Journal of Applied Sciences

ISSN 1812-5654

science alert

ANSInet
an open access publisher
http://ansinet.com

Journal of Applied Sciences 13 (15): 3084-3088, 2013
ISSN 1812-5654 / DOI: 10.3923/jas.2013.3084.3088

Predicting Financial Situation for Companies Through Integration of Adaboost Algorithm and BP Neural Network

[1,2]Jianfang Cao, [1]Junjie Chen and [1]Haifang Li
[1]College of Computer and Software, Taiyuan University of Technology, Taiyuan, 030024, China
[2]Department of Computer Science and Technology, Xinzhou Teachers' University, Xinzhou, 034000, China

Abstract: In study, a prediction model is proposed based on combined Adaboost algorithm and BP neural network in order to predict company's financial situation and improve prediction accuracy of BP neural network model. The significance of solving the problem is to adjust the company's financial expenditure and make better forecast and analysis for the development of companies. The proposed method regards BP neural network model as weak predictors and uses Adaboost algorithm to construct strong predictor, which solves the problems of local minima defects and slow convergence of BP neural network model. The core innovation is to construct strong predictor using Adaboost algorithm in the research. The efficiency of the proposed prediction model is proved by training and predicting 1350 groups of statistical data of company's financial situation. The computer simulations have shown that the model is effective and suitable, has higher forecasting accuracy and is applicable to practice compared with previous work.

Key words: Financial prediction model, BP neural network, Adaboost algorithm, prediction accuracy

INTRODUCTION

Company financial prediction system is the alarm system to prevent the company's finance from deviating from the expected goal and has targeted and predictive features. It evaluates and forecasts financial status, trends and changes through analyzing the company's indexes and provides intellectual support for scientific decision making of decision makers. Therefore, financial prediction model plays an important role in the course of national and regional economic development planning. Accurate prediction result is helpful to improve the operation efficiency for a company. At present, Theodoridis and Koutroubas (1999), Chau (2007) and Orlando *et al.* (2009) uses the following prediction methods: Regression analysis, grey model, Markov forecast method and so on. But the accuracy of these prediction methods is not ideal, prediction results are sometimes obviously lag and need be qualitatively analyzed and corrected. Some researchers have introduced neural network for finance prediction in recent years and many scholars use BP neural network to predict the company's financial situation. But Wen *et al.* (2003) proposed BP neural network had two distinct disadvantages: Firstly, it is easy to fall into local minimal value; Secondly, its convergence speed is slow and the effect is not ideal when solving many problems such as less sample size and much noise. Hu *et al.* (2008) verified the Adaboost algorithm can improve the prediction accuracy of any given weak predictors; it has been successfully applied in many machine learning problems. In order to improve the prediction precision of BP neural network and overcome limitations of initialization for BP neural network weights and subjective factors of the training samples, this paper combined the Adaboost algorithm with BP neural network, constructed Adaboost-BP neural network prediction model; the model is applied to finance prediction for companies and verified the validity of the model through simulation.

In this study, we exploit financial prediction system for companies based on Adaboost-BP Neural network. It regards BP neural network as a weak predictor predicting sample output by repeated training and uses Adaboost algorithm to optimize output of multiple BP neural network weak predictor in order to form strong predictor. Once the training process is completed, the Adaboost-BP neural network will be used to predict the company's financial situation. We use 1350 groups of company financial data to train and generate 10 BP neural network weak predictors, finally construct strong predictor to forecast the company's financial situation.

The rest of this study is organized as follows. Section 2 introduces BP neural network prediction model.

Corresponding Author: Jianfang Cao, Department of Computer Science and Technology, Xinzhou Teachers' University, Xinzhou, Shanxi, China Tel.: +86 156 3506 7998, +86 350 212 5786 Fax: +86 350 212 5586

Section 3 proposes the basic idea and algorithm of Adaboost-BP neural network prediction model. The experiment results and analysis are given in Section 4. Section 5 gives some conclusions based on the study.

