasoning really works and binary or Boolean logic is simply a special case of it.

Fuzzy logic includes 0 and 1 as extreme cases of truth (or "the state of matters" or "fact") but also includes the various states of truth in between so that, for example, the result of a comparison between two things could be not "tall" or "short" but ".38 of tallness."

Fuzzy logic seems closer to the way our brains work. We aggregate data and form a number of partial truths which we aggregate further into higher truths which in turn, when certain thresholds are exceeded, cause certain further results such as motor reaction. A similar kind of process is used in neural networks, expert systems and other artificial intelligence applications. Fuzzy logic is essential to the development of human-like capabilities for AI, sometimes referred to as artificial general intelligence: the representation of generalized human cognitive abilities in software so that, faced with an unfamiliar task, the AI system could find a solution.

2. Related work

Taiwan's small and medium-sized enterprises (SMEs) in China are faced with tough challenges. To escape intense competitions and the micro-profit economy, many of them have

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shifted their sales focus to foreign markets or placed an equal emphasis on both the domestic market and foreign markets. However, no matter which kind of markets they focus on, they need managers with a robust personality and heightened attention to customer service quality. When faced with a bottleneck in management, managers with an internal locus of control are more able to lead the company staff to overcome difficulties and patiently solve all the problems [1].

According to [2], individuals with an internal locus of control find the sense of achievement more important and will take more aggressive and constructive actions when they experience frustrations. In contrast, individuals with an external locus of control feel anxious easily. They tend to take less constructive actions when faced with frustrations and care more about the fear after failure than about the achievement after success.

With the growth of per capita income levels, consumers are paying more attention to their rights and benefits. To meet consumers' varying needs, businesses have to introduce new services and promotional activities from time to time. Hence, how to develop customer relationships and improve the quality of the relationships has become one of their major concerns [3].

In this new economic environment, managers need an internal management accounting information system (MAIS) that can efficiently provide accurate and effective information to support their decision-making. Using MAIS as a control instrument in business management is common among modern businesses [4].

Through the assistance of MAIS, managers can process a multitude of complicated transaction records and customer data to obtain insights in market changes and trends [5].

If SME managers identify changes in the market and formulate strategies based on data provided by MAIS and effectively implement the strategies in their management, they can certainly improve the quality of their customer relationships. Because personality is closely related to work behavior [6], managers' personality plays a pivotal role in organizational operations. In this study, we argue that managers' personality affects their perception of the usefulness of MAIS, which in turn, affects customer relationship quality.

E-commerce websites and online shopping are the upcoming trends in today's busy world. People buy and sell products by just a single click. All e-commerce websites are in a race to make their websites the best and increase their sales and productivity. It is hence very essential to identify the upcoming trends in online sale of products. In our system we will perform analysis on the sales data using various data mining techniques which gives us a valuable insight of the inner -workings of Online Sales. Data mining will help to analyze our systems database which will help us in generating patterns of sales of products. The next step after obtaining patterns of sales of products our system will work on   optimization of these sales. By optimizing the sales we can manage our product inventory by stocking up the fast- selling products and lowering prices or offering discounts on less selling products. This will indeed increase the overall productivity and profits of our system.

Data mining [7]: Data mining is the abstraction of covert information from large databases as it has a great potential to help companies focus on the most important information in their data warehouses. Organizations make proactive and knowledge-driven decisions using data mining tools which predict future trends and behaviors. Time consuming business questions can be answered easily using these tools.

Extracting patterns from customer data and classifying them is very important factor for business support and decision making. Identifying newly emerging trends is needed in business process. Sales patterns from inventory data indicate market trends and can be used in forecasting which has great potential for decision making, strategic planning and market competition [1]. Pattern analysis plays a crucial role for merchandize planning because the patterns are studied and ordered from the inventory accordingly [8], [9].

3. Proposed work

In this section implementation of developed algorithm has been discussed. The algorithm on the whole can be divide into sections which are explained sequentially below.

1) Sales Database: Category based sales data with individual products sales figures are required to analyze the sales report of each category and product individually. The data is needed to be segregated at least on monthly basis and should have a history of previous year's sales figures as well. The data used here in this work is system generated so that a deep analysis can be made for the simulation purpose and scenarios can get modified as per the testing case, though the database can also be downloaded from the UC Irvine Machine Learning Repository. Database generated will be sorted by categories and the table will be sorted by the months.

2) Sales Analysis: This function deals with the category wise analysis of the sales. This MATLAB script asks user to provide a duration input for the analysis of the products categorically.

Sales generation function generates and segregates the numerical data available for the individual products into an excel sheet individually for each product for the analysis of product sale's record for the consecutive years in each month. Segregating data is important as finding average for each month is important and on the basis of that the sales figures can be manipulated and the lifecycle of a product can be understood from it.

