Analysis Of Exchange Rate Forecast Model of US Dollar Against RMB Based on BP Neural Network

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Abstract. Judging from the economic development situation in recent years, the uncertainty of exchange rate fluctuation will be affected by the exchange rate, not only for domestic and foreign trade but also for the cost of enterprises and individuals. Therefore, in view of this crucial problem, in this study, BP(Back Propagation) synthetic neural network is drilled by the opening price of the day in order to predict the closing price in the next day. The method is to divide 5000 groups of data into 4000 training sets and 1000 test sets. Single hidden layer neural network is adopted, and the number of nodes is determined to be 6 and 15 through the experiment of the influence of the quantity of nodes on model performance. The simulation test show that the root mean square errors in the prediction set and the verification set are very small, which are 0.0004 and 0.0006 respectively, so the neural network has good accuracy in forecasting the closing price of the next day, and some opinions on this model are also given.

Keywords: BP neural network; deep learning; prediction.

1. Introduction

Under the background of economic globalization, exchange rate is becoming more and more important for transactions between economies. With the increase of international trade and capital flow, exchange rate fluctuations directly affect on the import and export costs, profit margins and international competitiveness of enterprises. Therefore, the accurate prediction of exchange rate has become an important data for enterprises and investors in making decisions [6]. In an economic like China, exchange rate forecasting is particularly important, but the problem is that human beings can't predict it accurately. As one of the largest exporters in the world, China's RMB exchange rate greatly influent on the global economy and commerce. The fluctuation of exchange rate is related to the profitability of foreign trade firms, the risk of cross-border investment and the stability of financial markets [7]. Therefore, accurately predicting the exchange rate of RMB against the US dollar and other major currencies has attracted the attention of China companies and investors. The aim of this training model is to establish a relatively accurate exchange rate forecasting model by using computer science and artificial intelligence technology, so as to help enterprises and investors better cope with the risk of exchange rate fluctuations and reduce the uncertainty of production and investment [1]. Specifically, this paper will use BP neural network as a prediction model, and use pass exchange rate opening price data as input to predict the closing price of the next day. Through the training and optimization of the model, we expect to get more accurate prediction results. Accurately forecasting the exchange rate can strengthen the balance of government revenue and expenditure, because forecasting the exchange rate can promote exports according to macroeconomic theory [6]. In this projects, BP artificial network aims to predict the daily closing price of CNY/USD exchange rate, and relatively accurate results are obtained. But this kind of network also has some problems. The author will give some comments and suggestions on the limitations in the article.

2. Methods

2.1. Data sample pretreatment

This paper selects the daily data of the exchange rate of US dollar and RMB from January 2000 to October 2019. This paper extracts the daily opening and closing price. The opening price becomes the input data of this network, also the closing price is the sample data used to compare with the output results. There are 5000 groups of such data, and the data is divided into training set and test set respectively. The training set consist of four fifths of the total, and there are 4000 groups, which are used to train BP neural network to get an optimal weight parameter. However, we should pay attention to the order of data arrangement. If the data are arranged in date order, some humanistic or political factors may occur in a certain period of time, which may affect the final training results of the neural network model to some extent [6]. Therefore, this paper uses a random method to disassemble these data, which not only ensures that the performance will not be affected, but also is more convincing than the traditional method [3].

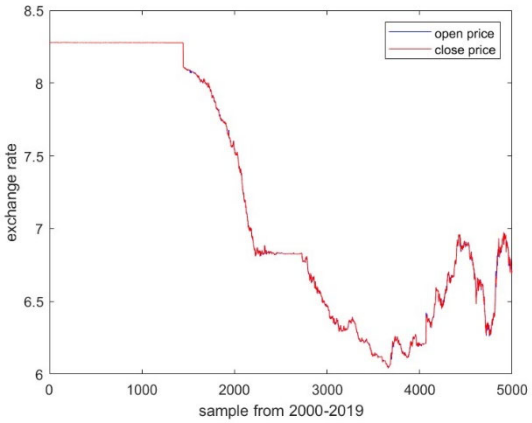


Fig. 1 CNY/USD exchange rate from 2000 to 2019 in chronological order.

