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Application and Analysis of Fuzzy Neural Network Algorithm Based on Cloud Computing Platform in Enterprise Network Marketing

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The emergence of cloud computing provides a convenient and efficient tool for solving the problem of enterprise network marketing. Cloud computing service mode can effectively reduce the cost of software and hardware, and flexibility to adapt to the needs of enterprises in different stages of development. Therefore, the construction mode of cloud computing will effectively solve the problem of enterprise network marketing. Combined with the characteristics of enterprise system and management, cloud computing can achieve data and application sharing between different devices with lower equipment requirements. With the characteristics of network marketing, this paper analyzes the basic structure of cloud computing, and proposes a kind of intuitionistic fuzzy neural network algorithm which is based on cloud computing. First, we divide the training sample into several sub blocks, and then put each sub block into the training network. After the training, we put the results into the membership network and non membership network. At the same time, we take the test sample to complete the calculation of the membership network and non membership network. Finally, the output value of the test sample and the training sample is synthesized by intuition, and the output value of the intuitionistic fuzzy neural network is obtained. In addition, we use MAP-REDUCE to determine the connection weights of neural networks in cloud computing. This effectively solves the problem of big data and long time consuming in the data mining network marketing information. Finally, we validate the algorithm on the cloud computing platform. The experimental results show that this paper has good application effect and prospect in the field of enterprise network marketing.

1. Introduction

The emergence of cloud computing provides a convenient and efficient tool for solving the problem of enterprise network marketing. Cloud computing service mode can effectively reduce the cost of software and hardware, and flexibility to adapt to the needs of enterprises in different stages of development. Therefore, the construction mode of cloud computing will effectively solve the problem of enterprise network marketing. Combined with the characteristics of enterprise system and management, cloud computing can achieve data and application sharing between different devices with lower equipment requirements. Cloud computing can meet the needs of enterprise network marketing in the aspects of personalization, diversification, flexibility and so on, which will be an important trend of the development of enterprise network marketing. At this point, the processing of network marketing data in the cloud computing environment is particularly important.

Since intuitionistic fuzzy sets were come up with by Atanassov (1986), it has been widely used in the uncertainty problems research field. For intuitionistic fuzzy sets, it is difficult to ascertain the concrete numerical value of the membership and non-membership degree, frequently only approximate values range is given. Considering this situation, Atanassov and Gargov (1989) extended the concept of intuitionistic fuzzy sets, and raised interval intuitionistic fuzzy sets. Bustince (1995) defined the correlation of the interval intuitionistic fuzzy sets. Hung (2002) computed the correlation coefficient of interval intuitionistic fuzzy sets by using centroid method. Mondal (2001) studied the topological properties of interval intuitionistic fuzzy sets. Deschrijver (2003) discussed the relationship between the interval intuitionistic fuzzy and L-fuzzy sets. On the basis of the relationship between interval-valued fuzzy sets, Zheng Wenyi (2012) studied two forms of reasoning, that is easy interval value fuzzy reasoning and multiple interval value fuzzy reasoning. Yager (2009), Yuan Xuehai, Li Hongxing et al. (2009) studied the character of the cut sets of interval-valued intuitionistic fuzzy sets. Lei Yingjie (2011), Zhang Qiansheng (2010) and Shen Xiaoyong (2010) studied interval-valued intuitionistic fuzzy reasoning and its application.

With the characteristics of network marketing, this paper analyzes the basic structure of cloud computing, and proposes a kind of intuitionistic fuzzy neural network algorithm which is based on cloud computing. Based on the theory of fuzzy set, the parameters of neural network can be adjusted according to the adaptive learning ability of intuitionistic fuzzy neural network. First, we divide the training sample into several sub blocks, and then put each sub block into the training network. After the training, we put the results into the membership network and non membership network. At the same time, we take the test sample to complete the calculation of the membership network and non membership network. Finally, the output value of the test sample and the training sample is synthesized by intuition, and the output value of the intuitionistic fuzzy neural network is obtained. In addition, we use MAP-REDUCE to determine the connection weights of neural networks in cloud computing. This effectively solves the problem of big data and long time consuming in the data mining network marketing information. Finally, we validate the algorithm on the cloud computing platform. The experimental results show that this paper has good application effect and prospect in the field of enterprise network marketing.

