A review of stock market predictions usingdeep learning models

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Abstract

Stock trading has always been an appealing option in the world of financial market to make significant profits. As a popular saying goes, "Trading is not gambling". It is true for the case of stock trading also. Successful traders always do a lot of research and analysis before buying and selling their stocks. This analysis usually includes looking at past record of a stock and finding patterns for future predictions. As machines are very good at processing huge amount of data and finding patterns from the data, we can see why the use of deep learning models can be beneficial in this case. In this paper, we are going to study various deep learning models used by researchers in the past to predict stock prices.

Keywords: Stock market, Deep learning, ANN, CNN, RNN.

1   INTRODUCTION

"The stock market refers to the public markets which exists for the purpose of issu- ing, buying, and selling of stocks of many different companies"**[2]**. There are two main purposes of stock market. First is to provide funds to the companies to expand their business. And second is to give chance to the investors to share profits of the company by buying the company's stocks. Stock market plays a vital role in the economic growthof a developing country. Stock market and economic growth are proportional to eachother i.e. if the stock market of a country rises then the economy will rise and if it falls then the economic growth will be slow**[8]**.

Deep learning(DL) is considered as a subset of machine learning which is able to learn from its past experiences by determining the accuracy of its predictions through its own neural networks and without the need of any external guidance. In the past decade, many deep learning models have been studied by researchers for stock market predictions, few

of which are ANN, RNN, CNN and LSTM.

According to the efficient market hypothesis, stock prices changes rapidly according to new information once it becomes public which the task of predicting stock market's movement very difficult[5]. And this is the reason of short term investments in stock being very risky.

In the past decade, various DL models have been used for the purpose of forecasting stock market movement. In [12], they made use of feed forward neural networks to forecast the future stock prices of S&P 500. In [17] Yetis et al. used artificial neural networks to predict NASDAQ stock market index. In [15], researchers used recurrent neural networks for predicting stock prices. In the recent years, many hybrid models have been established by researchers with the use of met heuristic algorithms and other procedures to get better accuracy and low complexity. In [11], Ghasemiyeh et al. used met heuristic algorithms to optimize artificial neural networks for stock price prediciton. Ahmed et al.[3] used Ant Colony Optimization algorithm, a met heuristic algorithm, to predict Nigerian stock exchange. Their method resulted in better accuracy than the other three methods with which they compared their results. The other methods used were Decision tree , ANN, and the combination of both decision tree and ANN.

2 Artificial Neural Network (ANN)

Artificial neural networks are influenced from biological neural networks which forms the structure of a human brain. As in humans neurons are interconnected with each other which facilitates the transfer of information, similarly ANNs also have neurons which are connected with each other thorough various layers. And these neurons are called nodes.
Artificial neural network consists of three layers-

Input layer

Hidden layer

Output layer

Artificial neural networks are of two types-

Feed Forward ANN - This is the very basic neural network. It comprises of a input layer, output layer and atleast one layer of neurons in hidden layer. Input layer takes the input and pass it on to the hidden layer where all the calculation takes place to find the hidden patterns and features from the input data. Then the computed result is passed on to the output layer.

Feed Back ANN - In feedback ANN, the output layer pass the data back to the hidden layer to achieve best evolved results. This ANN is well suited for optimization problems.
In a artificial neural network that contains only 1 hidden layer, the total number of neurons in the input layer is always proportional to the dimensions of input data. The

connection between every two neurons from the input layer to the hidden layer, has a coefficient known as weight, which acts as the decision maker for signals. These weights gets continually adjusted during the process of learning. And after the learning process finishes, the Artificial Neural Network will have optimal weight values. The hidden layer nodes applies a sigmoid function or any other function like tanh, relu etc. on the sumof weights which is coming from the input layer and it is known as activation function. Then these values are passed onto the output layer.

Abdulrazak F.Shahatha Al-Mashhadani et al.[4] applied ANN to forecast Malaysian stock market. They trained their model with 3000 epochs and used it on four different datasets. They got the best prediction of accuracy 98.67% and the worst prediction of accuracy 97.48%. But it was achieved only by taking a sole input, if multiple inputs like volume of stock transactions and difference of highest and lowest price of a day are taken then the accuracy of the model decreases.

Shahvaroughi Farahani, M., Razavi Hajiagha[9] applied a hybrid ANN to fore- cast the stock prices. In their proposed hybrid ANN model they used genetic algorithm for feature selection. And also they applied two metaheuristic algorithms, social spider optimization and bat algorithm, separately for optimization of ANN parameters. Use of these metaheuristic algorithms resulted in faster calculations, reduced model complexity, higher accuracy and high robustness. But these algorithm can fall for the local optima trap.

3 Recurrent Neural Networks (RNN)

Recurrent neural networks(RNN) are designed to save the output of data and use it back as one of the next input for getting better predictions. The first layer of this NN typically acts as a feed forward neural network layer then followed by a RNN layer where some information had been stored by memory function from the previous input case. If the prediction made is wrong then learning process uses backpropagation to gradually sway the model towards making right predictions. But RNN has a drawback of not being able to store data for a very long time. To solve this problem LSTM networks are used to forecast cases with very long time of data.

