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Investigating Efficiency of Machine learning algorithms over Prediction of Stock Market Indices

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Abstract : Finding efficient ways to understand, process, and interpret stock market data into knowledge that can be applied to improved investment decisions is the aim of modern finance. Financial tasks are often very diverse and complicated; they frequently possess unpredictable, dynamic, nonlinear, time-varying, and changeable structural properties; and they are influenced by a wide range of political and economic factors. Researchers and academicians working on the problem of predicting the stock market are divided into two groups: some who think they can create algorithms for this purpose and those who believe the market is efficient and self-corrects when new information emerges. Machine learning methods have created powerful application recently that can mine meaningful data from a sizable database. a lot of study is being done to see the behavior of Machine Learning algorithm over financial time series data like stock market/stock index prices. This work is an attempt to predict and compare stock market trends using machine learning models namely k Nearest Neighbor (KNN), SVM algorithms, Adaboost, and decision trees.

IndexTerms **- Component,formatting,style,styling,insert.**

I. INTRODUCTION

Stock market forecasting has consistently been an interesting activity for many professionals around the world because of the clear large monetary benefit involved. The ability of stocks to absorb and react to information that is promptly reflected in their pricing makes them an incredibly fascinating investment option. Academicians and researchers have shown keen interest in studying the predictability of the stock prices, since it throws more light in understanding the behavior and dynamics of the stock market..

1.1 Introduction to Share market

A stock market is a public place where businesses or individuals can raise capital. Companies can buy or sell shares in the market. Share prices are influenced by interest rates and share supply. Trading is the process of buying and selling shares; exchanging is only permitted for Listed Companies. Recently, significant sums of money are traded globally on the stock market. National economies are closely related and have a significant impact on how their stock markets operate.

Stock market forecast is the procedure of attempting to focus the future stock estimation of an organization. The effective forecast of a stock's future cost could return a huge benefit. Stock value movements are administered by the speculations random walk hypothesis and efficient-market hypothesis.

In the literature, a number of methods have been employed to forecast stock market returns. These methods can be divided into four main categories: Machine Learning, Traditional Time Series Forecasting, Technical Analysis, and Fundamental Analysis.

1.2 Machine Learning

Machine learning techniques can be classified using a variety of characteristics, such as the fundamental learning process, how information is presented, or the application domain. Langley and Simon identified five important machine learning standards: descriptive learning, inductive learning, genetic calculations, and instance-based learning. These standards all have the same goal of improving the presentation of some task, which is typically achieved by identifying and taking use of regularities in data preparation.

Many of the most common machine learning algorithms used in data mining are capable of detecting on the peculiarities of the dataset as they process it. Their knowledge of the data increases as they process the dataset more. Typically, the complete collection of data under analyzed is divided into two groups.the training set and the test set. The training of the data mining models takes place with the training dataset. This learning phase is usually iterative and time consuming. The test dataset is earmarked to validate the performance of trained models. Once the model achieves the desired level of prediction accuracy with the training dataset, it is applied on the test dataset and the difference between predicted outcome and the actual values in the test dataset is measured. In data mining terminology, they are called prediction errors. Using different error metrics available in the data mining literature, performance of the models, and predictability of the system under study can be evaluated.

Four different machine learning techniques, including K Nearest Neighbor (KNN), SVM algorithms, Adaboost, and decision trees, were used in this study to predict the share market. This algorithm was chosen based on evidence from a literature review and

the desire to test a novel algorithm on stock market data. In this study, the performance of each algorithm is calculated using a performance matrix, and the results of all algorithms are compared.

1.3 Problem Statement

A Stock Market Prediction Using Machine Learning is a system of prediction of trends of stock (UP/DOWN). The study mainly focuses on investigating the predictability of the stock market indices using various Machine Learning models i.e., k-Nearest Neighbor (KNN), Decision tree, Adaboost and SVM. It determines and compares the efficiency of the model.

II. LITERATURE SURVEY

In literature review it is evident that many of the researchers deployed different prediction techniques in share market prediction few of many are addressed below.

Buche, A., & Chandak, M. (2019) [8] This study examined and assessed the prediction of stock price movement using various sentiment analysis techniques that are used as an input to various machine learning algorithms. With the help of opinions taken from the text and the use of predictive analysis and technical analysis, different technical and economic indicators can be used to discover and improve stock price movement decisions in order to optimize trading profits.

