Future Generation Computer Systems 115 (2021) 872–879

Contents lists available at ScienceDirect

Future Generation Computer Systems

journal homepage: www.elsevier.com/locate/fgcs

The application research of neural network and BP algorithm in stock price pattern classification and prediction

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ARTICLE INFO

Article history:
Received 15 July 2020
Received in revised form 3 October 2020
Accepted 11 October 2020
Available online 13 October 2020

Keywords:
Neural network
BP algorithm
Stock price prediction
Stock price pattern classification

ABSTRACT

Under the background of big data and Internet finance, quantitative investment is becoming more and more critical, and the prediction of the stock price has become the focus of investors' concern and research. The purpose of this work is to apply neural network and BP algorithm onto the classification and prediction of stock price patterns. The method is to use the BP algorithm neural network for the transaction data of 5 consecutive days as input samples, so there are 20 input layer nodes. The final value of the next day is used as the output sample, and the number of nodes in the output layer is 1. The purpose of network training is to find 20 spline functions. After the training of the BP algorithm neural network, the test data (stock price data for 5 consecutive days) independent of the training data is leveraged as the input of the neural network, and the closing price of the next day is used as the target output of the network. Through the error between the actual output and the target output, the stock price prediction performance of the network model is analyzed. The results have shown that the prediction accuracy of the stock price is 62.12% under the prediction of deep learning fuzzy algorithm and 73.29% under the prediction of the BP algorithm neural network. When the prediction range is between 15 days, the error of 30 prediction values relative to the real value is within $\pm$ 10%, accounting for 90% of the total days, and the prediction effect is the best. By analyzing the prediction of the number of hidden layers on the stock price and different ranges, it can be concluded that the prediction of the stock price trend prediction model of BP algorithm neural network is better than that of the deep learning fuzzy algorithm prediction model. This algorithm provides investors with a certain value for stock forecasting, which makes government gain a more active position in macroeconomic regulation and control.

1. Introduction

With the development of research on stock market rules, most stock market prediction models are generated, which are suitable for the actual investment activities. These forecasting models and methods can clarify the operation rules of the stock market to a certain extent. However, due to the structural uncertainty of the stock price system itself and the complexity of external economic environment factors, the forecasting work of the stock market will be challenging. Part of the results of the forecasting models and applications currently used are not satisfactory to investors.

With the rapid development of artificial intelligence and computer technology, the stock market forecasting model is continuously updated and integrated. The principle of the neural network is to model according to the internal mechanism of internal data, which is widely used in pattern recognition, intelligent control, signal processing, and other fields, and has achieved amazing results. Therefore, the artificial neural network is used to predict the stock price. In the prediction of the nonlinear system of the stock market, the rationality and applicability of the model construction have its advantages, which can provide the nonlinear prediction system for the stock market and theyrovide a wider space for development.

For the prediction of the stock market, Kim et al. proposed a new long-term and short-term mixed memory (LSTM) model to predict the change of stock price. Using Kospi 200 index data, the authors found a hybrid model composed of LSTM and 1–3 GARCH models. The performance of each model was compared with the existing methods. The performance was also compared with the proposed hybrid LSTM model. It was found that gew-slstm is a hybrid model composed of the LSTM model and three GARCH models, and its prediction error is the lowest in terms of mean absolute error, mean square error, heterodispersity adjusted Mae and Hetero dispersity adjusted MSE. By combining the neural network model with a single econometric model and multiple econometric models, their model greatly improves the existing

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https://doi.org/10.1016/j.future.2020.10.009
0167-739X/

