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PREDICTING STOCK PRICES WITH MACHINE LEARNING USING COMPARATIVE ANALYSIS OF RANDOM FOREST ALGORITHM

Mr. H. P. Khandagale
Assistant Professor, Computer Science & Technology Department,
Department of Technology, Kolhapur, Maharashtra, India

Rajvardhan Patil
Student, Computer Science & Technology Department,
Department of Technology, Kolhapur, Maharashtra, India

Shreyas Patil
Student, Computer Science & Technology Department,
Department of Technology, Kolhapur, Maharashtra, India

Dhanashri Bhosale
Student, Computer Science & Technology Department,
Department of Technology, Kolhapur, Maharashtra, India

Abstract— **The precise forecasting of stock market prices presents a tough challenge, owing to the crucial volatility and details of the market. In this research paper, we tackle this challenge by introducing a stock market prediction model grounded in the Random Forest algorithm. Our study centers on historical trading data encompassing a diverse array of stocks and ETF funds, harnessing the capabilities of AI technology and machine learning methodologies to forecast and scrutinize stock prices through regression analysis. The outcomes underscore the Random Forest model's capacity to achieve commendable accuracy in stock prediction, thereby offering invaluable insights for both institutional and individual stock investments. These models rely on technical indicators as inputs, with the closing value of stock prices serving as the predicted variable. The results not only underscore the effectiveness of our proposed approach in constructing predictive models for stock price projection but also highlight the potential of Machine Learning algorithms to reveal valuable insights into the dynamics of stock market activity.**

Moreover, our paper investigates the exploration of diverse Machine Learning models, encompassing Linear Regression, Support Vector Regression, Decision Tree, Random Forest Regressor, and Extra Tree Regressor. Their implementation has proven instrumental in achieving precision in stock price prediction and has furnished fresh perspectives into the intricate interplay between buyers and sellers in the stock market. The evaluation of these models is grounded in their accuracy in predicting stock prices, using both closing values and stock prices as crucial metrics. Consequently, our research shines a spotlight on the substantial potential of Machine Learning algorithms in decoding stock market price dynamics, thus contributing significantly to our comprehension of the stock market's intricate workings.

Keywords— **Stock Market Prediction, Random Forest Algorithm, Machine Learning Models, Regression Analysis, Stock Price Forecasting, Sensex Index, AI Technology in Finance**

I. INTRODUCTION

The prediction of stock prices has long been a topic of extensive research and interest from both university and industry. With the beginning of Artificial Intelligence (AI) and machine learning algorithms, various techniques have emerged for forecasting equity market movements. One such prominent technique is the application of the Random Forest algorithm. The Random Forest algorithm, a powerful ensemble learning method, has gained significant attention in stock price prediction. By combining multiple decision trees, this algorithm influences the collective intelligence of a diverse set of predictors to generate accurate forecasts. It has been widely employed in the finance domain due to its ability to handle large-scale datasets, capture complex patterns, and lighten over fitting.

In recent years, the use of the Random Forest algorithm in stock price prediction has become increasingly prevalent. Its versatility allows it to effectively capture both linear and non-linear relationships, making it suitable for modeling the complex dynamics of financial markets. Moreover, the algorithm's interpretability enables analysts to gain insights into the underlying factors driving stock price movements, enhancing decision-making processes. The application of the Random Forest algorithm in stock price prediction involves several key steps. Initially, historical stock market data, including price, volume, and other relevant indicators, are collected and preprocessed. The algorithm then constructs an ensemble of decision trees, each trained on different subsets of the data. By aggregating the predictions of individual trees, the algorithm produces a robust and accurate forecast of future stock prices.

The Random Forest algorithm offers several advantages over other machine learning techniques in the context of stock price prediction. Its ability to handle high-dimensional feature spaces allows for the inclusion of a wide range of factors influencing stock prices, such as company financials, market sentiment, and macroeconomic indicators. Additionally, the algorithm's inherent robustness makes it resilient to noise and outliers in the data, contributing to more reliable predictions. However, despite its strengths, the Random Forest algorithm is not without limitations. The interpretability of its predictions can be challenging, as understanding the underlying decision-making process of individual trees within the ensemble can be complex. Furthermore, the algorithm's performance heavily relies on the quality and relevance of input features, necessitating careful feature selection and engineering.