4 Long Short Term Memory (LSTM)

LSTM network is a type of upgraded RNN which lets the data to be stored for a much longer time. This neural network can handle the fading gradient problem of basic recur- rent neural network. LSTM architecture consists of three parts, very much like a RNN cell, which are known as gates. The first part decides if the data arriving from the pre- vious stage is relevant to be remembered or not. The cell uses new input provided to it to learn some new information in the second part. And in last part, the cell hands over the updated data from current stage to the next stage. First part of the cell is called the forget gate, next one is called the input gate, and final one is known as the output gate.
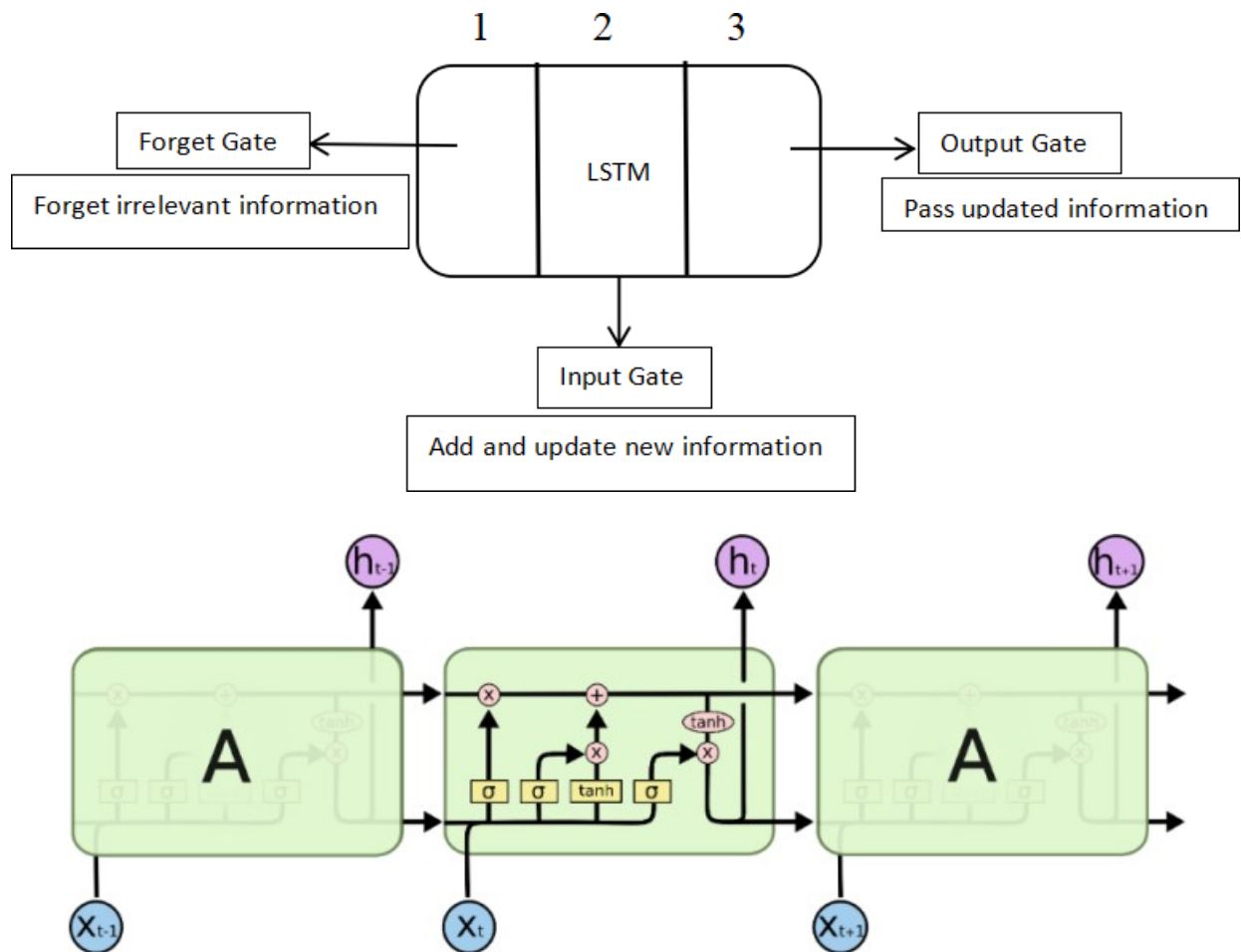
Figure 1: Detailed internal structure of
LSTM[1].

Adil Moghar, Mhamed Hamiche[13] proposed a RNN model formed upon LSTM network to predict future values for assets of GOOGL and NKE. The results confirmed that by taking a large number of epochs their model is able to forecaste the opening prices of both stocks. It provided better results compared to a random prediction method.

Jingyi Shen and M. Omair Shafiq[16] proposed a unique customized LSTM model with comprehensive feature engineering procedure to forecast the stock market. Their feature engineering procedure included feature expansion approach, recursive fea- ture elimination and principle component analysis. They tested their model on 2 years of Chinese stock market data. This customized model used along with the LSTM network provided high accuracy predictions which were better than the results provided by other models in the similar field.

