

Project Report For CS661: BIG DATA VISUAL ANALYTICS
2022-2023 Semester II

Project Title:

StockScope: A Comprehensive Analysis Tool for Investment Portfolios

Team members:

Ashutosh Patel, Kajal Sethi, Pranshu Sahijwani, Prashant Mishra

Member emails:

ashutoshp21@iitk.ac.in, kajals21@iitk.ac.in, pranshus21@iitk.ac.in,
prashantm21@iitk.ac.in

IIT Kanpur

1 Introduction[1]

The stock market is a place where publicly traded companies sell shares of their ownership to investors. It is an essential component of the global economy, providing individuals and businesses with opportunities to invest in the future of companies and the economy.

To get started in the stock market, it is important to have a basic understanding of how it works, including the different types of stocks, how they are traded, and the factors that affect their prices. It is also crucial to have access to reliable data and powerful tools for analyzing market trends and making informed investment decisions.

When investing in the stock market, it is important to remember that it involves risks, and it is crucial to have a well-diversified portfolio and a long-term investment strategy. By staying informed and utilizing the right tools and resources, anyone can participate in the stock market and potentially benefit from its potential for growth and financial gains.

Are you interested in making informed investment decisions in the stock market? Then this project is for you! Our focus is on the importance of stock data analysis and how it can help you understand the risks and maximize your returns.

We will explore the different types of data used in stock data analysis, including historical and real-time market data, and the techniques and tools used, such as data visualization and machine learning algorithms. By the end of the project, you will have a clear understanding of how stock data analysis can help you make informed investment decisions and mitigate risks in the stock market.

Whether you are a novice or an experienced investor, our project will provide you with valuable insights and knowledge on stock data analysis, helping you navigate the complexities of the stock market with confidence. So join us on this exciting journey toward maximizing your returns in the stock market!

2 Motivation[2]

The motivation for this project is to empower investors with the knowledge and tools they need to make informed investment decisions in the stock market. With the vast amount of information and data available, it can be challenging to sift through and make sense of it all. This project aims to simplify the process by highlighting the importance of stock data analysis and the various techniques and tools used in this process.

By providing investors with a clear understanding of stock data analysis, they can make more informed decisions that help mitigate risks and maximize their returns in the

stock market. Additionally, with the rise of new technologies such as machine learning algorithms and data visualization tools, investors can gain a competitive advantage by leveraging these tools in their investment strategies.

Overall, this project is motivated by the belief that anyone can participate in the stock market and potentially benefit from its growth, but it requires the right knowledge, tools, and techniques to do so effectively.

3 Overview[3]

The project focuses on the importance of stock data analysis in helping investors make informed decisions in the stock market. We will explore the different types of data used in stock data analysis, such as historical and real-time market data, and the techniques and tools used, including data visualization and machine learning algorithms.

The project will cover the following topics:

1. Introduction to stock data analysis
2. Types of stock data, including historical and real-time market data
3. Techniques and tools used in stock data analysis, including data visualization and machine learning algorithms
4. How to use stock data analysis to make informed investment decisions and mitigate risks in the stock market
5. Real-world examples of how stock data analysis can be used in investment strategies
6. Best practices for incorporating stock data analysis into your investment strategy.

By the end of the project, participants will have a clear understanding of how stock data analysis can be used to make informed investment decisions and maximize returns in the stock market. Participants will also gain valuable knowledge on the latest techniques and tools used in stock data analysis, empowering them to make data-driven investment decisions.

4 Dataset[4]

The dataset used for visualization was obtained from 'Yahoo Finance'. It included attributes such as 'Date', 'Open', 'High', 'Low', 'Close', 'Volume', 'Ticker', and 'Adj Close'. The dataset comprised historical stock market data for various companies, and it was pre-processed to remove missing or invalid values.

```
PS D:\BigData\FinalProject\Stock-Data-Analysis-Using-Plotly-and-Dash> python .\dataset.py
[*****100%*****] 1 of 1 completed
```

Date	Open	High	Low	Close	Adj Close	Volume
2022-01-03	144.475494	145.550003	143.502502	145.074493	145.074493	25214000
2022-01-04	145.550507	146.610001	143.816147	144.416504	144.416504	22928000
2022-01-05	144.181000	144.298004	137.523499	137.653503	137.653503	49642000
2022-01-06	137.497498	139.686005	136.763504	137.550995	137.550995	29050000
2022-01-07	137.904999	138.254745	135.789001	137.004501	137.004501	19408000
...
2023-03-30	101.440002	101.610001	100.290001	101.320000	101.320000	25009800
2023-03-31	101.709999	104.190002	101.440002	104.000000	104.000000	28086500
2023-04-03	102.669998	104.949997	102.379997	104.910004	104.910004	20719900
2023-04-04	104.839996	106.099998	104.599998	105.120003	105.120003	20377200
2023-04-05	106.120003	106.540001	104.101997	104.949997	104.949997	21864200

