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A Systematic Study of Stock Markets Using Analytical and AI Techniques

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Abstract

Predicting stock market patterns is seen as a crucial and highly productive activity. Therefore, if investors make wise choices, stock prices will result in significant gains. Investors face a lot of difficulty making predictions about the stock market because of the noisy and stagnating data. As a result, making accurate stock market predictions is difficult for investors who want to put their money to work for them. Predictions of the stock market are made using mathematical techniques and study aids. Out of 30 research papers advocating approaches, this study offers a thorough analysis of each, including computational methodologies, AI algorithms(machine learning and deep learning), performance evaluation parameters, and chosen publications. Research questions are used to choose studies.

As a result, these chosen studies contribute to the discovery of ML methods and their corresponding data set for predicting security markets. The majority of Artificial Neural Network and Neural Network techniques are employed for producing precise stock market forecasts. The most recent stock market-related prediction system has significant limitations despite the substantial amount of work that has gone into it. In this survey, one may infer that the stock price forecasting procedure is a comprehensive affair and it is very necessary to look more closely at the typical parameters for the stock market prediction.

Keywords: Security market forecasting, Artificial Intelligence (AI), ML(Machine learning) and DL (Deep learning) classifications, ANN (Artificial Neural Networks), SVM (Support Vector Machine).

I. INTRODUCTION

The financial markets are among today's most intriguing creations. There is a big impact from these financial markets [1] on several fields, including employment technology and economics. In order to invest money in the stock market and obtain higher returns with less risk, investors have relied on two major tactics. The growth of the [2] financial markets projections has achieved enormous relevance by many of knowledgeable investors and researchers. The turbulent market situation makes it incredibly challenging to analyze stock market [3] and price movements. The complexity with the stock price affects a lot of variables, including market news and quarterly earnings reports.

Stock market capitalizations are used to calculate stock indices [4]. Because of this, predicting the stock market with accuracy [5] is a highly challenging process while the market landscape is shifting. The development and testing of stock market behavior interested market analysts and researchers [6, 7]. Because this model gives historical evidence and postulates theories of normalcy, several statistical approaches are used, including autoregressive integrated moving average and clustering for stock market projections. The use of Support Vector Machine, Neural Network, and Genetic Adversarial Network (GAN) Machine Learning approaches in tjhe field of share market forecasting applications has been extensively studied [8, 9]. The data analyst employed an artificial neural network (ANN) and support vector regression (SVR) machine learning methods to make a guess at the share market price index [10].

Each ML algorithm has a technique for recognizing patterns. To calculate the Relative Strength Index, some writers [11] have proposed a hybrid technique that combines a basis set with an Artificial Neural Network (ANN) (RSI). When concerning the strength of the pricing relative to the past, the RSI functions as a gauge oscillator. In comparison to existing ML approaches, the results demonstrate that the suggested hybrid approach might successfully account for substantial price movements on the share market. In general, some researchers [12] anticipate combining genetic algorithm with Long-Short Term Memory (LSTM) to forecast the security market using the Korean Stock Price Index and easily accessible financial data (GA). The projected stock pattern feedback network has been used in

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several networks [13, 14]. This study's major goal is to provide readers an overview of share market prediction techniques that can be quite useful in foretelling future financial market trends. In order to anticipate the stock market, this study investigates several machine learning (ML) and statistical techniques, as well as the datasets that support them. The investigation should be conducted using diverse methodologies, efficiency matrices, data sets, and security market forecast tools. The results of this survey are as follows:

Part 1: Explains the elaborated foundation of the security market prediction.

Part 2: Explains the requirements related to security market prediction.

Part 3: Explains the methodologies for the selection of the research topics.

Part 4: Summarization of the results and discussions.

Part 5: Explains the research results.

II. SIGNIFICANCE OF THE SURVEY

In the security market, the investor expresses an enthusiasm in making money by making an investment. Because of sophisticated applications, where predictions can result in lucrative market predictions, the stock market has piqued investors' curiosity. Predicting the stock market's moves [15] exactly depends on the anticipated information Stock market forecasting tools [16, 17] can track the market and keep an eye on information that can be used to make the best selections. The complete financial market's worth of information [18] concerning industrial stocks must be processed by the stock market.

