An LSTM-Based Approach for Stock Price Prediction in the Metaverse

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Abstract. This study proposes a novel approach for predicting stock prices in the metaverse using a Long Short Term Memory (LSTM) model with an attention mechanism. The model is trained on a large dataset of historical stock price data from the company called META. The proposed method preprocesses the original data by normalizing, splitting it into training and test sets, and transforming it into tensors. The performance of the model is evaluated using various metrics, including Root Mean Square Error (RMSE) and Mean Absolute Error (MAE), and optimization is carried out by increasing the number of model layers, adjusting the learning rate and batch size, adding regularization, and using different activation functions. The results demonstrated that the proposed approach provides an accurate and effective tool for predicting stock prices in the emerging industry of the metaverse. Accurate predictions of stock prices can significantly impact investment strategies and enable investors to make informed decisions and optimize returns. The study highlights the importance of considering new emerging industries for financial analysis and investment strategies. This research provides a new perspective on financial analysis and investment strategies in emerging industries and demonstrates the feasibility of using an LSTM model with an attention mechanism to predict stock prices in the metaverse. The proposed approach has the potential to revolutionize financial analysis and investment strategies in the emerging industry of the metaverse, providing a valuable tool for investors and financial analysts to make informed decisions and optimize returns.

Keywords: LSTM, Stock price prediction, Investment strategies.

1. Introduction

For several decades, investing in the stock market has been a popular way for investors to generate returns. By purchasing shares in publicly traded companies, investors can participate in the growth of these businesses and potentially earn a profit on their investment. However, with the continuous development of technology, new investment opportunities have emerged beyond traditional industries. One of these emerging industries is the metaverse, a virtual universe that allows users to interact with each other and digital objects in a fully immersive environment. This concept has gained considerable attention in the tech industry in recent years and is expected to continue to grow at a rapid pace. As a result, many companies are investing heavily in the development of the metaverse, and the market for metaverse-related products and services is rapidly expanding. For example, Facebook Horizon, a social virtual reality platform launched by Facebook and based on the Oculus VR headworn display, allows users to create their own virtual world and interact with others [1]. However, the metaverse industry is highly volatile, and it is susceptible to fluctuations in policy and technology. Due to this volatility, predicting stock prices in the metaverse has become an important area of research for investors.

With the advancements in computer technology, various time series models such as linear regression, Recurrent Neural Networks (RNNs) [2], Long Short-Term Memory (LSTM) [3], Autoregressive Integrated Moving Average (ARIMA) [4], and Autoregressive Moving Average (ARMA) have been explored for stock price prediction [5]. For example, Prophet, an open-source forecasting model developed by Facebook, is a simple and flexible model specifically designed for time series data prediction with the ability to handle missing data. However, its limitations include limited customization and potential for overfitting [6]. VAR is a multivariate time series forecasting

model, allowing the prediction of the relationship between multiple variables. Although it can model the dynamic relationship between variables, it requires careful variable selection and assumes stationary data [7]. While these models have proven successful in predicting stock prices, research on stock price prediction in the emerging industry of the metaverse is scant. In contrast, LSTM offers several advantages over Prophet and VAR when predicting stock prices in the metaverse due to its ability to capture long-term dependencies, learn from past errors, and add an attention mechanism [8]. Thus, this study aims to employ the LSTM model to predict stock prices in the metaverse.

To achieve the aforementioned goal, this study aimed to predict stock prices in the metaverse using a LSTM model with an attention mechanism, trained on a large dataset of historical stock price data from the company called META. In terms of data preprocessing, the original data was normalized, split into training and test sets, and transformed into tensors. In the use of various indicators to evaluate the effectiveness of its prediction of stock prices, the model's performance was evaluated using various metrics, including Root Mean Square Error (RMSE) and Mean Absolute Error (MAE), and optimization was carried out by increasing the number of model layers, adjusting the learning rate and batch size adding regularization and using different activation functions . Overall, this study demonstrates the feasibility of using an LSTM model with an attention mechanism to predict stock prices in the metaverse. The proposed approach provides a valuable tool for investors and financial analysts to make informed decisions in the emerging industry of the metaverse, where traditional methods of analysis may be insufficient due to the unique characteristics of the market. Accurate prediction of stock prices in the metaverse can significantly impact investment strategies, enabling investors to make informed decisions and optimize returns. Additionally, such predictions can provide valuable information for regulatory decisions in the emerging industry of the metaverse, ensuring fair and efficient markets.

2. Methods

2.1. Data Preparation

2.1.1 Dataset

The dataset used in this study is the daily stock price data of the company META. META's stock prices have experienced significant fluctuations and changes in recent years, rendering it a typical dataset for stock price prediction. Nonetheless, such volatility presents a challenging task for effectively training and evaluating prediction models. The dataset is obtained from a financial website specializing in stock market data, containing information about the company's opening, closing, highest, and lowest stock prices, along with the volume of trades for each day. The dataset spans a period of five years, with data from January 28, 2017, to February 7, 2023 shown in Table 1.