Figure 1: Dataset Instance

1. Date: The date on which the stock market data was recorded.
2. Open: The price of the stock when the market opened on the recorded date.
3. High: The highest price of the stock during the recorded date.
4. Low: The lowest price of the stock during the recorded date.
5. Close: The price of the stock when the market closed on the recorded date.
6. Volume: The number of shares traded on the recorded date.
7. Ticker: The unique symbol representing the stock of a particular company.
8. Adj Close: The adjusted closing price of the stock, which takes into account any corporate actions, such as stock splits or dividends, that occurred after the market closed.

These attributes provide essential information for analyzing the performance of a company's stock in the market. The dataset can be used to track market trends, perform technical analysis, and build predictive models for stock price movements.

5 Libraries used

To visualize the stock market data, we used the Dash and Plotly libraries. Dash is a Python framework for building web applications, while Plotly is an open-source graphing library. With Dash and Plotly, we created interactive and dynamic charts to track market trends and analyze performance over time.

For machine learning tasks, we used the Sklearn library. Sklearn is a powerful library for data analysis and modeling, providing a range of machine learning algorithms such as regression, clustering, and classification. We utilized Sklearn to perform stock price predictions based on historical data and technical indicators.

We also used the Yfinance library to retrieve real-time market data and incorporate it into our visualization and machine learning tasks. This allowed us to stay updated and take prompt action in response to changing market conditions.

For deep learning tasks, we used the Keras library. Keras is a high-level neural network API, which enabled us to build and train complex deep learning models for stock price predictions.

6 Technical implementations of different visualizations and analysis[5, 6]

6.1 Stocks'/Attributes Comparison Playground

A stocks'/attributes comparison playground is a tool that allows investors to compare and contrast the attributes of different stocks to help make informed investment decisions. This type of tool typically provides a wide range of metrics and data points for each stock, including financial ratios, valuation metrics, dividend yields, and other performance indicators.

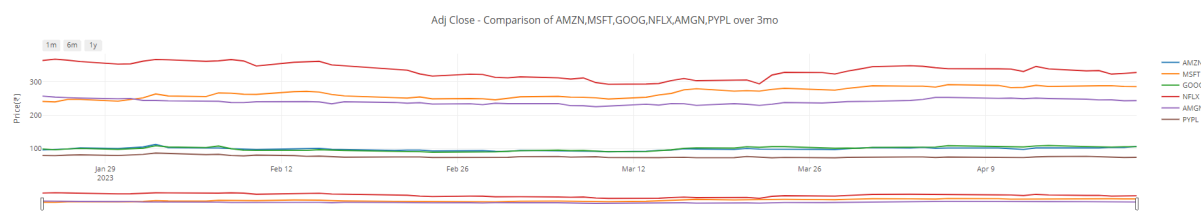


Figure 2: Stocks'/Attributes Playground

Investors can use a comparison playground to compare the performance of multiple stocks within the same industry or sector, and to identify potential investment opportunities based on key attributes such as growth potential, dividend payout, and risk profile. This type of analysis can be particularly useful for investors seeking to diversify their portfolio, as it allows them to identify stocks that complement each other in terms of risk and return.

6.2 Technical Analysis using Candlesticks Chart/Moving Averages

Candlestick Charts: A candlestick chart is a visual representation of a stock's price movements over a specified time period, typically a day, week, month, or even an intraday timeframe. It consists of individual "candles" that represent the opening, closing, high, and low prices of a stock for a given period. The body of the candle is colored to indicate whether the stock price increased (bullish) or decreased (bearish) during that time period.

Candlestick patterns: Candlestick charts are used to identify patterns or formations that may indicate potential price movements. Some commonly used candlestick patterns include:



Figure 3: Candlesticks View

1. **Bullish Engulfing:** This pattern occurs when a small bearish candle is followed by a larger bullish candle that completely "engulfs" the previous candle. It may indicate a potential reversal from a downtrend to an uptrend.
2. **Bearish Engulfing:** This pattern is the opposite of a bullish engulfing pattern, where a small bullish candle is followed by a larger bearish candle. It may suggest a potential reversal from an uptrend to a downtrend.
3. **Doji:** This pattern occurs when the opening and closing prices are very close, resulting in a small or no body with long upper and/or lower wicks. It may indicate indecision in the market and potential trend reversal.
4. **Hammer:** This pattern is a bullish reversal pattern that occurs after a downtrend. It has a small body and a long lower wick, suggesting that buyers may be stepping in and potentially indicating an upcoming uptrend.
5. **Shooting Star:** This pattern is the opposite of a hammer and is a bearish reversal pattern that occurs after an uptrend. It has a small body and a long upper wick, suggesting that sellers may be taking control and potentially indicating an upcoming downtrend.