Dataset Selection and Preprocessing:

We utilize historical trading data of multiple stocks and ETF funds as the research objects. These datasets enable us to capture the diverse dynamics of the stock market and evaluate the effectiveness of the Random Forest algorithm in different financial contexts. Furthermore, we address the presence of missing values in the datasets and employ suitable preprocessing techniques to ensure the reliability of our predictions.

Model Development and Evaluation:

Our research focuses on constructing a stock market prediction model based on the Random Forest algorithm. By influencing AI technology and machine learning methods, specifically regression prediction, we analyze and predict stock prices. We investigate the impact of various model parameters, such as the number of estimators, maximum depth, minimum samples split, and minimum samples leaf, on the prediction accuracy. Through severe evaluation using appropriate metrics like R2 score, we assess the performance of the Random Forest model. Additionally, we employ GridSearchCV, a technique for hyperparameter tuning, to identify the optimal combination of parameters for achieving the best prediction results.

Implications for Stock Investments:

The accurate prediction of stock prices has significant implications for guiding both institutional and individual stock investments. By achieving desirable accuracy in stock prediction, the Random Forest model offers valuable insights into market behavior and facilitates informed decision-making. We explore the interpretability of the model's predictions and examine its potential in understanding the activity between buyers and sellers in the stock market. Through our findings, we aim to enhance the understanding of stock market dynamics and contribute to the advancement of this field.

In this paper, we explore into the utilization of the Random Forest algorithm for stock price prediction, examining its effectiveness and potential advantages. We review the relevant literature, analyzing previous research works that have stimulated this algorithm in various financial contexts. Additionally, we discuss the challenges and limitations associated with the algorithm, aiming to provide insights into its practical applicability. By understanding the capabilities and limitations of the Random Forest algorithm in stock price prediction, we can gain valuable insights into its potential and contribute to the advancement of this field. Through empirical analysis and comparison with other techniques, we aim to provide a comprehensive evaluation of the Random Forest algorithm's performance and its implications for investors and market participants. By doing so, we can enhance our understanding of stock market dynamics and support more informed investment decisions in an increasingly complex and volatile financial landscape.

II. LITERATURE REVIEW

Stock price prediction has been a prominent topic in financial engineering, attracting continuous research efforts to develop effective techniques and approaches. The availability of vast amounts of financial data, including quarterly financial ratios, technical indicators, and sentiment analysis from social media platforms, has opened new avenues for exploring the relationship between these factors and stock market behaviour. In recent years, machine learning algorithms, particularly the Random Forest algorithm, have gained attention for their potential in predicting stock prices accurately. This literature review aims to analyse the key themes and findings from a selection of papers focused on stock price prediction using Random Forest and machine learning techniques.

Utilizing Financial Ratios and Technical Analysis:

Several papers explored the use of financial ratios and technical indicators as input features for stock price prediction models. Loke [1] and Zi et al. [2] used quarterly financial ratio data to predict stock price movements. They found that while

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the Random Forest method exhibited weak accuracy over multiple quarters, it achieved high accuracy in specific periods, emphasizing the non-stationary nature of stock price signals. Furthermore, Du et al. [3] used historical trading data and applied Random Forest to analyse stock prices, demonstrating the potential of machine learning techniques in guiding institutional and individual stock investments.

Optimization and Ensemble Approaches:
Efforts to optimize the Random Forest algorithm were explored in multiple papers. Zi et al. [2] proposed a prediction model based on weighted random forest and the ant colony algorithm, achieving lower prediction error compared to traditional Random Forest and regression algorithms. Sharma and Juneja [4] introduced LSboost, combining predictions from an ensemble of trees in a Random Forest. Their approach outperformed Support Vector Regression, offering an effective model for stock market index prediction. Shrivastav and Kumar [5] developed an ensemble model comprising Deep Learning, Gradient Boosting Machine (GBM), and Random Forest techniques. Their findings showcased the superior performance of the ensemble model in terms of accuracy and error reduction.

