Survey on Stock Prediction Based on Deep Learning

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Abstract. Stock prediction has always been a hot topic in the field of research. In the present era,along with the Internet rapid development,all kinds of complicated information are easy to affect the accuracy of people's judgment. Therefore, how to establish a stock prediction model with both accuracy and computing speed is of great importance to investors. Researchers are committed to the exploration of the stock market, looking for the development law of the market for stocks, in order to realize the purpose of grasping the law of the equity market in advance. This paper conducted a comprehensive study on various stock prediction models, introduced the time series based model, long short-term memory network model, convolutional neural network model, radial basis network model, back propagation neural network model, support vector machine model and combination model, and introduced the advantages and disadvantages of each model. It also makes a comprehensive summary and outlook on the stock forecasting methods, and provides an accurate and powerful judgment for the majority of investors.

Keywords: stock forecast; neural network; deep learning; machine learning

1 Introduction

With the rapid increase of the economy, more and more people have begun to devote themselves to the stock industry for stock trading. However, stock trading is uncertain, and both returns and risks coexist. If investors do not understand the rules and invest at will, it will bring incalculable losses. If you can predict the direction of the stock market in advance, you can get a high rate of return for investors. Therefore, stock predictions are crucial for investors. It is a difficult task for researchers to build a model with accurate predictions, fast and efficient.

For a long time, scholars in the fields of mathematics, finance and computer have made considerable contributions in the field of stock prediction, including that researchers only used historical data to forecast stocks at the beginning, ignoring factors that could lead to stock price fluctuations, such as the sentiment of shareholders, the policies of the stock market, interest rates, principal, etc. With the continuous progress of big data technology, methods based on neural networks, machine learning and deep learning have shown great advantages in the field of stock prediction.

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2 Single model

2.1 Time Series

Stock data has the property of time series, and time series analysis reveals the law of historical data changes with time. The characteristics of time series are that its value has a certain sequence and randomness. The time series models mainly include the autoregressive moving average model ARMA, the differential integrated moving average autoregressive model ARIMA, the autoregressive conditional heteroscedasticity model ARCH and the generalized ARCH model GARCH. The ARMA model is proposed for the stationary time series, and the financial data is not stationary, so the ARIMA model is introduced. ARCH model was first proposed by Professor Robert Engel [1] in 1982, which can simulate the change of the volatility of time series variables. On the base of ARCH model, the GARCH model is proposed, which shows great advantages in describing the change law of yield fluctuation with time.

Li Xiuqin and Liang Manfa [2] used ARIMA model to predict the closing index in April 2006, and confirmed the use of time series. It is feasible for ARIMA model to predict the stock market. Mamun Miah [3] applied the generalized autoregressive conditional heteroscedasticity (GARCH) model with different lags to model the stock return volatility and found that the return sequence of DSE was not normally distributed. From the value of high excess kurtosis, it can be seen that the DSE return sequence also exhibits volatility clustering and fine kurtosis. In other words, GARCH (1,1) performed best in modeling the simulating of DSE stock returns. Murat [4] introduced two different volatility prediction methods. The performance of one month out of sample volatility prediction by (MIDAS) and GARCH, two statistics-based models with mixed data sampling, was evaluated.

2.2 Long Short-Term Memory

In 1997, Hochreiter and Schmidhuber [5] raised the LSTM neural network model and conducted research on it. LSTM (Long Short-Term Memory) is a long short-term memory neural network, a temporal recurrent neural network, which is an improvement on the basis of RNN model. There are three main stages in LSTM: forget stage, select memory stage and output stage. The basic structure of the Forget phase LSTM is to store data in a memory. When the data is read, it deletes the unimportant content from the memory, and no data is lost. Select the memory stage, in which the amount of information entered into the system is continuously reduced, while the output is dynamically adjusted as required of the user to accomplish the desired goal. The output phase refers to the information stored in the system is sent to the outside world. The transmission state is controlled by gating state, which can avoid the problem of gradient disappearing and gradient explosion during the main long training sequence. LSTM can remember the state of the network between forecasts and is suitable for classification of sequence and time series data, where the network prediction or output must be based on a memorized sequence of data points. By changing the hidden nodes in the common recurrent neural network to self-cyclic form and maintaining the error flow to keep the memory unit, the effective information can be remembered for a long time, which has great application value in the stock prediction problem.