2. Cloud computing platform for enterprise network marketing

Next, with the characteristics of enterprise electronic commerce, we give the cloud computing framework of enterprise network marketing.

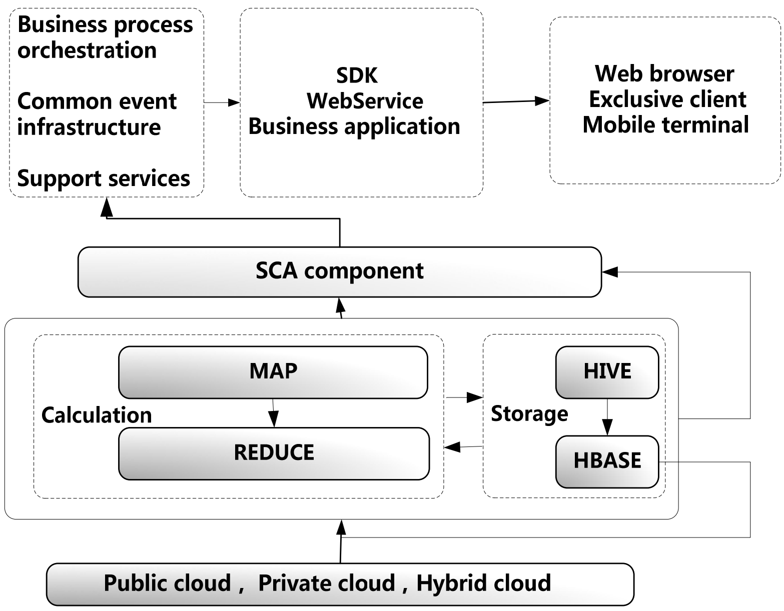

Figure 1: Cloud computing architecture of enterprise network marketing

3. Related knowledge

3.1 Neural network

Neural network is a kind of adaptive dynamic system which is composed of a large number of neurons. It is the abstract and simulation of the human brain. Each neuron is connected to other, which forms a network of neurons. In accordance with the size of the external excitation signal, the strength of the connection between the neurons can be adaptive changes. The network learning process is the process of adaptive changes of connection strength between neurons. Neuron network is a collective action of a large number of neurons, which is a complex nonlinear dynamic system. The structure and performance of the neural network are determined by the neuron, the network structure and the learning rule. The commonly used neuron models as shown in figure 2.

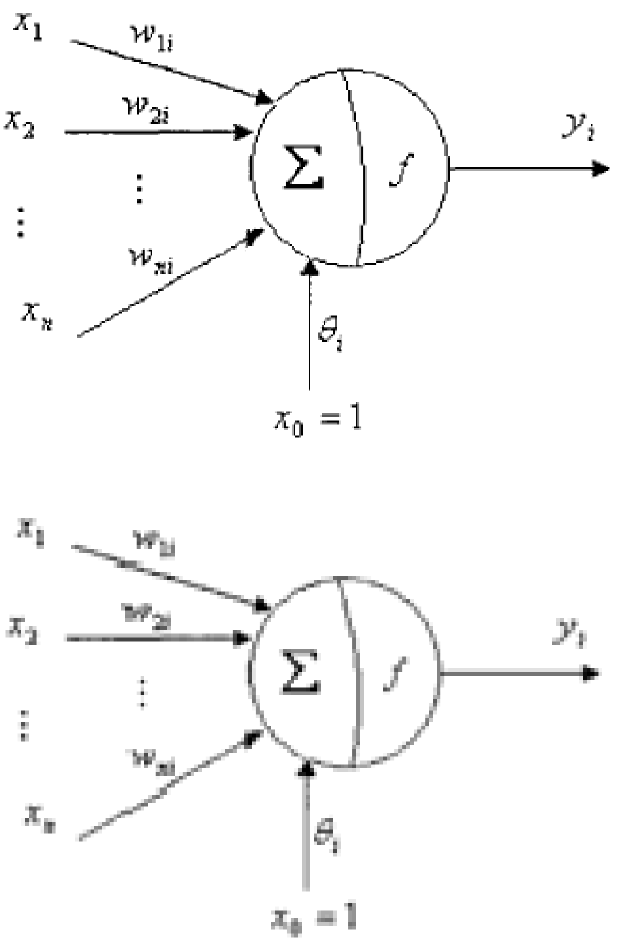

Figure 2: Artificial neuron model

(1) The initial connection weights of the network

The initial connection weights determination method is randomly selected in the fixed range. The weight values ω are nonzero values which are close to zero. Because of the characteristics of the Sigmoid excitation function, the initial weight distribution is generally required between -0.5 and 0.5, which can effectively avoid the calculation of the neural network into the saturated zone.

