National College of Ireland

Stock market price prediction using time series models

MSc Research Project

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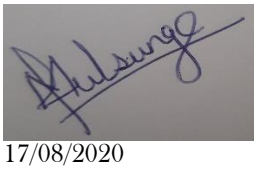

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Stock market price prediction using time series models

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Abstract
Stock market prediction is a very mysterious job for traders in stock market. Investors are risking their funds to gain the profit. Even so, they do sometimes face losses because of the incorrect stock index forecast. India has fifth largest economy by nominal GDP in the world. The time series prediction can be particularly be applied in financial matters. In this paper, the time series models such as PROPHET, KERAS with LSTM and ARIMA are used to forecast the stock market for four popular Indian banks. Data gathered from yahoo finance over the last 10 years was used to create required models. To find the best time series model, the RSME value of each model has been drawn. Model with lowest value of RSME will be considered as a best model. At last, the web application has been developed which will help users to provide the predicted values of the some future which will help in lowering the risk of losing the money.
Keywords: PROPHET, ARIMA, KERAS, LSTM.

"Rule number one: Don't lose money.
Rule number two: Don't forget rule number one"
–Warren Buffett (one of the mostsuccessful investors)

Introduction
The stock market has become one of the main economic factors as its exposure to the consumers, enables the big budget corporations to buy shares and ownership. Stock market is sector set where shares, bonds and equity movements happen. The stock market primarily concerns securities and such securities include the movement of a shares or stocks from buyer to seller as part of the protection for fixed interests and stock exchange trade. Shares are the possession of an organization which are divided into minor units which are then sell to gain the profits. The primary reason for this is when an organization needs money for their growth or expansion, they try to sell their shares in primary share market as IPO (Indian Public Offer). These shares or equity can be sold in different markets. Stock exchange supports all of such activities. SEBI (Securities and Exchange Board of India) supports two major stock exchanges, known as National Stock Exchange (NSE) and Bombay Stock Exchange (BSE). The stock market system continues to grow under constant refining. Investors need to make every investment very carefully to earn income based on variables. The nature of the stock market is

very straightforward because it gives person the freedom to invest or not their shares in a specific company by encouraging them to purchase or sell shares in an entity to the investors via the stock offering process. It will help a company negotiate with its creditors. India has around 1.2 billion people out of which only 20-25 million people are interested in investing in stock market which makes only 2% of the total population. As markets are so unpredictable, people are afraid of investing their hard-earned money in stock market, in fact Indians are more interested in investing in lands and gold. Corona virus has affected the stock market very badly all around the world and specially in India. India has faced the biggest stock market hit by losing 26% in terms of dollar while European and US market has faced the downfall of 20% and 14% respectively, whereas China, the origin of pandemic, is least affected between the period of last 3 months. This is so much pain. The market is undergoing through a several fluctuations and investors must move between areas to get the most out of it. The investors will have to reshape the overrated sectors to underrated sectors.

The Organization for Economic Co-operation and Development (OECD) has stopped the projected growth of GDP by 2020 because of the pandemic. Everyone is waiting for the things to get normal as soon as possible. Updated stock prices are available 24x7 on yahoo finance website for all the firms present in India where the prices are updated in each second. The prediction of stock markets is quite tricky due to various changing data in due course. This data also gives back the methodology that gives strong encouragement to forecast and create new predictive models. Stock market data is not any random data, this data is occurred from time to time which is generated from defined numerical data set where objects are obtained on the regular interval times at successive points. The key aspect of the stock market is that it gathers up investors who choose to buy, hold or sell the shares to ensure equal trading and accountability in the deals. So here the prediction for stock market is been done for four Indian banks using the 10 years of data from yahoo finance. For the prediction, different time series models are taken into consideration, PROPHET, ARIMA, KERAS with LSTM. Python 3.7 is used for analyzing time series models. IDE like Jupyter notebook and PyCharm are used for visualizing and processing of the data with different Python libraries like Pandas, NumPy, Sklearn, TesnsorFlow and KERAS. The prediction of stock market will be done. RMSE values will be calculated from every model and will be displayed using bar diagram. Lower the value of RMSE, better is the model.

Figure 1: Bombay Stock Exchange (Based in Mumbai, India, is the Asia's first one of the largest exchanges in the world)

Research Question

"To predict the stock market for the next 10 days and which is the best time series algorithm to do so and designing the web application for the prediction of the stock prices using the ticker symbols"

Objectives

Taking the research study into consideration, the following objectives are established.

Objective 1: Collecting the clean data for four Indian banks from the trusted website called 'Yahoo! Finance'.

Objective 2: Evaluating and Implementing the time series models to forecast the stock market.

Objective 3: Calculating the RMSE value of all the models and comparing them to find the best suitable time series model.

Objective 4: Building the user graphic with the help of web frame called 'Flask' in Python.

The datasets are driven from the website called "Yahoo! Finance". It is one of the most trusted websites globally. Many researchers have also considered using this site for their research work. (Naadun, et al., 2019) has used datasets from this site and has worked on the stock market predictions using machine learning techniques.

(Samuel Olusegun, et al., 2019) have used the same for the research in stock market behaviors prediction using stacked LSTM network. (Bharne & Prabhune, 2019) have studied ANN by using it in predicting the stock market rates.

Literature Review

(M, et al., 2020) have made the stock market prediction using sentiment analysis of the social media. They have performed sentiment analysis of various social media platforms like Facebook, YouTube, Twitter, Instagram, Forums, Blogs etc. They have found that all the data available on these platforms which people post's or write, have a great effect on stock market. By studying and extracting the insights from these unstructured data, many hidden patterns and information can be derived, and they done this by using natural language processing techniques like sentiment analysis. Here they have used the dataset from the site 'Moneycontrol'. They have used various tools like Numpy, Pandas, NLTKit, KERAS, Matplotlib, sckit learn. (Bo & Rasheed, 2010) They have purposed two inputs for the stock market prediction. One of the two inputs include from the data acquired from different social media platforms and the data which is been collected from social media is then pre-processed due to presences of noise in it which is then used to study the psychology of the people who are likely to invest in stock market. The second input is the time series data which is analyzed by LSTM (Long Short-Term Memory). The output from the first input and the data are then combined to predict the stock market price. This method gives the accuracy of about 96.95% and the error of about 3.05%, which is considered great. (Hind, et al., 2019) has done a detailed study on how the emotions of people makes a hug effect on stock market. They have provided an overview on the link among the social media platforms and the financial market which will help investors to make a wise decision about investing their money in this risky market. They have mainly studied three social media platforms, namely, Twitter, Facebook and Google search. They have mentioned that tweets have great consequences on the predictions of the stock prices. (Anjaria & Guddeti, 2014) Negative comments have negative impact, while positive comments have positive impact in this market. In short we can say that public mood have a great influence on the stock market. After performing the sentiment analysis on the Facebook, it was seen that decision of investment for passive household and non-profit organization of selling or purchasing is linked with Facebook data. After using the GSU (Google Search Volume) approach, it was found that high number of google search results in negative returns. The large number of google search results in important higher stock prices for the following two weeks.