Sales analysis generate product data sale can be represent graphically with month to month analysis same month to month and with different analysis, year to year analysis etc. there can be n number of analysis.

3) Product analysis: this mat lab script performs an analysis over lifecycle performance. It is important to analysis product lifecycle during the active years also, it should be compared to other product from the same category. This mat lab script analysis the product individually with its own sales record and with other record sales product as well.

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It is a numerical base function which requires no mathematical equation but it requires mathematical modeling but structuring of data base.

4) Year performance: this mat lab script comprises of detail analysis of products during their lifecycle and their sales record. This block of code works on fuzzy logic. Fuzzy logic is a linguistic tool box for making decision and to make a conclusion over a situation.

Year performance script analysis month to month sales vector and then verdicts for the final vector, the same is than conversed with for consequent year's verdict to form an opinion about the product progress. Though they are certain factors which are considered to make sure that the Verdict is based on the history as well as over the current scenario. To achieve the same goal priority indexing has been done along with the condition along with the condition that the last year's verdict will get two priority indexes, one is sequentially related and the other one for the most recent sales status.

For priority indexing the furthermost will be one and for the most recent year it will be highest, its value will be define by the number of the year consider for analysis.
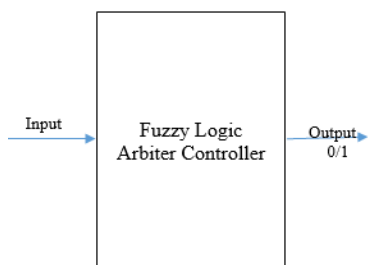

Fig. 1. Fuzzy Logic Controller Box

This is a fuzzy based script which works over a vector which can be either upward or downward. For upward can be 1 or for downward linguistic value can be 0.

5) Transportation cost is basically a price where we estimate the price of the product from factory outlet to store outlet. This will comprises labor cost, fuel cost, number of transportation medium and total distance.

TC = Fuel Cost+ LC
Fuel cost= fuel required * fuel price * NoT
Fuel required = distance / average of the vehicle
Percentage Change = (TC/PP) * 100
Where,
TC = Total Cost;
LC = Labor Cost
NoT = Number of Trucks
PP = Total Product Price.

6) Employee Cost script calculates the total cost bear by the store to accommodate the proper functionality of the store and stock and also what effects or percentage change it is going to make over the products.

Tot Emp Cost = NoE * DW * 365 * 9;
Where,

Tot Emp Cost = Total Employee Cost
NoE = Number of Employees
DW = Daily Wages of each Employee per hour
365 is the number of days and 9 represents the working hours of the day.

4. Results

The complete script on simulation gives various outputs in different forms such as in the detailed excel format, detailed analysis of the products on yearly basis or over the monthly basis also. The script generates many numerical based databases which helps the user to analyze the database in detail and the user can figure out the strategies for the upcoming months or even for the quarter or for a year.

Year performance function generates the vector results as shown in figure 2.

Fig. 2. Year performance function vector output

A table of output can also be shown as below:

Table 1
Output of a Sample Product from a Sample Category

Year	Mon January Sa	February S	March Sal	April Sale	May Sales	June Sales	July Sales	August Sa	Septembe	October S	Novembe	Decembe	Annual Sal
2009	112	112	108	112	74	78	56	80	112	64	61	102	1071
2010	53	58	86	110	96	87	71	68	50	116	117	104	1016
2011	92	63	117	94	58	50	54	54	69	106	110	68	935
2012	56	72	70	91	59	107	119	63	114	86	100	91	1028
2013	83	83	83	117	95	81	84	100	120	76	70	61	1053
2014	109	52	78	102	89	66	88	89	108	65	120	81	1047
2015	106	120	108	117	56	63	119	84	96	118	72	105	1164
2016	92	107	54	108	115	65	74	60	70	103	101	119	1068
2017	91	116	54	96	83	78	92	86	57	57	59	65	934
2018	55	95	102	102	67	99	68	76	110	91	102	99	1066

The Results generated in this work are different from the results that has been generated earlier. As previously there were no sign of predicting sales records vector feature that has been a new addition also there were no FUZZY Controller inclusion that has been made here and which actually helps the system to consider various feature before giving its verdict for the sale of the product.

5. Conclusion

From the above work this can be concluded that the above implemented algorithm works with the latest trends of the market and can guide the store staff to reduce the dead inventory and can maximize the profits by blocking the losses that occurs due to the improper management of the database.

6. Future scope

This system can be updated for the direct implementation of

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it over the online platforms and the inclusion of fully functional artificial intelligence could lead this system to do wonders for the store owners and sellers.

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