STOCK PRICE PREDICTION USING LSTM

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

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Dr. Manas Kumar Mishra

Dean SCSE

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ABSTRACT

Predicting stock market prices is a complex task that traditionally involves extensive human-computer interaction. Due to the correlated nature of stock prices, conventional batch processing methods cannot be utilized efficiently for stock market analysis. We propose an online learning algorithm that utilizes a kind of recurrent neural network (RNN) called Long Short Term Memory (LSTM), where the weights are adjusted for individual data points using stochastic gradient descent. This will provide more accurate results when compared to existing stock price prediction algorithms. The network is trained and evaluated for accuracy with various sizes of data, and the results are tabulated. A comparison with respect to accuracy is then performed against an Artificial Neural Network.

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1. INTRODUCTION

1.1 Introduction

The stock market is a vast array of investors and traders who buy and sell stock, pushing the price up or down. The prices of stocks are governed by the principles of demand and supply, and the ultimate goal of buying shares is to make money by buying stocks in companies whose perceived value (i.e., share price) is expected to rise. Stock markets are closely linked with the world of economics —the rise and fall of share prices can be traced back to some Key Performance Indicators. The five most commonly used KPI's are the opening stock price (`Open'), end-of-day price (`Close'), intraday low price (`Low'), intra-day peak price (`High'), and total volume of stocks traded during the day (`Volume'). Economics and stock prices are mainly reliant upon subjective perceptions about the stock market. It is near impossible to predict stock prices to the T, owing to the volatility of factors that play a major role in the movement of prices. However, it is possible to make an educated estimate of prices. Stock prices never vary in isolation: the movement of one tends to have an avalanche effect on several other stocks as well. This aspect of stock price movement can be used as an important tool to predict the prices of many stocks at once. Due to the sheer volume of money involved and number of transactions that take place every minute, there comes a trade-off between the accuracy and the volume of predictions made; as such, most stock prediction systems are implemented in a distributed, parallelized fashion. These are some of the considerations and challenges faced in stock market analysis.

Figure 1 shows the annual distribution of the papers collected and reviewed.

Table 1. The distribution of different types of articles in this paper

Types of methods	Total papers	Number of papers in Journals	Number of papers in conferences

1. CNN	18	6	12
2. RNN	38	13	25
3. LSTM	9	5	4
4. DNN	5	2	3

1.2 Motivation for the work

Our primary goal is to help the traders/ investors, improve and organize the process of price prediction and invest after having accurate knowledge. Additionally, we seek to:

- Provides a stock price prediction system.
- Reduce process errors by providing automated and a reliable stock price prediction using LSTM.
- Increase accuracy and security which can result in better and safe results.
- Flexibility, authorities capability of predicting prices.

1.3 [About Introduction to the project including techniques]

Stock price prediction using LSTM is a real-world solution of handling prediction of stock prices. This system consists of four modules- database collection, face extraction of features, creation of LSTM and predicting the trend. The most critical objective of data collection is ensuring that information-rich and reliable data is collected for statistical analysis so that data-driven decisions can be made for research. Feature Scaling (Preprocessing of data) is one of the most important stages as it improves the functionality of the algorithms. Split of the dataset for train and test. Then Converting features into NumPy array and reshaping the array into shape accepted by LSTM model. The LSTM does have the ability to remove or add information to the cell state, carefully regulated by structures called gates. Gates are a way to optionally let information through. They are composed out of a sigmoid neural net layer and a point wise multiplication operation. Run the model and check if it meets all the requirements and runs without any of the errors. The model is tested based on various criteria to test its proper functionality. Though not perfect, LSTMs seem to be able to predict stock price behavior correctly most of the time. Note that you are making predictions roughly in the range of 0 and 1.0 (that is, not the true stock prices). This is okay, because you're predicting the stock price movement, not the prices themselves.

1.4 Problem Statement

The stock market appears in the news every day. You hear about it every time it reaches a new high or a new low. The rate of investment and business opportunities in the Stock market can increase if an efficient algorithm could be devised to predict the short term price of an individual stock. Previous methods of stock predictions involve the use of Artificial Neural Networks and Convolution Neural Networks which has an error loss at an average of 20%. In this report, we will see if there is a possibility of devising a model using LSTM which will predict stock price with a less percentage of error.

1.5 Objective of the work

The main objective of this project is to build a model using Recurrent Neural Networks (RNN) and especially Long-Short Term Memory model (LSTM) to predict future stock market values. Another objective is to see in which precision a Machine learning algorithm can predict and how much the epochs can improve our model.

