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Predictive Modeling of Apple Share Prices: A Comparative Study of Deep Learning Techniques

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Abstract

This study examines stock market analysis through computational models to forecast stock price fluctuations, with a specific emphasis on the AAPL dataset from Apple Inc. This model is known for its ability to deal with long-term and sequential data. Due to these reasons, LSTM is the best model to deal with stock pricing predictions. Data preprocessing in this model includes time-series formatting, feature scaling, and the creation of sequential datasets. This model is trained by 80% of data and tested by 20% of data and been evaluated by (MAE), (MSE) to know its performance the result indicates that the model's performance is well and makes a good prediction with accuracy 93% using 100 epochs to train the model in neural network. This model offers effective stock price prediction and a smart strategy for it. This model solved the problem of stock price prediction effectively.

Keywords: Market Analysis; LSTM Model; RNN; LSTM; Prediction.

1 | Introduction

The Market for stocks is one of the dynamic, complex environments wherein prices fluctuate based on various economic conditions, market trends, and investor sentiments. Predicting stock prices is a challenge, it demands analysis of historical data to find patterns and trends guiding future forecasts. Traditional traders and investors have used manual chart analysis and statistical models to predict stock movements, but most of these methods cannot capture the intricate and nonlinear relationships that exist among financial data. This would turn with high development regarding technology, where deep learning techniques emerged to be mighty tools in performing time-series forecasting, presenting their capability to learn from difficult patterns in sequential data [1-2]. Of these, the model named Long Short-Term Memory has shown great promise for a solution to the problem of long-term dependencies and vanishing gradients in traditional RNNs. This research is dedicated solely to the application of an LSTM model for stock price prediction using historical data from Apple Inc. (AAPL). By leveraging LSTM's capabilities, this research aims to further demonstrate how deep learning has the potential to enhance both the accuracy and reliability of stock price forecasts [4].

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This study will be of help to traders, investors, and financial analysts in the course of decision-making in a very volatile market environment [9].

Time series analysis plays a key role in identifying market trends, such as bullish or bearish, and helps improve investment decisions. Stock price prediction techniques are categorized into:

- Fundamental Analysis: Long-term forecasting based on financial metrics such as sales and earnings.
- Technical Analysis: Short-term forecasting based on historical prices, using techniques such as moving averages.
- Time Series Forecasting: Examining historical pricing trends to anticipate future fluctuations. Time series analysis is widely used in analytics, data science, econometrics, and operations research. Though there are several tools available for stock prediction, most of them are extremely expensive and not that accessible to beginners; therefore, there is a need for more affordable and user-friendly options.

2 | Literature Review

Deep learning has evolved as a highly promising topic of study in recent years, with applications in diverse tasks, including text classification, picture processing, and speech recognition, among others. It has proven effective in time series prediction due to its ability to manage chaotic data, randomness, and nonlinearity. To gain a better understanding of equities, brokers and investment managers employ numerous techniques. Based on corporate news, expert opinions on potential yields, and a stock's relative performance in the market, they make their decisions. All the information helps them predict the potential short- and long-term performance of a specific stock.

A 2019 study by Nikou et al. [3] examined several machines learning techniques, including SVM and Random Forest, and Deep Learning. By comparing the methods, they showed that the long short-term memory model, as a special way in RNN in deep learning, outperforms other methods in stock close price prediction.

Kavinnilaa J. et al. [5] have used a morally correct forecasting approach to find the indexes of the stock market. Since the LSTM model outperforms the others, the ability of the model to understand long-term patterns in data allows it to outperform RNNs with improved handling of information. With accurate precisions of forecasts, the authors provide a worthy direction for investors, analysts, and the public for informed decision-making in the stock market.

Chong et al. [6] used deep neural networks to create a more sophisticated model for stock market prediction. The model uses deep features to learn to find the key patterns in the stock return data rather than relying on past knowledge. High-frequency data from the Korean stock market was used to test the model. This method makes the system a potent tool for forecasting stock market movements since it enables it to extract abstract elements from the data without requiring prior knowledge of the predictors. They used the LSTM model to make stock price predictions and gained good accuracy, among others.