BP NEURAL NETWORK PREDICTION MODEL

BP neural network is a multilayer feed forward neural network. Its main features are signal forward transmission and error back propagation (Basheer and Hajmeer, 2000). In the course of forward transmission, the input signal is handled layer by layer from the input layer to the output layer through hidden layer. The state of each layer of neurons only influences that of next layer of neurons. If the output layer is not the expected output, BP neural network starts the back transmission. The prediction output of BP neural network would be gradually approximated to the expected output by adjusting the network's weights value and threshold value according to the prediction error. BP neural network can be considered as a nonlinear function, the input value and the predicted value of network respectively for the independent variable and dependent variable of the function. When the input node number is nand the output node number is m, BP neural network is expressed as a function mapping relation from the n independent variable to m dependent variable.

If the input of a nonlinear discrete dynamical system is $X_i = (x_{i,1}, x_{i,2}, ..., x_{i,k})^T$ and the output is Y_t using a typical three layer BP neural network with the structure of k-p-1, the BP neural network realizes the mapping: f: $R^k \rightarrow R^1$ and the input of hidden layer node is:

$$S_j = \sum_{i=1}^{k} w_{ij} x_i - \theta_j, \quad j = 1, 2, \cdots, p \tag{1}$$

In the Eq. 1, w_{ij} is the connection weight value between input layer and hidden layer; θ_j is threshold value of the hidden layer nodes.

The activation function of hidden layer of BP neural network has a variety of forms, but more commonly used form is Sigmoid function:

$$f(x) = \frac{1}{1 + e^{-x}}$$

We also chooses the Sigmoid function as the activation function of hidden layer. Therefore, the output of the hidden layer is:

$$b_j = 1 \Big/ [1 + \exp(-\sum_{i=1}^{k} w_{ij} x_i + \theta_j)], \quad j = 1, 2, \cdots, p \tag{2}$$

Similarly, the input and output of the output layer node, respectively are:

$$L = \sum_{j=1}^{p} v_j b_j - \gamma \tag{3}$$

$$y_i = 1 \Big/ [1 + \exp(-\sum_{j=1}^{p} v_j b_j + \gamma)] \tag{4}$$

In the Eq. 3 and 4, v_j is the connection weights value between hidden layer and output layer; b_j is threshold value of the output layer nodes.

Because the connection weight value w_{ij}, v_j and threshold value θ_j, γ of BP neural network could be obtained by training to, Y_i is predictable. The above Eq. 4 is the prediction model of BP neural network.

BP neural network randomly initializes the connection weight value and threshold value of all layers in [0, 1] before training, which often could make the convergence speed of BP neural network be slow and be easy to make the final results be the non optimal solution.

ADABOOST-BP NEURAL NETWORK PREDICTION MODEL

Basic thought: Adaboost algorithm (Hu *et al.*, 2008) is an iterative algorithm. The idea is to combine outputs of multiple weak predictors to generate an effective prediction. At present, the research and application on the Adaboost algorithm are mostly concentrated in the classification problem. But it is also applied in forecasting questions in recent years. The Adaboost algorithm could improve the prediction accuracy of any given weak predictor. Therefore, this paper combines the Adaboost algorithm with BP neural network and constructs a Adaboost-BP neural network prediction model in the light of limitation and subjective factors of BP neural network when selecting training samples and in order to improve the prediction accuracy.

The model regards BP neural network as a weak predictor and reduces or increases the corresponding weight values according to prediction quality of each training sample and uses changed weight values to train weak predictor, finally integrates the training results of weak predictors to generate the final output. The prediction process is as shown in Fig. 1.

Adaboost-BP neural network prediction algorithm: The basic steps of the algorithm are as follows:

Step 1: Initialize data selecting and network. Randomly select m groups of training data from the sample space, initialize distribution weight value of test data:

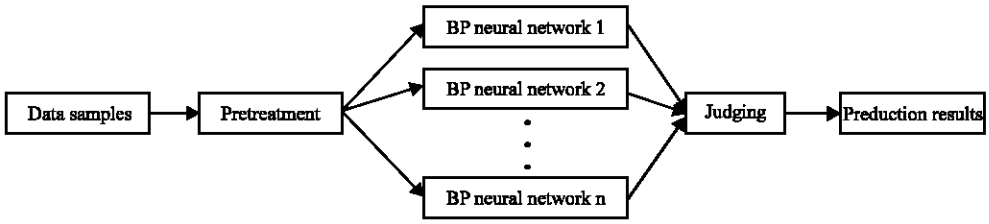

Fig. 1: Prediction flow chart

$$D_t(i) = 1/m$$

determine the structure of neural network according to dimensions of input and output samples, initialize weight value and threshold value of BP neural network

