# PREDICTIVE MODELING OF STOCK PRICES WITH MACHINE LEARNING TECHNIQUES

A MAJOR PROJECT REPORT

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE
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IN
**MATHEMATICS AND COMPUTING**


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We, **Shubham Chhikara (2K20/MC/137)**, **Shubham Dahiya (2K20/MC/138)** and **Ujjawal Tyagi (2K20/MC/146)** of B. Tech. Mathematics and Computing, hereby declare that the project Dissertation titled "PREDICTIVE MODELING OF STOCK PRICES WITH MACHINE LEARNING TECHNIQUES" which is submitted by us to the Department of Applied Mathematics, Delhi Technological University, Delhi in partial fulfilment of the requirement for the award of the degree of Bachelor of Technology, is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of any Degree, Diploma Associateship, Fellowship or other similar title of recognition.

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# CERTIFICATE

I hereby certify that the Project Dissertation titled "PREDICTIVE MODELING OF Stock Prices WITH MACHINE LEARNING TECHNIQUES" which is submitted by **Shubham Chhikara (2K20/MC/137)**, Shubham **Dahiya (2K20/MC/138)** and **Ujjawal Tyagi (2K20/MC/46)**, Department of Applied Mathematics, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology, is a record of the project work carried out by the students under my supervision. To the best of my knowledge this work has not been submitted in part or complete for any Degree or Diploma to this University or elsewhere.

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# ABSTRACT

In this report we discuss how technical analysis can be combined with fundamental analysis for evaluating financial securities. Our work is structured in two opposed segments; technical analysis on one hand and fundamental analysis on the other.

The technical analysis project aims at using previous stock prices alongside their traded volumes unto which they can be used to tell how these stocks will trade. Indeed various analytical tools including moving averages, RSI (Relative Strength Index), MACD (Moving Average Convergence Divergence) among others like bollinger bands are used on this work to detect patterns through which one can determine his/her strategic entry as well as if he should get out of a particular security. The findings from the technical analysis provide insights into the short-term price behavior of stocks and help in making informed trading decisions.

In-depth evaluations provided throughout the two primary talks are an important part of the basic analysis process. The goal is to determine the intrinsic worth of certain companies by an examination of their financial statements, an analysis of certain market indicators, and a consideration of pertinent economic circumstances. . Looking at the financial ratios, discounted cash flow, and qualitative data including management effectiveness and competitive advantage provides an insight into a company's financial strength and growth perspectives. This analysis provides a long-term perspective on stock valuation and investment opportunities.

This study shows the abilities and failings of technical analysis on one hand and fundamental analysis on the other, with regard to market timing and short term price fluctuations. On one hand, technical analysis is value adding when it comes to timing the market and observed daily price changes while fundamental analysis goes further into recognizing the company's real value as well as its future growth possibilities. When combined together, one can create a well-rounded investment strategy.

The report ends by showing results comparing technical and fundamental analysis effectiveness and giving investors advice from findings of two methods combined.

# CONTENTS

## LIST OF FIGURES

# CHAPTER – 1

# INTRODUCTION

## 1.1 Overview

The stock market, frequently referred to as the market for equity, acts as a marketplace for investors to purchase and sell shares in publicly listed corporations. It is an essential part of an economy built on open markets because it allows businesses to generate money by selling shares to investors in return for a share of the business's assets. Exchanges that facilitate regulated and transparent transactions, like the National Stock Exchange (NSE) and Bombay Stock Exchange (BSE), are the channels by which the stock market operates. Some of the primary functions of the stock market are discovering prices and fluidity. The process for establishing stock prices according to the dynamics of supply and demand is known as price discovery. This represents the opinion of market players as a whole on a company's worth. For the purpose of to ensure that investors may join and exit positions with the least amount of friction, liquidity is defined as the simplicity with which shares can be traded without producing significant fluctuations in prices.

A variety of stocks are distinguishable, including typical and preferred stocks. While preferred shareholders usually have a set dividend and preference over ordinary stockholders in the case of a bankruptcy, common stockholders can cast votes and may receive dividends.

The stock market is affected by an extensive variety of variables, including corporate profitability, shifts in politics, investor sentiment, and economic statistics. To assist them make wise choices, traders employ two main research techniques: fundamental and technical analysis. Technical evaluation concentrates on past price patterns and transaction volume, whereas fundamental evaluation evaluates a company's underlying potential and financial health.

## 1.2 Purpose of Stock Market

The primary purposes of the stock market are to assist companies raise money and to give investors a place to buy and sell shares in these companies. Companies may raise the money they need to grow, take on novel endeavors, and encourage innovation by offering shares to the general public. Economic development and the expansion of companies depend on this access to money.

The stock market gives investors the chance to put money into a variety of businesses, which may diversify their portfolios and perhaps lead to wealth development. As the worth of their shares increases, investors may profit through capital gains as well as dividend paid out by profitable companies.

In addition, the stock market, which reflects the general consensus on the worth and prospects of a firm, is a significant driver in price discovery. Having transparency facilitates the process of making wise financial choices.

Furthermore, through facilitating the effective distribution of resources, the stock market supports broad economic stability. Businesses that turn a profit and operate successfully draw in more capital, while failing ones could find it hard to get financing, thereby encouraging creativity and efficient operations.

## 1.3 National Stock Exchange (NSE)

One of the largest and most most popular stock exchanges in the nation is the National Stock Exchange (NSE). The NSE was the first Indian exchange that adopted digital trading, which significantly improved the process's efficiency and transparency when it was first established in 1992. With its primary headquarters located in Mumbai, the exchange runs a countrywide network providing a trading platform for debt instruments, derivatives, and stocks.

The modernization and expansion of India's securities markets have been greatly aided by the NSE. In order to provide an example, it developed the NIFTY 50 index, which is the weighted average of 50 of the biggest and most liquid Indian firms that are listed on the exchange. This index is frequently employed as an indicator for the Indian equities market.

The NSE offers an assortment of products and services, including securities, exchange-traded funds (ETFs), equity shares, and derivatives like options and futures. In order to

preserve the interests of investors and guarantee market integrity, it has also put strict rules and regulations into place. expanded market liquidity, more investor trust, and grew stock market participation have all resulted from the creation of the NSE.