prediction performance. Finally, his method can be used as a comprehensive model including time series model and neural network model to expand to various fields, or as a comprehensive model to predict the volatility of the stock market. The accuracy of this method is low and shown in Ref. [1]. Putrier believed that in securities investment, the management of investor funds can be regarded as a dynamic optimal control problem. To optimize the capital structure of investors, investors must predict the stock price dynamics of the portfolio. Author used the ARIMA Kalman filter to predict the daily share price of the portfolio. Next, the return value of the stock price was calculated according to the stock price forecast. Authors tried to use model predictive control (MPC) to solve combinatorial optimization problems. If we use the MPC algorithm to get the best controller, we can get the best combination management strategy [2]. Kuang Y, Singh R, Singh S, et al. A novel macroeconomic et al. proposed a new macroeconomic prediction model based on improved multimedia support BP neural network model and Ariko algorithm. The choice of fault prediction technology is limited and the prediction technology is uncertain, so the model mainly focused on the following two aspects. The uncertainty of the selection error of the prediction method is more prominent. The possibility of a wrong prediction method leading to a correct prediction result is minimal. Limitations of prediction methods. It does not depend on which prediction method has applicable conditions It is neither robust nor static. Thus, to improve the previous methods, it is needed to study the updated technology. He used Ant Colony Algorithm to change the BP model and continues to predict points appropriately, which refers to fixed value prediction. The practicability of this method is not reliable [3].

This study first introduces the stock market and its basic terms in detail, then classified the methods and difficulties of stock forecasting, lists three kinds of stock price forecasting methods, i.e. time series method, securities investment analysis method and artificial intelligence forecasting method. Three forecasting difficulties influencing factors, i.e. internal factors, fundamental factors, and policy factors. Then, the BP neural network and its mathematical model are described, including the formula of weight adjustment, algorithm derivation, and so on. At the same time, experimental modeling is carried out in this study. After the completion, the data are simulated and analyzed, and the results have been obtained. Through the analysis of the number of hidden layer to the stock price prediction, the analysis of BP algorithm and fuzzy algorithm to the stock price prediction, the comparative analysis of the errors of different algorithms and the analysis of the prediction effect of different ranges. This study demonstrates the validity and superiority of the prediction model of the BP algorithm neural network in this study.

2. Prediction of stock price model and BP algorithm

2.1. Basic terms of stock

(1) Opening price: also known as the opening price of the market, it is the price at which one shares is traded as a unit after the centralized bidding process before the market [4].

(2) Closing price: originally refers to the last trading price of the stock. At present, the closing prices of Shanghai and Shenzhen stock markets are weighted average prices. This refers in particular to the weighted average price of all transaction prices one minute before the last transaction [5].

(3) Lowest price: refers to the lowest value of all trading prices of stocks on that day.

(4) Maximum price: refers to the highest value of all trading prices of shares on the day.

(5) Transaction amount: from the formula, it is equal to the transaction price multiplied by the corresponding quantity. Another form of currency, representing the total sales of shares [6,7].

(6) Trading volume: the total number of shares traded on that day. The minimum unit is 1 batch (100 shares).

(7) Up and down: through the closing price of the stock price for two consecutive days, to judge whether the stock price is significantly up or down, the latest closing price will rise when it is higher than the previous closing price, otherwise it will fall [8].

(8) Pressure point: this means that the stock price stops rising after reaching a certain point in the rising process, which is called pressure point.

(9) Support point: this means that the stock price continues to fall, reaches a specific position, and stops falling, then rises, which is called the support point [9].

(10) K line: it is an analysis chart of specific changes in stock price during the unit period. This is an essential reference for short-term investors to analyze stocks, with specific technical requirements.

2.2. Stock market

The stock market is the issuing and trading market, which includes the issuing market and the circulation market. The circulation market is the so-called issuing market, and the circulation market refers to the circulation market. A company limited by shares can raise a lot of capital quickly by issuing shares to the society. This is used to expand the scale of the business. People who invest in stocks are reluctant to share the risk of enterprise development and expansion, because they want the value of the invested capital [10,11].

Introduction to primary and secondary markets:

The primary stock market is also known as the issuing market. Enterprises that need funds can issue a limited number of shares, so that investors can choose to buy necessary funds. Companies that issue stocks usually sell stocks not directly to ordinary investors, but through intermediaries, i.e., securities brokers, so the primary stock market is also known as the brokerage market. The public offering method of listed companies is called a graveyard, which is the public offering of the market. The method of issuing shares to specific objects is called a private offering, that is, a non-public offer [12].

