Stock Market Prediction using Supervised Machine Learning Techniques: An Overview

Conference Paper · December 2020

DOI: 10.1109/CSDE50874.2020.9411609

3 authors, including:

Zaharaddeen Karami Lawal
Universiti Brunei Darussalam
26 PUBLICATIONS **302** CITATIONS
SEE PROFILE

Rufai Zakari Yusuf
University of Electronic Science and Technology of China
38 PUBLICATIONS **310** CITATIONS
SEE PROFILE

Stock Market Prediction using Supervised Machine Learning Techniques: An Overview

Zaharaddeen Karami Lawal
Department of Computer Science
Federal University Dutse
deenklawal13@gmail.com

Hayati Yassin
Faultyof Integrated Technologies
Universiti Brunei Darussalam
hayati.yssin@ubd.edu.bn

Rufai Yusuf Zakari
Department of Engineering
University of Electronic Science and Technology of China
rufaig6@gmail.com

2020 IEEE Asia-Pacific Conference on Computer Science and Data Engineering (CSDE) | 978-1-6654-1974-1/20/$31.00 ©2020 IEEE | DOI: 10.1109/CSDE50874.2020.9411609

***Abstract*— Stock price prediction is one of the most extensively studied and challenging glitches, which is acting so many academicians and industries experts from many fields comprising of economics, and business, arithmetic, and computational science. Predicting the stock market is not a simple task, mainly as a magnitude of the close to random-walk behavior of a stock time series. Millions of people across the globe are investing in stock market daily. A good stock price prediction model will help investors, management and decision makers in making correct and effective decisions. In this paper, we review studies on supervised machine learning models in stock market predictions. The study discussed how supervised machine learning techniques are applied to improve accuracy of stock market predictions. Support Vector Machine (SVM) was found to be the most frequently used technique for stock price prediction due to its good performance and accuracy. Other techniques like Artificial Neural Network (ANN), K-Nearest Neighbor (KNN), Naïve Bayes, Random Forest, Linear Regression and Support Vector Regression (SVR) also showed a promising prediction result.**

Keywords*— *Stock Market Prediction, Supervised Machine Learning, Classification, Regression, Support Vector Machine (SVM), Artificial Neural Network (ANN)

I. INTRODUCTION

Stock price prediction is one of the most extensively studied and challenging glitches, which attracting several researchers from many fields comprising of economics, and business, arithmetic, and computational science. [1]. Stock price prediction has been at focus for years since it can yield significant profits. Predicting the stock market is not a simple task, mainly as a consequence of the close to random-walk behavior of a stock time series[2]. Stock market prediction is one of the most pains taking tasks due to its volatility. The challenge of stock market prediction is so productive that even a small increase in prediction by the new model can bring about huge profits. Stock prices are an essential part of the prediction[3]. In recent years, the fast growing financial markets opened new horizons for investors and the same time bringing new challenges for financial analysts in their efforts to make effective decisions and reduce the investment risks. Stock market is a highly dynamic and complex system since there are a great number of interacting factors that affect the future prices[4]. Researchers have worked very tough to ascertain the point that financial markets are predictable. With the advancement and availability of technology, stock markets are now more accessible to investors. Various models have been proposed, both in industry and academia, for stock market prediction ranging from machine learning, to data mining, to statistical models[5].

A few speculations with respect to markets exchanges have been conceptualized throughout the long term. They either attempt to clarify the idea of market exchanges or attempt to clarify whether the business sectors can be beaten [6]. Financial organizations and traders have made different exclusive models to attempt to beat the market for themselves or their customers, however seldom has anybody accomplished reliably higher-than-normal degrees of profitability [7].

Machine learning has the potential predict stock market by training and testing the models with the historical datasets, social media data, crawled financial news or trends.

This paper discussed the usage of machine learning models in stock market predictions where it details out how supervised machine learning algorithms/techniques (Classification and Regression) are applied. The paper is organize as follows: Section II elucidates the methodology used to conduct this review; Section III explains the findings and discussion. Conclusions are drawn in Section IV.

II. SYSTEMATIC REVIEW METHODOLOGY

Research method that has been adopted in this paper is Systematic Literature Review (SLR). A systematic review can be define as a research technique and process for identifying and critically appraising relevant research, as well as for collecting and analyzing data from said research[8]. Execution of a systematic review can be grouped into three main stages: planning, conducting the review and reporting the review[9].