1.6 Summary

The system is developed for deploying an easy, secure and accurate way of predicting down stock price. Data collection ensures that information-rich and reliable data is collected for statistical analysis so that data-driven decisions can be made for research. Feature Scaling (Preprocessing of data) improves the functionality of the algorithms. Spliting of the dataset for train and test and converting features into NumPy array and reshaping the array into shape accepted by LSTM model. Though not perfect, LSTMs seem to be able to predict stock price behavior correctly most of the time.

2. LITERATURE SURVEY

2.1 Introduction

In developing countries like India, the stock market plays an important role in broadening and growing the country economically in a much faster way. Study of the stock market is an interesting and attractive way to gain knowledge about opportunities to traders, investors, analysts, merchants and researchers in different ways it offers. Stock indexes, predictions, trends, deep learning, machine learning, LSTM are the major terminologies that are explored during all this project. Country's development and growth is directly proportional to stock i.e. increase in stock market will result in country's economic development. Stock prediction can be defined as a combined process of investment, gambling, mind games, transaction,potentially suffering of gaining or losing all together at a gigantic level. According to CNN Business, countries like Argentina, Hungary, Jamaica tops the rankings as the best performers from year 2015 having success rate of 37.48%, 30.78%, 28.5% respectively in stock markets have used several statistical methods for deep studying and doing research on it whereas India is on 41st position with a success rate of 2.58%. The trend and pattern of the stock market may differ from an individual to a country's perspective. For example, understanding the behavioral changes in stock prediction, identifying suitable and profitable trading periods and by looking at past datas, to invest in those organizations that can result in maximum profit, etc. Because of such uncertain and dynamic behavior of stock, very few people of any country gain attraction towards the stock market. As this field is very much unpredictable, people find this field extremely challenging. So, to change people's mindset and to reduce the risk of losing, analysis of market prediction methods come into play to bring much better results. Prediction through LSTM helps organizations and individuals to understand the behavior and trend in an effective way and provide accurate results. Long Short Term Memory(LSTM) recurrent neural networks belong to the field of deep learning algorithms. This model is chosen over other neural networks as it is very efficient in terms of time- series forecasting and processing the entire sequence data. After importing the required libraries, datas of a few days, months or years are taken and then visualized for training purposes. To preprocess the data and improve the accuracy of the project, LSTM comes into play for testing purposes. New data will be fetched for training purposes and LSTM will be tested on it. After fetching new data, test the LSTM project and predict the stock prices from the earlier one. This will increase the level of accuracy in statistical ways as it will discover the trends and dynamics of stock

prediction. Our aim will be to cover the loopholes by using LSTM.

2.2 Libraries used in the project

So the libraries we have used in our project are as following-

1. pandas as pd - Python-based data analysis toolkit which can be imported using import pandas as pd . It presents a diverse range of utilities, ranging from parsing multiple file formats to converting an entire data table into a NumPy matrix array.

2. Numpy as np - NumPy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays.

3. matplotlib.pyplot as plt - matplotlib. pyplot is a collection of functions that make matplotlib work like MATLAB. Each pyplot function makes some change to a figure: e.g., creates a figure, creates a plotting area in a figure, plots some lines in a plotting area, decorates the plot with labels, etc.

4. tensorflow as tf - TensorFlow is a free and open-source software library for machine learning. It can be used across a range of tasks but has a particular focus on training and inference of deep neural networks. Tensorflow is a symbolic math library based on dataflow and differentiable programming.

5. sklearn - Scikit-learn is a free software machine learning library for the Python programming language. It features various classification, regression and clustering algorithms including support vector machines.

6. keras - Keras is an open-source software library that provides a Python interface for artificial neural networks. Keras acts as an interface for the TensorFlow library. Up until version 2.3 Keras supported multiple backends, including TensorFlow, Microsoft Cognitive Toolkit, Theano, and PlaidML.

2.3 Existing algorithms for predicting stock prices using LSTM and their drawbacks

Traditional approaches to stock market analysis and stock price prediction include fundamental analysis, which looks at a stock's past performance and the general credibility of the company itself, and statistical analysis, which is solely concerned with number crunching and identifying patterns in stock price variation. The latter is commonly achieved with the help of Genetic Algorithms (GA) or Artificial Neural Networks (ANN's), but these fail to capture correlation between stock prices in the form of long-term temporal dependencies. Another major issue with using simple ANNs for stock prediction is the phenomenon of exploding / vanishing gradien, where the weights of a large network either become too large or too small (respectively), drastically slowing their convergence to the optimal value. This is typically caused by two factors: weights are initialized randomly, and the weights closer to the end of the network also tend to change a lot more than those at the beginning. An alternative approach to stock market analysis is to reduce the dimensionality of the input data and apply feature selection algorithms to shortlist a core set of features that have the greatest impact on stock prices or currency exchange rates across markets. However, this method does not consider long term trading strategies as it fails to take the entire history of trends into account; furthermore, there is no provision for outlier detection.

