

Forecasting Model of Supply Chain Management Based on Neural Network

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Abstract. Neural network technology has been successfully applied in many business areas. This paper systematic summarizes the applications of neural network technology in supply chain management, which include three areas: optimization, forecasting and decision support. Then, the BP neural network is used to forecast the demand of bicycle in a certain region, the forecasting result demonstrates that BP neural network has a better forecasting accuracy than that of traditional forecasting model.

Introduction

Neural networks are an emerging artificial intelligence technology, which is put forward based on the modern biology research achievements of human brain tissue. Simulating the human brain structure and behavior is its principle. Neural network technology breakthrough in the study of some of the limitations of artificial intelligence(AI), which has been successfully applied in many fields, and shows the efficiency and accuracy of the other AI techniques can not be compared. In fact, many aspects of supply chain management have applied the neural network technology, but so far, few people combined these two concepts together and systematically expounded neural network technology in supply chain management, which is what this paper work to be done.

Neural Network

BP (Back Propagation) network is a group of scientists led by Rumelhart and McClland put forward in 1986, is a kind of error back-propagation algorithm for training multilayer feedforward network, its learning rule is to use the method of steepest descent, to constantly adjust the network weight value and threshold value by back propagation, make the network and the minimum sum of square error. BP neural network is mainly composed of an input layer, one or more hidden layers and one output layer, the mutual connection between the layers of neurons, but between each layer between the neurons are not connected relationship.

The learning process of the BP neural network model composed of by two parts, forward and backward. In the forward process of communication, information from the input layer through the middle hidden layer to the output layer weighted propagation, in the output layer to obtain the input of the network response, output value by comparing the function calculation and target output value, if there are errors, error back propagation along the route before the return, i.e., from the output layer after each intermediate the hidden layer to adjust the connection weights, finally back to the output layer, to reduce the error, with the neural network error reverse spread to revise the weights continuously, the entire network accuracy of input information in response to natural also improved.

Neural network is essentially a simulation system for the human brain's thinking process. Its core is the mathematical models and algorithms, and the physical implementation is computer software. Just like thins are composed of atoms, neural network is composed of many interconnected neurons. Fig. 1 shows the basic work principle of neurons, and the mathematical expression is as follows:

$$y = f\left(\sum w_i x_i\right) \quad (1)$$

Where x_i and y are respectively the input and output. w_i is weight coefficient. f is characteristic function, which reflects the mapping relationship between inputs and outputs, and it is

usually a nonlinear function.

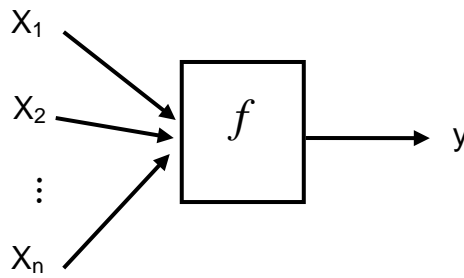


Fig. 1 The neuron model

This seemingly simple model will produce a powerful neural network combining different network topology and network algorithms together. Neural network consists of input layer, hidden layer and output layer, which is shown in Fig. 2.

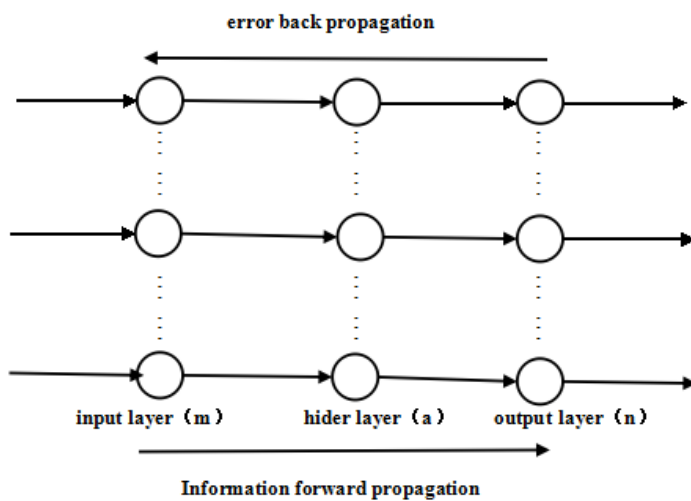


Figure 2.A classical 3-layer BP network model

With a lot of development of neural networks, it was found that no matter how the organizational structure of the network it is, It is always has the following two characteristics:

(1) Self-learning

Neural networks can be modified according to the external environment of their own behavior in order to adapt to the external environment, which is mainly due to its learning process. Learning is often the first step in using neural networks. When a group of information is input, neural networks can continue to adjust its internal parameters (or say weighting coefficient), and eventually produce a series of consistent output.

(2) Generation

Once after the self-learning, the response of neural network, to some extent, to the reducing of input information and their own local defects are no longer sensitive. This mechanism can make the neural network has a strong fault tolerance and reduce the input data quality requirements.