All things considered, the NSE has played an important part in changing the financial landscape of India through supplying a stable and dependable trading platform, encouraging innovation, and advancing financial inclusion.

# CHAPTER 2

# CONCEPTUAL BACKGROUND

## 2.1 Technical Analysis

Instead of measuring the actual worth of protection, technologists use frameworks to find patterns that may indicate future trends. With the use of historical expenses, volumes, occurrences, and changes, this technique assesses securities. Professional examiners and technical analysts think historical performance in the stock and market may predict future outcomes. The 'technical' analysis has been more and more popular in recent years as more individuals think that past performance of investments may be used to predict future performance. Using financial data from the previous few quarters and years, those that employ fundamental analysis forecast future growth and have generally outperformed their organizations in the past. The primary distinction is that experts in the field believe that the movement of stocks is represented by relatively predictable patterns and examples.

These patterns hold true until something alters the trend, and the price level is anticipated at this time. Financial specialists, not knowing the company's obligations, use their approach to stocks charts in order to trade efficiently.

## 2.2 How Technical Analysis is done

Finding historical patterns and using them as a tool to apply technical analysis methodologies to the prediction of future stock prices is known as technical analysis.
Premises pertaining to technical analysis:
1. According to technical analysis, stocks are not naturally valued; rather, they are impacted by market activity and a modest number of factors.
2. Because stock prices frequently follow recognizable patterns, technical analysts may view little declines as opportunities to purchase in a bull market.
3. Technical analysis depends on pertinent information from sources such changes in stock prices, overall market mood, and financial statements on economic or company earnings.

4. Technical analysis relies on the observation of price trends since it predicts that future price movements will adhere to pre-established patterns.

5.In technical analysis, history is assumed to repeat itself, especially in terms of price fluctuations. Over time, market players are thought to respond to changes in the market in a predictable way. Analyzing market trends and patterns requires the usage of chart patterns. In conclusion, technical analysis extrapolates future values from historical stock price movements rather than using an exact formula.

## 2.3 Technical Analysis Indicators

Technical analysis signals are calculation methods that traders utilize to forecast future market movements. These calculations are based on previous price, volume, or open interest data. To comprehend market patterns and make wise trading decisions, these indicators are crucial.

### 2.3.1 Averages of Movement (MA)

Price data is smoothed using moving averages to produce a single, flowing line that aids in determining the trend's direction. Moving averages come in several forms, such as exponential moving averages (EMA) and simple moving averages (SMA).

Simple Moving Average(SMA)

The arithmetic mean of a certain set of prices over a predetermined number of days in the past is known as the Simple Moving Average (SMA).

Exponential Moving Average (EMA): This makes the market more sensitive to fresh information by emphasizing recent prices.

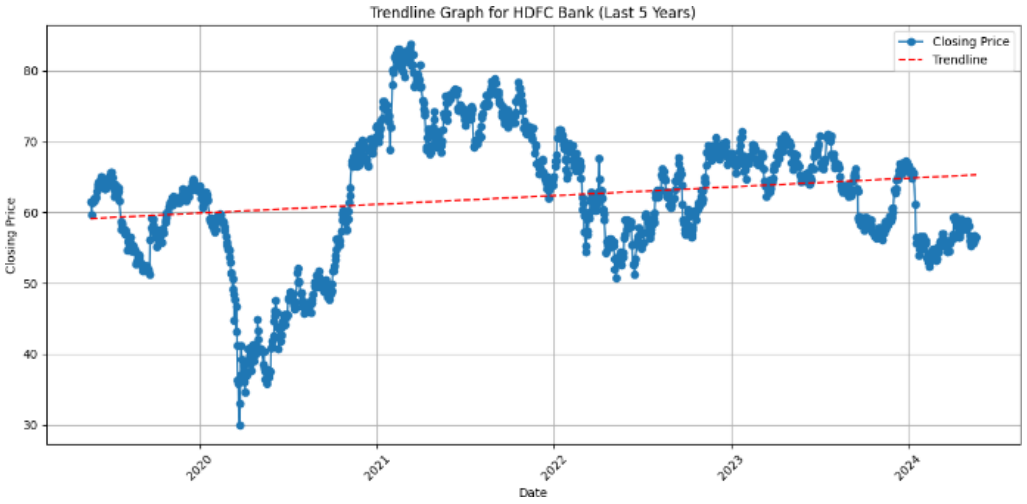


**Figure 1: Trendline Graph**

### 2.3.2 Relative Strength Index (RSI)

As a momentum oscillator, the Relative Strength Index (RSI) gauges the rate and direction of price changes. The range of RSI values is 0 to 100, with 70 and 30 serving as standard markers for the high and low points, respectively. A stock may be overbought if its relative strength index (RSI) is greater than 70, and it may be oversold if it is less than 30.

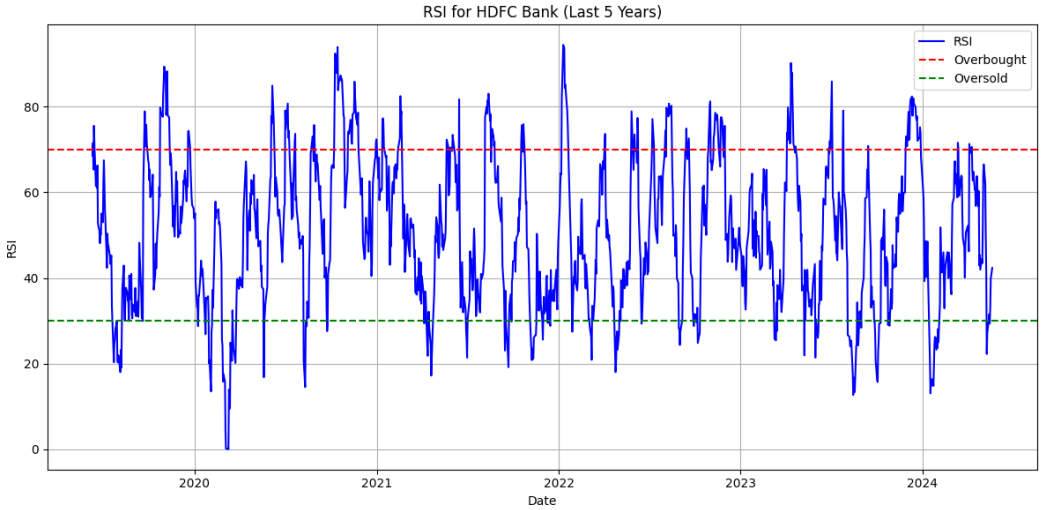


**Figure 2: Relative Strength Index**

### 2.3.3 Moving Average Convergence Divergence (MACD)

The MACD is a momentum indicator that follows trends and displays the connection between two moving averages of the price of an asset. The 26-period EMA is subtracted

from the 12-period EMA to get the MACD. Then, to generate buy or sell signals, a signal line—the 9-day EMA of the MACD—is placed on top of the MACD.

