# PROPHETIQ (A SAAS WEBSITE)

Chennupati Pavan Sanjay
*Department of AIT-CSE*
*Chandigarh University*
Gharuan, Punjab, India
pavansanjay8@gmail.com

Guttula Venkata Surya
*Department of AIT-CSE*
*Chandigarh University*
Gharuan, Punjab, India
surya270304@gmail.com

Thiramdas Karthik
*Department of AIT-CSE*
*Chandigarh University*
Gharuan, Punjab, India
thekarthikthiramdas@gmail.com

Nimmala Manideep Reddy
*Department of AIT-CSE*
*Chandigarh University*
Gharuan, Punjab, India
nimmalamanideepreddy@gmail.com

Ms. Shubhangi Mishra
*Department of AIT-CSE*
*Chandigarh University*
Gharuan, Punjab, India
shubhangi.e13142@cumail.in

*Abstract*— **This project proposes the creation of a Software-as-a-Service (SaaS) website that would provide reliable stock market price predictions using machine learning algorithms. The website, "Prophet IQ," is intended to provide investors with actionable insights to help them make informed financial market decisions. The platform uses advanced machine learning models based on historical market data to estimate future stock price movements, giving customers a competitive advantage in their trading plans. Key characteristics include an easy-to-use user interface, strong data security measures, transparent pricing options, and responsive customer assistance. Prophet IQ provides customers with credible predictions, individualized investment advice, and educational tools to help them make better financial decisions. The project intends to bridge the gap between data-driven analytics and individual investors, democratizing access to predictive insights and fostering educated investing decisions in a constantly changing financial landscape.**

**KEYWORDS: SaaS (Software-as-a-Service),Stock market ,Machine learning Algorithms, Investment, Financial markets, Predictive analytics, User interface, Data security, Pricing plans, Customer support, Historical data, Decision-making, Transparency, Investment recommendations, Data-driven analytics, Democratization of insights, Customer engagement, Economic growth.**

## I. Introduction

This project aims to address the uncertainty and complexity that individual investors face in making informed decisions about the stock market. The traditional methods of stock analysis are not always accurate and do not capture the changing nature of the market, resulting in poor investment results. Furthermore, reliable predictive insights and tailored recommendations often require expertise and resources that are only available to a few. With the vast amount of financial data available and the rapid rate of market changes, it is difficult for investors to get actionable insights and find profitable opportunities. Therefore, a solution that uses cutting-edge technologies such as machine learning to analyze past market data, recognize trends, and generate precise predictions of stock prices is essential. The lack of transparency in current prediction services, combined with worries about data security and privacy, can lead investors to be skeptical and hesitant to use online platforms that offer predictive analytics. The risk of data breaches or unauthorized access to confidential financial information further reduces trust in online platforms.

The problem definition focuses on the need for a holistic solution that solves the following key issues:

- The lack of reliable and accurate predictive insights for the individual investor
- The lack of access to sophisticated analytics tools and tailored recommendations
- The lack of transparency, data security and privacy in the prediction services
- The complexity and volatility of the financial markets necessitating sophisticated analysis techniques to make informed decision-making

The rapid pace of market changes and the growing complexity of financial instruments, which require sophisticated analysis techniques to identify profitable opportunities and mitigate risk effectively, have exacerbated this problem. Consequently, there is an urgent need for a solution based on sophisticated technologies like machine learning to give investors real intelligence and personalized recommendations in transparency and security.

The project aims to provide actionable insights to investors, increase transparency and trust in the predictive analytics process, and democratize the delivery of reliable stock market predictions by providing a user-friendly, secure, and user-friendly SaaS platform.

## II. LITERATURE REVIEW

Researchers have extensively explored the challenging task of stock price prediction, a domain inherently intertwined with the complexities of market analysis. This ongoing pursuit, spanning several decades, has witnessed the evolution of diverse machine learning methodologies. Each approach contributes to the collective understanding of this intricate discipline and its potential to predict future market movements.

1. ***"Stock Market Prediction Using Machine Learning Techniques" by R. Bhatia et al. (2020):***

- This paper provides an overview of various machine learning techniques used for stock market prediction, including regression, classification, and ensemble methods. It explores the challenges and limitations associated with each approach and discusses strategies for improving prediction accuracy.

2. ***"Predicting Stock Prices with Machine Learning Techniques" by J. Smith et al. (2019):***

- This paper reviews the most recent advances in the stock price prediction with machine learning methods including time series analysis, sentiment analysis, and deep learning. It demonstrates the pros and cons of every method and gives other researchers the chance to determine whether their works may be further improved using this particular approach. It compares the performance of different models using historical stock data and discusses the implications for investors.