(Selvamuthu, et al., 2019)had made use of tick data. The tick by tick data is a website which provides detailed information of the market with exact time, direction and number of contracts that were traded. Here they have used 3 ANN

algorithms, LM (Levenberg-Marquardt), Scaled Conjugate Gradient and Bayesian Regularization on the two different sources of datasets, tick by tick and 15 min dataset. It was seen that tick data provided 99.9% accuracy while 15 min dataset shows 96.2%-98.9% accuracy. They concluded that sentiment analysis and RNN would have performed more better in this case. (Adebiyi, et al., 2014) have comprehensively worked on ARIMA (Autoregressive Integrated moving Average) model. They have made use of NYSE (New York Stock Exchange) and NSE (Nigeria Stock Exchange. They have compared the actual and predicted values on Zenith Bank stocks and Nokia stock where it was seen that the predicted values show very less error percentage when compared with the actual value. Hence, they concluded saying that ARIMA model best suits for the short-team predictions while challenging the other available methods for the forecasting the stock price. (Sable, et al., 2019) have proposed two models ARIMA and SVM for the stock market prediction. They have forecasted the stock market price for the next 20 days where they have compared the predicted values of ARIMA and SVM after comparing the both models, RMSE was taken of each model and it was seen that RMSE of SVM was less than the RMSE of ARIMA. Lesser the RSME, better the performance of the model. Hence, when compared with ARIMA, SVM showed the better performance. (Naadun, et al., 2019) had tried to make predictions of stock market for Dow Jones30 for future 1,7, 15 and 30 days. They have extracted the data from four sources, first is from twitter, where they have performed the sentiment analysis, then they took the data from Yahoo Finance, third they took performed the wen scraping from google and fourth, they did web scraping on online financial news. Output of each variable is used for the multivariate and univariate time series forecasting using LSTM which is then integrated with ensemble method and the final output is presented in AWS EC2 server. It was observed that web new data along with Twitter are shrinking for the long run forecast while Twitter is fair for short run forecast. (A, et al., 2020) had used two different approaches for prediction of stock market and they are sentiment analysis and LSTM model. They have used five years of data from google stock market price. They have gathered ten significant news articles in respect to google stocks. After performing the sentiment analysis, LSTM model has been applied to get the full benefit. After performing the experiment, it was seen that when just LSTM model was used for the prediction, it failed to totally imitate the actual value while thus issue was solved when the sentiment analysis was considered for the training the data. The predicted value was imitating the actual values. It was seen that a plain sentiment analysis can increase the capability of prediction by 40%.

(Samuel Olusegun, et al., 2019) the dataset for NASDAQ composite (IXIC) was taken from yahoo finance. Ten years of data have been taken into consideration. 10% of its data has been used for testing while the remaining 90% of the data is been used for training later on the stacked LSTM is been used for training the data which

is then judged by calculating the mean squared error (MSE) and mean absolute division (MAD). This paper concluded that, the prediction of SM cannot only be predicted based on its past data, but the other element which should also be taken into note is the ongoing news in the world of finance and the politics that plays the major role in the area of the stock market. (Samuel, et al., 2019) here the datasets are taken from NSE (Nairobi Stock Exchange). 3792 days of data has been considered here. Adaptive boosting and kNN are the two machine learning classifiers, gradient booster and stacking ensemble classifiers are used for the stock market prediction. For the base level classifier adaptive boosting and kNN are used while for the top layer classifiers, as a meter level classifier, gradient boosting machine was used. Finally it was seen that machine learning models can also be the best fit models for the prediction of Stock market analysis other than the traditional time series model. The three major elements which plays important roles in the stock market are its open close attribute, high low attribute and the market capitalization. (Bharne & Prabhune, 2019)have taken the datasets from yahoo finance and used the artificial neural network to predict the stock market. (M.S & P, 2014)have used recurrent error based neuro-fuzzy system with the momentum (RENFSM) and adaptive neuro-fizzy inference system (ANFIS) for the prediction of stock market. Four years of data is considered while 70% is used for training set and remaining 30% for test set. In this paper, they have observed that there is a bond between price on momentum of some particular days and the stock market price rate. It was observed that if solid momentum keeps on increasing, the accuracy will also boost. Hence, it was seen that RENFSM gives better presentation when compared with ANFIS and recurrent ANFIS.

Research Methodology

CRISP-DM which is Cross-industry process for data mining method has been used in this project. It is very popular methodology which is robust and provides us a structural approach for the planning of a project. It has various steps in it which helps us to achieve the results in very easy and sophisticated manner. This method is very powerful and flexible. It is also known as the life cycle of data scientist. It includes various steps like business understanding, data understanding, data preparation, modelling, evaluation and deployment. The first step is business understanding in which it is very important to understand the main objective and necessity of the business. In second step which is data understanding, starts with essential data gathering process and processing it to get mix up with data, which helps in identifying the problems of data which helps in taking out the insights from data. The final dataset is been

constructed from the raw data in the data preparation stage. In modelling stage different modelling techniques has been applied. In evaluation mode, the models are been evaluated and executed to build a model according to the business requirements. The final stage is deployment in which the model is been deployed after checking all the important things like is the model meeting the all the business requirements or no and then according to that the models is been deployed.

