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Using LSTM models to build a better portfolio of Apple Company

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Abstract: This article is mainly about how to use LSTM method to estimate the investment portfolio. Since stock market forecasting is a hot topic and many investors are attracted and confused right now, we will take a method for more accurate stock market forecasting. We analyzed losses, normalized closing price, and when do purchases have the highest income and when do purchases have the lowest income. In this paper, we mainly analyze the stock market situation of Apple. To visualize our results, we draw five figures. The results of the experiment show that our method perform better compared with other method.

1. Introduction

In recent years, stock trading has become a trend in China[1]. The stock market is unpredictable and the trend of stock prices is changeable. Maket forces can change quickly. Stock forecasting has become a hot and complex problem. Everyone need to manage their portfolio. Therefore, predicting the trend analysis of the stock market has become an important goal. In the investment process, investors will be affected by many external factors, which lead to asset losses, When deciding whether to buy or sell stocks, investors should consider a variety of different factors[2]. Investors should consider the overall business environment and market development prospects, the financial situation and development potential of companies where different stocks are located, and whether it is worth buying or selling stocks. Financial markets present an opportunity for perceptive investors to buy undervalued assets. In today's financial markets, where most trades are performed in their entirety by electronic means and the largest fraction of them is completely automated, an opportunity has risen from analyzing this vast amount of transactions[3]. This is a question worth thinking deeply about[4]. So investors need a scientific and reliable stock price forecasting method. Now consumers urgently need a scientific and effective way to predict stock prices[5].

This paper focuses on the LSTM algorithm to research and predict Apple's stock price. Based on the analysis, we need to understand how big the Apple industry is. In the first quarter of 2015, Apple's revenue from the iPhone alone was $51.2 billion, far more than Yahoo's total market cap of $45.5 billion, more than three times Google's total revenue in the third quarter of 2014, and nearly twice Microsoft's quarterly revenue. Apple's cash flow is more than $178 billion, which is enough to buy the entire IBM. Apple could buy Ford (F), General Motors (GM), and Tesla (TSLA) and still have $41.3 billion left over. In other words, the same as Netflix, Tesla, Twitter, Dropbox, Pandora, and

Spotify combined. Apple's operating cash flow is twice that of the US Treasury. In the last quarter, Apple's net income was $18 billion, the highest ever for a company in a single quarter. (The previous record was held by Gazprom, Russia's natural gas giant, which posted its highest quarterly profit of $16.2 billion in August 2011.) Apple is an exception because the rest of the list of the top 25 quarterly profits of all time are energy companies. From this point of view, Apple Inc. as a technology company has unparalleled economic strength.The source and foundation of this economic strength is the strong scientific and technological innovation strength of Apple, which has made a lot of achievements in the field of scientific research and innovation. Apple's A-Series chips, introduced every year, are at the top of the mobile phone chip chain, while the M Series chips, used in laptops and tablets, are A breakthrough between ultra-low power consumption and balanced performance.

This paper is divided into four parts to illustrate that LSTM model can predict the stock price of Apple. The first part is an introduction. It introduces the current situation of China's stock market, which shows that stock price forecasting is necessary, and leads to this experiment. The second part is experiment analysis, through data analysis to illustrate the prediction effect of LSTM model. The third part is literature review, reflecting the academic nature of this experiment. The fourth part summarizes the research results of the whole experiment and explains the prediction effect of LSTM model.

2. Related Work

The price trend of the stock market is impossible to estimate, it depends on many factors, such as investors' sentiment, or what has happened recently. Researchers and traders realize that events happen on a stock market would effect the price of the stock market positively or negatively[5]. In the past, people mainly relied on machine learning and deep knowledge of stock market prediction based on hypothesis [6]. Some scholars have also gone on to construct optimal portfolios to obtain maximum returns [7-8]. However, what we mainly focus on is not short-term stock price changes. What we want to analyze is long-term stock price changes, so we use a model -LSTM.Take the Indian economy, it comprises two stock exchanges: The Bombay Stock Exchange and the National Stock Exchange. In the past, investment in the stock market was restricted to stockbrokers, which obviously meant that ordinary people were not allowed to participate. But with the development of the Internet in recent years, advanced technology has changed the way of trading [9].

There are many other approaches, such as investors considering multiple investments over time, given a model set, and then we use the least variance model and the market capitalization weighted l model to better predict the stock market price [10]. Neural network models have been widely used because they showed a better performance.In the continuous development of models, there are time prediction models, and the model LSTM is one of them.