Das, D., & Shorif Uddin, M. (2013) [9]. Using conventional techniques might not guarantee the accuracy of the prediction. In this study, they examine the potential for using two well-known techniques data mining and neural network to forecast the stock market. Both data mining and neural networks can be used to extract useful information from large data sets and forecast future trends and behaviors. Consequently, using both of these methods could make the prediction much more accurate.

J. Jayapradha, Kishore Jagan Jothi Kumar, Binti Deka (2015)[10]. Support vector machine, Random Forest, and Naive Bayes are the three classification methods that are the subject of this study. The three different classification methods have been used to the data after it has been gathered, normalized, and applied. Using various evaluation criteria, the best model has been developed. In this study, we outline the strategy for putting the best model into practice; the findings of this study demonstrate that Random Forest is more effective than the other two Classification algorithms for the data set studied.

Emami, S. S. (2018) [12]. In this study, the development and applicability of the technical analysis study's backdrop as well as future discussion of the topic were all addressed. . The next is the well-known technical analysis, in which the indicators were initially evaluated by traders at the Tehran Stock Exchange, following which a decision matrix was created and the indicators were ranked by VIKOR for future investigations.

Garg, P., & Vishwakarma, S. K. (2019) [13]. The goal of this work is to research, create, and evaluate several methods for predicting upcoming stock movements. As per the experimental findings, a variety of classification approaches can be used to accurately anticipate share prices. This research aims to forecast the share price of State Bank of India using various data mining techniques. To forecast share price employ many data mining methods, and suggested various ways to aggregate the outcomes of various algorithms. This study was conducted by gathering historical SBI share prices from the yahoo finance website.

R. Suganthi and P. Kamalakannan (2015) [14].This study's main objective is to apply machine learning methods to find certain sector stocks in real-time stock market trades. Its secondary goal is to show how machine learning algorithms can be used to analyze stock market data. To develop a database that represents a particular stock market sector based on a dataset, to predict the daily trade data. This study to compare the accuracy level and time needed while creating models using machine learning algorithms (K-means, optics, EM, Cobweb), and to evaluate which model is best for making decisions using daily trade data.

Gupta, A., Bhatia, P., Dave, K., & Jain, P. (2019) [15]. Two models, primary and secondary, comprise their suggested system a core model uses three basic algorithms to predict stock price, while the secondary model adds a sentiment quotient calculated from twitter feeds. In comparison to the existing single isolated system, it is possible to provide better results due to model integration. Different machine learning and deep learning methods are used in the literature for prediction and classification. Various papers use deep neural networks for classification purposes

Since there are significant financial benefits involved in stock market predictions, it has long been an interesting activity for many researchers worldwide. Studies of the literature show that prediction outcomes vary across financial markets. Machine learning tools are consistently better to other statistical methods, which is another intriguing finding. According to the research, Machine learning tools are expected to be more accurate than other techniques at forecasting changes in stock market prices. The most obvious advantage of data mining technology is that it is between 5 and 20 percent more precise and superior to conventional statistical methods.

III. PROPOSED SYSTEM

This work is predict the movement and price of select Indian stock indices machine learning algorithms which are used namely k-Nearest Neighbor (KNN), Decision tree, AdaBoost and SVM. Classification model is built for each machine learning algorithm using training data set further every model is tested by test data set and compare the performance of above models in predicting the stock index movement and price.

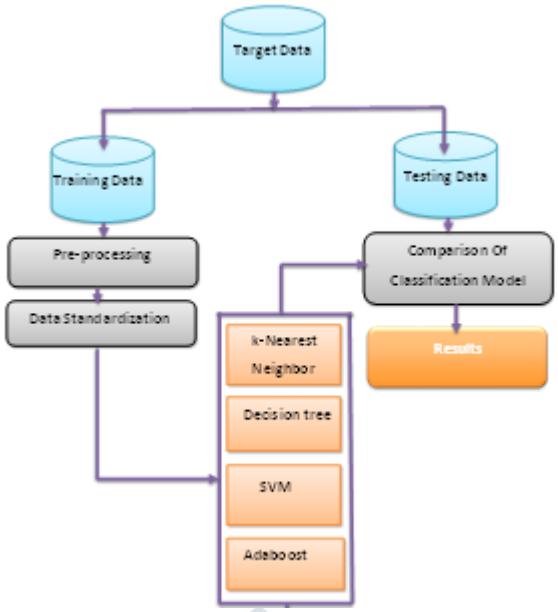

Figure1: Architecture of proposed system

Above figure 1 is the architecture of the proposed system is mainly divided into two sub parts. First is the training part and second is the testing part.

