ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25apr718

Exploring Machine Learning for Stock Price Prediction and Decision Making

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Publication Date: 2025/04/19

Abstract: Intricate dynamics of the stock market makes its prediction a challenging and daunting activity. In order to create precise predictive models, researchers are employing emerging machine learning models and methods. The research starts with the collection of the history, the volumes of trade and other related indicators. Then the data is preprocessed feature engineering is done, thereby producing useful input representations for machine learning models. The model employed in the research is SVR model. Grid search CV method is utilized to discover the best possible parameters' values that are utilized in SVR model. The model assists in predicting the intraday stock values based on recent past data. This makes the model respond promptly to trends and changes, making it optimal for short-term and momentum trading strategies.

Keywords: *Support Vector Regression (SVR), Grid Search CV.*

How to Cite: Dr. Geetha T V.; Sayandeep Mondal; Sumran Verma; Jeeval Chawla. (2025). Exploring Machine Learning for Stock Price Prediction and Decision Making. *International Journal of Innovative Science and Research Technology*, 10(4), 549-552. https://doi.org/10.38124/ijisrt/25apr718.

I. INTRODUCTION

Machine learning-based predictive analysis of the trends in stock market is a fast-developing field that utilizes sophisticated computational methods to predict future movements in stock prices. This data-driven methodology depends largely on past stock data, including historical prices, volumes of trades, market indicators, and even news sentiment in some cases, to train machine learning models that can recognize patterns and make well-informed predictions. The central concept involves pulling useful understanding from large-scale datasets that generally are too bulky or complicated to be analyzed very well by usual methods. It is an applied field that involves the intersection of statistics, computer science, and finance, putting together ideas borrowed from all these fields to design strong predictive models that help inform traders and investors to make smart choices.

Various Machine learning algorithms are widely applied in predicting stock market trends. Among these, deep learning algorithms—particularly recurrent neural networks (RNNs) and long short-term memory (LSTM) networks—have been increasingly popular for their capacity to learn from complexly structured data. These models are capable to analyze trends and identify time-based dependencies in stock price data, leading to more accurate predictions of values for future trends. Ensemble learning methods like random forests and gradient boosting machines also help enhance prediction accuracy by taking advantage of the strengths of several base learners.

The biggest assest of machine learning for predicting stock markets is its capacity to adjust to the changing nature of markets and find subtle patterns that human analysts may not perceive. Traders and investment companies are relying more on algorithmic models to stay competitive in high-frequency trading, where milliseconds matter. Predictive models are also utilized in generating trading strategies, including where to buy and sell best, when to enter and exit, and how to create diversified investment portfolios. When applied properly, predictive models have the potential to enhance returns while minimizing human emotions and biases.

But it is critical to recognize the risks in applying machine learning for forecasting of stocks. The stock exchange is subject to numerous uncontrollable factors, such as changes in political and economic scenarios, international crises, and investor sentiment, which are hard to accurately model. Although machine learning can advance forecasting precision up to some point, it is not possible to eradicate the intrinsic volatility and uncertainty of financial markets. Overfitting to past data, generalization failure, and black-box model behavior are some of the typical issues encountered during model building and deployment.

II. RELATED WORK

F Ghallabi et al. [2] in a study forecasted stock prices of clean energy by using ESG stock market along with various ML methods and NGBoost. Stock data is given in the data set

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after world crises like covid-19 etc. Use of Shapely Adaptive Explanation has also been covered in analysis of the paper for enhancing the interpretability of the data. The findings show that NGBoost performs better than other ML techniques with high parallels among Clean Energy stocks and ESG market.

S. Gupta et al. [16]. Paper solves the problem of predicting the performance on individual business stock on stock market because the market is exposed to continuous change. A comparative analysis of applications and outcomes of various machine learning approaches is presented providing baselines for commonly used algorithms such as linear regression, SVM and neural network methods such as CNN, RNN etc.

V. Chang et al. [15]. The research seeks to tackle the issue of unpredictability and non-linearity in data of stock market, particularly after the pandemic. Solution proposed in the paper is the emphasis on RNN models such as GRU and LSTM and testing the efficiency of the same in forecasting the stock prices.

The research incorporates techniques such as ARIMA and XGB in the improvement of the model's robustness.

Results showed GRU performed better than LSTM in Prediction and Training. This aided in giving insight regarding predictive strengths of such models and emphasized potential of GRU and XGB in accurately predicting the stock market.

H. Zheng et al. [12]. Examines different applications of machine learning using financial time series analysis such as future trend predictions in economic data and enterprises involved in finance. Paper elucidates on conventional models like ARIMA and how effective they are with ML models and Hybrid ML models. Their ability to interpret non linear data is reiterated. Predictions and integrity analysis are carried out on deep learning by using techniques like cross validation and empirical analysis. Paper presents several potential avenues of ML application in financial prediction, thereby providing a methodological framework for more accurate and trustworthy predictions.

J. M. Sangeetha and K. J. Alfia. [7]. Paper talks about objective stock market prediction and access of machine learning to acquire predictions for various stock prices. Emphasis is on training the various models on high economic prices, therefore, achieving good and noticeable enhancement in automated stock market prediction. The paper highlights investigation of linear regression based Machine learning methods for predicting market prices.