3. Methods

LSTM (Long Short-Term Memory), also known as long-term memory structure, can effectively capture semantic associations between long sequences and relieve gradient disappearance or explosion. At the same time, the structure of LSTM is more complicated, and its core structure can be divided into four parts to analyse: Forgotten Gate， Input door， Cell state and Output door.

$$i_t = \sigma(W_i \cdot [h_{t-1}, x_t] + b_i$$

$$i_t = \sigma(W_i \cdot [h_{t-1}, x_t] + b_i$$

We can regard f(t) as the gate value, just like the degree of opening and closing of a door. The door value will act on the cell state of the upper layer through the tensor of the door, and the forgetting

door value will act, representing how much information forgotten in the past. And because the forgetting gate value is calculated by x(t), h(t-1), the whole formula means that according to the current time step input and the implicit state h(t-1) of the previous time step, decide how much the previous information carried by the cell state of the previous layer of forgotten.

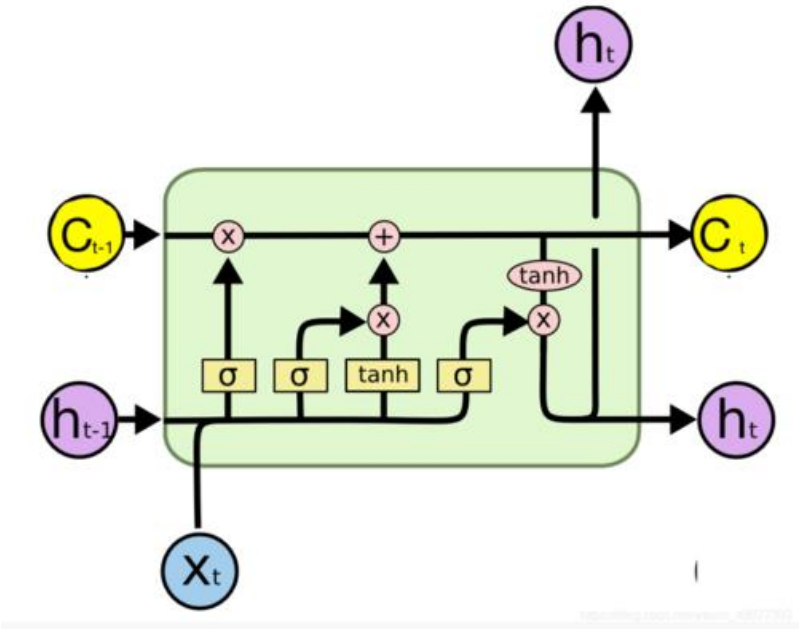

Figure 1: Structural Explanation Diagram of LSTM model

$$o_t = \sigma(W_o[h_{t-1}, x_t] + b_o$$

$$Ci_t = tanh(W_C \cdot [h_{t-1}, x_t] + b_{C_t}$$

LSTM has two outputs, and the next time step has three inputs. We can see that there are two formulas for calculating the input gate. The first is the formula that generates the input gate value, which is almost the same as the forgetting gate formula. The difference is only in the goal they want to act later. This formula means how much information input needs to be filtered. The second formula of the input gate is the same as the internal structure calculation of traditional RNN. For L STM, it gets the current cell state.

$$C_t = f_t * C_{ot-1} + i_t * \widetilde{C_t}$$

There is no full connection layer here, but multiply the forgotten gate value just obtained with the C(t 1) obtained in the previous time step, plus the result of multiplying the input gate value with the inundated C(t) obtained by the current time step. Finally get the updated C() as part of the next step input.

$$i_t = \sigma(W_i \cdot [h_{t-1}, x_t] + b_i$$

$$Ci_t = tanh(W_C \cdot [h_{t-1}, x_t] + b_{C_t}$$

There are also two formulas for the output gate part. The first is to calculate the gate value of the output gate. It is the same as the forgetting gate and the input gate. The second is to use this gate value to generate the implied state h(t), which will act on the updated cell state C(t) and activate tanh, and finally get h(t) as part of the next step input. The whole process of the output gate is to generate an implied state h(t).