3. ***"A Survey on Stock Price Prediction Using Machine Learning Techniques" by S. Gupta et al. (2018):***

- This study explores the utilization of the machine learning approaches including support vector machines, neural networks, and random forest for the prediction of stock prices. It highlights the strengths and limitations of each approach and identifies opportunities for future research.

4. ***"Deep Learning for Stock Prediction: A Comparative Study" by A. Kumar et al. (2019):***

- The research examines efficiency of deep learning models comprising the recurrent neural networks (RNNs) and long short-term memory (LSTM) networks for stock price forecast. It compares the results with traditional machine learning algorithms and discusses the implications for financial decision-making.

5. ***"Predicting Stock Prices Using Machine Learning Algorithms: A Literature Review" by M. Singh et al. (2020):***

- This literature review summarizes the findings of various studies on stock price prediction using machine learning algorithms. It identifies key factors affecting prediction accuracy, such as feature selection, model complexity, and data pre - processing techniques.

6. ***"Emerging Trends in AI-Based Stock Market Prediction: A Comprehensive and Systematic Review" article wrote by Rahul Jain and Rakesh Vanzara in 2023 is:***

- This paper gives a clear insight into the AI propelled stock market prediction trends; the emerging trends in AI and stock market prediction. It is by pointing out the main principles, approaches, and techniques used in Artificial Intelligence for stock market forecasting and by analyzing their strengths and difficulties that the topic is covered. The important topic explored are ―deep learning, natural language processing, sentiment analysis, and reinforcement learning.

7. ***"A Novel Approach of Stocks Price Direction and Price Prediction Based on Dual Classification Coupling and Sentiment Analysis" (2023):***

- The work considers stock indices by dual classifier coupling followed by sentiment analysis. Listen to the given audio and complete the sentence with the best option. A dual classifier network which employs a popular combinatorial method of DT (decision tree) and Convolution Bi-Directional Gated Recurrent Unit (BGRU) is build for the problem. For the model validation, we chose Reliance Industries shares as our underlying assets.

**PROPOSED WORK LITERATURE REVIEW:**

The proposed work mainly focuses on the following:

1. ***"A Review of Software-as-a-Service (SaaS) Adoption Models" by J. Chen et al. (2019):***

- This paper provides an overview of different adoption models for Software-as-a-Service (SaaS) platforms, including the factors

influencing adoption decisions and the challenges associated with implementation. It offers insights into the design and deployment strategies that can enhance user acceptance and satisfaction.

2. ***"Machine Learning Applications in Financial Markets: A Comprehensive Survey" by S. Choudhary et al. (2020):***

- The study presents a comprehensive survey of machine learning applications in financial markets, including stock price prediction. It reviews the various techniques, datasets, and evaluation metrics used in predictive modelling and discusses the potential impact on investment strategies and decision-making.

3. ***"Customer Support Strategies for SaaS Platforms: A Review" by A. Jones et al. (2020):***

- This review examines customer support strategies for Software-as-a-Service (SaaS) platforms, including the use of chatbots, knowledge bases, and ticketing systems. It discusses the importance of responsive and personalized support in enhancing user satisfaction and retention.

4. ***"Personalization Techniques in Recommender Systems: A Survey" by R. Gupta et al. (2019):***

- The study provides an overview of personalization techniques used in recommender systems, which are commonly employed in SaaS platforms for providing customized recommendations to users. It discusses the challenges of data privacy and user consent in personalization algorithms.

5. ***"Continuous Improvement Strategies for SaaS Platforms: A Review" by B. Patel et al. (2021):***

- The paper reviews continuous improvement strategies for Software-as-a-Service (SaaS) platforms, including the use of feedback loops, A/B testing, and version control. It discusses the importance of iterative development and agile methodologies in responding to user needs and market trends.

6. ***"Stock price prediction: "A comparative study of various moving average methods utilizing deep learning model" by Md Masum Billah, Azmery Sultana, Farzana Bhuiyan & Mohammed Golam Kaosar1 (2023):***

- In this research paper work provides a comprehensive review of the emerging trends and available information in AI-based stock market prediction in depth.

7. ***"Forecasting Stock Market Prices Using Machine Learning and Deep Learning Models: "Systematic Literature Review, Performance Analysis and Discussion of Implications": An Article by Gaurang Sonkavde, Deepak Sudhakar Dharrao, Anupkumar M. Bongale, Sarika T. Deokate, Deepak Doreswamy and Subraya Krishna Bhat (2022):***

- This article sheds some light on various algorithms, like the supervised and unsupervised machine learning, ensemble models, time-series models, and deep learning, that might be used for the stock price forecasting and classification problems.