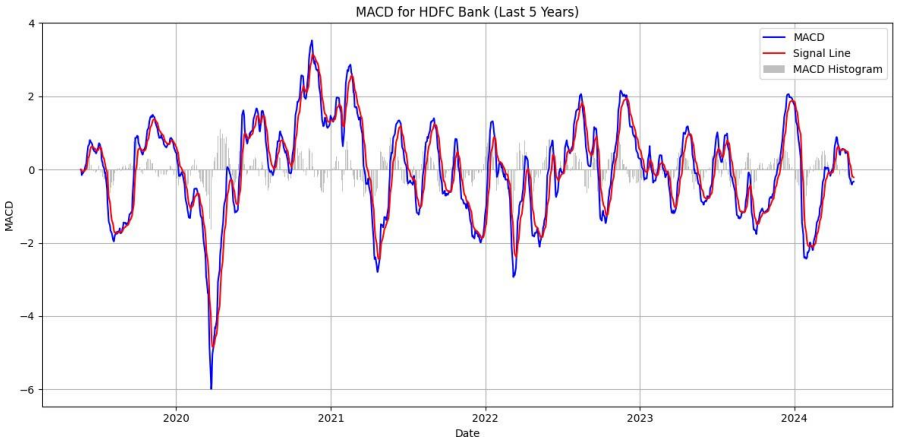


**Figure 3: Moving Average Convergence Divergence**

### 2.3.4 Bollinger Bands

John Bollinger created a particular kind of price envelope known as Bollinger Bands. They are displayed above and below a basic moving average at standard deviation levels. These bands provide a dynamic range for price movements and aid in identifying overbought or oversold situations by expanding and contracting in response to changes in the market.

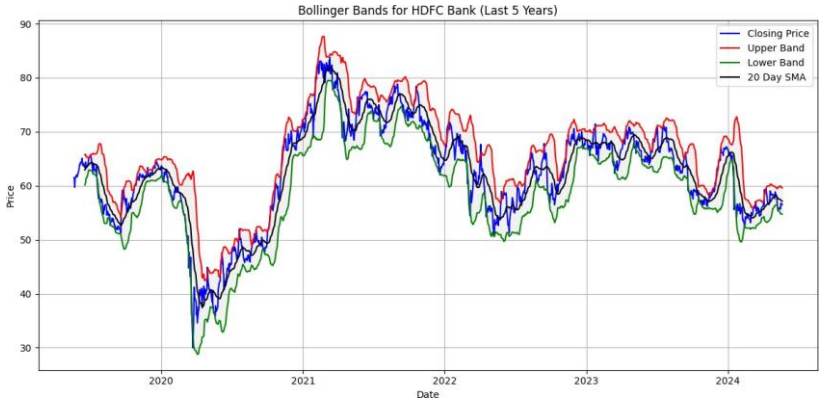


**Figure 4: Bollinger Bands**

## 2.4 Fundamental Analysis

Analysing a security's fundamental value entails looking at relevant financial, economic, and other qualitative and quantitative aspects. It offers a more thorough comprehension of a business's operations and prospects for expansion. This technique entails examining the financial accounts of a business, as well as its management, rivals, and competitive advantages, in addition to the overall situation of the economy.

Fundamental analysis compares a stock's market price to its underlying value in order to

assess whether it is undervalued or overpriced. This method is usually applied to long-term investment choices, emphasizing the viability and development potential of a company's business plan.

### 2.5 Fundamental Analysis Indicators

In fundamental analysis, a variety of crucial indicators are utilized to evaluate the worth of a business and financial standing. These metrics offer perceptions into the overall financial viability, liquidity, efficiency, and profitability of a business.

#### 2.5.1 Price to Earnings (P/E) Ratio

The current share price of an organization is contrasted to its earnings per share utilizing the Price to Earnings (P/E) ratio. It is a frequently employed way to assess a company's worth and evaluate it against rivals. A high price-to-earnings ratio (P/E) might be an indication that a company is overpriced or that investors expect substantial growth in the future.

#### 2.5.2 Price to Book (P/B) Ratio

A business's book value, or the worth of its assets minus its liabilities, is contrasted to its market value using the Price to Book (P/B) ratio. A lower P/B ratio may indicate an undervalued firm, while a greater ratio may suggest a stock that is overpriced.

#### 2.5.3 Return on Equity (ROE)

Return on Equity (ROE), which demonstrates how much profit a business makes with the money that investors have invested, is a measure of a company's profitability. By dividing net income by the equity of shareholders, it is computed. Greater ROE is a sign of superior equity capital usage.

#### 2.5.4” Debt to Equity Ratio”

The debt-to-equity ratio indicates how much debt and shareholders' equity were used to fund the assets of a company. By dividing total liabilities by shareholders' equity, it is calculated.

A higher proportion indicates that an organization is financing its growth with more debt, which might be riskier.

### 2.5.5 Dividend Yield

The quantity of dividends an organization pays out yearly in relation to its share price is shown as its dividend yield. For investors seeking to earn income, it's an informative figure that gives them a better understanding of the income produced by owning stocks. A higher dividend yield may appeal to investors who are searching for a consistent source of income.