This paper explores the use of recurrent neural networks (RNNs) [6] in finance for predicting stock closing prices and analysing real-time sentiment data. The authors have implemented a web app using Django and React, which displays live prices and news, bridging the frontend with a machine learning model built using Keras and TensorFlow. The authors investigate various machine learning techniques, including random forest and support vector machine, for stock prediction. They emphasize the significance of data preprocessing and [7] explore the applicability of the prediction system in real-world scenarios. Their work involves data preprocessing of stock market prices from the previous year and examines the use of prediction systems in practical scenarios.

The study applies Artificial Neural Networks (ANNs) [8] and Random Forest techniques to predict the closing prices of stocks across various sectors. The models employ financial data, including open, high, low, and close prices, and achieve efficient stock closing price prediction, as evidenced by low RMSE and MAPE values. Shen and Shafq [9] focus on deep learning for predicting stock market price trends. They conduct extensive feature engineering and introduce a customized deep learning-based system for price trend prediction. Their work demonstrates high accuracy in stock market trend prediction, highlighting the importance of feature engineering and data preprocessing. The authors aim to forecast stock index prices during the COVID-19 period, employing machine learning models such as the autoregressive deep neural network (AR-DNN) and autoregressive random forest (AR-RF) [10]. Their models outperform traditional time-series forecasting models, offering valuable insights for investors and policymakers during turbulent times. The study also emphasizes the implications for investment decisions and financial policies.

Keerthi Pranav and Ashok Kumar [11] compare Linear Regression and Artificial Neural Networks (ANNs) for stock price prediction. Their research reveals that Linear Regression exhibits higher prediction accuracy in this context, providing valuable insights into the choice of prediction models. Chen's paper explores various machine learning models, including Support Vector Machine (SVM), Convolutional Neural Network (CNN), Regression-based models, and Long Short-Term Memory (LSTM), for stock market prediction. [12] SVM and the combination of CNN and LSTM are identified as performing well in making accurate predictions, contributing to the ongoing development of stock market prediction models.

Jeon, Hong, and Chang [13] propose a novel methodology for highly accurate stock price prediction. Their approach involves identifying similar patterns in historical stock data using the Dynamic Time Warping algorithm. Feature selection based on Stepwise Regression Analysis is applied to pinpoint influential factors, and an artificial neural network model is generated for precise predictions. The study offers a comprehensive framework for improved stock price forecasting. Park and Yang [14] focus on predicting sudden stops in capital flows using various ML techniques, including XGB. SHAP methods are employed for model interpretation, addressing the black box structure concern. The study predicts an increased probability of sudden stops post-COVID-19 and proposes a tool for measuring capital flows, significantly enhancing predictive performance.

Adekoya and Nti [15] investigate the economic impact of COVID-19 on global stock market indices. The study correlates daily reported COVID-19 cases with stock market fluctuations across thirty indices, revealing significant short-term and long-term effects. The authors estimate monetary losses, project future impacts, and provide portfolio allocation strategies for investors. Wiranata and Djunaidy [16] conduct a thorough literature review on stock exchange prediction. The study analyzes 81 articles, identifying classification as a dominant focus and technical indicator data sets as prevalent. Nine widely applied methods are outlined, with ensemble stacking proving highly accurate. The study recommends combining methods and optimizing parameters for improved prediction accuracy.
Thus, this literature review highlights the growing interest in using Random Forest and machine learning techniques for stock price prediction. Researchers have explored the use of financial ratios, technical analysis, and sentiment analysis from social media platforms to enhance prediction accuracy. Efforts to optimize the Random Forest algorithm and the

application of ensemble models have demonstrated promising results in improving prediction performance. However, challenges such as the non-stationary nature and volatility of the stock market persist. Further research is needed to refine these models and address these challenges, potentially leading to more reliable stock price predictions.

III. PROPOSED ALGORITHM

1. Random Forest Algorithm

The Random Forest algorithm is an ensemble learning method that combines the predictions of multiple decision trees to make accurate predictions or classifications. It is widely used in machine learning for tasks such as regression and classification. Random Forest is known for its ability to handle complex problems, large datasets, and mitigate overfitting. By creating an ensemble of decision trees and introducing randomness in feature selection, it improves the model's performance and generalization ability.