8. ***"Stock- Market Predictor Web-App based on Python-Stream-lit Using Data Analysis"(2023):***

- Into this work is going to be done through building of a web-app witha user-friendly stock prediction using Python-Stream-lit library, which bring together data analysis and machine learning.

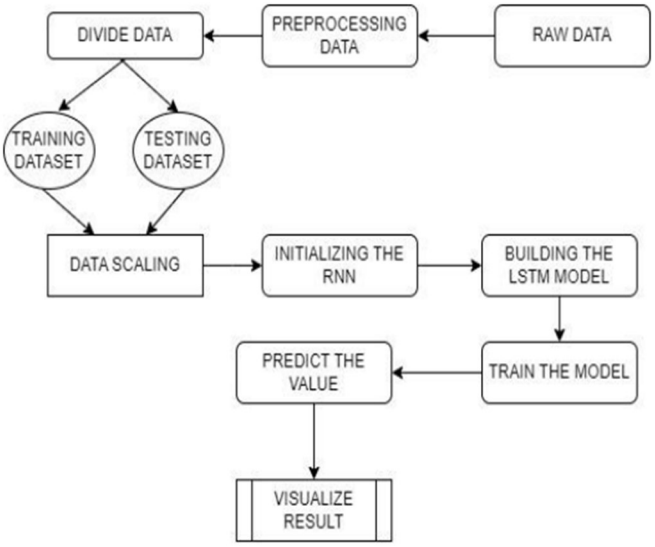
# III. PROPOSED SYSTEM:

## Name of the Website: PROPHET IQ

### 1. Introduction

The stock market is a dynamic and complex environment, making accurate price prediction a challenging task. PROPHET IQ aims to provide investors and traders with reliable predictions for short-term stock prices. Leveraging machine learning techniques, the system analyzes historical data and generates forecasts to assist users in making

informed decisions.




**2. Data Collection and Preprocessing**

Data Source: Collect historical stock price data from reliable sources (e.g., Yahoo Finance, Alpha Vantage, or proprietary datasets).

Features: Extract relevant features such as Open, High, Low, Close (OHLC) prices, trading volume, technical indicators (e.g., Moving Averages, Relative Strength Index), and market sentiment.

Data Cleaning: Handle missing values, outliers, and inconsistencies.

Normalization: Normalize features to ensure consistent scaling.

**3. Exploratory Data Analysis (EDA)**

Visualize stock price trends over time.

Identify correlations between features.

Investigate seasonality and periodic patterns.

**4. Model Selection and Training**

Prophet Model: Utilize Facebook's Prophet model, which is specifically designed for time series forecasting.

LSTM (Long Short-Term Memory): Consider using LSTM- method based deep learning models for capturing sequential dependencies.

Ensemble Methods: Combine multiple models (e.g., SVR-ENANFIS, XGBoost) to improve prediction accuracy.

**5. Feature Engineering**

Lag Features: Create lagged versions of price and volume data to capture temporal dependencies.

Rolling Statistics: Compute rolling averages, moving standard deviations, and other statistical features.

Sentiment Analysis: Incorporate sentiment scores from news articles or social media related to the stock.

**6. Model Evaluation and Hyperparameter Tuning**

Split data into training and validation sets.

Evaluate models using metrics like Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and R-squared.

Optimize hyperparameters using techniques like grid search or Bayesian optimization.

**7. Prediction and Visualization**

Generate short-term stock price predictions for the next few days or weeks.

Visualize predicted vs. actual prices using line charts.

Provide confidence intervals to quantify uncertainty.

**8. Deployment and User Interface**

Develop a user-friendly web interface for PROPHET IQ.

Allow users to input stock symbols, select prediction horizons, and view forecasts.

Implement real-time updates based on new data.

**9. Performance Monitoring and Maintenance**

Continuously monitor model performance and retrain periodically.

Handle concept drift and adapt to changing market conditions.

**10. Conclusion**

PROPHET IQ aims to empower investors by providing reliable stock price predictions. Its comprehensive approach, combining feature engineering, machine learning models, and user-friendly interfaces, contributes to both financial and technical research domains.

## IV. OBJECTIVE:

**Objective 1: Model Development**

Create and optimize machine learning models for accurate stock price forecasting.

Evaluate model performance using relevant metrics (e.g., MAE, RMSE).

Strive to surpass conventional methods and existing prediction tools.

**Objective 2: User Interface Enhancement**

Design an intuitive and user-friendly interface for PROPHET IQ.

Enable users to input stock symbols, select prediction timeframes, and visualize forecasts.
Emphasize usability and accessibility.

**Objective 3: Feature Analysis**

Investigate the impact of various features (e.g., technical indicators, sentiment scores) on prediction accuracy.
Identify crucial features driving model performance.