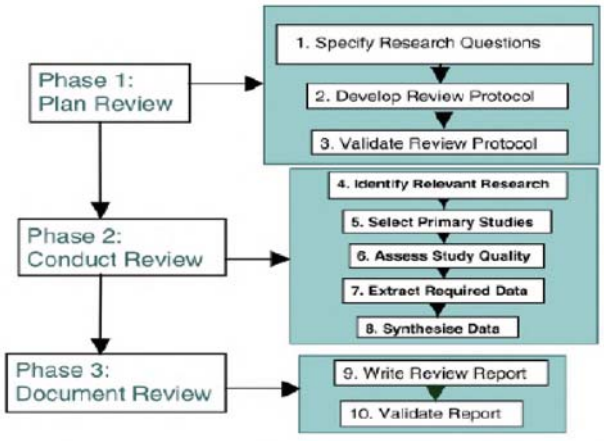

Fig. 1. Systematic Literature Review Process[9].

Literature review from all the journal publications and conference articles gathered and used to answer the research questions mentioned as follows:

R1: What are the Supervised Learning Algorithms that are commonly used in Stock Market Prediction?

R2: How Supervised Machine Learning techniques are applied in Stock Market Prediction?

R3: Which technique is considered the best or frequently used for Stock Market Prediction among the Supervised Machine Learning techniques?

978-1-6654-1974-1/21/$31.00 ©2021 IEEE

R4: What are the directions of future research on Stock Market Prediction?

A. *Supervised Machine Learning Techniques in Stock Market Prediction*

Stock-market prediction using machine-learning technique which aims at developing effective and efficient models that can provide a better and higher rate of prediction accuracy [40]. Numerous classification and regression models have been used in stock market predictions for many years. Several supervised machine learning techniques applied in stock market prediction yielded a better outcome. For more than a decade, a number of supervised machine models and techniques has been proposed or implemented for stock market predictions. Plethora of researchers and technology practitioners tried their level best in order to come up with an algorithm that will give the best stock market prediction.

The majority of work published on supervised machine learning techniques used in stock market predictions are categorized as follows: are not included in the study:

- The comparison of classification algorithms
- The comparison of regression algorithms
- The comparison of classification and regression algorithms of

B. *Systemtic Literature Review Approach*

We collected journals and conference papers via electronic sources using credible and relevant databases such as IEEE Xplore, ScienceDirect, Google Scholar, Semantic Scholar, Open Access and Springer. The search keywords used to search publications are "Stock Market Predictions using Machine Learning", "Stock Market Prediction using Supervised Machine Learning Techniques/Algorithms" and " Stock Market Prediction using Classification/ Regression Algorithms".

The study has address issues of Supervised Machine Learning and Stock Market Predictions therefore they were excluded. The articles has reduced the number from 84 to 38.

The following criteria has been used in eliminating the papers that are not included in the study:

- Exclude if the paper do not emphasis on Machine Learning Predictions.
- Exclude if the paper do not discuss about Supervised Machine Learning in Stock Market Predictions or Stock Market Predictions

III. FINDINGS AND DISCUSSION

In this section, the answers to research questions as presented in Section II we have provided in details where the result of first research question is discussed in Section 4.1 while the answers to the remaining research questions are discussed in Section III.A, III.B and III.C respectively. The research questions are provided with details answers based on the chosen case studies.

A. *Supervised Machine Learning (SML) Algorithm Investigation in Stock Market Prediction*

Table I illustrated the most widely used supervised machine learning techniques in stock market prediction. Some studies used a single while others used more than 1.

