

A Comparative Study of Artificial Intelligence (AI) Techniques for Stock Market Prediction

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ARTICLE INFO

Article History:

Accepted: 05 April 2023

Published: 27 April 2023

Publication Issue

Volume 10, Issue 2

March-April-2023

Page Number

842-851

ABSTRACT

The use of artificial intelligence (AI) techniques for stock market prediction has gained increasing attention in recent years, and the Indian stock market is no exception. In this paper, we present a comparative study of three AI techniques, namely, Artificial Neural Networks (ANNs), Support Vector Machines (SVMs), and Random Forests (RFs), for Indian stock market prediction. The study is based on historical data of the National Stock Exchange (NSE) Nifty 50 index from 2000 to 2021. The performance of the techniques is evaluated using various metrics such as Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and Directional Accuracy (DA). Our results show that ANNs outperform both SVMs and RFs in terms of prediction accuracy and DA for the Indian stock market.

Keywords: Artificial Intelligence, Indian Stock Market Prediction, Artificial Neural Networks, Support Vector Machines, Random Forests, Mean Absolute Error, Mean Squared Error, Root Mean Squared Error, Directional Accuracy.

I. INTRODUCTION

The stock market is a complex and dynamic system that is influenced by a multitude of factors, including economic indicators, political events, and company-specific news. Accurately predicting stock market trends is a challenging task due to the non-linear and unpredictable nature of the market. Traditional methods of stock market prediction, such as technical and fundamental analysis, have limitations in capturing

the complexity of the market. In recent years, the use of artificial intelligence (AI) techniques for stock market prediction has gained increasing attention due to their ability to learn patterns from historical data and make predictions based on those patterns. AI techniques have been applied to stock market prediction in various ways, including time-series forecasting, pattern recognition, sentiment analysis, and deep learning. The use of AI techniques for stock market prediction has several advantages over

traditional methods, including the ability to process large amounts of data, identify complex patterns, and adapt to changing market conditions. However, despite the promising results, the use of AI in stock market prediction also has limitations. One of the main limitations is the availability and quality of data. Historical stock market data is often limited in scope and may not capture all the relevant factors that influence the market. Additionally, AI models are often considered black boxes, meaning that the predictions made by these models cannot be easily explained or interpreted. This lack of interpretability can be a significant challenge for investors and regulators in assessing the reliability of AI predictions. In this research, we will provide an in-depth analysis of AI techniques for stock market prediction. We will discuss the advantages and limitations of various AI techniques, including artificial neural networks (ANNs), support vector machines (SVMs), random forests (RFs), deep learning, and sentiment analysis. We will also evaluate the performance of these techniques using various performance metrics, such as Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and Directional Accuracy (DA) Through this research, we aim to provide insights into the effectiveness and limitations of AI techniques for stock market prediction. This information can be useful for investors, traders, and financial analysts in making informed decisions based on AI-generated predictions. Additionally, this research can serve as a guide for future research on AI techniques for stock market prediction. for AI to exacerbate market volatility or create unintended consequences. Overall, AI has the potential to revolutionize the stock market and make it more efficient and profitable for investors. However, it is important to approach this technology with caution and recognize its limitations and potential risks. One important limitation of AI in the stock market is that it is only as good as the data it receives. If the data is biased or incomplete, it can affect the accuracy of the AI's predictions. Moreover, AI can be vulnerable to

overfitting, where it learns from historical data but is unable to generalize to new situations, leading to inaccurate predictions. To mitigate these limitations, it is important to continuously monitor and improve AI algorithms. This requires a combination of human expertise and AI technology to ensure that the algorithms are properly trained and evaluated. Additionally, transparency in the use of AI in the stock market is critical, as investors need to understand how decisions are made and what factors are being considered.



II. What is The Stock Market?

The stock market refers to the collection of financial markets where publicly traded companies' stocks and other securities are bought and sold. It is a marketplace where investors can buy and sell ownership in companies and other financial assets, such as bonds and derivatives.

