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FORECASTING STOCK CLOSE PRICE USING MACHINE LEARNING MODELS

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ABSTRACT

Forecasting is about determining which variables contribute to the prediction of other variables. The stock forecasting problem is difficult due to its unpredictable and non-linear nature. Prediction and evaluation are two of the most challenging tasks. A machine learning (ML) classifier was used to address prediction issues in this paper. Linear Regression (LR) was used to develop the new Stock Close Price Prediction (SCPP) algorithm. The model was built using Yahoo Finance's data of different stocks using LR, Bernoulli Naïve Bayes (BNB), and Support Vector Machine (SVM). Among these, the model forecasts the stock close price effectively with LR. In this, the Apple stock's close price was predicted with the features: Low, Open, High, Volume, and Close. From the results, LR outperforms the SVM and BNB in close price prediction with an accuracy of 99.97 %.

Keywords: stock market, stock close price prediction (SCPP), stock prediction, machine learning, bernoullinaïve bayes (BNB), support vector machine (SVM), linear regression (LR).

INTRODUCTION

The quantity of financial activities has increased in recent days as a result of strong economic expansion, and their variation trend has also become more difficult. Both academic institutions and financial institutions are interested in determining the pattern of financial activity and anticipating their future growth and changes. The stock sector is an essential part of the country's economy since the majority of the money is moved from here throughout the globe [1]. Consequently, the performance of the stock market has an impact on the national economy. It's crucial for attracting and distributing distributed funds and savings in the most efficient way possible.

Despite the large number, the number of individuals that make money from the stock market is really modest. By analyzing market data, stock market investors and speculators hope to boost their profits. As a result, one could benefit from the stock market if they have the right models to forecast stock price and fluctuations, which are impacted by macroeconomic factors and also hundreds of many other factors [2]. The primary goal of this research is to predict a stock's closing price so that it can be acquired and sold at a gain.

If anyone really wants to succeed in the stock sector, the person must study data. Because market data is chaotic and non-stationary, most researchers find it very hard to gain insights and make precise forecasts regarding stocks [3]. Because of the large data capacity, standard techniques fail, and the program produces incorrect results. For prediction tasks in the trading world, a variety of strategies are used [4]. Social media has always been a big part of most people's lives, but it's changed in many ways in recent years. It's a significant online communication medium. People offer their ideas on a range of issues and debate the newest trends. Internet and social networking platforms such as Twitter, Facebook, MySpace, and Instagram [5]. Due to the many options, there are nine strategies to anticipate inventory costs, but not all work the same. Even with the identical data set, each approach has a different outcome. Machine learning provides a wide array of algorithms, all of which are said to have the ability to forecast future stock values. Machine learning has been used to examine price trends and anticipate stock prices and index changes. Most stock traders rely on sophisticated trading algorithms to estimate rates based on varied needs and conditions, helping them make rapid investment selections. The global stock markets are active, so it's hard to know when to buy and sell. Many different strategies for forecasting the movement of stock prices have been created throughout the course of time [6]. While it's tough to replace an experienced trader's expertise, an accurate predictor model may lead to obvious investor gains, demonstrating that the prediction simulation is tied to its profit. We want to undertake a technical analysis while utilising Machine Learning on Stock Data to evaluate whether our algorithm understands the stock's fundamentals. Machine learning can measure and predict a company's effectiveness and other key analytical factors. The best encrypted stock prediction and referral mechanisms combine Fundamental and Technical Analysis.

In recent years the concept of LR has emerged as one of them. For information processing, LR may self-organize to discover characteristics from inputs, change them, and investigate valuable patterns to identify the category and make predictions [7], [8], and [9]. Because manually developing features is time-consuming and insufficient for complicated inputs and large-scale issues, LR can be quite beneficial.