Stock Market Dataset: Initiating trades will be based on real-time data, and pricing trends can be predicted using past market data. The time frame can be a second, an hour, a day, a week, a month, and so on. Due to the wide range of security and own fundamental properties, choosing the best period is frequently a difficult process. In this study, the closing values of NSE-NIFTY and BSE stock data are examined in relation to the opening, highest, lowest, and closing prices as predictors. The NSE-NIFTY and BSE stock index data are retrieved individually from the NSE and BSE websites for the years 1990 to 2022. The data is divided into two 75:25 sub-tests. The system can operate on any suitable share market data set.

Preprocessing: The values of the selected attributes were all continuous numeric values when the data was initially collected. The data was transformed into a discrete set of values by making generalizations it to a higher-level concept. The rule for converting the numerical values of each attribute to discrete values was the previous day's closing price. This process also involves validating the data. In order to prepare for further processing, input data and its format must be examined during validation.

Data Standardization: Rather than on the effectiveness of the prediction algorithm, the accuracy of a forecasting model mostly depends on the selection of predictors. Ten commonly used technical indicators, including the stochastic percent K, stochastic percent D, Momentum indicator, Price rate of change, Williams percent R, Moving Average Convergence and Divergence (MACD), Price minus Moving Average, A/D oscillator, Price oscillator, and Relative Strength index, are used in this study. Additionally, intraday index movements, such as the open price, high price, low price, and close price, are used as predictors.

Classification model using K-Nearest Neighbor (KNN): One of the simplest machine learning methods is the k-NN algorithm. It is based on the theory that items closer to one another will also have same attributes. In this way, it is simple to forecast an object's immediate neighbors given one of its defining characteristics are known.

The k-NN technique is an improvement on the nearest neighbor technique in which prediction is based on votes from "k" nearest neighbors rather than a single nearest neighbor. It's based on the idea that any new instance can be categorized by getting the consent of at least k of its neighbors, where k is a positive integer that's usually very short. With respect to the day for which a prediction is to be made, the k-NN method identifies the nearest neighbors in the training dataset. Once k-NNs have been found, the prediction for that day is calculated as the weighted average of the neighbors' average closing prices for the following day. The k-NN method tests with different values of k in the training dataset to get the ideal value of k that yields the best prediction outcome. The test dataset is then used to apply this predictive model, with the optimal value of k, in order to forecast the closing price for the following day. Performance metrics, which are used to assess the performance of the predictive model, are computed using the output of the predictive model and the actual values of the test dataset.

Classification model using Decision tree: Decision tree is a popular decision-making tool and it is a widely used classifier among the data miners. It is based on constructing hierarchical trees from the historical dataset available and the fully grown trees and pruned trees are then used for forecasting new instances. A series of questions that separates the total dataset into shorter and shorter subgroups functions as the representation of decision trees. It looks for a single predictor variable and its specific value that divides the entire dataset into two segments with the highest degree of decision variable homogeneity. The impurity function informs the selection of the split variable. The Gini Index and the entropy measure are two of the most widely used impurity function metrics. The predictor with least impurity measure is the choice of splitting the dataset. This splitting process is then continued with each of the resulting data fragments until leaves or decision nodes are reached.

Making decision rules for forecasting can be done using the generated tree. An unknown instance is categorized by moving it down the tree in accordance with the values of the characteristics examined in subsequent nodes, and when it reaches a leaf, it is categorized in accordance with the class assigned to the leaf.

Classification model using AdaBoost: Since Freund and Schapire initially introduced the composite modelling approach known as "boosting" in 1997, it has been a popular method for solving binary classification problems. By transforming a number of weak learners into strong learners, these algorithms increase the prediction power. The Boosting method used as a Prediction Model in Machine Learning is called the AdaBoost algorithm, or Adaptive Boosting. In adaptive boosting, the weights are reallocated to each instance, with higher weights assigned to instances that were wrongly classified.

