The Application of Neural Network Technology in Electronic Commerce Evaluation System

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Abstract
Customer relationship management data mining are introduced in this paper. BP neural network is used in intelligent business-to-customer relationship evaluation. The customer relationship evaluation model is built based on the evaluation index system, which can train data samples and then obtain evaluation results. This paper also describes analysis of a customer relationship evaluation system based on neural network technology that is implemented using ASP.NET 2.0, SQL Server 2005 and MATLAB, conceptual design of the system, and implementation of the system. It is worth mentioning that the system has solved the MATLAB mixed programming problem, which promote the programming development of MATLAB application.

Keywords: Electronic Commerce evaluation; neural network; system design;

1. Introduction
With the increasing popularity of e-commerce technology, customer relationship management (CRM) is increasingly becoming the wide attention and research focus in business community and academic world. Customers have become one of the most important and valuable intangible assets in a modern enterprise. Customer retention is an important issue in the research and practice of customer relationship management [1]. In order to achieve customer retention effectively, the accurate customer relationship evaluation is especially important, which will help the enterprises carry out better targeted customer marketing decision-making management. Evaluating customer relationship effectively is the prerequisite and guarantee to customer relationship management goals. Evaluation methods like K-means, fuzzy analytic hierarchy process were used before. But the complexity of customer relationship evaluation being affected by various factors shows non-linear characteristics, which makes it difficult to meet evaluation requirements fully using general mathematical methods. Fuzzy analytic hierarchy process can solve the problem about the weight of evaluation index system, but human subjective factors and decisions affected the evaluation and customer relationship data stored in the databases with information technologies being widely used in enterprises can not be leveraged effectively. The data mining technology can effectively deal with the problem of obtaining useful information from the vast amounts of information. The information-processing capacity of non-linear and adaptive features of BP neural network in data mining technologies overcome the shortcomings of traditional methods to better simulate a variety of factors influencing on the evaluation complexly, which is advantage and feasible. This paper aims at customer relationship evaluation based on BP neural network, and develops an e-commerce customer relationship evaluation system based on Web. MATLAB neural network toolbox components are also embedded in the system. The customer relationship in a restaurant as a case is studied to implement a valid evaluation of customer relationship.

2. Building customer relationship evaluation model based on BP neural network

2.1 Customer Relationship Evaluation
Customer relationship management make business processes of enterprise marketing, marketing management and customer service and support information through the use of information technology, to efficiently manage client resources [2]. It focuses on "customer-centric" strategy to improve customer satisfaction and customer relationship, thereby enhancing the competitiveness of enterprises.
Enterprises should pay sufficient attention to Customer Relationship Management. Customer relationship is the basis of enterprises profit and customer evaluation has been a difficult issue in enterprises [3]. Customer relationship helps companies fully implement customer retention and wins the most valuable customers, which promotes the business developing continuously, stability and rapidly.

What criteria system can be used to evaluate customer relationship? The availability and development of customer relationship benefit from customer loyalty. Customer loyalty is not only the highest stage of customer relationship development but also the ideal target of Customer Relationship Management. Therefore, customer loyalty is one of important evaluation standards of customer relationship [4]. Secondly, as are shown by the studies on customer segmentation, customer satisfaction is another important standard of maintaining customer relationship [5]. This paper follows comprehensive, scientific, objective, adaptive design principles combining qualitative analysis and quantitative analysis, to establish a comprehensive evaluation criteria system based on customer loyalty and customer satisfaction. Specific evaluation system will be discussed in a restaurant case.

Customer loyalty is the customer's feeling of devoted attachment and affection to business goods or services [4]. Based on the following four aspects: behavior loyalty, affection loyalty, cognition loyalty and intention loyalty, 10 indicators about customer loyalty can be identified as: wallet share(x1), average payment(x2), monthly consumption times (x3), recent interval(x4), holding time(x5), the number of suggestions(x6), the number of recommending others(x7), preference(x8), possibility of paying high price(x9), possibility of preferring(x10). Customer satisfaction is used to measure consumption values of customers’ choice after customer consumption patterns have been changed [4]. The indicators about customer satisfaction in this case are defined as service quality(x11), food quality(x12), food prices(x13), dining environment(x14).

2.2 BP Neural Network

An artificial neural network is an information processing system simulating human brain structure and function. BP (error Back Propagation) network is the most widely used because of its simple structure and the strong ability extracting rules from samples [6]. BP network is a multilayer feedforward feedback neural network, which avoids the limitations of regression method and accurately establishes the mapping relations between the input and output variables [7]. BP network is basically a gradient decent algorithm designed to minimize the error function in the weights space. During training of the neural network, weights are adjusted to decrease the total error, which is a predictive learning algorithm. It has been proved by Kolgomorov theorem that any nonlinear function can be approximated by BP network with only one hidden layer [7]. The numbers of input and output layer are determined according to the specific application. But, it is not easy to choose the number of the hidden layer. In this paper, using empirical formula [7] determines it.

