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Research paper

Predict Stock Prices using Neural Networks with Historical Stock Prices

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Abstract

Stock markets have always intrigued researchers in industry as well as in academia. Some researchers consider stock price movements completely random. Many scholars have attempted to predict stock price using various sources of data available (like historical stock prices, news articles, twitter data, so on), by applying indigenous methods. Predicting stock prices is a regression task, many conventional techniques have been used to predict stock prices. In recent years, the neural network approach has risen to tackle the problem. The neural networks' approach has been used to predict the stock prices and stock indexes.

Keywords: *Stock market; stock price; stock index; neural networks; time series analysis.*

1. Introduction

The stock market is a means to buy and sell equities and securities. It is the backbone of any economy. Although, some believe stock market is completely random [1], many researchers have been successful at predicting stock prices to a great extent. It helps companies raise the capital that empowers the world. More than 75% of the stock trading in United States exchanges are done by automated trading systems. And now in 2018, this number is even greater.Stock prediction systems can help investors to identify right stock(s) to invest in.

The reasons why stock prediction is difficult are, (i) Stock price movement are very noisy, hence a machine learning algorithm may overfit, (ii) Some undocumented event may also cause the stock prices to change suddenly, and (iii) Confidence in prediction.

2. Literature Survey

In recent years, there have been many advances in forecasting of stock returns. In earlier years, researchers mostly used linear models to establish relationship between macroeconomic inputs and the stock returns. But with the discovery of nonlinearity in stock prices and indexes [2], in later years, there has been a rise in the use and research of nonlinear methods in the field. The stock market returns are uncertain, noisy, non-linear, and chaotic in nature. ANN have proved to be a better technique in capturing the relationship between stock's performance and its factor features [3].

In literature, different researchers used different techniques and different data sets to predict stock returns in many stock markets. Some researchers even added pre-processed data and added new features, to the existing features.

Siekmann et al. (2001) used fuzzy rules to split inputs into increasing, decreasing trend, and stable variables [4]. He implemented a neural network architecture that had the adaptable fuzzy parameters in the weights of the connections between the first and second hidden layers.

There has also been a number of efforts for predicting stock prices and its trends, using textual data [5], [6], [7], [8], [9]. This textual data is collected from twitter, daily news articles, so on [10], [11].

In many papers, Autoregressive integrated moving average (ARIMA) model is pitched against ANN models, to predict the forecasting accuracy. Jung-Hua Wang; Jia-Yann Leu [12] developed a prediction system of RNN trained by using features extracted from ARIMA analysis, as inputs.

Researchers from Kobe University, used Long Short-Term Memory (LSTM), to forecast the stock prices in Tokyo Stock Exchange [10]. Their neural network not only used numerical information, but it also used textual information. They converted news articles into paragraph vectors which stores the semantics and the order of the news articles. They compared their LSTM architecture with MLP, RNN, and so on, to find that LSTM performed better than the rest of the architectures to predict the stock prices.

Researchers have validated the accuracy of neural networks in forecasting the stock market returns in various stock markets around the globe. Literatures are available for forecasting index returns of U.S markets like New York Stock Exchange [13], Financial Times Stock Exchange [14], Dow Jones Industrial Average [15], Standard & Poor 500 [16], [17]. Some researchers also conducted research on Hang Seng Stock Exchange, Korea Stock Exchange, Tokyo Stock Exchange and Taiwan Stock Exchange.

3. Neural Networks

The neural network is a mathematical model, which resembles the design of human neural network of a brain in some sense. Neural networks will be used to map the inputs to the outputs by a function. The inputs are called features. There are three things that make a supervised neural network,

(i) architecture of the neural network,
(ii) activation of the neurons, and
(iii) error function.

Rectified Linear unit (ReLU) is preferred activation function, as it is computationally cheap and effective. Each connection between two neurons has a weight to it. As a neural network gets trained, these weights change and converge to a value where they give least error.

