The Stock Market Prediction of Tesla

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Abstract. As a matter of fact, stock price prediction attracts various investors. The direction of this research paper is stock prediction, the research object is Tesla, the research model is LSTM and GRU model, the research process is to extract the past five years of Tesla's stock market data and then through the comparison of the two models predicted the future trend of the stock to determine which model is more suitable, in which one has to use the two mathematical formulas of MSE and RMSE in the explanation of the modeling process, and at the same time, research on the strengths and weaknesses of the RNN neural network, the results of the research is that the GRU model can be more quickly and more accurately to get the results, as well as the back-order of the depth of research and development is the goal of how to improve the accuracy.

Keywords: LSTM; GRU; prediction of the stock market; MSE; RMSE.

1. Introduction

Under the premise of the current development of electrification, there are many electric vehicle companies on the market [1-3]. One of the most famous and best-selling companies is Tesla. The company was the first to electrify cars and is one of the most valuable companies. Through the development and evolution of these years, Tesla has developed from a small company that no one cares about to a household name. They not only have their own advantages in the field of electric vehicles, but also have incredible achievements in aviation and intelligence [4].

Predicting the stock market is a complex and challenging task. The stock market is known to be volatile, dynamic and nonlinear - making accurate stock price prediction extremely challenging due to multiple macro and micro factors like politics, global economic conditions, unexpected events or company financial performance that all may influence it [5-7]. Many factors influence stock prices, and they can be influenced by unpredictable events and sentiment. While no method can guarantee accurate predictions. There are many models in this world that are used for prediction models. This is also the work that many financial engineers have been doing. The purpose is to achieve more accurate prediction results.

Therefore, in this context, my team will make a prediction of Tesla's future stock market by combining previous data and materials and compare the changes of data in the past decade. This study will implement two models. The main aim of this project is to create an AI system that can predict Tesla's stock trends by analyzing historical data:

To build an AI system that can use a lot of past stock data to predict future prices.

To find important patterns in the data that might affect Tesla's stock price.

To improve the AI system's accuracy by adjusting it and testing it against real-life results.

Compare the two models and draw conclusions, compare the advantages and disadvantages, and then think about future development.

Continuously deepen the results

2. Data and Method

This study mainly uses python as the main tool, among which Numpy, Pandas, matplotlib, CSV are the most common means, and this study will use Keras Tuner (“A library for hyperparamete tuning. It's used to find the best hyperparameters for the LSTM model”) and Datetime (“To parse date strings into datetime objects”) for the first time to work. After careful screening and collection, this study will choose to use the data on kaggle as the base database. Before diving into the details of LSTM and GRU models, let's first understand what recurrent neural networks (RNN) are. RNN is a type of neural network architecture that is designed to handle sequential data. It is different from other types of neural networks because it has a feedback loop that allows it to process sequential data by using its previous output as input for the next step.

LSTM and GRU models are two types of RNN models that have gained popularity in recent years [8-10]. LSTM models were introduced in 1997 and have been used in various applications such as speech recognition, natural language processing, and more recently, stock market predictions. GRU models were introduced in 2014 as a simpler alternative to LSTM models, yet they have shown comparable performance in various applications. To understand how RNN works, let's take the example of predicting the next word in a sentence. In a traditional neural network, the input is processed sequentially, but each input is independent of the previous input. In contrast, RNN takes the previous output as input for the current step. This feedback loop allows RNN to handle sequential data such as speech, time-series data, and text.

One of the challenges with traditional RNN models is that they suffer from the vanishing gradient problem, which makes it difficult to learn long-term dependencies. This is where LSTM model and GRU model come in. This study mainly used two models, LSTM and GRU, and carried out comparative experiments on the two models. LSTM and GRU models are two types of RNN models that are designed to overcome the limitations of traditional RNN models. LSTM model and GRU model are known as "memory cells" because they have the ability to remember previous inputs and use that information to make better predictions.

LSTM models have three gates: input, forget, and output. These gates control the information that is remembered or forgotten by the cell. The input gate decides which information is important and should be remembered, the forget gate decides which information should be forgotten, and the output gate decides which information should be outputted.

GRU models, on the other hand, have two gates: reset and update. These gates control the information that is remembered or forgotten by the cell. The reset gate decides which information should be discarded, and the update gate decides which information should be updated.

This study started by importing the data and exporting the first few rows to see if the data was imported successfully, and because Tesla Inc.'s data spans a large period of time, this study chose to use data from 2018 to 2022 for the test. Analyzing the trends in the stock's open, close, high, and low prices can provide valuable insights into the stock's overall movement. By visualizing and comparing these trends, one can identify any potential long-term patterns or short-term fluctuations. To train the LSTM model and GRU model effectively, one needs to prepare the stock's close price as the target variable. By isolating and normalizing this variable, one can ensure that the models learn and predict this crucial aspect of the stock's performance accurately. To focus solely on the stock's close price, one creates a separate dataframe that contains only this variable. By isolating this column, one can simplify the analysis and train the models specifically on the stock's closing price. Visualizing the stock's close price over time can provide valuable insights into the stock's historical performance. By plotting this price series, one can identify any significant trends, patterns, or anomalies that may influence the predictions.