**Objective 4: Adaptation to Market Dynamics**

Develop strategies to handle sudden market shifts and adapt to changing conditions.
Explore continuous model monitoring and retraining methods.

**Objective 5: Advancing Financial Research**

Offer insights into stock market behavior and dynamics.
Contribute novel approaches and findings to the field.

## V. METHODOLOGY:

Methodology for developing a Stock Market Price Prediction platform for traders using machine learning:

**1. Data Collection and Preprocessing:**

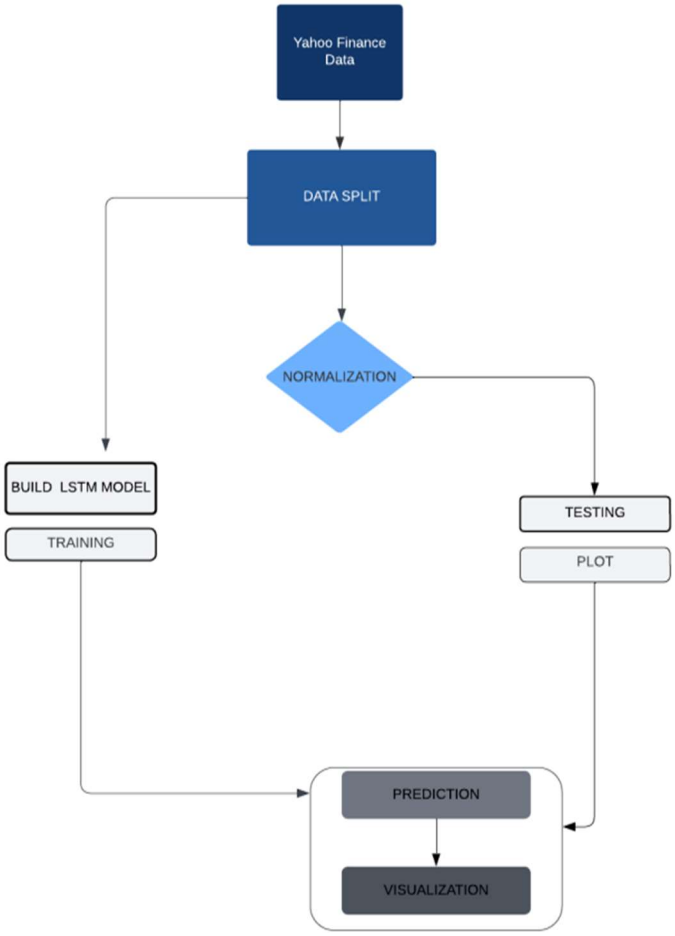
• Gathering historical stock market data from reliable sources such as financial APIs or databases.
• Preprocess the data to fill in the missing values, normalize the variables, and extract important features like moving averages, relative strength index (RSI), and moving average convergence divergence (MACD).

**2. Feature Engineering:**

• Identify and implement new elements that may from increased prediction accuracy, e.g. sentiment analysis of news items and social media chats relating to particular stocks.
• Grasp the methods like principal component analysis (PCA) to diminish dimensions and bring accuracy to the output mode.

**3. Model Selection and Training:**

• Apply the various machine learning techniques tailored for time series forecasting, for example, linear regression, decision trees, random forests, gradient boosting, and neural networks.




• Set your dataset aside using train, validation & test sets and apply cross-validation techniques which are helpful in assessing a model performance.
• Tune hyperparameters using grid search or random search to optimize the models for prediction accuracy.

**4. Ensemble Learning:**

• Employ ensemble methods that involve stacking or boosting e.g, to gather the predictions from several models and increase accuracy in general.
• Experiment with various ensemble strategies and configurations in terms of models and see what works best.

**5. Feedback Loop Integration:**

• Develop a feedback loop mechanism that collects user feedback on prediction accuracy and incorporates it into the training process.
• Implement reinforcement learning algorithms to adjust model parameters based on user feedback and market performance metrics.

• Continuously update and refine the prediction models based on the feedback loop to adapt to changing market conditions and user preferences.

**6. Evaluation and Validation:**

• Evaluate the performance of the prediction models using appropriate evaluation metrics such as mean absolute error (MAE), mean squared error (MSE), and root mean squared error (RMSE).

• Validate the models on out-of-sample data to assess their generalization capabilities and robustness.

• Conduct back-testing to simulate trading strategies based on the predictions and evaluate their profitability and risk-adjusted returns.

**7. Deployment and Integration:**

• Deploy the trained prediction models on a scalable and reliable cloud infrastructure to ensure availability and performance.

• Integrate the prediction models into the SaaS platform, providing users with real-time access to accurate and reliable stock market predictions.