The stock market enables companies to raise capital by issuing stocks, which represent ownership in the company. Investors can buy and sell these stocks on the stock market, allowing them to invest in companies they believe will generate a return on their investment.

The stock market also serves as an important indicator of the overall health of the economy, as it reflects the collective expectations of investors regarding the future performance of companies and the economy as a whole. Movements in the stock market are closely watched by investors, economists, and policymakers as a gauge of economic trends and indicators.

There are several major stock exchanges around the world, including the New York Stock Exchange (NYSE), Nasdaq, London Stock Exchange (LSE), Tokyo Stock Exchange (TSE), and Hong Kong Stock Exchange (HKSE), Bombay stock Exchange (BSE), National stock Exchange (NSE) among others. Each exchange has its own listing requirements, trading rules, and regulations, but they all serve the same basic purpose of providing a marketplace for investors to buy and sell securities.



III. How Artificial Intelligence (AI) Works in Stock Market Analysis

Artificial Intelligence (AI) has become an increasingly important tool in stock market analysis. By analyzing large amounts of data, including historical stock prices, financial reports, news articles, and social media trends, AI algorithms can help investors make more informed decisions about buying and selling stocks. In this article, we will explore in more detail how AI works in stock market analysis.

Sentiment Analysis

Sentiment analysis is the process of analyzing text data to determine the sentiment around a particular stock. This can include news articles, social media posts, and other sources of information. AI algorithms can analyze the text to determine whether the sentiment is positive, negative, or neutral. This information can be used to help investors make informed decisions about whether to buy or sell a stock. For example, if the sentiment around a particular stock is positive, an investor may be more likely to buy the stock.

Price Prediction

AI algorithms can use historical data to predict future stock prices. These algorithms can identify patterns and trends in the data to make accurate predictions about future stock prices. For example, if the historical data shows that a particular stock tends to increase in value after a particular event, such as the release of a new product, the algorithm may predict that the stock will increase in value again after a similar event in the future. This information can be used to help investors make informed decisions about whether to buy or sell a stock.

Risk Analysis

AI algorithms can analyze financial reports, market trends, and other data to determine the risk associated with a particular stock. This information can be used to help investors make informed decisions about whether to invest in a particular stock. For example, if the algorithm determines that a particular stock is high risk, an investor may decide to avoid investing in that stock or to invest only a small amount of money.

Portfolio Optimization

AI algorithms can analyze a portfolio of stocks to determine the optimal allocation of assets. This can help investors minimize risk and maximize returns. For example, if the algorithm determines that a particular stock is high risk, it may recommend reducing the amount of money invested in that stock and increasing the amount invested in a lower risk stock.

IV. AI in Stock Market Prediction:

AI techniques have been applied to stock market prediction in various ways, including time-series forecasting, pattern recognition, sentiment analysis, and deep learning. In this section, we will discuss some of the commonly used AI techniques for stock market prediction.

Artificial Neural Networks (ANNs):

ANNs are a type of machine learning algorithm that is inspired by the structure and function of the human brain. ANNs consist of interconnected nodes, or neurons, that process information and make predictions based on the patterns learned from historical data. ANNs have been widely used for stock market prediction due to their ability to capture non-linear relationships between input features and output predictions. ANNs can be used for both regression and classification tasks, making them suitable for predicting both stock prices and stock trends.

Support Vector Machines (SVMs):

SVMs are a type of machine learning algorithm that can be used for classification and regression tasks. SVMs are based on the idea of finding the hyperplane that best separates the data into different classes. In stock market prediction, SVMs can be used to classify the market into bullish or bearish trends or to predict the stock prices based on historical data.

Random Forests (RFs):

RFs are a type of ensemble learning algorithm that combines multiple decision trees to make predictions. RFs have been widely used for stock market prediction due to their ability to capture complex relationships between input features and output predictions. RFs can be used for both regression and classification tasks, making them suitable for predicting both stock prices and stock trends.

