A Novel Evaluation Indicator System and Evaluation Method for Network Marketing Performance Evaluation

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Abstract. Implementing performance management is an effective way to enhance the network marketing effects for network enterprises, and how to evaluate network marketing performance is one of the difficulties and hot research fields for the researchers related. The paper advances a novel system evaluation for evaluating network marketing performance based on improved BP neural network algorithm. First, an evaluation indicator system of network marketing performance is designed; Second, immune genetic algorithm is used to correct BP neural network to speed up the convergence and simplify the structure and to improve evaluating accuracy of the original BP algorithm; Finally the experimental results verify that the new algorithm can guarantee the effectiveness and validity of performance evaluation for network marketing of network enterprises in its engineering application.

Keywords: BP neural network algorithm, Performance evaluation, Network marketing, immune genetic algorithm.

1. Introduction

With the development of the Internet and the globalization of trade, the Internet has become a new force which affected the development of marketing. The rise and development of network marketing cannot separate from the development of the Internet. The widespread use of network marketing makes internet marketing performance emerged. Network marketing performance evaluation makes objective and accurate evaluation on the development of enterprises and operating results, which to sum up and improve the network marketing activities. And only by making correct evaluation on the previous marketing activities of enterprises can the launching of current and future marketing activities of enterprises be better guided. Hence, network marketing performance evaluation is becoming a more and more popular research hotspot, also a research difficulty, becoming one of the urgent problems in various fields related [1].

2. Literature Review

Up to now, mathematical models adopted by evaluating network marketing performance mainly include the following categories. Analytic hierarchy process is a good method for quantitative evaluation via quantitative method, having the functions of establishing the ideal weight structure of evaluated object value and analyzing the weight structure of actually-built value by evaluated object; however, the method has strong limitations and subjectivity, with large personal error, not suitable for complicated system with lots of evaluation indicators [2]. Fuzzy comprehensive evaluation is a method carrying out comprehensive evaluation and decision on system through fuzzy set theory, the greatest advantage of which is that it works well on system evaluation of multi-factor and multi-level complicated problems. However, the membership of fuzzy evaluation method as well as the definition and calculation of membership function are too absolute, difficult to reflect the dynamics and intermediate transitivity of evaluation indicators of English course education performance [3-4]; BP neural network evaluation method makes use of its strong capability in processing nonlinear problems to carry out evaluation of English course education performance; the method has advantages like self-learning, strong fault tolerance and adaptability; however, the algorithm is easy to be trapped into defects like local minimum, over-learning, strong operation specialization[5-6]. The paper use immune genetic algorithm to correct and modify BPNN model to overcome the question of slow convergence speed of BPNN. In so doing, not only the problem of convergence speed of BPNN has been solved, but also the simplicity of the model structure and the accuracy of the transformation are ensured and a new customer classification model is advanced to evaluation Music education for universities.

3. Evaluation Indicator System Construction

It is found from the study on evaluation system of network marketing performance at home and abroad that the perspective of studies on performance evaluation systems at home and abroad differ a lot. The performance evaluation system established by foreign scholars is mainly for e-commerce marketing website, and what it evaluates is the website itself. However, Chinese scholars carry out studies on the evaluation indicator system of network marketing performance in a deeper way, and evaluation indicator system is perfecting. This paper, integrating literatures at home and abroad, combining the characteristics of network marketing, establishes an extensive and scientific evaluation indicator system of network marketing performance, which includes four hierarchies, three categories, nine second-class indicators, twenty-four third-class indicators, seeing Table 1 for details.