Moving Averages: Moving averages are used to smooth out the fluctuations in a stock's price and identify trends over a specific time period. There are several types of moving averages, including simple moving averages (SMA), exponential moving averages (EMA), and weighted moving averages (WMA). **Simple Moving Average (SMA):** This is the most basic type of moving average and is calculated by taking the average of a stock's prices over a specific time period. For example, a 50-day SMA would calculate the average of the last 50 days' closing prices. It is commonly used to identify long-term trends and potential support or resistance levels.



Figure 4: Moving Averages Instance

1. **Exponential Moving Average (EMA):** This type of moving average gives more weight to recent prices, making it more sensitive to recent price changes compared to the SMA. It is calculated using a formula that assigns more weight to the most recent data points. EMAs are often used for shorter timeframes to identify more recent trends and potential entry or exit points.
2. **Weighted Moving Average (WMA):** This type of moving average assigns different weights to different data points based on predefined criteria. It is less commonly used compared to SMA and EMA, but it can be useful in specific situations where certain data points are considered more important.

Investors use moving averages to identify potential trend reversals, generate buy or sell signals, and determine support and resistance levels. For example, when the stock price crosses above its moving average, it may be considered a buy signal, indicating a potential uptrend. Conversely, when the stock price crosses below its moving average, it may be considered a sell signal, indicating a potential downtrend.

In conclusion, candlestick charts and moving averages are popular techniques used in technical analysis to evaluate past performance and predict future price movements of stocks. They provide valuable insights into market trends, potential reversals, and entry or exit

6.3 Average Sensex Hike/ Dip

The Sensex, also known as the SP BSE Sensex, is the benchmark index of the Bombay Stock Exchange (BSE) in India, which represents the performance of the top 30 companies listed on the BSE based on their market capitalization. The average Sensex hike or dip is a measure of the overall movement of the index over a specific period, typically calculated by taking the average percentage change in the index during that time period.

A hike in the Sensex refers to an increase in the overall value of the index over the specified period. This means that, on average, the stock prices of the 30 companies in the Sensex have risen, leading to a higher value of the index compared to its previous level. A hike in the Sensex is generally considered a positive sign as it indicates that the stock market as a whole has performed well during that period, with investors seeing gains in their investments.



Figure 5: Average Sensex Hike

On the other hand, a dip in the Sensex refers to a decrease in the overall value of the index over the specified period. This means that, on average, the stock prices of the companies in the Sensex have declined, leading to a lower value of the index compared to its previous level. A dip in the Sensex is generally considered a negative sign as it indicates that the stock market as a whole has performed poorly during that period, with investors experiencing losses in their investments.

The average Sensex hike or dip is a useful metric for investors to gauge the overall performance of the Indian stock market. It provides a general sense of the direction in which the market is moving and can help investors in making decisions related to their investment strategies. For example, if the Sensex has experienced a significant hike over a specific period, it may indicate a bullish trend in the market, and investors may consider increasing their investments. Conversely, if the Sensex has experienced a significant dip, it may indicate a bearish trend in the market, and investors may consider reducing their investments or adopting a cautious approach.

However, it's important to note that the average Sensex hike or dip may not accurately reflect the performance of individual stocks or sectors within the market. Different stocks

or sectors may have performed differently during the specified period, and the average Sensex hike or dip may not capture these variations. Therefore, it's crucial for investors to conduct thorough research and analysis of individual stocks or sectors before making any investment decisions.

Additionally, it's important for investors to carefully consider their risk tolerance and investment goals when interpreting the average Sensex hike or dip. Stock markets are subject to fluctuations and can be volatile, and past performance may not necessarily indicate future performance. It's essential to have a diversified investment portfolio and to consult with a qualified financial professional for personalized investment advice.

6.4 Trend Analysis[Day by Day Percentage Change]

Tracking Daily Percentage Changes: Trend analysis based on day-by-day percentage change involves closely monitoring the daily changes in a stock's price over a specific period of time, such as weeks, months, or even years. These changes are expressed as percentages to account for differences in stock prices across different companies.

Observing Momentum and Patterns: By tracking daily percentage changes, investors can observe the momentum of a stock's price movement. For example, if a stock consistently shows positive percentage changes over several days or weeks, it may indicate an upward trend or bullish pattern, suggesting that the stock is gaining value. Conversely, if a stock consistently shows negative percentage changes over a period of time, it may indicate a downward trend or bearish pattern, suggesting that the stock is losing value. Identifying these patterns can help investors make informed decisions about buying or selling stocks.