RELATED WORK

To process financial data, finance scholars first employed simple linear models like the simple auto regression approach and the simple moving average approach. In the topic of employing computers to

examine price patterns and identify stock prices and index changes. There has also been a lot of interesting work done recently. Scholars from all over the world have experimented with a variety of stock forecasting methods, including the VAR Model [10], Error Correction Model [11], and Kalman Filter Model [12], among others.

Different stock prediction strategies may be divided into two categories. The first class of algorithms comprises those that attempt to increase prediction performance by strengthening prediction models. The next type of algorithm, on the other hand, focuses on improving the attributes that are used to make the forecast.

ML techniques for market prediction have steadily become a prominent research area among academics in recent times [13], [14], [15]. White [16] has used a neural network model for predicting the IBM shares price, but the findings were unsatisfactory. Zhang [17] predicts stock prices using a neural network and an ARIMA. The experiments demonstrated that neural networks are better at predicting nonlinear data, although the accuracy requires development. Hammad *et al* [18] analysed the Jordan stock market using an MLBPN, however, they missed that the typical BP network slides towards a local minimum. An NN-based empirical technique was developed by Vanstone and Finnie [19] for the purpose of constructing ANN-based automated trading systems.

Kara *et al* [20] developed two models for the direction forecast of the ISE National 100 Index movement. They used two classifiers to generate the models: ANN and SVM, with the ANN surpassing the SVM. By employing a MLP model, Jasemi *et al* [21] investigated the information contained in Japanese stock charts. Ticknor [22] has proposed a Bayesian network-based stock prediction model and tested its performance using information from Goldman Sachs Group Inc. and Microsoft Corp. stocks. To forecast error series, Li [23] employed experimental model segmentation and an SVM. Wang [24] developed the NN stochastic time-effective function and utilized it in conjunction with principal component analysis to anticipate the different asset prices.
S madge *et al*. [25] developed the SVM machine learning approach. The model predicts whether a stock's price will rise or fall from a certain day. It analyses the closing prices of 34 technology companies to assess price fluctuations and sector momentum. K. H Sadia *et al*. [26] developed a technique to anticipate stock market price. They will show and evaluate a more practical strategy to accurately predict stock movement. In addition to that, this method delivers a model for machine learning that can predict stock persistence in an environment of intense competition. Successful stock forecasting helps firms and investors find answers. S Shen *et al*. [27] introduced a novel prediction method that employed temporal correlation among global markets and major items to anticipate trend of following day stock. In this study, the classification was done via the SVM. Financial market predictions rely heavily on machine learning. The effective stock prediction will be a tremendous asset for stock market institutions and bring real-life answers to stock investor difficulties [28].

In [29], they presented Apache Spark, a fast streaming framework for ultra-large scale data management, and offer an innovative technique for processing vast geographic data. They also study the geographical data framework integrate with Resilient Distributed Datasets (RDD) geometric data framework, which is intended to enable different iterative methods [30].

In [31] AI, the goal is to create an entity that imitates human brains, learning exponentially from real-life situations to solve real-world computer issues. Which identifies intellectual traits offered by each human brain to more development and develops innovative knowledge to integrate sensory organ information, they construct brain hugely inspired KGS which is achieved to incredibly knowledge expanding with the assistance from information accumulation over time [32].

The student essay is compared to admin-suggested keywords. If there is a resemblance between the two pieces of writing that is less than twenty percent, then the essay does not meet the requirements. Segmentation, stop words removal, word frequency calculations, numerical characteristics, phrase validation, and spell check are also used [33]. There are assessment tools, but ours is more accurate. The sequential forward feature selection method compares accuracy and chooses the best subset this way. This approach generates an efficient subset from a single empty set and works well on tiny data [34], [35]. This resource must cluster data and deliver only relevant information. For filtering, they employed density-based k-means and graph clustering. After filtering, they rank the data by keyword frequency, relevancy, and similarity [36]. This study proved how to detect distinct emotions in a tweet regarding elections using sentiment analysis approaches centred on supervised machine learning, i.e., Naive Bayes [37]. J K. K. Patel *et al*. [38] anticipate to study each of these models, ten technical factors that represent the state of the stock and the stock price index are used. The Trend Deterministic Data Preparation Layer is an important and unique addition to the study. This layer is used in the process of converting each of the technical indicators' continuous Process values accordingly.