Table 1 Indicator system of network marketing performance evaluation

Target Hierarchy	First-class Indicator	Second-class Indicator	Third-class Indicator
Performance of Network Marketing	Website Performance	Website Design	Selection of Domain Name
			Style and Visual Effects
			Retrieval Function
			Information Update Frequency
		Website Performance	Security
			Function Comprehensiveness
			Downloading Speed of Home Page
			Effectiveness of Links
			Convenience for Interaction with Users
		Online Promotion	Promotion Effect of Search Engine
			Online Advertising Effect
		Website Traffic	Quantity of Unique Visitors
			Daily Page Views
			Traffic Conversion Rate
	Enterprise Performance	Financial Performance	Growth Rate of Sales Revenue
			Growth Rate of Sales Profit
		Competitive Performance	Brand Awareness
			Increase of Market Share
			Consumer Penetration
	Customer Relationship	Customer Service	Service Response Speed
			Efficiency of Problem Solving
		Customer Satisfaction	Customer Feedback Evaluation
		Logistics Distribution	Integrity of Products Received
			Speed of Receiving Goods

4. Evaluation Method Design

4.1. Simultaneous Analysis and Design.

De Castro indicated that there were similarities among the quality of weight value initialization of back-propagation neutral network and the relationship of network output and the quality of antibody instruction system initialization in the immune system and the quality of immune response. A simultaneous analysis and design---SAND algorithm was advanced to solve the problem regarding the weight value initialization in the back-propagation network [6]. In SAND algorithm, each antibody corresponds to a weight value vector of neuron given in one of several layers of neural networks, the length is l, and the affinity $aff(x_i, x_j)$ between antibody x_i and antibody x_j is shown by their derivative of Euclidean distance function $D(x_i, x_j)$ in Formula 1. In which, ε is a positive of value adoption 0.001. The definition of Euclidean distance function $D(x_i, x_j)$ is shown in Formula 2[6].

$$aff(x_i, x_j) = \frac{1}{D(x_i, x_j) + \varepsilon} \tag{1}$$

$$D(x_i, x_j) = \sqrt{\sum_{k=1}^{l} (x_{ik} - x_{jk})^2} \tag{2}$$

SAND algorithm aims to reduce the similarities between the antibodies and produce the antibody repertoire to cover the entire form space with the best, so energy function is maximized. The energy function is shown in Formula 3.

$$E = \sum_{i=1}^{N} \sum_{j=i+1}^{N} D(x_i, x_j) \tag{3}$$

In the method of Euclidean form space, the energy function is not percentage. With a view to the diversity of the vector, SAND algorithm has to define the stop condition. Given vector $x_i, i = 1,2,...N$, its standardization is unit vector $I_i, i = 1,2,...N$, $\bar{I}$ shows to calculate the average vector. Therefore, Formula 4 shows the diversity of unit vector, in which, $\|\bar{I}\|$ means the average vector distance from the origin of coordinate. Formula 5 shows the stop condition U of SAND algorithm.

$$\|\bar{I}\| = (I^T I)^{1/2} \tag{4}$$

$$U = 100 \times (1 - \|\bar{I}\|) \tag{5}$$

4.2. BP Neural Network Design Based on Immune Genetic Algorithm.

According to the actual application, providing that both the input and output number of node and the input and output values in BPNN have been confirmed, activation function adopts S type function. The following steps show BP neural network design based on immune genetic algorithm.

Every layer of BPNN carries on the weight value initialization separately by SAND algorithm.

Antibody code. The initial weight value derived by SAND algorithm constructs the structures of BPNN. Each antibody corresponds to a structure of BP neural network. The number of hidden node and network weight value carry on the mixture of real code. Each antibody serials are shown in Fig.1.

N number of hidden node	Weight value corresponding to the first hidden node	Weight value corresponding to the second hidden node	…	Weight value corresponding to the N hidden node

Fig.1 Antibody code

Fitness function design. Fitness function $f(x_i)$ is defined as the mean value function of squared error of neural network in Formula 6, in which, $E(x_i)$ is shown by Formula 7. In Formula 7, p is the total training sample, o is the number of node of output layer, T_j^n and Y_j^n are the n training sample's expected output and actual output in the j output node separately, and ξ is the constant larger than zero.