2.1 | Objectives

One of the goals of stock price predictions. Helps investors and traders understand the market and decide when to buy and when to sell to maximize profits and earn much money depending on the analysis of the market, this helps them to reduce risk improve safety, and be in a safe area without any challenge or risks, despite that, stock price prediction is complex but it is more useful for market and people to maximize trade and save money from waste.

So, using the LSTM model to make predictions is the most useful way to predict market trends, so this paper introduces Apple stock price predictions as an example to use this model in price predictions to make profits without risks. It produces a smart and effective investment approach, and it shows the power and role of the LSTM model in market and price analysis and predictions.

3 | Methodology

My goal in this study is to demonstrate how to accurately assess, pre-process, and predict stock values using sophisticated Artificial Neural Network (ANN), Recurrent Neural Network (RNN), and Long Short-Term Memory (LSTM) models [7, 8]. The process of forecasting stock prices using LSTM deep learning models is described in the flowchart in Figure 1.

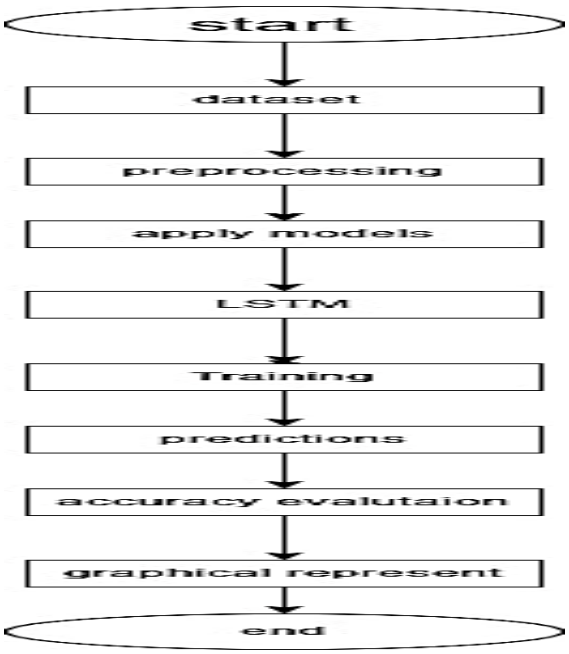

Figure 1. Flow chart of the proposed system.

3.1 | Dataset Collection

For my stock price forecasting investigation, I gathered the Apple Inc. (AAPL) stock price dataset. The dataset will be sourced from the Kaggle website and spans the period from January 4, 2010 to April 12, 2024. Store the retrieved data in a pandas Data Frame to guarantee effective data handling. This will facilitate manipulation and analysis. There are seven columns and 3593 rows in the dataset. Figure 2 displays a sample dataset.

	Date	Open	High	Low	Close	Adj Close	Volume
0	2010-01-04	7.622500	7.660714	7.585000	7.643214	6.470744	493729600
1	2010-01-05	7.664286	7.699643	7.616071	7.656429	6.481926	601904800
2	2010-01-06	7.656429	7.686786	7.526786	7.534643	6.378825	552160000
3	2010-01-07	7.562500	7.571429	7.466071	7.520714	6.367033	477131200
4	2010-01-08	7.510714	7.571429	7.466429	7.570714	6.409364	447610800
...	...	...	...	...	...	...	...
3588	2024-04-08	169.029999	169.199997	168.240005	168.449997	168.449997	37425500
3589	2024-04-09	168.699997	170.080002	168.350006	169.669998	169.669998	42451200
3590	2024-04-10	168.800003	169.089996	167.110001	167.779999	167.779999	49709300
3591	2024-04-11	168.339996	175.460007	168.160004	175.039993	175.039993	91070300
3592	2024-04-12	174.259995	178.360001	174.210007	176.550003	176.550003	101593300

3593 rows × 7 columns

Figure 2. Sample Dataset.

- Open - The first price at which a stock trades at the start of a trading day is known as the open price.
- High - The highest price at which the stock was traded during a trading day is referred to as the high price.

