

Simulation of Customer Behavior Using Artificial Neural Network Techniques

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Abstract: In recent years, service industries and companies have faced big customer data which its analysis takes a lot of time. Hence, there is an urgent need for systems able to extract useful information from a mass of information. One technique to do this is data mining. Today, data mining and neural network techniques can be used to analyze customer behavior and find hidden information in that behavior. Prediction of behavior of loyal and new customers of a service company has a significant impact on that company's marketing techniques and the profit earned by that. In this paper we discuss a data mining technique for identification of customers' favorite products based on their purchase and analyze the results. Finally the aim of this research paper is to predict customer behavior using artificial neural networks and data mining techniques.

Key words: Data mining • Customer behavior prediction • Demand forecasting • Customer relationship management

INTRODUCTION

Nowadays, large companies and enterprises in many parts of the world are doing their own operations and many data can be produced from different parts. Therefore, decision makers of companies need access to these resources to make strategic decisions [1]. Data mining is a suitable tool which can be used to extract the best patterns and information from raw data. With an Increase of the contention in the world and in order to survive, companies must predict the market status in the future. This makes them make big decisions in their working environment which is quite helpful for their advancement [2].

One of the practical ideas of data mining is the area of marketing. Researchers have devised specific techniques and appropriate patterns to understand which goods to which extents are more useful and which advertisements have a key role in selling out more. So, in order to make a clearer decision and providing more services, the current data can be changed to practical information. The results of research shows that behavior of past customers has a high impact on finding

behavioral patterns to make a new strategy. [3-6] have provided such patterns in which using data mining techniques, the hidden information of the database have been extracted and by predicting valuable customers and their future behaviors, a plan has been devised to provide goods and services in the time of demands which enhances the income of the company and lessens the stock [7].

In another work, researchers have devised a pattern to predict waiting time of the manufacturing process based on customer orders [8]. Kusiak and Smith utilized data mining techniques to design products and production systems and recognized some parameters such as better utilization from unstructured information, integration of data mining techniques with current functionality and feasibility of data mining models for users as ahead challenges of data mining [1].

In a research the results of which is provided in the following, we have tried to predict the behavior of customers using organizational database and neural networks in data mining and based on that, the appropriate basket of goods is recommended to customers.

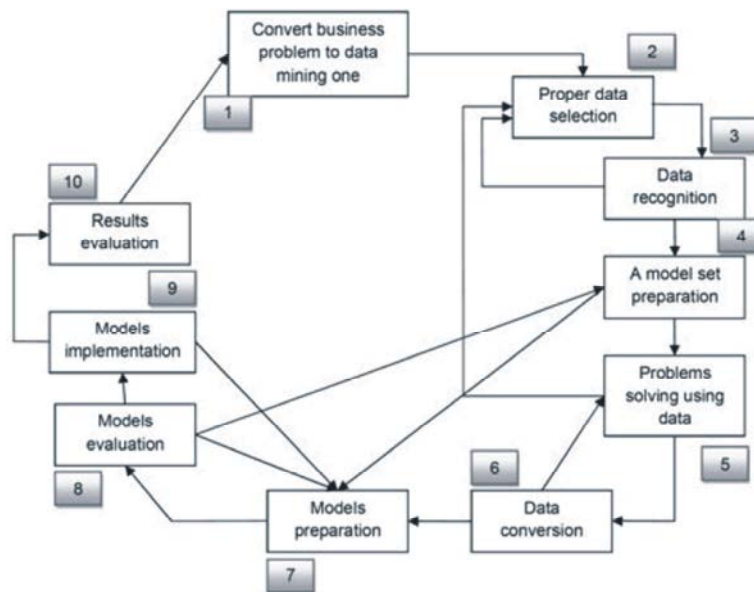


Fig. 1: Data mining techniques scheme

Data Mining: Data mining is the process of searching and data analysis in order to find potentially useful information [9]. This procedure contains selection, detection and modeling a large part of data which is used for detection of unknown patterns and extraction of intelligible data from large databases. Data mining comprises a variety of methods and techniques containing statistical analysis, decision tree, neural networks and the like. Although the used tools for data mining have a long time history and are available to the professionals and researchers of this field for a long time, their advance in computer software and hardware especially mining tools such as data visualization and neural networks renders data mining more pleasant and applicable [4]. Data mining has applications in time and cost saving, making feasible understanding the knowledge for which no previous analysis is possible, proposing a new solution and answering some questions which were not previously interpreted and optimal usage of data [7].