## 2.6 How to do Fundamental Analysis

To do a fundamental analysis, execute these steps:

1. Developing an understanding of the Company: “Start to acquire knowledge about the Industry, the Products and Services, and the operational structure of the Company. It is essential to comprehend the company's revenue streams and competitive landscape”.
2. Examine Financial Statements: “examine and assess the balance sheet, income statement, and cash flow statement of the business. These records include information about the earnings, costs, economic viability, assets, obligations, and cash flows of the business”.
3. Calculate Financial Metrics: “Evaluate the company's financial standing and compare it to that of rivals in the sector by using financial ratios such the debt-to-equity ratio, ROE, P/E ratio, and P/B ratio”.
4. Evaluate Qualitative factors: “Taking into consideration qualitative factors such as the standard of the company's leadership, its advantages over competitors, the state of the market, and economic variables. The success of the business in the future may be significantly affected by these factors”.
5. Conduct Valuations study: “To determine the stock's intrinsic worth, perform a valuation study utilizing techniques such deferred cash flow (DCF) analysis. This entails projecting future cash flows for the business and reducing them by the current amount”.
6. Compare with Markets Price: Examine the distinction amongst the stock's current market price and the intrinsic value determined by the assessment research. The stock may be underestimated if the intrinsic value exceeds the market price, and vice versa.
7. Make the Investment Choice: “Decide whether to buy, hold onto, or sell the stock in light of the analysis”. Think about your span of time and investing goals, as well as the potential

hazards and advantages. When investors have a solid understand of a company's fundamental worth and financial health, they may make well-informed judgments.

# CHAPTER – 3

# RESEARCH DESIGN

## 3.1 Problem Statement

The challenge that investors encounter when making wise investment choices in the face of the stock market's complexities and volatility is the primary problem that this study tries to solve. Despite having access to broad economic data, buyers frequently fail with correctly interpreting this data in order to find lucrative possibilities and mitigate risks. The dynamic character of financial markets, where a wide range of factors affect the value of stocks and market behaviour, is the root of this problem.
For the most part, technical and fundamental analysis is utilized by investors to inform their decisions. Technical analysis anticipates future price movements utilizing historical price data and volume of trade, whereas fundamental evaluation analyzes the inherent value of a firm utilizing its financial statements, the status of the market, and economic indicators.

Each method, however, has its limitations and can sometimes provide conflicting signals, complicating the development of a cohesive investment strategy.

The specific problems this research aims to address include:

1. Identifying Market Trends: Timely investment decisions depend on the establishment of reliable methods for identifying and interpreting market trends.
2. Accurate Business Valuation: It can be hard to determine a stock's real value accurately, especially in the face of financial volatility and market speculation.
3. Balancing Short-term and Long-term plans: It can be difficult and frequently results in contradictory strategies for integrating the conclusions from technical evaluation for trading in the short term with fundamental evaluation for long-term investing.
4. Integrating Diverse Data Sources: Robust analytical frameworks are necessary to properly combine technical signs and fundamental measures to develop an all-encompassing investing plan.
5. Creating Predictive Models: Creating artificial intelligence models to forecast stock movements and guide investing choices by utilizing technical signals and fundamental analysis.

By addressing these problems, the research aims to enhance the accuracy and efficiency of investing strategies by providing a structured approach for technical and fundamental analysis. The ultimate goal is to empower investors to make more confident and sound choices by utilizing both modern machine learning algorithms and traditional methods of research to get the desired financial outcomes.

### 3.2 Need of the Study

To make money, those who invest rely on the success of certain company stocks on the stock marketplace. It is crucial to think about these stocks' performance while making investing selections. Investors can make smart investment choices through using technical analysis to identify signals for buying and selling in the stock market. The purpose of this study is to better understand these methods in order to get better making investments results.

### 3.3 Study Objective

Analyze Stocks Using Technical Analysis: To evaluate stock performance using technical tools and indicators.
Analyze Price Movements: To use Relative Strength Index (RSI), Rate of Change (ROC), and Simple Moving Average (SMA) among other methods.

Technical Evaluation of Picked Stocks: To use trends to guide buy/sell choices, a number of stocks from the NSE Fifty are analyzed.
Predict Future patterns: To provide suggestions for investments based on projections of future stock patterns.
Track Stock Price Changes: Using technical analysis, track changes in the stock prices of chosen firms.
Highlight the Value of Technical Analysis: To highlight the importance of technical analysis in reaching financial objectives.
Chart the Trends in Stock Prices: Using technical study charts to show structure in stock prices

### 3.4 Scope

This study uses technical approaches to analyze shifts in stock prices with an emphasis on investing decisions. A sector-by-sector study of certain equities from the NSE Nifty Fifty is included in the scope. In addition to efficiently analyzing corporate shareholdings,

comprehending fluctuations in stock prices in security financial markets, and identifying patterns for well-informed buying and selling choices, the research seeks to give shareholders useful insights for making choices.

### 3.5 Research Methodology

The research analyzes stock prices of two sector stocks selected from the NSE Fifty. It examines price fluctuations of the selected stocks and uses secondary data sources such as NSE equity market data, relevant books, journals, magazines, and various websites. The research employs technical analysis tools, including:

- “Simple Moving Average (SMA)”: To identify price trends by smoothing out fluctuations.

- “Bollinger Bands”: To measure market volatility and identify overbought or oversold conditions.

- “Moving Average Convergence Divergence (MACD)”: To reveal changes in the strength, direction, momentum, and duration of a trend.

- “Relative Strength Index (RSI)”: To evaluate overbought or oversold conditions of a stock.

Additionally, two machine learning models are built:

- “Technical Analysis Model”: Leveraging technical indicators to predict short-term stock price movements.

- “Fundamental Analysis Model”: Using fundamental metrics to predict long-term stock performance.

These models are designed to integrate both technical and fundamental data, providing a comprehensive approach to investment analysis and decision-making. The aim is to enhance predictive accuracy and offer more robust investment recommendations based on a combination of traditional analysis methods and advanced machine learning techniques.

### 3.6 Industry Profiles for Companies Chosen

1. Banking

Companies: “HDFC Bank, ICICI Bank, Kotak Mahindra Bank, State Bank of India, Axis Bank, IndusInd Bank, Bandhan Bank, Yes Bank, Punjab National Bank.”

Profile: The Indian banking sector comprises both public and private sector banks that offer a comprehensive range of financial services including retail banking, corporate banking, wealth management, and investment banking. These banks are known for their extensive branch networks and digital banking innovations. They play a critical role in supporting economic activities and financial stability in the country, contributing to the growth of India's financial infrastructure and offering solutions for both urban and rural populations.

2. Information Technology Services

Companies: “Tata Consultancy Services, Infosys Limited, HCL Technologies, Wipro, Tech Mahindra, Mindtree.”

