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PREDICTING THE FUTURE STOCK PRICE OF INFOSYS LTD. USING LSTM RNN MODEL

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Abstract

It has been a challenging task to predict the stock markets as they follow a random path most of the time. Traditionally time-series models such as ARIMA and GARCH were used to model the stock markets but it has its own limitations. But with the development of artificial intelligence and machine learning this task can be done in a better way. Thus, in this paper an attempt has been made to use LSTM model to make predictions of the future stock market price of Infosys Ltd and to test how does the different number of epochs improve the model.
Key Words: *Stock Price, time-series models, stock market, LSTM Model, Infosys Ltd.*

INTRODUCTION

A subset of artificial intelligence called machine learning uses algorithms to model and predict outcomes based on data. Machine learning is used in finance for several tasks, including forecasting stock prices, identifying fraud, and assessing financial risk. An inherent advantage of using machine learning techniques to make stock market predictions over traditional time-series analysis is that in time series analysis the data needs to be stationary which is not the case with machine learning models. There are a variety of machine learning techniques which are being used to model financial datasets such as logistic regression, support vector machines, artificial neural networks, and random forests to name a few. These algorithms are helpful in in revealing complex patterns from the data which are non-linear in nature and might be difficult to uncover using linear techniques. One such technique is Long-Short Term Memory (LSTM) which is a type of Recurrent Neural Network. The aim of this paper is to use LSTM model to forecast the closing price of a single stock namely Infosys Ltd.

RECURRENT NEURAL NETWORK (RNN) AND LONG-SHORT TERM MEMORY (LSTM)

Machine learning models called artificial neural networks (ANNs) are modelled after the structure and operation of the human brain. They are made up of networked information processing and transmission nodes called neurons. ANNs have been extensively employed in the finance industry for activities including algorithmic trading, stock price forecasting, and credit risk assessment.

An ANN type called recurrent neural networks (RNNs) is made specifically to handle sequential data. RNNs keep an internal hidden state that is updated at every time step, enabling them to detect dependencies in the input sequence between time steps. Although RNNs have been employed in banking, time series predictions and sentiment analysis they inherently suffer from the vanishing gradient problem, where the gradients used in the backpropagation process become very small and causes the network to forget information from earlier steps. This makes it difficult for RNNs to capture long-term dependencies in sequential data.

To address the shortcomings of conventional RNNs in capturing long-term dependencies in sequential data, a particular sort of RNN called Long Short-Term Memory (LSTM) was developed. LSTMs have gates that regulate the flow of information into and out of the memory cell and a memory cell with a long-term retention capacity. These characteristics make LSTMs capable of selective memory and forgetting, which makes them suitable for handling sequential data with long-term dependencies. LSTMs have been applied to financial applications like algorithmic trading and stock price prediction.

REVIEW OF LITERATURE

Traditionally prediction in stock markets was made using time-series analysis tools. A big limitation of using time-series analysis is that the time series needs to be stationary to be able to accurately make predictions. This limitation of the time-series analysis can be resolved with machine learning methods although overfitting is a big problem in machine learning algorithms. There have been many studies that have tried to predict stock market using machine learning algorithms. Support vector machines (Cortes & Vapnik, 1995) (SVM) and artificial neural networks are widely used for this purpose. Moghar, A., & Hamiche, M. (2020) tried to predict the opening stock price of Google and Nike using the LSTM RNN model using different values for epochs and concluded that LSTM models can predict the opening stock prices of these two stocks with reasonable accuracy.

Selvamuthu, D., Kumar, V., & Mishra, A. (2019). used Levenberg-Marquardt, Scaled Conjugate Gradient and Bayesian Regularization for stock market prediction based on tick level data as well as 15-min data of Reliance Pvt. Ltd. and concluded that all the three models have an accuracy of more than 90%. Arafat Jahan Nova, Zahada Qurashi Mim, Sanjida Rowshan, Md. Riad Ul Islam, Md Nurullah and Milon Biswas used high frequency, average frequency and low frequency data to train an LSTM model and found that high frequency data is the most useful in making stock market predictions.

These are some of the studies that show the usefulness of the LSTM models in predicting stock markets however the limitations of the LSTM model indicate that there is a room for improvement in LSTM models, hence the motivation for carrying out this research.

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METHODOLOGY AND DATA

The data in this paper consists of the daily closing price of a stock namely Infosys ltd extracted from yahoo finance for the period going from 11/03/2012 to 10/07/2021. To build the model LSTM RNN is used. 80% of the data is used as training data and rest 20% of the data is used as testing data. The target variable is the next day's closing price. To normalize the data min-max scalar was used. To test the model different epoch values were used (10, 20,100). For optimizing the model 'adam' optimizer was used instead of 'stochastic gradient descent' as it takes less time to optimize the model compared to stochastic gradient descent algorithm. In the LSTM model deployed in this paper EMA's of lengths 20, 100 and 150 have been used. The activation function used by the model was linear. The number of steps used in the model were 30. There are a total of 8 features used to forecast the next day's closing price:

- **Open Price** – The opening price of the stock on a given day.
- **High Price** – The high price of a stock on a given day.
- **Low Price** – The low price of a stock on a given day.
- **Adjusted Close** – The closing price of a stock on a given day adjusted for stock splits and dividends.
- **Relative Strength Index** - The Relative Strength Index (RSI) is a technical indicator used in stock market analysis to measure the strength of a stock's price action. It oscillates between 0 and 100 and is used to identify overbought (above 70) and oversold (below 30) conditions, as well as potential reversal points in the stock's price. The RSI is calculated by comparing the magnitude of a stock's recent gains to the magnitude of its recent losses, and it is typically smoothed using a moving average over a specified number of periods. In this paper the number of periods used to calculate RSI is 14.