TABLE I. SUPERVISED MACHINE LEAARNING TECHNIQUES

Journal/Conference Paper	Stock Market Prediction Models	Algorithm Type
Robert P. Shumaker et al [10]	SVM	Regression
Han Lock Slew et al [11]	Linear Regression (LR)	Regression
Khalid Alkhatib et al [12]	KNN and None Linear Regression	Classification and Regression
Carol Hargreaves et al [13]	Logistic Regression	Regression
Usman Hegazy et al [2]	LS-SVM	Classification
Abubakar S. Magaji et al [14]	SVM-SMO	Classification
Saahil Madge et al[1]	SVM	Classification
Shashaank D.S et al [15]	Hybrid future selection	Classification
Hakob Grigorian et al [4]	SVM	Classification
Khan, W. Ghazanfar et al [16]	SVM, KNN and Naïve Bayes classifiers	Classification
Makram Zaidi et al [17]	ANN	Regression
Aparna Nayak et al [18]	Decision Tree, Logistic Regression and SVM	Classification and Regression
Mustansar Ali Ghazanfar et al [5]	SVM	Classification
Mr. Pramod Mali et al [19]	LR and Multiple Regression	Regression
Hakan Gunduz et al [20]	SVM and ANN	Classification
D. A Puspitasari et al [21]	SVM and KNN	Classification
Gareja Pradip et al [22]	Naïve Bayes	Classification
Meizhen Liu et al [23]	SVM	Classification
R.Seethalakshmi et al [24]	Linear Regression (LR)	Regression
Bruno Miranda Henrique et al [25]	Support Vector Regression (SVR)	Regression
V Kranthi Sai Reddy et al [26]	SVM	Classification
K. Hiba Sadia et al [27]	SVM and Random Forest	Classification
Lakshminarayanan et al [3]	LSTM and SVM	Classification
Neha Bhardwaj et al [28]	Random forest and KNN	Classification
Mariam Moukalled et al [29]	RNN, SVM and SVR	Classification and Regression
Dev Shah et al [6]	ANN, SVM and Naïve Bayes	Classification
Amit Gupta et al [30]	ANN and SVM	Regression
Nitin Nand Kumar Sakhare et al [31]	LR and SVR	Regression
Poornima S P et al [32]	KNN and LR	Classification and Regression
Vaishnavi Guruj et al [33]	LR and SVM	Classification and Regression
Alaa F. Sheta et al [34]	ANNs, SVM and Multiple Linear regression (MLR)	Classification and Regression
N P Samarth et al [35]	Random Forest	Classification
Sikkisetti Jyothirmayee et al [7]	SVM and KNN	Classification
Chi-Cheng Chen et al [36]	ANN and SVM	Classification
Wasiat Khan et al [37]	Random Forest	Classification
Sidra Mehtab et al [38]	ANN, LR, SVM, KNN and Decision Tree	Classification and Regression
Mehtabhom Obthong et al [39]	ANN, SVM, SVR, KNN, LR, etc.	Classification and Regression
Isaac Kofi Nti et al [40]	Decision tree, SVM and NN	Classification and Regression

Based on 38 case studies reviewed, the supervised machine learning techniques that are used for stock market predictions summarized in Table II as following. Majority of the case studies showed that classification is the most widely used for stock market /price predictions.

TABLE II. SUPERVISED MACHINE LEAARNING ALGORITHMS

Supervised Machine Learning Algorithms	Case Studies
Classification	50%
Regression	24%
Comparison between Classification and Regression	24%

Table II showed that classification is the most frequently used algorithm for stock market predictions. To answer the first research question clearly from the aforementioned research questions. The chart below shows the publications based on technique(s) used in ten years. Although the chart is static due to availability of publications we have for this study. Fig. 2 illustrated journals/ conference papers published in 2006 and 2012 used regression algorithms, while in 2013 published articles uses classification, regression and comparison between classification and regression. In 2014 and 2015 the authors used classification technique in their publications. From 2016 to 2020 comparison between both algorithms rose from a single publication in a year to 4 and 3 publications in 2019 and 2020 respectively.

B. *SML Techniques in Stock Market Prediction*

Supervised machine learning algorithms can be applied in stock market predictions depending on how they are designed to perform. Fig. 2 and Table III summarized the answers to the second research question of this paper, in which it clarifies how supervised machine learning algorithms are used or applied in stock market predictions.

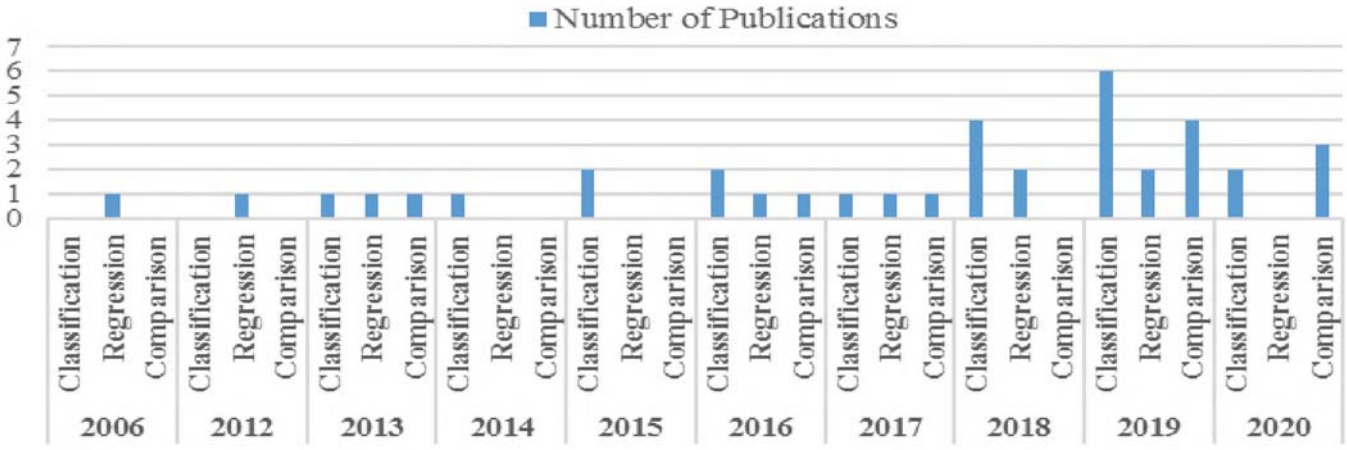

Fig. 2. Publications on Stock Market prediction using supervised ML in the last ten years.