For customer relationship Evaluation, current customers’ information can affect and guide new customers positively, which belongs to predictive learning. Simulating nonlinearity and predictive learning are just the reasons of choosing BP artificial neural network to evaluate customer relationship. Because BP learning algorithm has the shortages of convergence speed and local minimum, most of the improved algorithms are used in fact. This paper uses momentum-adaptive learning rate adjustment method as learning and selects network error sum of squares as the objective function.

2.3 The Process of Building Customer Relationship

Evaluation Model Based on BP Neural Network

In order to guarantee correctness and validity of the results, building evaluation model construction is divided into two phases:

* Setting up model: Setting up the model is to decide the number of three layers’ node and use data training samples to train the model.
* Testing model: Test the model with testing samples. If it can not match the need, it will be adjusted through data pre-processing, or model structure adjusting.

As discussed above, the 14 indicators in the customer relationship evaluation criteria system can evaluate the types of customer relationship between customer and business. Therefore, the 14 indicators are defined as the 14 nodes of input layer of the model, and the types are the outputs of the
model. In practice, the types of customer relationship are divided into the four types: gold, important, developing and latent. The number of model output layer node is set to 1, whose value is divided into four areas, representing the four types: 0.0-0.25 for latent, 0.26-0.50 for developing, 0.51-0.75 for important, 0.76-1.0 for gold. The number of the hidden layer node in this paper uses empirical formula and programming experiment to determine as 8 [7]. The customer relationship evaluation model based on BP neural network is shown in Figure 1.

![BP neural network model](image)

Figure 1. The customer relationship evaluation model based on BP neural network.

The customers in a restaurant are taken as the research objects. The corresponding questionnaire is designed based on the 14 indicators mentioned above. The customers are invited to complete the relevant questionnaire. According to the questionnaire investigation and the performance, the experts evaluate these customers into the four types: gold, important, developing and latent. Thus, this is what sample data set come to. All sample data are normalized to the region: [0, 1]. The sample data set of 150 records regarding the customers, consists of two unequal subsets, One representing the training set (100 records) and the other the testing data set (50 records).

3 Design and implementation of customer relationship evaluation

3.1 System Analysis and Design

3.1.1 Development architecture of evaluation system

The development architecture of Evaluation System is shown in Figure 2, which mainly deploys MATLAB neural network tool to build the model to complete evaluation, and uses ADO.net component to access employee information database (shown in Figure 2).
3.1.2 Structural design of system functions

Taking into account the objectivity and subjectivity of customer evaluation, customer relationship evaluations system should include the following basic functions:

a) User information management module
   It includes administrators and customers logging in and modifying their passwords.

b) Evaluation management module
   It is the main function of the system to build and test the evaluation model based on BP neural network using the training sample data set, to evaluate new customers.

c) Query management module
   Administrators can query the results of any customer classification types and customers can query their types and customer service being enjoyed.

d) Sample maintenance management module
   This is a new feature of this system, which is mainly to ensure that the sample data is updated in real time. An administrator can find the customer sample data being not maintained (i.e. the new customers evaluate by the model). The system provides a function to compare customer evaluation results with the actual situations after a period of actual observations. The actual results can be adjusted and confirmed into the sample data set to participate in the future evaluation training.

3.1.3 Database design

Database is the foundation and core of an information system. The quality of database design will directly affect whether system development is successful or not. Through the analysis of business processes, this system is involved in the main data tables: user profiles (including user name and password fields), the sample data and evaluation results in Table ceping (including 14 indicators, the actual evaluation type and model evaluation type fields).

3.2 System implementation

3.2.1 Implementation environment

Servers use Microsoft Windows 2003 as the operating system, using Microsoft IIS 5.0 as the Web server to publish Web pages. Clients can install Windows 98, Windows 2000 or Windows XP, etc.

3.2.2 Software development platform

The System is developed on Microsoft ASP.NET 2.0, using Visual Basic.NET 2005 as developing language, which is the most advanced object-oriented programming languages in the world. Compared with the VB 6, it has many new features, such as implementation inheritance, overloading and parameterized constructor, to simplify the preparation of a more stable application development process [8,9]. To meet actual demand of the big amount of data and computational complexity, Microsoft SQL SERVER 2005 is selected as developing database. Its next-generation data management and analysis solution bring enhanced security, scalability and availability to enterprise data and analytical applications, making them easier to create, deploy and manage [10]. The system uses MATLAB 7.0.1 software to build the model based on BP neural network, which is mainly used to complete the establishment and training of the neural network.

