CHAPTER I

INTRODUCTION

1.1 Stock market

The term stock market refers to a group of marketplaces where shares of companies are exchanged for and against cash. These exchanges, which can be online or in person, are where these transactions happen. Although it has been demonstrated that stock market investments yield higher returns over time, this is not always the case. The profit that can be made depends greatly on the stock that is invested in. Purchasing a stock essentially means lending our money to a certain firm that is listed on the stock market in the hopes of realizing an optimal profit. An investment cannot be considered sound if the investor has not done their homework beforehand. A thorough analysis is a necessary step before deciding to invest in a specific stock. Choosing stocks at random for investment can result in unfavorable losses [1].

Nowadays, a lot of novice investors are clueless about what the stock's future holds. For them, investing is more akin to a game of chance: buy any stock at random and hope that its price increases. If not, better luck next time! It doesn't operate that way. The art of astrologically projecting future stock prices is one of the most popular and hotly contested subjects. The primary goal of this predictive astrology is, without a doubt, to predict stock price trends so that they can be purchased and subsequently sold for higher profits.

The relationship between supply and demand, market dynamics, and other variables all affect the price of the stock. A stock's price increases when the market's demand for it exceeds supply; conversely, when supply exceeds demand, the price of the stock decreases. The majority of stock market participants also hold strong beliefs! Some people think it's difficult to predict the stock price, while others assert that it can be done with some simple graphical analysis and historical computations. Although the second group of investors has a valid point in their opinions, in reality, it goes much more than that. The problem of predicting stock price is heavily influenced by the expectations, attitudes, and sentiments of stock investors.

Stock price prediction is a major concept that is prepared with the aim of forecasting or predicting trends. The stock market can decide the economic status of the country. The stock

price prediction methods can help people to make better decisions using historical behaviors and they can manage future problems. The prediction of the stock market data is trying to regulate the future performance of a company based present behavior of a particular stock.

The successful prediction model can produce considerable profits for both investors and clients. The efficient-market hypothesis states that stock prices represent all information that is presently available as well as any price variations unrelated to previously released information. One of the key factors in the financial industry that helps investors boost their profits is stock market prediction. Throughout the last few decades, researchers and investors have played a crucial role in stock market prediction by paying attention to a trustworthy method of predicting stock price or index. To create a profitable market trading plan, an accurate forecast is essential [2].

The stock market is a dynamic, difficult, nonparametric, nonlinear, and chaotic landscape, predicting the stock market with more accuracy is not a simple challenge for investigators to do [3]. Additionally, the stock market is affected by numerous inclusive economic factors such as political events, the firm's strategy, wide-ranging economic circumstances, investor expectation, institutional shareholder preference, the progress of another stock market, and the psychology of shareholders, etc.,

1.1.1 Indian stock market

When India was ruled by the British in the late 18th century, that is when the history of the Indian stock market began. Here is a quick synopsis of its development:

- **Early times (Late 18th and Early 19th Centuries):** Initiated (1875) as the Native Share and Stock Brokers Association, the Bombay Stock Market (BSE) is regarded as the eldest stock market in Asia (Bombay).

- **Regulation and Growth (20th Century):** During the 20th century, there were notable regulatory reforms and growths in the Indian stock market. The Securities Contracts Act was passed by the Indian government in 1956 to regulate stock exchanges and safeguard investors. Leading trading hubs included the BSE and several regional exchanges.

- **NSE and electronic trading introduction (1990s):** The National Stock Exchange of India (NSE) (1992) to offer a national automated trading platform. With the introduction

of computerized trading, the Indian stock market saw a transformation that enhanced efficiency and accessibility.

- **Liberalization and Economic Reforms (1990s):** In 1991, India opened its economy to overseas investment and removed various regulatory hurdles. This was the commencement of economic liberalization and financial reforms. These reforms had a big impact on the Indian stock market and attracted foreign investors and more market participation.

- **Boom and Bust Periods:** Over the years, there have been several cycles of boom and bust in the Indian stock market. Notable examples of bull runs are the late 1980s, the mid-2000s, and the late 1990s dot-com boom. After periods of rapid market expansion, there were times of severe corrections.

- **The Securities and Exchange Board of India (SEBI):** SEBI was initiated in 1988, and is a key regulatory body for the Indian securities industry. SEBI oversees brokers, stock exchanges, and other intermediaries to advance equity, transparency, and investor protection.

- **Demutualization and Corporatization:** With the processes of demutualization and corporatization, Indian stock exchanges divided ownership and trading privileges in the early 2000s. This measure was taken to improve the governance, efficiency, and transparency of the stock market.

- **Integration with International Markets:** The globalization and advancement of technology led to the increasing integration of the Indian stock market with overseas markets. Some of the key factors affecting the value of Indian stocks are foreign institutional investment, geopolitical developments, and global economic trends.

- **Recent developments:** AIFs, exchange-traded funds (ETFs), and equity derivatives are among the novel financial instruments that have been brought to the Indian stock market in recent times. The market has also been impacted by policies.

In general, the Indian stock market has changed dramatically over time, moving from old-fashioned dealing under banyan trees to a contemporary electronic market with strong regulatory frameworks and increasing investor involvement.

1.1.2 Stock exchange

A platform where the investors and traders come together to buy and sell the equities. India has a regulatory body called SEBI Securities and Exchange Board of India to monitor the stock exchange. In this market, securities are bought and exchanged. An organized market for buying and selling stocks of listed companies where the price is determined on a supply-demand basis is the definition of the stock market. The stock exchange is the main element of the stock market. It is not required for stocks to be traded on the stock exchange after they are allocated through the stock market. This type of trading is referred to as over-the-counter or off-exchange[4].