Najeb Masoud *et al*. [39] used a daily data-based ANN model to test whether LSM was expected to be important by Libyan learning procedures of the ANN model. Artificial sensors or nodes are highly-connected computer devices used to mimic an artificial neural network's computational theory. Each node is responsible for carrying out a basic process on an input in order to generate an output, which is then sent to the next node.

In this paper, LR, one of the Regression models will be used to forecast the stock closing price. The methodology and framework of the model will be explained in the next section.

METHODOLOGY

Dynamic, unpredictable, and non-linear describe the stock market. Predicting stock prices is difficult because of several aspects, including politics, the global economy, financial statements, performance, etc. Thus, anticipating stock prices in advance by evaluating the pattern over the previous several years might be useful for making stock market movements to maximise profit and minimise losses.

A. Dataset Description

This work was initially built on python for retrieving data in structured or unstructured format from Yahoo finance [40]. As known retrieving features from structured data is quite easy compared to unstructured data. For the research, unstructured data of Apple, Amazon, Microsoft, and Google have been considered as known websites. The stock's high, low, open, close, adjacent close, and volume values are all included in the data. Among them, only the stock's day-by-day closing price has been predicted in this research. Table-1 shows the dataset statistics used in training and testing. Table 2 below depicts several dataset representations.

Table-1. Dataset representation.

Data Set	Duration	Training Data	Testing Data
Yahoo	1st January 1996 to 1st February 2022	4935	1646

B. Objective

One of the major uses of ML and DL is stock market analysis, which has been a significant area of research. The major goal is to implement a cutting-edge model for forecasting stock closing prices. The data size for stock price prediction is particularly large and non-linear. To deal with such a big data collection, data-efficient algorithms that can uncover hidden patterns and complicated relationships are required. In this field, ML approaches have proven to be more efficient than previous methods.

C. System Architecture

In this article, the stock closing price prediction model is implemented using LR, BNB, and SVM. LR is a statistical tool for predicting outcomes. When forecasting the closed stock trading, it helps us with the value that is reliant on the independent variable and how it changes in stock closing prediction. By considering the SVM method, which aids in the decision-making process in classification and regression issues based on anticipated values. The architecture of the model is illustrated in Figure-1.

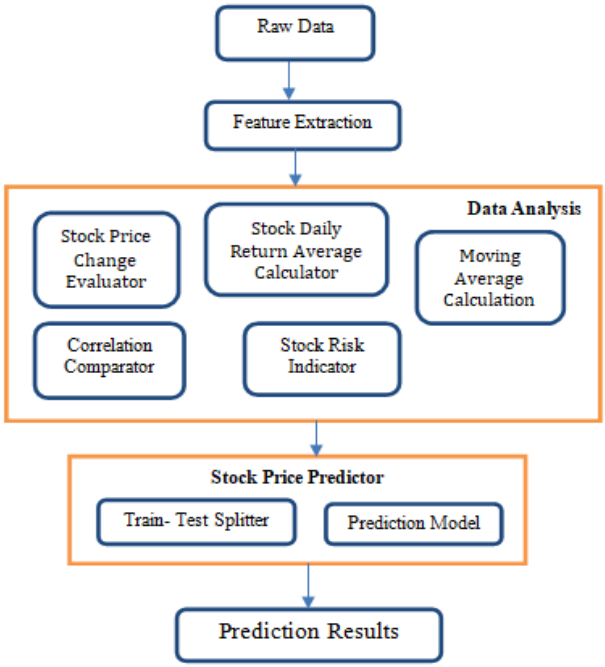

Figure-1. The SCPP framework.