2.2. BP neural network principle introduction and design

This paper attempts to predict the exchange rate of CNY/USD by using BP synthetic network model.It is a novel neural network, which consists of many neuron layers, in which data information can only flow in from the input layer as well as output from the output layer, AI network learning process with back propagation error algorithm is added[1,4]. Error and information in this artificial network are made of two processes, namely forward information and backward propagation error [3]. The proto principle of BP neural network is to adjust the weights of nodes of this network through inverse propagation algorithm, therefore network can approach or fit complex nonlinear functional relationships [5]. Forward propagation means that the sample data enters this neural network through the input layer, and an output result is obtained through complex calculation in the hidden layer [10]. In which each neuron performs the operation of weighting and activation function on the input data. However, when the output results are compared with the actual results, there will be different degrees of errors. Therefore, back propagation calculates the adjustment size of the adjustment weight through this error, thus reducing the error [5]. This is an iterative process. Through the learning rate, that is, the step size of adjusting the weight, this network can better fit the training data after many trainings [8]. Figure 1 below shows the structure of single-layer BP neural network.

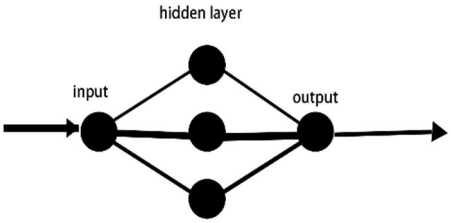


Fig. 2 Mechanism topology of single-layer BP network [4]

2.3. Analysis of the figure of hidden nodes on model performance and BP network setting.

The figure of nodes of inner layer has a certain relationship with the model performance after training, so using too many or too few nodes will reduce the final performance of the model[8]. If the figure for nodes in intrinsic layer is too small, leading ability of modifying parameters in the training of the model is likely to weaken, otherwise, too many nodes will waste the computing performance of the computer and reduce the efficiency, so it is necessary to make an experiment to figure out the fit number of nodes [2]. The BP network toolbox in Matlab R2023A creates the network model and simulates the test. Newff function ship network, set up a single hidden layer, the number of maximum turns of training is 10,000, the target accuracy is 0.001. And for loop is used to get the performance data of 20 models, among which the figure of hidden nodes of each model is different. By comparing the absolute average error, the number of nodes with the best performance is obtained. This experiment has been carried out for 10 times, and the results are shown in the following chart.

Table.1 After many experiments and previous experience[1], the number of nodes is finally determined to be 6 and 15.

Turns	1	2	3	4	5	6	7	8	9	10
#of nodes	7	6	4	13	15	1	15	1	6	4
Mean error	0.007	0.011	0.0045	0.005	0.0039	0.003	0.008	0.0113	0.0046	0.008

2.4. BP network training process

The training part is to give the weight a random value at the beginning, and it is done with the function rand () in Matlab. It should be noted that this function generates a decimal between 0 and 1, so you can get a random number from -1 to 1 by subtracting 1 from twice, and the initial weight parameters must be positive and negative. After many times of training, the network converges to an acceptable range. Among them, the incremental rule is to adjust the parameter size. If the expected effect is not achieved, the basic principle is related to the back propagation mentioned above.