In papers of this research area there are different categories in the context of data mining and in one of the most important papers the data mining techniques have been divided into eleven steps [10] which is shown below:

- Transforming business problem to a data mining problem.
- Selection of appropriate data.
- Data recognition
- Generation of model set

- Data troubleshooting
- Data transformation for information extraction
- Model generation
- Model evaluation
- Model implementation
- Evaluation of results
- Restart (Figure 1)

Data Mining Applications in Analysis of Customer Demands:

Attention to customer demands has become a very critical issue for managers these days. It is so important that the life cycle of a company depends totally on customers and recognition of their interests and tastes. On the other hand, in traditional styles, due to low number of customers and possibility of face to face connection with them, the salesperson gains much information about interests, preferences and in case of continuity of purchase habits of customers, the volume of loyalty of customers. In the new method, considering wide spread of technology penetration in the societies and the growing the number of customers, the possibility of discovery and generation of knowledge (containing properties, demands and customer behavior) is rare. In this way, the only wealth of the company to access knowledge of its customers can be gained by the archived digital data of the company database based on customers' purchase. So, in order to discover customer's data, the importance of using knowledge discovery and data mining is critical in companies. This issue has two important advantages: firstly, the discovered knowledge

is generated away from personal judgment of and is based on objective data. Secondly, the discovered knowledge base on data mining, unlike the previous method, is not tied up in minds of an expert and can be shared to other persons as well.

Problem Statement: In our proposed method, database of a dairy products company is utilized. In this company in addition to different types of yoghurt, probiotic yoghurt is produced as well. The word probiotic comes from a Greek word which means “for life”. Probiotic is usually a mixture of some microorganisms that when used by a person or an animal, can improve digestion microflora features of the host organism. Probiotics can help stimulating growth of advantageous bacteria of intestine and subsiding pathogenicity of harmful microbes and their operation mechanism relies on their survival in digestion system.

The problem considered in this paper is appropriate forecasting of customer purchase of all kinds of probiotic yoghurt. Marketing and production managers can, in case of having trustable knowledge in this area, program the production volume of the abovementioned products. To help solve this problem, in the current research we tried to concentrate on this issue by using artificial neural networks as well as generation of rules from data mining algorithm.

In order to forecast purchase volume of probiotic yoghurts, using MATLAB software, we generated artificial neural networks. MATLAB is based on the mathematical concept of a matrix and is a powerful calculation system which is helpful in carrying out scientific calculations and engineering problems. This system is designed to do simple matrix calculations. One of the main points in MATLAB is that it can be utilized in an interactive form which means that when given an order it can produce the answer very quickly [11].

In this artificial neural network the Train LM algorithm is used. This method, just similar to other Newton like methods, tries to reduce the computation burden. It is the fastest implemented method in MATLAB and possesses a very high efficiency. The generated network is called back-propagation network [11].

In the studied company three probiotic yoghurts are produced: Bucket 2.2 low fat probiotic yoghurt, 800 gr. Low fat probiotic yoghurt and bucket 2.2 high fat probiotic yoghurt. In the following, the methodology and results of our research are presented and analyzed.

Research Methodology: In this research, a part of database has been used as input data for training our neural network and two records (containing data of two customers) have been used as test data. The results of training and test of the neural network for different products is presented in the following. It is noteworthy that the purchased number of all product kinds is a number in range 1-5. One and five show the least and highest number of purchases, respectively. Customers of intended company buy their required products in bulk. The number of purchased products between 0 and 100 lies in range 1, between 100 and 200 in range 2, between 200 and 300 in range 3, between 300 and 400 in range 4 and between 400 and 500 lies in range 5. (1: very low, 2: low, 3: average, 4: high, 5: very high).

The following signs and abbreviations are used: MSE is mean squared error, Elapsed time is the training time and Performance denotes the performance of the network.

Research Results

The Output of Neural Network Using MATLAB: The output of the neural network for 2.2 low fat bucket probiotic yoghurt is shown in Table 1.

MSE = 0.2735

Elapsed time = 0.545856 seconds

Performance = Goal met

For this product, the neural network has predicted appropriate results. These results are near actual values and also, mean squared error is negligible. Also, the network performance has been favorable and the goal is reached. The gained numbers demonstrate achievement to the desired outcome.

The output of artificial neural network for low fat 800 gr. Probiotic yoghurt is shown in Table 2.

MSE = 1.3160

Elapsed time = 0.950611 seconds

Performance = Maximum gradient reached

For 800 gr. Low fat probiotic yoghurt the results are almost desirable. The output of the network is not that satisfactory for the first customer. But for the second customer, outputs are in the actual range. The mean squared error is rather low. The gained numbers demonstrate relative achievement to the results. The output of artificial neural network for bucket 2.2 high fat probiotic yoghurt is shown in Table 3.

Table 1: Low fat bucket probiotic yoghurt

Customer number	Actual value	The ANN calculated
1001	2	1.5803
2006	3	2.6358

Table 2: Low fat 800 gr. Probiotic yoghurt

Customer number	Actual value	The ANN calculated
1001	5	2.4167
2006	5	5.0009

Table 3: Bucket 2.2 high fat probiotic yoghurt

Customer number	Actual value	The ANN calculated
1001	3	2.8178
2006	2	1.1847

MSE = 0.3082

Elapsed time = 1.736262 seconds

Performance = Goal met

The predicted values of artificial neural network are also satisfactory for this product such that the calculated numbers are near the actual ones and also, the mean squared error is low. The performance of network for this product is very great and goal is reached. The calculated numbers show that we have reached appropriate results.