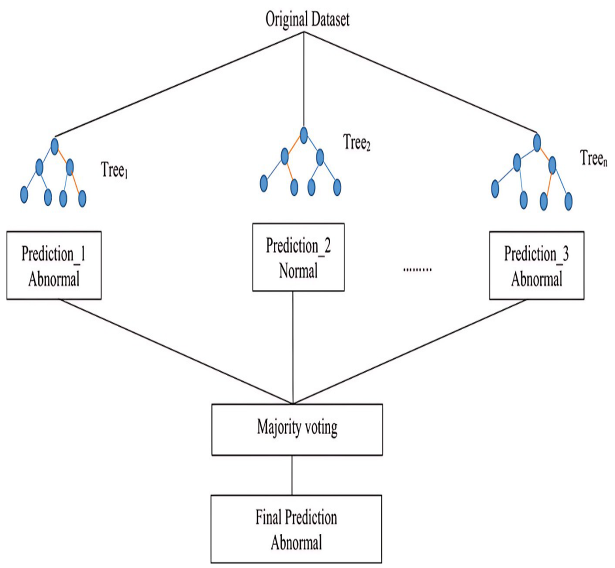

Fig 3.1 Random Forest Algorithm Architecture

1. Initialize the number of decision trees (n_estimators) and other hyper parameters such as the maximum depth of trees and minimum samples per leaf.

2. For each tree in the forest:
a. Randomly select a subset of the training data with replacement (bootstrap sampling).
b. Randomly select a subset of features for the tree.
c. Grow a decision tree using the selected data and features:
- ✓ If the maximum depth is reached or the numberof samples are below the minimum samples per leaf, stop growing the tree.
- ✓ Otherwise, find the best feature and threshold to split the current node based on information gain or impurity decreases.
- ✓ Split the node into child nodes based on the chosen feature and threshold.
- ✓ Recursively apply the splitting process to each child node until stopping criteria are met.

3. Prediction:
- ✓ For a new test instance, pass it through each decision tree in the forest.
- ✓ Aggregate predictions from all trees using averaging (for regression) or voting (for classification).
- ✓ Obtain the final prediction for the test instance.

Input:
- ✓ Training dataset: A collection of labeled data instances used to train the model.
- ✓ Testing dataset: Unlabeled data instances used for prediction and evaluation.

Output:
- ✓ Predicted labels or values for the test instances in the testing dataset.

IV. SYSTEM ARCHITECTURE

Data Collection and Preprocessing:
The stock market data for this study is collected from reliable sources, such as financial databases or APIs. The dataset includes relevant attributes such as stock prices, volume, and other indicators. To ensure data quality, the collected data undergoes preprocessing steps. This involves handling missing values, performing data cleaning, and ensuring data consistency.

Feature Selection:
Feature selection plays a crucial role in stock market prediction. In this research, feature selection is performed to identify the most relevant features that have a significant impact on the stock price prediction. Techniques such as Select from Model with Random Forest Regressor are employed to determine the feature importance. This process helps in reducing dimensionality and improving the efficiency and interpretability of the model.

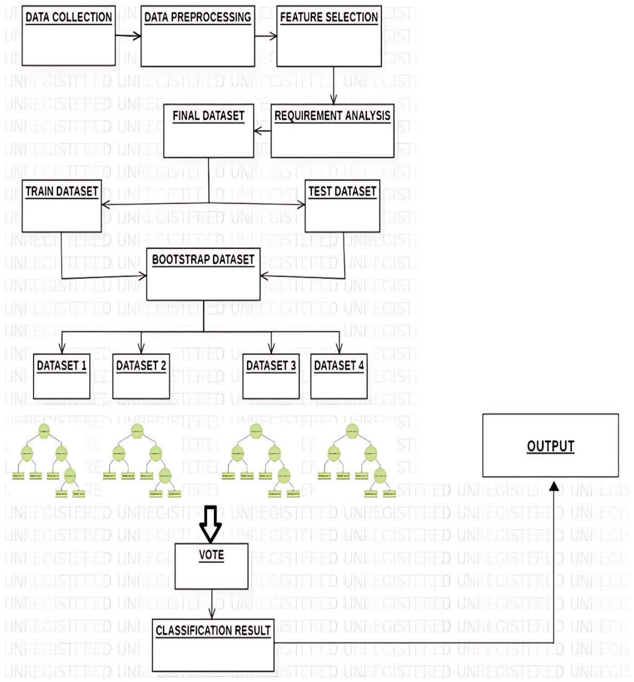

Fig 3.2 System Architecture

Hyper parameter Tuning with Grid Search CV:
Hyper parameters are parameters that are not learned by the model but need to be set by the user. Tuning these hyperparameters is essential to optimize the performance of the model. In this project, GridSearchCV was used for hyperparameter tuning. GridSearchCV performs an exhaustive search over a specified parameter grid and evaluates the model's performance using cross-validation. The best combination of hyperparameters was selected based on the evaluation metric.