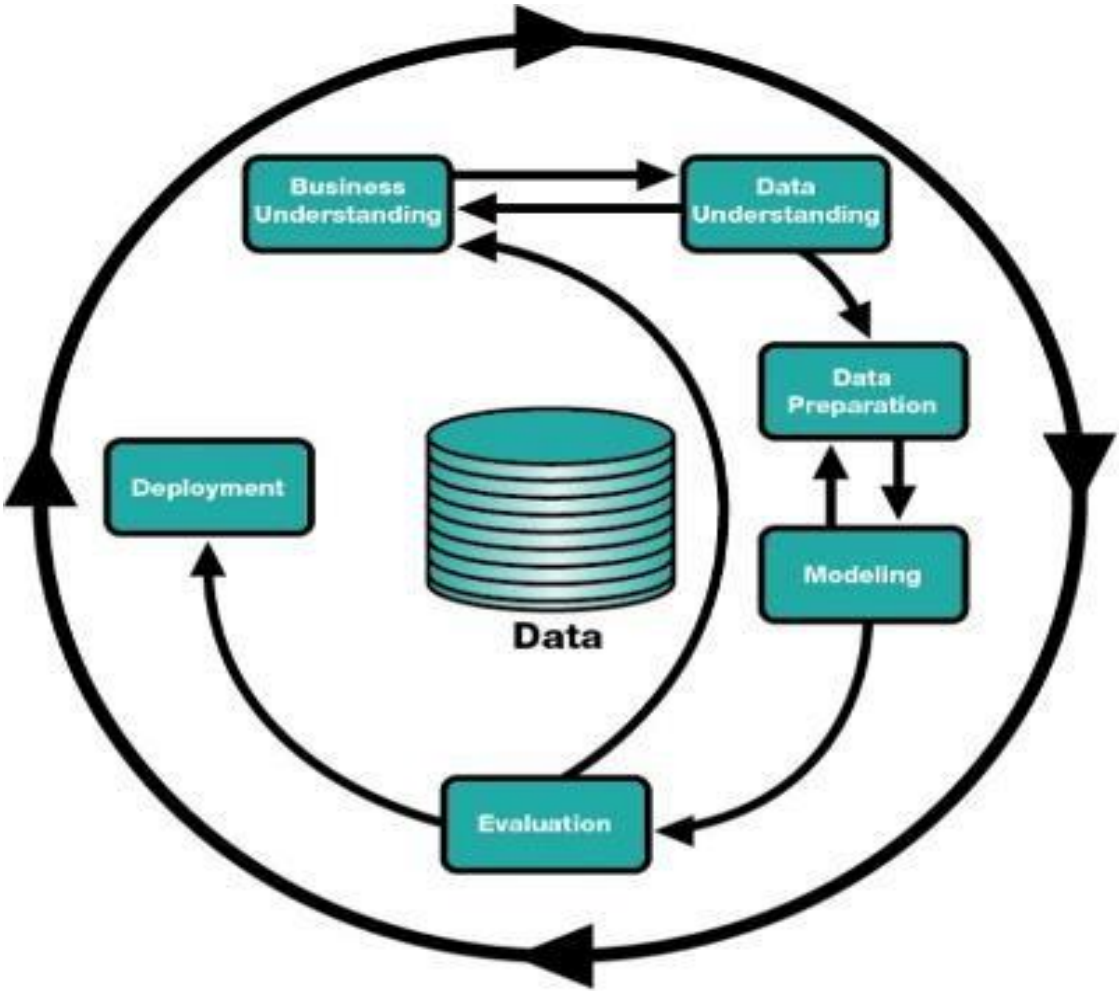

Figure 2. CRISP-DM

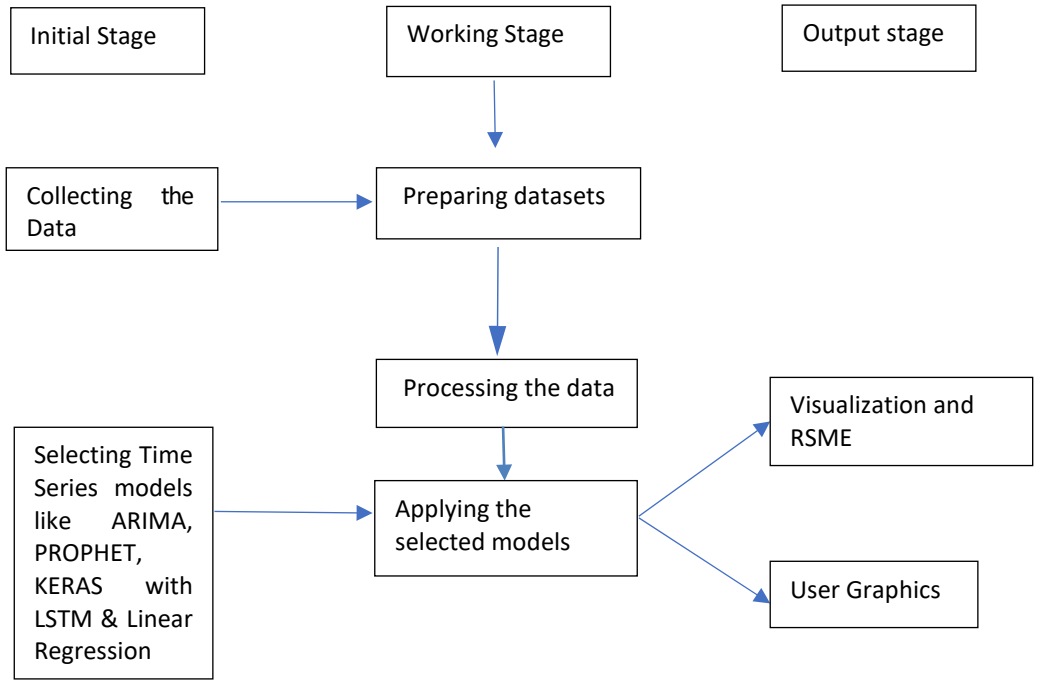

Figure 3. Flow Diagram for Methodology approach.

The above diagram provides the information of how the methodology is been driven from the three important stages. The initial stage which is the input stage begins with the collection of required data. Here the required data is been collected from the trusted website which is 'Yahoo! Finance'. It provides the news, data, stock quotes, financial reports and many more all regarding the finance for all the small and major companies across the globe. The working stage is the most important stage. The major work like data cleaning, processing, selecting the appropriate models is been carried out in this stage. The final stage is the output stage where the results of the models are been studied and visualized with their respective RSME values which will help us to find out the best model for the prediction of stock market and then the interactive UI is been created which will provide the information about the next 10-15 days stock prediction of any bank from India. The architecture includes the different steps. The first is preparation step. The data is collected by the yahoo finance. The desire data have in total seven different attributes like date, open, close, high, low, adjustment close and volume attribute. These attributes are all related to the stock market. The testing and training of the data have been carried out in an open source web application called as Jupter notebook. The different models of time series are been used like ARIMA, KERAS with LSTM, Linear Regression and PROPHET. The RMSE will be calculated of each time series model which will provide us the best suitable model for the stock market prediction. The user interface will also be developed with the help of the web frame called Flask. The user interface will us to provide the predicted stock for

the different banks in India. It will take the data from the website yahoo finance and will predict accordingly. For the front end, HTML file will be used, while Prophet.py file will be used for the back end of the user interface. The results will be shown in graphs formats so that it will be easy for people to understand them.

Implementation

The data from four different banks which are in India is been collected from yahoo finance. The following image represents how the collection has taken place in Juypter notebook.

Implementation of ARIMA

Autoregression Integrated Moving Average (ARIMA) is a type of a analysis model which is statistics in nature. It is most widely used for forecasting trends. It helps in better understanding of the data. Its is widely used for non-seasonal time series. Auto Regression (p), Moving Average (q) and difference used for the time series station (d).

Figure 4. Closing time series of data

The above figure shows the graph of the stock market for the Indian bank named ICICI. The graph shows the past stock prices which we have read in jupyter notebook.