- Low - The lowest price at which the stock is traded during a trading day is known as the low price.
- Close - The final price at which stock is traded on a given day is known as the close price.
- Volume - The total number of shares purchased and sold during a specific trading period is used to calculate.
- AdjClose- this provides a realistic depiction of value over time by taking splits and dividends into account

3.2 | Data Pre-processing

In this phase after collecting the data the first step is to detect missing and null values in this data there are no missing or null values I have converted the date column into datetime type which enables me to deal with them and use them in model then I used 2870 day to train the model and test on another day. I spliced data into 80% train and 20% test. Then, the standard scale to the data. Using the LSTM model, entered data into it, built the neural network with one hundred epochs with 0.2 dropouts with three layers, and used Adam as the optimizer. Figure 3 shows the Apple stock price. Figure 4 shows the total open price by year. Figure 5 shows yearly open and close price. Figure 6 shows the model summary. Figure 7 shows neural Network Architecture.

Figure 3. Apple stock price.

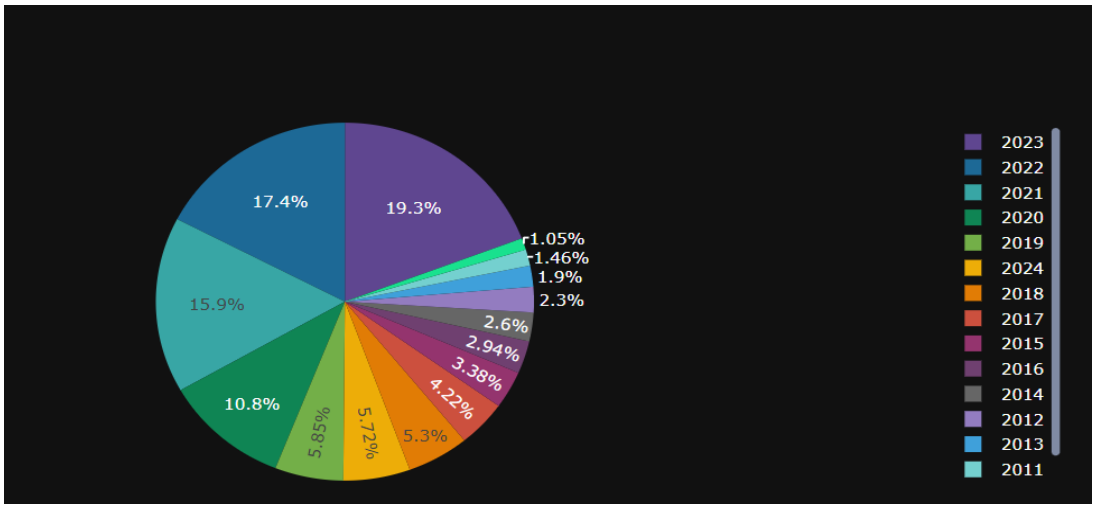

Figure 4. Total open price by year.