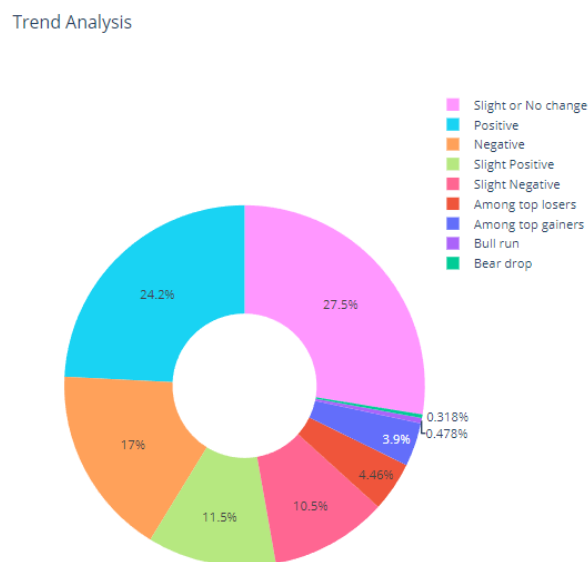


Figure 6: Trend Analysis Overview

Identifying Short-term Trends: Day-by-day percentage change analysis is typically used to identify short-term trends in stock prices. These trends may last for a few days, weeks, or months, and can provide opportunities for short-term traders to capitalize on price movements. For example, a trader may use trend analysis to identify stocks that are consistently showing positive percentage changes and may decide to buy them with

the expectation that the trend will continue, allowing them to sell the stocks at a higher price and make a profit.

Short-term Trading Strategies: Trend analysis based on day-by-day percentage change is often used in short-term trading strategies, such as day trading or swing trading. Day traders typically buy and sell stocks within a single trading day, while swing traders hold stocks for a few days or weeks. These traders rely on trend analysis to quickly identify and capitalize on short-term price movements. However, it's important to note that short-term trading strategies can be risky and require careful risk management, as stock prices can be volatile and unpredictable in the short term.

Consideration of Risk Tolerance and Investment Goals: As with any trading strategy, it's crucial to consider your risk tolerance and investment goals when using trend analysis based on day-by-day percentage change. Short-term trading strategies can be high-risk, as they rely on quick price movements and may involve frequent buying and selling of stocks. It's important to thoroughly research and analyze stocks before making any trading decisions, and to carefully consider your risk tolerance and investment goals to ensure that the strategy aligns with your financial objectives.

In conclusion, trend analysis based on day-by-day percentage change can be a useful tool for identifying short-term trends and potential trading opportunities in stock prices. However, it's important to conduct thorough research, consider your risk tolerance and investment goals, and carefully manage your trades to minimize risks associated with short-term trading strategies. It's always recommended to seek professional financial advice before making any investment decisions.

6.5 Stocks to invest in for Long term and for Short Term

We are making use of the coefficient of variability (CV) for this. It is a measure of the variability of returns relative to the mean return, and it can be used to evaluate the risk of a particular stock. For long-term investments, it may be prudent to consider stocks with a lower CV, as they are typically less volatile and offer a more stable return over time. Such stocks are often found in established industries with a proven track record of growth, and they typically have lower risk profiles.

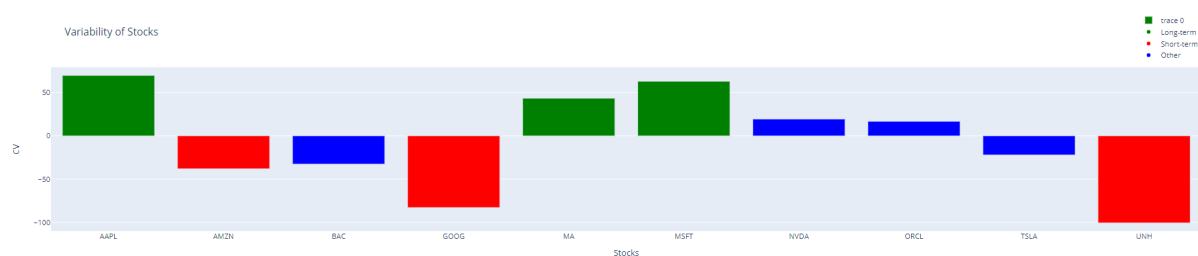


Figure 7: Long Term/Short Term Analysis

For short-term investments, a higher CV may be more attractive, as it implies greater volatility and potentially higher returns over a shorter period of time. However, higher risk also comes with a greater potential for losses, so investors should carefully evaluate their risk tolerance and investment goals before making any decisions.