3. Performance evaluation of neural network

3.1. Training Results and Simulation Test

The training results are as follows

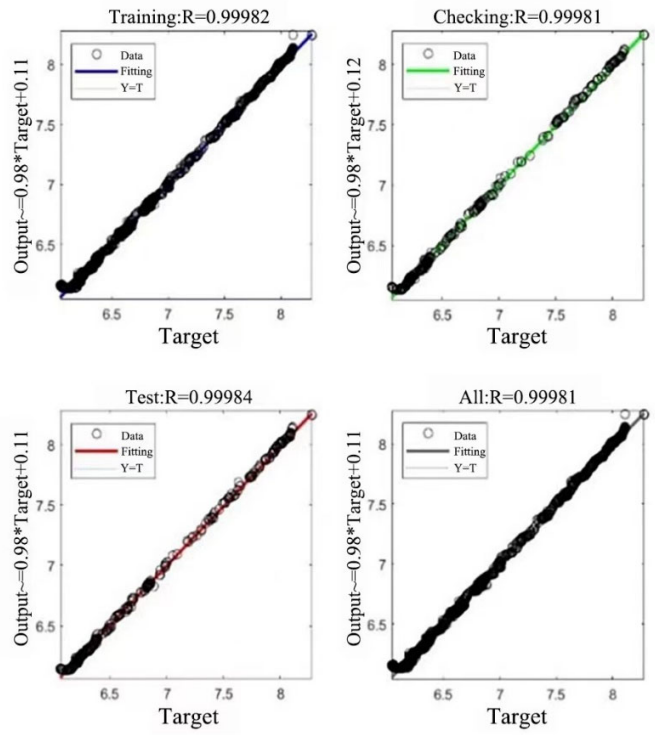


Fig. 3 regression when 15 nodes

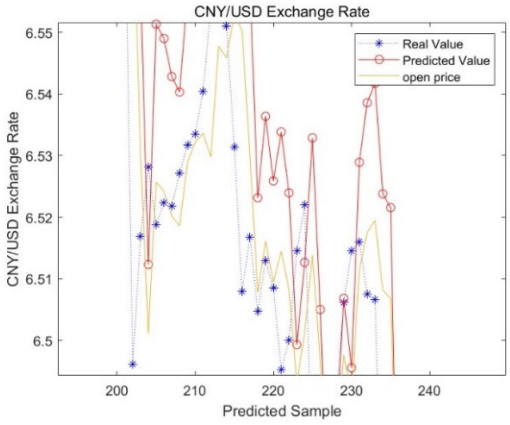


Fig. 4 contrast when 6 nodes(enlarged)

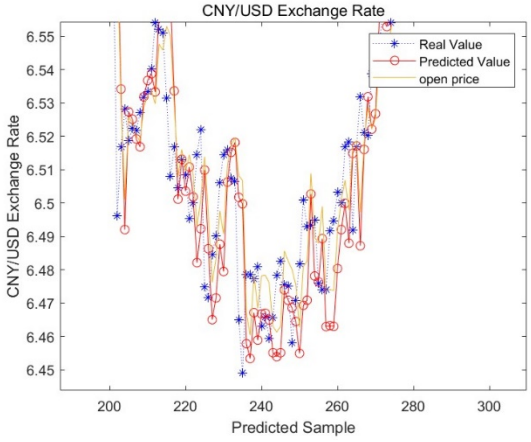
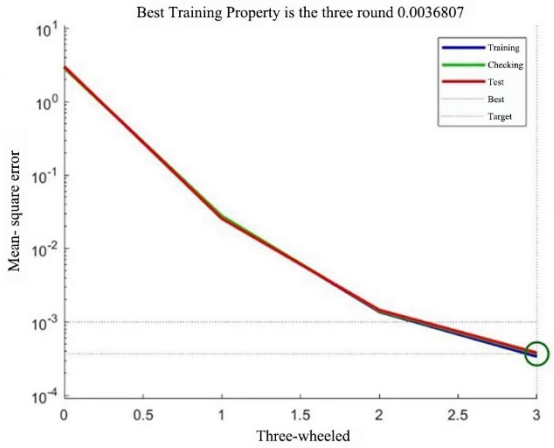


Fig. 5 contrast when 15 nodes (overview)



Figer.6 Performance when there 6 nodes

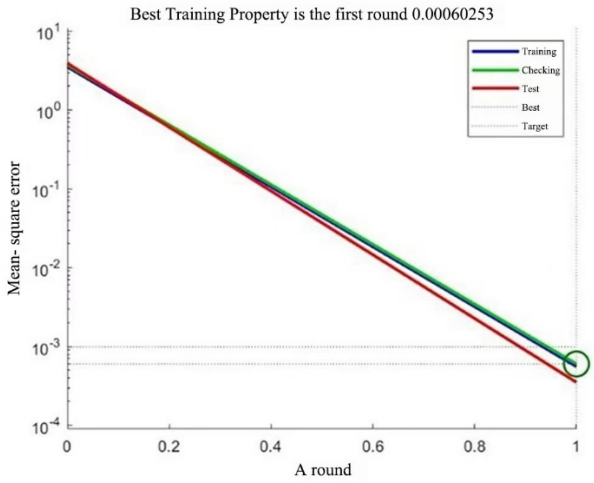


Fig.7 Performance when there are 15 nodes

Because the fitting situation has no fixed changing trend, the above results are all the neural network models with the highest performance obtained through many experiments. As shown in Figure 4 to Figure 9, the regression chart, contrast chart and performance chart show that the prediction results are close to the real situation or even fitted. After this training fitting, the mean square error (MSE) is 0.00036807 and 0.00060253, and the goodness of fit R is 0.99968 and 0.99982. The model finds the changing law of internal information that human beings can't perceive, and it is convincing.