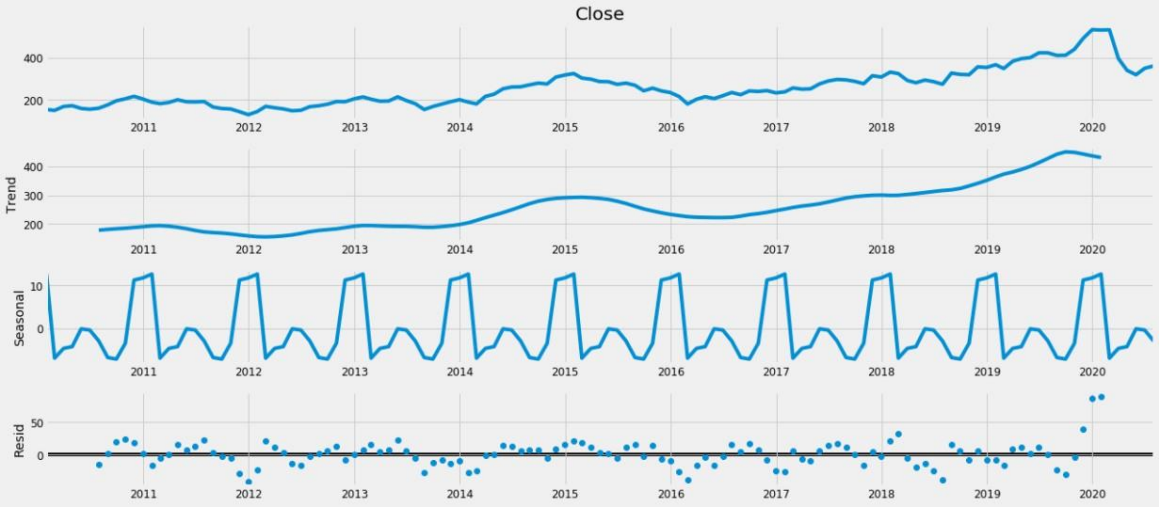

Figure 5. Decomposition of time series graph

The above graph shows the non-seasonal components of ARIMA: trend, seasonal and noise. After determining this we are going to predict the close price of the stock.

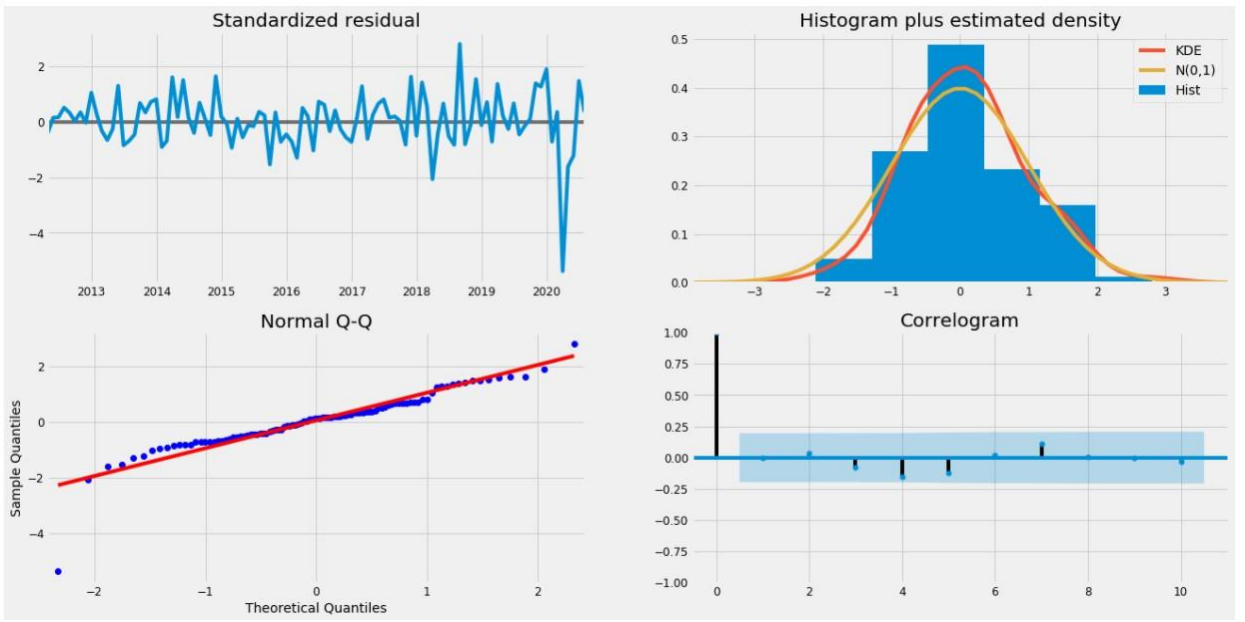

Figure 6. Results of Diagonistic graph

Figure 6. shows the different aspects of the model. By studying this one can say that the model is good enough to predict the future of the stock market. Standardized residual, histogram plus estimated density, normal Q-Q and correlogram has satisfied the requirements.

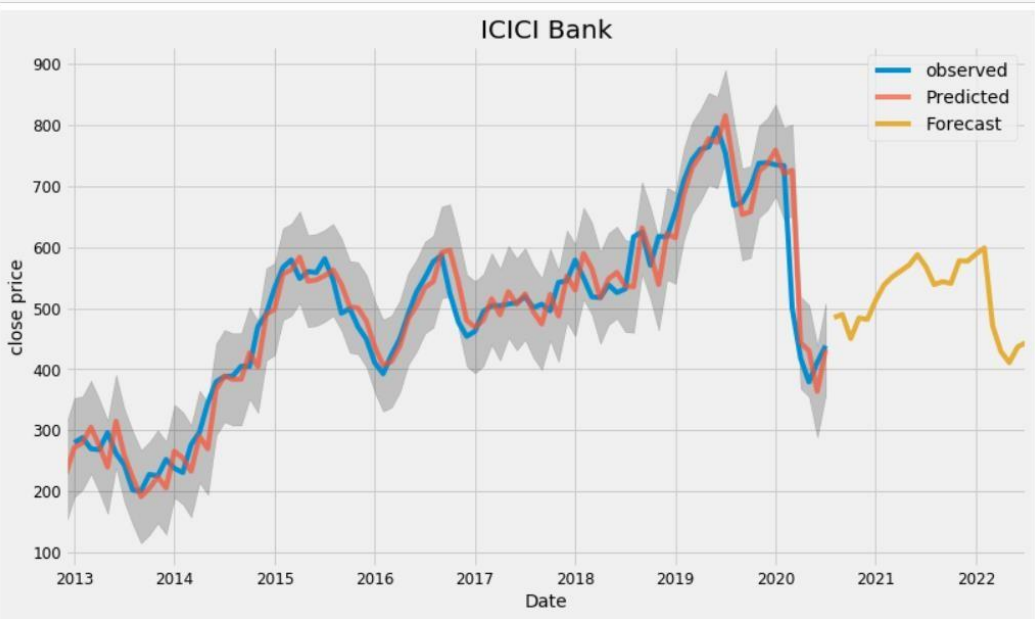

Figure 7. The forecasted result of the bank for the year 2021 and 2022

Implementation of Prophet Model

Prophet is one of the most popular time series model. It fits perfectly where the trends like yearly, weekly, daily seasonality. It suits with the series which have many seasons and strong seasonal effects of historical data.