The stock exchange operates as a component of the global securities market. The Dow Jones Industrial Average (DJIA) index is based on the price-weighted average of thirty prominent firms that are traded on the New York Stock Exchange (NYSE). Founded with 12 companies when it was first established in 1896, it is currently the most often quoted global stock market index[5].

1.1.3 Role of Stock Exchange

In this safe environment, intentional trade takes place. Securities are bought and sold here by clear policies and procedures. The securities addressed here include bonds and unsecured bonds issued by public and administrative bodies, as well as shares of publicly traded companies that are officially listed on stock exchanges.

- Its main purpose is to serve as a marketplace for the buying and sale of securities, such as stocks, pledges, and unsecured bonds. Stated differently, stock exchanges facilitate continuous trading of securities.

- Secondly, it offers investments in securities liquidity, allowing those assets to be sold on stock exchanges. Macroeconomic and microeconomic aspects influence share value. Third, market quotations on securities prices, which are supplied by stock exchanges, help in securities valuation.

- Finally, because share price changes are impacted by a range of factors including macroeconomic settings, economic and financial policy, tax rates, and political trials, it serves as a barometer for the strength of the nation's financial system.

1.2 Indian stock exchange

The busiest and best-organized market is now the Indian stock market. The Native Stockbroker Association (1975) by a group of stockbrokers who helped promote corporate shares in Bombay throughout the 1800s. One of the first stock exchanges in Asia, this organization eventually changed its name to the Bombay Stock Exchange (BSE).

1.2.1 BSE

On Mumbai's Dalal Street, the BSE was established in 1875. This stock exchange is the largest in the globe. As of January 23, 2015, the BSE ranked eleventh in the world's stock exchanges, with a total market value of US $1.7 trillion. On the BSE, there are roughly 5,500 publicly traded companies.

The BSE index was created in 1986 and is used to evaluate the exchange's overall performance. In 2000, BSE launched a futures market using its index. The S&P BSE SENSEX, which is traded on significant exchanges in the BRCS nations, is the most monitored stock market index.

The BSE switched to an electronic trading platform created by CMC Ltd. in 1999. BSE On-Line Trading (BOLT), another fully automated screen-based trading system offered by the BSE, is ranked second globally for having achieved certification. BSE introduced BSEWEBx.co.in, a centralized exchange-based online trading facility, so that investors may trade on the BSE platform from any location in the world.

1.2.2 NSE

The NSE with its main office located in Mumbai, was established in April 1993 according to the authorization granted by the Securities Contract Act of 1956. According to Wikipedia, the NSE has a total market value of USD 1.65 trillion. As of January 23, 2015, NSE was the twelfth-largest stock exchange globally. It serves several cities and towns. The primary goal of the completely automated, screen-based NSE trading system is to offer trading services for all securities at the national level.

Investors from all across the world, particularly India, frequently use the NSE's CNF NIFTY index. Investors can quickly reach the NSE from anywhere in the nation by using the telecommunications network. NSE is a well-known player in one of India's top markets: the derivatives market, which encompasses interest rate futures, equities derivatives, and currency derivatives. In certain situations, the stock market can act as a corporate bond when it comes to lending.

1.2.3 Comparison of BSE and NSE

As is often known, the BSE is India's largest stock market, but the NSE is the eldest stock exchange. Table 1 presents a comparison and contrast of the BSE and NSE.

Table 1 : Comparisons of BSE and NSE

Characteristics	BSE	NSE
Listed companies	5309 (As of January 2024)	2266(As of December 2023)
Main Index	BSE SENSEX	S&P CNX Nifty
Location	Mumbai	Mumbai
Key Person	Mr Sundararaman Ramamurthy (CEO and MD)	Ms Ashish Chauhan (MD and CEO)
Index Value	81921(As on 10.09.2024)	25041 (As of 10.09.2024)
World Ranking	7th (As of May 2024)	11th (As of March 2023)
Established in	1875	1992
Top companies as per market Capitalization (As of March 2023)	“Reliance Industries, Tata Consultancy Services (TCS), ICICI Bank, and Infosys Ltd.”	Reliance Industries, TCS, ICICI Bank Ltd., Infosys Ltd.
Website	“www.bseindia.com”	“www.nseindia.com”

1.2.4 Role of the Stock Market in Economy

Success has a big influence on organizational growth, and this tendency is bad for any nation's financial system. Stated differently, the stock market often acts as a leading indication of the country's growth and stability in terms of finance. As a result, central banks, management, and companies all closely monitor stock market activities. Growing share prices and increased trading investment are inversely correlated. In the context of business

and industry, the stock market is very important. A business trying to grow can get financial backing from the stock market. Buyers and sellers can trade publicly listed firm equities on this well-known market. On the stock market, anyone can always list their shares for sale and profit from their investments[6].

Because of this, stocks are known as liquid assets that entice investors to visit the stock market. The success of the stock market is a reflection of the overall sentiment. The Securities and Exchange Commission (SEC), a regulatory body, was established in the US to carry out this vital duty. The primary responsibilities of the SEC are to protect shareholder interests and guarantee appropriate transparency in all trading activity. The SEC has the authority to prohibit unlawful parties or people from engaging in the stock market and investigate any dubious stock market activity[7].