The main advantages of the BP neural network is simple, easy to implement, has the ability, generalization ability and fault tolerant ability to approximate arbitrary nonlinear mapping, learning algorithm is derived clearly, high precision, has been widely applied in many fields. But as a feedforward neural network is a typical BP network, there are some limitations in the practical application. First of all, the biggest drawback is BP algorithm is easy to fall into local minima, because the error surface usually are rough, there will be more extreme point. The second is the slow convergence speed, when using the gradient descent method is not easy to determine the step length, step length is too long is not up to the precision, even divergence; too small to iterative steps to increase, slow convergence speed. The last is the network number of hidden layers and the unit layer choice there is no theoretical guidance, is generally based on experience or through repeated testing to determine the network; therefore, there are often redundancy greatly, to a certain extent, also increased the burden of network learning.

Supply chain management and neural network

Supply chain is a network which includes some companies and sectors. In this network, the material is acquired and processed into intermediate or finished products, and finished products then are sent to the users. Therefore, it can be seen as a multi-level system, including production, distribution, retail and other sectors. Supply chain management means that through designing, planning and controlling the supply chain, logistics, information flow and capital flow, a balance between supply and demand is achieved, customer satisfaction is improved, and overall operating costs of the supply chain is reduced. Based on the foregoing characteristics, neural networks currently applied in the supply chain management are mainly in the following three areas: optimization, forecasting and decision support.

(1) Optimization

Neural network is the most popular computing technology to solve the optimization problems. It has an important significance for supply chain management. Currently, it has been studied how to apply neural networks to solve the supply chain management optimization problem, such as shop scheduling, warehouse management, selection of transportation route and so on. Some of these problems are the core problems to build the logistics information system of the enterprise. In addition, compared with other technologies, neural network has a strong adaptation ability, and it can promptly consider and accommodate emerging constraints with real-time processing capabilities.

(2) Forecasting

For a long time, uncertainty is the biggest obstacle for company decision-makers. The uncertainty in supply chain comes mainly from changes in product demand, delivery delays and mechanical failures. Because of the inaccurate forecasting for the local aspects of the supply chain, the overall supply chain will have a big fluctuation and this volatility will progressively enlarge. Thus, how to improve the forecasting accuracy and minimize the uncertainty of supply chain management has become the core issue. As we all know, the information supporting our decision-making generally is not sufficient, which has become the insurmountable obstacles of other forecasting techniques such as expert systems, statistical methods, and time series. But the black box function in neural network can avoid this obstacle, and obtain a more satisfactory forecasting result. Furthermore, the neural network is essentially a nonlinear system. Many of the supply chain forecasting problems are more complex, non-linear problems, which the linear forecasting tools are powerless, while the neural network is even easier.

(3) Decision support

When managers are making decisions, there are two problems they are facing. One is that the decision-making information is too large, and the other is that the decision-making information is incomplete. As mentioned earlier, they are serious impediment to the application of expert systems, statistical methods. In contrast, the neural network simulates the human brain thinking. To some extent, It has a "creativity", so that it can make more rational and informed decisions only with the incomplete information. Now, most of the research for decision support system focused on the management and analysis of the decision-making data. Due to the neural network's unique identification ability, data classification capabilities and self-organizing capabilities, it becomes the ideal data search technology in supply chain management. A neural network system for determining the potential customer in the sales process has been developed. Another important issue the decision support system faced is how to find the intrinsic relationship between the data from the huge data. Self-organization and generalization capabilities of the neural networks become a powerful tool for solving this problem.

Specific example analysis

As mentioned above, changes in demand for products is one of the main sources of uncertainty in the supply chain, and is the most important reason for causing the fluctuations in the supply chain. Therefore, focusing on the market demand of product is the top priority of supply chain management. A bicycle market in a certain region is set as an specific exam. The neural network

model and linear regression are respectively used to make a forecasting analysis for the market demand for the bikes.

The related factors influencing bike market demand contain wage levels, price index, population and the savings rate. The BP neural network is selected as the learning algorithm. The number of hidden layers in a network model is set as 1. The hidden layer nodes take 9 and the learning square error takes 0.0005. The forecasting results of these two model are shown in Table 1.

Table 1. The forecasting of models

Year	Actual value (Ten thousand)	BP neural network model		Linear regression model	
		Forecasting value	Relative error(%)	Forecasting value	Relative error(%)
2010	780.32	775.09	0.67	653.52	16.25
2011	816.48	808.07	1.03	707.40	13.36
2012	862.34	847.94	1.67	711.61	17.48
2013	900.36	887.30	1.45	726.41	19.32

The experimental results show that the neural network prediction accuracy is much higher than the prediction accuracy of linear regression.

Conclusion

The neural network displays a satisfactory ability to solve most of difficult problems appeared in supply chain management. In addition, Neural network has a strong ability to adapt and easily combines with other technologies, which can learn from each other and make up their own deficiencies. The hybrid model can solve more problems appeared in supply chain management, which is a subject worthy of studying in the future.

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