(2) Learning rate and momentum coefficient

In practical applications, scholars usually choose a small learning rate (usually between 0.01 and 0.8). The greater the η, the greater the weight change. In order to reduce the network training time and do not cause the shock, we can modify the learning rate of the back propagation. Then, we let the learning speed contains a dynamic correction term α, which is generally about 0.9.

$$\omega(t+1) = -\eta\frac{\partial E}{\partial \omega} + \alpha\omega(t) \tag{1}$$

3.2 Intuitionistic fuzzy sets

Definition 1: Set X is a non-empty classic set, triples that on X like $A = \{< x, \mu_A(x), \nu_A(x) >| x \in X\}$ which is called intuitionistic fuzzy sets on X. The μ_A: $X \to [0,1]$ and ν_A: $X \to [0,1]$ are the membership function of X, and $0 \le \mu_A(x) + \nu_A(x) \le 1$. Here, $\mu_A(x)$ and $\nu_A(x)$ is the membership degree and non-membership degree about x of X belong to A. They are expressed as the evidence that support element x belongs to A export lower bound of affirmative membership degree, and the evidence that oppose element x belongs to A export lower bound of negative membership degree. For example $[\mu_A(\text{x}), \nu_A(\text{x})] = [0.5, 0.3]$, In voting model which can be interpreted as in 10 people, 5 people agree, three people oppose and two people default.

For random intuitionistic fuzzy sets A on X, $\pi_A(x)=1-\mu_A(x)-\nu_A(x)$ is called intuitionistic index of element x in intuitionistic fuzzy sets A. Intuitionistic index of element x in intuitionistic fuzzy sets A expresses hesitation that x belongs to A. Obviously, $0\le\pi_A(x)\le 1$, $x\in X$. If $\pi_A(x)=0$, intuitionistic fuzzy sets A becomes fuzzy sets. Thus, intuitionistic fuzzy sets is a generalization of the fuzzy sets, fuzzy sets is special case of intuitionistic fuzzy sets.

Definition 2: $D[0,1]$ is the set of all closed subinterval on interval $[0,1]$, X is a non-empty classic set, and triples that on X like $A=\{<x,\mu_A(x),\nu_A(x)>|\, x\in X\}$ is called interval-valued intuitionistic fuzzy sets on X, including μ_A: $X\to[0,1]$ and ν_A: $X\to[0,1]$ are membership function on X, $0\le\sup_x\mu_A(x)+\sup_x\nu_A(x)\le 1$.

Here interval $\mu_A(\mathrm{x})$, $\nu_A(\mathrm{x})$ is the membership degree and non-membership degree about x of X belong to A respectively. For each $x\in X$, $[\nu_A(x)]^L$ and $\nu_A(x)$ are closed interval on $[0,1]$, its lower bound, upper bound are $[\mu_A(x)]^L,[\mu_A(x)]^U$ and $[\nu_A(x)]^L,[\nu_A(x)]^U$ respectively. All interval-valued intuitionistic fuzzy sets on X are recorded as $IVIFS[X]$.