1.3 Stock prediction

Shares prediction is the process of trying to project the forthcoming value of a company's shares or another type of financial instrument that is traded on an exchange. Accurately forecasting changes in the security market's price index could result in enormous profits. Investors must understand their current investment costs, acquisition objectives, and possible future selling prices to forecast future price trends. Despite this, investors continue to track share prices over time to formulate their next investment decisions. While some investors steer clear of sinking stocks because they think the value will only increase, many steer clear of buying rapidly growing stocks because they think the value will change quickly. Prediction approaches fall into three comprehensive categories namely fundamental, technical, and ML methods.

1.4 Fundamental analysis

Fundamental analysts are disturbed that encourage the stock itself and it assesses the company's performance and the consistency of its financial statement. Several performance ratios are produced to support the fundamental analyst in evaluating the validity. The major objective of fundamental analysis in the stock market is to accomplish the true value of a stock and then it can be matched with the value. Therefore, pointed out whether the value of stock is undervalued or not. Finding out the true value can be completed by several methods with fundamentally the same standard [8].

Fundamental analysis is used by traders to identify the original net worth of the company before buying the stock by checking and evaluating the financial, economic, and growth of the company. This type of analysis of the company's intrinsic value for buying the stock or selling or holding decision-making will be done by long-term stock traders.

1.5 Technical analysis

Technical analysis is used to seek to determine the upcoming price of a stock based exclusively on the trends of the historical price. Technical analysis is reasonably used for short-term approaches, and then the long-term approaches with extensive in commodities. In this investigation, there are numerous basic assumptions used, and everything significant about a company is beforehand priced into the stock [9].

The key factors of technical analysis are to check the pattern, trend, indicators, price charts, support, resistance, and volume analysis, unlike fundamental analysis which considers companies' financial data. The main goal of technical analysis is to decide on trading stocks by understanding the chart pattern and trend to find out where the price trend will move in the future.

1.5.1 Machine learning

The prediction has motivated the scientific realm of machine learning. There are many research works have been developed on the prediction of stock prices which helps customers or buyers to make future decisions. In terms of machine learning, it can produce higher efficiency compared with technical and fundamental analysis. Hence, the following paragraph discusses some of the ML techniques for solving stock market prediction problems efficiently. There are four kinds of learning methods such as supervised, unsupervised, semi-supervised and reinforced learning. Figure 1 shows the kinds of ML approaches and the following subsection discusses details about them,

a) **Supervised learning (SL):** Under supervision, a neural network can be trained when the input and the output are known. The network compared the observed output with the expected output of the system. The network reverses the direction of the error and modifies the previously given weights. This procedure is carried out repeatedly until the desired results are not obtained. The same data set was used repeatedly during the training procedure. The system designer will reevaluate the system's input and output, complete layers, individual layer components, activation and learning process, connections between

the layers, and the network's initial weight whenever a problem is beyond the capabilities of a network. Changing the previously specified factors results in the creation of a successful network.

b) **Unsupervised learning (UL):** An algorithm is trained on a dataset using unsupervised learning, a sort of machine learning, in the absence of explicit supervision or labeled replies. Finding hidden patterns, structures, or relationships is the aim of unsupervised learning. Numerous applications, including data compression, make extensive use of unsupervised learning. Because it allows for exploration and discovery within the data without the requirement for human-labeled samples, it is especially useful when obtaining tagged data is difficult or excessively expensive. Unsupervised learning yields uncertain results even when the system's inputs are known. The feature that this network will utilize to generate the input data set must be chosen. As of now, unsupervised learning is not recognized as producing acceptable outcomes. At the moment, this type of learning is at a standstill.

c) **Semi-supervised learning (SSL):** A sort of ML known as semi-supervised involves training the algorithm that consists of both labeled and unlabeled data. In semi-supervised learning, unlabeled data is readily available and plentiful, but labeled data is usually expensive or scarce to collect. The primary concept underlying semi-supervised learning is to use the information found in both labeled and unlabeled data to enhance the model's functionality. This is accomplished by feeding the unlabeled data into the learning process so that the model may learn from it and improve its ability to generalize and predict data that hasn't been seen. Because it enables the model to utilize a wealth of unlabeled data to enhance performance, semi-supervised learning is especially helpful in situations where acquiring labeled data is costly or time-consuming. The union of the marked and unmarked samples is the network input. To understand the pattern for data layout and forecasting, one must learn algorithms. Issues include things like regression and classification, whereas example algorithms are adaptable programs that produce claims about how to represent unmarked data.

d) **Reinforcement learning (RL):** This learning describes the input values that are given to a system as provocation so that it can respond and continue. In contrast to supervised learning, feedback is given as a result of rewards or penalties rather than during the training process. The example issues include robots and systems controlling, and the

example techniques are Q learning and temporal difference learning. Through interactions with its surroundings, an agent that uses reinforcement learning (RL) can make decisions by aiming to maximize a concept known as cumulative reward. Reinforcement learning learns by trial and error where the system learns patterns without explicit feedback. When an agent engages in reinforcement learning, it acts in the environment and gets feedback in the form of incentives or penalties that reflect how well it performed. Finding a policy—a mapping from conditions to actions—that exploits the increasing repayment over time is the agent's objective. Depending on whether the policy chooses acts with certainty or with a probability distribution, it can be either deterministic or stochastic. Applications for reinforcement learning can be found in several fields, such as autonomous driving, robots, recommendation systems, gaming, and finance. Its capacity to resolve intricate decision-making scenarios in which explicit supervision or labeled data may be lacking has attracted a great deal of attention.