3.2.3 Implementation of key technology modules

Database interface, BP neural network evaluation model implementation with MATLAB tool and MATLAB mixing programming interface are used in the Evaluation management module.

a) Database interface
   ADO.NET technology in Visual Studio.NET 2005 is used to implemented database interface (input and output). ADO.NET is a part of Microsoft .NET framework, which consists of a set of tool and layer. Application can easily communicate with and manage file-based or server-based data storage.
ADO.NET class libraries are in the System.Data namespace. The libraries include the functions of connecting to data source, executing commands and storing, operating and reading data. The core objects are SqlConnection, SqlCommand, SqlDataReader, SqlDataAdapter. ADO.NET technology is mainly used read and write users’ and sample data from the SQL Server database. The relevant codes in the system are as follows:

'--Data from the database to read in DataSet
Dim SqlDataAdapter1 As New System.Data.SqlClient.SqlDataAdapter()
SqlConnection1.Open()

str = "select * from gongchengshi"
Dim sda As Data.SqlClient.SqlDataAdapter = New Data.SqlClient.SqlDataAdapter(str, SqlConnection1)
Dim ds As Data.DataSet = New Data.DataSet()
sda.Fill(ds, "gongchengshi")

'--------- The data into the DataSet inside an array inside sdata
Dim dt As Data.DataTable = ds.Tables(0)
Dim len As Integer = dt.Rows.Count
n = (dt.Rows.Count + 1) * 14 - 2
ReDim sdata(n, 0)
ReDim sdata_img(n, 0)
k = 0
For i = 0 To len - 1
For j = 0 To 13
sdata(k, 0) = Convert.ToDecimal(dt.Rows(i)(j))
k = k + 1
Next j
Next i

b) MATLAB implementation of evaluation model based on BP neural network
The MATLAB tool box includes functions and commands building and training BP network, the program is as follows:

function [result]=bpnet(data)
s1=8;
plen=14;
n=size(data,1);
dsum=sum(data);
for i=1:n;
data(i,1)=data(i,1)/dsum;
end
p=zeros(plen,n-plen);
t=zeros(1,n-plen);
for i=1:n-plen;
for j=1:plen;
p(j,i)=data(i+j-1,1);
end
end
t(1,i)=data(i+plen,1);
end
net =newff(minmax(p),[s1 1],{'tansig','purelin'},'traingdx');
net.trainParam.show = 50;
net.trainParam.lr = 0.05;
net.trainParam.mc = 0.9;
net.trainParam.offsets = 5000;
net.trainParam.goal = 0.0000000000000000001;
[nut]=train(net,p,t);
sp=zeros(plen,1);
for i=n-plen+1:n;
sp(i-n+plen,1)=data(i,1);
end
result=sim(net,sp);
result=result*dsum;

c) Mixing programming interface between MATLAB and VB.NET

Mixing programming interface between MATLAB and VB.NET is the system's difficulty. The solution is to communicate with MATLAB by calling MATLAB engine (ENGINE) interface in VB.NET and using OLE communication channel in Windows. Then, the MATLAB function and graphics libraries can be used directly in the program through Object.Execute statements. The main step are as follows: (1) Establish MATLAB's OLE Automation server. (2) Use VB.NET to connect the database to obtain historical data. (3) Pass the data to MATLAB space. d) implement MATLAB functions for training and testing neural network, evaluate the results and store them in the MATLAB space. (4) Transmit evaluation results back to VB.NET. The relevant codes to call MATLAB as the following shown:

```matlab
matlab = CreateObject("matlab.application")
Call matlab.putfullmatrix("d", "base", sdata, sdata_img)
matlab.Execute("r=newffnet(d)"")
Call matlab.GetFullMatrix("r", "base", rreal, rimag)
matlab.quit()
```

3.3. Result analysis and discussion

A customer relationship evaluation system based on neural network technology can intelligently learn and extract evaluation rules or patterns from current customer relationship, which can be used for the evaluation classification of new customers. This plays a better supportive role in managing customer relationship marketing decisions. In addition, sample maintenance module make administrators can modify the evaluation results not matching with the actual situation and add them to the sample for future training, which ensures the training samples used in real-time and accurately.

It should be noted that neural network technology is a process of nontrivial extraction of implicit, previously unknown and potentially useful information from historical sample data. So, data's objectivity and authenticity greatly impact on the results of this evaluation model, which could fully reflect intelligence, but the correctness of the sample data is required highly. In this case, some indicators in the sample are not easily quantifiable and only able to depend on expert experience, which affects satisfaction of results.

4 Conclusions and further work

Applying the intelligence theory to customer relationship evaluation is a new attempt. In view of the complexity and practical nature of customer relationship management issues, this paper focuses only on the customer relationship evaluation. Further research is in progress in order to extensively explore the solution space and possibly provide more accurate and explicable results regarding the management decision in electronic commerce. The further research into establishing Evaluation criteria system and obtaining more accurate sample data would be worthwhile. The system is designed primarily for simple application of the model, whose decision-making functions and interface could be studied more deeply.

5. References