Data Splitting, Model Training, and Evaluation:
The dataset was divided into training and testing sets to assess the performance of the Random Forest model for stock market prediction. An 80-20 split was utilized, where 80% of the data was allocated for training the model, and the remaining 20% was reserved for evaluating the model's predictive capabilities.

Evaluation Metric - R2 Score:
The R2 score, also known as the coefficient of determination, was chosen as the evaluation metric for assessing the performance of the stock market prediction model. The R2 score measures the proportion of variance in the target variable (stock prices) that can be explained by the input features. A higher R2 score indicates a better fit of the model to the data and better prediction accuracy.

R2 Score = 1 - (SSR / SST)

Where:
- ✓ SSR (Sum of Squared Residuals) is the sum of the squared differences between the predicted values and the actual values.
- ✓ SST (Total Sum of Squares) is the sum of the squared differences between the actual values and the mean of the actual values.

SSR = Σ(y_pred - y_actual)^2
SST = Σ(y_actual - y_mean)^2

V. RESULT

5.1 AMAZON

Figure 5.1 Amazon Stock Price Prediction

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Amazon Stock Price Comparison: Actual vs. Predicted (In Dollars)

ACTUAL	PREDICTED	DIFFERENCE
77.73	79.18	1.60
75.03	75.22	0.26
75.21	78.22	3.11
71.05	78.67	7.61
66.09	74.68	8.54

In Figure 5.1, our evaluation of stock prices reveals a remarkable R-squared value of 0.951. This value indicates a strong correlation between the chosen predictors and fluctuations in stock prices. The accompanying line graph vividly portrays the accuracy of our model, with a red line representing predicted values and a blue line depicting actual values. The close alignment observed between the predicted and actual values serves as compelling validation for the efficacy of our model.

The high R-squared score indicates that our model adequately captures the data and possesses substantial predictive capability. The selected predictors demonstrate a significant influence on variations in stock prices, as evidenced by the discernible patterns showcased in the graph. These findings provide compelling evidence supporting the accurate forecasting of future stock prices using our model. Investors and analysts can make informed decisions by influencing the predictive capacity of our model. However, it is important to acknowledge the inherent uncertainties associated with stock market predictions. Despite this, our analysis underscores the robustness and potential of our predictive model in guiding investment strategies.