3.2. Test Set Error Evaluation

Error is one of the most important reference factors in evaluating neural network. This experiment obtains a relative error rate through the prediction results and actual data.

$$\text{Relative error rate} = \frac{|\text{sample value} - \text{real value}|}{\text{real value}} \times 100\% \quad (1)$$

The test results are shown in the figure below.

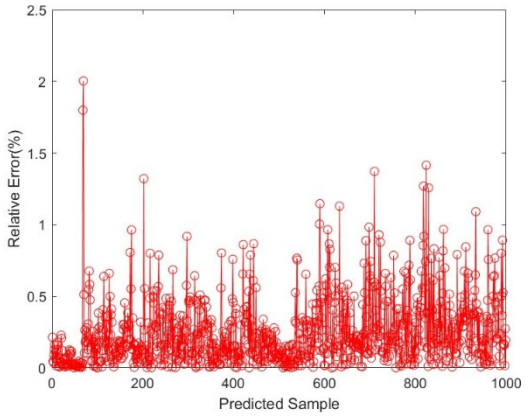


Fig. 8 Relative error ratio when there are 15 nodes

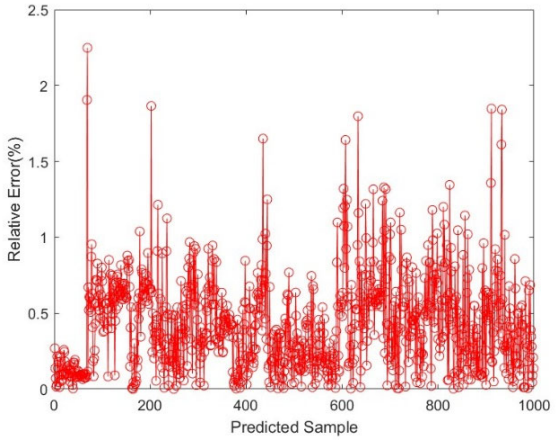


Fig. 9 Relative error rate when there are 6 nodes

According to the picture results, all the errors are between 0% and 2.5%, and most of them are between 0% and 1.5%, so the accuracy of the network model is very high.

4. Discussion and Conclusion

4.1. Discussion and suggestions

In the simulation test, a part of the predicted values and the real results are fitted, because most of the data show the same law and trend. However, the other part of the data greatly deviates from the true value, because a small part of the data belongs to extreme situations, and the exchange rate's short-term extreme fluctuation is disturbed by special factors, such as political reasons, natural disasters and events with great social influence [6]. Therefore, it is suggested that we can refer to the previous experiments and use normalization to map the data to a specific range to remove the dimensions of data with different dimensions [7]. Usually transforming ranges are [0, 1] and [-1, 1], also the most familiar normalization approach is Minimum and Maximum normalization, and the formula is as follows [4].

$$Xnew = \frac{X - Xmin}{Xmax - Xmin} \tag{2}$$

Doing so can induce the distribution of sample data, accelerate the convergence of training and improve the ability of the model [8].

4.2. Conclusion and prospect

The results illustrate that the BP model is reliable because most of the error rates are above 0%-1.5%. Secondly, we can build a hybrid neural network model, such as adding a convolutional neural

network, and give full play to the advantages of each model to achieve more accurate prediction. Therefore, according to macroeconomic theory, the trend of RMB exchange rate affects the price of international trade in China. If exchange rate rises, exports will be encouraged, because export prices will fall, and the competitiveness of China's goods and services will be enhanced. It is important to note that short-term forecasting models can be used as a reference, minimizing losses rather than as a tool for individuals to pursue short-term speculative interests.

Authors Contribution

Bowei Zhang not only contributed to Conceptualization, Methodology, Programming and data curation. But also writing-original draft, modification, Verification and giving suggestion. Rouye Chen contributed to data collection and conclusion.

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