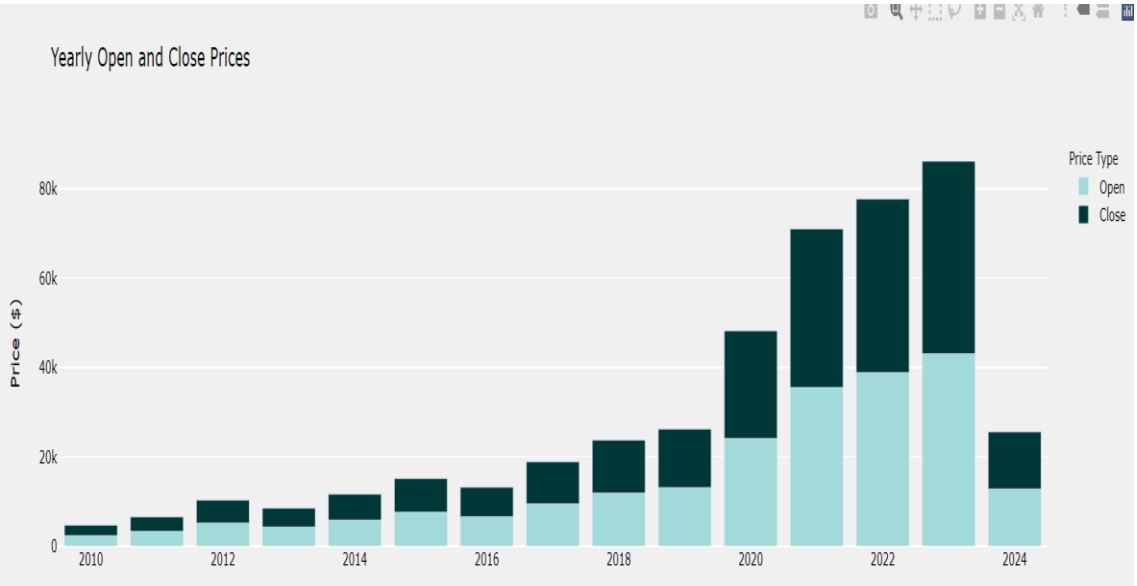

Figure 5. Yearly open and close price.

```
model.summary()
```

Model: "sequential_16"

Layer (type)	Output Shape	Param #
lstm_32 (LSTM)	(None, 28, 50)	11,400
dropout_32 (Dropout)	(None, 28, 50)	0
lstm_33 (LSTM)	(None, 50)	20,200
dropout_33 (Dropout)	(None, 50)	0
dense_16 (Dense)	(None, 1)	51

Total params: 94,955 (370.92 KB)
Trainable params: 31,651 (123.64 KB)
Non-trainable params: 0 (0.00 B)
Optimizer params: 63,304 (247.29 KB)

Figure 6. Model summary.

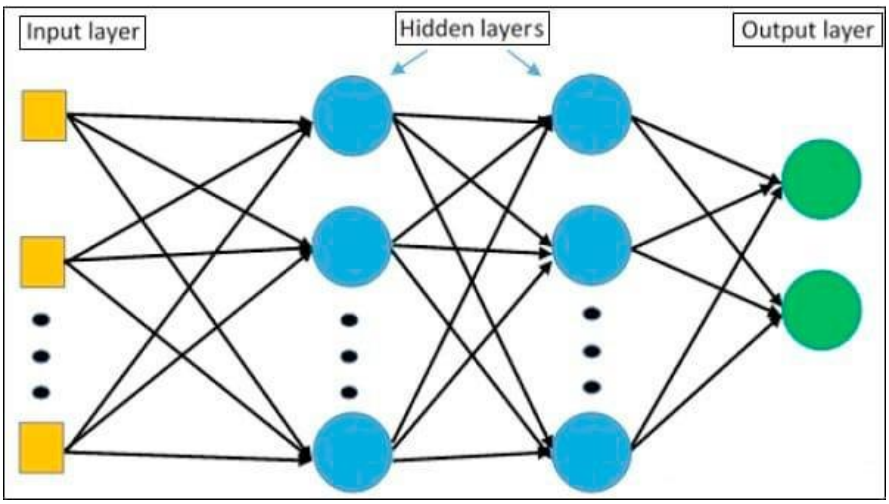

Figure 7. Neural Network Architecture.

3.3 | LSTM

A specific type of neural network called LSTM (Long Short-Term Memory) is used to process data sequences, such as time series or words. The classic RNN (Recurrent Neural Network) has been enhanced. In order to address the issue of disappearing gradients in conventional neural networks, LSTM was created. This problem hindered the network's ability to retain long-term information and learn from lengthy data sequences [3].

The issue of long-term dependency that typical recurrent neural networks (RNNs) encounter is specifically addressed by LSTM networks. Specialized memory cells and gating mechanisms are used by LSTMs to get around this issue. The essential elements of an LSTM consist of:

- Memory cell: It traverses the entire sequence like a conveyor belt. Important information can be stored in this cell and transferred across the sequence's several steps.
- Input Gate (I): This gate controls how much extra data is integrated into the cell state. It determines what is necessary to preserve by analyzing the memory and the current input.
- Forget Gate (f): This gate selects which cell state data to ignore. To determine what is no longer important, it also examines the memory and input that are now available.
- Output Gate (o): Based on the cell state, the output gate determines what information to provide. The output for the current step is created by combining the memory with the current input.

