

Neural Networks Based Integrated Evaluation Method for the Effectiveness of CRM

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ABSTRACT

Customer relationship management (CRM) has become one of the leading business strategies in the new economy. The effectiveness of CRM can be measured as a satisfaction level achieved by CRM activities. CRM has emerged as a major business strategy for e-business, but little research has been done in evaluating the effectiveness of CRM because of its complexity. In this paper, on the basis of building a CRM evaluation index system, we propose neural networks based integrated evaluation method for the effectiveness of CRM. It can simulate evaluation made by experts and avoid subjective mistakes. The results from the simulation are satisfied.

Keywords: customer relationship management, neural networks, integrated evaluation

1. INTRODUCTION

Transforming enterprises to become customer centric to get more revenue and profit is one of the hottest strategies in business today. This strategy is known as customer relationship management (CRM). As enterprises pursue CRM strategies, they become aware that the costs and benefits of CRM initiatives are significant, and they strive to grasp the financial impacts and economic factors that contribute to their success. For enterprises to achieve ROI (return on investment) from CRM, investments in the application domains and technologies of CRM should contribute tangible business benefits to the enterprise, as well as intangible benefits. The effectiveness of CRM can be measured as a satisfaction level achieved by CRM activities. As CRM has emerged as a major business strategy for e-business, evaluating its effectiveness is very important. However, little research has been conducted to evaluate CRM effectiveness. In the CRM world, increased emphasis is being placed on developing measures that are customer-centric and give managers a better idea of how their CRM policies and programs are working [1].

In this paper, we develop neural networks based integrated evaluation method for the effectiveness of CRM. Because artificial neural network (ANN) acts as a model of real world system or function. The model then stands for the system it represents, typically to predict or to control it. Among the various artificial neural networks presented so far, the multi-layer feed forward neural network is employed in this study. It is found that the ANN modeling is very effective and accurate.

2. CUSTOMER RELATIONSHIP MANAGEMENT

CRM can be defined as managerial efforts to manage business interactions with customers by combining business processes and technologies that seek to understand a company's customers. Companies are becoming increasingly aware of the many potential

benefits provided by CRM. Some potential benefits of CRM are as follows:

- (1) Increased customer retention and loyalty
- (2) Higher customer profitability
- (3) Creation value for the customer
- (4) Customization of products and services
- (5) Lower process, higher quality products and services

3. A FRAMEWORK FOR EVALUATING THE EFFECTIVENESS OF CRM

3.1 The CRM process model

Because it is difficult to evaluate tangible returns on the resources expended to plan, develop, implement, and operate CRM, we have to measure the intangible nature of benefits such as customer loyalty, service quality, value enhancement, effectiveness of processes, innovation of operation, service improvement, competitiveness, trust, and efficiency. To evaluate the effectiveness of CRM, we need to build a evaluation framework, it must be a multi index system and it must can evaluate the whole CRM process. In figure1 we give the model of CRM process.

From figure1 we can see. First, a company accumulates a huge amount of customer information and creates a customer profile. Next, the company discovers large and hidden customer characteristics through data mining tools and techniques. As CRM has tremendous potential for collecting and storing customer preferences, CRM can make it possible to create new products and customize existing products in innovative ways. Second, the company integrates all relevant information on each customer across the enterprise in order to facilitate more effective planning, marketing and services. Identified customer knowledge helps to find customer needs when a company interacts with customer. As customer requirements and expectations are met, loyal customers are created. Customer value can be added by product and service customization, additional information provision,

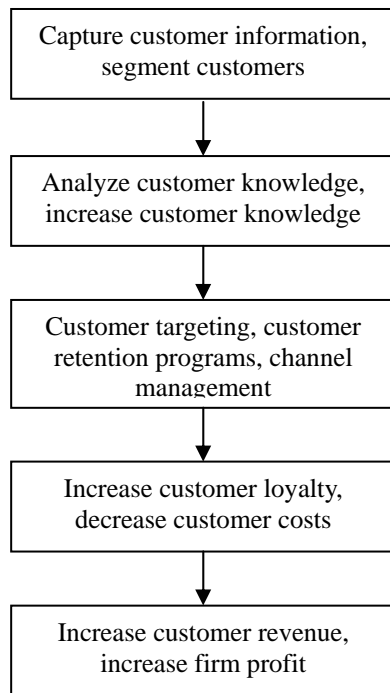


Figure 1. The model of CRM process

and quality enhancement. Understanding and collecting customer needs are critical to conducting these value-adding activities. Third, satisfactory long-term customer relationships can be established, as channels aid employees to serve customers effectively and profitably. Finally, the company increases revenues and profits. Typically, business value can be added by improving brand image, establishing customer relationships, enhancing public relations, and generating sales leads [2].