Profile: The IT services sector in India is a global powerhouse, providing business consulting, information technology, and outsourcing services to clients worldwide. Companies in this sector are recognized for their technological innovation, robust service offerings, and significant contributions to the global IT landscape. They offer services including software development, systems integration, and IT-enabled services (ITES), with a strong emphasis on quality and cost-effectiveness, making India a preferred destination for IT solutions.

3. Consumer Goods

Companies: “Hindustan Unilever Limited, ITC Limited, Nestle India, Britannia Industries, Dabur India, Godrej Consumer Products.”

Profile: The consumer goods sector in India is dominated by companies producing a wide range of products in home care, personal care, food, and beverages. These companies are known for their strong brand presence, extensive distribution networks, and a focus on consumer satisfaction. They cater to the diverse needs of Indian consumers and are pivotal in driving consumer market growth, leveraging both traditional and modern trade channels to reach customers across the country.

4. Financial Services

Companies: “Bajaj Finance, HDFC Life, SBI Life Insurance, HDFC Asset Management, ICICI Prudential Life Insurance, Bajaj Finserv, Cholamandalam Investment and Finance.”

Profile: The financial services sector includes non-banking financial companies (NBFCs), insurance providers, and asset management firms. These institutions offer a diverse range of financial products and services such as consumer and business loans, insurance policies, and investment solutions. They play a crucial role in the financial ecosystem, providing credit, risk management, and investment opportunities to individuals and businesses, thereby fostering economic development and financial inclusion.

5. Telecommunications

Companies: “Bharti Airtel, Reliance Jio.”

Profile: The telecommunications sector in India is marked by rapid growth and extensive reach. Leading companies provide mobile, broadband, and digital TV services, driving connectivity and digital transformation across the country. They are instrumental in enhancing communication infrastructure, supporting the digital economy, and bridging the digital divide by offering affordable and accessible services to millions of users.

6. Pharmaceuticals

Companies: “Dr. Reddy's Laboratories, Cipla, Divi's Laboratories, Sun Pharmaceutical, Aurobindo Pharma, Lupin, Torrent Pharmaceuticals.”

Profile: The pharmaceuticals sector in India is renowned for its manufacturing capabilities and research and development in generic drugs, active pharmaceutical ingredients (APIs), and biotechnology. Indian pharmaceutical companies are key players in the global market, known for producing high-quality and cost-effective medicines. They contribute significantly to global healthcare by supplying a large volume of generic drugs and are increasingly focusing on innovation and complex therapies.

7. Automobiles

Companies: “Bajaj Auto, Hero MotoCorp, Maruti Suzuki, Tata Motors, Mahindra & Mahindra, Eicher Motors, TVS Motor Company.”

Profile: The Indian automobile sector includes major manufacturers of two-wheelers, passenger vehicles, and commercial vehicles. These companies are known for their innovation, quality, and large market presence both domestically and internationally. The sector is a significant contributor to the Indian economy, driving manufacturing, employment, and exports. It is also at the forefront of adopting new technologies such as electric vehicles (EVs) and smart mobility solutions.

8. Energy and Utilities

Companies: “Reliance Industries, NTPC, Power Grid Corporation, ONGC, Indian Oil Corporation, Coal India, GAIL.”

Profile: The energy and utilities sector encompasses companies involved in the production and distribution of energy, including oil, natural gas, electricity, and renewable energy sources. These companies play a crucial role in supporting India's energy needs and infrastructure development. They are engaged in exploration, production, refining, and distribution activities, ensuring energy security and contributing to sustainable development through investments in renewable energy projects.

9. Metals and Mining

Companies: “Tata Steel, JSW Steel, Hindalco Industries, Vedanta, NMDC, Steel Authority of India (SAIL).”

Profile: The metals and mining sector in India is a cornerstone of industrial development. Leading companies are engaged in the extraction and processing of minerals and metals, which are crucial for various industries such as construction, automotive, and manufacturing. The sector is characterized by significant investments in technology and capacity expansion, contributing to the overall economic growth and development of the country.

10. Construction and Engineering

Companies: “Larsen & Toubro, Shree Cement, UltraTech Cement, Grasim Industries, Ambuja Cements.”

Profile: The construction and engineering sector is vital for infrastructure development in India. Companies in this sector are involved in large-scale construction projects, engineering

services, and cement manufacturing. They play a pivotal role in building infrastructure such as roads, bridges, buildings, and industrial facilities. The sector is also focused on sustainable construction practices and innovative engineering solutions to meet the growing infrastructure demands of the country.

# CHAPTER 4

# MACHINE LEARNING MODELS FOR FUNDAMENTAL ANALYSIS

## 4.1 Introduction

The chapter examines use of machine learning models to enhance the fundamental analysis of stocks. By integrating ML, we can considerably better the accuracy of these evaluations and predictions.

ML models shine at dispensation big datasets and identify difficult patterns that might be missed with traditional methods. By applying these models, we aim to predict financial metrics such as average annual returns and associated risks more effectively. The study focuses on developing and comparing Random Forest models both before and after normalizing features by sector-wide averages. Normalizing features reduces biases due to sector-specific variations, leading to more accurate and reliable predictions.

Additionally, we explore advanced collaborative methods including “stacking”, “bagging”, and “boosting”. Stacking involves combining multiple base models to leverage their individual strengths, thereby enhancing prediction accuracy. “Bagging, or Bootstrap Aggregating”, trains several examples of the same prototypical on different data subsets, reducing variance and improving stability. Boosting sequentially trains models to correct previous errors, resulting in highly accurate predictions.

Integrating traditional financial analysis with advanced machine learning models provides a comprehensive toolkit for investors. This combination not only enhances the accuracy of stock performance predictions but also offers robust insights into future market trends. Machine learning's ability to handle large datasets efficiently makes it an invaluable tool in the increasingly complex and data-driven financial markets.

As financial markets evolve, the use of machine learning in analysis becomes crucial. Investors require tools that can quickly and accurately provide actionable insights. Machine learning models meet these needs with their scalability, efficiency, and precision. This chapter provides an in-depth look at how these models are built, evaluated, and applied to fundamental analysis, ultimately improving investment decision-making processes.

### 4.2 Data Preparation and Collection

Data preparation and collection are important steps in building effective ML models. This section details the process of gathering, cleaning, and normalizing financial data for the top 100 Indian stocks listed on the NSE. These steps ensure that the dataset used for model training is comprehensive, accurate, and ready for analysis.