Classification model using SVM.: Vladmir Vapnik created the SVM algorithm, a potential new machine learning technique, in 1995. It may be used to classify both linear and nonlinear dataIt converts the initial training data into higher dimension planes using nonlinear mapping. It looks for a linear optimal separation plane separating one class from the other within the new dimension.

Kernel functions handle the conversion of data between lower-dimensional and higher-dimensional planes. SVM can use a variety of kernel functions, such as linear, polynomial, and radial bias functions (RBF). It is possible to simplify linearly inseparable classification issues into a linearly separable instance in a higher dimension,

Comparison of models

In this phase k-Nearest Neighbor (KNN), Decision tree, AdaBoost and SVM models are trained and developed using 75% of actual data set i.e. training data set. Comparisons of classification model are done by deploying the 25% of actual dataset which is a testing dataset. The efficiency of this model is recorded through a confusion matrix. The accuracy of all models is identified and compared with each other.

IV. CREATING THE ENVIRONMENT FOR IMPLEMENTATION

Python is used to carry out the suggested solution. Many libraries and tools are used to fully implement the suggested approach. These include the machine learning libraries such as Matplotlib, a plotting library for the Python programming language, is one of the libraries. Other software tools used in the implementation include TensorFlow and Sklearn.

Data presented visually is recognized more quickly than text. GUIs are simple to use for non-programmers because they don't require any prior knowledge of computing procedures. They are not concerned with writing or debugging code. Because of this, users find GUI to be simple to learn.

To provide good human computer interaction, a graphical user interface (GUI) is designed. Forecasting Indian stock indices includes two main phases one is comparison of machine learning algorithm and another is developing a prediction system which is shown in Figure 2

Figure 2 User interface.

In this phase comparison of identified prediction models is done using designed Graphical User Interface. There are several steps involved in this phase namely Data Selection, Preprocessing, Data Standardization, Training, Testing and Result. Below figure 3 and 4 shows the share indices data selection and share indices data on frame.

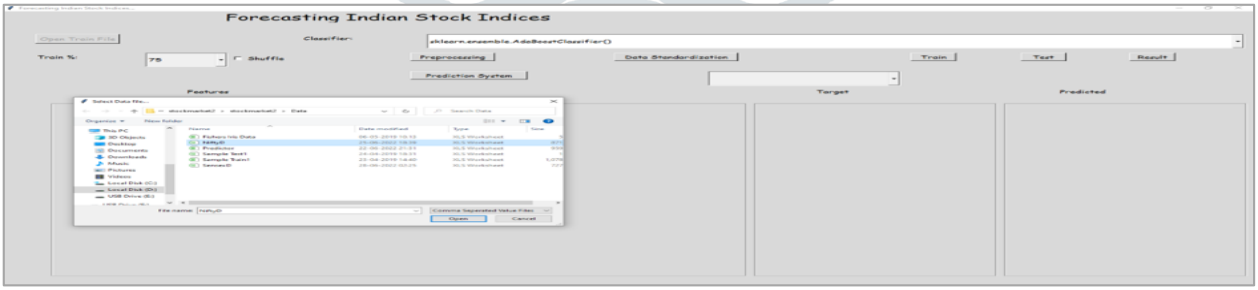

Figure 3 Share Indices Data Selection

Data preprocessing is the process of data validation in which whether data is in suitable format present or not is checked and if data is not present in suitable format for further process then manually convert data to suitable format which is shown below in figure 4

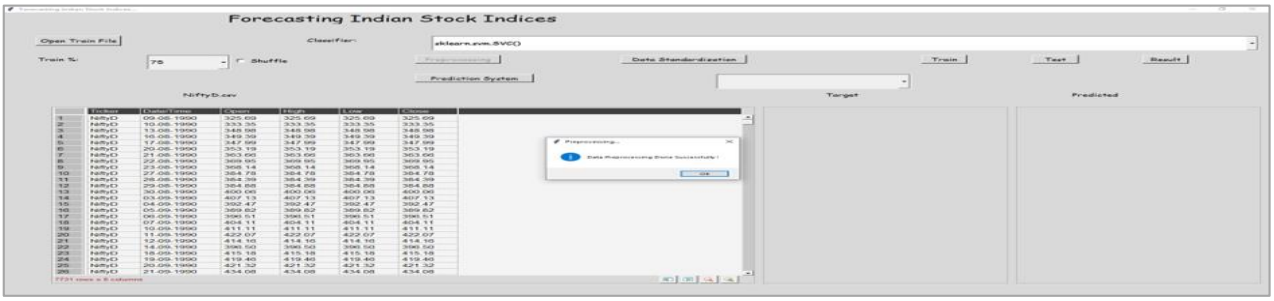

Figure 4 Preprocessing of Data

Data standardization is the important step in this system which converts data in to ten different indicators further it is considered as parameter or predictor for the prediction system. Below figure 5 shows the data standardization process.