Definition 3: X is a non-empty classic set, $A,B\in IVIFS[X]$, $\lambda>0$ is any real number,

$A=\{<x,[[\mu_A(x)]^L,[\mu_A(x)]^U],[[\nu_A(x)]^L,[\nu_A(x)]^U]\}>|\, x\in X\}$,

$B=\{<x,[[\mu_B(x)]^L,[\mu_B(x)]^U],[[\nu_B(x)]^L,[\nu_B(x)]^U]\}>|\, x\in X\}$,

operational relationship is stipulated as follow:

(1) The sum of interval-valued intuitionistic fuzzy sets:

$$\begin{aligned}A+B=\{&<x,[[\mu_A(\mathrm{x})]^L+[\mu_B(\mathrm{x})]^L-[\mu_A(\mathrm{x})]^L[\mu_B(\mathrm{x})]^L,[\mu_A(\mathrm{x})]^U+[\mu_B(\mathrm{x})]^U-[\mu_A(\mathrm{x})]^U[\mu_B(\mathrm{x})]^U],\\&[[\nu_A(\mathrm{x})]^L[\nu_B(\mathrm{x})]^L,[\nu_A(\mathrm{x})]^U[\nu_B(\mathrm{x})]^U]>|\, x\in X\}\end{aligned}\tag{2}$$

(2) The product of interval-valued intuitionistic fuzzy sets:

$$\begin{aligned}AB=\{&<x,[[\mu_A(\mathrm{x})]^L[\mu_B(\mathrm{x})]^L,[\mu_A(\mathrm{x})]^U[\mu_B(\mathrm{x})]^U],[[\nu_A(\mathrm{x})]^L+[\nu_B(\mathrm{x})]^L-[\nu_A(\mathrm{x})]^L[\nu_B(\mathrm{x})]^L,\\&[\nu_A(\mathrm{x})]^U+[\nu_B(\mathrm{x})]^U-[\nu_A(\mathrm{x})]^U[\nu_B(\mathrm{x})]^U]>|\, x\in X\}\end{aligned}\tag{3}$$

(3) The product of interval-valued intuitionistic fuzzy sets and number:

$$\lambda A=\{<x,[1-(1-[\mu_A(\mathrm{x})]^L)^\lambda,1-(1-[\mu_A(\mathrm{x})]^U)^\lambda],[([\nu_A(\mathrm{x})]^L)^\lambda,([\nu_A(\mathrm{x})]^U)^\lambda]>|\, x\in X\}\tag{4}$$

4. The parallel intuitionistic fuzzy neural network method

Intuitionistic fuzzy neural network (FNN) consists of four parts: the underlying training network, the fuzzy neural network FNN_μ based on the membership degree μ, the fuzzy neural network FNN_ν based on the non membership degree ν, and the intuitionistic fuzzy synthesis. First, we divide the training sample into several sub blocks, and then put each sub block into the training network. After the training, we put the results into the membership network and non membership network. At the same time, we take the test sample to complete the calculation of the membership network FNN_μ and non membership network FNN_ν. Finally, the output value of the test sample and the training sample is synthesized by intuition, and the output value of the intuitionistic fuzzy neural network is obtained. In addition, we use MAP-REDUCE to determine the connection weights of neural networks in cloud computing.

In the stage of Map, Map () function to receive the key-value pair. According to the network structure, Map () function decomposing the input component and the expected output component. Then, for each of the network connection weights ω, we calculate the local gradient change of the weight $\Delta\omega$ that is generate by back propagation, and generate the intermediate key-value pair which forms such as（$key=\omega, value=\Delta\omega$）. The Map task generates an intermediate key-value pair that is kept in the local system file at a time. In the stage of Reduce, the Reduce () function uses the（$key=\omega, value=\Delta\omega$）as the intermediate input value which is generated in Map stage, and carries on the reduction operation.

5. Simulation experiment and result analysis

In this paper, the performance of the intuitionistic fuzzy neural network is tested by UCI standard data set. The UCI standard data set is used for data mining, pattern recognition, classification, regression and so on. UCI gives the attributes and categories of data, users use their own method to classify UCI data sets. In this paper, we select one data set from the UCI standard date set. The data source of the data set is the characteristics of the enterprise network marketing. The data set has 320M data, and it is divided into 32 categories. In order to verify the performance of the high performance computing system under the background of big data, this paper uses the Hadoop cluster environment is made up of 8 SYSTEM X3850 IBM server, each server is a quad core PC, each core as a Hadoop node. One of them is NameNode, the other is the DataNode. Experimental results are shown in figure 3.

