Research on Forecast Model Based on BP Neural Network Algorithm

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Abstract. Back propagation Neural Network is a well-known method of prediction. Due to the development of the neural network technology, there has been an increasing amount of neural network application research in the last decade, with a majority of application focusing on financial decisions. Firstly, this paper demonstrates the algorithm of back propagation Neural Network. Then, the application of Back propagation algorithm in prediction sector is explained in detail through the design of pre-warning model of financial distress for real estate industry in China. Meanwhile Z-score model is utilized to produce the only output nodes of Back propagation Neural Network. The research can provide evidence of forecast performance based on BP Neural network technique.

Keywords: Artificial intelligence; back-propagation; neural Network; pre-warning.

1. Introduction
The research of Neural Network is originally started from the late nineteenth century and the early twentieth century, it originated from interdisciplinary study of Physics, psychology and neurophysiology. With the development of Artificial intelligence network, NN have recently begun to be applied in all the sectors. Back propagation as one kind of Neural Network with most wild application is originally introduced by Rumelhart and McClelland in 1986, Back propagation belong to the category of multi-layer feed-forward network based on the Error Back Propagation Algorithm.

In order to illustrate the application of BP in depth, this paper conducts the application of BP in business sector. In reality, as the rapid development of market economy, financial distress emerge as the main concern of enterprises. To be successful in any business there is a need to predict the financial scenario of the near future. Due to the drastic breakthrough of Artificial intelligence, algorithm of Neural Network is used to solve these prediction problems.

2. BP neural network model
Neural Networks are massively parallel, distributed processing systems that can continuously improve their performance via dynamic learning. BP Neural Network as a type of Neural Network mimics certain processing capabilities of the brain. Figure 1 shows process flow chart of network.
The back propagation neural network architecture is a hierarchical design consisting of input layer, hidden layers, output layers, the hidden layers receive signal from input layer through the function, output layers receive signal from the hidden layers below, fig2 illustrates the transfer process:

\[
\alpha_p = \sum_{i=1}^{m} u_{ip} X_i = [X_1, X_2, \ldots, X_m] \begin{bmatrix} u_{11} & \ldots & u_{1q} \\ \vdots & \ddots & \vdots \\ u_{m1} & \ldots & u_{mq} \end{bmatrix}
\]  

(1) From input layer to hidden layer

\[
\alpha_p = \sum_{i=1}^{m} u_{ip} X_i = [X_1, X_2, \ldots, X_m] \begin{bmatrix} u_{11} & \ldots & u_{1q} \\ \vdots & \ddots & \vdots \\ u_{m1} & \ldots & u_{mq} \end{bmatrix}
\]  

(1) From input layer to hidden layer

Figure 1. Network flow chart.

Figure 2. Architectural of BP neural network.
(2) The function of hidden layer

The activation function through the hidden layer is shown in the following formula (2). We usually use the sigmoid function.

\[ a_p = f(\alpha_p - \gamma_p) \]  

(3) From hidden layer to output layer

The formula of the output neuron j is shown in formula (3).

\[ \beta_j = \sum_{p=1}^{q} v_{pj} a_p = [a_1 \ a_2 \ \ldots \ a_q] \begin{bmatrix} v_{11} & \cdots & u_{1n} \\ \vdots & \ddots & \vdots \\ u_{q1} & \cdots & u_{qn} \end{bmatrix} \]  

(4) The function of output layer

The activation function through the output layer is shown in the following formula (4), and it’s usually a linear function.

\[ Y_j' = f(\beta_j - \delta_j) \]  

(5) The error

The error calculation formula is shown in the following formula (5). During the operation of the model, we need to set a parameter, and then when the error reaches this value, the model will stop running.

\[ E = \sum_{j=1}^{n} (Y_j' - Y_j)^2 \]  

3. Z model

Single variate model cannot provide the comprehensive review. Therefore, this paper uses a multiple linear model to discuss the financial risk. The multiple linear discriminate analysis was firstly applied in the sector of the prediction of financial crisis by Altman. This model provides the Z-score which can be applied to evaluate the financial condition.

Through the Z-score model, the data sample can be classified into three types of firms, financial distress was modeled into three types: 1: healthy; 2: unsound; 3: vulnerable. Three data groups were applied into the illustration of Back propagation neural network.

4. Application

4.1. Parameter settings

Firstly, this study considered 15 early-warning indicator variables as the input layer. These variables are closely related to the financial condition of listed companies. Then, we use trial calculation methods to determine the optimum value of hidden layers numbers and the nodes numbers in each hidden layer. Meanwhile, the type of financial distress based on the Z-score model is used as the only one output node. Finally, parameters were set to improve the accuracy of the early warning model continuously during the simulation of the model’s operation.

The data sample consists of 122 in 2019, 100 observations are used as learning sample, 22 observations are used as testing sample. The architecture of BP Neural Networks was 15 input nodes, three hidden nodes and one output node. During the parameter setting process, this paper has selected all training samples, the RBF is 55, the lasting times is 60, Alpha is 0.9, the overlapping value of RBF is 1.0. The importance used to analyze the sensitivity of the input indicators are as follows:
Figure 3. Importance of part variables.

X1: inventory turnover; X2: ROE; X3: rate of return on sales; X4: administrative/sales; X5: cost of goods sold/sales; X6: EPS; X7: selling expenses/sales; X8: NPG; X9: operating profit growth rate; X10: Gross profit ratio; X11: interest coverage ratio; X12: accounts receivable turnover; X13: current ratio; X14: debt ratio; X15: financial expenses/sales.

4.2. Testing process
In the testing process, we test the BP neural network model and compare the output value of the model with the actual financial condition of the company, the result can be used to verify the accuracy of the model constructed in this article. In this application, the accuracy of BP model reached 59.1% which indicates the BP neural network model proposed in this paper can effectively predict the financial distress for business sector. The specific result is shown in Table 1 below:

|       | Actual number | Model prediction | Model accuracy |
|-------|---------------|------------------|----------------|
| healthy | 6             | 6                | 100%           |
| unsound| 5             | 0                | 0              |
| vulnerable | 11        | 7                | 64%            |
| Total   | 22            | 13               | 59.10%         |

5. Conclusion
BP neural network application research in the prediction of financial distress has always been challenging and attractive. BP neural network algorithm provide not only a statistical and intelligent techniques, but also utilizes the Z-score model to solve the complex prediction problem. The research suggests the weight of pre-warning indicator variables differs in the prediction model. The accuracy of the BP model depends on the integrity of indicator variables. Further, BP neural network algorithm reported a prediction accuracy of 59.1% which outperforms the other prediction techniques. What's more, the model is better performed in healthy group which can reach a prediction accuracy of 100%. The future scope for improvement could be to exclude more learning factors and inertial factor that affect the accuracy of BP neural network.
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