Tesla Price Prediction Based on LSTM and GRU

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Abstract. As a matter of fact, in today's society more and more people are becoming aware of stocks and are finding that they can gain great benefits from them. In this case, investors want to propose a method that can accurately predict the stock market in order to gain extra return from the markets. With this in mind, by studying the historical data of Tesla's stock, an LSTM model and a GRU model were implemented to analyze this data as well as give different predictions for the short-term future. According to the analysis, the result was that the GRU model's predictions were more accurate than the results predicted by the LSTM model based on several statistic indicators. Based on the evaluations, a better prediction model is derived from this study and the factors affecting the efficiency of the model are discussed in depth. Overall, these results shed light on guiding further exploration of price prediction.

Keywords: Price prediction; LSTM; GRU.

1. Introduction

In recent years, with the development of the economy, it turns out that more and more people begin to contact the stock market, hoping to realize the preservation and appreciation of wealth. The stock market is a non-linear system with complex internal structure and variable external factors [1]. Although stock is a way to bring high returns, it is also accompanied by high risks, and the stock prices that change every moment make people realize that nowadays one needs a scientific method to predict the stock market's changes, so as to avoid the risks and get a better return on investment [2]. As it known to all, since the invention of the stock market, the stock market has been characterized by complexity and unpredictability, so predicting stock prices is a worldwide problem, but the huge economic benefits it contains still attracts a large number of scholars and experts around the globe to conduct research on it [3]. Historically, many scholars have expressed different views on the stock market. Eugene Fama proposed that the fluctuation of stock prices is actually a random process, so it is unrealistic to predict the future of stocks, and it is impossible to obtain extraordinary gains by analyzing historical price data and other information, which is the famous efficient market hypothesis. However, in recent years, more and more research results show that this theory is not consistent with the facts [4]. Edgar proposed the fractal market hypothesis in the early 1990s, in which he explicitly mentioned that the market of securities is actually predictable, because the degree of information acceptance in the securities market and the time of investment have an impact on investors [5], so he believed that all stable markets have fractal structure.

Based on the premise that the stock market is predictable, this study tested two different models that will analyze the stock market and predict the future direction of the stock market in the short term, and then compare the results of the two models, analyze the differences between the two models, and conclude which model is more suitable for the prediction of stocks. First of all, one uses two models, the first is LSTM model. LSTM model through its unique unit structure [6], can deeply dig out the inherent laws in the time series, it is a special form of recurrent neural network, its selective memory function and the special structure inside the unit is improved by the RNN model, which makes the LSTM model is more suitable for analyzing the financial time series [7], but in terms of the current financial market, the use of the LSTM model to predict the direction of the stock market is still relatively small, the domestic and foreign scholars of the application of the LSTM model for the majority of the application of the LSTM model also stays in the speech recognition, text processing etc. [8].

The second is GRU model, compared with traditional neural networks, deep neural networks have more advantages for financial time series prediction, and can better learn the nonlinear relationship between variables and variables, GRU model and LSTM model are the same as the representatives of deep learning methods, with the improvement of computer computing power, LSTM and GRU have carried out a lot of research in the field of stock price prediction. Both models show good results [9], GRU model, as an optimized version of CNN model, can effectively extract the high-dimensional features of stock prices, and also has the ability to memorize the long-term historical information of time-series data, which further improves the prediction accuracy of stock prices [10].

In today's high-tech world, the use of neural networks to analyze and predict the stock market can be an effective help, people also need a system that can quickly analyze large amounts of stock data and accurately predict its future direction to help them make better choices. This paper will analyze the historical stock data of Tesla in recent years and predict the future direction of Tesla stock in the short term. This paper will be divided into three parts: background introduction, main content of this test, analysis and conclusion. The main aim of this project is to create an system that can predict Tesla's stock trends by analyzing its historical data. The goals are building an system that can use a lot of past stock data to predict future prices; finding important patterns in the data that might affect Tesla's stock price; as well as improve the system's accuracy by adjusting it and testing it against real-life results.

2. Data and Method

The dataset of Tesla Technologies, Inc. was chosen for this paper, in this dataset the stock market data of Tesla from April 2018 to March 2022 is covered, where you can see the daily stock market prices at the opening of the market, the closing of the market as well as the highest stock market price of the day, the lowest stock market price of the day, and also the daily turnover (in US Dollars). With this data it is possible to have a preliminary idea of the stock market evolution of Tesla as a company in recent years at the time of research. First, one imports the data and export the first few rows to see if the data was imported successfully. Since the data of Tesla Inc. spans over a large period of time, this this study chose to use data from 2018 to 2022 for testing. Then, a chart was created using the daily opening and closing prices of Tesla Inc. in the data to make it easier to observe the fluctuations. Next, the volume of Tesla stock in recent years was derived using the data in the dataset and presented on the chart (seen from Fig. 1). It can be seen that the volume of Tesla stock has fluctuated greatly in recent years, which is one of the reasons why people say the stock market is unpredictable.