3.2 The evaluation index system for effectiveness of CRM

The model of CRM process can give a clue as to what perspective are important to evaluate the effectiveness of CRM. That is customer knowledge, customer interaction, customer value, and customer satisfaction. So an evaluation index system can be shown in figure 2.

Where, CK₁: collecting appropriate customer information;
 CK₂: analyzing customer data;
 CK₃: acquiring new customers;
 CK₄: understanding customer needs;
 CK₅: improving skills of employee;
 CK₆: improve CRM techniques;
 CK₇: secure service;
 CI₁: appropriate response to customer request;
 CI₂: integration of business process;
 CI₃: improving channel management;
 CI₄: maximizing the effectiveness and efficiency of enterprise operations;
 CI₅: customizing products and services;
 CV₁: improving customer retention;
 CV₂: profits increase;
 CV₃: improving customer service and support;
 CV₄: building attractive virtual community;
 CS₁: improving service quality;
 CS₂: establishing relationship with customers;
 CS₃: responsiveness;
 CS₄: reliability.

The customer knowledge (CK) perspective represents the status of the customer segment and customer data management. Customer knowledge focuses on technology learning, understanding customer needs, and customer profiles, which influence ways of interacting with customers. The varied tastes and preferences of customers make it difficult to classify customers into a large homogenous population to develop marketing strategies. A customer wants to be served according to his or her individual and unique needs. To analyze customer needs, CRM uses appropriate data mining tools and data warehousing techniques. Technology learning is also important towards understanding customers. It is required, therefore, to assess employee skill to use customer information effectively. Security is another basic and critical prerequisite when dealing with customer information [2]. Security, in particular, has been a serious issue concerning online purchases and an impediment to the acceptance of the e-channel. Many customers are concerned about the amount of personal information that is contained in databases and how it is being used. Customers perceive safety of transactions and seller empathy as important.

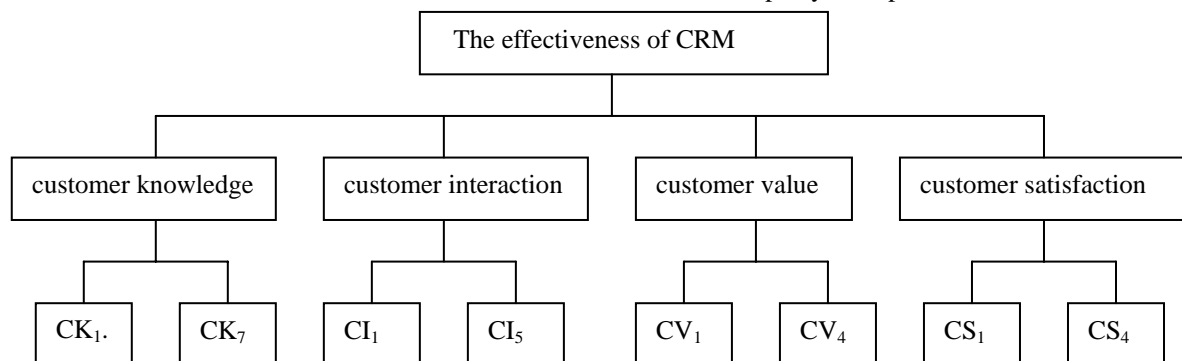


Figure 2. The evaluation index system for effectiveness of CRM

The customer interaction (CI) perspective represents operational excellence and channel management of customer services and management processes. To manage various communication channels efficiently, managers make an effort to monitor the business processes. Winer suggested a relational program that includes customer service, loyalty programs, customization, rewards programs, and community building [1]. To analyze customer interaction, some important measures need to be considered, such as the number of marketing campaigns, total cost for promotion, frequency of contents updates, payment, response channels, and so on. Communication channels not only include classic communication channels such as letters, fax, and telephone but also emerging new channels such as call centers, service centers, Web sites, and virtual internet communities. It is vital to manage various channels efficiently and immediately.

The customer value (CV) perspective represents the benefits gained from customers, such as lifetime value. If the customer is satisfied with the service of a company, there will be no problem concerning customer deviation. To maintain this relationship, the CV perspective continues to find ways to build customer commitment and loyalty. In addition, customers are identified by their value and are treated accordingly. Customer value describes tangible and intangible benefits gained from CRM activities, which help to arrange the relationship with the customer successfully. In order to determine the customer value, we need to analyze such information as customer retention, profits increase, customer service and support, virtual community. Current customer profitability should be calculated, establishing a baseline and comparing new calculations to that baseline periodically. Calculating customer value potential and using it as a guideline will be profitable in the future [3].