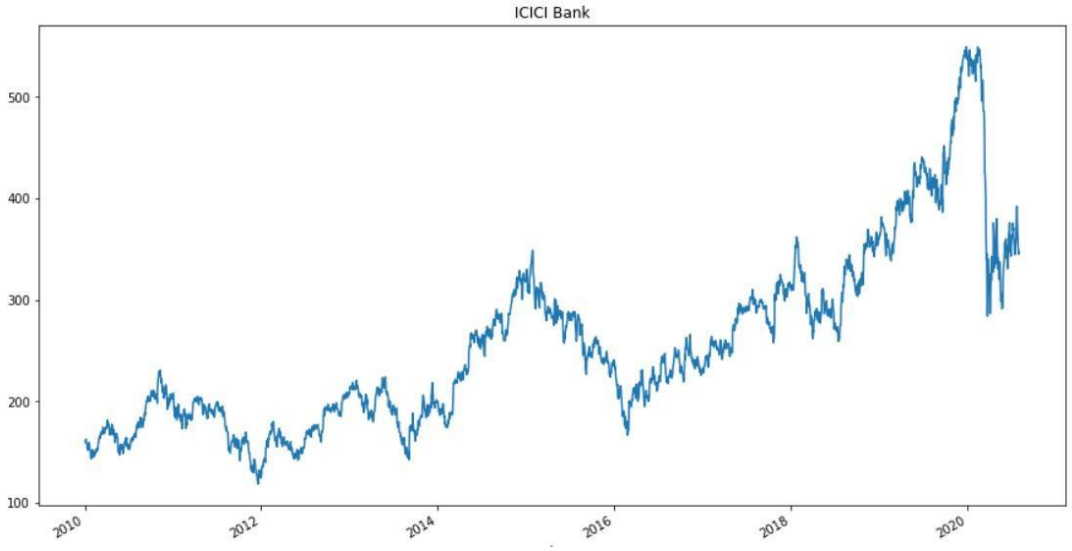

Figure 8. Reading the close attribute of the data .

The above figure explains the attribute which have the useful data of the stock market. The python library Matplotlib has been used for this visualiztion.

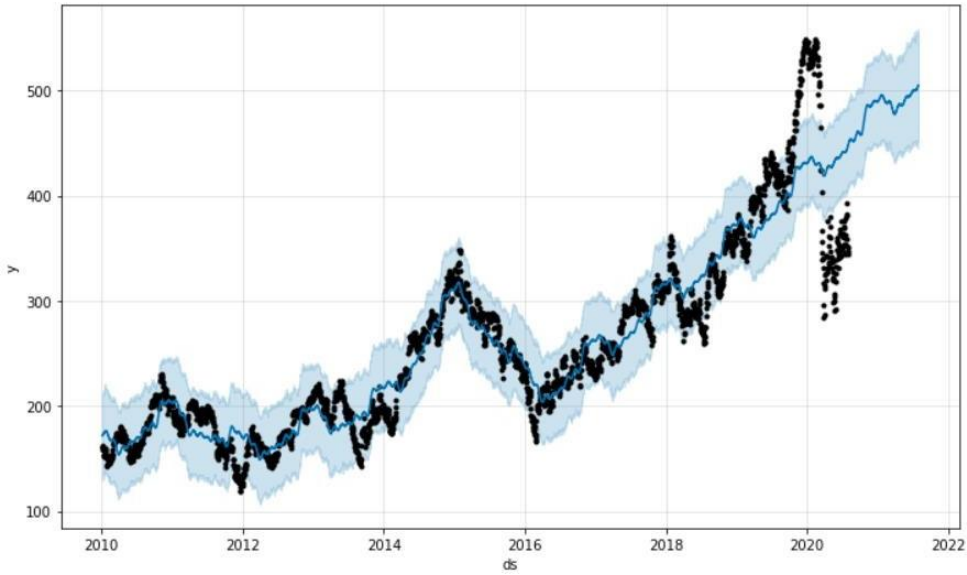

Figure 9. Forcaste of the stock market.

The above graph depics the prediction of the bank for the next two years. With the help of the plot component, this was made possible.

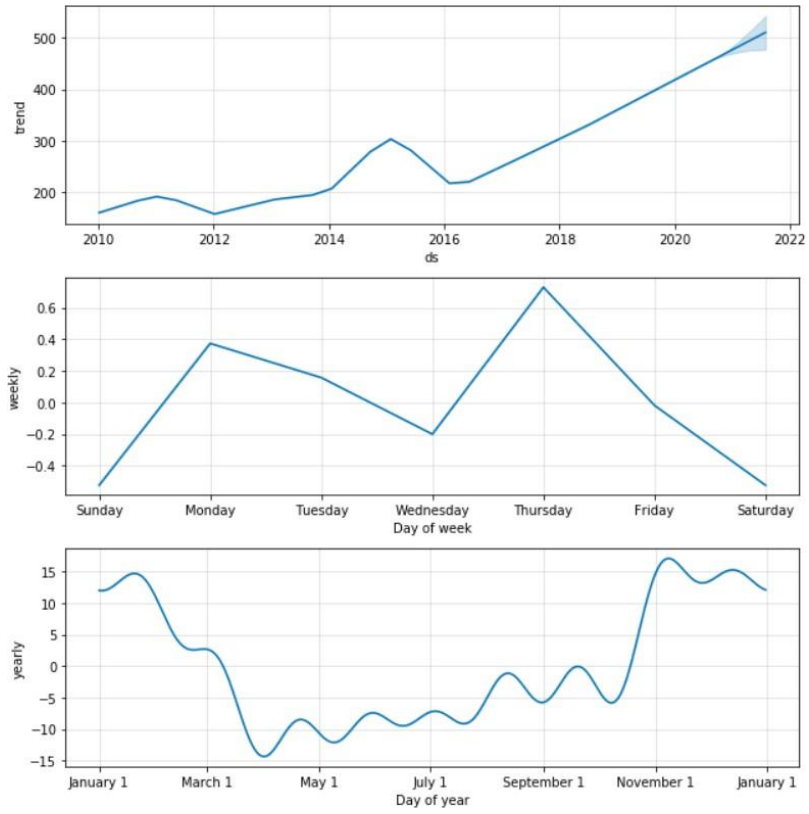

Figure 10. Trend, weekly and the yearly components of the graph.

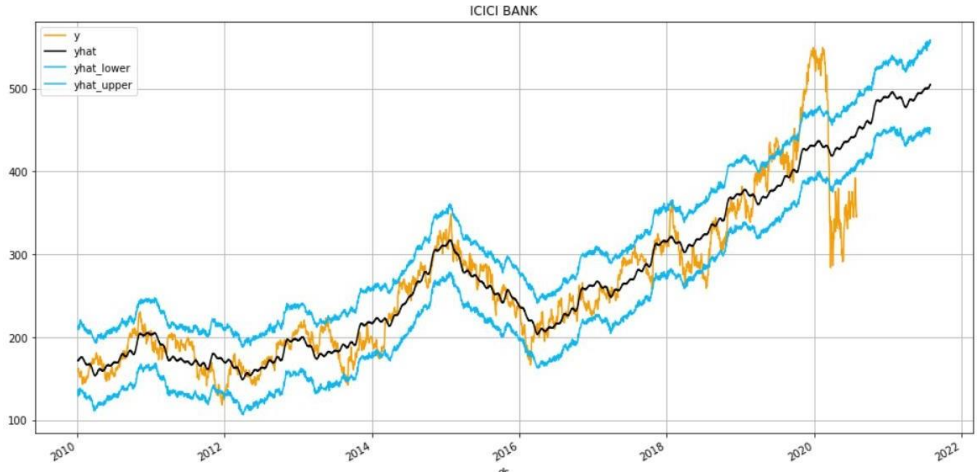

Figure 11. The predicted graph

Y is the actual value of the stock market
Ythat is the predicted value of the stock market
Ythat_lower and Ythat_upper ia the uncertain interval of the stock market

Implementation of LSTM

It is an artificial recurrent neural network. It comes with the feedback connections unlike, other typical feedforward neural networks. It over comes the drawback of RNN as it makes the use of GATES for control of memorizing process.