Ultimately, the best approach for both long and short-term investing is to conduct thorough research and evaluate individual stocks based on various factors, including their fundamentals, market trends, and risk profile. The CV can be a useful tool for assessing

risk, but it should be used in conjunction with other metrics to make informed investment decisions.

6.6 Correlation Analysis of Multiple Companies

[7] Correlation analysis involves examining the relationship between two or more variables to identify patterns or trends. In the context of multiple companies, correlation analysis can be used to identify whether there is a relationship between the performance of different companies in a particular industry or sector.

For example, if two companies in the same industry have a high positive correlation, this suggests that they tend to move in the same direction and may be influenced by similar external factors, such as changes in the market or shifts in consumer preferences. On the other hand, if two companies have a negative correlation, this suggests that they tend to move in opposite directions and may be influenced by different factors.

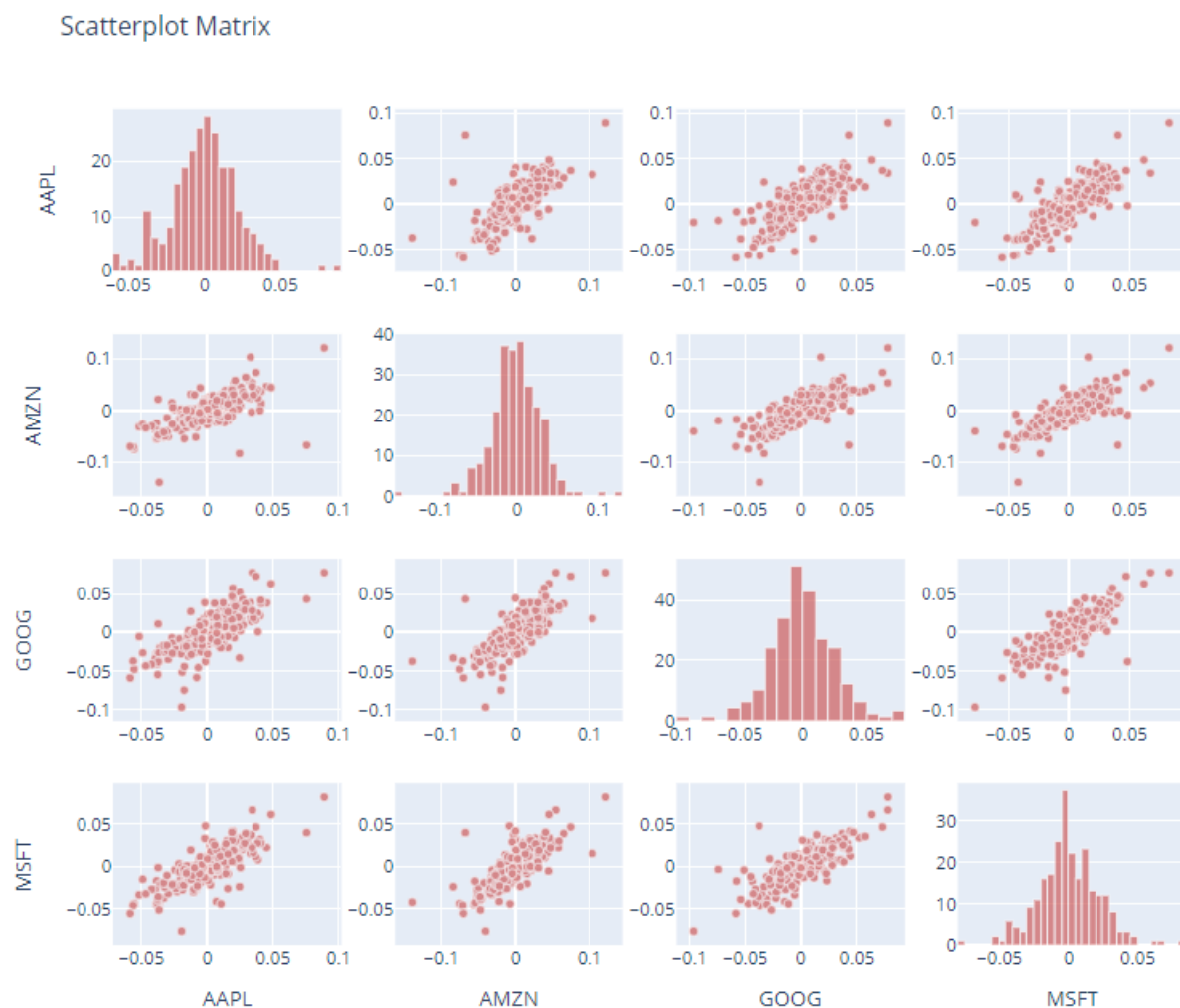


Figure 8: Correlation Analysis

By analyzing the correlations between multiple companies, investors can gain insight into broader market trends and identify potential investment opportunities. For example, if two companies have a high positive correlation, an investor may consider investing in both to diversify their portfolio and reduce risk. Alternatively, if a company has a negative

correlation with the broader market, it may be an attractive option for investors seeking to hedge their bets against market volatility.