These are modified [19, 21] taking into account sales and acquisitions in accordance with the investors' business position. The market's position is affected by a number of variables, including changes in management, public releases about profits, and estimates of future profits. Therefore, a reliable stock market forecast [22] aids in the decision-making of investors. The high risk investor can profit more using ML approaches. The procedure of the stock price forecasting is shown in Fig. 1.

Initial real-time data for Fig. 1 is acquired based on their price index from a number of websites and older datasets, like NASDAQ [23]. By comparing the current price to earlier market prices, investors can determine performance using the price index, a segment of the stock market. The data is pre-processed [24] after collection to get rid of noise and other things. Forecasts for the stock market can then be made using the pre-processed data. A small subset of features is chosen by feature selection algorithms from a large body of data [25]. Two categories—the present and the projections—are used to split the data collection by some user-friendly apps or data analysis elements. Making wiser trading decisions is much easier when you are aware of these facts.

Following a formal decision, investors will be informed of the price index [26, 27]. This notice [28] is extremely beneficial to investors because it reports the profit or loss situation of the price index. If the application status is [29] profit, the investor can use the shares for high turnover, and if the price index is [30] low, more attention is given to the development so that better decisions can be made.
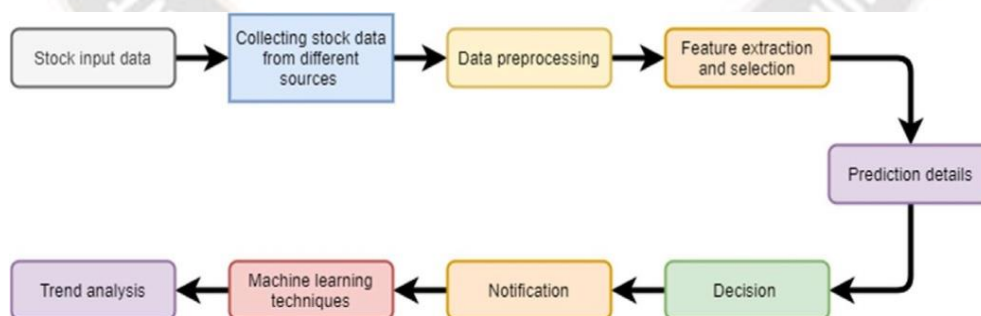

Fig. 1: Procedure of forecasting Security Market

III. APPROACH

Our survey's primary objective is to compile the empirical data supporting ML-based stock market projections. This approach applies five research questions to the narrative synthesis method and Research Question - 4 to the vote counting method. The information-gathering research

questions are included in the study approach.

From the selected studies, we created the following research questions:

Research Question 1: What different statistical techniques are used in an analysis of the stock market?

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Research Question 2: What sort of machine learning (ML) algorithms are utilized for stock market forecasting?

Research Question 3: What various data sets are employed in the stock market forecasting model?

Research Question 4: Has or has not security market forecasting been done using a mixed ML model approach?

Research Question 5: Which performance metrics are taken into account while making security market prediction?
Research Question 6: Which periodicals are significantly important for security market forecasting?

IV. RESULTS AND DISCUSSIONS

Based on research topics, we are choosing a few research publications. This section goes through the research question that was discussed in the section before. The following research inquiries are listed:

Research Question 1: What different statistical techniques are used in an analysis of the stock market?

We extract the data and analyze it after a few studies. We also examined a number of statistical and analytical techniques used in stock market research. A number of statistical techniques were applied in the investigation that included basic explanatory research for interpretation of security market. For share market forecasting, few of the chosen research adopt the ARIMA, Regression, and clustering methodologies. Following is a definition of each method:

a. ARIMA: A statistical technique called ARIMA [11] is used to predict upcoming patterns in time series in order to comprehend the dataset.

b. Clustering: Sets of items with related properties are grouped using the clustering approach [13, 14]. Stocks with a strong correlation are placed in one basket, and those with a low correlation are placed in a different basket. Until every stock is assigned to a group, this process is repeated.

