The Application of Deep Learning in Stock Prediction

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Abstract. The computer may be the most important innovation and creation in human history. It does not just change daily life, also it plays a significant role in the development of knowledge and technology. Compared to traditional ways to do the math on paper and solve problems by hand. The computer is significantly efficient in the applications of sophisticated topics. The stock market is usually unpredictable in terms of infinitesimal views. People are creasy about it because of the expected return and risks that may experience. The stock market is dependent on too many factors so that predicting the return and risk is super complicated. The non-parametric and nonlinear data makes it a deep academic topic. The computer, however, is a fitting tool to use in modeling the stock market. In recent years, deep learning and neural network become the mainstream in research. The technique is successful, but it is not perfect.

Keywords: Deep Learning; Stock Price Prediction; Time Series.

1. Introduction

The deep learning is a famous modern concept, which is based on artificial neural networks, it is now everywhere in human lives. Thanks to the fast-developing computer and semiconductors industries, which is important for machine learning and deep learning, machine learning and neural network are developing faster and faster so that the algorithm and models play important roles in various new industry and service sectors. For example, autonomous vehicles are the product of deep learning, and shopping applications people used for daily are also powered by deep learning techniques. The application of deep learning has achieved significant outcomes in all the filed. Because of the strong ability to deal with big data and the nonlinear relationship between input features and prediction target. Deep learning is likely to be more accurate and reliable than traditional statistical methods. Indeed, deep learning has shown a better performance than both linear and machine learning models on the tasks that include stock market prediction, which is a very important field, and people and countries are insane about it.

Traditional techniques indicate that the stock market earnings are obtained based on previous stock returns and other financial variables and macroeconomics, which is the sophisticated time series. Expected-return or reward-timing involves adjusting the portfolio allocation according to beliefs about future asset return [1]. The prediction of stock market revenues directed the investors towards examining the causes of predictability. The forecasting of stock trends is a difficult process as it is influenced by other factors, such as the expectation of stock return, financial circumstances, administrations, and some international events [2]. Also, the stock prices are usually dynamic, complicated, noisy, non-parametric, and nonlinear because of their complexity. The forecasting of financial time series becomes an issue due to certain complex features, like volatility, irregularities, noise, and changing trends. Also, the data cannot be perfect, so nobody could ensure the result from any data is always enough. With the development of technology, the more powerful computer helped the improvement of deep learning. This chaotic data makes it hard to analyze and predict the financial market, but deep learning is not constrained by the properties of the stock market. By analyzing more and more data, the prediction of the models will become much more accurate and reliable compared to the result which is forecasted from smaller data. According to the basic concept, the model will be better and better by involving more data.

In recent years, deep learning is widely practiced so that more techniques come up in research and experiments. Constructing a portfolio by proper stock selection has been considered an essential task for individual and institutional investors [2]. The hotshot is growing well in the computers around the whole world. Many researchers came up with methods about deep learning to work with financial data. However, the traditional approaches are still the main techniques in many places. This is because there are not so many explanations about the performance of deep learning in the stock market, and many people even do not know it is practical on stock data. The following part reviews some deep learning methods that work in predicting stock markets. These methods from different researchers are really efficient in forecasting the stock market.

2. Background

Stock market prediction has been a valuable research topic for a long time, and there are some review papers put effort on the deep learning methods. In fact, the application of deep learning in the financial market is not just one example in the field. Many researchers already took it as their main focus and concentration. The prediction of the stock trend is based on the stock data, which is real and reliable. This useful tool could be beneficial to regulate, monitor and predict the stock market. Also, it can be the support of people to make their decisions. The deep learning can help the investors to predict future trends and behaviors of the stock market so that companies can yield positive solutions to make rational choices.