3. SYSTEM ANALYSIS

3.1 Introduction

3.1.1 Background Introduction

In developing countries like India, the stock market plays an important role in broadening and growing the country economically in a much faster way. Study of the stock market is an interesting and attractive way to gain knowledge about opportunities to traders, investors, analysts, merchants and researchers in different ways it offers. Stock indexes, predictions, trends, deep learning, machine learning, LSTM are the major terminologies that are explored during all this project. Country's development and growth is directly proportional to stock i.e. increase in stock market will result in country's economic development. Stock prediction can be defined as a combined process of investment, gambling, mind games, transaction, potentially suffering of gaining or losing all together at a gigantic level.

3.1.2 Current System

Long Short-Term Memory (LSTM) is one of many types of Recurrent Neural Network RNN, it's also capable of catching data from past stages and use it for future predictions.

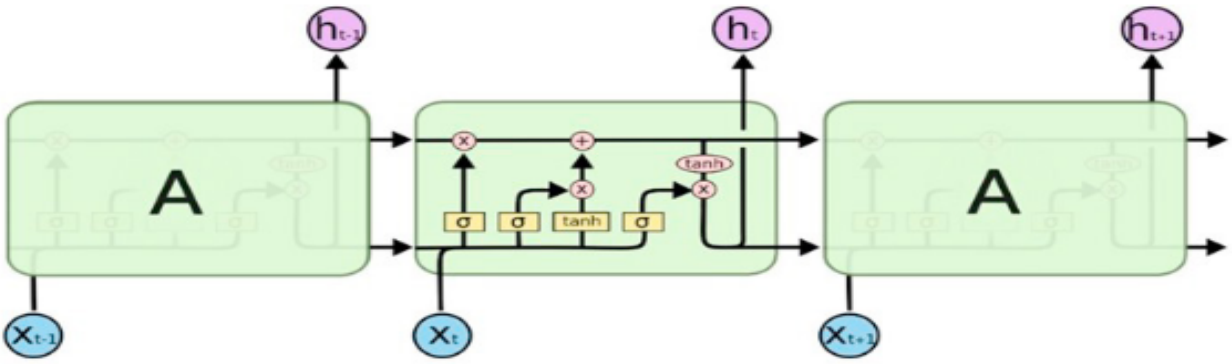


Figure 1. The internal structure of an LSTM [5].

The ability of memorizing sequence of data makes the LSTM a special kind of RNNs. Every LSTM node most be consisting of a set of cells responsible of storing passed data streams, the upper line in each cell links the models as transport line handing over data from the past to the present ones, the independency of cells helps the model dispose filter of add values of a cell to another. In the end the sigmoidal neural network layer composing the gates drive the cell to an optimal value by disposing or letting data pass through. Each sigmoid layer has a binary value (0 or 1) with 0 “let nothing pass through”; and 1 “let everything pass through.” The goal here is to control the state of each cell, the gates are controlled as follow:

- Forget Gate outputs a number between 0 and 1, where 1 illustration “completely keep this”; whereas, 0 indicates “completely ignore this.”

- Memory Gate chooses which new data will be stored in the cell. First, a sigmoid layer “input door layer” chooses which values will be changed. Next, a tanh layer makes a vector of new candidate values that could be added to the state.

- Output Gate decides what will be the output of each cell. The output value will be based on the cell state along with the filtered and freshest added data.

The following are brief descriptions of four articles that used LSTM for stock prediction. Table- lists the papers' authors,models, datasets and variables.

Table 4 lists the papers that used the Long Short Term Memory (LSTM) model.

Author	Model	Dataset	Variables	References
Lakshminarayanan, S.K.	LSTM	Dow Jones Industrial Average (DJIA)	Close price, moving average, crude oil price, and gold price	[12]
Achkar, R.	RNN with LSTM	Facebook stocks, Google stocks, and Bitcoin stocks collected from Yahoo finance	Close price	[13]
Skehin, T.	ARIMA-LSTM-Wavelet	Facebook Inc. (FB), Apple Inc. (AAPL), Amazon.com Inc (AMZN), Netflix Inc. (NFLX), and Alphabet Inc. (GOOG) in NASDAQ of S&P 500	Close price	[14]
Jin, Zhigang, et al.	LSTM with sentiment analysis model	Apple stock price	Sentiment and stock price data	[15]

Lakshminarayanan, S.K. proposed an LSTM model combined with crude oil price, gold price, and moving average, which performed much better than the LSTM model without them and the SVM model. It showed that the crude oil and gold prices had some impact on stock price

prediction [12].