The secondary market circulation market provides a trading place for issuing stocks, which is a stock trading place. Because the secondary market provides liquidity for stocks, investors can cash at any time, so stockholders can cash at any time. Hence, the secondary market has the function of price setting. The main functions of the secondary market include: absorbing idle private funds for the development of enterprises and effectively guiding the flow of funds. It is also the primary function of the market economy. The secondary market reflects the social and economic situation and provides the basis for the formulation of national policies. The secondary market and primary market promote and restrict each other. According to type, quantity, and method of the stocks issued in the circulation market, the structure of the securities circulating in the secondary market is determined. As a stock exchange, the secondary market promotes and promotes the development of the primary market. Through reasonable organization and high-quality service, the stocks in the circulation market can be effectively distributed and transferred, making investors more suitable for circulation [13,14].

2.3. Prediction method of stock market

(1) Time series method

The time series method is a statistical relation model that combines stock price index with time-series framework. The classical models include the RW model (complete random model), and ARIMA model (autoregressive moving average model). In the time series method (uniform instability model), according to the variables contained in the model, it is used to distinguish the single variable and the multivariable of the measurement method. For the decision of the multivariable model and the selection of parameters, a lot of complex data analysis is needed. Empirical evidence shows that the time series method may have a good impact on short-term stock price prediction. However, if the prediction period is very long, the prediction accuracy of the time series model will continue to decrease [15].

(2) Analysis method of securities investment

The methods of securities investment analysis are usually divided into two types: basic analysis and technical analysis. The technical analysis method mainly refers to deciding whether to buy or sell stocks according to the short-term trend of the stock investment market, and the basic analysis method mainly determines the stock investment based on the overall external environment [16]. Fundamental analysis is mainly to study various factors of supply and demand in the stock investment market and comprehensively judge the stock price. The technical analysis mainly investigates the influence of the past and present changes of the stock market on the future price trend of the stock market, and uses various economic mathematical models to predict the future of the stock market by taking the past and present data of the stock market as the survey samples, which is a kind of price change analysis. Technical analysis methods include moving average method, K-line chart analysis method, point and number analysis method, histogram analysis method, trend analysis method, shape analysis method, angle analysis method, golden section spiral calendar method, incredible series, four-dimensional space method. The basic method to wait for the above-mentioned technical analysis methods is chart information. When choosing the influencing factors in the analysis chart, user mainly deal with them through subjective judgment and rely too much on the subjective experience analysis method. In the complex stock price forecasting, the reliability of this method is questioned.

(3) Artificial intelligence prediction method

In recent years, with the rapid development of artificial intelligence theory and algorithm, BP neural network is undoubtedly hot research in the application of neural networks to stock price prediction. In the field of finance, many scholars in Europe and America have studied and applied neural networks [17].

2.4. Difficulties in stock price prediction

Its price usually determines the price of a stock, but it is also affected by many factors such as market sentiment and market trends. We can often see that there is a big deviation between the stock price and the price, which is mainly affected by the relationship between supply and demand. In the bullish market, investors tend to exaggerate blindly, resulting in the stock price exceeding its value many times. Similarly, in the bearish market, due to the pessimistic expectations of investors, the stock market continues to be depressed, and the share price is lower than the net asset per share. The supply–demand relationship is the cause of the stock price. It is influenced by many factors such as internal market factors, basic factors, policy factors [18,19].

(1) Market internal factors

The internal cause of the market is the supply and demand of stocks, that is, the relationship between the total number of stocks issued and the capital expected to invest in the stock market. If the stock system is expanded indefinitely, the value of the issued stock will be correspondingly reduced. Therefore, the government spent a lot of time to investigate the impact of the number of shares issued on the whole stock market and the national economy, and mastered the pace of IPO [20].

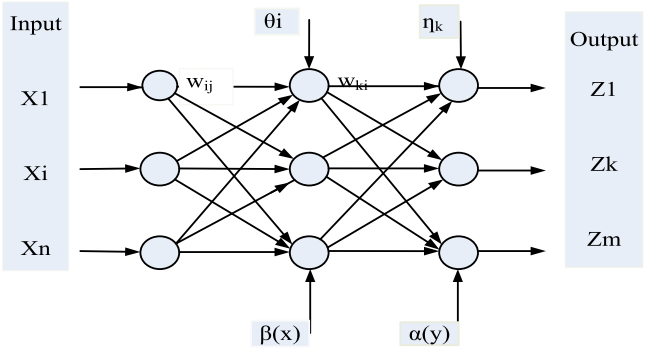

Fig. 1. Topology of a typical three-layer BP neural network.