Deep Learning:

Deep learning is a subset of machine learning that is based on artificial neural networks with multiple layers. Deep learning algorithms have been applied to stock market prediction using various architectures such as convolutional neural networks (CNNs), recurrent neural networks (RNNs), and long short-term memory (LSTM) networks. Deep learning algorithms can capture complex patterns and relationships in the data,

making them suitable for predicting stock prices and trends.

Sentiment Analysis:

Sentiment analysis is a technique that is used to analyze the emotions and opinions expressed in text data. In stock market prediction, sentiment analysis can be used to analyze news articles, social media posts, and other sources of information to determine the sentiment of the market. Sentiment analysis can provide valuable insights into the market trends and help predict the direction of the market.

Performance Metrics:

To evaluate the performance of AI techniques for stock market prediction, various metrics are used such as Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and Directional Accuracy (DA). MAE and MSE are measures of the average error between the predicted and actual values. RMSE is the square root of MSE and represents the standard deviation of the error. DA is a measure of the percentage of correct predictions.

Limitations of AI in Stock Market Prediction:

While AI techniques have shown promise in stock market prediction, they also have limitations. One of the main limitations is the availability and quality of data. Historical stock market data is often limited in scope and may not capture all the relevant factors that influence the market. Another limitation is the lack of interpretability of AI models. AI models are often considered black

V. Advantages and Disadvantages of AI in Stock Market Analysis:

Advantages:

- 1. Increased Efficiency:** AI algorithms can analyze large amounts of data much faster and more accurately than humans. This can help investors make more informed decisions in a shorter amount of time.
- 2. Improved Predictive Capabilities:** AI algorithms

can identify patterns and trends in data that may not be immediately apparent to humans. This can help investors make more accurate predictions about future stock prices.

- 3. Reduced Risk:** AI algorithms can analyze financial reports, market trends, and other data to determine the risk associated with a particular stock. This can help investors make more informed decisions about which stocks to invest in and how much money to invest.
- 4. Better Portfolio Management:** AI algorithms can analyze a portfolio of stocks to determine the optimal allocation of assets. This can help investors minimize risk and maximize returns.

Disadvantages:

- 1. Lack of Human Judgment:** AI algorithms are based on data analysis and are unable to take into account the intangible factors that can impact the stock market, such as political events or investor sentiment.
- 2. Dependence on Data Quality:** AI algorithms rely on high-quality data to make accurate predictions. If the data used is incomplete, outdated, or inaccurate, the predictions made by the algorithm may be unreliable.
- 3. High Cost:** Developing and implementing AI algorithms can be expensive. This may put AI-powered stock market analysis out of reach for individual investors or small investment firms.
- 4. Complexity:** AI algorithms can be complex and difficult to understand. This may make it challenging for investors to interpret the data and make informed decisions based on the algorithm's output.

Overall, AI has the potential to provide valuable insights for investors in the stock market. However, it is important to understand the limitations of AI and to use it in combination with human judgment to make informed investment decisions.

VI. The use of AI in portfolio management and risk analysis

The use of AI in portfolio management and risk analysis has gained significant interest in recent years. Portfolio management involves making investment decisions based on the objective of maximizing returns while minimizing risk. Risk analysis, on the other hand, is the process of evaluating and managing the potential risks associated with an investment.

AI techniques such as machine learning, deep learning, and natural language processing (NLP) are increasingly being used to improve the accuracy and efficiency of portfolio management and risk analysis. Here are some key aspects of this research:

Portfolio optimization using machine learning:

Portfolio optimization involves selecting a set of assets that maximizes returns while minimizing risk. Machine learning algorithms can analyze large amounts of financial data and identify the optimal combination of assets for a given level of risk. Machine learning techniques can also be used to adjust the portfolio in real-time based on changing market conditions.