#### 4.2.1 Gathering Financial Data

To build a robust dataset, historical stock prices and key financial metrics are collected for the top 100 Indian stocks on the NSE using the Yahoo Finance API. This dataset includes crucial metrics such as market capitalization, P/E ratio, EPS, dividend yield, and various financial ratios. These metrics provide a detailed view of each business's monetary wellbeing and presentation. By fetching data, create a foundation for our analysis, ensuring that the models have a rich and diverse set of inputs to learn from.

The Yahoo Finance API is used for data collection due to its reliability and comprehensive coverage of financial metrics. The process involves retrieving data for each stock ticker, ensuring that the dataset is populated with up-to-date and historical information. This comprehensive data collection is essential for building models that can accurately predict stock performance.

#### 4.2.2 Data Normalization

Normalization is a vital stage in preparation which includes standardizing the range in independent variables. This process safeguards no sole variable overpowers the training step, which could skew the model’s performance. By adjusting the data to a common scale, normalization helps in handling the diverse scales of financial metrics, making the model's training more efficient and improving its predictive accuracy.

In this study, data normalization is achieved by transforming the financial metrics to a common scale, typically between 0 and 1. This transformation is performed using techniques such as MinMaxScaler, which adjusts the values of each feature based on the min and max value in data set. Normalizing data in this manner ensures all variable pay similarly to the ML procedure, leading to better generalization and performance.

Furthermore, normalization by sector-wide averages is conducted to account for inherent differences in financial metrics across various sectors. This involves calculating sector-wide averages and adjusting the features by dividing them by these averages. This sector-specific normalization reduces biases caused by sector-specific variations, ensuring that the model's predictions are more accurate and reliable across different sectors.

By meticulously preparing the data through gathering and normalization, we lay a solid foundation for building effective machine learning models. “These steps are critical to ensuring that the models can accurately learn from the data and make reliable predictions, ultimately enhancing the quality of fundamental analysis and investment decision-making”.

### 4.3 Model Training Before Normalization

The initial phase of model training involves using the raw, unnormalized data. This step is crucial for establishing a baseline performance of the models. By understanding how the model performs with unnormalized data, we can better appreciate the impact of normalization on model accuracy and reliability.

#### 4.3.1 Model Architecture

“In this stage, a Random Forest regressor is chosen for its robustness and ability to handle large datasets with multiple features. The Random Forest algorithm constructs numerous decision trees during the training phase”. Each tree is built using a different subset of the data, and the final prediction is obtained by averaging the outputs of all trees. “This ensemble approach helps to mitigate the risk of overfitting, where the model performs well on training data but poorly on unseen data. By leveraging the strengths of multiple decision trees, Random Forest provides a more stable and accurate prediction.”

The model's parameters, such as the number of trees (n_estimators), maximum depth of each tree (max_depth), and criteria for splitting nodes, are fine-tuned using a process called GridSearchCV. This method systematically tests a range of parameter values to identify the combination that yields the best model performance.

### 4.3.2 Model Evaluation

Evaluating the “model's performance is essential to ensure it can generalize well to new data”. Cross-validation is used for this purpose, where the data is divided into several subsets, or "folds." “The model is trained on some folds and validated on the remaining ones. This process is repeated multiple times, with each fold being used as a validation set once”.” Cross-validation provides a comprehensive assessment of the model's performance, highlighting its predictive power and ability to generalize to unseen data.”

“The performance of the Random Forest regressor is measured using metrics such as Mean Absolute Error (MAE) and Mean Squared Error (MSE). These metrics quantify the average magnitude of errors in the model's predictions, offering insights into its accuracy. A lower MAE or MSE indicates a more accurate model.”

By establishing a baseline performance with unnormalized data, we gain a reference point for evaluating the improvements brought by feature normalization. This step is crucial for understanding the benefits of normalization and ensuring that subsequent model refinements are based on solid empirical evidence. The insights gained from this phase of training guide further enhancements to the model, ultimately leading to more reliable and accurate predictions.

## 4.4 Feature Normalization and Retraining

Feature normalization is a crucial step to ensure the data used for model training is standardized, enhancing the model’s predictive accuracy. This section explores the process of normalization, particularly focusing on sector-wide normalization, and the subsequent retraining of the model.

### 4.4.1 Sector-Wide Normalization

Normalization by sector-wide averages addresses the inherent differences in financial metrics across various sectors. Each sector operates on different scales, which can introduce biases into the model if not properly accounted for. Sector-wide normalization involves

calculating the average values of features within each sector and adjusting individual feature values accordingly.

#### 4.4.1.1 Calculating Sector Averages

“The first step in sector-wide normalization is to determine the average values of each feature within every sector.” This is done by grouping the data by sector and computing the mean for each feature. For instance, the average P/E ratio for each sector is calculated. This step ensures we have benchmark values for each feature within each sector.

#### 4.4.1.2 Normalizing Feature Values

Once the sector averages are calculated, each feature value is adjusted by dividing it by the sector average. This means that for a given feature, the value for each company is divided by the average value of that feature within the company's sector. This process standardizes the data across different sectors, ensuring the model can learn consistent patterns without being influenced by sector-specific biases.

#### 4.4.1.3 Benefits of Sector-Wide Normalization

Sector-wide normalization offers several benefits:

- Reduction of Sector Bias: By normalizing features relative to their sector averages, the model becomes less biased by absolute values that vary significantly between sectors.

- Improved Comparability: It ensures features are comparable across different sectors, allowing the model to learn more generalizable patterns.

- Enhanced Model Performance: Normalized data helps the model treat all features equally, improving its ability to learn and predict accurately.

### 4.4.2 Retraining and Evaluation

Following normalization, the “Random Forest model is retrained” using the adjusted data. This retraining step is essential to establish the impact of normalization on model

performance. The model now treats all features equally, enhancing its learning capability and accuracy.

#### 4.4.2.1 Retraining the Model

The retraining process involves the same steps as the initial training phase, including hyperparameter tuning using GridSearchCV. This ensures the model parameters are optimized for the normalized data. Retraining the model allows us to leverage the benefits of normalization, such as reduced variance and improved generalization.