ANNs are an information processing system that follows the behavior of the human neural scheme. Artificial neural systems *"learn"* to execute tasks by considering instances, normally without programming with task-specific procedures. An ANN is based on a group of connected nodes or units called artificial neurons that are the neurons in a biological intelligence. Each connection is connected similar to the synapses in a biological brain and it can interconnect a signal with one to other neurons. An artificial neuron accepts a signal then develops it and can neuron of the signal is linked to it. The fundamental behavior of neural systems [10].

In the development of an ANN, the connection signal is considered a real number, and the output of each neuron is considered by the specific non-linear function of the summation of its inputs. The connections of each node are called edges. Hence, neurons and edges classically have adjusted weights as learning proceeds. An increase or decrease in the weight is the power of the signal at each connection. Neurons have a threshold value such that a signal is lead only if the joined signal crosses that threshold value. Indeed, neurons are combined into layers. Various layers may accomplish different conversions on their inputs. Signals move from the first layer called the input layer, to the last layer called the output layer probably after traversing the layers numerous times. The objective of the original ANN method was to solve a problem in a similar way to a human brain. However, attention progressed to performing precise tasks, leading to deviations from biology.

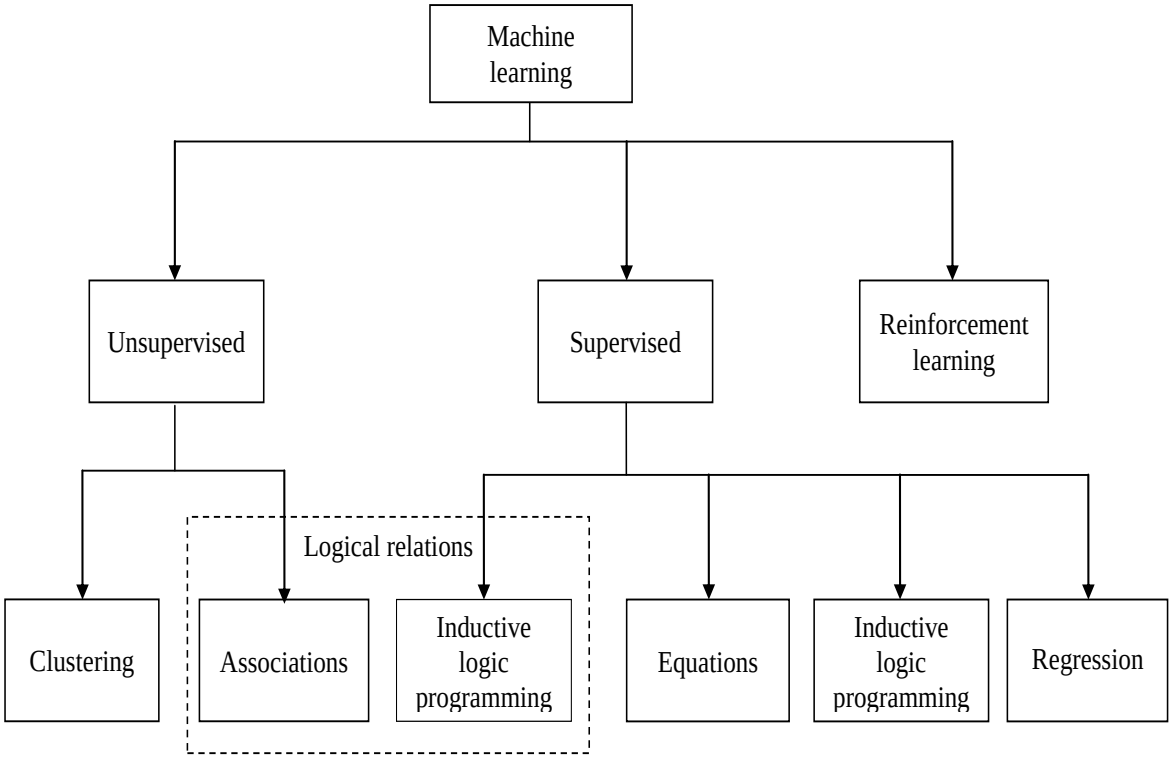

Figure 1 : Types of machine learning algorithms

The goal of ANNs is to reduce the error between the actual result and the outcome of the architecture with the help of adjusting their connection weights. The last error of the network replicates superior stability and the highest error of the network reflects the worst stability. The accuracy of the architecture is determined by the selecting proper topology such as hidden neurons, activation functions, inputs, outputs, and the methods of weight updating strategy. The hidden neuron is determined depending on the input and output layer of the architecture. Hence, there is no proper thumb rule to define a proper network topology. The selection of an optimum number of hidden neurons is to avoid underfitting or overfitting during the training process [11].

1.5.1 Characteristics of ANNs

The ANNs have high mapping capabilities such as mapping the input signal to their connection with the output example.