(2) Fundamentals

Fundamentals are part of the analysis that are being paid attention by investors. If it is not clearly understood the industry, major businesses, interests, and other important information of the investee companies; it is not easy to judge the value of the company. The so-called fundamentals mainly refer to the macroeconomic factors and internal factors of the company. Macroeconomic factors mainly include interest rate, fiscal revenue and expenditure, money supply and demand, and residents' income. The company's internal factors refer to the company's interests, liabilities, cash flow, and strategic policies [21,22].

(3) Policy factors

The policy factor refers to the corresponding adjustment made by the state in response to various economic conditions. These policies often directly or indirectly affect the operation of listed companies and the whole stock market. Although it is essential for investors to study national policies, there are relatively few investors with high research capacity [23].

The capital market is an absolute interest seeking place. In the past 100 years, professional investors have summed up many advanced investment concepts and methods. The most striking one is the value investment school represented by Buffett. Among the investment operators, the annual profit margin is more than 20%. In addition, there are also many colleges based on Taoist theory that mining historical data rules to predict the future trend of the stock market, and many investors who have obtained great benefits. There are also institutional investors using mathematical methods for quantitative analysis of the stock market. Even if there are a few people who can get rich returns in the market, they still cannot accurately predict the trend of long-term stock prices. Therefore, it is difficult to predict the stock market [24].

2.5. Overview of BP neural network

BP (back propagation) network is a neural network learning algorithm. The neural network is composed of the input layer, output layer, and hidden layer. The hidden layer contains at least one layer, usually more than three network mechanisms. Show the basic 3-layer neural network model. As shown in Fig. 1, the topology of a typical three-layer BP neural network is shown.

The learning process of the BP neural network has two parts: the forward propagation of the signal and the backpropagation of error. The input sampling signals are transmitted in the order of

the input layer, hidden layer and output layer. Finally, the actual output is compared with the teacher signal. When the difference is large, the error will be backpropagation, and the error will be distributed to each node of each layer to generate the error signal of each node. The neural network will change the weight value of each node on this basis. The weighted correction process will continue to cycle, and the network learning and training process will continue until the final error reaches an acceptable range or reaches a predetermined number of learning times [25].

2.6. Mathematical model of BP neural network

(1) Basic model

For the three-layer BP neural network mathematical model, the following assumptions are made: the input vector of the model is $X = (x_1, x_2, \ldots, x_i, \ldots, x_n)^T$; the output vector of the output layer is $O = (o_1, o_2, \ldots, o_k, \ldots, o_l)^T$; the output vector of the hidden layer is $Y = (y_1, y_2, \ldots, y_j, \ldots, y_n)^T$; the expected output vector is $d = (d_1, d_2, \ldots, d_k, \ldots, d_l)^T$; $V = (V_1, V_2, \ldots, V_j, \ldots, V_m)$ is the weight matrix from the input layer to the hidden layer, $W = (W_1, W_2, \ldots, W_k, \ldots, W_l)$ is the weight matrix from the hidden layer to the output layer; V_j is the weight vector corresponding to the jth neuron in the hidden layer; W_k is the weight vector corresponding to the kth Shenjing element in the output layer.

For the output layer, the following equation exists:

$$o_k = f(net_k), k = 1, 2, \ldots, l \tag{1}$$

$$net_k = \sum_{j=0}^{m} w_{jk} y_j, k = 1, 2, l \tag{2}$$

For hidden layers, the following equation exists:

$$y_j = f(net_j), j = 1, 2, m \tag{3}$$

$$net_j = \sum_{i=0}^{n} v_{ij} x_i, j = 1, 2, \ldots, m \tag{4}$$

Set the transformation function f (x) as unipolar sigmoid function

$$f(x) = \frac{1}{1 + e^{-x}} \tag{5}$$

By derivation, we can get:

$$f'(x) = f(x)[1 - f(x)] \tag{6}$$

The above formulas constitute the basic model of three-layer BP neural network.