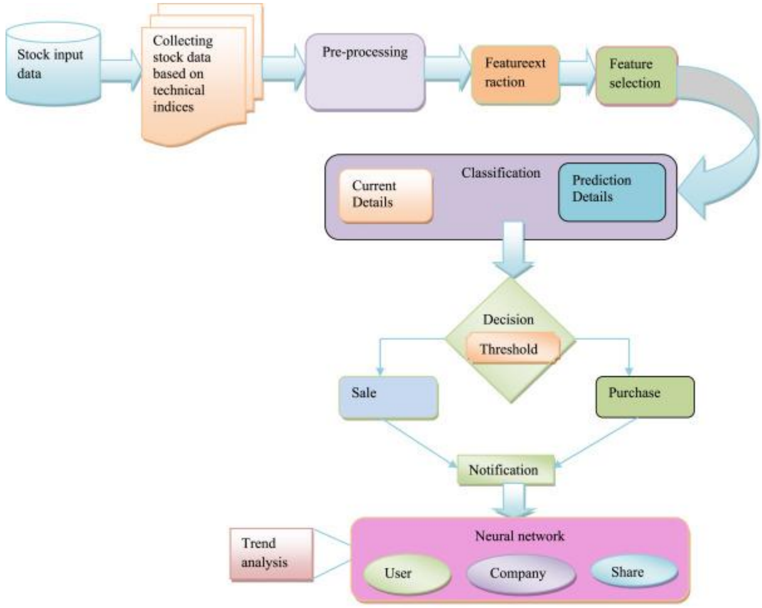

Fig. 1 Block diagram of the functioning of the stock market prediction system.

This picture explained how the system works with the data. First, the historical stock data are collected from various datasets. Here, the technical index is defined as the relevance of the product to be utilized in a specific application. Then, the collected data need to pre-process to remove the noise within datasets. During this part, the data needs attribute relevance analysis to be applied for removing the part with low correlations. Then, the pre-processed data are ready to select the significant features, which can be useful for predicting the stock trends. Then, the selected feature is analyzed for extracting the knowledge using a large amount of data. Here, the data analyzer divides the obtained details into two classes, which are prediction details and current details. These two details are the foundation for decision making. The prediction details, the current details, and the threshold values are ready to see in the system. And this value is important for people to understand profit or loss.

One data used is real life data. For example, the historical daily financial time series from January 2010 to September 2019 from the Yahoo Finance Website. The daily data includes the close price of S&P500, Dow Jones, DAX, and Nikkei225.

In deep learning models, loss error is important to evaluate within the prediction, which refers to the difference between the observed value and the predicted value. In order to evaluate the loss error, different concepts can be practiced. The standard metrics in this type of models include root-mean-square error (RMSE), mean absolute error (MAE), and mean absolute percentage error (MAPE). The following part is the equations

$$MSE = \frac{1}{n}\sum_{i}^{n}(y_i - \hat{y})^2 \tag{1}$$

$$MAE = \frac{1}{n}\sum\nolimits_{i=1}^{n}|y_i - \hat{y}| \tag{2}$$

$$MAPE = \frac{1}{n}\sum\nolimits_{i=1}^{n}|\frac{y_i - \hat{y}}{y_i}| \tag{3}$$

3. Recent Researches

3.1. Research 1

The article Stock price prediction based on deep neural networks by Yu and Yan [3] talked about predicting stock market by using deep neural networks which combines deep learning and neural networks. The financial data has complex, incomplete and fuzzy information, so it is difficult to predict financial data. In this article, however, the deep neural network is a satisfactory method for understanding financial data [3]. Also, this method shows better accuracy on prediction. According to authors, DNNs can better represent complex high-dimensional functions, such as highly varying functions. Comparing to old ways, this method can easily solve the nonlinear models instead of transforming nonlinear data to linear. this method is much more efficient. This method is successfully deployed on predicting exchange rate and changes in stock price.