C. *SML Models in Stock Market Prediction*

Many algorithms have shown a promising prediction result, depending on the type of data used for training models. Some algorithms perform better with small amount of data while some predict better with large amount data. Support Vector Machine (SVM) are the most commonly used algorithm found in this study. Fig. 3 summarized the answer to third research question of this study in which it explains the most frequently used supervised machine learning algorithm among the classification and regression categories that are used in stock market predictions from the 38 case studies.

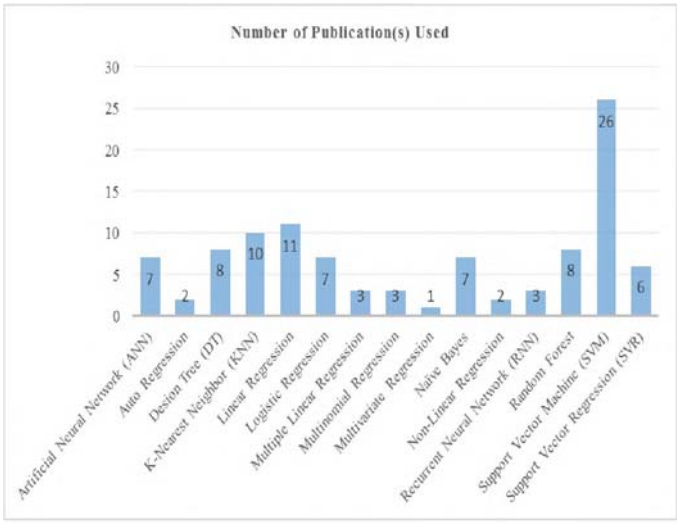

Fig. 3. SML Techniques used in 38 case studies

D. *Direction of future research on Stock Market Prediction*

To overcome the challenges in the stock market analysis, several computational models based on soft-computing and machine learning paradigms have been used in the stock-market analysis, prediction, and trading[40]. Despite the better accurate results recorded in stock market predictions by using techniques like Support Vector Machine (SVM), K-Nearest Neighbor (KNN), Support Vector Regression (SVR), Linear Regression and Artificial Neural Network (ANN). There is need for an efficient technique(s) that will overcome the challenges faced by using the existing techniques. In spite of the high accuracy, robustness and ability to handle noisy and missing data. Over fitting remains the challenge of using ANN in stock market prediction. SVM is also sensitive to outliners and parameter selection. RNN has also shown a good prediction result, but training its models is a difficult task. SVR is also sensitive to user's defined free parameters. Addressing the aforementioned problems of the existing techniques are the future research direction directions of stock market prediction using supervised machine learning.