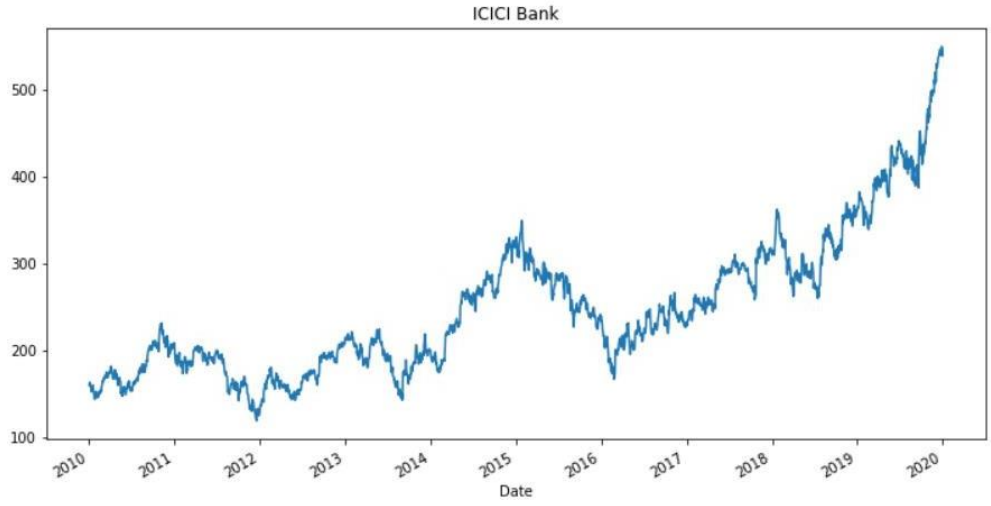

Figure 12. Reading the close attribute from the historical data of the stock market

The above diagram shows the closing attribute for the ICICI Bank from the historical data. On the x axis, the date attribute is present and the y axis shows the

close value of the stock market.

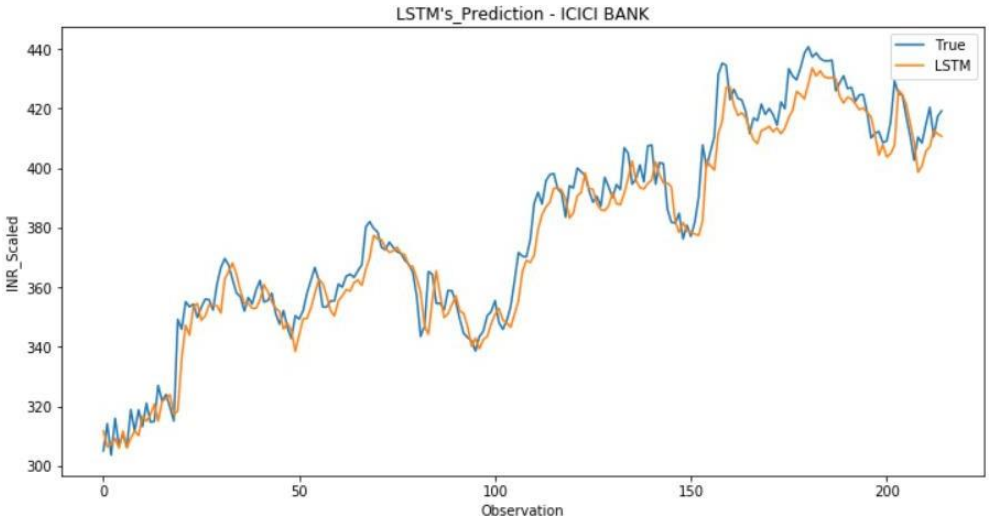

Figure 13. The predicted output

From the above graph we can say the model LSTM is giving the near about same prediction. The predicted value is mimicking the actual value.

Evaluation

Root Mean Square Error Value (RMSE) represents the standard deviation of the prediction error which is also known as the residual. The prediction errors or the residuals tell us the distance between the regression line and the data points. So in that case root mean square error value measures the distance of the residuals when they are spread. In short that can say the determination of the data around the best fit.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N} (Predicted_i - Actual_i)^2}{N}}$$

Figure 14. The RMSE formula

Lower the RMSE, better is the performance of the model. Here we have calculated the RMSE for all the three time series models which will tell us the best time series model among the three.

RSME value for ARIMA

```
Mean Absolute Error: 26.574348324345515
Mean Squared Error: 1471.3092437847674
Root Mean Squared Error: 38.35764909095404
```

Figure 15. RSME for Axis Bank

```
Mean Absolute Error: 29.390805641020258
Mean Squared Error: 1496.6250036041126
Root Mean Squared Error: 38.68623790967678
```

Figure 16. RSME for Canara Bank

```
Mean Absolute Error: 16.577637263318177
Mean Squared Error: 530.2155483321505
Root Mean Squared Error: 23.02640980118591
```

Figure 17. RSME for ICICI Bank

```
Mean Absolute Error: 4.300195022684449
Mean Squared Error: 31.551281667238147
Root Mean Squared Error: 5.617052756316086
```

Figure 18. RSME for Federal Bank

RSME value for PROPHET Model

```
Mean Absolute Error: 46.90756447314818
Mean Squared Error: 4434.654973314306
Root Mean Squared Error: 66.59320515874202
```

Figure 19. RSME for Axis Bank

```
Mean Absolute Error: 31.52274809736875
Mean Squared Error: 1550.1038251412251
Root Mean Squared Error: 39.371357928590996
```

Figure 20. RSME for Canara Bank

```
Mean Absolute Error: 21.36432852252943
Mean Squared Error: 985.2617057794989
Root Mean Squared Error: 31.38887869579764
```

Figure 21. RSME for ICICI Bank

```
Mean Absolute Error: 5.867479330297596
Mean Squared Error: 66.54068122300586
Root Mean Squared Error: 8.15724715961248
```

Figure 22. RSME for Federal Bank

RSME value for KERAS with LSTM

```
Mean Absolute Error: 11.262476437590843
Mean Squared Error: 214.35819540313167
Root Mean Squared Error: 14.640976586386978
```

Figure 23. RSME for Axis Bank

```
Mean Absolute Error: 5.676435106854103
Mean Squared Error: 55.46224496105878
Root Mean Squared Error: 7.447297829485455
```

Figure 24. RSME for Canara Bank

```
Mean Absolute Error: 5.985877600381545
Mean Squared Error: 59.12123383656153
Root Mean Squared Error: 7.689033348644128
```

Figure 25. RSME for ICICI Bank

```
Mean Absolute Error: 1.6601219709529436
Mean Squared Error: 4.617420931641814
Root Mean Squared Error: 2.148818496672489
```