- Generalization capability
- Adaptively

- Learn by examples i.e. can be trained with identified examples
- The NNs can be predicted with the help of past behaviors
- The NNs are healthy systems
- Fault-tolerant
- An information process in parallel mode
- High speed
- Consumption power is low
- Distributed mode

1.5.2 Activation functions

An activation function is used to compute the output response of neurons and the sum of the output of the signal is applied to the activation function to get the output of the response. There are many activation functions applied to evaluate the output neurons of the ANNs that are separated into two kinds of models such as linear and nonlinear [10]. Mostly, the nonlinear function can be used in the multilayer perceptron (MLP). Some examples of activation functions are listed below,

A) Linear

If the value of the gradient is zero, then not possible to update the gradient surface during the learning process. Hence, the output is an attempt to use a linear function rather than a simple step function. The linear activation function is defined as

$$\phi(\mu_k) = \mu_k \tag{1}$$

B) Rectified Linear

The rectified linear activation function is the most extensively used activation function during the learning process. It is nonlinear means it can simply back-propagate the errors and has numerous layers of neurons being motivated by the rectified linear activation's function. The major advantage is it does not stimulate the whole neuron at the same and it is defined as follows,

$$\phi(\mu_k) = \begin{cases} \mu_k & \mu_k \geq 0 \\ 0 & \mu_k < 0 \end{cases} \tag{2}$$

C) Sigmoid

The sigmoid activation function is well-defined most of the problem used and it handles the range between 0 and 1 only. It is a S-shaped curve analysis. The major benefit is an overstep and linear function and non-linear functions. The mathematical formulation is as follows,

$$\phi(\mu_k) = \frac{1}{1+e^{-\mu_k}} \tag{3}$$

D) Hyperbolic Tangent

The tangent activation function is used to make it easier to typical inputs that have toughly negative, impersonal, and powerfully positive values. The remaining is followed by the Sigmoid function. It is defined as follows,

$$\phi(\mu_k) = \frac{e^{\mu_k - e^{-\mu_k}}}{e^{\mu_k + e^{-\mu_k}}} \tag{4}$$

1.6 Sentiment analysis

Through the analysis and interpretation of public sentiment, feelings, and opinions expressed in a variety of textual sources sentiment analysis plays a crucial part in stock market prediction. Understanding investor sentiment toward certain companies, markets, or industries is made easier with the use of sentiment analysis.

Its suggestions perceptions into stockholder confidence and market mood and, through the analysis of copious volumes of textual data, may ascertain if sentiments are positive, negative, or neutral. Stock values can be greatly impacted by news articles and events. Sentiment analysis assesses the sentiments expressed on companies or sectors in news articles and posts on social media. Positive announcements like new product launches or strong earnings can incite bullish enthusiasm, while negative announcements like lawsuits or scandals might incite pessimistic sentiment. Analyzing this emotion allows one to predict short-term changes in stock values.

Sentiment research can help foretell more general market patterns by analyzing broad opinions toward the economy, geopolitical happenings, and other macroeconomic variables. Positive emotion toward economic data, such as GDP growth or employment statistics, can

lead to a bullish mood in the market, and negative sentiment can lead to a bearish mood. By predicting these patterns, investors can make educated decisions on asset allocation and portfolio management.

Opinion research can be used to identify abnormalities in the market or discrepancies between investor opinion and stock prices. For example, if sentiment analysis reveals that investors are disproportionately positive about a particular company while the stock price is declining, this may suggest a potential buying opportunity if the sentiment is judged to be unjustified or excessive.

Sentiment analysis, which identifies potential hazards or threats based on negative feelings expressed in news articles or posts on social media, can also aid in risk management. Sentiment analysis, for example, may reveal new risks—like product recalls, regulatory obstacles, or corporate governance issues—that investors can utilize to alter their portfolios and lower potential losses. Sentiment analysis is widely used in conjunction with algorithmic trading techniques to automate trading decisions based on sentiment signals. It would be simpler for investors to profit from sentiment-driven market movements if algorithms were developed that would execute transactions by pre-established sentiment thresholds or patterns.

1.6.1 Classification

The process of classifying data elements, categories, or groupings based on predefined attributes or qualities is known as classification in structured language (SL). Using taken into consideration data; this SL approach builds a model to predict the class of fresh, hidden data. It is an essential task in data mining since it enables firms to make decisions based on their data that can be defended. Retailers, for example, might use data classification to segment their businesses into multiple groups based on customer demographics and historical spending patterns. This data can be used to target marketing campaigns that are specific to the demands of each segment, hence raising customer satisfaction. Applications for classification are numerous and include

- Sentiment analysis
- Image recognition
- Text categorization

- Spam detection
- Medical diagnosis

1.6.2 Role of sentiment analysis

Sentiment research can provide insightful information about investors' attitudes, beliefs, and sentiments toward particular stocks, and businesses. Sentiment analysis of the market looks at news sections, posts, economic reports, and other information sources to ascertain the overall attitude or mood of the market. Positive sentiment may indicate optimism and confidence and, as a result, lead to improved purchasing activity and higher stock prices, whilst negative sentiment may indicate selling burden and lower stock prices [12].

Sentiment analysis can also be used to ascertain the opinions of others regarding specific stocks or businesses. Investing in news articles, financial reports, press releases, and social media discussions about a particular company can provide investors with more information about public opinion, customer satisfaction, management effectiveness, and other factors that may impact stock prices. Sentiment analysis can be used to uncover noteworthy incidents or news stories that could have an impact on stock prices. By monitoring the emotions around events like as product promotions, earnings releases, mergers and achievements, managerial changes, or business scandals, investors can forecast market moves and adjust their trading strategies accordingly.

Sentiment indicators or indexes that gauge market sentiment can be developed by sentiment analysis, which is based on the analysis of textual data. These sentiment indicators can be utilized in conjunction with traditional technical and fundamental analysis methods, in addition to providing extra insights into market dynamics.