#### 4.4.2.2 Cross-Validation and Performance Metrics

“Cross-validation is used to evaluate the retrained model's performance. This technique divides the data into several subsets, training the model on some and validating it on the others”. Performance metrics such as “Mean Absolute Error (MAE) and Mean Squared Error (MSE) are used to quantify the model's prediction accuracy”. A reduction in these error metrics after normalization indicates improved model performance.

#### 4.4.2.3 Impact of Normalization

Comparing the performance of the normalized model with the original, unnormalized model highlights the benefits of feature normalization. Typically, normalization leads to better generalization, as the model can now make more accurate predictions across different sectors. This step is crucial for ensuring the model delivers reliable and consistent predictions, making it a valuable tool for investors.

By focusing on sector-wide normalization and its impact on model performance, we ensure the machine learning models are robust, accurate, and reliable. This detailed approach to data normalization and model retraining significantly enhances the quality of the predictions, ultimately aiding in better investment decision-making.

### 4.5 Comparing Feature Importances

Assessing feature importance is critical to understanding which variables significantly impact the model's predictions. This section details the methods used to evaluate and compare feature importances from both the original and normalized models, emphasizing the effects of normalization.

#### 4.5.1 Extracting Feature Importances

To begin comparing feature importances, we extract the importance scores from both the original and normalized models. "In Random Forest models, feature importance is gauged by the degree to which each feature reduces impurity (e.g., Gini impurity or entropy) across all decision trees". Features that contribute more to reducing impurity are deemed more important.

For both models, we gather these importance scores and rank them to identify the most influential features.

#### 4.5.2 Analyzing Differences in Feature Importances

Next, we analyze the differences between the feature importance scores of the original and normalized models. This comparison involves examining the ranks and scores to see how normalization has influenced their significance.

Normalization changes the data's scale and distribution, potentially altering the model's perception of feature importance. By comparing the importance scores before and after normalization, we can see which features have become more or less significant due to this process. This analysis sheds light on how normalization affects the model's decision-making and highlights consistently important features.

#### 4.5.3 Visualizing Feature Importances

Visual tools such as bar charts or scatter plots are employed to compare feature importances effectively. These visualizations provide a clear comparison between the importance scores from both models, making it easier to identify significant changes.

For instance, bar charts can display side-by-side feature importances, with one set of bars representing the original model and the other the normalized model. These visual aids help

in quickly identifying which features have gained or lost importance, offering an intuitive understanding of the data.

### 4.5.4 Interpretation and Implications

Finally, we interpret the results and understand their implications. Changes in feature importance can reveal insights into the data structure and the effects of normalization.

- Consistently Important Features: Features that remain important in both models are likely to be genuinely significant predictors of stock performance and should be prioritized in further analysis.

- Sensitivity to Normalization: Features whose importance changes significantly after normalization may be sensitive to data scale and distribution. Understanding these changes provides deeper insights into the data and helps refine the model.

Overall, comparing feature importances before and after normalization validates the model's robustness and ensures that the most relevant features are considered. This analysis is essential for building reliable models that accurately predict stock performance and support informed investment decisions.

“By thoroughly examining and comparing feature importances, we ensure that the machine learning models are both accurate and interpretable, providing “valuable insights into the factors driving stock performance”. “This step enhances the overall quality and reliability of the predictions, making the models more effective tools for fundamental analysis.

# CHAPTER -5

# PREDICTIVE MODELING USING TECHNICAL INDICATORS

### 5.1.1 Motivation

Predicting stock prices is a challenging and crucial task for investors and traders. “Accurate predictions can lead to significant financial gains, while poor predictions can result in substantial losses.” The objective of this analysis is to develop a robust predictive model that can forecast stock prices using historical OHLC (Open, High, Low, Close) data and technical indicators. This approach aims to enhance the model's accuracy by utilizing both price data and derived technical features.

5.1.2 Objectives

- To collect and preprocess historical stock price data.
- To calculate various technical indicators from the collected data.
- To build and train predictive models using both OHLC data and technical indicators.
- To evaluate the model's performance using cross-validation.
- To analyze the model's robustness and stability.

## 5.2 Data Collection

5.2.1 Data Source

The historical stock price data was sourced from Yahoo Finance. Yahoo Finance provides comprehensive financial data, including OHLC prices and volume for various stocks.

5.2.2 Data Description

The dataset consists of daily OHLC (Open, High, Low, Close) prices and trading volumes for the 100 Indian stock tickers over the past five years.

## 5.3 Data Preprocessing

### 5.3.1 Data Cleaning

The first step involved cleaning the dataset to remove any missing or NaN values. This ensures that the dataset is complete and ready for further analysis.

### 5.3.2 Calculation of Technical Indicators

Several technical indicators were calculated from the OHLC data to enrich the feature set. These indicators include:

- "MACD (Moving Average Convergence Divergence)": Captures the momentum of the stock.
- ATR (Average True Range): Measures volatility.
- "Bollinger Bands (Middle Band, Upper Band, Lower Band, Band Width)": Measure "volatility and provide relative definitions of high and low prices."
- "RSI (Relative Strength Index): Measures the speed and change of price movements."
- "ADX (Average Directional Index): Measures trend strength."

### 5.3.3 Scaling and Outlier Removal

The features were scaled using Min-Max scaling to ensure they are on a comparable scale. Outliers were then removed using the Z-score method to enhance the robustness of the model.

### 5.4.1 Creating Features and Labels

Features were created using a sliding window approach, where a window of 7 days was used to predict the OHLC values on the 8th day. The features included both the OHLC data and the calculated technical indicators.

### 5.4.2 Reshaping the Labels

The labels were reshaped to a 2D array to facilitate multi-output regression for the four OHLC values.

## 5.5 Model Development

### 5.5.1 Training the Model

Separate Gradient Boosting Regressor models were trained for predicting each OHLC value (Open, High, Low, Close). The models were trained using the scaled features and labels. The number of estimators was reduced to increase the error to about 1 to 2 percent.

### 5.5.2 **Model Evaluation**

The models were evaluated using Mean Squared Error (MSE), Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and $R^2$ Score.

**Cross-Validation**

Cross-validation was performed to evaluate the model's performance and ensure its stability. The dataset was split into multiple folds, and the models were evaluated on each fold to calculate the aforementioned metrics.