(2) Network error and weight adjustment

The final output error is defined as follows:

$$E = \frac{1}{2}(d - O)^2 = \frac{1}{2}\sum_{k=1}^{l}(d_k - o_k)^2 \tag{7}$$

If the error definition is expanded to the hidden layer, then:

$$E = \frac{1}{2}\sum_{k=1}^{l}[d_k - f(net_k)]^2 \tag{8}$$

Push back to the input layer, then:

$$E = \frac{1}{2}\sum_{k=1}^{l}\{d_k - f[\sum_{j=0}^{m} w_{jk} f(net_j)]\}^2 \tag{9}$$

The network error is a function of the weights w_{jk}, v_{ij} of each layer, so the error can be reduced by modifying the weights. To reduce the error continuously, the adjustment size of the weight should be in direct proportion to the decrease of the error gradient, namely:

$$\Delta w_{jk} = -\eta \frac{\partial E}{\partial w_{jk}}, j = 0, 1, 2 \ldots n; k = 1, 2, \ldots, l \tag{10}$$

In the formula, the negative sign represents the gradient decline, and the constant $\eta \in (0, 1)$ represents the scale coefficient, which is often called the learning rate of the neural network.

(3) Derivation of BP algorithm

The formula of weight adjustment of the three-layer BP algorithm is deduced.

$$\Delta w_{jk} = -\eta \frac{\partial E}{\partial w_{jk}} = -\eta \frac{\partial E}{\partial net_k} \frac{\partial net_k}{\partial w_{jk}} \tag{11}$$

An error signal is defined for the output layer and the hidden layer respectively, so that:

$$\delta_k^o = -\frac{\partial E}{\partial net_k}; \delta_j^y = -\frac{\partial E}{\partial net_j} \tag{12}$$

$$\Delta w_{jk} = \eta \delta_k^o y_j; \Delta v_{ij} = \eta \delta_j^y x_i \tag{13}$$

For the output layer, expand to:

$$\delta_k^o = -\frac{\partial E}{\partial net_k} = -\frac{\partial E}{\partial o_k}\frac{\partial o_k}{\partial net_k} = -\frac{\partial E}{\partial o_k} f'(net_k) \tag{14}$$

$$\frac{\partial E}{\partial o_k} = -(d_k - o_k) \tag{15}$$

Comprehensive:

$$\delta_k^o = (d_k - o_k) o_k (1 - o_k) \tag{16}$$

Formula (16) is the final derivation formula of two error signals. Combining formula (13) and formula (16), the weight adjustment formula of BP learning algorithm of three-layer network is obtained as follows:

$$\begin{cases} \Delta w_{jk} = \eta \delta_k^o y_j = \eta (d_k - o_k) o_k (1 - o_k) y_j \\ \Delta v_{ij} = \eta \delta_j^y x_i = \eta \left(\sum_{k=1}^{l} \delta_k^o w_{jk} \right) y_j (1 - y_j) x_i \end{cases} \tag{17}$$

3. Construction of stock price trend prediction model

3.1. Data set

The experimental data is collected from the stock market database from August 12, 2019, to December 12, 2019, and collected randomly the stock price information of more than 58 000 per minute by Gree Electric (Stock Code: 000651), Maotai (Stock Code: 600519) of Shanghai mainboard and BYD (Stock Code: 002594) of small and medium-sized boards, with the opening price, closing price and maximum price of three stock prices High value, minimum value and trading volume are the main stock price trends. Feature extraction these information functions can be used to reflect the trend of the stock price. Therefore, five information are selected as the input of the prediction model in this paper. Considering the amount of data, a prediction model is set up to predict the stock price trend with five information amounts of the initial 10 points and 11 points. Fig. 2 shows the stock price trend of a company.

3.2. Data analysis

The input variables used in the experiment are n-day profit rate, price yield, price to book ratio, maximum price, minimum price, opening value, closing value, K value, D value, J value of KDJ indicator, etc. The values of these indicators are described in the selection of the first sample in this chapter. The forecast process

Fig. 2. Stock price trend.

is the input index value of the past n trading days. After the network model passes BP, the output value will be generated. This output value is the forecast value in the following table. The input variables of the second comparative experiment are the highest value, the lowest value, the starting value, the ending value, the K value, the D value, and the J value. That is to say, the value index of Experiment 1 is deleted. The prediction process is the same as the initial experiment, and a series of predicted values will be obtained later. Finally, the results of the two experiments are compared by error analysis.