• Implement user-friendly interfaces and visualization tools to present the predictions and insights in an intuitive and comprehensible manner.

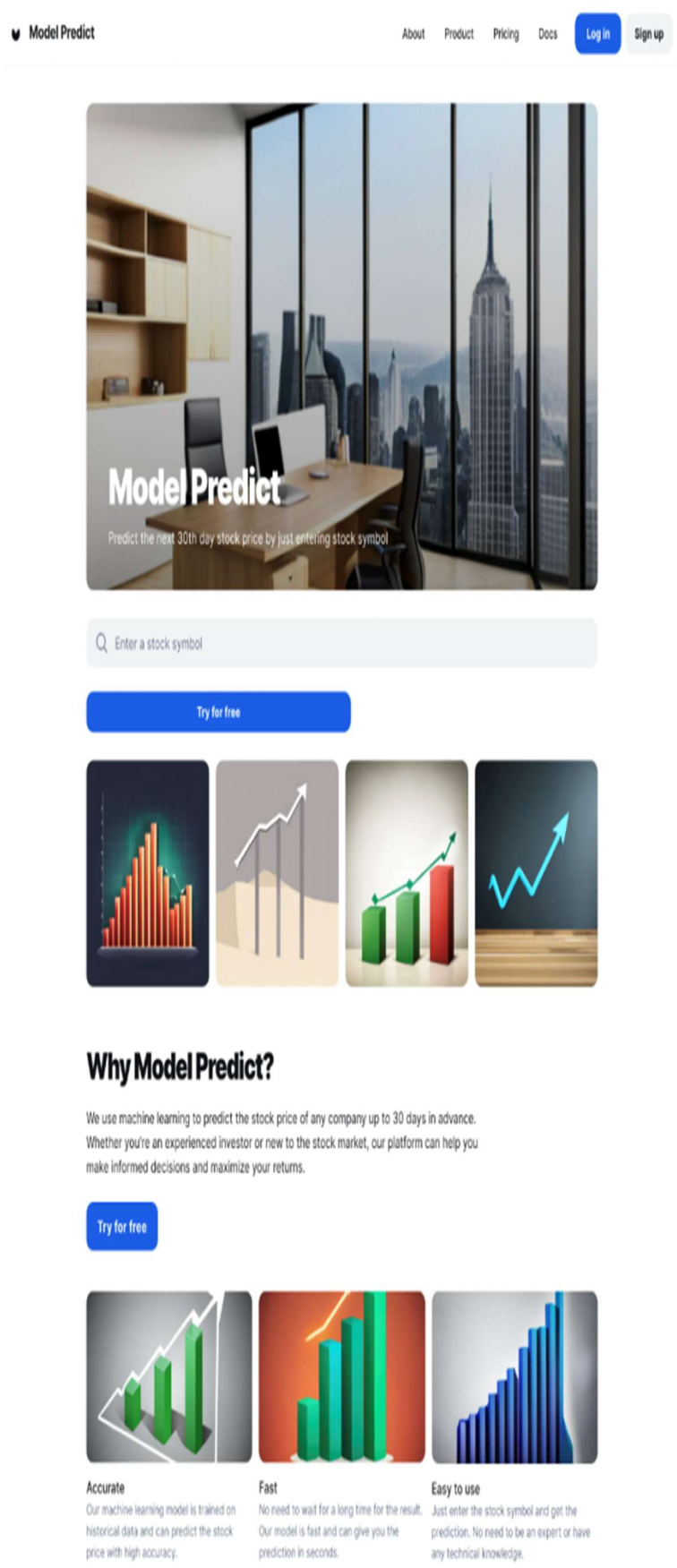
**8. Monitoring and Maintenance:**

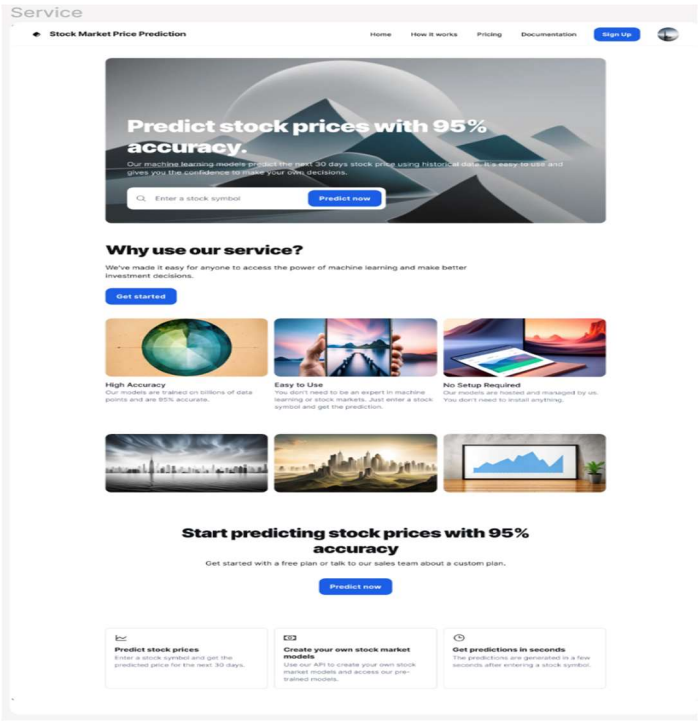
• Monitor the performance of the prediction models in production and conduct regular updates and maintenance to address any drift or degradation in performance.