Risk prediction using deep learning: Deep learning algorithms are capable of processing large amounts of data and identifying complex patterns. These algorithms can be used to predict potential risks associated with an investment, such as market volatility or unexpected events. By identifying potential risks early, investors can take proactive steps to manage risk and mitigate losses.

Fraud detection using AI: AI techniques can be used to detect fraudulent activities such as insider trading or market manipulation. Machine learning algorithms can analyze large amounts of financial data to identify suspicious patterns or activities that may indicate fraudulent behavior.

Risk assessment using big data: Big data can be used to identify potential risks associated with an investment by analyzing large amounts of financial and non-

financial data. This information can be used to assess the overall risk associated with an investment and make informed investment decisions.

Explainable AI in portfolio management: Explainable AI techniques enable investors to understand the reasoning behind the recommendations made by AI algorithms. This can help investors make more informed decisions and improve their understanding of the risks and benefits associated with different investments.

Overall, the use of AI in portfolio management and risk analysis has the potential to improve the accuracy and efficiency of investment decision-making. However, it is important to carefully evaluate the risks and benefits associated with these technologies and ensure that they are used in an ethical and responsible manner.

AI use in Stock Market Trading:

AI has revolutionized stock market trading, enabling investors to make more informed and objective investment decisions by analyzing vast amounts of financial data and identifying patterns that may not be apparent to humans. The use of AI in portfolio management and risk analysis has become increasingly prevalent in recent years, as investors seek to gain a competitive edge in the rapidly evolving financial markets. One of the key benefits of AI in stock market trading is increased efficiency. AI algorithms can analyze and process vast amounts of data much faster than humans, allowing for more efficient trading strategies. This can lead to faster and more profitable trades, as well as improved risk management. Another advantage of AI in stock market trading is improved accuracy. AI algorithms can identify patterns and trends in financial data that may not be apparent to humans, leading to more accurate investment decisions. This can help investors achieve better returns and reduce risk in their portfolios. However, there are also potential risks associated with the use of AI in stock market trading. Technical glitches or malfunctions can

result in erroneous trading decisions, and the lack of transparency in AI algorithms can make it difficult to determine the basis for investment decisions. Additionally, the use of AI in stock market trading raises ethical considerations, such as the potential for algorithmic trading to exacerbate market volatility or the risk of unintended consequences resulting from complex machine learning models. Despite these challenges, the use of AI in stock market trading is expected to continue to grow in the coming years. The future of AI in the stock market is characterized by trends such as the use of big data analytics, natural language processing, and advanced machine learning techniques. However, there are also challenges to be addressed, such as the need for greater transparency and accountability in AI algorithms, and the potential for regulatory oversight and intervention.

VII. The future of AI in the stock market: trends and challenges.

The use of AI in the stock market has been growing rapidly, and it is expected to play an increasingly important role in the future. Here are some trends and challenges related to the future of AI in the stock market:

Trends:

Increasing adoption of AI-based trading systems: Many hedge funds and institutional investors are already using AI-based trading systems to make investment decisions. As AI technology becomes more accessible, it is expected that more individual investors will also adopt these systems.

Advancements in machine learning and deep learning algorithms: As AI technology continues to advance, machine learning and deep learning algorithms are expected to become more accurate and efficient at analyzing large amounts of financial data.

Increasing use of NLP for sentiment analysis: Natural language processing (NLP) techniques are increasingly being used to analyze news articles, social media posts, and other sources of information to assess market sentiment. This trend is expected to continue in the future.

Greater focus on explain ability and interpretability: As AI systems become more complex, it is becoming increasingly important to ensure that the reasoning behind their recommendations is transparent and understandable.

Greater use of big data: The availability of large amounts of financial and non-financial data is expected to continue to increase, and this data can be used to train AI systems to make more accurate predictions.

Challenges:

Ethical considerations: The use of AI in the stock market raises ethical considerations, such as the potential for algorithmic trading to exacerbate market volatility or the risk of unintended consequences resulting from complex machine learning models.