3.3. Establish BP algorithm neural network prediction model

The BP algorithm neural network used has an input layer and output layer. Next, five consecutive days of transaction data will be used as input samples, so there are 20 input layer nodes. The final value of the next day is used as the output sample, and the number of nodes in the output layer is 1. The purpose of network training is to find 20 spline functions ($I = 1, 2, \ldots, 20$) set to 1/20 of the average distribution.

3.4. Simulation prediction

After the training of the BP algorithm neural network, the test data independent of the training data (stock price data for 5 consecutive days, etc.) is used as the input of the neural network, and the closing price of the next day is used as the target output of the network. The prediction performance of the network model is analyzed by the error between the actual output and the target output. Here the sum of squares of the errors is used as the analysis index.

4. Prediction and analysis of stock price based on BP algorithm of neural network

4.1. Analysis of the number of hidden layers on the prediction of stock price

The data collection interval is expected to be 5 min, and the 30-min stock price information data of Gree Electric from December 10, 2019 to December 10, 2019 will be randomly intercepted. Table 1 shows the share price information of Gree Electric.

Table 1 and experimental results show that if three hidden layers are used, the prediction accuracy of the network model is 56.17%. The selected training sample data is imported into the

Table 1
Price information data of Gree Electric.

Time	Starting price	Maximum price	Minimum price	Closing price	Volume
09:40	25.95	26.06	25.95	26.05	1 950 753
09:45	25.91	25.92	25.79	25.8	3 098 312
09:50	25.96	25.96	25.93	25.93	803 555
09:55	26.11	26.11	26.07	26.08	1 133 100
10:00	26.01	26.03	26	26.01	664 900
10:05	26.1	26.13	26.1	26.12	826 510
10:10	25.95	25.96	25.9	25.92	1 364 700

depth configuration network model, which contains only four hidden layers for training. Then the parameter training is completed according to the modeling method. After in-depth training of the network model, finally, input the inspection sample data of green to predict the stock data, and the prediction accuracy of the model can be found. The experimental results show that when four hidden layers are used, the prediction accuracy of the BP neural network model is 59.73%. The selected training sample data is imported into the BP neural network model, including only five hidden layers for training representation. When using five hidden layers, the prediction accuracy of the network model with high reliability is 63.41%.

If the model is built according to this research method, the experimental results of setting the number of hidden layers show that the prediction accuracy of the BP algorithm neural network model with five hidden layers is excellent. So far, this research is based on the trend prediction model of stock price prediction based on neural network. Among them, the input layer inputs 50 (5 * 10) in total, in the order of time per minute. There are three neurons in the output layer (not up, down, up, down). The number of hidden layers of the network model is 5. The number of neurons in each layer is 150, 100, 60, 40, 20.

4.2. Analysis of BP algorithm and fuzzy algorithm for stock price prediction

The selected training sample data is imported into the BP algorithm neural network prediction model of this paper for training, and compared with the deep learning fuzzy algorithm for training. According to the modeling method, the parameters are trained in turn. After configuring the network model in training depth, input the following content at last. Test the sample data of stock data prediction to find out the accuracy of model

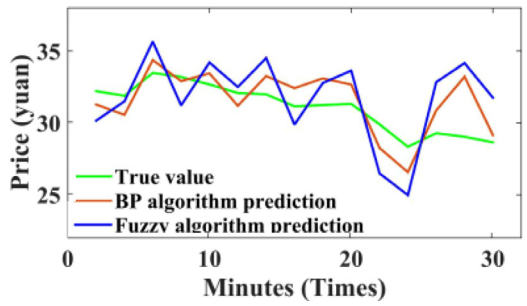

Fig. 3. Prediction results of two algorithms.

prediction, as shown in Fig. 3 is the prediction result chart of two algorithms.

It can be seen from Fig. 3 that the actual price fluctuates between 28 and 34. Although the prediction results of the BP neural network algorithm will vary greatly, there will be specific errors. The prediction result of deep learning fuzzy algorithm is more significant, more prominent, and chances of error is high.