4. Empirical Analysis

The core of this paper is to use LSTM to construct a portfolio to measure the return of our portfolio. We analysed several important parts of the stock market such as loss, closing price and how to buy and sell stock. We compare training data with test data to analyse closing price. To describe the data better, we use the chart for visualization. We compared the training data with the test data in Figure 1:

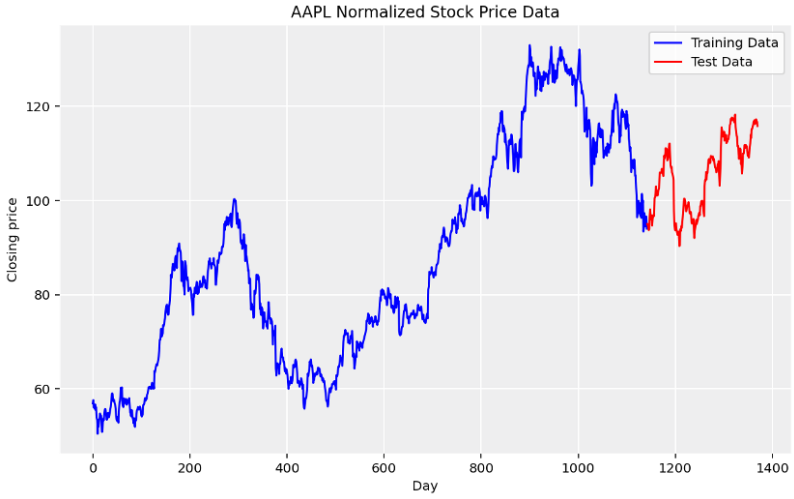

Figure 2: The comparison of training data and test data

It can be seen that the gap between training data and test data is large at the beginning, the gap becomes smaller and smaller later. In the analysis of training loss, we found that with the increase of epoch, value-loss has always been in a fluctuating state, while loss has decreased significantly in the range of epoch 0~25, and it has always been in a fluctuating and stable state in the later period.
An overall description of the losses using a diagram in Figure 2.

Figure 3: The training losses

After analysis, we found that the normalized closing price's prediction is lower than the actual closing price in most cases. In addition, the closing price changes greatly both in the forecast and the actual situation. Both predicted and actual Normalized closing prices are shown in Figure 3. On the whole, the price shows an upward trend at 0-50days, then a rapid decline, and then a small rise and fall between 50-100days, and the stock price basically shows an upward trend after 100days.

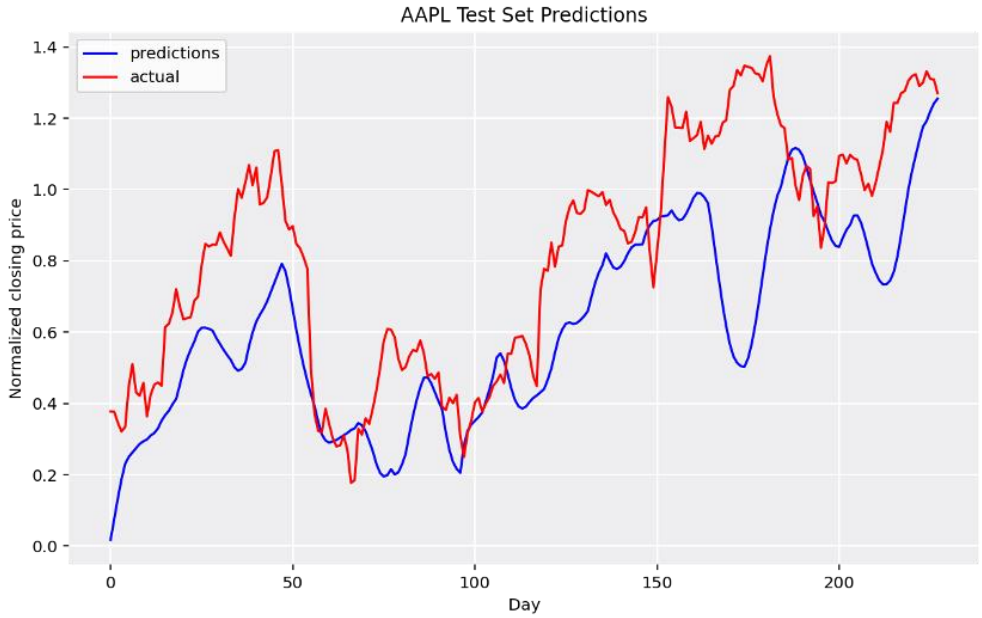

Figure 4: The normalized closing price

Usually, in our cognition, we sell at a high price and buy at a low price. Is this method applicable to Apple? According to the analysis, most people still choose to sell at a high price and buy in a low price. The price change is still a big fluctuation, the general trend is to rise and then fall, and then generally rise according to Figure 5. We set up a simple trading strategy by creating two simple moving averages for the time series, which exist independently. They have different backtracking periods of 7 days and 30 days respectively. When the short-term moving average is longer than the long-term moving average, the operation: buy; When the long term moving average is shorter than the short term moving average, operation: sell.