1.7 Motivation for the Research

An important part of a nation's economy is the stock market. Companies are disciplined by the stock market because it exposes them to the scrutiny of investors and market forces. Companies need to run effectively, uphold transparency, and follow strong corporate governance procedures to draw in investors and keep or raise their stock prices. Better resource management and increased company performance follow, both of which boost the economy in the long run.

The stock data are noisy, non-stationary, volatile, complex dimensionality, and nonlinear distinguishing which makes it a complicated task to predict the price [13, 14]. In the early stages, the prediction of the stock market price or indices is performed using statistical learning methods such as moving average, exponential smoothing ARIMA, etc.[15]. However, the statistical methods make it very difficult to accomplish the stock prediction of the non-stationary scenery. To overwrite the above addressing shortcomings, many research works have been investigated with the help of various computational intelligence methods. The ANNs are used to predict the future behavior of the stock market price. ANNs a more efficient to handle the nonlinear stock market datasets due to their high acceptance ability with high accuracy [16].

These days, ML models are widely applied in the financial sector. Both ANNs and well-known ML techniques produce noteworthy outcomes. Because ANNs are naturally good at accurately approximating any nonlinear function and at detecting complicated nonlinear correlations based on historical data, their usage in modeling economic scenarios is rapidly expanding. A novel batch learning technique called ELM has recently been planned for training single hidden layer neural networks (SLFNs).

The ELM approach computes the output weights of SLFNs analytically and first initializes hidden node values at random. For the randomly chosen input weights and hidden layer biases, ELM will produce the least squares solution of a system of line equations for the unknown output weights with the minimum norm property. For numerous real-world applications, ELM has shown good generalization results with a very fast learning rate.[17-20]

Nevertheless, there are still a lot of issues with the actual application of the ELM. The most important one is the selection of the perfect number of hidden nodes. Generally speaking, the ELM requires more hidden neurons than more conventional tuning-based learning methods. As a result, a lot of studies have been done to determine the best weights and biases for ELM to improve prediction outcomes. However, there are numerous flaws in the standard methods, including local optima, a lengthy computation time, and a low convergence rate.

Therefore, the weight and bias of the ELM known as DELM for stock price prediction, were adjusted using deterministic weight modification (DWM). When the DELM

was compared to some predictable and modified ELM, the accuracy result was greater. Conversely, the developed stock market prediction algorithms ignore other factors that affect stocks and their complex internal workings in favor of primarily using historical data as their input. Because people are inconsistent, the stock market does not always operate according to systematic rules. Their behavioral, psychological, and emotional characteristics are vital in the economic system.

Furthermore, new research has shown that investor attitude may have a significant impact on stock market returns. There is a strong hint that investors are not irrational, and as social networks become more important in people's lives, shareholder connections are getting easier and more common. Consequently, the sentiment and viewpoints of other investors as well as those expressed on social media platforms may have an impact on an investor's opinion and administrative processes.

These monies can be utilized to pay for social initiatives, infrastructure improvements, or budget deficit reduction, all of which promote economic growth and the general welfare. The stock market acts as a bridge between investors and savers, acting as a crucial financial middleman.

It gives people and organizations a place to put their savings into profitable investments like stocks and bonds, directing money from the economy's surplus to its deficit. This intermediary role facilitates effective capital allocation and fosters economic expansion. All things considered, the stock market is essential to the economy because it facilitates capital formation, encourages corporate governance, creates and distributes wealth, acts as an economic indicator, finances public projects, eases financial intermediation, and affects the confidence of both consumers and businesses. Its success and general well-being are strongly linked to the expansion and general prosperity of the economy.

The choice of ELM in combination with sentiment analysis for stock market prediction stems from its superior generalization over conventional methods, speedy processing of vast amounts of data, and effective capture of non-linear correlations. Because ELM is faster, more generalizable, and less computationally demanding than traditional machine learning models, it is preferred. Deep learning models, such as LSTM, are computationally costly because to their need for substantial hyperparameter adjustment and vast volumes of data. Even with a small training set, ELM's random feature mapping prevents

overfitting and improves generalization, resulting in increased accuracy and improved flexibility in response to market changes.

Conversely, news, social media trends, and market psychology all have an impact on stock prices. By identifying changes in market sentiment, sentiment analysis enhances prediction accuracy. Conventional models ignore changes in market sentiment in real-time and solely take into account past stock values. Sentiment analysis pulls emotional cues from social media, financial information, and news sources.

This study accomplishes the following by integrating sentiment analysis and ELM: The created prediction approach is appropriate for real-time stock forecasting since it is faster than classic deep learning models, has greater generalization than SVM and BPNN, integrates emotional market aspects to increase prediction accuracy, and has a lower computing cost.

1.8 Problem description

The process of projecting future movements or levels of a specific stock's price is known as stock price prediction. Predicting whether a stock's price will climb, fall, or stay mostly unchanged over a certain time horizon is a fundamental task in financial research and investing decision-making. Predictive modeling tools, historical data, and a variety of quantitative and qualitative elements are used in stock price prediction to produce projections.

Anticipating and analyzing the key drivers of the stock is hard because of its volatility and complexity. It's also difficult to create models that can forecast stock price fluctuations over the long and short terms. However, a lot of individuals believe that investing in the stock market is dangerous, mostly due to the intricate aspects that influence shared values. Due to the stock market's risk, investors may occasionally lose more money than they gain. Decisions about investments are greatly influenced by one's awareness of the dangers and different external factors. A reliable source for stock market investing is the market's information, news, advice, and sentiments.