Step 2: Predict weak predictors. We use the training data to train BP neural network and predict the output of training data, obtain the sum of predicted error e_t of forecasting sequence g (t) when training the weak predictor of No. t. The computing formula of e_t is:

$$e_t = \sum_i D_t(i) \quad i = 1, 2, \cdots, m \ \ (g(t) \neq y) \tag{5}$$

In the above equation,g (t) is predicted result and y is expected result:

Step 3: Compute weights of prediction sequence. According to the prediction error the e_t of prediction sequence g (t), we compute the weight of the sequence a_t. The computing formula of weight a_t is:

$$a_t = \frac{1}{2}\ln\left(\frac{1-e_t}{e_t}\right) \tag{6}$$

Step 4: Adjust the weights of the test data. We adjust the weights of next round of training samples according to the weight of prediction sequence. The formula of adjustment is:

$$D_{t+1}(i) = \frac{D_t(i)}{B_t} \times \exp[-a_t y_i g_t(x_i)] \quad i = 1, 2, \cdots, m \tag{7}$$

In the Eq. 7, B_t is the normalization factor whose aim is to make the sum of the distribution weights be 1 in the case of unchanging the weight ratio:

Step 5: Construct strong predictive function. Normalize the weights of t weak predictors a_t:

$$a_t = \frac{a_t}{\sum_{i=1}^{t} a_t} \tag{8}$$

Therefore, the result of strong predictive function y (x) is:

$$y(x) = a_t h(x) \tag{9}$$

In the Eq. 9, h (x) is the predicted value of the sample obtained by t weak predictors.

EXPERIMENT AND RESULT ANALYSIS

Index analysis of company financial prediction warning system: The indicator system of financial crisis prediction warning system can be divided into six indexes: table-in information, profitability, repayment ability, growth capacity, linear flow and table-out information. Each index can be divided into a number of small indexes. For example, the index of profitability can be again divided into the following indexes: return rate of net assets, return rate of total assets, earnings of per share, profit rate of main business and profit rate of cost etc. The model is too complex if all indexes are synthesized after evaluation when forecasting company's finance. Furthermore, indexes need be filtered because the correlation among indexes is strong.

Index selection involves two steps: Significance analysis and factor analysis. Significance analysis analyzes ST company and non-ST company using t-test method and finds the financial indexes which can obviously distinguish two classes of company. Factor analysis calculates principal eigenvalue on the basis of significant analysis and finds out the indexes whose eigenvalue are bigger as the final evaluation indexes. Finally ten indexes are selected as the evaluation index: Utilization rate of ingredient cost, capital operation ability, company total assets, growth ratio of total assets, current ratio, operating cash flow, the type of audit opinion, earnings per share, stock turnover rate and the liabilities rate of assets, which can more fully reflect the company's financial status.