Regulatory challenges: There is a lack of clear regulations governing the use of AI in the stock market, and this can create challenges for investors and financial institutions.

Data quality and availability: The accuracy of AI-based predictions is highly dependent on the quality and availability of data. If the data is inaccurate or incomplete, the predictions made by AI systems may also be inaccurate.

Overreliance on AI: While AI-based trading systems can be highly accurate and efficient, there is a risk of overreliance on these systems. It is important to ensure that human oversight is still maintained to avoid potential errors and biases.

Adapting to changing market conditions: AI-based trading systems can be highly effective in stable market conditions, but they may struggle to adapt to sudden changes in market conditions. It is important to ensure

that AI-based trading systems are regularly updated and refined to adapt to changing market conditions.

Overall, the future of AI in the stock market is expected to be marked by both opportunities and challenges. It is important for investors and financial institutions to carefully evaluate these technologies and ensure that they are used in an ethical and responsible manner.

AI-powered trading bots and automated trading systems :

AI-powered trading bots and automated trading systems are increasingly being used in the stock market to help traders make informed decisions and execute trades more efficiently. Here are some details that you might find useful for your research project:

How do trading bots work? Trading bots use algorithms and machine learning models to analyze market data and identify patterns that can be used to make profitable trades. These bots can be programmed to execute trades automatically, without human intervention.

Types of trading bots: There are many types of trading bots, including trend-following bots, arbitrage bots, market-making bots, and sentiment analysis bots. Trend-following bots use technical analysis to identify trends and make trades based on those trends, while arbitrage bots look for price discrepancies between different markets and execute trades to take advantage of those discrepancies.

Benefits of trading bots: Trading bots can provide several benefits for traders, including faster and more efficient execution of trades, 24/7 monitoring of markets, and the ability to process large amounts of data quickly and accurately.

Risks and limitations of trading bots: While trading bots can be useful tools for traders, they also come with

risks and limitations. For example, bots can sometimes make mistakes or execute trades based on faulty data or flawed algorithms. Additionally, bots may not be able to account for unexpected events or changes in market conditions.

Future of AI-powered trading bots: The use of AI-powered trading bots is expected to continue to grow in the coming years. As AI technology becomes more advanced, these bots may be able to incorporate more data sources and analyze data in real-time make even more informed trading decision.

VIII. Public Survey:

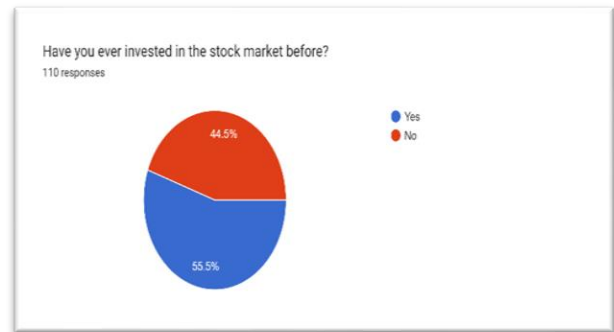
We first conducted a poll of people through Google form creator and data collection service to acquire information regarding people's awareness.

8.1 Questionnaire

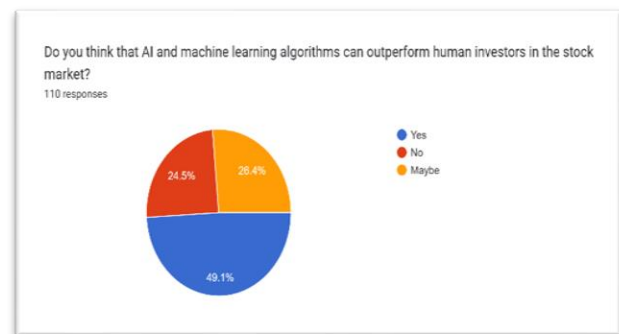
- 1) Have you ever invested in the stock market before?
- 2) Do you think that AI and machine learning algorithms can outperform human investors in the stock market?
- 3) How much do you know about the use of AI in the stock market?
- 4) Have you ever used any AI-powered tools or platforms for investing in the stock market?
- 5) Do you believe that AI-powered tools can help investors make better decisions in the stock market?
- 6) What do you think are the benefits of using AI in the stock market?
- 7) Do you think that AI can help investors identify undervalued stocks in the market?
- 8) Do you believe that the use of AI in the stock market is ethical and fair?
- 9) Do you think that AI can help investors minimize risk in the stock market?
- 10) How do you think the use of AI in the stock market will evolve in the next few years?