The results show that the prediction accuracy of the prediction model based on deep learning is 62.12%, and that of the prediction model based on the BP algorithm neural network is 73.29%. The training sample data of the selected deep learning fuzzy algorithm is imported into the prediction model of the BP algorithm neural network for training, and the parameter training is completed in turn according to the modeling method. After training the deep reliability network model, input the BYD test sample data.

Compared with the effect of the model, the accuracy of Gree Electric Appliance Based on the prediction model of deep learning is 62.12%, and the accuracy of the prediction model based on BP neural network is 73.29%. Therefore, the prediction effect of the BP algorithm neural network model is better than that of deep learning fuzzy algorithm model.

4.3. Error comparison and analysis of different algorithms

When n is 5, the model uses each indicator value within 5 days to predict the closing price of the next day. There are currently 46 input variables. Five opening prices, five closing prices, the five highest prices, five lowest prices, 5K values, 5D values, 5J values, and five dynamic price returns-value, five dynamic prices to book ratio and one profit margin value. The output variable is the closing price of the next trading day. The number of hidden layer nodes is 7.

A problem was found in the training process: the smaller the given fitting error, the better the final prediction result. This is because if the wrong setting is allowed to be too small, the model will lead to overfitting, and the final prediction result is far from the real value. With the increase of the given error, the final prediction error will first decrease and then increase. That means there is the most suitable specified permissible error that can minimize the prediction error without changing other conditions. To find the relative optimum value, some experiments have been carried out to adjust the allowable error ε from 0.01 to 0.7. Table 2 is the error comparison table.

MAE is the average absolute error of the final predicted price and the actual price, MSE is the mean square error of the predicted price and the actual price. It can be seen from the table that when the allowable error ε is 0.4, Mae and MSE are both the minimum, and when n = 5, 0.4 is the best allowable error value. As shown in Fig. 4, the error comparison analysis diagram of the two algorithms is shown.

Table 2
Error comparison table.

Time	ε	mae	mse
0	0.01	11.51	157.81
5	0.05	9.63	126.84
10	0.1	7.15	71.65
15	0.2	4.46	29.21
20	0.3	2.14	9.39
25	0.4	0.89	1.76
30	0.5	1.17	2.54
35	0.6	1.79	3.68
40	0.7	2.56	7.95

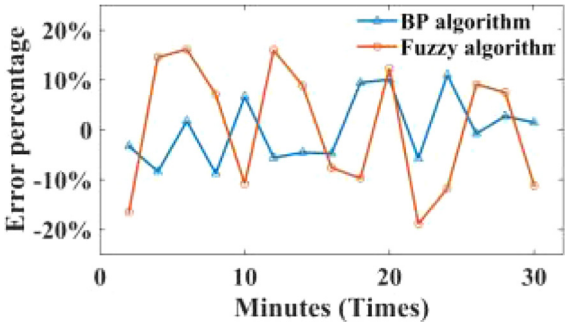

Fig. 4. Error comparison analysis of the two algorithms.

From Fig. 4, it can be seen that the error variance of the BP algorithm neural network prediction model is small minimal, and it tends to become 0, the highest is only 10%, and most of them are within 10%. The maximum error of the fuzzy algorithm based on deep learning is 20%, and the fluctuation range and fluctuation range are not within 10%. The advantages and functions of the two algorithms can be easily found.

4.4. Analysis of prediction effect in different ranges

When fitting the closing price with 7-day information, the prediction error of 5% days is 43% of the total days, and the prediction effect is much better than that of n = 5. Tian's stock price information cannot fully represent the process of stock price change.

In the case of n = 10, the number of 30 predicted values for the true value is within ±10%, 25, accounting for 83% of the total days. There are 15 errors within ±5% of the total number of days, the prediction effect is further improved, and the number of days within 5% of the error range reaches 50%.

When n = 15, the number of 30 predicted true values is within ±10% of 27, accounting for 90% of the total days. There are 17 errors within ±5%, accounting for 56% of the total days. The predicted result is slightly better than that of n = 10.