The code starts by splitting the training and testing into two parts, where "0.75" means that the first 75% of the data will be used as the training dataset, while the remaining 25% will be used as the testing dataset. That is to say, the model receives the first 75% of the data to start training, after training to give its own prediction of the latter 25% of the stock market direction, wait until the prediction curve out to be able to see the model's prediction and real-world data whether or not the fit, the yellow curve represents the model's prediction of the direction of the red curve is the real world of stock market data. After all the preparations are ready, the predicted data can be output. In order to test the accuracy of the prediction, the RMSE module is added to the code to visualize the difference between the predicted values and the observed values.

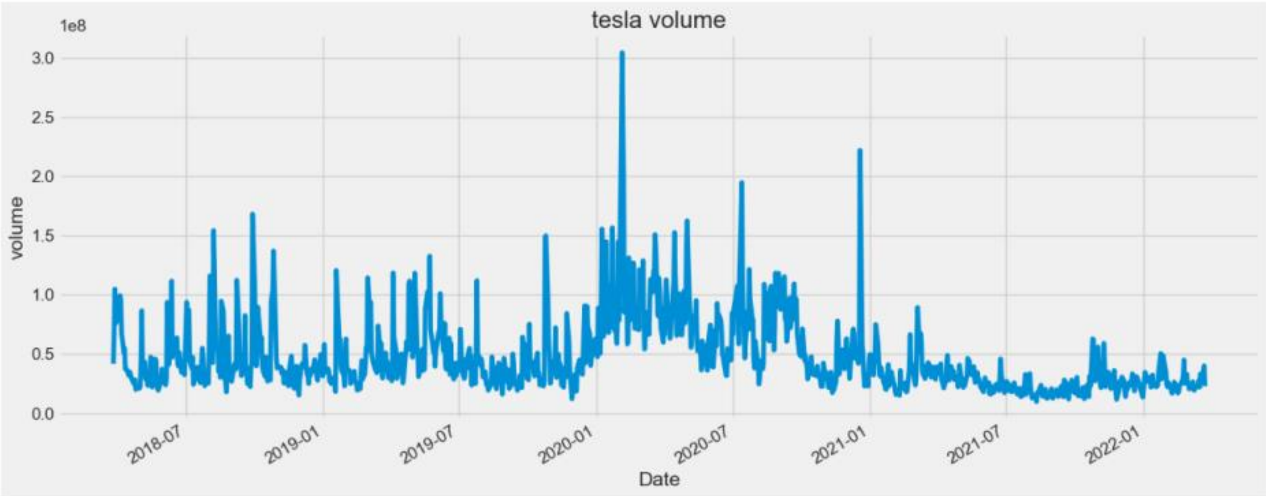

Fig. 1 The trading volume of Tesla.

3. Results and Discussion

When it comes to the most important part of the training dataset, this dataset is trained using the LSTM model and its error is calculated and then presented in the form of a graph. Seen from Fig. 2, one can see the change in squared error and absolute error as the number of epochs increases. Fig. 3 presents the result predicted by the LSTM model, the blue curve represents the training part of the data, the yellow curve represents the prediction of the model towards while the red curve is the real world stock market data. It can be seen that the short-term future stock market direction of Tesla Inc. predicted by the LSTM model is not relevant, and the values predicted by the LSTM are very different from the real-world data at several points in time when the stock market is volatile.