TABLE III. SUPERVISED MACHINE LEAARNING TECHNIQUE IN STOCK MARKET PREDICTION

Journal/ Conference Paper	Stock Market Prediction Models
Robert P. Shumaker et al [10]	The authors developed four different models and varied the data given to them. The first model, Regress, was a simple linear regression estimate of the +20-minute stock price. While they acknowledge the obvious violation of Random Walk Theory, within such a compressed amount of time weak predictive ability remains. Next, the three models use the supervised learning of SVM regression to compute their +20-minute predictions.
Han Lock Slew et al [11]	The authors of this paper examine the theory and practice of regression techniques for the prediction of stock price trends by using a transformed data set in an ordinal data format. The original pre-transformed data source contains data of heterogeneous data types used for handling of currency values and financial ratios.
Khalid Alkhatib et al [12]	In this paper, the authors applied the K-Nearest Neighbor algorithm and Non-Linear Regression approach in order to predict stock prices for a sample of 6 main companies itemized on the Jordanian stock exchange to support investors, management, decision-makers, and users in making correct and informed investments decisions. According to their results, the KNN algorithm is robust with a small error ratio; consequently, the results were coherent and also reasonable.
Carol Hargreaves et al [13]	In this paper, the authors construct a framework that enables them to make class predictions about industrial stock performances. In order to have a systemized approach for the selection of stocks and a high likelihood of the performance of the stock price increasing, they applied several analytical techniques. A trading strategy is also designed and the performance of the stocks evaluated.
Usman Hegazy et al [2]	This paper proposes a machine learning model to predict stock market prices. The authors proposed an algorithm in order to integrate Particle swarm optimization (PSO) and least square support vector machine (LS-SVM). The proposed model was applied and evaluated using thirteen benchmark financials datasets and compared with artificial neural networks with the Levenberg-Marquardt (LM) algorithm.
Abubakar S. Magaji et al [14]	The authors presented the Naive Bayes and SVM-SMO algorithms as a tool for predicting the Nigerian Stock Exchange Market; subsequently, they used the same transformed data of the NSEM and explored the implementation of the Logistic function on the Back-propagation algorithm on the WEKA platform, and results obtained, made them to also conclude that the Back-propagation model of Artificial Neural Network (ANN) performed very well and thus it is another algorithm that can effectively and efficiently be used for predicting the Nigerian Stock Exchange Market.
Saahil Madge et al[1]	This study uses day-to-day ultimate prices for 34 technology stocks to compute price volatility and momentum for individual stocks and for the whole sector. Their model tries to predict whether a stock price erstwhile in the future will be higher or lower than it is on a given day.
Shashaank D.S et al [15]	This paper use Weka to try is to explore and rate the performance of classifiers based on the features selected by Hybrid Feature Selection. The authorized dataset for predicting the turnover was taken from www.bsc.com and included the stock market values of various companies over the past 10 years.
Hakob Grigorian et al [4]	This research emphasizes on financial time series prediction problem. The authors combined prediction model based on support vector machines (SVM) with independent component analysis which they called (ICA) (called SVM-ICA) .They first uses the ICA technique to remove important features from the research data and then applies the SVM technique to perform time series prediction.
Khan, W. Ghazanfar et al [16]	The author(s) of this paper presents a detailed study on data of London, New York, and Karachi stock exchange markets to predict the future trend in these stock exchange markets. In this research, they have applied machine learning classifiers before and after applying principle component analysis (PCA) and reported errors and accuracy of the algorithms before and after applying PCA.
Makram Zaidi et al [17]	The dataset used for this research covered the trading days from 5th April 2007 to 1st January 2015. With logistic regression, it may be observed that four variables i.e. open price, higher price, lower price, and oil can classify up to 81.55% into two categories up and down. Although with neural networks The prediction accuracy of the model is high both for the training data (84.12%) and test data (81.84%).
Aparna Nayak et al [18]	In this paper, an effort has been made to the prediction of the stock market trend. Two models were built one for daily prediction and the other one is for monthly prediction. Supervised machine learning algorithms were used to build the models. As part of the daily prediction model, historical prices are combined with sentiments. Up to 70% of accuracy is witnessed using supervised machine learning algorithms on the day-to-day prediction model. The monthly prediction model tries to calculate whether there is any match between any two months trend.
Mustansar Ali Ghazanfar et al [5]	In this research, authors applied and compared salient machine learning algorithms to predict stock exchange volume. The performance of these algorithms has been compared using accuracy metrics on the dataset, collected over the period of six months, by crawling the KSE and SSE website.
Mr. Pramod Mali et al [19]	The development and implementation of a stock price prediction was explained in this project and for this purpose regression algorithm and object-oriented approach of software development is used.
Hakan Gunduz et al [20]	This paper aimed at the stock daily return prediction problem, the set of features is extended to contain indicators not only for the stock to be predicted itself but also a set of other stocks and currencies. Afterwards, Different feature selection and classification methods are utilized for prediction.
D. A Puspitasari et al [21]	In this paper, Support Vector Machines (SVM) with K Nearest Neighbor (KNN) approach applied to forecast stock prices of a listed companies in Indonesia Stock Exchange (IDX). The stock data are collected from January 2013 to December 2016.
Gareja Pradip et al [22]	In this research, the authors explain, the development and implementation of a stock market price prediction application using a machine learning algorithm.
Meizhen Liu et al [23]	The authors developed Support vector machine (SVM) based on statistical learning theory new method, its training algorithm is basically a problem of solving the quadratic programming.
R.Seethalakshmi et al [24]	This paper concentrates on best independent variables to predict the closing value of the stock market.
Bruno Miranda Henrique et al [25]	In this stud, the authors used a machine learning technique called Support Vector Regression (SVR) to predict stock prices for big and minor capitalizations and in three different markets, using prices with both daily and up-to-the-minute frequencies.
V Kranthi Sai Reddy et al [26]	In this paper, machine learning technique called Support Vector Machine (SVM) was used to predict stock prices for the large and small capitalizations and in the three distinct markets, employing prices with both every day and up-to-the-minute occurrences.
K. Hiba Sadia et al [27]	The author of this paper reviewed a more feasible method to predict the stock movement with higher accuracy. The paper also presents a machine-learning