The customer satisfaction (CS) perspective represents the level of satisfaction achieved by products or services. Customer satisfaction is the feeling that a product or service meets customer expectations and determines whether the buyer will become a permanent customer or not. The assessment of customer satisfaction is one of the most important stages of the implemented model. Customer satisfaction is difficult to measure because it is hard to quantify the satisfaction level [4]. Customer satisfaction represents a modern approach for quality in enterprises and organizations, and serves the development of a truly customer-focused management and culture. Measuring customer satisfaction offers an immediate, meaningful, and objective feedback about customer preferences and expectations. Among the four perspectives, the customer satisfaction perspective is the most important because customer satisfaction is directly linked to a company's profits. Customer satisfaction can be measured from the four dimensions: service quality, the relationship between enterprises and customers, responsiveness, reliability. Responsiveness is the willingness to help customers and provide prompt

service [5]. Reliability is the ability to perform the promised service dependably and accurately.

4. NEURAL NETWORKS BASED INTEGRATED EVALUATION METHOD

Artificial neural network algorithm has been used successfully in many applications, because it acts as a model of real world system or function. The model then stands for the system it represents, typically to predict or to control it. ANN can model a function even if the equation describing it is unknown the only prerequisite is representative sample of the function behavior and that is from the experimental data and not from a theoretical understanding. Figure 3 shows the schematic diagram of a multi-layer feed forward network used in this paper. The neurons in the network can be divided into three layers: input layer, output layer and hidden layers.

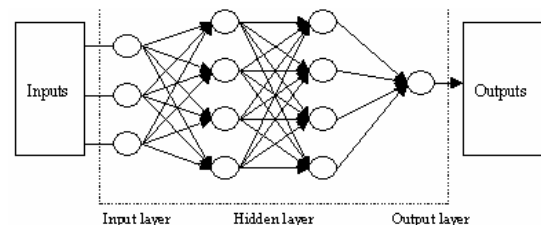


Figure 3. The structure of a multi-layer neural network

Each neuron of the output layer receives a signal from inputs through hidden layer neurons along connections with modifiable weights. The neural network can identify input pattern vectors, once the connection weights are adjusted by means of the learning process. The back propagation learning algorithm which is a generalization of Windrow-Hoff error correction rule is the most popular method in training the ANN and is employed in this work[6]. This learning algorithm is not presented here.

Scaling of the input-output data has a significant influence on the convergence property and also on the accuracy of the learning process. It is obvious that the range of the output of the network must be within [0, 1]. The input variables should be kept small in order to avoid saturation effect caused by the sigmoid function. Thus, the input-output data must be normalized before the initiation of training of the neural network. After the normalization, the input variables can then be easily made to fall in the range [-1, 1]. Further, the range of the normalized output vector component is made to fall within [0, 1].

There are 20 indexes in the evaluation index system. But each index should have a score made by experts. The scores can be divided into five scales: 1, 0.7, 0.5, 0.3, and 0.1. Echoes best, better, medium, worse and worst respectively. In this example, we take the scores made by experts as the inputs ($ck_1, ck_2 \dots cs_4$) of the neural network model. The expected output is only one neuron,

Table 1. The evaluation data made by experts

order	CK1	CK2	CK3	CK4	CK5	CK6	CK7	CI1	CI2	CI3	CI4	CI5	CV1	CV2	CV3	CV4	CS1	CS2	CS3	CS4	score
1	0.7	1	1	0.7	0.7	1	0.7	0.7	1	1	0.7	1	0.7	0.7	0.7	0.7	1	1	1	1	0.861
2	0.5	0.7	0.5	0.7	0.7	0.5	0.5	0.7	0.5	0.7	0.7	0.5	0.7	0.5	0.7	0.7	0.7	0.7	0.7	0.5	0.604
3	0.5	0.5	0.3	0.5	0.3	0.3	0.3	0.5	0.3	0.5	0.3	0.3	0.3	0.5	0.3	0.3	0.3	0.3	0.3	0.1	0.340
4	0.5	0.5	0.5	0.5	0.7	0.3	0.3	0.5	0.5	0.7	0.7	0.5	0.3	0.5	0.7	0.7	0.7	0.7	0.3	0.5	0.488
5	0.5	0.5	0.5	0.7	0.7	0.51	1	0.7	1	0.7	0.7	1	1	0.7	0.7	0.7	1	0.7	0.7	0.1	0.713
6	1	0.7	0.7	1	1	1	1	0.7	1	1	0.7	1	1	0.7	1	0.7	1	0.3	0.7	1	0.931
7	1	0.7	1	1	1	1	1	0.7	1	1	0.7	1	1	0.7	0.7	0.7	1	1	0.7	0.1	0.810
8	0.7	0.7	1	0.7	0.7	0.5	0.7	0.5	0.7	0.7	0.5	0.5	0.7	0.7	0.7	0.7	0.7	0.7	1	0.5	0.641
9	0.7	0.7	0.5	0.7	0.7	0.5	0.7	0.5	0.7	0.7	0.7	0.5	0.7	0.7	0.5	0.7	0.7	0.7	0.7	0.5	0.683
10	0.7	0.7	1	1	0.7	0.5	1	0.7	1	1	0.7	1	1	0.7	1	1	0.7	0.7	1	0.5	0.827
11	0.7	0.5	1	0.7	0.7	0.5	0.7	0.7	0.5	0.7	0.7	0.5	0.7	0.7	0.7	0.5	0.7	0.7	1	0.5	0.647
12	0.7	0.7	0.5	0.7	0.7	0.5	1	0.7	1	0.7	0.7	1	1	0.7	0.7	0.7	1	0.7	0.7	0.1	0.727
13	0.7	0.7	1	0.5	0.3	0.5	0.3	0.5	0.5	0.5	0.7	0.5	0.3	0.5	0.7	0.5	0.7	0.3	0.3	0.5	0.460
14	0.7	1	0.3	1	0.7	1	1	0.7	1	1	0.7	1	0.7	0.7	0.7	0.7	0.7	0.7	1	0.5	0.817
15	0.7	0.7	0.5	1	0.7	1	1	0.7	1	1	0.7	1	1	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.766