Some of the selected subjects deal with stock market forecasting statistical techniques, according to the examination of Table 1. Only 18% of the issues receive attention, particularly when it comes to stock market forecasts, while only one study is used in merger negotiations.

Statistical Techniques	Selected Surveys	Percentage of contribution in survey
ARIMA	RS8, RS3, RS8, RS13, RS14, RS16	18%
Clustering	RS17	3%

Table 1: Statistical methods applied in a chosen studies

Research Question 2: What sort of machine learning (ML) techniques are utilized for security market prediction?

To predict the stock market, the large percentage of selected subjects uses machine learning (ML) or deep learning (DL) techniques. A few carefully chosen researches employ the hybrid approach to forecast the stock market with greater accuracy. This section mainly elaborates on stock market forecast methods. The following are examples of the most popular prediction methods:

a. Support Vector Machine (SVM): Support Vector Machine is among the most efficient techniques for forecasting time series. SVM may be employed for problems involving regression and classification. SVM operates by plotting [15, 16] data as a point in n-dimensional space. On various coordinate planes, these stock market metrics are described and displayed. The most potent and precise tool in the financial market is SVM.

b. Neural Networks (NN): Neural Network consists of several algorithms [17] that pinpoints a process and depicts how the human brain functions while also identifying the changing dataset. A stronger outer break NN method was created by Chung and Shin [18] for stock market forecasting. The livestock market provides the information right away. In this case, the embedding layer made use of the deep LSTM dependent NN. LSTM neural network encoder for stock trend forecasting.

c. Artificial Neural Networks (ANNs): Artificial Neural Networks are more effective than many other statistical techniques at capturing the stock's structural relationship [19], in particular its production and its causes. Many studies used the ANN model without first performing any data preparation. In RQ5, it is stated how many different performance indicators are employed in stock market forecasting.

d. Convolutional NN (CNN): The neural network is

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fed data from the CNN [20]. Comparing CNN to conventional neural network methods, more hidden layers are present in CNN. A thorough learning system known as CNN is utilized to forecast the share market.

e. Recurrent Neural Network (RNN): An Artificial Neural Network with nodes connected in a graph shape that is oriented along with their chronological chain is called as Recurrent Neural Network [20]. As a consequence, it enables the demonstration of sophisticated dynamic pattern.

f. Support Vector Regression (SVR): Support Vector Regression is a technique that uses the ideas of support vector machines (SVM), albeit there are only minor differences between the two. Although support vector machine is utilized in security market prediction based on their time-series, Support Vector Regression is employed in forecasting future prices in share market.

g. Generative Adversarial Network (GAN): A novel framework called the Generative Two variants of the zero joy game is trained using the adversarial network (GAN) [23]. One may claim that the generator in the antagonist cycle is fraudulent because it attempts to provide data that is as real as possible although the racist assumes the role of judges to distinguish between the data which is being processed and the actual data.

h. Naive Bayes (NB): For a particular Bayes-based dataset theorem, the Naive Bayes is a classification technique that produces Bayesian networks. It is presumed that the given dataset comprises a singular function that has no connections to any other functions of a class. It is a straightforward method that excels at high-quality grading techniques for huge datasets. Additionally, few of the chosen researches employ either machine learning L or deep learning methods to forecast the stock market. These algorithms were tested using performance metrics while using the real-time dataset and its features. In Table 2, each selected study's description and ML method implementation are presented.

According to the analysis in Table 2, the majority of the chosen researches regularly employ NN techniques. The percentage of technique is depicted in Fig. 2.

Question 3: What various data sets are employed in the stock market forecasting model?

In order to make predictions of the security market, a particular study makes use of a variety of datasets. Some datasets, according to a few researches, are accessible to the general public. The large percentage of the chosen participants used open-source datasets to forecast the security markets. These collected sets of data are employed for categorization or prediction tasks. In Table 3, several kinds of dataset utilized by several chosen research are listed and characterized as follows:

The aforementioned table demonstrates how the majority of the chosen research used the dataset of NASDAQ for security market prediction.