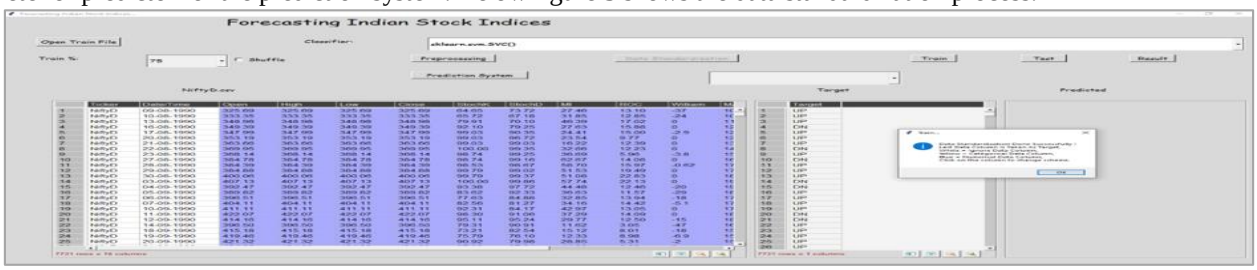

Figure 5 Data Standardization.

After data standardization next step is creating a classification model for this each classification model needs to train in this view Training of SVM classification model is performed with 75 percent of total Data Set which is shown below in figure 6 after multiple iterations model is trained and ready for testing.

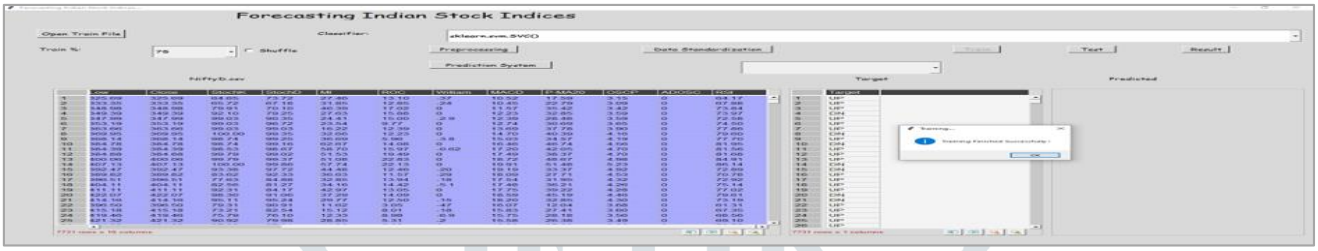

Figure 6 Training Data set Using SVM.

After training the SVM classification model the model is ready for testing and the model with 25 percent of remaining total data set is used for testing which is show below in figure 7. The system shows testing completion message with accuracy achieved.

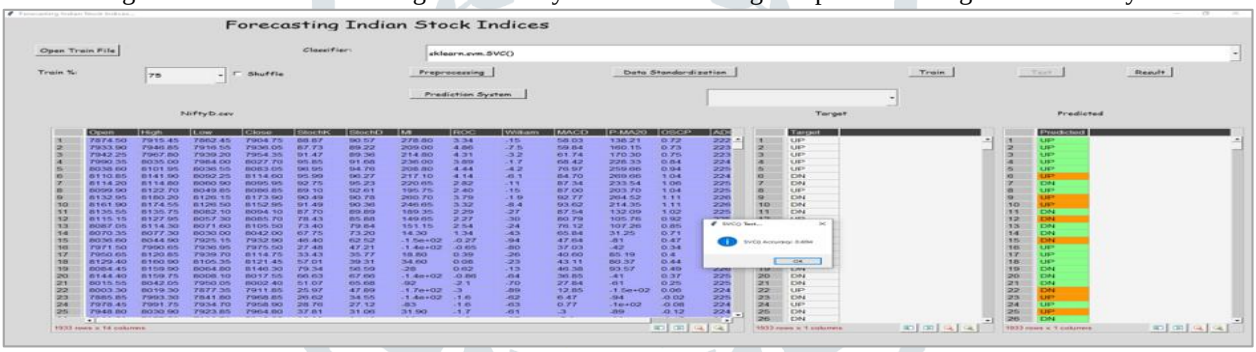

Figure 7 Testing Data set Using SVM.