$$f(x_i) = \frac{1}{E(x_i) + \xi} \tag{6}$$

$$E(x_i) = \frac{1}{2p}\sum_{N=1}^{p}\sum_{j=1}^{o}(T_j^n - Y_j^n)^2 \quad (7)$$

Genetic operation. The model here adopts the Gaussian compiling method to go on the genetic operation so as that each antibody decoding is the corresponding network structure and change the network weight value as shown in Formula 8, in which, x_i and x_i^m are the antibodies before and after the variation, μ (0,1) shows that the mean value is zero and squared error is normal distribution random variable of l, and $\partial \in (-1,1)$ is the individual variation rate. It is seen in Formula 8 that the variation degree varies inversely as the fitness, i.e. the lower the fitness is (the less the fitness value of objective function is), the higher the individual variation rate is, or vice versa. After the variation, all the hidden node and weight value components constitute a new antibody again.

$$x_i^m = x_i + \partial \exp(-f(x_i)) \times \mu(0,1) \quad (8)$$

Group renewal based on density. In order to guarantee the antibody diversity, improve the entire searching ability of the algorithm, the model adopts the Euclidean distance and the fitness based on the antibodies to calculate the similarity and density of the antibody. Providing that there are x_i and x_j antibodies, and $\eta \succ 0$, $t \succ 0$ given constants, the fact that Formula 9 is satisfied indicates that x_i and x_j antibodies are similar, the number of antibody similar to the antibody x_i is the density of x_i marked by C_i. The probability of selecting antibody x_i is $p(x_i)$ as shown in Formula 10, in which, α and β is the adjustable parameters between (0, 1), and $M(x)$ is the maximum fitness value of all the antibodies. It is seen in Formula 10 that while the antibody density is high, the probability of selecting the antibody with high fitness is low, and conversely high. Therefore, excellent individual is not only retained, but the selection of similar antibodies is reduced, and the individual diversity is guaranteed.

$$\begin{cases} D(x_i, x_j \le \eta \\ |f(x_i) - f(x_j)| \le t \end{cases} \quad (9)$$

$$p(x_i) = \alpha C_i[1 - \frac{f(x_i)}{M(x)}] + \beta \frac{f(x_i)}{M(x)} \quad (10)$$

5. Experimental Results and Analysis

Experimental data come from database of three network enterprises, called A, B and C respectively. For data of customer part, 500 network consumers of each network enterprises are selected as the basis for data training and experimental verification in the paper, totally 1500 consumers' data for study data that come from practical investigation and visit. In order to make the selected consumers' data representatives, 300 learners(100 learner from each university) with more than 2 years network buying experience, 300 consumers with 1 years learning experience, 300 learners with less than 1 years learning experience.

Limited to paper space, the evaluation of intermediate results is omitted here, only providing secondary evaluation results and final comprehensive evaluation results, see table 2.

Table 2. Part evaluation results of different network enterprises

	website performance	enterprise performance	customer relationship	final evaluation
Corporation A	3.083	4.221	4.165	3.673
Corporation B	3.671	3.901	4.461	3.982
Corporation C	3.988	4.510	4.812	4.431

As for the performance of the presented algorithm, this paper also realizes the application of the ordinary BP neural network [6], and fuzzy evaluation [3], evaluation performance of different algorithms is shown in table 3. In table 3 evaluation results of training effects of different network trade enterprises are selected and compared with artificial evaluation to calculate the evaluation accuracy. And the calculation platform as follows: hardware is Dell PowerEdge R710, in which processor is E5506, memory 2G, hard disk 160G; software platform is Windows XP operating system, C programming language environment.

Table 2. Evaluation performance comparison of different algorithms

Algorithm	Algorithm in This Paper	BP Neural Network Algorithm	Comprehensive Fuzzy Algorithm
Accuracy Rate	95.01 %	84.82%	70.66%
Time Consuming(S)	11	529	12

6. Experimental Results and Analysis

Comprehensive evaluation of network marketing performance is an effective method for guaranteeing network marketing performance, lying in the core status of the entire evaluation system of network marketing. Thus, there is a favorable application prospect for the analysis and competitiveness evaluation of network marketing performance based on BP neural network algorithm. This paper takes advantage of the positive effects of BP algorithm and overcome the negative effects through algorithm improvements to establish comprehensive evaluation model for network marketing performance, also carries out case study taking the data of three network enterprises as an example. Meanwhile, the improved evaluation method built in this paper can be reference for the analysis and evaluation of other multi-factor systems.

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