Research Question 4: Has or has not security market forecasting been done using a mixed ML model approach?
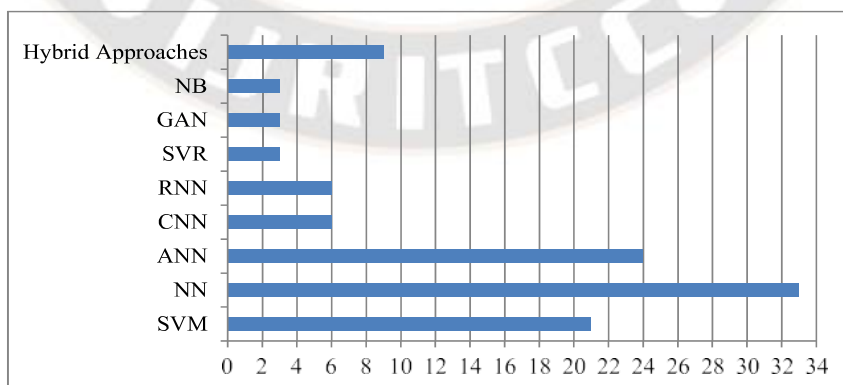

Fig. 2: Frequently used ML Techniques

Only three of the chosen studies as shown in Fig. 2, are using the hybrid method to predict the security markets. Selected study RS3 presented a hybrid approach combining GA and artificial neural networks to increase the performance of GA in stock market forecasts, and RS8 proposed a hybrid method that

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combines ANN and GA. Another study RS13 integrated the machine learning algorithm ANN (DWT-ANN) with the statistical method discrete wavelet transform (DWT-ANN) to predict the security market.

RQ5: Which performance metrics are taken into account while making security market forecasting?

Studies	Techniques	Percentage (%)
RS2, RS3, RS4, RS9, RS12, RS15, RS22	Support Vector Machine	21
RS1,RS2,RS10,RS12,RS17,RS18,RS21,RS24,RS25,RS27,RS29	Neural Networks	33
RS5,RS6,RS11,RS14,RS16,RS20,RS28,RS30	Artificial Neural Networks	24
RS24,RS26	Convolutional Neural Networks	6
RS24,RS26	Recurrent Neural Networks	6
RS5	Support Vector Regression	3
RS23	Generative Adversarial Networks	3
RS29	Naïve Bayes	3
RS7,RS8,RS13	Hybrid Approaches	9

Table 2: The proportion of research that employed each approach

Dataset used by selected studies

Research Study	Target Stock Market	Year	Values for Dataset(Days/Source)
RS1	Dow Jones Industrial Average Index[1]	2007	1024
RS2	National Stock Exchange, India[2]	2016	500
RS3	National Stock Exchange, India [3]	2019	NASDAQ
RS4	National Stock Exchange, India [4]	2019	1659/www.moneycontrol.com
RS5	National Stock Exchange, India [5]	2014	www.nseindia.com
RS6	National Stock Exchange, India [6]	2019	NASDAQ
RS7	Dhaka Stock Exchange[7]	2012	www.dse.com.hd
RS8	Pakistan Stock Exchange[8]	2014	OGDCL Pakistan
RS9	National Stock Exchange, India [9]	2002	104/FASM

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RS10	National Stock Exchange, India [10]	2016	TFIDM
RS11	National Stock Exchange, India [11]	2003	100/Instabul Stock Ex.
RS12	Stock Market Forecasting[12]	2005	MCcardy cd Mahen
RS13	National Stock Exchange, India [13]	2016	1414/TataSteel/Cisco
RS14	Stock Market Forecasting[14]	2013	734/Godman Sach Inc.
RS15	National Stock Exchange, India [15]	2017	108
RS16	National Stock Exchange, India [16]	2015	1024
RS17	National Stock Exchange, India [17]	2011	360
RS18	Korean Stock Exchange [18]	2018	4203/Korea Stock Index Price
RS19	National Stock Exchange, India [19]	2014	www.finet.hk
RS20	National Stock Exchange, India [20]	2017	38/KospiMarket
RS21	National Stock Exchange, India [21]	2018	2691
RS22	National Stock Exchange, India [22]	2016	Crawler
RS23	National Stock Exchange, India [23]	2019	5000/NYSE
RS24	National Stock Exchange, India [24]	2017	1721
RS25	National Stock Exchange, India [25]	2017	NASDAQ
RS26	National Stock Exchange, India [26]	2017	600
RS27	National Stock Exchange, India [27]	2018	500
RS28	Dhaka Stock Exchange [28]	2016	Dhaka Stock Exchange
RS29	National Stock Exchange, India [29]	2017	CS1300
RS30	National Stock Exchange, India [30]	2011	NASDAQ