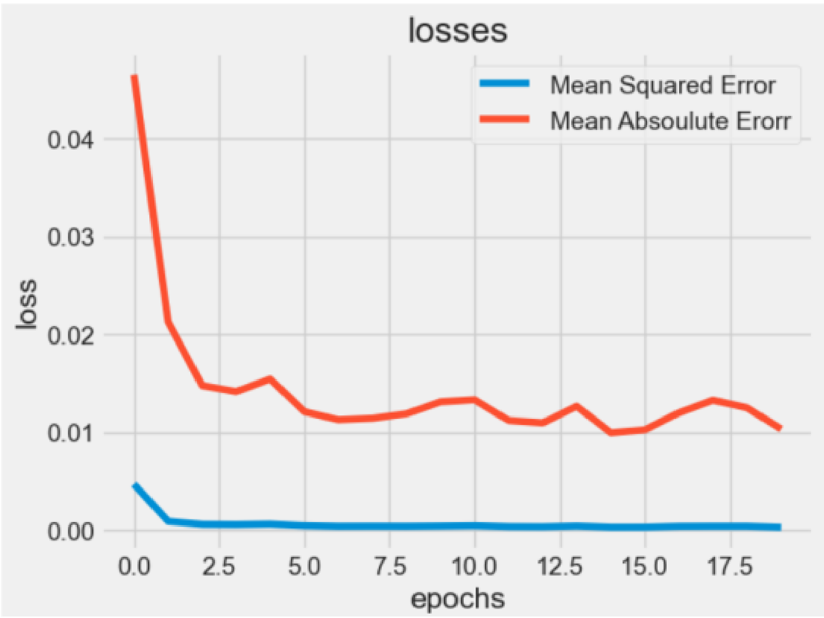

Fig. 2 The loss as a function of epochs.

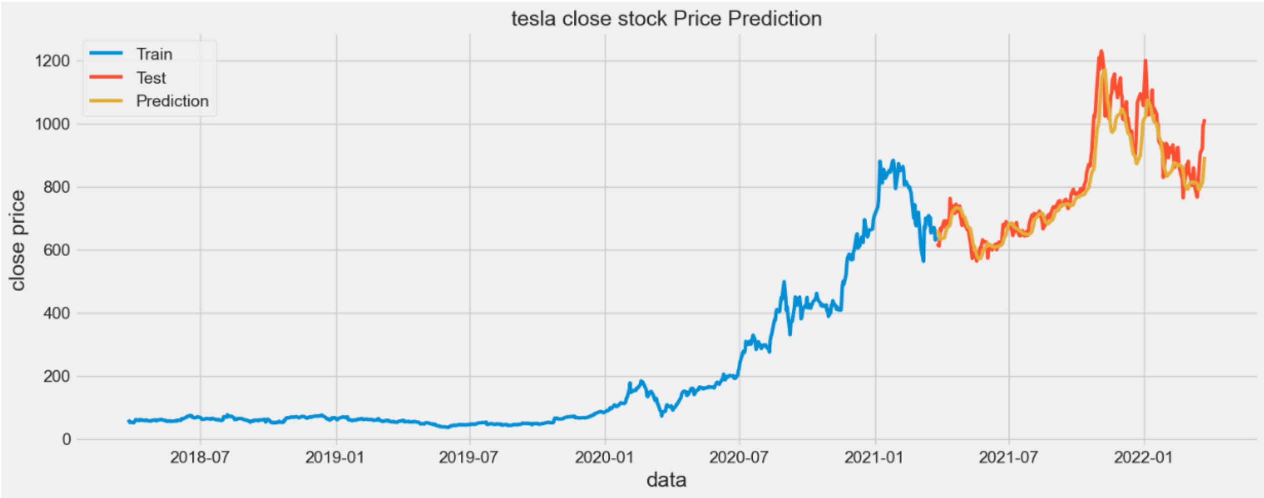

Fig. 3 Predicton results of LSTM.

Therefore, the second model GRU is used in this study. after modifying the LSTM model into the GRU model the result is like this, it can be seen that the prediction result given by GRU after training has very little difference with the real world data (as illustrated in Fig. 4), and basically achieves the research goal of predicting the short-term future direction of the stock market.

Putting the two graphs together and by comparing them, it can be clearly seen that the short-term future direction of the stock market derived from processing the Tesla stock data through the GRU model is more accurate than the short-term future direction of the stock market derived from processing the Tesla stock data using the LSTM model, under all the same conditions. Moreover, in another way, the size of the RMSE value can also reflect the degree of closeness between the predicted results of this model and the real-world data, the smaller the value of RMSE, the more close the predicted value is to the real-world value. So it can be more intuitively seen numerically that the RMSE using the GRU model is smaller compared to the RMSE using the LSTM model.

Therefore, after comparing the two different models, it can be concluded that the GRU model is better than the LSTM model in predicting the short-term future direction of the stock market, although the data set used in this study is only one company's data in recent years, but it can also be shown that the results of this model used in other different companies' stock market data in recent years are also basically the same. There are several points to know during the research process. Firstly, when the errors of both the training set and the validation or test set are large, the model at this point is underfitted, and it can be assumed that the model at this point fails to effectively capture the basic information present in the training data for decision making, and the model at this point has a large bias. Therefore, part of the code needs to be modified. First the first method is to increase the number of features involved in training, the second is to use a more complex model, the third is to increase the number of training iterations, and the fourth is to regularize the model. The efficiency of the model and the accuracy of the prediction can be further improved in these ways, and in this research the method of increasing the number of iterations was used to improve the value of RMSE.