	model to predict the longevity of stock in a competitive market.
Lakshminarayanan et al [3]	This study presents a comparative study of the performance of Long Short-Term Memory (LSTM) neural network models with Support Vector Machine (SVM) regression models. The framework built as a part of this study comprises of eight models.
Neha Bhardwaj et al [28]	In this paper, the authors presented a comparison of machine learning aided algorithms to evaluate the stock prices in the future to analyze market behavior. Our method is able to correctly analyze supervised algorithms and compare which algorithm performs the best to predict the future stock market prices in the market.
Mariam Moukalled et al [29]	In this work, the authors proposed an automated trading system that integrates mathematical functions, machine learning, and other external factors such as news' sentiments for the purpose of attaining enhanced stock prediction accuracy and allotting gainful trades.
Dev Shah et al [6]	This paper reviewed stock markets and taxonomy of stock market prediction methods. The study the focus on some of the research achievements in stock analysis and prediction. The paper also discussed technical, fundamental, short- and long-term methods used meant for stock analysis.
Amit Gupta et al [30]	The authors of this paper tend to utilize car backward model to predict the more drawn out term estimation of a stock. The model is extremely trendy and that they examine in predicting the stock costs in all respects accurately.
Nitin Nand Kumar Sakhare et al [31]	In this paper, the authors compared three different machine learning algorithms, namely, Linear Regression, Polynomial Regression and Support Vector Regression. They have applied stated techniques on data consisted of index and stock prices of S&P 500.
Poornima S P et al [32]	In this study, the authors applied KNN method and linear regression aimed at predicting the stocks. The performance of linear Regression model on the certain data set is better when compared to KNN algorithm technique. The stock holders can invest assuredly based on the results obtained from the model.
Vaishnavi Guruj et al [33]	This survey compared two algorithms, Linear Regression (LR) and Support Vector Machines (SVMs) to predict stock market values. Advantages and disadvantages of using both algorithms were also discussed.
Alaa F. Sheta et al [34]	In this article, the authors explore the use of Artificial Neural Networks (ANNs) and Support Vector Machines (SVM) to build prediction models for the S&P 500 stock index. They have also show how traditional models such as multiple linear regression (MLR) behave in this case. The developed models will be assessed and compared based on a number of evaluation criteria.
N P Samarth et al [35]	In this paper, the authors proposed an approach that uses machine learning algorithms and will be trained on the historical stock dataset that are available and gain intelligence, later it uses the knowledge acquired for predicting the stock prices accurately. Using Random Forest Regression algorithm.
Sikkisetti Jyothirmayee et al [7]	This paper is predominantly concerned with the best model to predict the stock market value. For the period of the mechanism of contemplating the various techniques and variables that can be taken into consideration, the authors discovered five models Which are based on supervised learning techniques i.e.., Support Vector Machine (SVM), Random Forest, K-Nearest Neighbor (KNN), Bernoulli Naïve Bayes. The experimental results show that SVC performs the best for large datasets and Random Forest, Naïve Bayes is the best for small datasets.
Chi-Cheng Chen et al [36]	This study compared three machine learning models: Artificial neural networks (ANN), support vector machines (SVM), and random forest. With a performance evaluation of S&P 500 index historical data spanning from 2014 to 2018, the authors found that: (1) By overall performance measures, machine learning models outperform benchmark market index. (2) By risk-adjusted measures, the empirical results suggest that Random Forest generates the best performance, followed by SVM and ANN.
Wasiat Khan et al [37]	In this study, the authors compare results of different algorithms to find a consistent classifier. Finally, for achieving maximum prediction accuracy, deep learning is used and some classifiers are ensemble. The experimental results show that highest prediction accuracies of 80.53% and 75.16% are achieved using social media and financial news, respectively. They also show that New York and Red Hat stock markets are hard to predict, New York and IBM stocks are more influenced by social media, while London and Microsoft stocks by financial news. Random forest classifier is found to be consistent and highest accuracy of 83.22% is achieved by its ensemble.
Sidra Mehtab et al [38]	In this paper, the authors presented a very robust and accurate framework of stock price prediction that consists of an agglomeration of statistical, machine learning and deep learning models. They also use the daily stock price data, collected at five minutes interval of time, of a very famous company that is listed in the National Stock Exchange (NSE) of India. They built eight classification and eight regression models based on statistical and machine learning approaches. Furthermore, a deep learning regression model using a long-and-short-term memory (LSTM) network was also built.
Mehtabhorn Obthong et al [39]	This study, reviewed and compared the state-of the-art of ML algorithms and techniques that have been used in finance, specifically the stock value prediction. The number of ML algorithms and techniques. Have been discussed in terms of types of input, purposes, advantages and disadvantages.
Isaac Kofi Nti et al [40]	In this research, the authors performed an extensive comparative analysis of ensemble techniques such as boosting, bagging, blending, and super learners (stacking). Using Decision Trees (DT), Support Vector Machine (SVM) and Neural Network (NN), they have constructed twenty-five (25) different ensemble regressors and classifiers. They have also compared their execution times, accuracy, and error metrics over stock data from Ghana Stock Exchange (GSE), Johannesburg Stock Exchange (JSE), Bombay Stock Exchange (BSE-SENSEX), and New York Stock Exchange (NYSE), from January 2012 to December 2018.