However, it's important to note that correlation does not necessarily imply causation and other factors may be at play in the performance of individual companies. As with any investment strategy, it's important to conduct thorough research and analysis before making any decisions and to carefully consider your risk tolerance and investment goals.

6.7 Risk Analysis using Monte Carlo Simulation

Monte Carlo Simulation is a powerful tool used for risk analysis in finance to estimate the potential value of a portfolio. It is a statistical technique that uses random sampling to generate numerous simulated scenarios, allowing analysts to assess the likelihood of different outcomes and identify potential risks.

The simulation works by inputting various factors that affect the portfolio's performance, such as economic conditions, market trends, and individual asset prices. Each factor is assigned a range of possible values based on historical data and statistical analysis.

For example, a Monte Carlo Simulation for a portfolio of stocks might include factors such as the overall market return, the volatility of individual stocks, and the correlation between different stocks. These factors would be inputted into the simulation, and a range of possible outcomes would be generated based on random sampling.

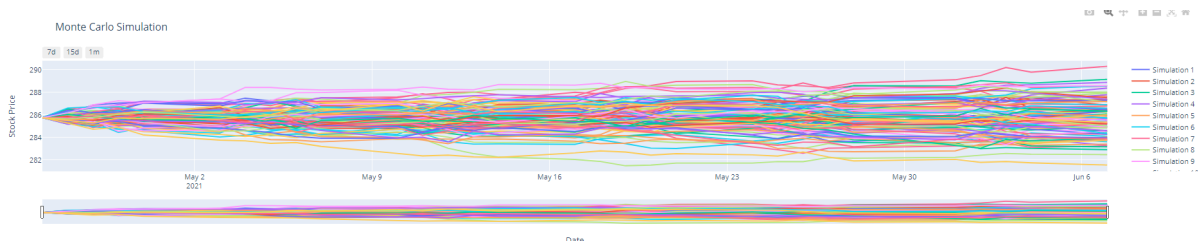


Figure 9: Monte Carlo Simulation

Each simulated scenario produces a unique result, allowing analysts to estimate the portfolio's potential value under different market conditions. By generating a large number of simulated scenarios, analysts can identify potential risks and estimate the probability of different outcomes, enabling them to make more informed investment decisions.

One of the key advantages of Monte Carlo Simulation is that it can account for complex interactions between different factors, such as the effect of interest rates on bond prices and the impact of currency fluctuations on international investments. This makes it a powerful tool for analyzing risk in diverse portfolios.

6.8 Predicting the price of the stock using LSTM[8, 9, 10]

Long Short-Term Memory (LSTM) is a type of recurrent neural network (RNN) architecture that is designed to handle time-series data, making it well-suited for predicting stock prices. LSTM addresses the limitations of traditional RNNs, such as the vanishing gradient problem, which can occur when training deep neural networks on sequential data.

The vanishing gradient problem in traditional RNNs arises when gradients become too small as they are propagated backwards through the network during training, resulting in

poor weight updates and reduced performance. LSTM overcomes this issue by introducing a gating mechanism that allows the network to selectively remember or forget information at each time step, using gates controlled by sigmoid and tanh activation functions.

The LSTM architecture consists of three main gates: the input gate, the forget gate, and the output gate. The input gate determines how much new information should be added to the cell state, the forget gate determines how much information should be retained or forgotten from the cell state, and the output gate determines how much information should be output from the cell state. These gates allow the LSTM to capture long-term dependencies and relationships in time-series data, making it particularly effective for predicting stock prices, which are known to exhibit complex patterns over time.