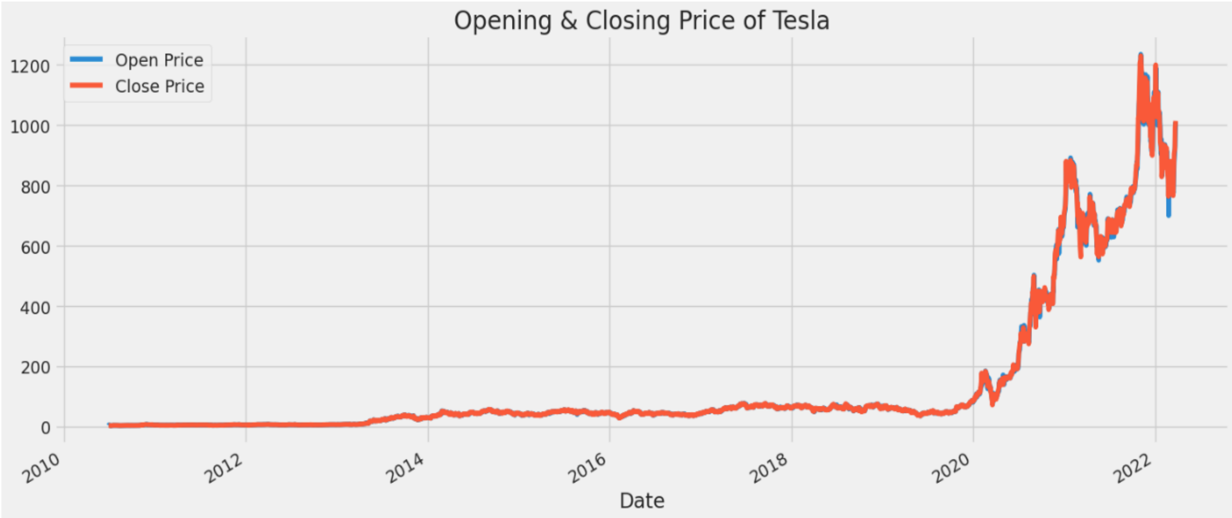

Fig. 1 The price of Tesla.

To prepare the data for time-series analysis and forecasting, one needs to transform the close price variable. This transformation ensures that the models can capture the temporal dependencies and patterns present in the data, leading to more accurate predictions. As shown in Fig. 1, these are the inputs and the csv files imported, and one also took an intercept of the original database. This study also took an intercept of the original database. Before diving into the data analysis, it is essential to check for any missing values in the dataset. By identifying and handling these null or NA values appropriately, one can ensure the accuracy and reliability of the predictions. Then, this study created a graph to facilitate the observation of fluctuations by using the daily opening and closing prices of Tesla in the data. The original database was from 2010 to 2022, but after the operation, one found that it took too long to run the words due to the large data, so one only selected the data of the past five years.

Next, this study used the data from the csv to derive the volume of Tesla's stock in recent years. This code splits 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, and the remaining 25% of the dataset will be used as the testing dataset.

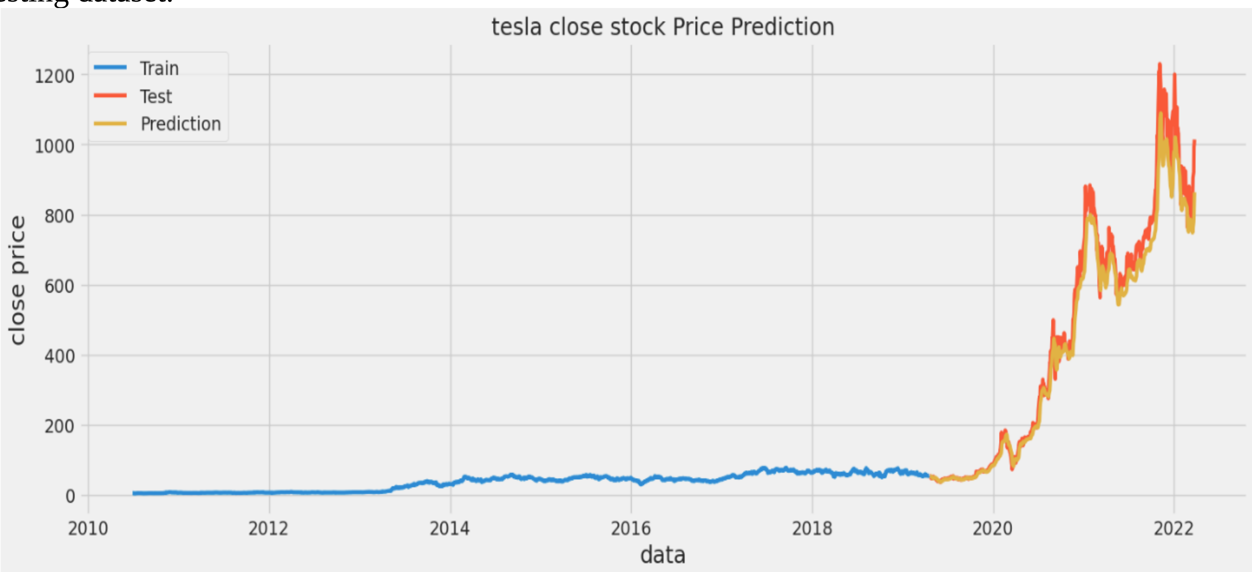

Fig. 2 Prediction of LSTM.