IV. CONCLUSION

The systematic review was organized based on the works published in Stock Market Prediction. In this paper, we discussed the usage of machine learning models in stock market predictions where we details out how supervised machine learning algorithms/techniques Classification and Regression are applied in stock market for predictions and we reviewed the literatures of the concepts and applications, and examined them using dimensions related to ongoing and emerging issues in Stock price prediction. This study is based on a literature review of Stock Market Prediction using a keyword Index and article title search on IEEE Xplore, Science Direct, Google Scholar, Semantic Scholar, Open Access and Springer.

REFERENCES

[1] Madge, Saahil, and Swati Bhatt. "Predicting stock price direction using support vector machines." Independent work report spring, 2015.

[2] Hegazy, Osman, Omar S. Soliman, and Mustafa Abdul Salam. "A machine learning model for stock market prediction." arXiv preprint arXiv:1402.7351 , 2014.

[3] Lakshminarayanan, Sai Krishna, and John McCrae. "A Comparative Study of SVM and LSTM Deep Learning Algorithms for Stock Market Prediction." In AICS, pp. 446-457. 2019.

[4] E. Studies, "A Stock Market Prediction Method Based on Support Vector Machines (SVM) and Independent Component Analysis (ICA)," pp. 12–21, 2000.

[5] M. A. Ghazanfar, S. A. Alahmari, Y. Fahad, A. Mustaqeem, and M. A. Azam, "Using Machine Learning Classifiers to Predict Stock Exchange Index," vol. 7, no. 2, pp. 24–29, doi: 10.18178/ijmlc.2017.7.2.614.

[6] Shah, Dev, Haruna Isah, and Farhana Zulkernine. "Stock market analysis: A review and taxonomy of prediction techniques." International Journal of Financial Studies vol 7, no. 2 pp 26., 2019

[7] S. Jyothirmayee, V. D. Kumar, C. S. Rao, and R. S. Shankar, "Predicting Stock Exchange using Supervised Learning Algorithms," no. 1, pp. 4081–4090, doi: 10.35940/ijitee.A4144.119119.

[8] H. Snyder, "Literature review as a research methodology : An overview and guidelines," J. Bus. Res., vol. 104, no. 2019, pp. 333–339, doi: 10.1016/j.jbusres.2019.07.039.

[9] N. S. Selamat, "An Overview of Big Data Usage in Disaster Management," vol. 11, no. 1, pp. 35–40.

[10] R. P. Schumaker and H. Chen, "Textual Analysis of Stock Market Prediction Using Breaking Financial News : The AZFinText System," no. 2006, pp. 1–29.

[11] H. L. Siew, "Regression Techniques for the Prediction of Stock Price Trend," doi: 10.1109/ICSSBE.2012.6396535.

[12] M. K. A. Shatnawi, "Stock Price Prediction Using K -Nearest Neighbor (k NN) Algorithm," vol. 3, no. 3, pp. 32–44, 2009.

[13] C. Hargreaves, "Prediction of Stock Performance Using Analytical Techniques," vol. 5, no. 2, pp. 136–142, doi: 10.4304/jetwi.5.2.136-142.

[14] Magaji, A.S,"An intense Nigerian stock exchange market prediction using logistic with back-propagation ANN model", Science World Journal, 9(2), pp.8-13, 2014.

[15] Shashaank, D. S., V. Sruthi, M. L. Vijayalakshimi, and Jacob Shomona Garcia. "Turnover prediction of shares using data mining techniques: a case study." arXiv preprint arXiv:1508.00088 ,2015.

[16] Khan, W., M. A. Ghazanfar, M. Asam, A. Iqbal, S. Ahmad, and Javed Ali Khan. "PREDICTING TREND IN STOCK MARKET EXCHANGE USING MACHINE LEARNING CLASSIFIERS." Science International 28, no. 2 ,2016.

[17] Zaidi, M., and A. Amirat. "Forecasting stock market trends by logistic regression and neural networks: Evidence from KSA stock market." Int. J. Econ. Commer. Manag 4,vol. IV, no. 6, pp. 220–234, 2016

[18] A. Nayak, M. M. M. Pai, and R. M. Pai, "Prediction Models for Indian Stock Market," Procedia - Procedia Comput. Sci., vol. 89, pp. 441–449, 1877, doi: 10.1016/j.procs.2016.06.096.