Y. Wu et al. [14]. The majority of the predictive models are based on supervised learning and therefore struggle to parse the trade information of regularly evolving stock market. The problem is solved by the paper proposing a hybrid model that combines unsupervised learning and reinforced learning. The paper discusses the process starting with collecting stock data from past data and then build a trading environment from unsupervised learning. After that designing a reward function in order to make accurate stock value predictions.

M. S. Smai and A. Ustundang. [9]. The paper discusses about a new prediction methodology integrating ensemble learning with feature selection algorithms. The central emphasis is placed on forecasting change in opening and closing stock prices by using a sliding window cross validation approach. Experiments demonstrated light Gradient Boost machines and Shapely Additive Explanations to be best model and demonstrate a phenomenal superiority over buy-and-hold stratergy.

A. Das. et al. [4]. Research investigates uses of various ML methods and algorithms in predicting stock market. Paper studies stocks as input values for ML algorithms and focuses on sophisticated technique to predict future stocks.

III. METHODOLOGY

This project employs Support Vector Regression (SVR) in stock price prediction. SVR employs an epsilon-tube to manage volatility by ignoring small errors. Data is gathered through the yfinance API, preprocessed, and trained with tuned hyperparameters (C, gamma, epsilon) through GridSearchCV. Matplotlib plots predicted vs actual values for assessment.

A. Proposed Architecture

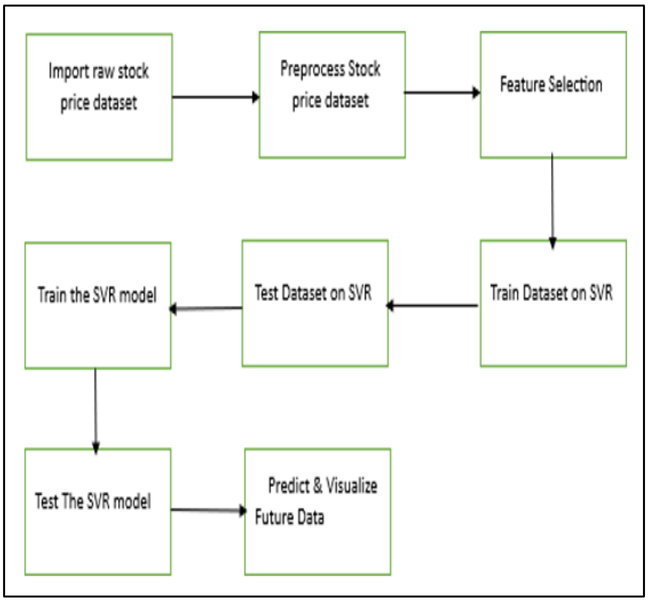

Fig 1: Diagram Highlighting the Proposed System

B. Data Collection and Preprocessing

We make use of yfinance API to get data collection. It means yahoo finance. It retrieves past data from the API. For implementation, we apply ticker_symbol. It retrieves historical for given ticker symbol. Preprocessing the data includes organizing raw data in the form appropriate for analysis and modeling. It consists of feature extraction where code incorporates hour and minute extraction. This is achieved with the dt.hour and dt.minute properties of the pandas Datetime object. It is a data manipulation method

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which can assist the model in learning patterns in time.

C. Training and Testing

The preprocessed data is then segregated into training and testing set. Training and testing sets are segregated by maintaining the test size value as 0.4, i.e., if the total dataset considered has 100 individual data sets, then 60 of them are utilized for training and 40 for testing. Random forest is yet another significant feature of scitkit_learn regarding training and testing since it introduces consistency in the shuffling while splitting the data into training and testing.

D. Feature Selection and Engineering

Discussing feature scaling, one of the crucial elements of any model, the first scaler that we employ is standardscaler, which standardizes features by stripping off mean and scaling to unit variance. The following features are C, gamma, epsilon. C is referred to as the generalization feature and aids in reducing trade- off between training and testing errors. An increased value of C reflects an increased emphasis on reducing training errors and vice- versa. Gamma is a significant property w.r.t radial bias function kernel, the kernel that aids in reading complicated and nonlinear data. Gamma determines how far-reaching the impact of one training sample is, where "low" and “high” values imply "far" and "close," respectively. Epsilon indicates epsilon-tube in which there is no penalty given meaning, if a predicted value falls in the tube it is considered as the predicted output.

E. Output Visualization

This assists us in interpreting the model performance and the correlating real v/s predicted values. This is done with the use of the matplotlib library which graphically represents the real and predicted values on a chart making them easily understandable.

F. Model Evaluation

Model evaluation measures are necessary to check the performance of predictive model. For that we use MSE or mean squared error function to find mean squared error between the different (real v/s actual) data values. Less is the MSE, more accurate is the model. The MSE is generated randomly based on the amount of data used and parameter values selected.