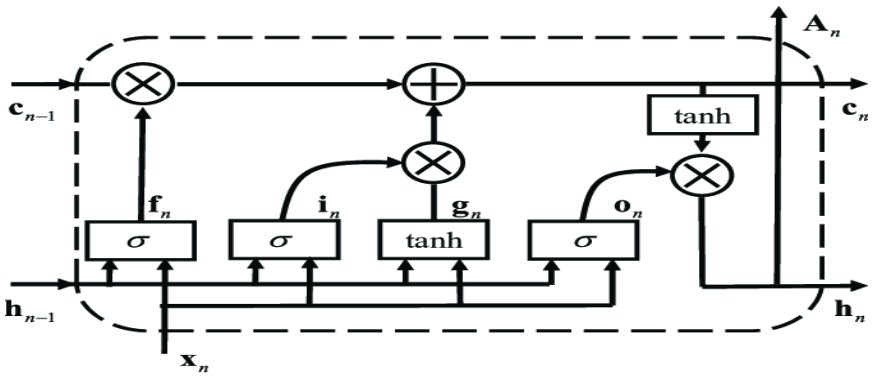

Figure 8. LSTM Architecture design.

Because stock price data is sequential by nature, with each data point reliant on its predecessors, LSTM models are essential for stock price prediction. Because they are built for sequential data, LSTMs are ideal for modeling changes in stock prices because they can identify patterns and trends over time. Figure 8 depicts LSTM Architecture.

4 | Application

By finishing data preprocessing, I used the LSTM model to make predictions with one hundred epochs and evaluate his performance by:

- Mean Squared Error (MSE): MSE computes the average squared difference between actual and predicted values.
- Mean Absolute Error (MAE): It calculates the meaning of absolute differences between observed and predicted values.

4.1 | Applying the LSTM Model and Evaluating Results

Utilizing Keras to implement a Long Short-Term Memory (LSTM) neural network for regression. The model captures temporal dependencies in sequential data and consists of three LSTM layers with 100 units each, separated by dropout layers (with a dropout rate of 0.2) to prevent overfitting. Regression results are obtained

from a dense output layer. The model is trained on the dataset for one hundred epochs with a batch size of thirty-two, using "Adam" as the optimizer and Mean Squared Error as the loss function. Following these procedures, the training data is used to train the LSTM model. Following training, the model is tested, and performance indicators like MAE and MSE are calculated. Figure 9 shows the actual open price. Figure 10 shows the APPL stock price prediction. Figure 11 shows the result model. Figure 12 shows the model accuracy. Table 1 shows the results of LSTM.

Table 1. Results of LSTM.

Models	Number of epochs	MAE	MSE	optimizer
My model	100	11.7	191.55	Adam
Their model	50	5.03	37.96	rmsprop

Figure 9. Actual open price.