IV. RESULT ANALYSIS

In machine learning, the accuracy of the model is generally the first parameter to be examined whenever a model is developed for any classification task. Classification accuracy can be calculated by dividing the number of accurate predictions by the total number of predictions the model made..

Test results for KNN model

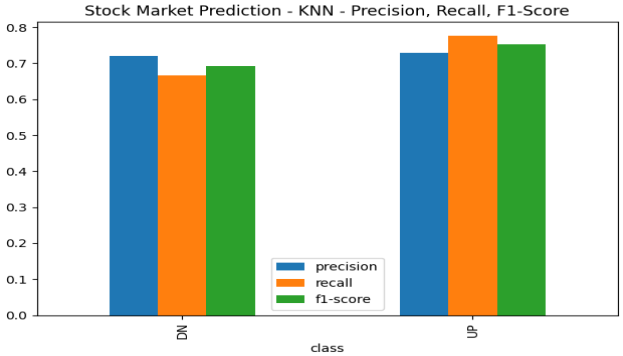

Figure 8 Precision, recall and f1 score for KNN

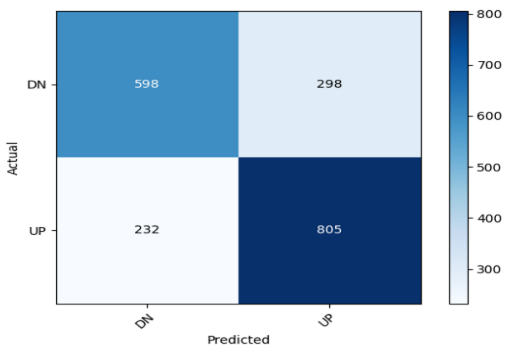

Figure 9 Confusion matrix for KNN

Above figure 9 shows the confusion matrix for the KNN model plotted in the implementation. The actual classes are on the Y-axis and the classes predicted by the model are on X-axis. In the confusion matrix above, the highlighted values show the best performance results. The best results are usually on the diagonal. Out of the 1933 share market indices the model predicted 1403 share market indices correct class that is either UP or Down. The KNN Model wrongly predicted 530 share market indices.

Test results for Decision Tree

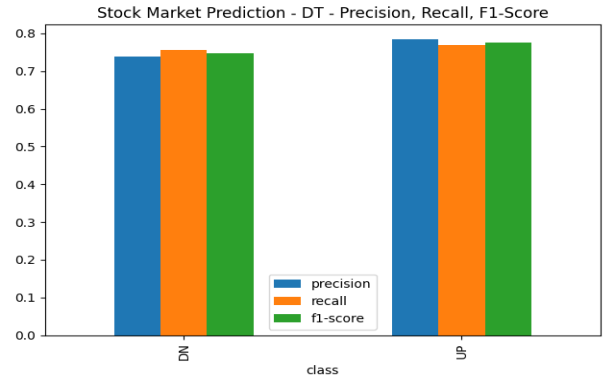

Figure 10 Precision, recall and f1 score for Decision Tree

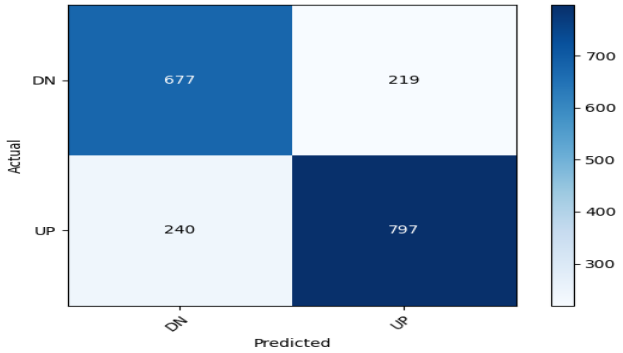

Figure 11 Confusion matrix for Decision Tree model

Above figure 11 shows the confusion matrix for the Decision Tree model plotted in the implementation. The actual classes are on the Y-axis and the classes predicted by the model are on X-axis. In the confusion matrix above, the highlighted values show the best performance results. The best results are usually on the diagonal. Out of the 1933 share market indices the model predicted 1474 share market indices correct class that is either UP or Down. The Decision Tree Model wrongly predicted 459 share market indices