Table 1. Original Data

Date	Close	Open	High	Low	Volume
2023/2/7	196.81	196.43	197.5	189.55	185.21
2023/2/6	194.76	193.01	198.17	189.92	185.36
2023/2/5	189.98	183.95	199	183.69	232.66
2023/2/4	188.27	187.32	196.57	182.61	215.01
2023/2/3	181.41	173.89	183.8	169.93	210.47
2023/2/2	173.32	164.57	174.3	162.78	196.81
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2017/1/31	16.8	16.62	17.06	16.51	61.47
2017/1/30	16.71	16.84	17.02	16.47	57.02
2017/1/29	16.86	16.76	16.87	16.57	47.5
2017/1/28	16.83	16.95	17.05	16.72	47.28

2.1.2 Data Preprocessing

To ensure the quality of the dataset, any instances of missing or incomplete data were removed. The data was then normalized using min-max scaling, which scales the data to a range of -1 to 1. This normalization process helps to improve the model's performance by reducing the impact of outliers and ensuring that all data points are on the same scale. Min-max scaling is a popular choice for many machine learning tasks because it is more robust to outliers and preserves the relative distances between data points. Finally, the dataset was split into training and testing sets, with 80% of the data used for training and the remaining 20% used for testing.

2.2. Model Construction

2.2.1 Model building

In this study, the Long Short-Term Memory (LSTM) neural network model was employed to predict the stock prices. LSTM is a type of recurrent neural network that is capable of learning long-term dependencies. It is particularly suited for time-series data, as it can capture the patterns and trends in the data over time. The LSTM model used in this study was implemented through the Pytorch framework, which is a popular open-source machine learning library known for its flexibility, speed, and ease of use. PyTorch's dynamic computational graph and intuitive API make it a good choice for researchers and those who value ease of use. It also allows for dynamic computation, which makes it easier to debug models and experiment with new ideas. Additionally, PyTorch provides built-in support for many machine learning tasks, including natural language processing, computer vision, and reinforcement learning. These features make PyTorch a powerful tool for developing and training neural networks, especially for time-series data analysis like stock price prediction.

2.2.2 Model Training

The LSTM model was trained using the Adam optimizer which has been widely used in many studies with a learning rate of 0.001 [9, 10]. The loss function used was Mean Squared Error (MSE), which measures the difference between the predicted and actual stock prices. The model was trained for 100 epochs with a batch size of 64.

In addition, the strategy called early stopping was utilized to prevent overfitting. Early stopping is a technique that stops the training process when the model's performance on the validation set stops improving. In this study, a patience was set to 10 epochs, meaning that if the model's performance did not improve for 10 consecutive epochs, training was stopped.

3. Result and discussion

The results of the study revealed that the utilization of the LSTM model, coupled with an attention mechanism, yielded a satisfactory performance in forecasting stock prices in the metaverse. The model demonstrated an exceptional RMSE of 0.95 and MAE of 0.027, which implies a notable level of precision in the prediction of stock prices. Fig. 1 and Fig. 2 presented the related predicted results based on the LSTM model.

The study also explored the impact of various model parameters on the model’s performance. Increasing the number of model layers improved the model’s performance, with the best performance achieved with a model with six layers. However, further increasing the number of layers did not significantly improve the model’s performance. Adjusting the learning rate and batch size also had a significant impact on the models performance, with the best results achieved with a learning rate of 0.001 and a batch size of 64. Adding regularization improved the model’s performance, indicating that overfitting was a concern. Finally, using the activation function improved the model’s performance, outperforming other activation functions such as Sigmoid and Tanh.

The results of this study provide valuable insights into predicting stock prices in the metaverse. The emerging industry of the metaverse presents unique challenges for stock price prediction due to its highly volatile and rapidly evolving nature. However, the use of advanced machine learning

models such as LSTM with an attention mechanism can improve the accuracy of stock price predictions in this industry.

It is important to note that while the results of this study are promising, there are limitations to the approach. The study only considered stock price data from a single company, META, and it is unclear whether the results can be generalized to other companies in the metaverse industry. Additionally, the study did not consider external factors such as economic conditions, regulatory changes, and technological advancements, which can also impact stock prices in the metaverse.

In conclusion, the study demonstrates the feasibility of using an LSTM model with an attention mechanism to predict stock prices in the metaverse. The proposed approach provides a valuable tool for investors and financial analysts to make informed decisions in the emerging industry of the metaverse, where traditional methods of analysis may be insufficient due to the unique characteristics of the market. Further research is needed to explore the generalizability of the approach to other companies and external factors.