Achkar, R. proposed an approach to predict stock market ratios using artificial neural networks. It considered two different techniques—Best performance algorithm (BPA)-Multilayer perceptron (MLP) and LSTM-RNN—their potential, and their limitations. And the LSTM-RNN model outperformed the other one slightly [13].

Skehin, T. proposed a linear Autoregressive Integrated Moving Average (ARIMA) model and LSTM network for each series to produce next-day predictions. Wavelet methods decomposed a series into approximation and detail components to better explain behavior over time. He combined these techniques in a novel ensemble model in an attempt to increase forecast accuracy [14].

Jin, Z., et al. proposed to incorporate a sentiment analysis model into LSTM; they successfully created a novel model which delivers a reasonable result [15].

3.2 Disadvantages/Limitations in the existing system

The stock market is fundamentally a reflection of human emotions. There are limitations to pure number crunching and analysis.

Stock markets are influenced by highly unstable factors such as weblogs and news, making forecasting stock market indexes based solely on historical data difficult.

A potential extension of this stock prediction system would be to supplement it with news feed analysis from social media like Twitter, where emotions are assessed from the opinion pieces or public information such as market news and corporate statistics. This sentiment analysis can be combined with the LSTM to improve train weights and overall accuracy.

3.3 Proposed System

We propose an online learning algorithm for predicting the end-of-day price of a given stock with the help

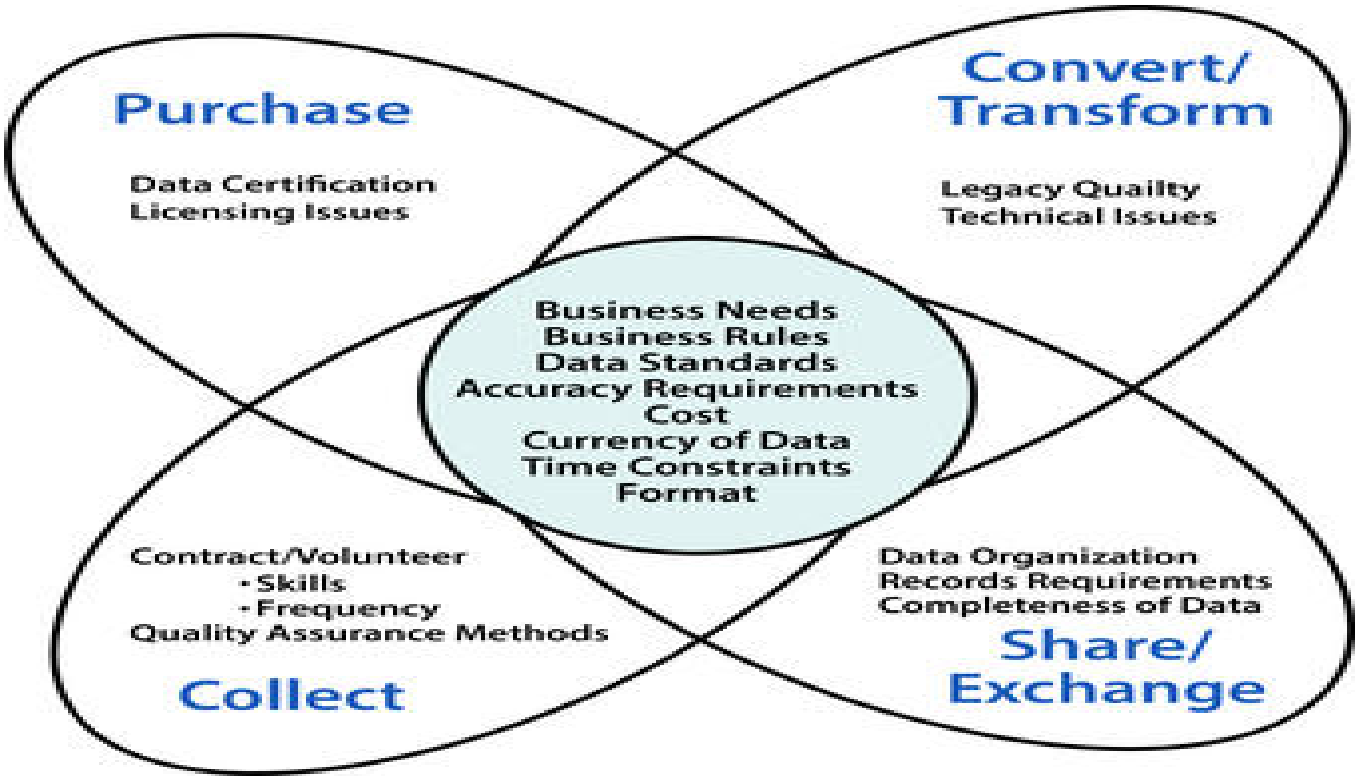
of Long Short Term Memory (LSTM), a type of Recurrent Neural Network (RNN).