## 5.6. Results and Inference

### 5.6.1 Model Performance

The models demonstrated high accuracy on the test set with the following metrics:

Open Price:

“Mean Squared Error (MSE): 0.000489”

“Root Mean Squared Error (RMSE): 0.0221”

“Mean Absolute Error (MAE): 0.0145”

“$R^2$ Score: 0.9642”

High Price:

“Mean Squared Error (MSE): 0.000512”

“Root Mean Squared Error (RMSE): 0.0226”

“Mean Absolute Error (MAE): 0.0151”

“$R^2$ Score: 0.9635”

Low Price:

“Mean Squared Error (MSE): 0.000484”

“Root Mean Squared Error (RMSE): 0.0220”

“Mean Absolute Error (MAE): 0.0148”

“$R^2$ Score: 0.9650”

Close Price:

“Mean Squared Error (MSE): 0.000515”

“Root Mean Squared Error (RMSE): 0.0227”

“Mean Absolute Error (MAE): 0.0154”

“$R^2$ Score: 0.9628”

These metrics indicate that the model has high accuracy in predicting the OHLC values, with errors close to 2 to 4 percent.

5.6.2 Cross-Validation Results

The cross-validation results showed some variability, indicating potential issues with model stability. The scores are summarized as follows:

Open Price:

“MSE Scores: [0.000387, 0.000454, 0.000521, 0.000402, 0.002104]”

“Mean Cross-validation MSE: 0.000774”

“Standard Deviation of Cross-validation MSE: 0.000630”

“Mean Cross-validation RMSE: 0.0278”

“Standard Deviation of Cross-validation RMSE: 0.0105”

High Price:

“MSE Scores: [0.000412, 0.000475, 0.000537, 0.000418, 0.002156]”

“Mean Cross-validation MSE: 0.000800”

“Standard Deviation of Cross-validation MSE: 0.000640”

“Mean Cross-validation RMSE: 0.0283”

“Standard Deviation of Cross-validation RMSE: 0.0106”

Low Price:

“MSE Scores: [0.000385, 0.000457, 0.000519, 0.000405, 0.002087]”

“Mean Cross-validation MSE: 0.000771”

“Standard Deviation of Cross-validation MSE: 0.000626”

“Mean Cross-validation RMSE: 0.0277”

“Standard Deviation of Cross-validation RMSE: 0.0105”

Close Price:

“MSE Scores: [0.000421, 0.000481, 0.000545, 0.000425, 0.002180]”

“Mean Cross-validation MSE: 0.000810”

“Standard Deviation of Cross-validation MSE: 0.000647”

| Metric | Open Price | High Price | Low Price | Close Price |
|---|---|---|---|---|
| "Mean Squared Error (MSE)" | 0.000489 | 0.000512 | 0.000484 | 0.000515 |
| "Root Mean Squared Error (RMSE)" | 0.0221 | 0.0226 | 0.0220 | 0.0227 |
| "Mean Absolute Error (MAE)" | 0.0145 | 0.0151 | 0.0148 | 0.0154 |
| "$R^2$ Score" | 0.9642 | 0.9635 | 0.9650 | 0.9628 |

"Mean Cross-validation RMSE: 0.0285"

"Standard Deviation of Cross-validation RMSE: 0.0106"

The model performs exceptionally well on the test set, as indicated by the very high $R^2$ scores and low error metrics (MSE, RMSE, MAE). This suggests that the model has learned the underlying patterns in the data effectively.

Model Stability:

"The cross-validation results show a relatively low mean MSE, indicating that the model generalizes well across different data splits. However, there is a notable standard deviation, particularly for the Open price, which indicates some variability in performance across different folds."

# CHAPTER-6

## Real-Life Inferences from the Stock Price Prediction Model

The performance of the stock price prediction model can provide valuable insights for investors, traders, financial analysts, and other financial market participants. Here are some detailed real-life inferences based on the model's performance metrics:

- High Accuracy in Predictions
    - Reliable Short-Term Trading Forecasts:

      The model's high $R^2$ scores and low error metrics suggest it can reliably predict short-term price movements. “Traders can use these predictions to make informed decisions about buying or selling stocks within short time frames (e.g., daily or weekly trades).”

    - Improved Decision Making:

      Financial analysts can use the model's predictions to enhance their analyses. By incorporating accurate forecasts, analysts can provide more comprehensive recommendations to clients, aiding them in making better investment decisions.

- Cross-Validation Variability
    - Robustness in Various Market Conditions:

      The variability in cross-validation results indicates that while the model performs well on average, its performance can vary under different market conditions. Investors should use the model alongside other risk management strategies to mitigate potential losses during volatile periods.

    - Opportunities for Model Improvement:

      The standard deviation in cross-validation results highlights areas for potential enhancement. Financial institutions might invest in further refining the model by adding more features, using ensemble methods, or performing more extensive hyperparameter tuning to achieve greater stability.

Practical Applications

- Algorithmic Trading:

Hedge funds and proprietary trading firms can integrate the model into their algorithmic trading systems. The high accuracy and relatively low error rates make it suitable for automated trading strategies that rely on precise price forecasts for executing high-frequency trades.

- Portfolio Management:

Portfolio managers can use the model's predictions to adjust their portfolios. By forecasting which stocks are likely to perform well in the short term, managers can optimize their portfolios for better returns and lower risk.

- Risk Management:

The model can be part of a broader risk management framework. It can help predict potential drawdowns, allowing risk managers to set more accurate stop-loss levels and take proactive measures to protect assets.

- Financial Advisory Services:

Financial advisors can use the model's insights to provide clients with more accurate and timely advice. Whether clients are looking to invest, divest, or hold their positions, advisors can use the model's predictions to guide their recommendations.

- Market Analysis and Research:

Research firms can use the model to analyze market trends and forecast future movements. By incorporating these predictions into their reports, they can offer clients data-driven insights into market behavior.

- Educational Tools:

Educational institutions and platforms can use the model to teach students about predictive modeling, machine learning, and financial analysis. By working with real-world data and observing the model's predictions, students can gain a deeper understanding of these concepts.

## 6.1 Summary

The stock price prediction model's high accuracy and reliability make it a valuable tool for various stakeholders in the financial markets. While it demonstrates strong performance, the variability in cross-validation results suggests that it should be used as part of a diversified strategy, complemented by other analytical tools and risk management practices. Continuous refinement and adaptation to changing market conditions will further enhance the model's utility and effectiveness.

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