D. Bernoulli Naïve Bayes Algorithm

The "naive" assumption of feature independence given the class variable supports naive Bayes techniques. Bernoulli NB conducts naïve Bayes training and classification for multivariate Bernoulli data; each feature is a binary-valued variable. There will also be access to more Naive Bayes models, such as the Guassian, Multinomial, and Complement, Bernolli, and Categorical Naive Bayes algorithms.

Stock forecasting can be achieved using two techniques: Technical analysis (TA) and Qualitative analysis. In this work, the TA has been used to forecast the stock close value. TA means analysis of the stock's historical information such as opening price, closing price, adjacent closing price, etc. for future stock price forecasting.

The algorithm initially collects the raw data of company stock prices from Yahoo finance. From the dataset, the unnecessary data will be removed in the pre-processing step. The pre-processing step will remove the rows having null values or rows having some values not available. After the data is pre-processed, the necessary features will be selected for model. The dataset will be split into training data and testing data after the feature selection. The training data will train the model and testing data will test the prediction model's performance. In this, the SCPP model has been developed by using LR. The LR is used because it works effectively on numerical features. The algorithm for stock close value prediction is stated below:

ALGORITHM: Stock Closing Price Prediction

Input: - Historical Stock Price Data

Output: Predicted and original stock closing prices for particular Stock.

Data Collection:
$\text{Dataframe} = \text{Read(Stock\_data)}$

Pre - processing:
$\text{df.drop(attribute\_name, axis} = 1, \text{inplace} = \text{True)}$

Train_Test_Split:
$x = \text{data\_frame ['attributes']}$
$y = \text{data\_frame ['attributes']}$
$\text{X\_train, X\_test, y\_train, y\_test} = \text{train\_(test\_split (x, y))}$
$\text{regressor} = \text{LinearRegression ()}$
$\text{regressor.fit}(X_{train}, y_{train})$
$\text{predicted} = \text{regressor.predict}(X_{test})$
$\text{dframe} = \text{pd.DataFrame}(y_{test}, \text{predicted})$
$\text{dfr} = \text{pd.DataFrame}$
$(\{'\text{Actual}': y_{test}, \ '\text{Predicted}': \text{predicted}\}$
$\text{regressor.score}(X_{test}, y_{test})$

There will be various models which can predict stock market's future trends, but with its dynamic and volatile nature only few models can produce accurate predictions. Linear Regression is one among them. It has been used in SCPP model implementation and it has produced better accuracy compared to Bernoulli Naïve Bayes and Support Vector Machine which is explained in section 4.

RESULTS

Experiments on historical data of "Apple" firm stock from January 1, 1996 to February 2, 2022 were undertaken to validate the efficiency of the suggested method [26]. The stock firms that were employed in this study are mentioned in Table-2.

Table-2. Stock companies list.

Stock Symbol	Stock Name
AAPL	Apple
MSFT	Microsoft
GOOG	Google
AMZN	Amazon

The experiments for forecasting a company's closing stock price are run on a computer with an Intel Core i3, 8 GB of RAM, and a 1 TB hard drive. Table-3 lists the remaining specifications. The model is written in Python and employs a variety of libraries, including NumPy, Pandas, Keras, and others.

Table-3. System Environments.

Environments	Version
Anaconda Navigator	V_2.0.3
Jupyter Notebook	V_6.3.0
NumPy	1.20.1
Pandas	1.2.4
Seaborn and Matplotlib	0.11.1 and 3.3.4
Scikit-Learn	0.24.1
Keras	2.2.4

In the procedure, the model estimates the stock closing price, as shown in Figure-1. Table-4 shows the fundamental statistical parameters of Apple stock.

Investors can use closing prices as a guide to determining how stock prices have changed over time. Even in the period of 24-hour trading, every stock has a closing price. Figure-5 depicts the closing price patterns of AAPL, GOOG, MSFT, and AMZN. The x-axis in Figure-5 shows time duration, whereas the y-axis represents neighbouring closeness.