The four modules of this proposed work are:

3.3.1 Data collection- A dataset is a collection of data. The data set may comprise data for one or more members, corresponding to the number of rows. Here we keep all our data in the form of csv files. In computing, a commaseparated values (CSV) file is a delimited text file that uses a comma to separate values. A CSV file stores tabular data (numbers and text) in plain text. Each line of the file is a data record. Each record consists of one or more field, separated by commas. The use of the comma as a field separator is the source of the name for this file format. Our dataset is kept in tabular format in excel with values such as date, open, high, low, last, low ,total trade and turnover values.

3.3.2 Data Preprocessing- Data preprocessing is an important step in the machine learning projects. Data-gathering methods are often loosely controlled, resulting in out-of-range values missing values, etc. Analyzing data that has not been carefully screened for such problems can produce misleading results. Thus, the representation and quality of data is first and foremost before running an analysis. Data preparation and filtering steps can take considerable amount of processing time. Data preprocessing includes cleaning, instance selection, normalization, transformation, feature extraction and selection etc. The product of data preprocessing is the final training set.

3.3.3 Data Acquisition- There are four methods of acquiring data: collecting new data; converting/transforming legacy data; sharing/exchanging data; and purchasing data. This includes automated collection (e.g., of sensor-derived data), the manual recording of empirical observations, and obtaining existing data from other sources.



3.3.4 Extraction of feature- The profit or loss calculation is usually determined by the closing price of a stock for the day, hence we will consider the closing price as the target variable.

- Since LSTM are sensitive to the scale of the data, so we apply MinMaxScaler to transform our values between 0 and 1
- Sklearn contains the preprocessing module that will allow us to scale our data and then fit it in our model.

TRAINING AND TESTING DATASET

- Splitting the data into training and test sets is crucial for getting a realistic estimate of our model's performance. We have used 75% of the dataset as the training set and the remaining 25% as the testing set.
- We will take 75% of the the total length of our data frame and store it as our training size and test size should be the length of (data frame-training size) of the data frame i.e 25%
- Using this we will create our training and test data and store it in variables.
- TimeSteps-How many data points we are going to use to predict the next datapoint in the sequence.
  .
- X_Train Input on the basis of which we will get the Y_Train output in the Training dataset.

- Similarly we will do the same segregation under test data as X_Test and Y_Test.

```
Timeseries data---> Train- 120,130,125,140,134,150  Test---160,190,154

120,130,125,140,134,150                              160,190,154,160,170

Timesteps=3
    X_train   y_train                        y_train f1   f2   f3  o/p(y_test)
f1   f2   f3   o/p
120  130  125  140                                    160  190  154  160
130  125  140  134                                    190  154  160  170
```

3.3.5 Creation of LSTM- The LSTM does have the ability to remove or add information to the cell state, carefully regulated by structures called gates. Gates are a way to optionally let information through. They are composed out of a sigmoid neural net layer and a pointwise multiplication operation.

Compile and fit the model (Training):

Run the model and check if it meets all the requirements and runs without any of the errors.

Evaluate the performance of model(Test):