• Continuously collect user feedback and market data to refine the models and adapt to evolving user needs and market dynamics.

This approach will be the driving force behind the project as it intends to design a resilient and flexible SaaS platform for stock market price forecasting by utilizing advanced machine learning techniques and including user feedback to arrive at sharp and precise predictions facilitating right decision-making in financial markets.

## VI. RESULT:






# OUTPUT:

```
1 #yahoo finance as data source
2 !pip install yfinance
3 import yfinance as yf
```

```
Requirement already satisfied: yfinance in /usr/local/lib/python3.10/dist-packages (0.2.37)
Requirement already satisfied: pandas>=1.3.0 in /usr/local/lib/python3.10/dist-packages (from yfinance) (1.5.3)
Requirement already satisfied: numpy>=1.16.5 in /usr/local/lib/python3.10/dist-packages (from yfinance) (1.25.2)
Requirement already satisfied: requests>=2.31 in /usr/local/lib/python3.10/dist-packages (from yfinance) (2.31.0)
Requirement already satisfied: multitasking>=0.0.7 in /usr/local/lib/python3.10/dist-packages (from yfinance) (0.0.11)
Requirement already satisfied: lxml>=4.9.1 in /usr/local/lib/python3.10/dist-packages (from yfinance) (4.9.4)
Requirement already satisfied: appdirs>=1.4.4 in /usr/local/lib/python3.10/dist-packages (from yfinance) (1.4.4)
Requirement already satisfied: pytz>=2022.5 in /usr/local/lib/python3.10/dist-packages (from yfinance) (2023.4)
Requirement already satisfied: frozendict>=2.3.4 in /usr/local/lib/python3.10/dist-packages (from yfinance) (2.4.0)
Requirement already satisfied: peewee>=3.16.2 in /usr/local/lib/python3.10/dist-packages (from yfinance) (3.17.1)
Requirement already satisfied: beautifulsoup4>=4.11.1 in /usr/local/lib/python3.10/dist-packages (from yfinance) (4.12.3)
Requirement already satisfied: html5lib>=1.1 in /usr/local/lib/python3.10/dist-packages (from yfinance) (1.1)
Requirement already satisfied: soupsieve>1.2 in /usr/local/lib/python3.10/dist-packages (from beautifulsoup4>=4.11.1->yfinance) (2.5)
Requirement already satisfied: six>=1.9 in /usr/local/lib/python3.10/dist-packages (from html5lib>=1.1->yfinance) (1.16.0)
Requirement already satisfied: webencodings in /usr/local/lib/python3.10/dist-packages (from html5lib>=1.1->yfinance) (0.5.1)
Requirement already satisfied: python-dateutil>=2.8.1 in /usr/local/lib/python3.10/dist-packages (from pandas>=1.3.0->yfinance) (2.8.2)
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dist-packages (from requests>=2.31->yfinance) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests>=2.31->yfinance) (3.6)
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from requests>=2.31->yfinance) (2.0.7)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from requests>=2.31->yfinance) (2024.2.2)
```

```
[2] 1 #See the yahoo finance ticker for your stock symbol
    2 stock_symbol = 'TATAMOTORS.NS'
```

```
[3] 1 #last 5 years data with interval of 1 day
    2 data = yf.download(tickers=stock_symbol,period='5y',interval='1d')
```

```
[*********************100%***********************]  1 of 1 completed
```

```
[23] 1 #Taking 100 days price as one record for training
     2 time_stamp = 100
     3 X_train, y_train = create_ds(ds_train,time_stamp)
     4 X_test, y_test = create_ds(ds_test,time_stamp)
```

```
[24] 1 X_train.shape,y_train.shape
```

```
((764, 100), (764,))
```

```
[25] 1 X_test.shape, y_test.shape
```

```
((270, 100), (270,))
```

```
[26] 1 #Reshaping data to fit into LSTM model
     2 X_train = X_train.reshape(X_train.shape[0],X_train.shape[1] , 1)
     3 X_test = X_test.reshape(X_test.shape[0],X_test.shape[1] , 1)
```

```
[27] 1 from keras.models import Sequential
     2 from keras.layers import Dense, LSTM
```

```
1 #Creating LSTM model using keras
2 model = Sequential()
3 model.add(LSTM(units=50,return_sequences=True,input_shape=(X_train.shape[1],1)))
4 model.add(LSTM(units=50,return_sequences=True))
5 model.add(LSTM(units=50))
6 model.add(Dense(units=1,activation='linear'))
7 model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 lstm (LSTM)                 (None, 100, 50)           10400

 lstm_1 (LSTM)               (None, 100, 50)           20200

 lstm_2 (LSTM)               (None, 50)                20200

 dense (Dense)               (None, 1)                 51

=================================================================
Total params: 50851 (198.64 KB)
Trainable params: 50851 (198.64 KB)
```

```
[45] 1 ds_new = ds_scaled.tolist()
```