1.9 Objectives of the Research

The main objective is to improve prediction accurateness of intraday closing price using neural network architecture based on sentiment analysis in stock market prediction. Then, the proposed prediction model can help investors to make more profit at the right time.

The objectives are mentioned as follows,

- To identify the scaling factor of the marginal value of the stock
- To reduce the computational complexity
- To enhance the prediction accuracy
- To enable an investor to purchase and sell stocks at the best possible times by providing them with more information
- To handle uncertainty and to manage the overfitting or underfitting.

1.10 Research Framework

The present research work used three different research methods, such as ANNs, DWM, and CNN methods.

1.10.1 ELM

Regression, classification, and other ML tasks are handled by the ELM. It is especially well-known for being straightforward and efficient, which makes it appropriate for a variety of uses, including stock market forecasting. It's critical to find pertinent factors that could affect stock values before using ELM. Historical stock prices, trading volumes, technical indicators, economic indicators, sentiment analysis scores, and other market-related factors are a few examples of these elements.

The ELM has a solitary hidden layer of neurons, with initialized input weights determined at random. The output weights are generated analytically through the use of a pseudo-inverse solution. Only the output weights are learned from the training data during the training phase; the input weights are fixed. By feeding the input features into the trained model and computing the output using the learned output weights, the ELM model can be trained to make predictions.

The model can be improved if needed by experimenting with other architectures, adding more features, and modifying the hyperparameters. To reduce possible losses, risk management strategies must be integrated into the stock market forecast process. This could entail varying the asset portfolio, employing stop-loss orders, and participating uncertainty estimates into the trading plan.

1.10.2 Deterministic weight modification (DWM)

Deterministic optimization algorithms rely solely on the gradient of the objective function to determine the magnitude and direction of parameter changes. Deterministic methods yield repeated and predictable results, which is helpful when consistency is essential or unpredictability is undesired. [21].

1.10.3 Convolutional Neural Networks (CNNs)

CNN's ability to detect spatial patterns in textual input makes it a valuable tool for sentiment analysis and stock tweet classification. CNNs are capable of extracting ranking features from stock tweets and using word embedding to acquire semantic information to classify sentiment. By knowing the emotions of the market, this enables traders and investors to make more informed judgments. When combined with word embedding's semantic information and their hierarchical feature extraction capabilities, CNNs can efficiently learn and categorize sentiment from stock tweets.

1.10.4 Weight modification method

In machine learning, deterministic weight modification is the act of modifying a model's weights according to pre-established rules or procedures. Unlike stochastic weight modification, which makes use of randomness or probabilistic methodologies, deterministic weight modification follows a specific, predictable pattern. In neural networks and other supervised learning algorithms, weight adjustment often occurs during the training phase, when the model is learning to map input data to output labels. To minimize a preset loss function—which determines the difference between the true labels and the anticipated outputs—the process involves iteratively changing the model's weights.

1.11 Dataset description

The present research work focused on six datasets-based stock market indices such as S & P BSE and Nifty 50 and stock market prices such as State Bank of India (SBIN), ICICI Bank, HDFC, and MSFT. Stock indexes, sometimes referred to as stock market indices, are statistical measurements that are used to monitor the performance of a collection of assets or stocks in a certain financial market. By illustrating the highs and lows of the underlying equities, they offer a glimpse of the overall performance of the market. The price at which a

specific stock is currently being traded on a stock exchange is referred to as the stock market price. A stock's price usually rises in response to strong demand and tends to decline in response to weak demand or selling pressure. Above mentioned datasets were chosen based on their sectoral representation, liquidity, volatility, and market influence. Every dataset offers insightful information about sentiment analysis, macroeconomic trends, and changes in stock prices. A thorough explanation of why each dataset should be used is provided below:

1.11.1 S & P BSE Sensex:

Thirty reputable, economically constant corporations listed on the BSE make up the free-float market-weighted BSE SENSEX, often known as the S&P BSE Sensitive Index or just SENSEX. The 30-element businesses, which include some of the biggest and most frequently traded equities, comprise a cross-section of the industrial sectors.

1.11.2 Nifty 50:

The fifty main Indian firms listed on the NSE are signified by the standard NIFTY 50 index. With an ecosystem made up of NSE and SGX futures and options, exchange-traded funds (both onshore and offshore), and exchange-traded funds, it has grown to become the main financial product in India. The greatest exported agreement internationally is the NIFTY 50. NSE is regarded as a frontrunner by surveys from WFE, IOM, and FIA. Since sectoral indexes including Bank, IT, Pharma, and Next 50 have grown in popularity, the NIFTY 50 index's market share of the NSE.

The NIFTY 50 offers savings administrators exposure to the Indian market inside a single portfolio by encompassing thirteen segments of the Indian economy. Financial services, including banking, are given 36.81% weighting in the NIFTY 50 as of January 2023. It is given 14.70%, oil and gas are given 12.17%, consumer goods are given 9.02%, and autos are given 5.84%.

1.11.3 SBIN:

SBIN is a global bank and financial services directing body in India, with its main office situated in Mumbai, Maharashtra. SBI ranked 48th internationally in terms of total assets, is the only Indian bank. It has a 25 percent market share and asset market share. The biggest public lender in the country reached a noteworthy milestone on February 7, 2024,

when its market value surpassed ₹ 6 lakh crore. This made it, after Life Insurance Corporation, the second public sector endeavor to accomplish this achievement.