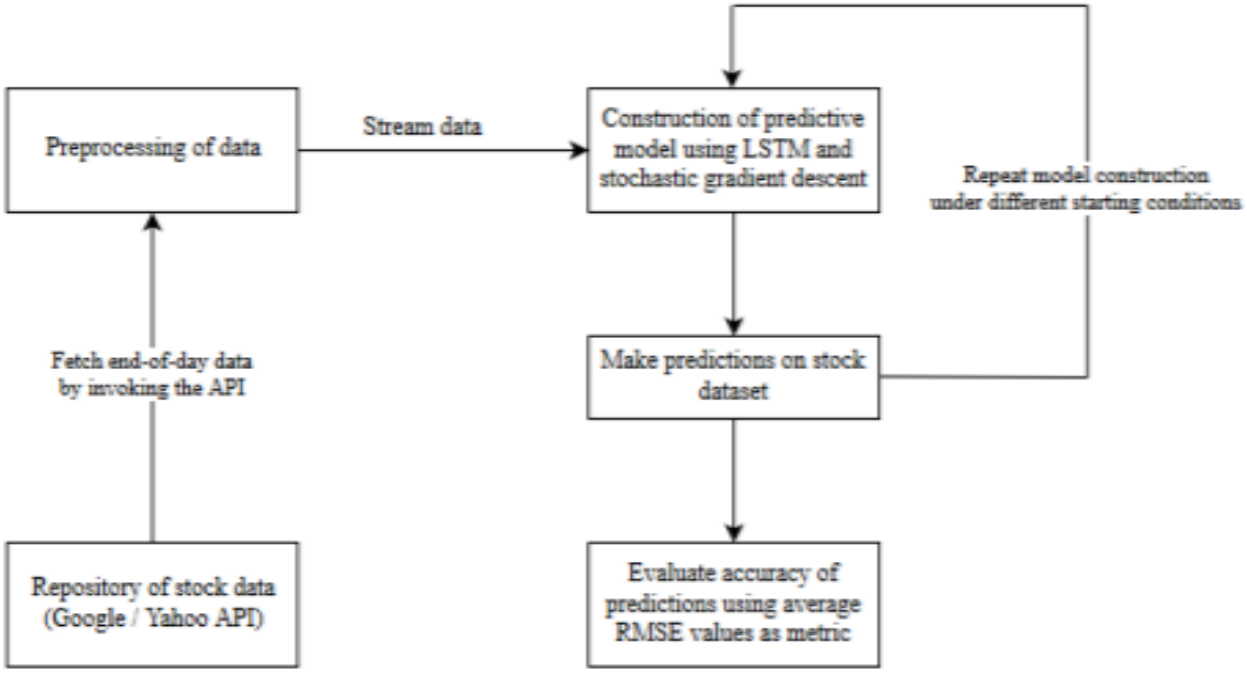
The model is tested based on various criteria to test its proper functionality.

3.3.6 Predicting the trend- Though not perfect, LSTMs seem to be able to predict stock price behavior correctly most of the time. Note that you are making predictions roughly in the range of 0 and 1.0 (that is, not the true stock prices). This is okay, because you're predicting the stock price movement, not the prices themselves.

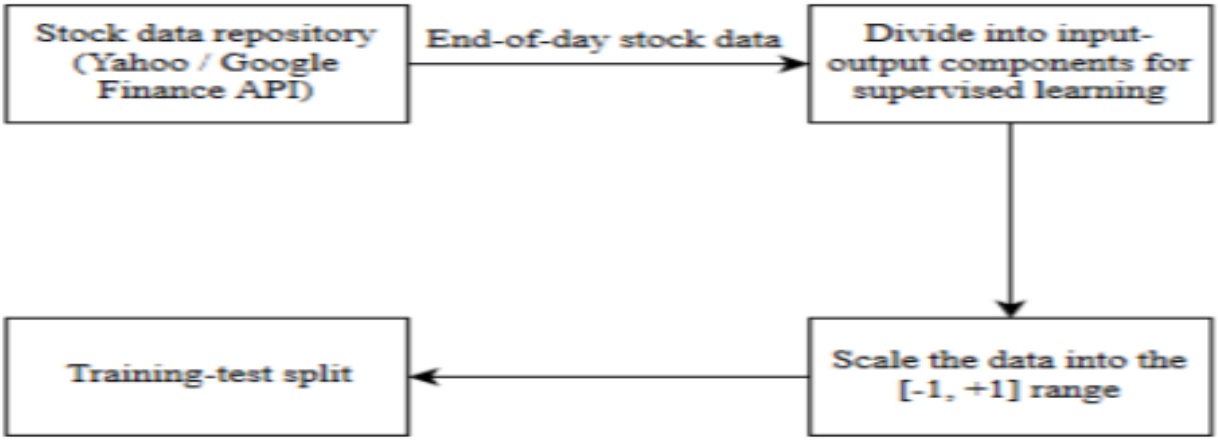
4. SYSTEM DESIGN AND IMPLEMENTATION

4.1 Introduction

The stock prediction system depicted in Figure has three main components. A brief explanation of each is given below:



4.1.1 Obtaining dataset and preprocessing-



Stock market data (for end-of-day prices of various ticker symbols i.e., companies) was obtained from two primary sources: Yahoo Finance and Google Finance. These two websites offer URL-based APIs from which historical stock data for various companies can be obtained for various companies by simply specifying some parameters in the URL.