Table 3: Dataset used by selected studies

To determine whether ML can more accurately predict stock markets, exchanges, and forecasts, many performance metrics are employed. These performance metrics assess a certain algorithm based on its methodology and dataset. The many performance metrics that the chosen studies employed to assess their performance are as follows:

a. Accuracy: One statistic used to evaluate the model classification is accuracy [21]. Informal correctness contributes to the conclusion that our

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model is reliable.

b. Root mean square error (RMSE): At the level where the difference between the expected model values and the retained data is calculated, the RMSE is employed. The database for training and validation is quite close to RMSE.

c. Mean absolute error (MAE): Regression coefficients are calculated using MAE [24, 25]. In this instance, error prediction is calculated as the total of the variances between the variables that were expected and those that were actually observed, divided by the total number of data points. Calculating the difference between two continuous variables is referred to as MAE.

d. Mean squared error (MSE): It is a loss function used to determine the minimum square regression [26, 27]. Additionally, it is the sum of the discrepancies between the variables that were anticipated and those that really occurred, divided by the total number of data points.

e. Mean absolute percentage error (MAPE): KPI [28] uses MAPE most frequently to calculate stock market forecasts. The average error percentage can be calculated by total number of absolute individual errors divided by the demand [30].

Additionally, a few individuals have forecasted the stock market using their database and these performance standards. Exchange rates of the financial markets rise or fall monthly or annually.
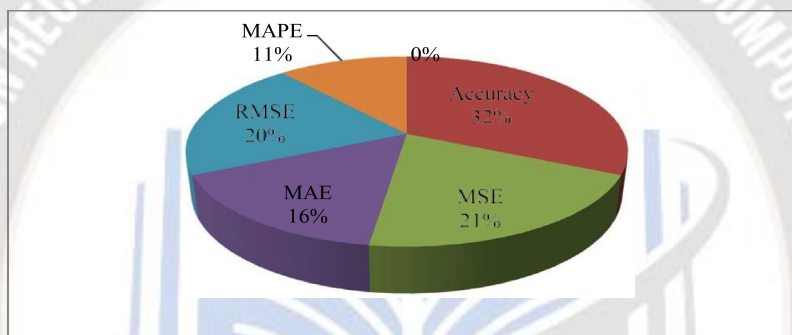

Fig. 3: Performance parameters used by selected studies

RQ6: Which periodicals are the most significant for security market forecasting?

The writers chose their subjects in order to forecast the stock market based on their research questions. These research topics are gathering data from a few carefully chosen trials. However, some of the chosen researches have appeared in both journals and conferences. In order to create prestigious journals and conferences, the writers have chosen the studies that are mentioned as:

Research Study	Name of Conference/Journal	Percentage of Contribution in study	Name of Publisher
RS1	"Applied Intelligence"[1]	3	Springer
RS2	"International Conference On Computer And Information Sciences"[2]	3	IEEE
RS3	"International Journal Of Financial Studies"[3]	3	MDPI
RS4	"Computational Intelligence In Data Mining"[4]	3	Springer
RS5,RS14, RS20,RS30	"Expert Systems With Applications"[5][14][20][30]	12	Science Direct
RS6	"International Conference On Information Technology And Systems"[6]	3	Springer
RS7	"International Conference On Computer And Information Technology"[7]	3	IEEE Scopus
RS8	"International Journal Of Computer Science And Information Security"[8]	3	Springer