IV. RESULTS AND DISCUSSION

The suggested model, employs support vector regression or SVR algorithm in order to predict stock prices. The model accordingly employs RBF kernel function, in order to deal with non linearity of the data. This enables the model to fit complexities of the financial data. By tuning the model with optimal values of C, gamma and epsilon, we can easily generalize unseen data, develop the optimal decision boundary for the model and minimize errors. Applying standardscaler to feature scaling ensures that all input features reflect the desired contribution in prediction process thereby enhancing the model's performance. The ability of the model, therefore, makes it accessible to anyone from a novice in trading to an expert to utilize them, particularly if they have an interest in frequency based intraday trading.

In total, the suggested system can produce good performance using comparitively smaller data compared to more data- intensive models and can minimize data requirements and training time. It is also very helpful for applications such as market trend analysis, stock price prediction, portfolio optimization, anomaly detection etc. The suggested system can also generalize effectively to unseen data and has good ability to deal with non-linear data.

- **Starting Grid Search for best parameters... Grid Search completed.**
- **Best parameters found:**
- **{'C': 1, 'epsilon': 0.1, 'gamma': 0.001}**
- **Best cross-validated MSE: 2.915625282189881**
- **Values of parameters used in the best model: C:1,gamma:0.001,epsilon:0.1**

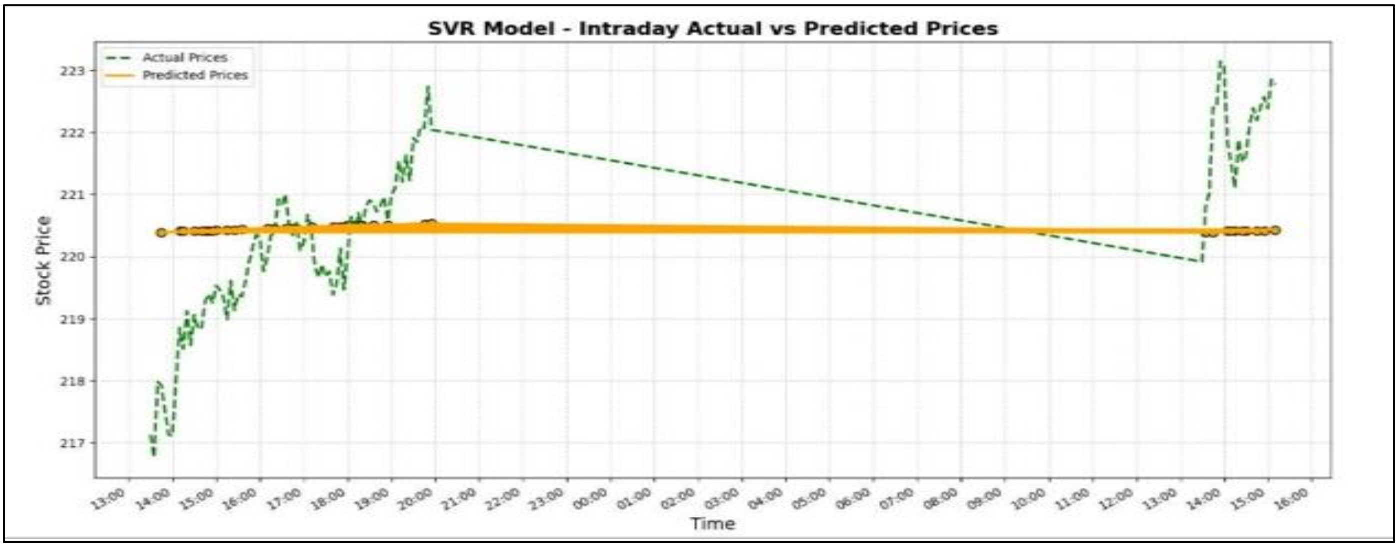

Fig 2: SVR Model –Intraday Actual vs Predicted Prices

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- **Starting real-time prediction loop...**
- **Predicted price for the next 5 minutes: 178.26 USD, Recent closing price: 178.49 USD**
- **Predicted price for the next 5 minutes: 178.27 USD, Recent closing price: 179.62 USD**
- **Predicted price for the next 5 minutes: 178.27 USD, Recent closing price: 179.96 USD**
- **Predicted price for the next 5 minutes: 178.28 USD, Recent closing price: 180.60 USD**
- **Finished running the prediction loop.**

V. CONCLUSION

The Support Vector Regression (SVR) model is a robust tool for prediction of stock prices. It balances the strengths of both conventional and machine learning models. Conventional models are efficient and simple, particularly when dealing with light data. SVR draws on this point by having a low computational cost, hence making it simpler to train and implement on resource- constrained systems. Concurrently, SVR also combines the sophisticated strengths of machine learning algorithms, especially their capacity to detect and learn from non-linear, complex and volatile patterns in stock price data. This renders the SVR model extremely resilient to real-world market conditions where price movement hardly traces linear patterns.

By combining these two methods, SVR offers a balanced and realistic solution for stock price forecasting. Its efficiency means that users do not need to use high-performance hardware to take advantage of its features. This makes the model available to more people, such as novice traders and retail investors. Additionally, its capacity to process complex data patterns improves decision- making, facilitates short-term trading strategies, and encourages improved risk management. Overall, SVR is an easy-to-use and smart model that provides timely and better-informed trading decisions in the stock market.

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