and it must be within $[0,1]$, and it represents the result of the evaluation. The result scales can be divided into four levels: if the value is between 0.7 and 1, we treat it as good, if the value is between 0.5 and 0.7, we treat it as medium, if the value is between 0.3 and 0.5, we treat it as poor, if the value is below 0.3, we treat it as very poor. In next section, we will develop a simulation from an example.

5. SIMULATION AND RESULTS

In this paper, we will use the data acquired from 15 firms, it is shown in table 1. The scores of each index were made by experts. The scores of last column are the results achieved by experts using multicriteria integrated evaluation method. We can use neural networks based integrated evaluation method to simulate. In this example, we choose the former 12 samples as training signals, and the left 3 samples as test signals. Then we use Matlab as the tool, leading rate is 0.0001, the number of hidden neurons is 7, the training times is 1500, weight adjusted parameters is 0.5. The results can be obtained in table 2.

Table 2. The learning results

Order	Results of training	Expected outputs	Errors / %
1	0.8583	0.861	0.270
2	0.6008	0.604	0.320
3	0.3394	0.340	0.060
4	0.4726	0.488	1.540
5	0.7078	0.713	0.520
6	0.9274	0.931	0.360
7	0.8057	0.810	0.430
8	0.6420	0.641	-0.100
9	0.6739	0.683	0.910
10	0.8253	0.827	0.170
11	0.6413	0.647	0.570
12	0.7257	0.727	0.130

We can see it is very similar to the expected outputs. The test results are shown in table 3. The error variation curve is shown in figure 4. The results of evaluation are consistent with the scores made by experts. Thus, the simulation is satisfied.

Table 3. The test results and Categorization

order	1	2	3
Test results	0.4508	0.8366	0.6615
Results from experts	0.4600	0.8170	0.6300
Errors / %	1.68	2.37	4.74
Categorized by simulation	Poor	Good	Medium
Categorized by experts	Poor	Good	Medium

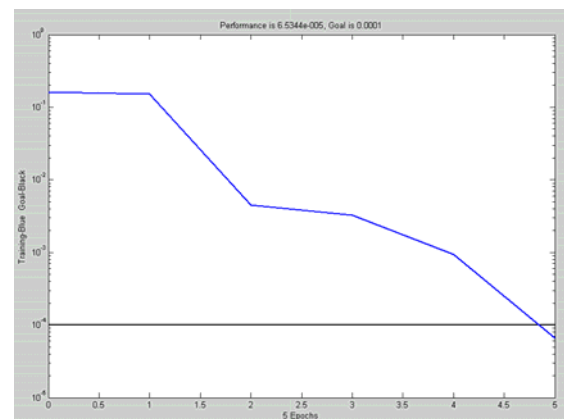


Figure 4. The error variation curve

6. CONCLUSIONS

Customer relationship management is one of the leading competitive business strategies in the new economy. It is very important to evaluate the effectiveness of CRM, because it is beneficial for enterprises to carry out the CRM activities. In this paper, on the basis of building a model of CRM process, we set up a evaluation index system for the effectiveness of CRM, then neural networks based integrated evaluation method are proposed, and the results of the simulation are satisfied.

That is to say, the evaluation method is a powerful assessment tool to evaluate the effectiveness of CRM. We expect that this related work of the method should be further researched so that we can evaluate other fields.

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