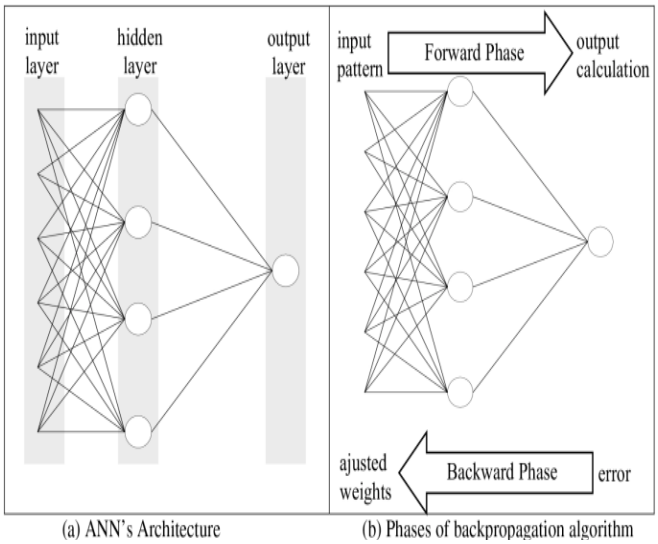

Fig. 1: ANN Architecture and Phases of back propagation algorithm.

We use Feed Forward Backpropagation neural network and Long-Short Term Memory neural networks to predict stock prices and indexes. As these methods are highly prone to overfitting, we use dropout layers to prevent overfitting. The dropout layer generalizes well. The term "dropout" refers to randomly drop out units (can be both hidden and visible) in a neural network.

One can play with many architectures, parameter and hyper-parameters of neural networks, and tune them to achieve better performance. The project was more empirical than theoretical.

4. Preprocessing

We can use two scaling techniques to avoid numbers becoming too large for the computer to handle. These two scaling techniques are: (i) Dividing each feature by its range, i.e. (Max – Min) of each feature, and (ii) Dividing each feature by the first temporal value, then subtracted one, this gives the percentage change in the stock price from the initial price. Both the approaches have been used in practice.

5. Long Short-Term Memory

Long Short-Term Memory or LSTM units are part of a Recurrent Neural Networks (RNNs). These neural networks are used to train sequence models. Stock prices, essentially being sequence of numbers, can use RNNs for prediction. The reason why these are so good is that, these units prevent vanishing gradients and are hence good at capturing long term dependencies.

The LSTM units have three gates, update gate, output gate and forget gate, which are responsible for cell memory updation.

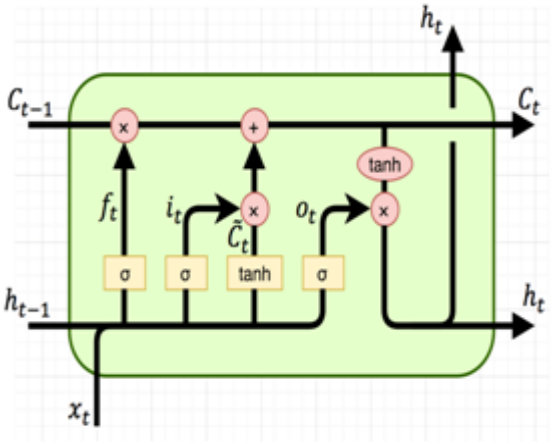

Fig. 2: An LSTM unit

6. Conclusion

We tried different models, with different parameters, to solve this problem. We tried to predict tle stock price of Apple (NASDAQ.AAPL) and SP500 (Standard and Poor 500), using last 5 stock prices, of 500 companies. Among the models that were tried, the model shown (Fig. 3) performed best. We trained this model for 1000 epochs, on adam optimizer, with learning rate = 0.001, beta_1 = 0.9 and beta_2 = 0.999. The loss function used was mean squared error. The training and validation set losses were plotted (Fig. 4).