[19] H. Karchalkar, A. Jain, A. Singh, and V. Kumar, "Open Price Prediction of Stock Market using Regression Analysis," vol. 6, no. 5, pp. 418–421, 2007, doi: 10.17148/IJARCCE.2017.6578.

[20] Y. Yaslan, "Stock daily return prediction using expanded features and feature selection," no. 2017, pp. 4829–4840, doi: 10.3906/elk-1704-256.

[21] A. You, M. A. Y. Be, and I. In, "Application of SVM-KNN using SVR as feature selection on stock analysis for Indonesia stock exchange Application of SVM-KNN Using SVR as Feature Selection on Stock Analysis for Indonesia Stock Exchange," vol. 020207, no. 2018.

[22] G. Pradip, C. Bari, and J. S. Nandhini, "Stock market prediction using machine learning," vol. 3, no. 10.

[23] M. Liu, C. Duan, and S. Price, "A Review of Using Support Vector Machine Theory to Do Stock Forecasting," vol. 147, no. Ncce 2018, pp. 2013–2015.

[24] A. Mathematics, "Analysis of stock market predictor variables using Linear Regression," vol. 119, no. 15, pp. 369–378.

[25] B. M. Henrique, V. A. Sobreiro, and H. Kimura, "Stock Price Prediction Using Support Vector Regression on Daily and Up to the Minute Prices," J. Financ. Data Sci., no. 2018, doi: 10.1016/j.jfds.2018.04.003.

[26] K. Sai and R. Vanukuru, "Stock Market Prediction Using Machine Learning," doi: 10.13140/RG.2.2.12300.77448.

[27] K. H. Sadia, A. Sharma, A. Paul, and S. Sanyal, "Stock Market Prediction Using Machine Learning Algorithms," no. 4, pp. 25–31.

[28] N. Bhardwaj and A. Ansari, "Prediction of Stock Market using Machine Learning Algorithms," pp. 5994–6005, 2008.

[29] M. Moukalled and W. E. Mohamad, "Automated Stock Price Prediction Using Machine Learning."

[30] A. Gupta and T. J. Nagalakshmi, "Stock Price Prediction using Linear Regression in Machine Learning," no. 12, pp. 1382–1385, doi: 10.35940/ijitee.L3932.1081219.

[31] N. Sakhare and S. S. Imambi, "Performance Analysis of Regression Based Machine Learning Techniques for Prediction of Stock Market Movement," no. 6, pp. 206–213.

[32] S. P. Poornima, C. N. Priyanka, P. Reshma, S. K. Jaiswal, and K. N. Surendrababu, "Stock Price Prediction using KNN and Linear Regression," no. 5, pp. 142–145.

[33] V. Gururaj, V. R. Shriya, and K. Ashwini, "Stock Market Prediction using Linear Regression and Support Vector Machines," vol. 14, no. 8, pp. 1931–1934, 1996.

[34] S. E. M. Ahmed, "A Comparison between Regression , Artificial Neural Networks and Support Vector Machines for Predicting Stock Market Index," vol. 4, no. 7, pp. 55–63.

[35] N. P. Samarth, G. V Bhat, and N. Hema, "Stock Price Prediction," no. 2, pp. 425–429, 2019, doi: 10.35940/ijitee.B1042.1292S19.

[36] C. Chen, C. Chen, and T. Liu, "Investment Performance of Machine Learning : Analysis of S & P 500 Index," vol. 10, no. 1, pp. 59–66, 2000.

[37] W. Khan, M. Ali, G. Muhammad, A. Azam, A. Karami, and K. H. Alyoubi, "Stock market prediction using machine learning classifiers and social media , news," J. Ambient Intell. Humaniz. Comput., no. 0123456789, doi: 10.1007/s12652-020-01839-w.

[38] S. Mehtab and J. Sen, "A Time Series Analysis-Based Stock Price Prediction Using Machine Learning and Deep Learning Models A Time Series Analysis-Based Stock Price Prediction Using Machine Learning and Deep Learning Models," doi: 10.13140/RG.2.2.14022.22085/2.

[39] M. Obthong and N. Tantisantiwong, "A Survey on Machine Learning for Stock Price Prediction : Algorithms and Techniques," 2014.

[40] I. K. Nti, A. F. Adekoya, and B. A. Weyori, "A comprehensive evaluation of ensemble learning for stock - market prediction," J. Big Data, 2020, doi: 10.1186/s40537-020-00299-5.