5   Convolutional Neural Network (CNN)

CNNs are feed forward networks which are composed of input layer, hidden layer and output layer just like any normal neural network but the amount of hidden layer is greater than a simple neural network. Also it has some extra features like pooling layers, full connection layers etc. Convolutional neural networks are often used in the computer vision field for the tasks like image classification, face recognition**[14][10]**. But some researchers have also used it for the task of forecasting stock prices. The result of their research shows that this neural network is not much inferior to other stock forecasting deep learning neural networks like LSTM and can be used to make predictions of good accuracy. But still LSTM is the first choice for analyzing time series data like stock market data.

Sheng Chen and Hongxiang He[7] introduced a convolutional neural network model to predict the Chinese stock market data. They made use of conv1d function to process the one dimensional data in the convolutional layer. Their result shows that the CNN model can be utilized to forecast stock price movement thanks to the micro change capturing ability of a convolutional neural network. In their testing they got the best accuracy of 75.2%.

6   Conclusion

In this paper, we studied the most common deep learning models used to forecast the stock market movements. As the stock market data is a time series data as it contains a lot of historical data , so RNN and LSTM are considered to be the first choice for forecasting stock prices. But other models like ANN can also be vastly improved with the use of metaheuristic algorithms.In recent years, we saw the integration of new procedures with the already established ingenious deep learning models which gave us great results. So researchers still have space left to apply more integrated procedures and creating more accurate prediction models.

References

[1] https://colah.github.io/posts/2015-08-understanding-lstms/.

[2] https://corporatefinanceinstitute.com/resources/knowledge/trading-investing/stock-market/.

[3] Muhammed Kabir Ahmed, Gregory Maksha Wajiga, Nachamada Vachaku Blamah, and Bala Modi. Stock market forecasting using ant colony optimization based algorithm. *American Journal of Mathematical and Computer Modelling*, 4(3):52–57, 2019.

[4] Abdulrazak F Shahatha Al-Mashhadani, Sanil S Hishan, Hapini Awang, and Kamal Ali Ahmed Alezabi. Forecasting malaysian stock price using artificial neural networks

(ann). *Journal of Contemporary Issues in Business and Government Vol*, 27(1), 2021.

[5] E Michael Azoff. *Neural network time series forecasting of financial markets*. John Wiley & Sons, Inc., 1994.

[6] Yang Bing, Jian Kun Hao, and Si Chang Zhang. Stock market prediction using artificial neural networks. In *Advanced Engineering Forum*, volume 6, pages 1055–1060. Trans Tech Publ, 2012.

[7] Sheng Chen and Hongxiang He. Stock prediction using convolutional neural network.In *IOP Conference series: materials science and engineering*, volume 435, page 012026. IOP Publishing, 2018.

[8] Eugene F Fama. The behavior of stock-market prices. *The journal of Business*, 38(1):34–105, 1965.

[9] Milad Shahvaroughi Farahani and Seyed Hossein Razavi Hajiagha. Forecasting stock price using integrated artificial neural network and metaheuristic algorithms com- pared to time series models. *Soft Computing*, pages 1–31, 2021.

[10] Ammarah Farooq, SyedMuhammad Anwar, Muhammad Awais, and Saad Rehman. A deep cnn based multi-class classification of alzheimer's disease using mri. In *2017 IEEE International Conference on Imaging systems and techniques (IST)*, pages 1–6. IEEE, 2017.

[11] Rahim Ghasemiyeh, Reza Moghdani, and Shib Sankar Sana. A hybrid artificial neural network with metaheuristic algorithms for predicting stock price. *Cybernetics and Systems*, 48(4):365–392, 2017.

[12] Shekhar Gupta and LP Wang. Stock forecasting with feedforward neural networks and gradual data sub-sampling. *Australian Journal of Intelligent Information Processing Systems*, 11(4):14–17, 2010.

[13] Adil Moghar and Mhamed Hamiche. Stock market prediction using lstm recurrent neural network. *Procedia Computer Science*, 170:1168–1173, 2020.

[14] Akhilesh Raj, Soumay Gupta, and Nishchal K Verma. Face detection and recognition based on skin segmentation and cnn. In *2016 11th International Conference on Industrial and Information Systems (ICIIS)*, pages 54–59. IEEE, 2016.

[15] Ajit Kumar Rout, PK Dash, Rajashree Dash, and Ranjeeta Bisoi. Forecasting finan- cial time series using a low complexity recurrent neural network and evolutionary learning approach. *Journal of King Saud University-Computer and Information Sci- ences*, 29(4):536–552, 2017.

[16] Jingyi Shen and M Omair Shafiq. Short-term stock market price trend prediction using a comprehensive deep learning system. *Journal of big Data*, 7(1):1–33, 2020.

[17] Yunus Yetis, Halid Kaplan, and Mo Jamshidi. Stock market prediction by using artificial neural network. In *2014 World Automation Congress (WAC)*, pages 718–722. IEEE, 2014.