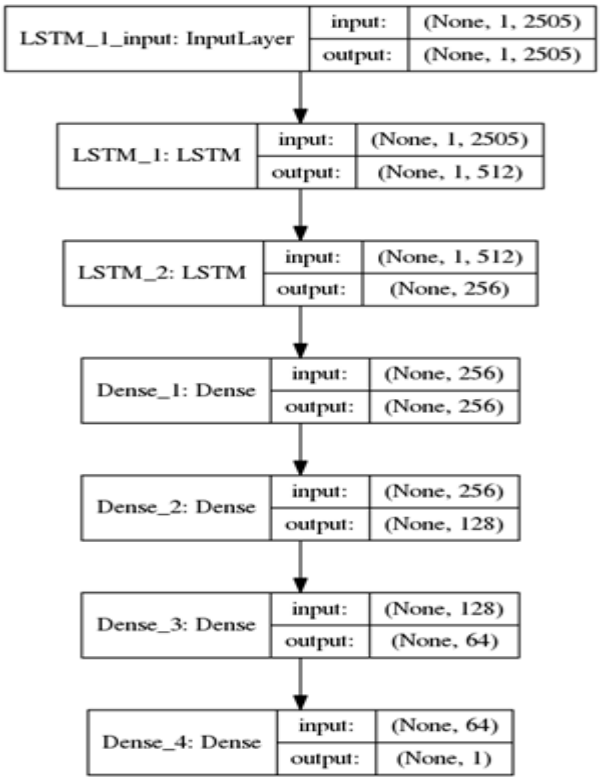

Fig. 3: Neural Network architecture

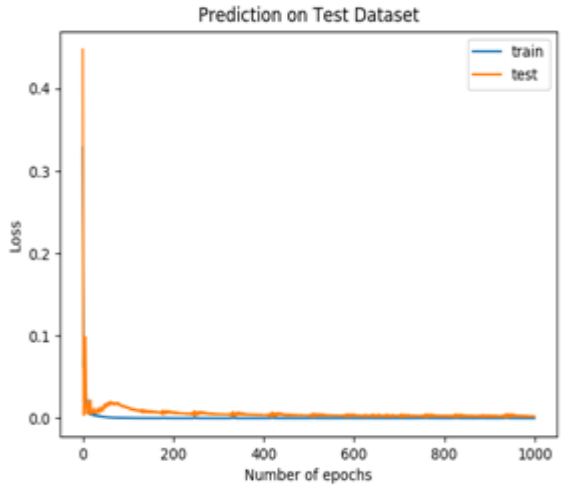

Fig. 4: Train and test loss during training (on preprocessed data)

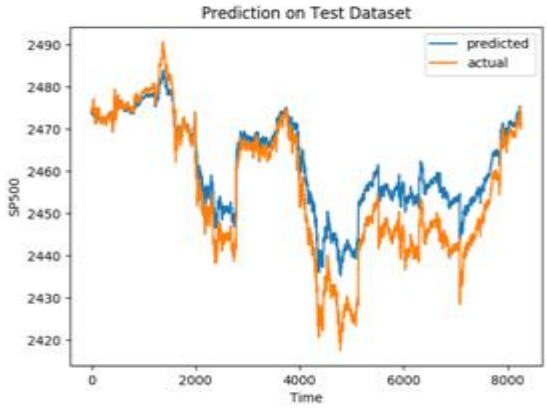

Fig. 5: Performance on test set

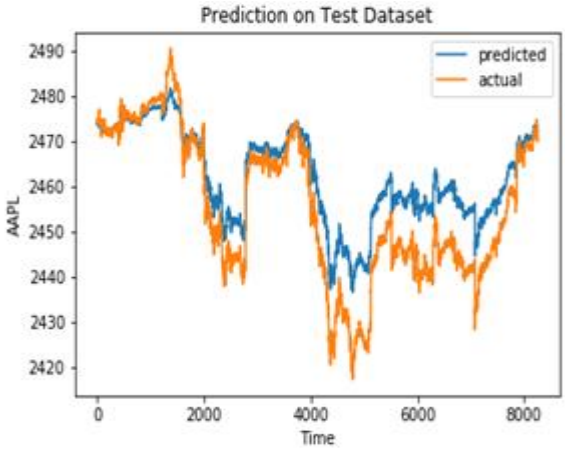

Fig. 6: Performance on test set

We got an error of 7.6 RMSE (for prediction of SP500) and 8.7 RMSE (for prediction of AAPL), measured on test set using mean squared error as the loss function. For this model to be accurate, we must retrain it after a period of time. This retraining will help to adjust the parameters to new trends, hence, predicting better estimates.

Therefore, we may conclude that using this model, we can estimate the immediate future stock prices, of almost all companies (if we have enough data, to train our neural network).

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