Can be seen from figure 3, the time consuming of the computation of the network algorithms in the same data dimension is also different. When dealing with small sample data sets, the difference between the two algorithms is not significant. And with the increase of the number of sample data, the time consuming of operation has gradually produced the difference. Obviously the computing speed of the parallel network algorithm is faster.

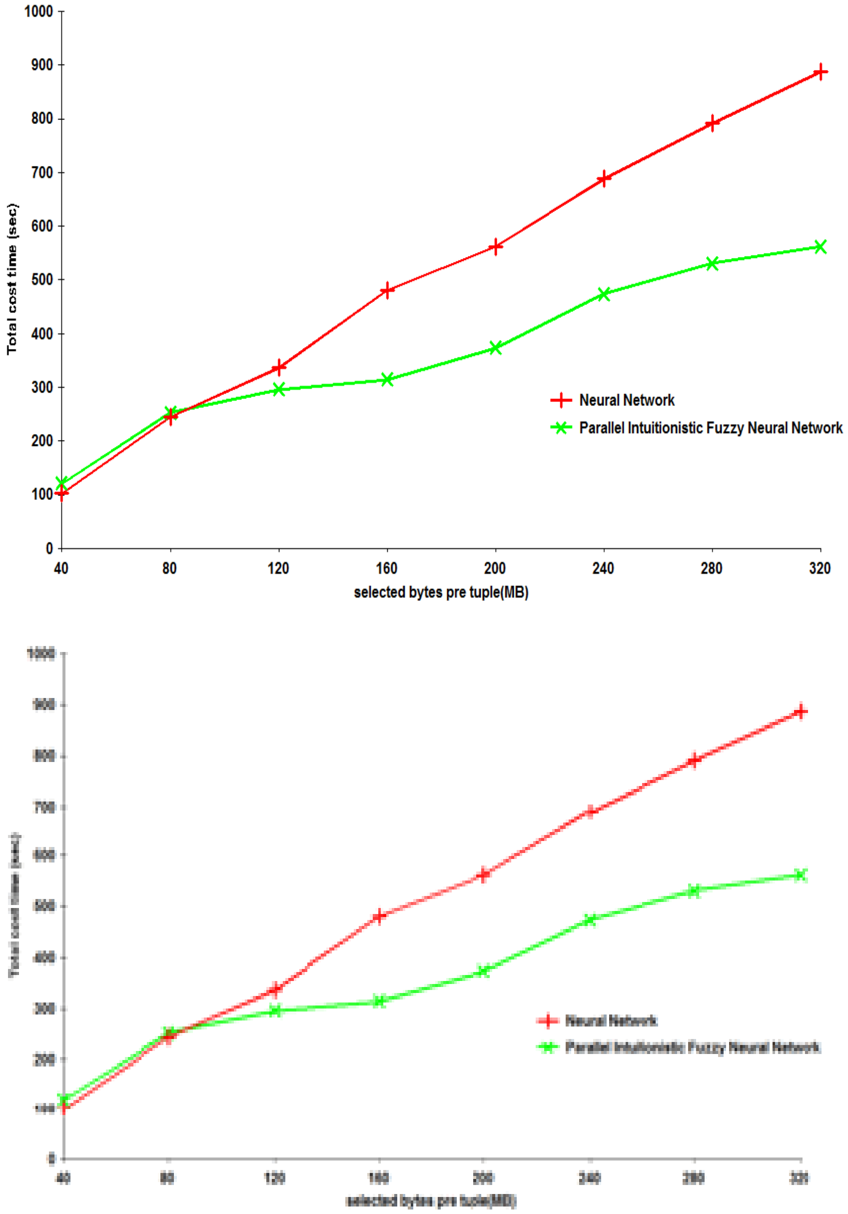

Figure 3: Performance evaluation of Map-Reduce execution with different base columns.

6. Conclusions

Based on the theory of fuzzy set, the parameters of neural network can be adjusted according to the adaptive learning ability of intuitionistic fuzzy neural network. First, we divide the training sample into several sub blocks, and then put each sub block into the training network. After the training, we put the results into the membership network and non membership network. At the same time, we take the test sample to complete the calculation of the membership network and non membership network. Finally, the output value of the test sample and the training sample is synthesized by intuition, and the output value of the intuitionistic fuzzy neural network is obtained.

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