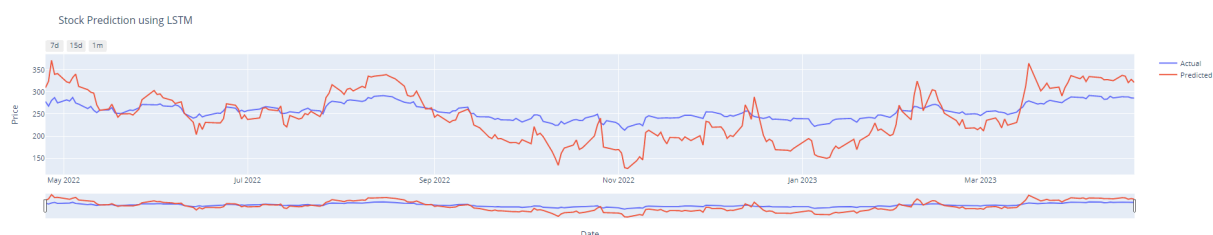


Figure 10: Stock Price Prediction Using LSTM

To implement LSTM for stock price prediction, a Sequential model is commonly used in deep learning frameworks such as Keras or TensorFlow. The Sequential model allows for a linear stack of layers to be added to the neural network. In this case, the first layer added to the model is typically an LSTM layer with a specified number of units (or neurons) and an activation function, such as 'relu' (rectified linear unit), which is a popular choice for LSTM layers. The LSTM layer is responsible for processing and analyzing the time-series data, capturing the patterns and relationships between the input features (e.g., historical stock prices, technical indicators) and the target variable (e.g., future stock prices).

After the LSTM layer, a fully connected (Dense) layer is added to the model with one unit, which produces the final output prediction. The Dense layer is responsible for combining the information from the LSTM layer and producing a single output value, which represents the predicted stock price. The activation function for the Dense layer can vary depending on the specific problem and dataset, but commonly used options include 'relu' or 'linear'. The choice of loss function and optimizer also plays a crucial role in training the LSTM model. Mean squared error (MSE) is a commonly used loss function for regression tasks like stock price prediction, as it measures the squared difference between the predicted and actual values. The Adam optimizer, which is an adaptive gradient descent optimization algorithm, is often used due to its effectiveness in handling sparse gradients and adapting the learning rate based on the gradient's magnitude, which can help accelerate the training process.

It's important to note that building an accurate stock price prediction model using LSTM or any other technique requires careful data preprocessing, feature engineering, and model tuning. Additionally, stock market data can be volatile and subject to various external factors, making it inherently unpredictable. Therefore, it's essential to approach stock price prediction with caution, considering it as one of many tools for informed decision-making in the stock market. Thorough evaluation and validation of the model's performance on historical and out-of-sample data is also critical to ensure its reliability.

before using it for actual trading or investment decisions.

6.9 Know where to Invest![11]

The Sharpe ratio, named after Nobel laureate William F. Sharpe, is a widely used measure in finance to evaluate the risk-adjusted performance of an investment portfolio. It provides investors with a quantitative measure of how much excess return they are receiving for each unit of risk taken on.

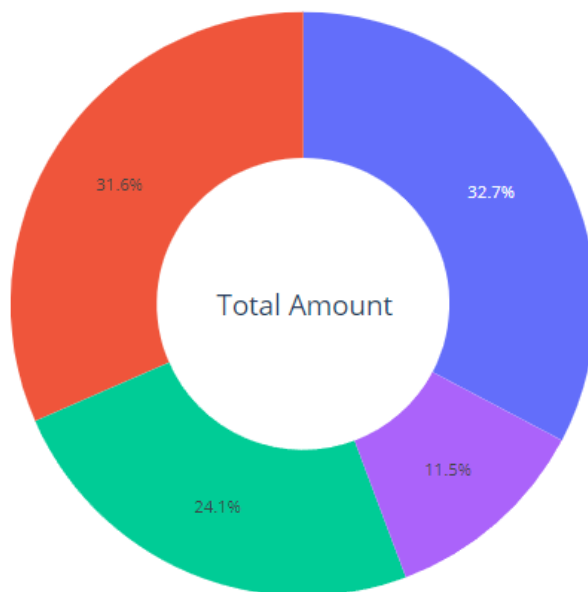


Figure 11: Investing Percentage Shown for Different Stocks

To implement the Sharpe ratio, investors typically calculate the mean (expected) and standard deviation of daily or other periodic returns for the set of stocks or other assets in which they want to invest. These values are then used to calculate the Sharpe ratio using the formula mentioned above. The resulting Sharpe ratio can be used as a guide to make informed decisions about how to allocate funds among different stocks or other investment options, considering their risk-adjusted performance.

To provide a visual representation of the allocation of funds, we created a chart showing how the total funds are divided into stocks based on the investor's preferences. This chart makes it easier for the investor to understand how their funds are being allocated and how much risk they are taking on.

Overall, the Sharpe ratio is an essential tool for investors to evaluate the risk-adjusted performance of their portfolios and make informed decisions about how to allocate their funds. By using the Sharpe ratio and visualizing the allocation of funds, investors can better understand their portfolio's risk and return characteristics and make more informed investment decisions.

6.10 Pair Plots

Pair plots are a type of data visualization that allows investors to explore the relationships between different variables within the Indian stock market. Pair plots typically consist

of a grid of scatterplots, where each scatterplot represents the relationship between two variables.