Stock price varies on daily basis, depending on a variety of factors. Figure-6 shows a diagrammatic representation of the shift in movement trends. The moving average was generated for each stock and displayed in Figure-6 to draw the graph. The change in the daily stock value can alternatively be expressed as a percentage. Figure-7 depicts the situation.

The degree to which two variables move in respect to each other is measured by correlation. Figure-2 is showing the correlation between four stocks: AAPL, GOOG, MSFT, and AMZN in this study. Risk can be measured in a variety of ways, but one of the most fundamental is to compare the expected return to the standard deviation of the daily returns, which can be done using the data obtained from daily percentage returns. The Risk indicator plot was shown in Figure-3.

Accuracy

It is a metric for identifying which model is the most accurate at finding patterns and correlations between diverse data based on the information, also known as training data.

The Mean Absolute Percentage Error (MAPE), Root Mean Square Error (RMSE), and Mean Bias Error (MBE) are used to discover the minimized errors in forecasted closing prices.

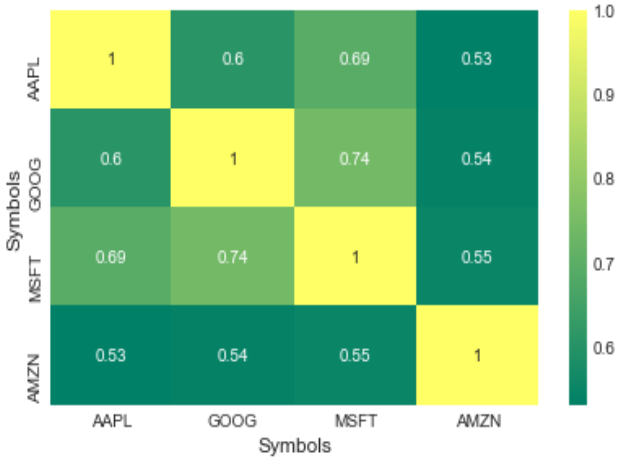

Figure-2. Correlation matrix.

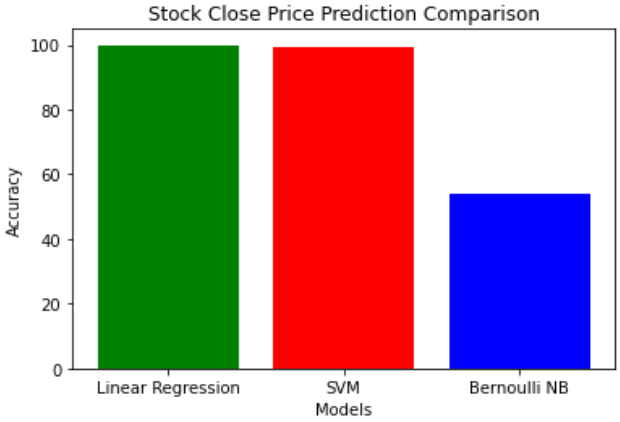

Figure-4. Accuracy comparison plot.

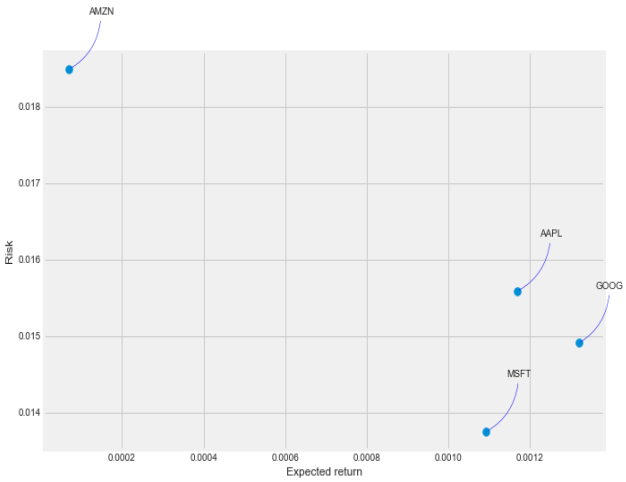

Figure-3. Risk Indicator plot.