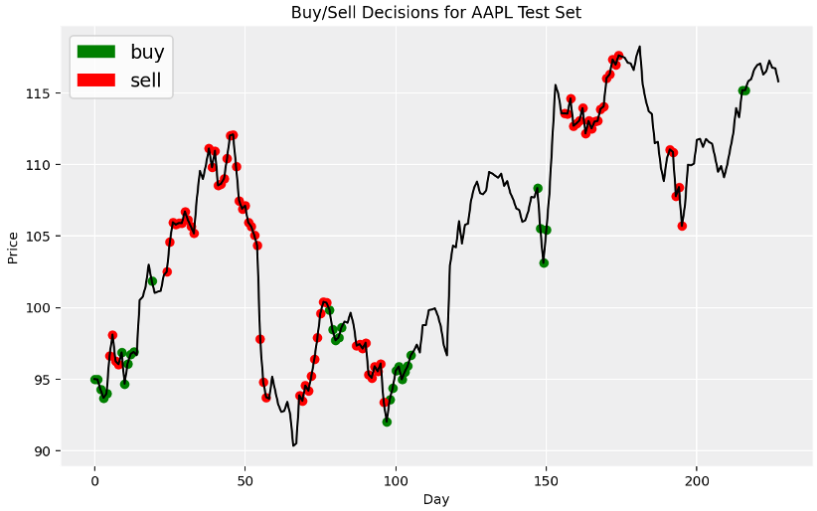

Figure 5: Buy/Sell Decisions for AAPL Test Set

One of our final analysis is that over time, the portfolio percent return tends to increase, decrease, and finally increase. In Figure 6, before 120 days, the portfolio percent return is most positive, and after 120 days, it is most negative. From 0-50 days, it remains flat, and from 50-100 days it peaks twice. And then from 100 days, it tends to decline until it reaches a low point between 150-200days. And then it keeps going up and it gets a high again about 200 days around 10, and then it goes down.

According to Figure 4, it can be seen that selling at the 150-200 day is not the right choice, because it is very low to get a lower yield. The highest Portfolio Percent Return is between 20 and 25, the lowest should be losing 15-20.

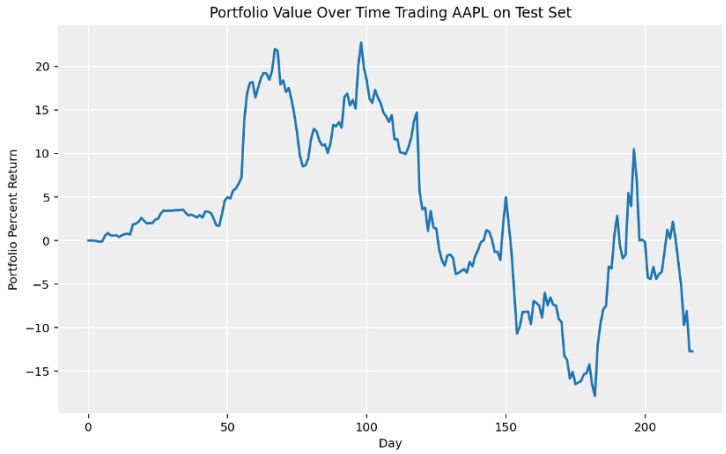

Figure 6: The Portfolio Percent Return

5. Conclusions

In this paper, we mainly introduce a method called LSTM which can remember long-term contexts better to predict the stock market price more accurately. To visualize our results, we present the data in 5 graphs. Our experiment's result show that our method can process the data better and more accurately. In general, LSTM is a good way to predict stock price. This model can be productive for individual traders as well as corporate investors. It can get the future behaviour of market price to make a profit accurately. This model should be considered different features of market to make prediction more accurately. The stock market is rapidly changing, we can not only analyze the past data and trends, but also the customer's attitude towards the stock market in the future value of the stock market.

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