RS9	"International Conference On Intelligent Data Engineering And Automated Learning"[9]	3	IEEE
RS10	"International Conference On ICT In Business Industry And Government"[10]	3	Scopus
RS11	"Neural Computing And Applications"[11]	3	IEEE
RS12	"Pakistan Multitopic Conference"[12]	3	Scopus
RS13	"Indian Journal Of Science And Technology"[13]	3	IEEE
RS15	"International Conference Of Electronics, Communication And Aerospace Technology"[15]	3	Scopus
RS16	"International Research Journal Of Engineering And Technology"[16]	3	Science Direct
RS17,RS22, RS23	"Procedia Computer Science"[17][22][23]	9	MDPI
RS18	"Sustainability"[18]	3	Springer
RS19	"Neural Computing And Applications"[19]	3	Springer
RS21	"International Conference on Advances in Computing and Communication"[21]	3	Springer
RS25	"Multimedia Tools And Applications"[25]	3	Springer
RS26	"International Conference On Computational Intelligence And Virtual Environments For Measurement Systems And Applications"[26]	3	IEEE
RS28	"Conference On Electrical, Computer & Telecommunication Engineering"[28]	3	IEEE
RS29	"International Conference On Service Systems And Service Management"[29]	3	IEEE

Table 4: Most dominant journals/conferences.

Most of the journals and conferences listed by the chosen research are shown in Table 4. The most popular publisher is depicted in Fig. 4.

The predominant journals include Procedia computer science and the majority of expert systems & applications.
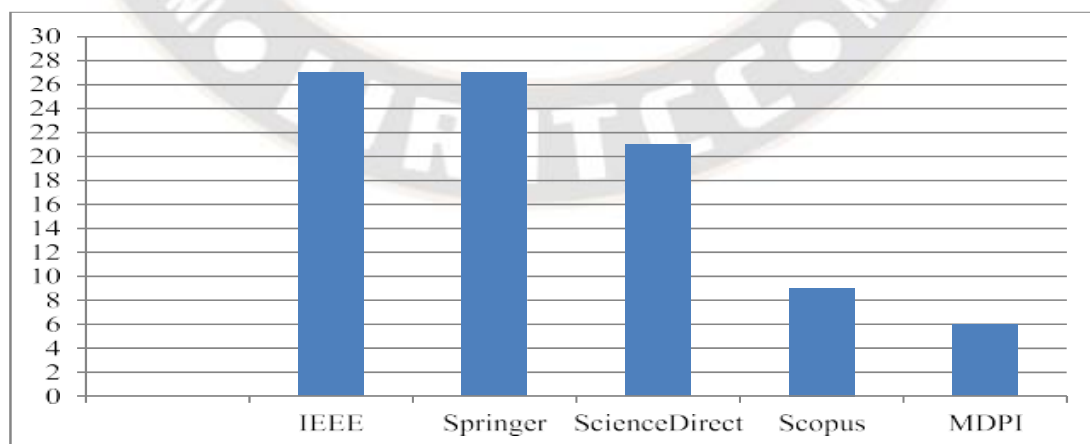

Fig. 4: Most frequently journals

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V. CONCLUSION

The many stock market split methods, broken down into mathematical and machine learning (ML) tactics, are examined in this research. This study aims to rank existing ML techniques in terms of modified procedures, various datasets that are being used, matrices to measure the performance, and application methods. 30 research pieces are used in the major journals. The methods employed in stock market forecasting are divided into various ML algorithms. Few of the selected research adopt combination of stock market approaches to boost prediction precision. Successful stock market predictions are frequently achieved using the ANN and NN approaches. These methods can be created for keeping an eye on the stock market as a whole.

The main difficulty in stock market forecasting is the inability to identify most modern methods using historical stock data. As a result, additional variables like B. Choices made by the government on policy and consumer behavior also affect the financial markets. In the future, we'll continue to improve the system in order to provide an accurate and dependable exchange system.

CONFLICT OF INTEREST

The authors hereby declare that they have no conflict of interest.

AUTHOR CONTRIBUTIONS

Neha Patidar has done all the study and literature survey related to this study and Dr. Harshal Shah supervised the research and revised the paper. All authors had approved the final version of manuscript.

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