The obtained data contained five features:

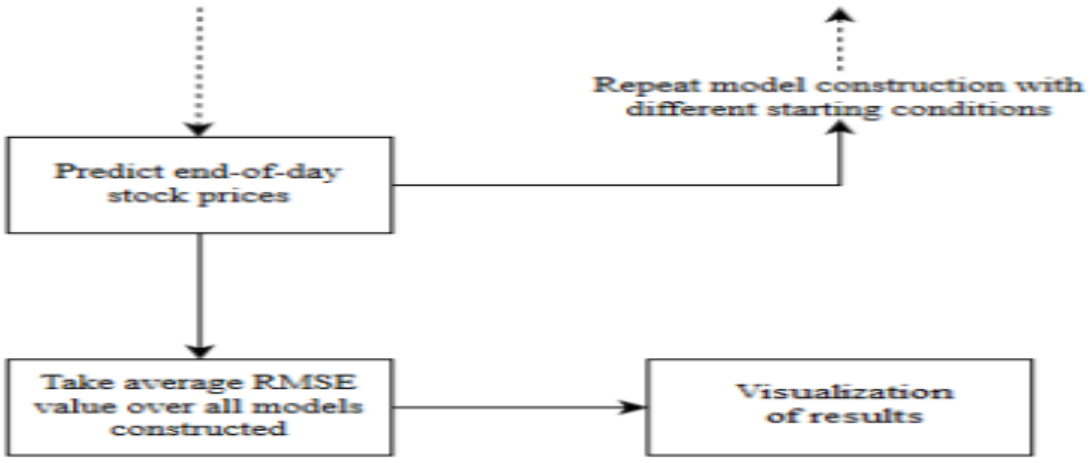
1. Date: of the observation
2. Opening price: of the stock
3. High: highest intra-day price reached by the stock
4. Low: lowest intra-day price reached by the stock
5. Volume: number of shares or contracts bought and sold in the market during the day
6. OpenInt i.e., Open Interest: how many futures contracts are currently outstanding in the market.

The above data was then transformed into a format suitable for use with our prediction model by performing the following steps:

1. Transformation of time-series data into input-output components for supervised learning
2. Scaling the data to the [-1, +1] range.

4.1.2 Construction of prediction model- The input data is split into training and test datasets; our LSTM model will be fit on the training dataset, and the accuracy of the fit will be evaluated on the test dataset. The LSTM network is constructed with one input layer having five neurons, 'n' hidden layers (with 'm' LSTM memory cells per layer), and one output layer (with one neuron). After fitting the model on the training dataset, hyper-parameter tuning is done using the validation set to choose the optimal values of parameters such as the number of hidden layers 'n', number of neurons 'm' per hidden layer, batch size, etc.

4.1.3 Predictions and accuracy-



Once the LSTM model is fit to the training data, it can be used to predict the end-of-day stock price of an

arbitrary stock. This prediction can be performed in two ways:

1. Static – a simple, less accurate method where the model is fit on all the training data. Each new time step is then predicted one at a time from test data.
2. Dynamic – a complex, more accurate approach where the model is refit for each time step of the test data as new observations are made available.

The accuracy of the prediction model can then be estimated robustly using the RMSE (Root Mean Squared Error) metric. This is due to the fact that neural networks in general (including LSTM) tend to give different results with different starting conditions on the same data.

We then repeat the model construction and prediction several times (with different starting conditions) and then take the average RMSE as an indication of how well our configuration would be expected to perform on unseen realworld stock data. That is, we will compare our predictions with actual trends in stock price movement that can be inferred from historical data.

5. FUTURE ENHANCEMENT AND CONCLUSION

5.1 Introduction

We intend to keep investigating ways to improve our model and its predictions by studying changes on the neural network architecture and different approaches for pre-processing the
input data as well as adding new different features.

5.2 Limitation/Constraints of the System

The stock market is fundamentally a reflection of human emotions.There are limitations to pure number crunching and analysis.
Stock markets are influenced by highly unstable factors such as weblogs and news, making forecasting stock market indexes based solely on historical data difficult.
A potential extension of this stock prediction system would be to supplement it with news feed analysis from social media like Twitter, where emotions are assessed from the opinion pieces or public information such as market news and corporate statistics. This sentiment analysis can be combined with the LSTM to improve train weights and overall accuracy.