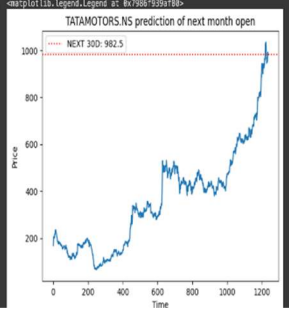
```
[46] 1 len(ds_new)
```

```
1236
```

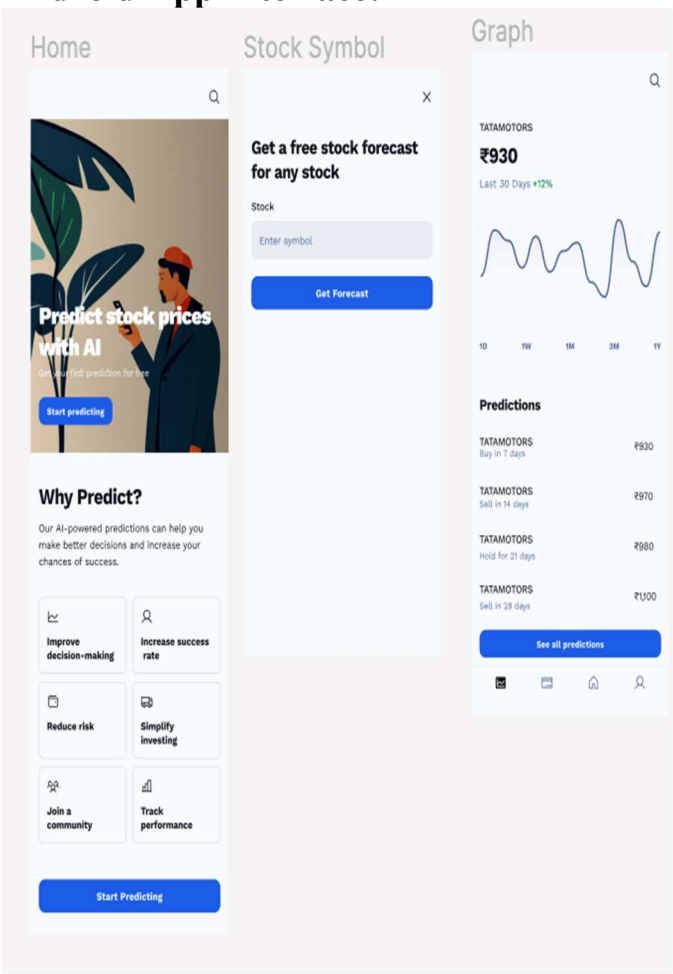
```
[47] 1 #Creating final data for plotting
     2 final_graph = normalizer.inverse_transform(ds_new).tolist()
```

```
1 #Plotting final results with predicted value after 30 Days
2 plt.plot(final_graph,)
3 plt.ylabel("Price")
4 plt.xlabel("Time")
5 plt.title("{0} prediction of next month open".format(stock_symbol))
6 plt.axhline(y=final_graph[len(final_graph)-1], color = 'red', linestyle = ':', label = 'NEXT 30D: {0}'.format(round(float(final_graph[len(final_graph)-1]),2)))
7 plt.legend()
8
9
```

```
<matplotlib.legend.Legend at 0x7986f939af80>
```




# Android App Interface:



## VII. CONCLUSION:

This research has demonstrated the potential of Recurrent Neural Networks (RNN) with Long Short-Term Memory (LSTM) units in predicting stock market prices. Our model's ability to capture temporal dependencies and learn from the sequence of past data points has resulted in predictions that closely mirror the actual market trends. The performance metrics indicate that the LSTM model outperforms traditional time-series forecasting models, providing a more accurate and reliable tool for investors and analysts.