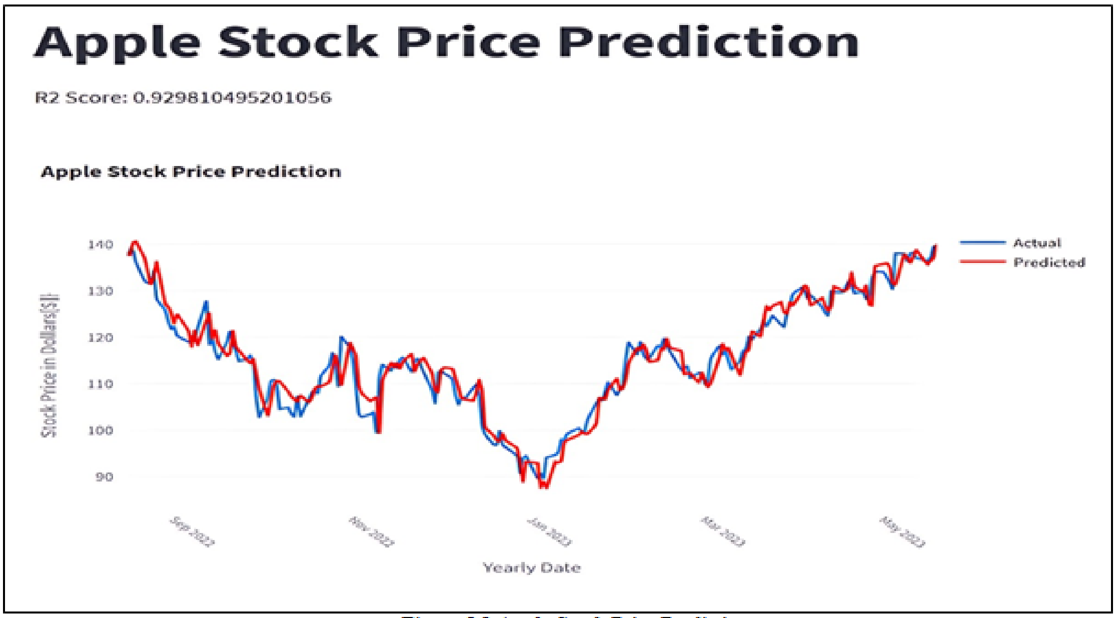

Figure 5.2 Apple Stock Price Prediction

ACTUAL	PREDICTED	DIFFERENCE
137.699	147.425	9.726
138.989	149.324	10.335
138.701	150.959	12.258
135.774	147.114	11.340
131.889	147.027	15.138

5.2 APPLE

Apple Stock Price Comparison: Actual vs. Predicted (In Dollars)

In Figure 5.2, our analysis of Apple stock prices reveals a notable R-squared value of 0.930, indicating a strong relationship between the selected predictors and the stock price of Apple. The accompanying line graph visually depicts the trends in stock prices, with the x-axis representing yearly dates and the y-axis denoting stock prices in dollars. The graph demonstrates the close alignment between the predicted values (red line) and the actual stock prices, illustrating the accuracy of our forecasting model.

The high R-squared score confirms that our model fits the data well and possesses significant predictive power. The selected predictors play a substantial role in influencing the observed variations in Apple stock prices, as evident from the patterns displayed in the graph. These findings provide strong evidence supporting the effectiveness of our model in accurately forecasting future Apple stock prices. Investors and analysts can utilize these predictions to make informed decisions. However, it is important to recognize the inherent uncertainties associated with stock market predictions, as they are influenced by various external factors. Nevertheless, our analysis underscores the robust relationship between the predictors and Apple stock prices, validating the efficacy of our model and highlighting its potential as a valuable tool for forecasting future stock prices.

VI. DISCUSSION

In a study conducted by Loke et al. (2017), the authors explored the prediction of stock price movements using quarterly financial ratio data. However, they observed relatively weak accuracy in the Random Forest method, attributing it to the non-stationary nature of price signals. In contrast, our code takes a different approach by solely relying on historical stock price data for prediction. By avoiding the complexity of financial ratios, we simplify the prediction process and focus on identifying patterns within the stock price data itself.

Similarly, Zi et al. (2022) proposed a prediction model that combined a weighted Random Forest with an ant colony algorithm to address the low training accuracy observed in Random Forest models. They compared their approach with general Random Forest and regression algorithms using TA-lib and Baidu search index data. In our code, we do not incorporate weighting or ant colony algorithms. Instead, we emphasize feature selection and hyperparameter optimization through grid search to optimize the Random Forest model. This approach allows our model to adapt to the specific characteristics of the stock data without the need for additional complex techniques.

Likewise, Du et al. (2022) presented a stock market prediction model based on the Random Forest algorithm, combining AI technology with the financial industry for stock price prediction and analysis. Our code also utilizes the Random Forest algorithm for stock price prediction, but we integrate feature selection and hyperparameter optimization through grid search. This approach enhances the accuracy of our model and enables it to effectively capture important patterns in the stock data, providing valuable guidance for institutional and individual stock investments.

In a study by Sharma and Juneja (2017), the authors proposed the combination of Random Forest estimates using LSboost for stock market index prediction. They compared their model with Support Vector Regression and employed technical indicators as inputs. In our code, we focus on predicting stock prices using the Random Forest model, with the closing price as the predicted variable. Rather than LSboost, we prioritize feature selection and hyperparameter optimization to improve the accuracy of our model.

Additionally, Shrivastav and Kumar (2021) introduced an ensemble model for stock market data prediction, combining deep learning, Gradient Boosting Machine (GBM), and distributed Random Forest techniques. They compared the performance of the ensemble model with each individual method. While our code does not explicitly incorporate deep learning or GBM, it leverages the Random Forest model and emphasizes feature selection and hyperparameter optimization. This approach achieves desirable accuracy and provides valuable insights for guiding stock investments.