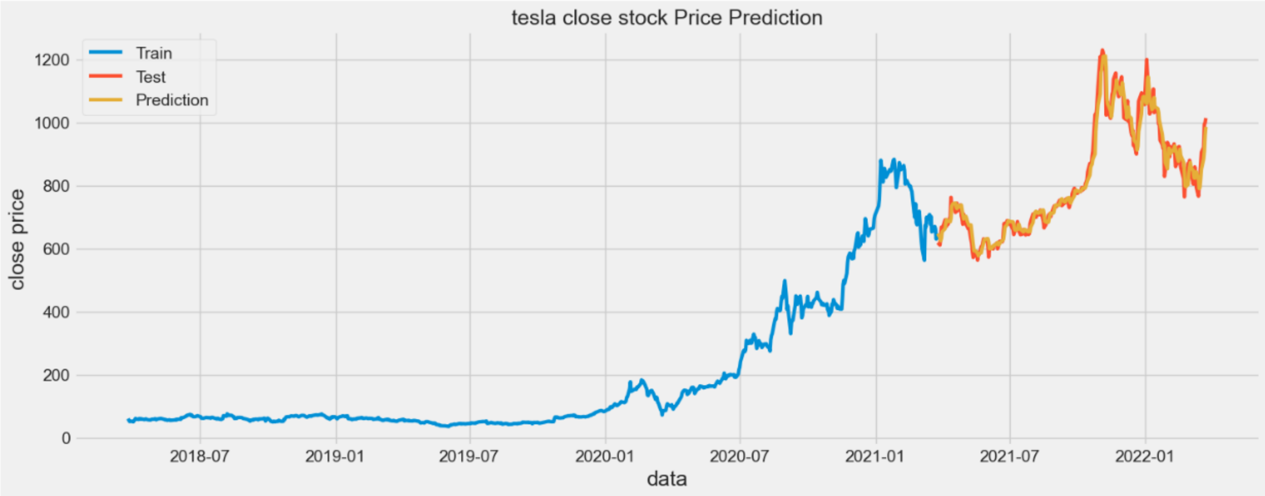

Fig. 4 Prediction results of Tesla.

The second point is the selection of the dataset, at the beginning this study used Tesla stock market data with a bigger time span from 2013 to 2022, but in the end the reason for only using data from 2018 to 2022 is that both models are inefficient when using the former because of the large amount of data and it takes a large amount of time to complete the training. Next is the accuracy, when a large amount of data is used as a training set, the gap between the predictions of the LSTM model and the GRU model is not very large, and the accuracy is not much different, so in order to test which model can come up with accurate predictions under the condition of a small amount of data, this paper chooses the Tesla data of the last five years, and the results are obvious, the prediction of the GRU model is more accurate than the prediction of the GRU model when a small amount of data is used. LSTM model's prediction is more convincing.

The third point is that the proportion of the training part and the testing part greatly affects the accuracy of the prediction, in this study, although the first 75% of the data was chosen as the training and testing set, but after many experiments, it was concluded that when the amount of the training data is the first 84% of the total data set, the value of the RMSE is the smallest, which means that the prediction accuracy is the highest at this time. However, the method of using the first 84% of the data as the training set is not rigorous, because it is well known that the more training data sets are given, the more accurate the prediction will be, and this argument has been rejected after many experiments, because when the training data set accounts for a large proportion of the time, many of the predicted values have been turned into the reality of the data, in which case there is basically no prediction to speak of, and in the extreme it is only the equivalent of copying the reality of the data directly to the prediction, which does not reflect the reality of the data, and the prediction of the data. In the extreme, it is just equivalent to copying the real data directly to the prediction, which does not reflect the good or bad prediction effect of a model, let alone judging which model is more accurate by comparing the prediction results of the two models. Therefore, a reasonable ratio of 3:1 is adopted in this study, under which each model can have a certain training data set and give a certain amount of prediction data, which is also conducive to a better comparison of the prediction results of the two models.

4. Conclusion

To sum up, this paper analyzes this data and gives different predictions by studying the historical data of Tesla stock from 2018 to 2022 using LSTM model and GRU model, the factors affecting the efficiency of the two models are studied and at the end of the ornamentation both models successfully predict the approximate direction of the stock market of Tesla and in terms of accuracy GRU model does a better job than LSTM model in predicting the stock market's short-term future direction is doing better than LSTM model.

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