1.11.4 ICICI bank

ICICI Bank is an international bank and financial services worker in India, with its headquarters located in Mumbai and its registered office situated in Vadodara. It offers both corporate and retail clients a wide variety of banking and financial services. This development finance company operates in 17 countries and has 16,650 ATMs and 5,900 locations across India.

1.11.5 HDFC bank

HDFC is one of the biggest private-sector banks in India, and makes up the HDFC dataset utilized for stock market prediction. The dataset facilitates the analysis of volatility, sentiment-driven price changes, and stock patterns. News, analyst reports, and conversations on social media all have a significant impact on HDFC stock.

1.11.6 MSFT

One of the biggest publicly traded IT firms is Microsoft Corporation (MSFT), which is listed on the NASDAQ Stock Exchange. It is a crucial gauge of market performance since it has a significant impact on the Dow Jones Industrial Average (DJIA), NASDAQ-100, and S&P 500.

1.12 Key Performance Indicators

Performance metrics are essential for stock market prediction because they offer quantitative measurements for evaluating the precision and potency of predictive algorithms. Performance metrics are essential for stock market forecasting because they let you assess and contrast the relative merits of various trading approaches and predictive models. They support the assessment of a model's accuracy, risk tolerance, and overall profitability. Here are a few vital performance indicators for stock market forecasting.

These measures direct efforts to select, adjust, and improve the models as well as analyze how effectively the models perform in making predictions. Performance metrics such as Mean Squared Error (MSE), Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), and R-square are frequently used to evaluate the accuracy of a model.

Lower values of these indicators indicate better predictive accuracy, whereas higher values imply less accurate projections. Several predictive models can be compared using performance measures to see which performs better for a given dataset and prediction task. By contrasting several models with the use of standardized measures, analysts can determine which model is most effective at forecasting the stock market.

- **MSE:** Another popular statistic for assessing the effectiveness of regression models, particularly those used to anticipate stock market movements, is MSE. It calculates the average of the squared discrepancies between the actual and model-predicted values. Because of the squaring process, MSE penalizes greater errors more severely than smaller errors. As a result, it provides information on the variance as well as the size of the mistakes produced by the prediction model. When it comes to stock market forecasting, a lower MSE represents higher extrapolative accuracy because it shows that the model's forecasts are more actual values.

- **RMSE:** RMSE is a crucial indicator for comparing and assessing models in data science, machine learning, and statistics. RMSE provides a measure of how well a model predicts the outcome. Less RMSE indicates better model performance. Several models can be compared with the same dataset thanks to RMSE. The best-performing model is said to have the lowest RMSE. RMSE is the function to be minimized. For example, in linear regression, model parameters are often optimized to lower the root mean square error (RMSE) on the training data.

- **MAE:** MAE is a well-liked metric for evaluating the accuracy of regression models, especially those that are used to predict the stock market. The mean absolute difference between the values that are observed and the values that the mode predicts is computed. The average magnitude of the mistakes produced by the predictive model can be understood as MAE in the context of stock market prediction. Better prediction accuracy is indicated by a lower MAE.

- **MAPE:** MAPE is a usually used metric to evaluate the predictability of figures, especially those related to stock market prediction. It computes the typical percentage difference between the model's predicted and the actual values. MAPE quantifies how accurately the model predicts actual values. It is particularly useful when working with data when the size of the variables varies substantially, like in financial forecasting.

Because a lower MAPE suggests that the model's predictions are generally more consistent with actual values, it is a better indicator of predictive accuracy. However, MAPE has its limitations, especially when actual values are close to zero, as this might lead to results that are undefinable or limitless. Moreover, data with irregular zero values or outliers may not be suitable for MAPE. The average value difference between the predicted and actual stock prices is known as the MAPE in the context of stock price prediction.

- **R-Square** (R^2): It is a statistical metric used to measure a model's goodness-of-fit. R can be used to gauge how well the predictive model fits the observed data in the context of stock market prediction0 indicates that the model is unable to account for all of the variability in the response data around its mean. 1 representing that the model fully explains all of the response data variability around its mean. Since it indicates that the independent variables account for a larger percentage of the variance in the dependent variable, a higher R-squared value specifies a well fit. A lower R-squared value raises the possibility that the model is unable to fully explain the underlying trends in the data

1.13 Organization of the Thesis

- Chapter 1 described the fundamental analysis of the stock market and its techniques, prediction using ANNs algorithm, and its advantages. Also, the objective and scope of the research work are briefly described with detailed citations.
- Chapter 2 gives a comprehensive review of the stock prediction models, ANNs, sentiment analysis, and recent analysis regarding the stock market prediction over ten years.
- Chapter 3 gives the details of the fundamental details of the proposed method and their detailed algorithms with a discussion of their merits and demerits.
- Chapter 4 describes the details of ANN prediction algorithms such as ELM, its architecture, layers, merits, and demerits of the ELM. Whereas, more discussion about the enhancement by the several learning algorithms, and proposed optimized ELM with DWM and detailed results.
- In Chapter 5, more discussion about Extreme learning machines with DWM using technical analysis, performance measures, and detailed results with their discussions.

Additionally, the error comparison of each prediction algorithm is also presented in a detailed manner. Comparisons result from various key factors.

- In Chapter 6, discussion about the proposed method using sentiment analysis, performance measures, and detailed results with their discussions. Additionally, the error comparison of each prediction algorithm is also presented in a detailed manner.

- Chapter 7 describes the conclusion about the proposed research works with its future enhancements.