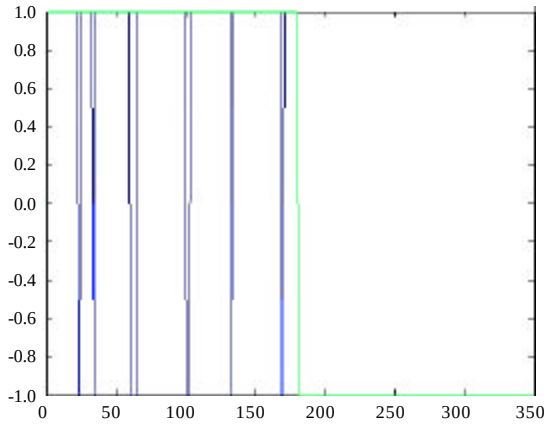

Fig. 2: Result of prediction

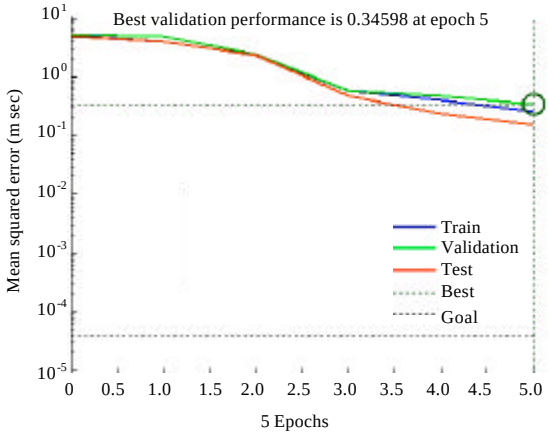

Fig. 3: Performance of prediction

Experiment condition: In order to verify effectiveness of the proposed algorithm, we write computer programs in the Matlab 2010b environment and apply Matlab neural network toolbox to construct two kinds of prediction model: Adaboost-BP model and BP model. In this paper, we use these two kinds of models to forecast the financial status of the company carry on the contrast experiment. In order to obtain better prediction effect, sample data are handled the normalization data whose mean is 0 and amplitude is 1 according to Eq. 10:

$$y_i = \frac{x_i - \frac{1}{n}\sum_{i=1}^{n} x_i}{\max(x_i) - \min(x_i)} \quad (10)$$

The experiment adopts 1350 groups of company financial data, the input of which is 10 dimensions, representing the 10 indicators and the output of which is 1 dimension, representing the company's financial situation. One indicates good financial status and -1 indicates financial problems. Randomly select 1000 groups of data as training data, 350 groups of data as test data. According to the data dimension, the structure of BP neural network is 10-6-1. The network is trained to generate 10 weak predictors of BP neural network. Finally we use 10 weak predictors to construct strong predictor for forecasting the company's financial status.

Results and analysis: The experiment adopts strong predictor which is composed of weak predictors of 10 BP neural networks to classify samples and count prediction error. There are 350 groups of test sample data. Fig. 2 and Fig. 3 are the result and performance of Adaboost-BP predictor.

Table 1: Prediction error counting

Prediction error rate of strong predictor (%)	Prediction error rate of weak predictor (%)
4.57	6.49

From Table 1, we can draw the conclusion that the prediction accuracy of the Adaboost-BP prediction model is higher than that of BP prediction model. The result shows the feasibility and the validity of the Adaboost-BP model. It can be used for the company's financial situation prediction.

CONCLUSION

Aiming at the problems of local minima defects and slow convergence of BP neural network prediction model, this paper puts forward a forecast model based on Adaboost-BP neural network. The model is applied in the company's financial situation forecasting and is compared with the BP neural network model. The simulation results show that the Adaboost-BP model has better convergence and the predicted results are more satisfactory with higher accuracy and good practicability. The proposed model can provide basis for forecasting financial situation of many companies. The deficiency and next research direction in this paper are as follows: (1) Neural network models require large training sets. More training data there are, more accurate the results of test are. It will spend a lot of time and human resource. How to obtain high prediction accuracy on the small sample sets is the emphasis in the next research content, (2) Extend the thought of using strong predictor to improve prediction accuracy to other areas.

ACKNOWLEDGMENT

This study was supported by the National Natural Science Foundation of China (No. 61202163) and by the Natural Science Foundation of Shanxi Province (No. 2013011017-2) and by the Technology Innovation Project of Shanxi Province (No. 2013150). The authors would like to express their many thanks to the reviewers' comments on this work, which really helped to improve the quality of presentation.

REFERENCES

Basheer, I.A. and M. Hajmeer, 2000. Artificial neural networks: Fundamentals, computing, design and application. J. Microbiol. Meth., 43: 3-31.

Chau, K.W., 2006. Application of a PSO-based neural network in analysis of outcomes of construction claims. Automation Construction, 16: 642-646.

Hu,W., W. Hu and S. Maybank, 2008. AdaBoost-based algorithm for network intrusion detection. IEEE Trans. Syst. Man Cybern. B Cybern., 38: 577-583.

Orlando, D., R. Nibaldo and A.C. Luiz, 2009. Neural networks for cost estimation of shell and tube heat exchangers. Expert Syst. Appl., 36: 7435-7440.

Theodoridis, S. and K. Koutroubas, 1999. Pattern Recognition. Academic Press, USA.

Wen, X., L. Zhou and X. Li, 2003. Simulation and Application of Neural Network by Matlab. Science Press, Beijing.