When n = 20, the number of 30 predicted true values is within ±10% of 26, accounting for 86% of the total days. There are 15 errors within ±5%, accounting for 50% of the total days. The prediction results show that the outcome of n = 15 is slightly worse, the greater n is, the higher the prediction effect is, and N is also the best value. As shown in Fig. 5, the comparison of different n-value prediction results is shown.

When n increases from 5, the prediction accuracy will decrease after the initial increase. When n = 15, the maximum relative value will be reached. Then, through several experiments to confirm the prediction results of n = 14 and N = 16, it is found that the result is slightly worse than that of n = 15. In this prediction model, n = 15 is the best value.

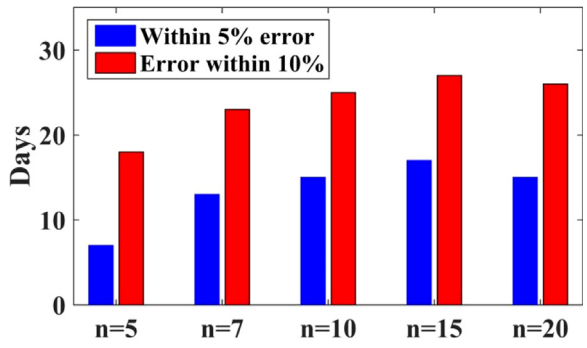

Fig. 5. Comparison of different n-value prediction results.

By comparing the training steps and errors, it can be judged that the number of nodes in the hidden layer is 4. After determining the parameters and structure of the model, we started the stock price training and prediction of Gree Electric and Guizhou Moutai. If the index value in the past 15 days is used as the input variable of the model, and the closing price of the next day is predicted, the effect will be the highest. In addition, the combination of value indicators and technical indicators as input variables is better than only one type of indicator.

5. Conclusion

In recent years, the application of artificial neural networks in the field of finance has become a research hotspot. In particular, BP neural network, which is mature and widely used, has the function of approximating complex continuous functions that many traditional methods cannot use. Compared with the prediction accuracy of the fuzzy algorithm based on deep learning, the neural network prediction model of the BP algorithm in this study has the experimental conclusion that the prediction accuracy of the fuzzy algorithm based on deep learning is lower than that of the neural network based on BP algorithm.

In the past technical analysis methods, if we predict such a nonlinear stock price, satisfactory results cannot be obtained in most cases. The BP neural network model used in this study is based on the premise of fully using the BP algorithm to improve the training speed. A stock price index is an experimental object. It forecasts the closing price of the next 30 days and achieves a satisfactory result. Therefore, the simulation experiment shows that the neural network stock price prediction method optimized by the BP algorithm has a specific value. The trained BP neural network has a certain prediction effect and can provide investors with the function of stock price prediction.

The prediction accuracy of this study is better than that of other algorithms, but there is still room for improvement. In the next step, research of more stock technical indicators are improved and find out the relationship between indicators and prediction accuracy. Further, improve the prediction accuracy of the law. In the process of forecasting the stock price with the help of a neural network system, this study is only in an ideal state. It does not consider other external factors such as economic development momentum, government policy factors, other emergencies and so on. In fact, in a certain period, these external factors have a great impact on the stock price.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

This work was supported by Heilongjiang Province Philosophy and Social Science Fund Project: Research on the Performance and Influencing Factors of Grain Subsidy Policy in the Agricultural Comprehensive Reform Experimental Area of Liangjiang Plain in Heilongjiang Province (17JYC144). Youth Innovative Talents Training Program in General Undergraduate Colleges and Universities in Heilongjiang Province: Research on the Development of New Rural Cooperative Financial Organizations in Major Grain Producing Areas Based on Farmers' Perspective (UNPYSCT2017203). Harbin University of Commerce School-level Project: Research on the Development of New Rural Cooperative Financial Organizations in Heilongjiang Province Based on Farmers' Perspective (17XN050). Heilongjiang Province Philosophy and Social Science Fund Project: Research on the coordination of grain production and farmers' income in Heilongjiang Province Based on the perspective of targeted poverty alleviation (18JYE669). Youth Innovative Talents Training Program in General Undergraduate Colleges and Universities in Heilongjiang Province (UNPYSCT2018125). Harbin University of Commerce School-level Project (17XN049). Special support project for postdoctoral in Heilongjiang Province (LBH-Z19073).

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