  RSI = 100 - (100 / (1 + RS))
  where RS = Average Gain / Average Loss over a specified number of periods.

- Exponential Moving Average (EMA) – Exponential Moving Average (EMA) is a type of moving average that places a greater weight on more recent prices to make the average more responsive to recent price changes. The formula for an EMA is as follows:

  EMA = (Current Price x Weighting Multiplier) + (Previous EMA x (1 - Weighting Multiplier))

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where, the Weighting Multiplier is a constant that determines the weight given to the most recent price, typically calculated as:

Weighting Multiplier = 2 / (Number of Periods + 1)

Model

Layer (type)	Output Shape	Param
lstm_input (Input Layer)	[(None, 30, 8)]	0
first layer (LSTM)	(None, 150)	95400
dense layer (Dense)	(None, 1)	151
output (Activation)	(None, 1)	0
Total params: 95,551		
Trainable params: 95,551		
Non-trainable params: 0		

RESULT AND DISCUSSION

The number of epochs used in the RNN LSTM model showed different results. The model has been tested on out of sample data ranging from 14/08/2020 to 08/07/2022.

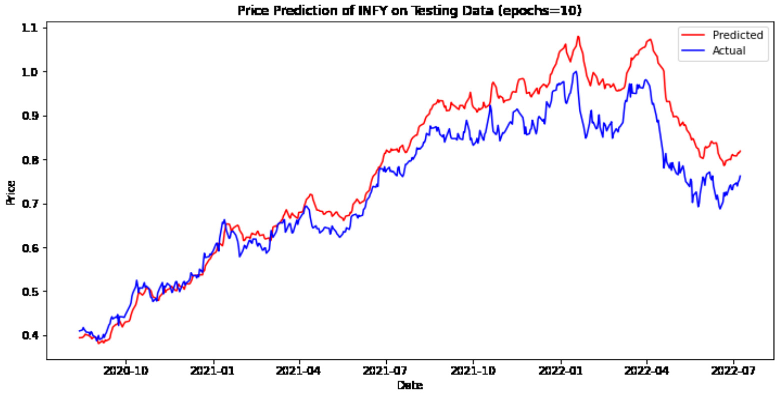

Fig 1

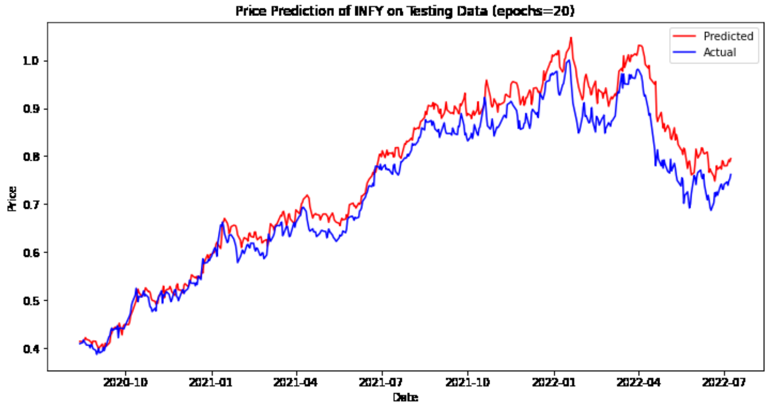

Fig 2

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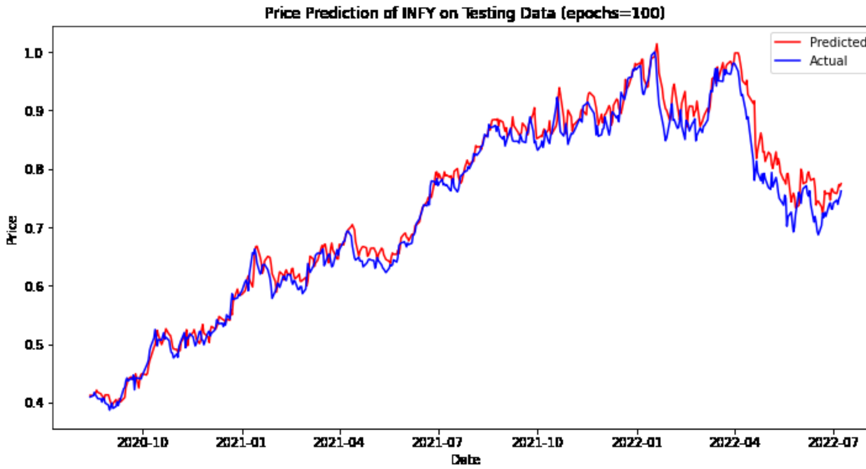

Fig 3

The above graphs represent the actual vs predicted values of Infosys Ltd. stock closing price. In the graphs above it can be clearly observed that increasing the number of epochs in the model improved the performance. This can also be observed in the RMSE of the different number epochs used. For instance, when only 10 epochs were used the RMSE of the model was 0.065776 which improved to 0.038851 when 20 epochs were used to 0.026029 when 100 epochs were used. Although other epoch values were also used but the RMSE values did not improve beyond 0.026029.

The proposed algorithm can predict next day's closing price with a very low error rate.

No. of epochs	RMSE of the model
10	0.065776
20	0.038851
100	0.026029

CONCLUSION

In this paper an attempt was made to predict the closing stock price of Infosys Ltd. Using LTSM RNN model using 8 features and step size of 30. The results above show that the model was able to predict the stock prices with a certain degree of accuracy. The model can be made more robust if more features are added and datasets for different time periods are included in the study. Also, in future enhancements of the study hyper parameter tuning can also be used which may further improve the performance of the model.

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