Table-4. Summary statistics for AAPL.

	High	Low	Open	Close	Volume	Adj Close
count	**254.000000**	**254.000000**	**254.000000**	**254.000000**	**2.540000e+02**	**254.000000**
mean	146.307284	143.357716	144.775355	144.894606	8.949949e+07	144.418932
std	17.256826	16.741952	16.928608	17.029719	2.843743e+07	17.202891
min	120.400002	116.209999	119.029999	116.360001	4.100000e+07	115.672501
25%	130.982498	128.902504	130.015003	130.247505	6.904782e+07	129.615738
50%	146.489998	143.760002	144.570000	145.560005	8.453615e+07	144.999428
75%	154.697502	151.214996	152.787502	152.982498	1.054095e+08	152.565178
max	182.940002	179.119995	182.630005	182.009995	1.954327e+08	181.778397

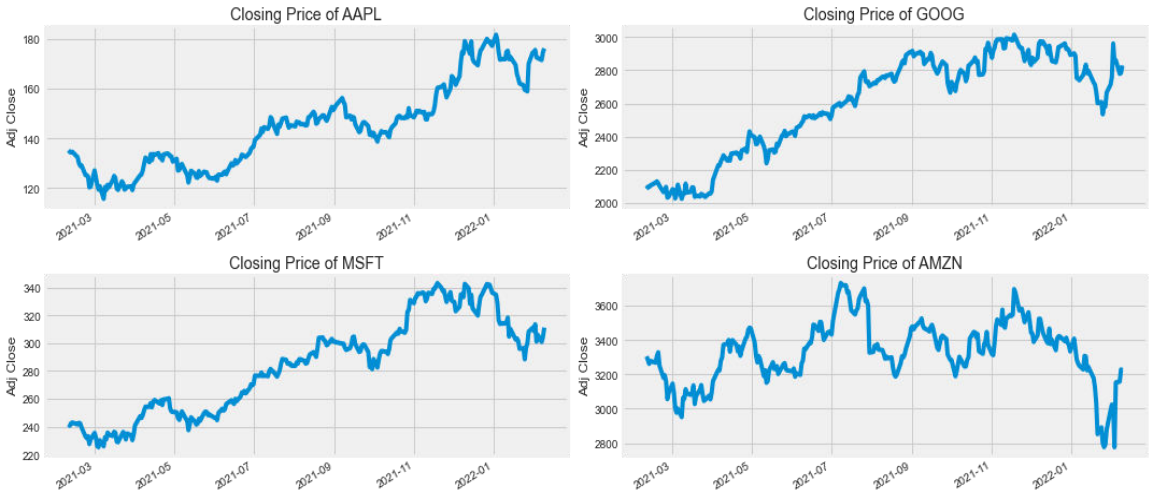

Figure-5. Historical trends of stock closing price.