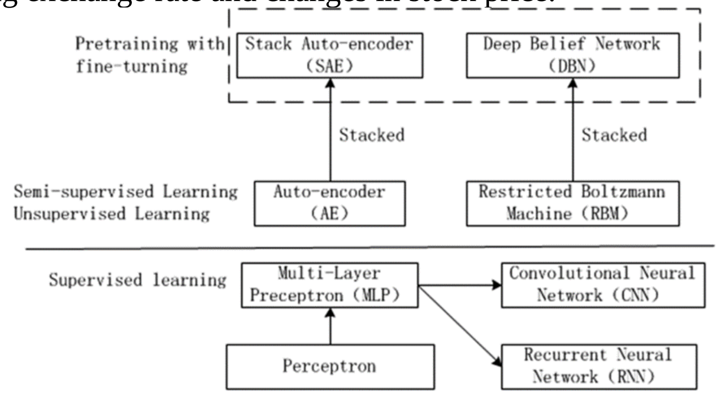

Fig. 2 Schematic diagram of the categorization of DL model structures

3.2. Research 2

In the article Stock Price Prediction Using Convolutional Neural Networks on a Multivariate Timeseries, the also show an efficient way to predict financial data. The author used NIFTY 50 index values of the National Stock Exchange (NSE) of India to predict the “Close” value of NIFTY 50 for the year 2019, with a forecast horizon of one week. The Convolutional Neural Network played an important role in predicting the data. according to the author, “the CNN based multivariate forecasting model is the most effective and accurate in predicting the movement of NIFTY index values with a weekly forecast horizon.” [4] The authors have three approaches in designing CNN models. In the first approach, the author builds a univariate autoregressive model that predicts the index values for the next week based on the previous “Close” values of the NIFTY index in the training dataset. The second approach used each of the variables “Open”, “Low”, “High”, “Close” of the NIFTY index in dataset to predicting the “Close” value of the next week. In the third approach, authors build submodels with each of the four variables to construct a separate CNN for univariate forecasting and combining them into a final composite forecast for the "Close" values for the next week.

3.3. Research 3

In the article A CNN-BiLSTM-AM method for stock price prediction, authors use a CNN-BiLSTM-AM method to predict the stock closing price of the next day. This method is including convolutional neural networks (CNN), bi-directional long short-term Memory (BiLSTM), and attention mechanism (AM). CNN is used to extract the features of the input data. BiLSTM uses the extracted feature data to predict stock closing price of the next day. AM is used to capture the influence of feature states on the stock closing price at different times in the past to improve the prediction accuracy. This picture represents the CNN-BiLSTM-AM training process.

3.4. Research 4

In the article Stock price prediction using deep learning and frequency decomposition, the authors named some deep learning method and algorithms that could deal with the prediction of financial data. Empirical mode decomposition (EMD) and complete ensemble empirical mode decomposition (CEEMD) algorithm could be effective in analyzing financial time series [5]. In fact, outcomes indicate that CNN alongside LSTM and CEEMD or EMD could enhance the prediction accuracy and outperform other counterparts. Also, the suggested algorithm with CEEMD provides better performance compared to EMD. EMD and CEEMD are useful in reducing the complexity of data series [6]. These methods can easily isolate the high fluctuating data into respective smaller frequency components. These algorithms play significant roles in analyzing fluctuated financial data.

4. Challenges

First, the data is still a big concern. the up-to-date data is very important to any model. If people cannot obtain the latest data, the model may not yield a reliable result. When managing a portfolio, one must take into account the volatility and the correlation associated with the various financial instruments [7]. So, researchers need to update their models on time. Out-of-date data is a potential risk to prediction. Some data with key factors may be totally changed the model and predictions. If the instituted does not release the latest data, or the new data is not true. The prediction of the stock market may not be as same as the expectation and risks.

Another concern is the higher power consumption of facilities. The computer for deep learning needs many powers and times to work. The device needs to update, and new devices could have better performance, but they may also need more power to work to maximize their performances. However, energy is a big concern. The international situation is changing, the world economy may go into depression in near future [8]. The higher requirement of energies may not get respond properly. The energy is crucial in the forecast of future lives. Especially now, the price of energy is still soaring, and the supply is not stable for both climate and political reasons. This may affect the important facilities. Also, these potential reasons affect the behavior of the stock market itself.

5. Conclusion

The deep learning becomes more common in financial research, it is apparently a solid and important background for analyzing financial data [9]. Quantitative trading has been used in various fields of finance, including financial instruments selection, timing, arbitrage, and risk control [10]. Its advantage over traditional techniques transforms irrational financial data into important resources. This is important to the economy and normal investors. However, there are still various challenges and concerns about the methods, but the method is unstoppable, and it has already been everywhere. In the future, the more advanced technologies and the increasing amount of data will build better models, this will make the prediction much more accurate.

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