Test results for SVM

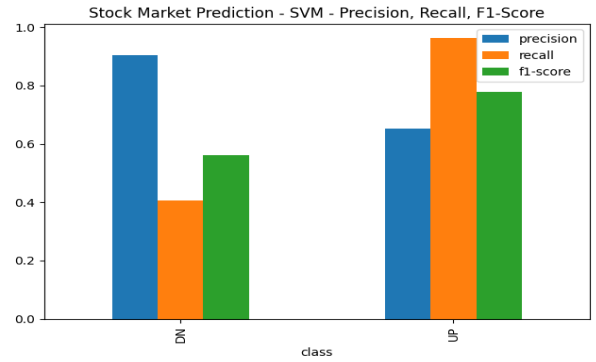

Figure 12: Precision, recall and f1 score of SVM

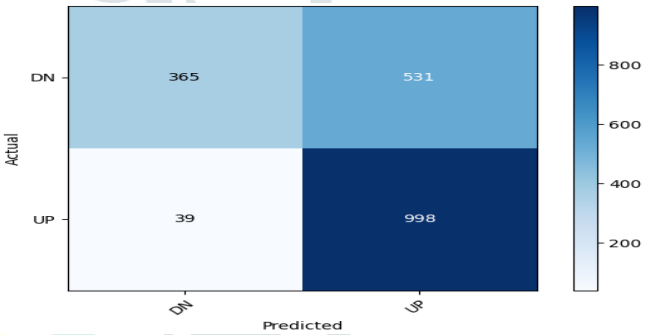

Figure 13: Confusion matrix for SVM

Above figure13 shows the confusion matrix for the Decision Tree model plotted in the implementation. The actual classes are on the Y-axis and the classes predicted by the model are on X-axis. In the confusion matrix above, the highlighted values show the best performance results. The best results are usually on the diagonal. Out of the 1933 share market indices the model predicted 1363 share market indices correct class that is either UP or Down. The SVM Model wrongly predicted 570 share market indices.

Test results for AdaBoost

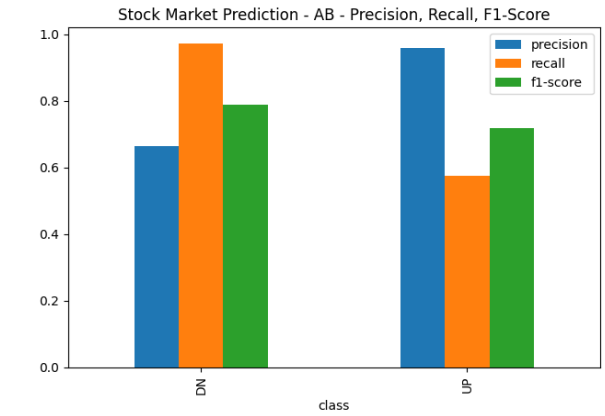

Figure 14: Precision,recall and f1 score of AdaBoost

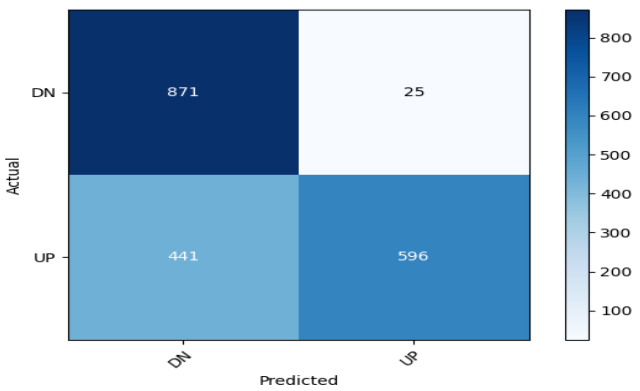

Figure 15: Confusion matrix for AdaBoost

Above figure 15 shows the confusion matrix for the Decision Tree model plotted in the implementation. The actual classes are on the Y-axis and the classes predicted by the model are on X-axis. In the confusion matrix above, the highlighted values show the best performance results. The best results are usually on the diagonal. Out of the 1933 share market indices the model predicted

1467 share market indices correct class that is either UP or Down. The AdaBoost Model wrongly predicted 466 share market indices.