5.3 Advantages

The main advantage of an LSTM is its ability to learn contextspecific temporal dependence. Each LSTM unit remembers information for either a long or a shortperiod of time (hence the name) without explicitly using an activation function within the recurrent components. An important fact to note is that any cell state is multiplied only by the output of the forget gate, which varies between 0 and 1. That is, the forget gate in an LSTM cell is responsible for both the weights and the activation function of the cell state. Therefore, information from a previous cell state can pass through a cell unchanged instead of increasing or decreasing exponentially at each time-stepor layer, and the weights can converge to their optimal values in a reasonable amount of time. This allows LSTM's to solve the vanishing gradient problem – since the value stored in a memory cell isn't iteratively modified, the gradient does not vanish when trained with backpropagation.

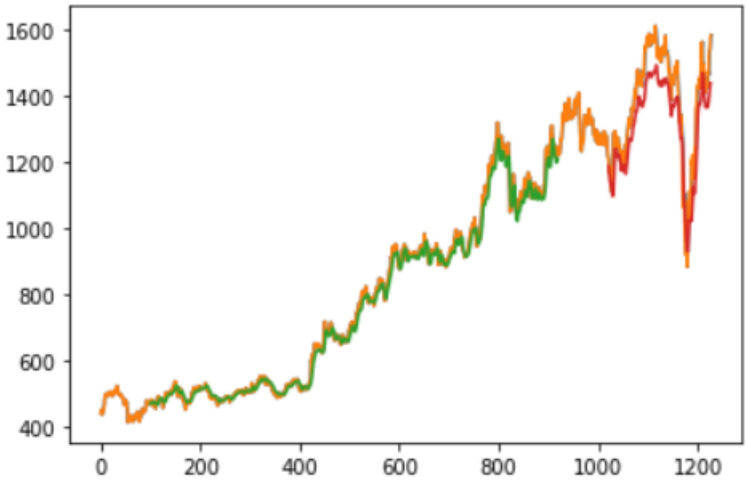
5.4 Result

The implementation of proposed LSTM model using python which predicts the future trends of Reliance_Stock share based on its historical data. The below visualization figure shows the visualization of Reliance_Stock prediction. In this report the implementation of an algorithm that predicts the stock price of a share for given time period, the below gragh from our algorithm will show the predicted price. In the result shown in the below graph is the plotted form of our algorithm outcome by applying LSTM model.

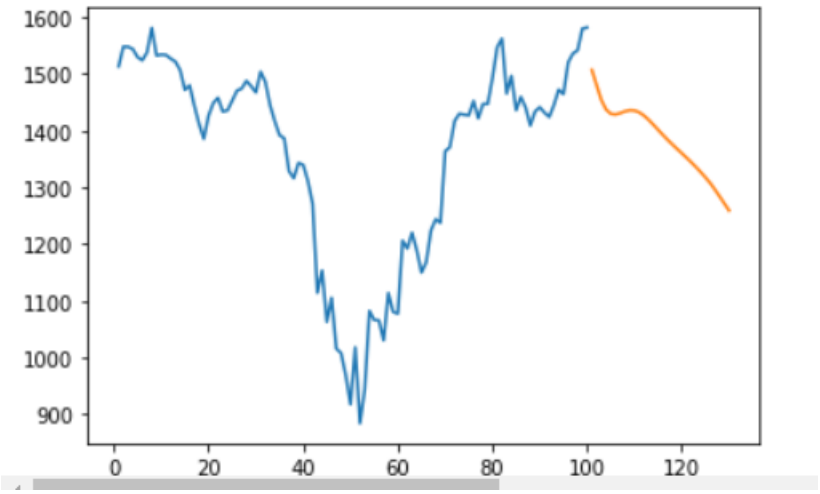
The given figure is drawn from the original dataset and show the result of the splitting of the train and test dataset. X-axis is the share price and y-axis is the number of days. The green line is for the

train data and the red line is for the test data. The orange line represents the original data set.

The graph curve which



given figure below is the representing an orange that is the prediction of 30 days stock trends will be our final output.



5.5 Conclusion

The Idea behind the stock market is to invest money.Nowadays Stock market is becoming very important from an investment point of view. Thus,we have found out a method for the prediction using new techniques. This technique is going to help any researcher and even those planning to invest in the stock market. In this project, we have used one of the most precise forecasting technology using Recurrent Neural Network and Long Short-Term Memory unit(LSTM) which helps investors, analysts or any person interested in investing in the stock market by providing them a good knowledge of the future situation of the stock market.This method can be considered as 99% efficient but may not give exact results as the original trends.

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