In Rajkar (2021) et al.'s recent study, they delve into the world of recurrent neural networks (RNNs) to predict stock closing prices. Their work includes the implementation of a web application that provides real-time data, adding practicality to their research. While exploring various machine learning techniques, their emphasis on data preprocessing underscores its importance in enhancing prediction accuracy.

The research by Ms. N. VivekaPriya and Dr. S. Geetha (2022) seeks to uncover the optimal model for stock market prediction. Their study places a significant focus on data preprocessing, recognizing its pivotal role in refining predictions and emphasizes practical implementation, ensuring their findings translate into real-world solutions.

Mehar Vijha (2020) and colleagues contribute to stock market prediction by employing Artificial Neural Networks (ANNs) and the Random Forest technique to forecast closing prices. Their research adds efficient prediction models to the existing body of knowledge, further enhancing the arsenal of tools available for stock price prediction.

Jingyi Shen and M. Omair Shafq (2020) concentrate their efforts on the short-term prediction of stock market trends, employing advanced deep learning techniques. Their work involves extensive evaluations and particular feature engineering, making a valuable contribution to the field of stock market analysis and prediction.

Amidst the COVID-19 pandemic, Abdullah Bin Omar and his team (2022) take on the challenging task of forecasting stock index prices. They employ the autoregressive deep neural network (AR-DNN) and autoregressive random forest (AR-RF) models to provide practical solutions for investors and policymakers during these turbulent times.

The research conducted by Myneni. Keerthi Pranav and S. Ashok Kumar (2023) focuses on comparing Linear Regression and Artificial Neural Networks (ANNs) for stock price prediction. Their findings highlight the critical role of selecting an appropriate prediction model in achieving accurate results, shedding light on model selection strategies.

Lastly, Qingyi Chen (2022) explores stock market prediction using a diverse array of machine learning models. In their comprehensive study, they identify Support Vector Machine (SVM) and the combination of Convolutional Neural Network (CNN) and Long Short-Term Memory (LSTM) as effective tools for making accurate predictions in the stock market.

Considering the discussions, our code implementation offers several advantages. Firstly, its simplicity lies in the direct utilization of historical stock price data, eliminating the need for complex financial ratios or external data sources. Moreover, the integration of feature selection within the Random Forest model enables it to identify and focus on the most important features for prediction. Additionally, by optimizing the model's hyperparameters through grid search, our implementation enhances its performance and generalization capabilities. Overall, our code provides a flexible and reusable solution for stock price prediction, combining the simplicity of historical data with the power of the Random Forest model.

VII. CONCLUSION

In conclusion, this research paper has explored the application of the random forest algorithm, combined with the grid search technique, for stock market prediction.

The findings have demonstrated the significant potential of this approach in accurately forecasting stock prices and capturing market trends. By leveraging historical stock market data and optimizing the random forest algorithm's hyperparameters using grid search, we have developed a predictive model that effectively captures important patterns and relationships within the data. The incorporation of grid search has enhanced the performance of the random forest algorithm by systematically exploring a range of hyperparameter combinations and selecting the optimal ones based on cross-validation. This process has resulted in improved prediction accuracy and generalization capabilities of the model. Moreover, the grid search technique has enabled us to fine-tune the model's parameters, effectively adapting it to the specific characteristics of the stock data and enhancing its robustness against overfitting.

The random forest algorithm, in conjunction with grid search, has exhibited impressive prediction accuracy and robustness, making it a valuable tool for stock market prediction. The feature importance analysis conducted in this research has provided insights into the key factors influencing stock market behaviour, offering valuable information for investment decision- making. However, it is crucial to acknowledge that stock market prediction is inherently challenging, as it is influenced by various unpredictable factors.

This research paper has demonstrated the efficacy of the random forest algorithm and the grid search technique in stock market prediction. The findings and insights derived from this study contribute to the advancement of predictive modeling in the financial domain. By leveraging the power of the random forest algorithm and optimizing its performance using grid search, investors and financial analysts can make more informed decisions, manage risks effectively, and gain a deeper understanding of stock market dynamics. As stock market prediction remains a complex and dynamic field, future research should continue exploring advanced techniques and incorporating additional factors to further improve the accuracy and robustness of predictive models. The utilization of grid search, along with other optimization approaches, can continue to play a crucial role in enhancing the performance of machine learning algorithms and advancing the field of stock market prediction.