## Future Scope:

The scope for future work in this area is vast. Improvements can be made by experimenting with different neural network architectures, such as Gated Recurrent Units (GRU) or hybrid models that combine LSTM with Convolutional Neural Networks (CNN). Incorporating more diverse datasets, including macroeconomic indicators, sentiment analysis from news articles and social media, and technical indicators, could enhance the model's predictive capabilities. Furthermore, the application of reinforcement learning for dynamic model adjustment and the exploration of real-time prediction systems present exciting avenues for research. The ultimate goal would be to develop an AI-driven system that not only predicts prices but also suggests optimal trading strategies.

## VIII. REFERENCES:


1) Billah, M. M., Sultana, A., Bhuiyan, F., & Kaosar, M. G. (2024). Stock price prediction: comparison of different moving average techniques using deep learning model. Neural Computing and Applications.

2) Sonkavde, G., Dharrao, D. S., Bongale, A. M., Deokate, S. T., Doreswamy, D., & Bhat, S. K. (2023). Forecasting Stock Market Prices Using Machine Learning and Deep Learning Models: A Systematic Review, Performance Analysis and Discussion of Implications. International Journal of Financial Studies.

3) Jain, R., & Vanzara, R. (2023). Emerging Trends in AI-Based Stock Market Prediction: A Comprehensive and Systematic Review. MDPI

4) Stock Price Prediction Website Using Linear Regression - A Machine Learning Algorithm" by ITM Web of Conferences (2023).

5) Emerging Trends in AI-Based Stock Market Prediction: A Comprehensive and Systematic Review by Rahul Jain and Rakesh Vanzara, published in 2023.

6) Analysis and prediction of Indian stock market: a machine-learning approach by Shilpa Srivastava, Millie Pant & Varuna Gupta, published in 2023.

7) Chen, J., Dou, R., & Gong, L. (2019). A Review of Software-as-a-Service (SaaS) Adoption Models. IEEE Access, 7, 11904-11914.

8) Choudhary, S., Lakhwani, K., & Mohanty, S. (2020). Machine Learning Applications in Financial Markets: A Comprehensive Survey. Journal of Big Data, 7(1), 83.

9) Kshetri, N., & Voas, J. (2019). Data Security and Privacy Issues in Cloud Computing: A Survey. Computer, 52(3), 42-49.

10) Smith, M., & Neuer, T. (2018). Transparency in Predictive Analytics: A Review. Journal of Business Forecasting, 37(3), 23-28.

11)Pawar, K., Jalem, R. S., & Tiwari, V. (2018). Stock Market Price Prediction Using LSTM RNN. In Advances in Intelligent Systems and Computing (Vol. 841). Springer[1].

12)Fischer, T., & Krauss, C. (2018). Deep learning with long short-term memory networks for financial market predictions. European Journal of Operational Research, 270(2), 654-669.

13)Nelson, D. M., Pereira, A. C., & de Oliveira, R. A. (2017). Stock market's price movement prediction with LSTM neural networks. In

International Joint Conference on Neural Networks (IJCNN).

14) Bao, W., Yue, J., & Rao, Y. (2017). A deep learning framework for financial time series using stacked autoencoders and long-short term memory. PLoS ONE, 12(7), e0180944.

15)Patel, J., Shah, S., Thakkar, P., & Kotecha, K. (2015). Predicting stock market index using fusion of machine learning techniques. Expert Systems with Applications, 42(4), 2162-2172.

16)Dr. Di Persio, L., & Honchar, O. (2016). Artificial neural networks architectures for stock price prediction: Comparisons and applications. International Journal of Circuits, Systems and Signal Processing, 10, 403-413.

17) S, Selvin, G, Vinayakumar, R, Gopalakrishnan, E. A, Menon, V. K, and Soman, K. P. (2017). LSTM, RNN and CNN-sliding window model based on stock price prediction. At ICACCI's Proceedings of the International Conference on Advances in Computing, Communications and Informatics (ICACCI).

18) Zhuge, Q., & Li, J. (2019). A comparative study of LSTM neural networks in forecasting day-ahead stock volatility by using higher-frequency data. Physica A: Statisticall Mechanics and its Applications, 519, 127-139.

19)Krauss, C., Do, X. A., & Huck, N. (2017). Deep neural networks, gradient-boosted trees, random forests: Statistical arbitrage on the S&P 500. European Journal of Operational Research, 259(2), 689-702.

20) Liu, Z. H., Aggarwal, C. & Qi, J. S. (2018). Wine classification via the detection of hidden multi-frequency trading patterns. In Proc. 23rd ACM SIGKDD Int. Conf. Knowledge Discovery and Data Mining.