Figure 26. RSME for Federal Bank

Comparing the time series models with respect to their RSME values

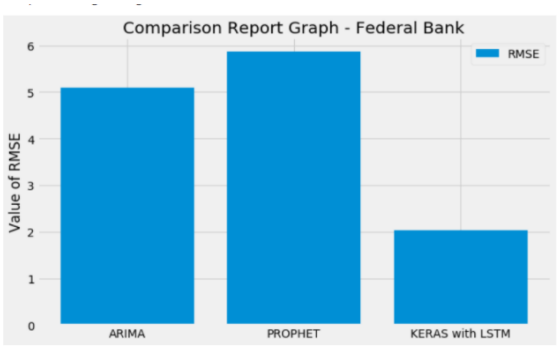

Figure 27. Federal Bank

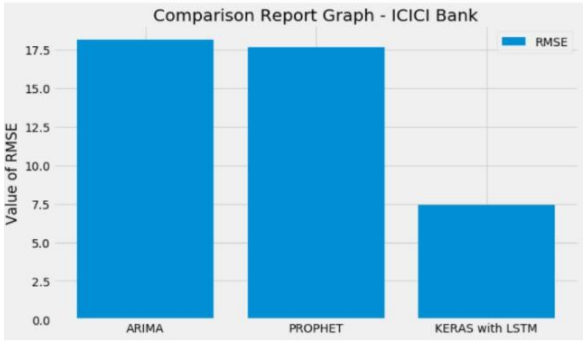

Figure 28. ICICI Bank

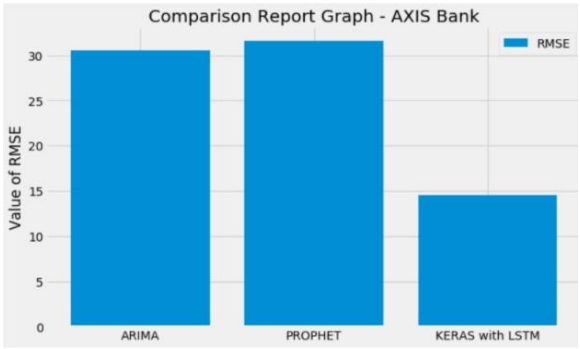

Figure 29. Axis Bank

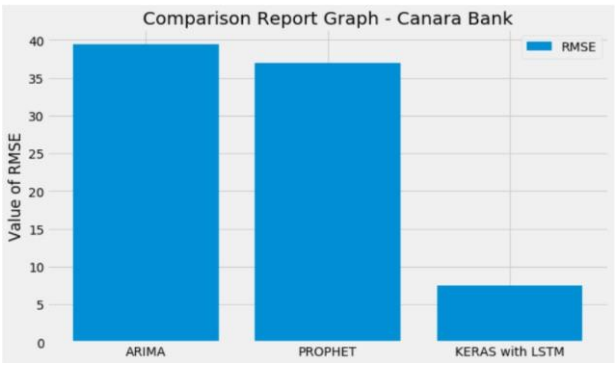

Figure 30. Canara Bank

After looking at all the figures, it is cleared that KERAS with LSTM time series model is best amongst all other time series models as the RSME value of the LSTM is much lower than that of ARIMA and PORPHET.

User Interface

User interface have built to make the work easy for the investors. This UI provides forecasted rates of the stock market for the next 10 to 15 days. This UI also gives the information of the bank which the investor has searched. This UI has been developed using python with the help of Flask web framework.

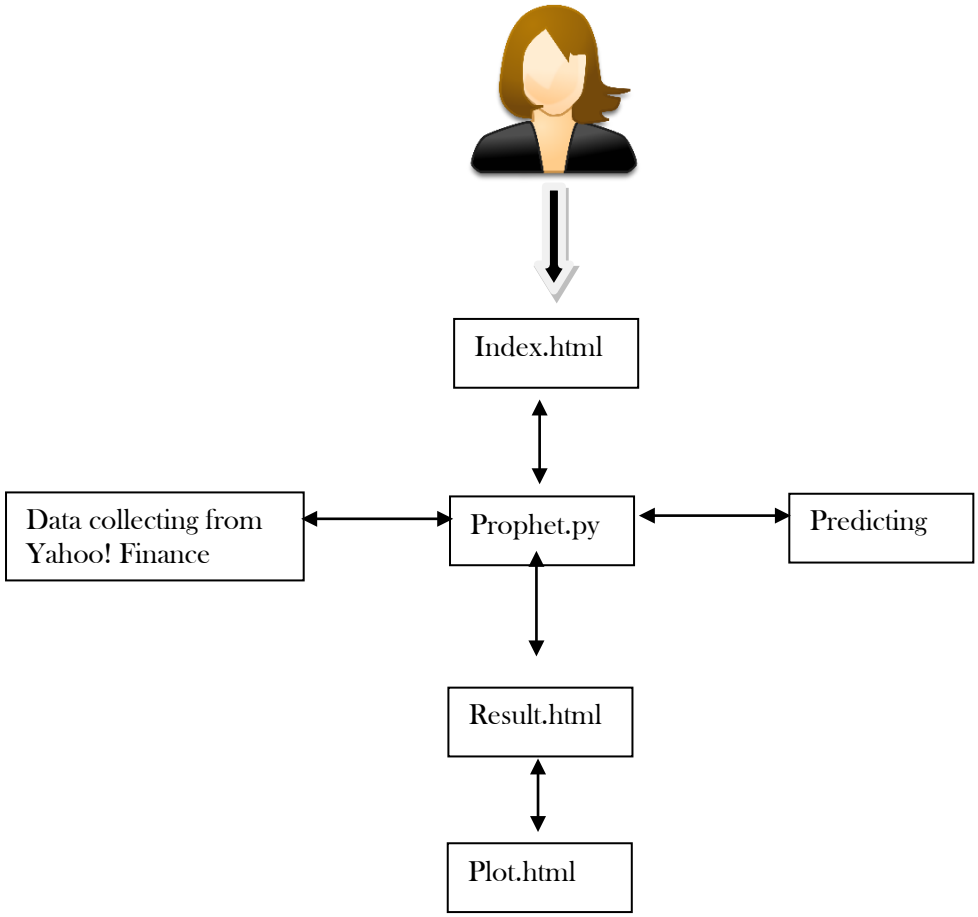

Figure 31. The flow diagram of the working of User Interface.

The users must put the ticker symbol in the search bar after which the prediction will get appear with some important information of the bank. The prediction will appear in the form of graph. As the user will ran the cursor through the graph, the predicted value will be seen.