Accordingly, using designed neural network we can predict the value of the company demands to produce this type of yoghurt and also, we can find out the daily, weekly and monthly usage of our customers from this type of yoghurt. Furthermore, we can make sure if purchasing this product is advantageous or not and how to arrange the production plan of the company to make the maximum profit. In what follows, using Clementine, which is a statistical and data mining software and GRI algorithm we aim to generate rules and then, we analyze the results.

Rule Generation Using GRI Algorithm: The GRI algorithm discovers association rules in data. For instance, the customers who buy razors and after-shave lotion, also proceed to purchase a shaving cream. GRI generates rules with the highest information based on support and confidence measures and is able to accept numerical and classified data but the object needs to be categorized. The working environment in Clementine is shown in Figure 2.

A part of the calculated results are shown in Table 4.

The generated rules based on GRI algorithm which are shown in Table 4 imply the following relations for the customer behavior in buying different products.



Fig. 2: Using Clementine software

- If the customer purchases 800gr. 6% fat super yoghurt and 250 gr. traditional shallots yoghurt in very low volumes and fresh 450 gr. 1.5% fat yoghurt in low volumes, then with a high probability he will buy low fat 800 gr. probiotic yoghurt in very high volumes.
- If the customer purchases 750 gr. succinct mix yoghurt and super 800gr. 6% fat yoghurt in very low volumes and 450 gr. fresh yoghurt in low volumes, then, with a high probability, he will buy low fat 800 gr. probiotic yoghurt in very high volumes.
- If the customer purchases 750 gr. succinct vegetables yoghurt and super 800gr. 6% fat yoghurt in very low volumes and 450 gr. fresh yoghurt in low volumes, then, with a high probability, he will buy low fat 800 gr. probiotic yoghurt in very high volumes.
- If the customer purchases 800 gr. 6% fat super yoghurt in low volumes and 250 gr. traditional shallots yoghurt in very high volumes, then, with a high probability, he will buy bucket 2.2 high fat probiotic yoghurt in low volumes.
- If the customer purchases 750 gr. succinct mix yoghurt in very low volumes and 250 gr. traditional shallots yoghurt in very high volumes, then, with a high probability, he will buy bucket 2.2 high fat probiotic yoghurt in low volumes.
- If the customer purchases 250 gr. traditional shallots yoghurt in very high volumes, then, with a high probability, he will buy bucket 2.2 low fat probiotic yoghurt in low volumes.
- If the customer purchases 800 gr. 6% fat super yoghurt in low volumes and 450 gr. 1.5% fresh yoghurt in very low volumes, then, with a high probability, he will buy bucket 2.2 low fat probiotic yoghurt in low volumes.

So, many different rules can be produced and based on these rules, which are hidden rules in the database, the company is able to make plans and decide about its product to attract more customers, produce higher quality products and make more profit.

Table 4. The generated rules of GRI

Consequent	Antecedent	Support %	Confidence %
800 gr. Low fat probiotic yoghourt=5	800gr. 6% fat super yoghourt=1 and 250 gr. traditional shallots yoghourt=1 and fresh 450 gr. 1.5% fat yoghourt=2	8.33	100.0
800 gr. Low fat probiotic yoghourt=5	750 gr. succinet mix yoghourt=1 and super 800gr. 6% fat yoghourt=1 and 450 gr. fresh yoghourt=2	8.33	100.0
800 gr. Low fat probiotic yoghourt=5	750 gr. succinet vegetables yoghourt=1 and super 800gr. 6% fat yoghourt=1, and 450 gr. fresh yoghourt=2	8.33	100.0
Bucket 2.2 high fat probiotic yoghourt=2	800 gr. 6% fat super yoghourt=2 and 250 gr. traditional shallots yoghourt=5	4.17	100.0
Bucket 2.2 high fat probiotic yoghourt=2	750 gr. succinet mix yoghourt=1 and 250 gr. traditional shallots yoghourt=5	4.17	100.0
Bucket 2.2 low fat probiotic yoghourt=2	250 gr. traditional shallots yoghourt=5	4.17	100.0
Bucket 2.2 low fat probiotic yoghourt=2	800 gr. 6% fat super yoghourt=2 and 450 gr. 1.5% fresh yoghourt=1	4.17	100.0

Concluding Remarks: Possessing a variety of tools and techniques and also using knowledge of other knowledge fields and their usage in means of tools and novel patterns, data mining has become a new and appropriate method for analysis of a bulk of current and historical data in large scale databases. Using data mining we can generate organizational knowledge which can be an important issue for managers in making organizational decisions and providing competitive advantages. One of the smart techniques which are growing fast, is neural networks. The results of this paper demonstrates that using artificial neural networks and the available data of the customers database based on data mining patterns, we can predict the purchase volume of customers with a high efficiency. Also, based on extraction of hidden patterns we can predict the relationships between purchasing different goods by a customer with a high confidence. Provisioning of enough confidence in this area can help managers and decision makers in planning the production rate based on information extraction.

In this paper, an initial effort has been made for an industry with low data volumes to use neural networks as a technique of data mining. Future research can be conducted based on higher volumes of data, mixing internal and external data of the organization, doing research for products of other industries and using other techniques of neural networks.

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