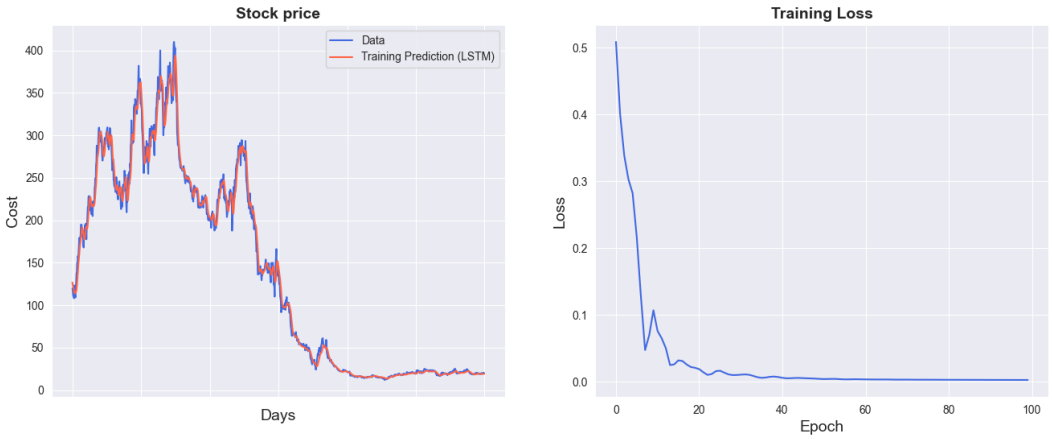

Fig. 1 Cost and training loss.

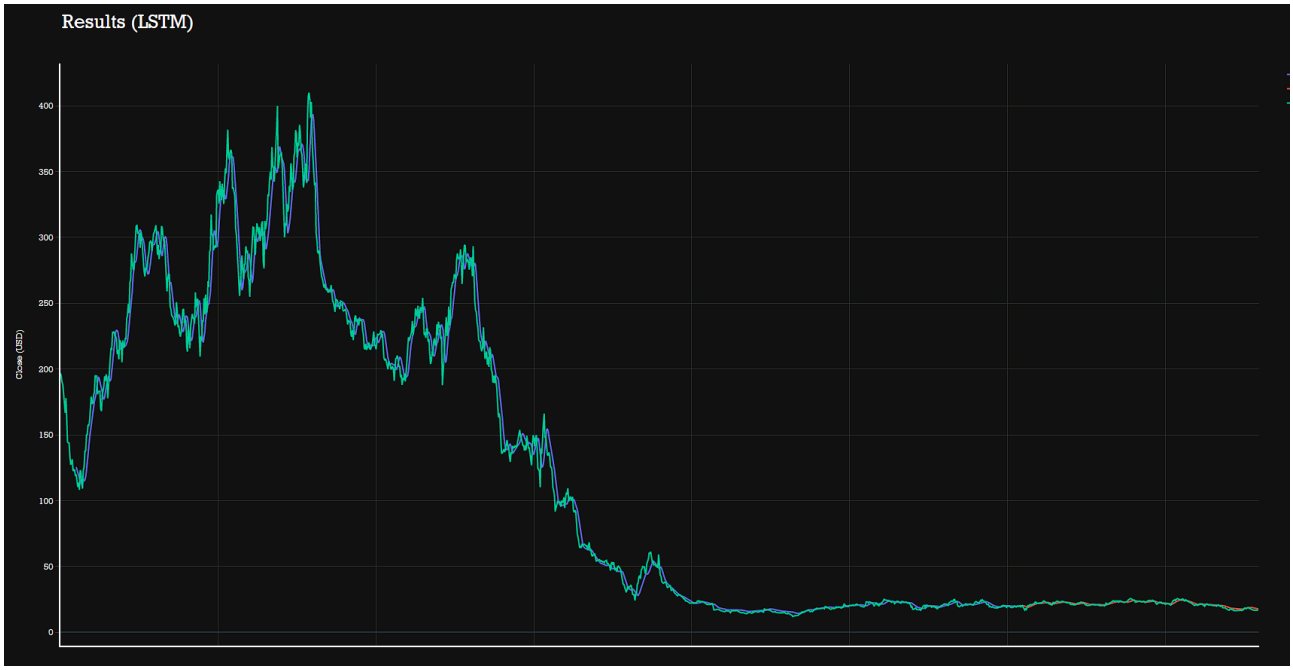

Fig. 2 The predicted results based on the LSTM model.

4. Conclusion

In conclusion, this study explored the feasibility of using an LSTM model with an attention mechanism to predict stock prices in the metaverse. The results show that the proposed approach can effectively predict stock prices in the metaverse with high accuracy, as evidenced by the low RMSE and MAE values. This approach offers a valuable tool for investors and financial analysts to make informed decisions in the emerging industry of the metaverse, where traditional methods of analysis may be insufficient due to the unique characteristics of the market. Accurate prediction of stock prices in the metaverse can significantly impact investment strategies, enabling investors to optimize their returns. Additionally, such predictions can provide valuable information for regulatory decisions in the emerging industry of the metaverse, ensuring fair and efficient markets.

Notwithstanding the favorable outcomes, the present investigation exhibits certain restrictions. First and foremost, it fails to incorporate a comparative analysis with other time series models like Prophet and VAR. Subsequent research could investigate the efficacy of these models in comparison to the suggested LSTM model. Secondly, the study relies solely on the utilization of a single firm's stock data for the purpose of model training and testing. To enhance the generalizability of the model, future studies may consider integrating data from multiple companies operating in the metaverse industry. In general, this study contributes to the existing literature on stock price prediction in the metaverse and establishes a foundation for further exploration in this field.

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