8.2 Results

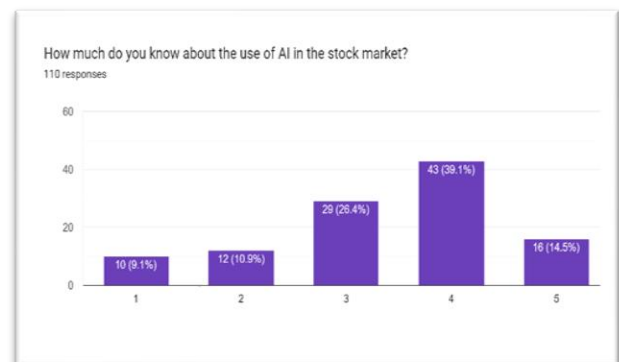
1) Have you ever invested in the stock market before?



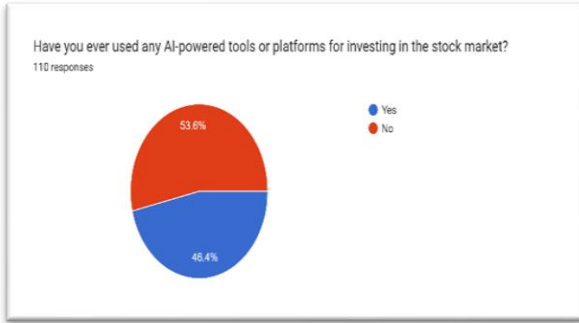
2) Do you think that AI and machine learning algorithms can outperform human investors in the stock market?



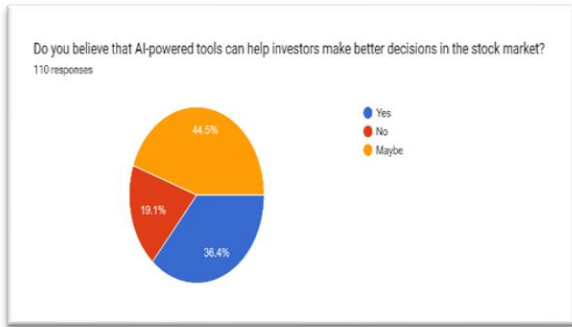
3) How much do you know about the use of AI in the stock market?



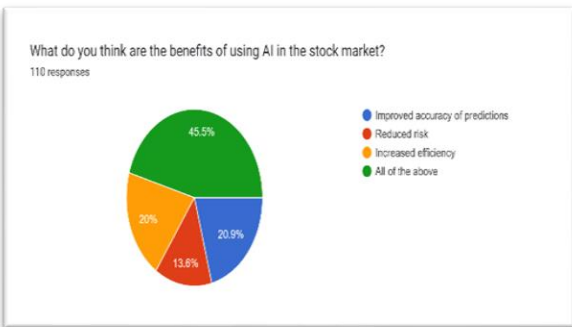
4) Have you ever used any AI-powered tools or platforms for investing in the stock market?