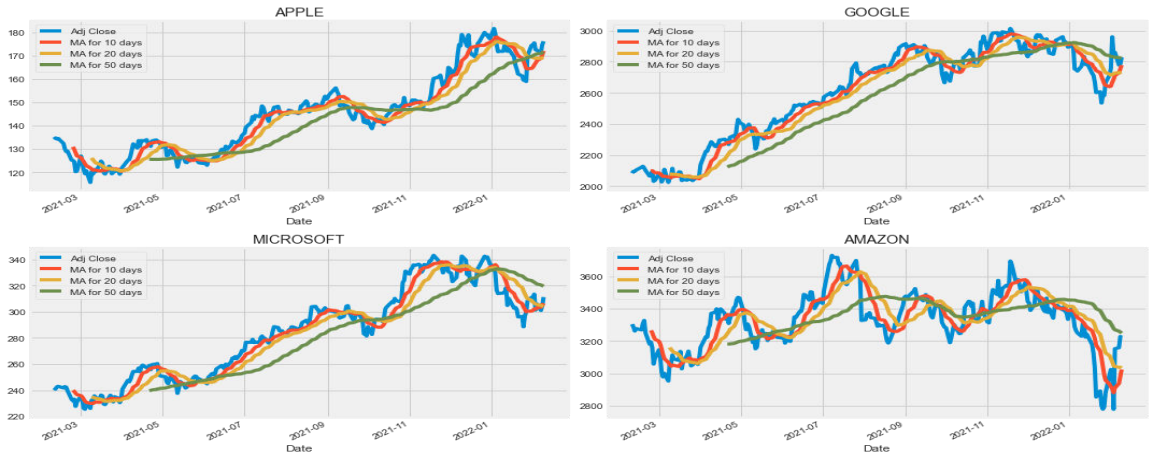

Figure-6. Plots with Moving Average MA=10, 20, and 50.

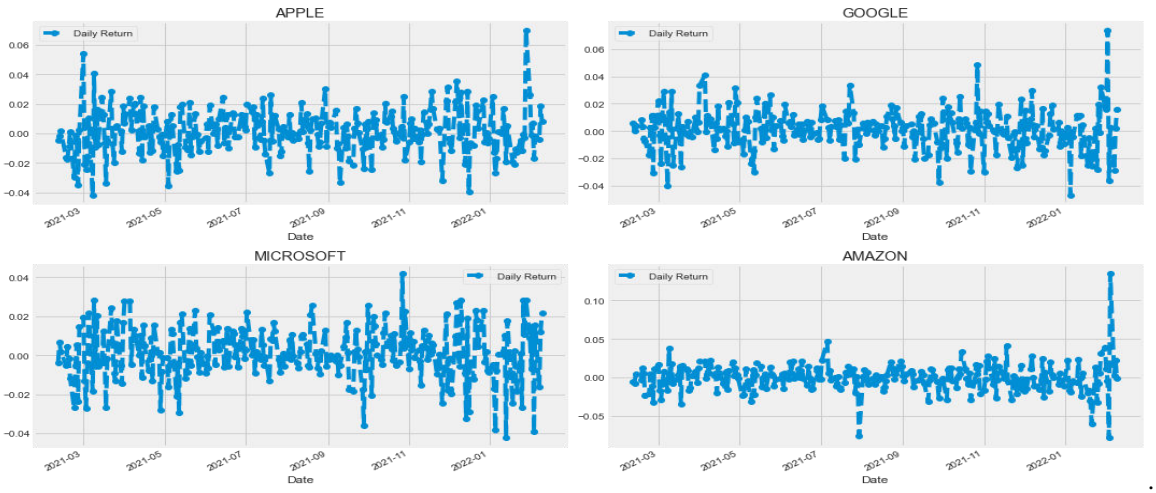

Figure-7. Daily stock change in percentage values.

Table-5. Classifier performance evaluation

Model Name	Performance Metrics		
	Accuracy	MBE	RMSE
Linear Regression	99.97%	0.082	0.286
SVM	99.13%	0.071	0.021
Bernoulli NB	53.95	0.005	0.012

In Table-5 the performance metrics was evaluated for various models has shown. After all the steps, the stock's closing price is predicted using LR, BNB, and SVM. LR has a 99.97 percent accuracy rate, while SVM and BNB has got 99.13, 53.95 percent accuracy respectively. Figure-4 depicts the graph plot for the accuracy stock closing price forecast. As a result, in terms of efficiency, LR outperforms SVM and BNB.

CONCLUSIONS

For closing stock price forecasting, a Linear Regression based model is implemented in this article. The prediction will continue to be a fascinating area of research, with domain experts looking for methods to improve existing predictive models. Due to the complicated nature of the stock market, stock value forecasting is considered one of the most interesting challenges in financial forecasting. The performance of the suggested approach has been tested by experiments on the dataset. Accuracy, RMSE, and MBE metrics have been utilized to assess the performance, and are also used to assess the error of a quantitative data model. The LR model attained great results, with an accuracy of 99.97% and have outperformed the SVM and BNB.

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