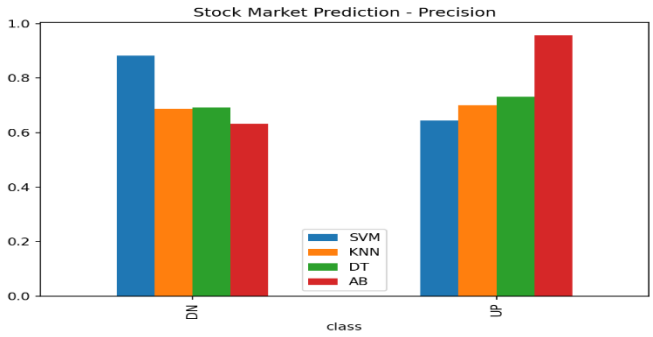

Figure 16: Precision of all models

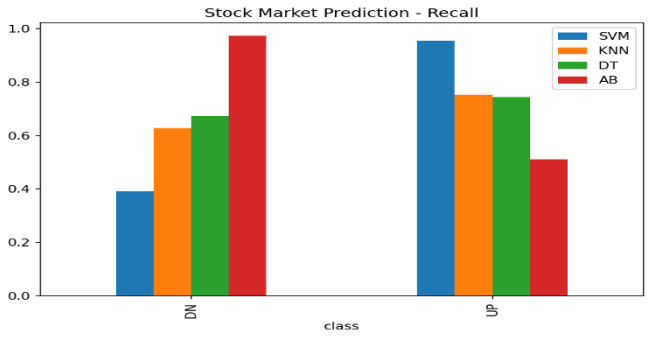

Figure 17: Recall of all models

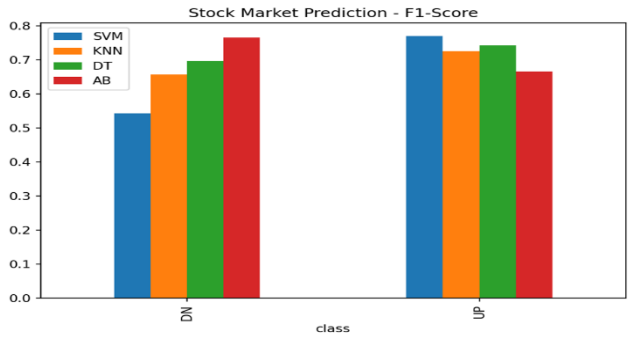

Figure 18: F1 score of all models

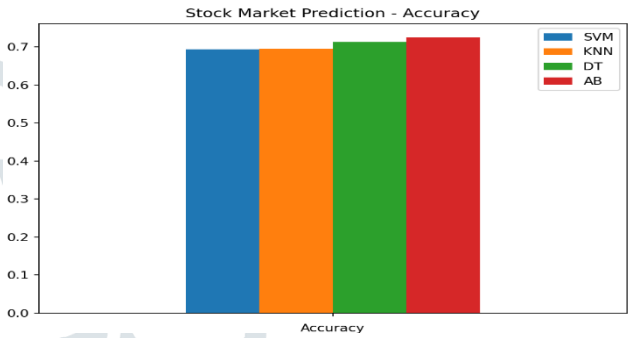

Figure 19: Accuracy of all models

The above bar graph shows the comparison of accuracy of all four models used in this work for predicting share market indices. The accuracy of KNN is the lowest at 69%. The accuracy of the decision Tree model is 72.2%. The accuracy of SVM is 69.4%. and the accuracy of AdaBoost is highest among all, 72.5%.
The figure indicates that the AdaBoost and SVM model performs well and it gives more accuracy and better results when compared to other two models.

V. ACKNOWLEDGMENT

In this work Machine Learning strategies have been applied to predict the future stock Indices. First, a KNN, Decision Tree, SVM, AdaBoost has been proposed to predict the future Stock Indices. Then every model is compared with a confusion matrix that is Accuracy, Precision, Recall and F1 Score calculated for every prediction class for every algorithm.

It is found that almost all classification models gave good performance on share market data set. SVM and AdaBoost are relatively better than the remaining other prediction models. AdaBoost is good at predicting down whereas SVM is good for predicting UP. Developed predictor models can work on any data set which is in suitable format.

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