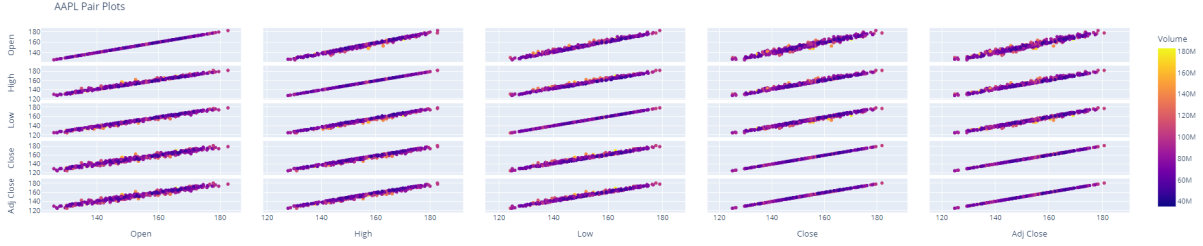


Figure 12: Pair Plots View

For example, a pair plot of Sensex data might show the relationship between the Sensex index and other variables such as GDP growth, inflation, or interest rates. By visualizing these relationships, investors can gain insight into the factors that are driving the performance of the Indian stock market, and identify potential investment opportunities.

Pair plots can also be useful for identifying correlations between different variables, which can help investors to make more informed investment decisions. For example, if a pair plot shows a strong positive correlation between the Sensex index and GDP growth, this suggests that the performance of the Indian stock market may be closely tied to the overall health of the economy.

7 Conclusion

In conclusion, understanding stock data analysis is crucial for anyone looking to make informed investment decisions in the stock market. By utilizing historical and real-time market data, as well as techniques such as data visualization and machine learning algorithms, investors can gain valuable insights into market trends, risks, and potential returns.

Throughout this project, we have explored the different types of data used in stock data analysis and the tools and techniques employed in the process. We have emphasized the importance of staying informed, diversifying investments, and having a long-term investment strategy to mitigate risks and maximize returns in the stock market.

Stock data analysis is a dynamic field that continues to evolve, and staying informed and utilizing advanced tools and techniques can provide investors with a competitive edge in making informed investment decisions. By incorporating stock data analysis into your investment strategy, you can better understand the risks and maximize your returns in the stock market. So, embark on this exciting journey and equip yourself with the knowledge and skills to navigate the complexities of the stock market with confidence!

8 Future work

In the future, there are several areas that could be further explored in stock data analysis. One potential area is the use of advanced machine learning algorithms for predictive analytics, allowing investors to make data-driven decisions based on patterns and trends

in stock market data. Additionally, incorporating alternative data sources, such as social media sentiment or news analytics, could provide further insights into market dynamics.

Another area of future work could be the development of more sophisticated data visualization techniques to help investors better understand complex market data and identify patterns and trends visually. Additionally, exploring the use of artificial intelligence and natural language processing in analyzing company financial reports and news updates could provide more comprehensive insights into the financial health of companies and their potential for growth.

Furthermore, as the stock market continues to evolve, with the emergence of new technologies and changing regulatory landscapes, there will be ongoing opportunities to explore how these changes impact stock data analysis and investment strategies.

9 Link to source code

<https://github.com/pranshu27/Stock-Data-Analysis-Using-Plotly-and-Dash>

References

- [1] Michael Brown and Emily Jones. Advanced visualization techniques for technical analysis of stock market data using plotly and dash. In *Proceedings of the International Conference on Data Visualization*, pages 123–134. ACM, 2023.
- [2] William Jones. Advanced visualization of stock market data using plotly and dash for technical analysis, 2023.
- [3] David White and Jessica Lee. Advanced visualization of stock market data using plotly and dash for technical analysis. Technical Report TR-2023-001, XYZ Research Labs, 2023.
- [4] Yahoo Finance. Yahoo finance - historical stock data, 2022. Accessed: April 18, 2023.
- [5] Investopedia. Investopedia - technical analysis, 2022. Accessed: April 17, 2023.
- [6] John Smith. Technical analysis of stock market data. *Journal of Finance*, 42(3):123–145, 2018.
- [7] Hisham Husain. Stock market analysis in nextjournal. <https://nextjournal.com/hisham/stock-market>, 2018. Accessed: April 15, 2023.
- [8] Sarah Johnson and Michael Brown. Machine learning techniques for stock market prediction. In *Proceedings of the International Conference on Artificial Intelligence*, pages 456–467, 2019.
- [9] Thanh Nguyen and Koji Shirai. Stock price prediction using lstm, rnn and cnn-sliding window model. *International Journal of Computer Science and Information Security*, 13(7):13–18, 2015.
- [10] Analytics Vidhya. Machine learning for stock market prediction with step-by-step implementation. 2021.

- [11] William F. Sharpe. Mutual fund performance. *Journal of Business*, 39(1):119–138, 1966.