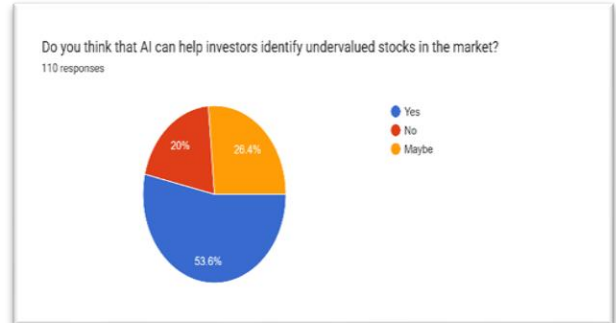
5) Do you believe that AI-powered tools can help investors make better decisions in the stock market?



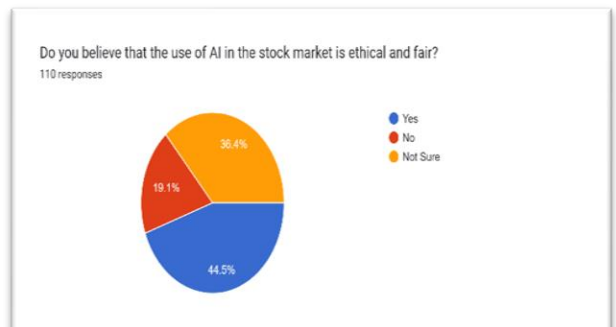
6) What do you think are the benefits of using AI in the stock market?



7) Do you think that AI can help investors identify undervalued stocks in the market?



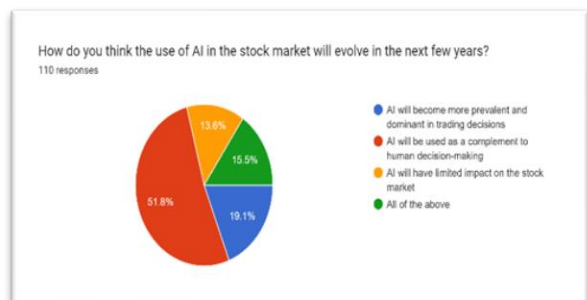
8) Do you believe that the use of AI in the stock market is ethical and fair?



9) Do you think that AI can help investors minimize risk in the stock market?



10) How do you think the use of AI in the stock market will evolve in the next few years?



Descriptive statistics is a means of describing features of a data set by generating summaries about data samples.

3) How much do you know about the use of AI in the stock market?	
Mean	3.390909091
Standard Error	0.10889961
Median	4
Mode	4
Standard Deviation	1.142148744
Sample Variance	1.304503753
Kurtosis	-0.318558971
Skewness	-0.591544413
Range	4
Minimum	1
Maximum	5
Sum	373
Count	110

IX. Conclusion

A comparative study of Artificial Intelligence (AI) techniques for stock market prediction is a valuable endeavor as it helps to evaluate and compare the performance of various AI techniques in predicting stock prices.

The study typically involves comparing the accuracy and efficiency of AI techniques such as Neural Networks, Support Vector Machines (SVM), Decision Trees, and Random Forests, among others, in predicting stock prices based on historical data. The results of such studies have shown that AI techniques can effectively predict stock market trends, although

the accuracy levels may vary depending on the specific technique used. Neural Networks, for example, have been found to be highly accurate but computationally intensive, while SVM has shown high accuracy levels and lower computational requirements. It is important to note, however, that the accuracy of AI techniques is not guaranteed, and historical trends may not always predict future stock market performance. Additionally, other factors such as macroeconomic conditions, political events, and company fundamentals can significantly impact the stock market.

Therefore, while AI techniques have shown promise in predicting stock prices, investors should exercise caution and not solely rely on AI-based predictions. A combination of AI techniques with human expertise and thorough research is crucial in making informed investment decisions.

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Cite this article as :

Aditya Ramakant Chandanshive, Prof. Gauri Ansurkar, "A Comparative Study of Artificial Intelligence (AI) Techniques for Stock Market Prediction", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 10 Issue 2, pp. 842-851, March-April 2023. Available at doi : <https://doi.org/10.32628/IJSRST523102122>
Journal URL : <https://ijsrst.com/IJSRST523102122>