4.2 | Comparison between our Model and their Model after Applying LSTM

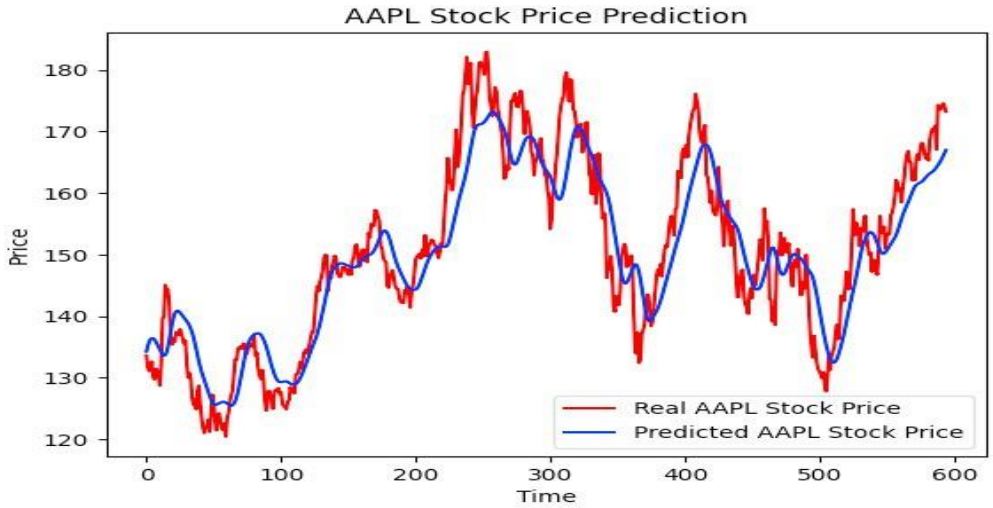

Figure 10. The APPL stock price prediction.

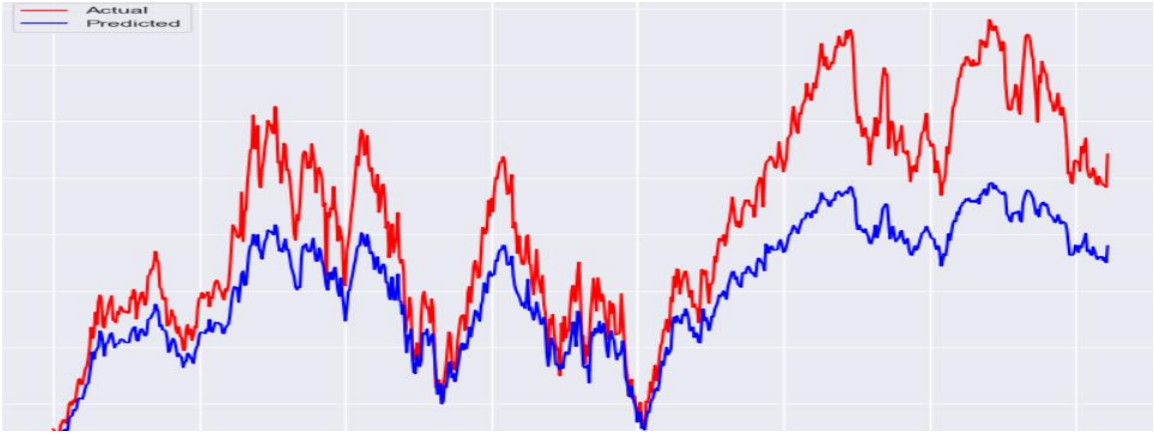

Figure 11. The result model.

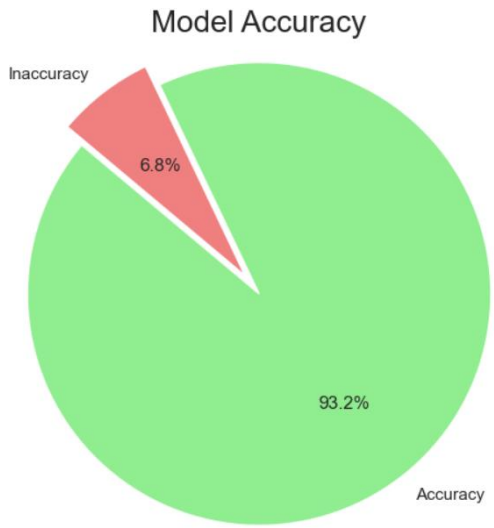

Figure 12. Model accuracy pie chart.

5 | Conclusion

In this paper, I have introduced the result of using the LSTM model for price prediction and proved that LSTM is the best model to make stock price predictions and that using the deep learning model is better than another model using the APPL dataset Model was instructed, examined, and put through a forecasting accuracy test. This contribution may be good for marketers and businesspeople to improve profits and maximize them.

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Author Contribution

All authors contributed equally to this work.

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Data Availability

The datasets generated during and/or analyzed during the current study are not publicly available due to the privacy-preserving nature of the data but are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that there is no conflict of interest in the research.

Ethical Approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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