Prediction of Regional Economic Trend with f Improved BP Neural Network Algorithm

Anmin Liu*, Jiang Zhu, Donghai Yue and Guangxin Liu
Mechanical and Electrical Engineering Department, Changzhou College of Information Technology, Changzhou, 213156, China

*Corresponding author e-mail: liuanmin_123@163.com

Abstract. Traditional BP neural network-based prediction method cannot accurately predict regional economic trend, and the operation efficiency is low. To this end, a method based on improved BP neural network algorithm is developed to predict regional economic trend. The Cobb-Douglas production function is used to select the most influential number of working people and economic investment in fixed assets, fiscal expenditure, gross foreign export value, retail sales of social consumer goods index as the sample data and normalized. The error of sample data is calculated by TangXC_BPModel model, and the the weights are modified uniformly so that and the regional economic trend is predicted accurately.

Keywords: BP neural network algorithm, Regional economy, Normalization method

1. Introduction
Economic gain is a very important topic in the development of human society[1]. The economic system is essentially a non-linear system subjected to constantly changing environment. Additional interference factors act directly on the whole process of macroeconomic system operation, together with various reasons that lead to the uncertain and incomplete historical data needed for macroeconomic modeling[2]. So that the traditional BP neural network prediction method for regional economic trend, in the analysis process of big data of regional economic trend, cannot accurately correct the weight, and operation efficiency is low. For traditional BP neural network,
forward propagation of information and backward propagation of error are two stages of its learning process. The input signal is first processed by the neurons in the input layer and hidden layer, then transferred to the output layer to show the result. If the desired output is not available at the output layer, it turns to the reverse propagation process. The error between the network output and the actual value is returned along the originally connected path. The error can be reduced through modifying the weights of the neurons at each layer. Go to the forward propagation process and repeat iteratively until the error is less than the given value. Therefore, an improved BP neural network-based method is developed to predict regional economic trend, which provides a reliable basis for regional economic development[3].

2. Prediction of Regional Economic Trend with Improved BP Neural Network Algorithm

2.1 The Number of Neurons in Hidden Layer

Although the BP algorithm has gained wide popularity, it also has its drawbacks. Because the algorithm is essentially a gradient algorithm of the nonlinear optimization problem, it has the problem of convergence. The network error is a curved surface with a complex shape in a high-dimensional space. For such a complex error surface, adjusting the connection weights may suffer from the following cases: (1) Convergence to the local minimum. Since the algorithm uses a gradient descent method, training gradually approaches the minimum error, and the network error surface is a high-dimensional uneven error surface. Therefore, it may be caught in the learning process. (2) The adjustment of connection weights is slow in flat areas. There are some flat areas on the error surface. Since the derivative of the activation function tends to zero, the gradient adjustment process almost keeps in a standstill even though the error is large. (3) Oscillate in steep gullies. The error surface usually has a steep groove, which makes the weight of the network converge to less than the minimum point and oscillate around the minimum point. (4) Skip better points. During the learning process, the network may also skip the better minimum point during network weight adjustment. This is mainly due to the fact that the concave surface of the error surface is too narrow and the gradient value is large, resulting in network weights Jump to a good minimum point near a good minimum point.

In the design of BP neural network structure, and the network accuracy can be improved by increasing the number of neurons in the hidden layer. In the specific design, the number of neurons in the hidden layer is initially determined according to the empirical formula, and then determined by training and comparing networks with different numbers of neurons. Here below is the empirical formula for determining the number of neurons in the hidden layer:

\[ n_i = \sqrt{n + m + a} \]  

(1)
Where \( n_h \) denotes the number of neurons in the hidden layer; \( n \) represents the number of neurons in the input layer; \( m \) stands for the number of neurons in the input layer; and \( a \) is the constant ranging between 1-10.

### 2.2 Selection and Processing of Samples

The prediction model must also be based on a certain macroeconomic theory. In this work, the input variables of the BP neural network prediction are set based on the production function.

For single-stage *Sigmoid* function, the output varies between 0 and 1 and the output reaches \((0, 1)\) only when the input is \((-\infty, +\infty)\). The general formulation is to normalize the input to \((0, 1)\). This paper uses \( f(v) = \frac{1}{1 + \exp(-av)} - 1 \) as the excitation function, the function is characterized by the range \((-1,1)\). The sample data is normalized using the following normalization formula:

\[
y = \frac{x - \min}{\max - \min}
\]

In formula (2), \( \max \) represents \( \min \) the maximum value and \( \min \) represents minimum value in sample data; \( x \) is the original sample data, and \( y \) is the transformed value. After completion of the neural network processing, anti-normalization will be performed. The output of the network is processed with the following formula so that the output data and the original data locate in the same range[4-5], the anti-normalization formula is: \( y = x'(\max - \min) + \min \), which is an inverse normalization of the raw data.

### 2.3 Weight Correction of BP Neural Network

The BP neural network inputs sample data in the input layer \( I \), and processes them in the hidden layer \( H \), and finally obtains the processing results in the output layer \( O \). If the processing results in line with the expected value, the process is finished, otherwise the corrected value continues to be processed in hidden layer \( H \) until the expected is met. Because weight need to be corrected for each input sample, the weight also needs to be modified in the iteration process[6], resulting in lower learning efficiency of BP neural network. A new model TangXC_BPModel is established in this paper, all samples are entered in turn, and then errors of all samples are calculated, and the weight are corrected after the accumulation of all systematic errors, which significantly improve the learning efficiency of BP neural network[7], and enhance the efficiency of regional economic prediction.

### 3. Experiment Analysis

The proposed method is utilized to forecast the GDP of the first quarter to the fourth quarter of 2016 in a certain region. The operating efficiency of GDP prediction using
the proposed method in different quarters is obtained.

Figure 1 depicts the out-of-sample prediction of the real GDP growth rate of an experimental area based on the proposed method, which is based on the growth rate of added value of industrial enterprises. Figure 1 shows that the proposed method holds a positive outlook for the real GDP of the experimental area at the beginning of 2015, as the economy and the industrial economy continues to decline\cite{8}, the predicated results become increasingly accurate. The average growth rate of added value of industrial enterprises from April 2016 to September 2016 is 5.7% and 6.4% respectively against the fourth quarter of 2016 and the first quarter of 2017, stating that the downturn in the industrial economy is a key factor. However, the prediction also reveals a very important economic trend, indicating that the experimental regional economy is undergoing fluctuations in the bottom, and the economy is slightly increased in the beginning of "13th Five-Year" period.

| Year | GDP growth rate |
|------|----------------|
| 2006 | 4%             |
| 2008 | 8%             |
| 2010 | 14%            |
| 2012 | 10%            |
| 2014 | 16%            |
| 2016 | 14%            |

Figure 1. Prediction for the real GDP growth based on the proposed method and the growth rate of added value of industrial enterprises

The analysis of above experimental results indicates the proposed method proposed can predict the regional economic trend well and has high application value. The regional economy can do a good job of macroeconomic regulation and control according to the forecast results. Enterprises and individuals adjust their economic activities such as investment and saving in the light of the actual situation in order to optimize economic decision-making and maximize economic benefits.

4. Conclusion
In this paper, a prediction method based on improved BP neural network is developed to predict the trend of regional economy. The proposed method can predict the regional economy and improve the convergence rate of the prediction model without
affecting the accuracy, effectively improve the efficiency of regional economic analysis and prediction, and reduce the percentage error, and have the advantages of higher operating efficiency.

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