Chen Weihua [6] used the LSTM model to forecast the volatility of the market for stocks, and concluded that the LSTM model had the best prediction effect through experimental

comparison. Huang Chaobin and Cheng Shiming [7] used the LSTM neural network model to forecast and analyze the Shanghai Composite Index, and compared the forecast results with those of other models. Under the same sample data, the prediction effect of the LSTM model has obvious advantages. Huang Yucheng and Fang Weiwei [8] proposed a neural network model based on LSTM. If the length value of time series is too small, the forecast accuracy results will be reduced. Therefore, the appropriate time series length has a very important influence on the prediction accuracy of LSTM neural network model.

LSTM model is improved on the basis of RNN model. In the light of maintaining the applicability of RNN model to time series data, LSTM model effectively solves the problem of long-term dependence on time, thus improving the prediction accuracy of LSTM model. Although LSTM performs well in processing time series data, it still needs to improve further in stock forecasting.

2.3 Convolutional Neural Networks

In the 1960s, Hubel and Wiesel et. studied neurons with local sensitivity and directional selectivity in the cat cerebral cortex and found that their unique network structure can effectively reduce the complexity of the feedback network. Convolutional Neural Networks (CNNS) are proposed for the first time. As a feedforward neural network, convolutional neural network has more advantages than traditional machine learning methods. The biggest advantage of convolutional neural network is that more complex nonlinear relationships can be modeled by increasing the number of network layers [9].

Zhang Jingyi [10] proposed a convolutional neural network prediction model, and on this basis, ADX index was introduced to increase the convolutional neural network model, and the improved model was compared with the traditional BP neural network, MLP neural network and the improved convolutional neural network model. The results showed that The Convolutional neural network is feasible, effective and superior to the traditional BP neural network and MLP neural network in stock price forecast. Wang Yuxuan [11] reconstructed financial time series data to form one-dimensional images and found a convolutional neural network model with good relative returns.

2.4 Radial Basis Function

In the late 1980s, J. Mody and C.Darken raised the radial basis function RBF neural network [12], which is a single hidden layer feedforward neural network. RBF neural network can draw near any nonlinear function with arbitrary precision, and it has global approximation ability, and there is no local minimum problem. The topology of this neural network is simple and compact. RBF neural network has strong robustness and adaptability when dealing with complex environments, but its shortcomings are also obvious: when there is a large error or unknown coefficient between the input variable and the hidden node, the training set can not achieve the expected effect; The ability to identify different types of information is poor, which can not be applied to practical engineering.

Fu Chenghong, Fu Ming and Que Jianrong [13] proposed an individual the model of stock price evaluating based on RBF neural network and achieved good results. Yin Yue 'an [14] used RBF neural network to train stock index with an accuracy of more than 97%, and achieved satisfactory results in short-term stock prediction. Kan Ziliang [15] applied the RBF neural

network model to the practical question of share price prediction, and predicted the closing price of stocks with genetic algorithm GA and K-means clustering algorithm. In the simulated investment test of some stocks, the investment strategy and portfolio investment strategy are used, and the test results were analyzed. This result show that this strategy can not only effectively increase the return of the stock market, but also effectively reduce the risk of the stock market. The universality of this forecasting method to solve the problem of stock price forecasting is verified.

2.5 Back Propagation Neural Network

In 1986, Rumelhart and McCelland proposed the BP neural network (backpropagation neural network), a multi-layer feedforward neural network whose training process uses the error backpropagation algorithm. BP neural network is composed of input layer, hidden layer and output layer. Its advantage is that it has strong nonlinear mapping function and flexible networking architecture. The neural network using BP algorithm can improve the accuracy with fewer iterations [16]. However, BP neural networks tend to fall into local minima, which is only one of them, as well as other shortcomings such as long training time, slow convergence speed and insufficient diversity of network structure selection.

Chu Wenhua [17] established a BP neural network model with three-layer data structure and selected appropriate data to increase the accuracy of stock prices in the short term. Wang Xiaodong, Xue Hongzhi and Jia Wenchao [18] proposed a prediction model for the rise and fall of multiple stocks based on BP neural network. Matthew Dixon, Diego Klabjan, and Jin Hoon Bang [19] used the BP neural network model to demonstrate their application in simple trading strategy backtesting of 43 different commodity and foreign exchange futures midprices at 5-minute intervals.

2.6 Support Vector Machines

In 1995, Corinna Cortes and Vapnik first proposed the Support Vector Machine (SVM) theory. It has excellent performance in dealing with small amounts of data, complex nonlinear data and high-dimensional pattern recognition. Support vector machines do not scale well in terms of sample size, and when the data volume is too large, they may face challenges in terms of runtime and memory usage. Another disadvantage is that the choice of kernel functions and parameters is very careful.