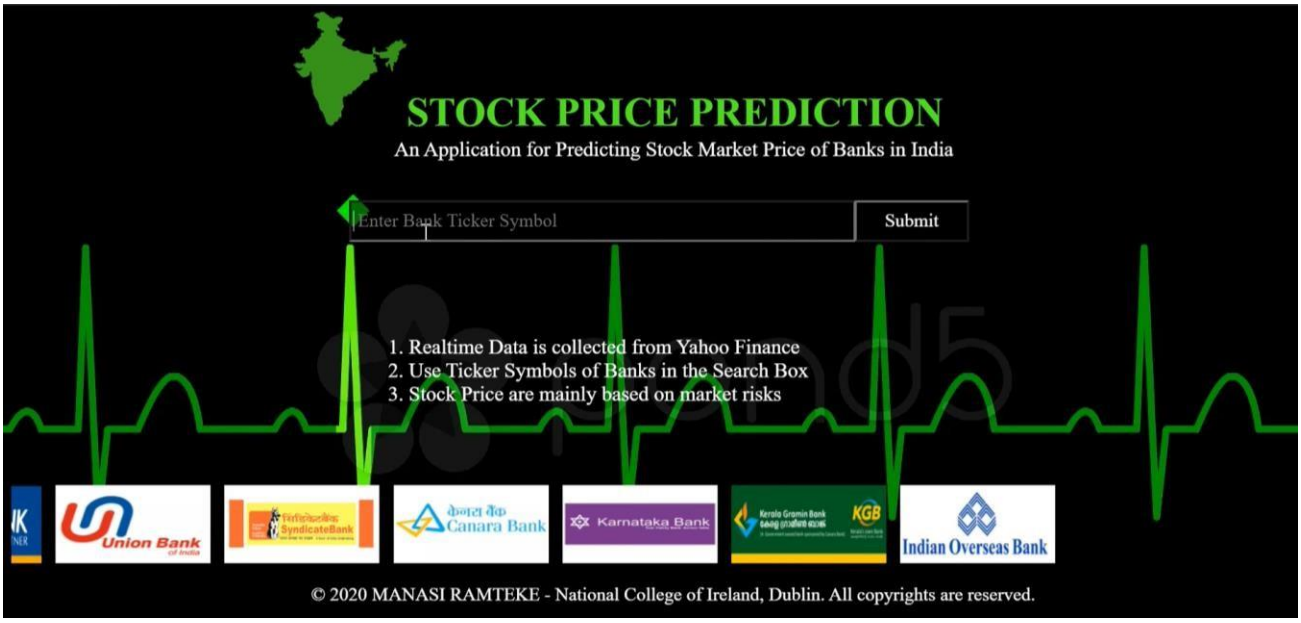

Figure 32. The web application homepage.

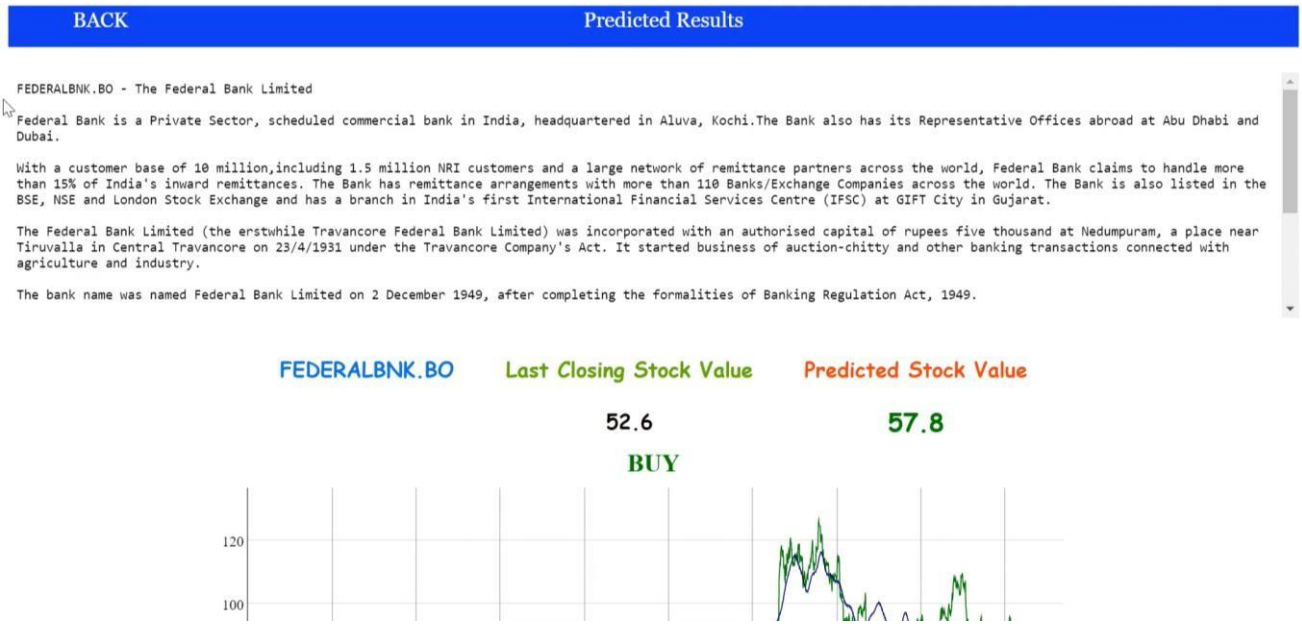

Figure 33. The useful information of the Bank

FEDERALBNK.BO is the ticker symbol of the bank name Federal Bank. In such way every bank has their own ticker symbol which is needed to put here.

Figure 34. The predicted graph

Discussion

To predict the stock market price, I have used three models of time series PROPHET, ARIMA and KERAS with LSTM. At first, I have read the dataset in time series model and have seen the graphs for the same. Then I have calculated the RMSE value of each model where it is found that KERAS with LSTM have shown the lowest value for all the banks in India. This lower RSME value has shown us the best suitable time series model for the prediction of stock market. In the final stage, user interface graphics has been build using PROPHET in PyCharm. This web application will help the investors in making decisions regarding the investments in the firm. Here I have used this web application only for some of the Indian banks, but this application can be used for any firm all over the globe. In this web application, invertors can see the predictions for the next 15 days.

Conclusion

Here we have studied the three important, well known and effective models of time series, PROPHET, ARIMA and KERAS with LSTM. We have used these models to successfully predict the very risky and tricky market which the stock market. Prediction of the stock market has always been the critical task for the many researchers across the globe due to its dynamic nature. The three respectable ways for forecasting the stock market prices are: The Machine Learning method, Typical Times Series Models and the Technical Approach. Out of these three methods we have choose here to go with time series models. We have studied their efficiency by comparing their RSME values. LSTM has shown the best result as the RSME value

of the KERAS with LSTM was low when compared with other time series models. User interface is built to easy the work of the investors which just needs a ticker symbol of the bank and after putting that the information of the bank and the forecasted rates of that bank will be displayed in graphical format. This will attract more people towards the stock market. This will also lower the risk of the loss to great extent. This will also make government to think of investment more in banking sectors by which new banks will be introduced which will provide different variety for the people to invest in banking sector.

Future Work

1. Just not only in the field of banking, this prediction can also to use in other various fields.
2. After going through more than 18 research papers on stock market prediction, one most important thing came into light that prediction of the stock market depends on many external facts also which is needed to be considered.
3. We should work towards making more user-friendly applications which will encourage many people to invest in various field by this way government will also take the initiative to develop the different fields which will there by help in developing the country.
4. There are many factors which contributes in prices of stock market like the political status, market fluctuations, market condition. Hence, these elements should also be considered.
5. There are many different numbers of algorithms available for the prediction of stock market, but more algorithm should be brought.
6. Accuracy of Prediction of the single stock can also be identified within the application which will ease the investors work.
7. Here I have used Prophet model for the web application for the forecast, but other models can also be used for the same.

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