VIII. REFERENCES

[1] Loke, K. S., 2017. "Impact of financial ratios and technical analysis on stock price prediction using random forests," in 2017 International Conference on Computer and Drone Applications (IConDA), May 2017. doi: 10.1109/iconda.2017.8270396.

[2] Zi, R., Jun, Y., Yicheng, Y., Fuxiang, M., and Rongbin,

L., 2022. "Stock price prediction based on optimized random forest model," in 2022 Asia Conference on Algorithms, Computing and Machine Learning (CACML), May 2022. doi: 10.1109/cacml55074.2022.00134.

[3] Du, S., Hao, D., and Li, X., 2022. "Research on stock forecasting based on random forest," in 2022 IEEE 2nd International Conference on Data Science and Computer Application (ICDSCA), Oct. 2022. doi: 10.1109/icdsca56264.2022.9987903.

[4] Sharma, N., and Juneja, A., 2017. "Combining random forest estimates using LSboost for stock market index prediction," in 2017 2nd International Conference for Convergence in Technology (I2CT), May 2017. doi: 10.1109/i2ct.2017.8226316.

[5] L. K. Shrivastav and R. Kumar, "An Ensemble of Random Forest Gradient Boosting Machine and Deep Learning Methods for Stock Price Prediction," Journal of Information Technology Research, vol. 15, no. 1, pp. 1–19, Nov. 2021, doi: 10.4018/jitr.2022010102.

[6] Rajkar, A., Kumaria, A., Raut, A., Kulkarni, N., 2021. "Stock Market Price Prediction and Analysis." doi: 10.17577/IJERTV10IS060047.

[7] VivekaPriya, N., and Geetha, S., 2022. "Stock Prediction Using Machine Learning Techniques." doi: 10.31838/ijcrt.22.10.354, pp. 2363–2371.

[8] Vijha, M., Chandolab, D., Tikkiwalb, V. A., Kumar, A., 2020. "Stock Closing Price Prediction using Machine Learning Techniques."doi: 10.1016/j.procs.2020.03.102, pp. 599–606.

[9] Shen, J., and Shafq, M. O., 2020. "Short term stock market price trend prediction using a comprehensive deep learning system." doi: 10.1186/s40537-020-00333-6.

[10] Omar, A. B., Huang, S., Salameh, A. A., Khurram, H., Fareed, M., 2022. "Stock Market Forecasting Using the Random Forest and Deep Neural Network Models Before and During the COVID-19 Period." doi: 10.3389/fenvs.2022.917047, pp. 1–11.

[11] Pranav, M. K., and Kumar, S. A., 2023. "Stock Market Prediction Using Linear Regression Algorithm by Comparing with Artificial Neural Network Algorithm to Improve Accuracy." doi: 10.21178/ecb.20231103001, pp. 1–15.

[12] Chen, Q., 2022. "Stock Market Prediction Using Machine Learning." doi: 10.2991/978-94-6463-030-5_47.

[13] Jeon, S., Hong, B., Chang, V., 2018. "Pattern graph tracking-based stock price prediction using big data." Pages 171–187.

[14] Park, S., Yang, J.-S., 2023. "Machine learning modeling to forecast uncertainty between capital sudden stop and boom." doi: https://doi.org/10.1016/j.eswa.2023.121662, pp. 121662.

[15] Adekoya, A. F., Nti, I. K., 2020. "The COVID-19 outbreak and effects on major stock market indices across the globe: A machine learning approach." DOI: 10.17485/IJST/v13i35.1180, International Journal of Science and Technology, vol. 13, no. 35, pp. 3695–3706.

[16] Wiranata, R. B., Djunaidy, A., 2021. "The Stock Exchange Prediction using Machine Learning Techniques: A Comprehensive and Systematic Literature Review." DOI: http://dx.doi.org/10.21609/jiki.v14i2.935, Jurnal Ilmu Komputer dan Informasi (Journal of Computer Science and Information), vol. 14, no. 2, pp. 91–112.