Li Jia-hao [20] proposed a support vector machine model to make an empirical prediction and analysis of China's stock development. Ma Yaolan [21] used the support vector machine method to establish a stock investment prediction model, conducted comparative experiments, and used the confusion matrix as the representation of classification rule features, and derived that the forecast accuracy and error rates of the decision tree model and the SVM model were the same, while the forecast accuracy rate of the BP neural network model was relatively low and the error rate was relatively high. Support vector machine can be used to screen out high quality stock prediction models, which has been proved to be scientific and feasible by experiments. Ding Yuxin [22] conducted SVM modeling analysis on the six pre-treated stocks, and found that the model fit was good by comparing mean square error, mean absolute error and rise and fall accuracy. Xiao Peng [23] proposed that the method of support vector machine can be applied to

stock prediction, which has good fitting degree and generalization ability, and has a satisfactory prospect.

3 Combination Model

With the in-depth study of stock forecasting, domestic and foreign scholars are no longer satisfied with a single model, because a single model has limitations and the prediction effect is not good. Researchers have begun to focus on combinatorial models, which can combine the respective advantages of multiple models to make predictions, reduce the sensitivity of a single model to data, simplify the process of model selection, and improve the accuracy of prediction results.

Deng Jiali, Zhao Fengqun and Wang Xiaoxia [24] combined MTICA algorithm with ACO-SVR prediction model to propose a new MTICA-ACO-SVR stock price prediction model, respectively using ICA-SVR model. The ICA-AELO-SVR model and the MTICA-AELO-SVR model predicted the closing price of the stock, and the prediction curve of the MTICA-AELO-SVR model was more similar to the true value curve. The results indicate that the model is an efficient and accurate stock price prediction model. Hu Di and Huang Wei [25] combined the nearest neighbor propagation (AP) algorithm with support vector machine (SVM) to propose a new cluster-based stock price rise and fall prediction method (AP-SVM). The results indicate that AP-SVM better than the traditional SVM method in terms of prediction accuracy. Xie Youyu and Wang Wanxiong [26] proposed an EMD-SSA-LSTM-SVR combined prediction model based on empirical mode decomposition (EMD) and singular spectrum analysis (SSA). The experiment shows that EMD-SSA-LSTM-SVR model has good forecasting performance for both the relatively stable yield series and the comprehensive index series with trend. Shi Jiannan, Zou Junzhong, Zhang Jian et al. [27] put forward a stock price forecast method based on dynamic modal decomposition - Long Short Term memory neural network (DMD-LSTM), and conducted price modeling prediction on fundamental data and modal characteristics. The results showed that the price forecast accuracy of DMD-LSTM model was higher than that of other single models. Zeng Lifang, Li Liping and Jiang Shaoping [28] combined genetic algorithm (GA) and BP neural network (GA-BP) to prediction the Shanghai Composite Index, and found that the GA-BP neural network model had smaller prediction error and better prediction effect than the BP neural network model. The price prediction accuracy of DMD-LSTM model is higher than that of other single models. Yang Yumeng [29], so as to solve the fluctuational problem of the complexity of the stock market price in different periods, a prediction and analysis model based on EEMD-GA-LSTM is proposed. The EEMD-GA-LSTM combinatorial prediction model proposed fully considers the nonlinear information of the sequence and the influence of model parameters on the prediction results. It can be found that the predicted value of the combinatorial model is closer to the real value through the model prediction comparison chart. The model can be well applied to the research of stock market, and can more accurately predict the future trend of stock price, so as to promote the research and development of financial market. This research has a profound impact on establishment and development of stock market.

4 Conclusions

As big data develops by leaps and bounds, there are many kinds of stock prediction models. Factors such as the state of national economy, macro policy, investors' psychology, the basis of enterprise management and technical indicators all affect the stock market price and make the stock price change irregular. Almost no model can take into account all the factors affecting the stock market, and it is difficult for a single forecasting model to accurately predict stocks. Compared with the single model, the combined model can process the information of the sample data more comprehensively. More and more academic researchers begin to study the application of portfolio model in stock prediction, and constantly improve the forecasting method of portfolio model, which can make use of strengths and avoid weaknesses, carry out more effective research on the change rule of stock price, and improve the accuracy of forecasting model.

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