Here, one identifies both train size and test size. After extensive debugging, one determined 25% as the test ratio, due to finding an equilibrium between predicted results and operational mechanism. Since it can be challenging to appreciate how large data predictions affect both quantity and quality data simultaneously, increasing test proportion may cause sample proportion to decrease further, possibly jeopardizing reliability of information provided to users. If test ratio decreases too drastically, its integrity could be jeopardised. Evaluating LSTM model and GRU model used in stock market predictions involves comparing predicted values against actual ones; various metrics exist such as mean squared error (MSE), mean absolute error (MAE), and root mean squared error (RMSE) that can help evaluate performance of stock market prediction models such as these LSTM/GRU pairs. The formulae are as follows:

$$MPAE = \frac{1}{n}\Sigma\left|\frac{Y_{real}-Y_{pred}}{Y_{real}}\right| \tag{1}$$

$$RMSE = \sqrt{\frac{1}{n}\Sigma\left(Y_{pred} - Y_{real}\right)^2} \tag{2}$$

3. Results and Discussion

The performance of the model can also be visualized as presented in Fig. 2 and Table 1. This allows the investor to see how well the model is performing and make informed decisions. When all the preparations are ready, one can output the predicted data, in order to test the accuracy of the prediction one also used the RMSE metrics to determine the difference between the predicted values and the observed values, but one can easily see from the results that the results predicted with the model LSTM are not very accurate.

Since the LSTM didn't predict the images accurately, one decided to use the GRU model to replace the LSTM model. To see if the results would be better and more accurate than the LSTM model predicted, so one changed the LSTM to GRU in this part and ran it again. These are two images of the results after using two different models, the orange line is the prediction and it's clear to see that, all else being equal, processing Tesla stock data and making predictions using the GRU model is the better choice. The main difference between LSTM model and GRU model and traditional RNN models is that they have memory cells that allow them to remember previous inputs. This makes them better suited for handling sequential data with long-term dependencies. Additionally, LSTM model and GRU model have multiple gates that allow them to control the flow of information, making them more flexible and powerful than traditional RNN models. LSTM model and GRU model have several advantages when it comes to stock market predictions. First, they are better suited to handle the sequential nature of stock market data. Second, they have memory cells that allow them to remember previous inputs, making them better at predicting long-term trends. Third, they have multiple gates that allow them to control the flow of information, making them more flexible and powerful than traditional RNN models.

Table 1. Metrics of the two models

	RMSE
GRU	0.83888
LSTM	26.6351

4. Conclusion

To sum up, this study predicted Tesla's stock market changes for April 2021 onwards by analyzing Tesla's data from recent years and presenting it through visualization, and then using the data from the start of March 2018 to March 2021 as a training dataset. GRU contains fewer gates and parameters than LSTM, making it simpler and faster while less capable and adaptable. On the other hand, LSTM features individual cell state/output connections for each state/output cell that allow it to store/output different information simultaneously, while GRU has a single hidden state that serves both purposes, which may limit its capacity.And in accomplishing this goal one again found that the GRU model was more accurate than the LSTM model in handling this data. Finally, the GRU model was used to predict more accurate data.

While LSTM model and GRU model have shown great promise in stock market predictions, there are still limitations and challenges that need to be addressed. One challenge is the need for large amounts of data and computational power. Another challenge is the difficulty in interpreting the results of the model. Additionally, the models may not perform well in certain market conditions, such as during a crisis or when there is a lot of volatility. Another limitation of LSTM model and GRU model is their susceptibility to overfitting, especially when the models are complex and have a large number of parameters. Overfitting occurs when a model performs well on the training data but fails to generalize to unseen data. This can lead to poor performance and inaccurate predictions in real-world scenarios. Regularization techniques, such as dropout and weight decay, can help mitigate this issue, but careful model selection and hyperparameter tuning are still necessary to ensure optimal performance.

Despite the limitations and challenges, LSTM model and GRU model are expected to continue to play a significant role in stock market predictions. Future advancements in these models are likely to focus on improving their interpretability and performance in various market conditions. Additionally, there may be advancements in the use of other machine learning techniques such as reinforcement learning and deep learning. The LSTM model and GRU model have revolutionized stock market predictions, providing greater accuracy and profit potential. These models have memory cells that allow them to remember previous inputs, making them better at predicting long-term trends. Additionally, they have multiple gates that allow them to control the flow of information, making them more flexible and powerful than traditional RNN models. While there are still limitations and challenges that need to be addressed, LSTM model and GRU model are expected to continue to play a significant role in stock market predictions. The future plan of this project is to continue to develop based on the GRU model, input more factors to make the prediction more practical, and then it is hoped that the model will become more stable and more accurate.

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