Analytics

Investment Portfolio - Project Report (Group 2)

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The topic "Investment Portfolio" is important for people who want to make money through investments. An investment portfolio is like a basket where you keep different types of investments like stocks, bonds, mutual funds.

We chose this topic because understanding how to build a good investment portfolio is key to being successful in making money through investments. Learning about investment portfolios helps people make smart choices about their money. It's not just for rich people; understanding how to invest can help anyone looking to save for the future or grow their savings. To make sure we give accurate and useful information, we use data from NASDAQ.

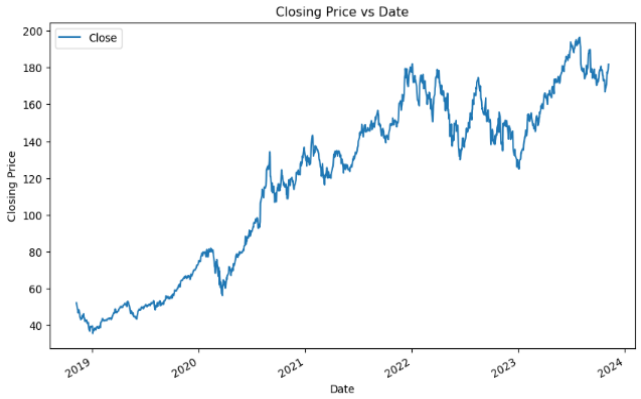
Data Collection:

The data for our analysis on investment portfolios was collected from NASDAQ, one of the largest and most trusted stock exchanges in the USA. NASDAQ is renowned for its accuracy and comprehensive coverage of market data, making it a reliable source for investors and analysts worldwide. We specifically gathered information from the last five years, ensuring a substantial quantity of data that reflects various market conditions. This time frame is adequate to understand trends, assess performance, and make informed decisions. By using NASDAQ's data, you can trust the authenticity and relevance of the information presented in our analysis.

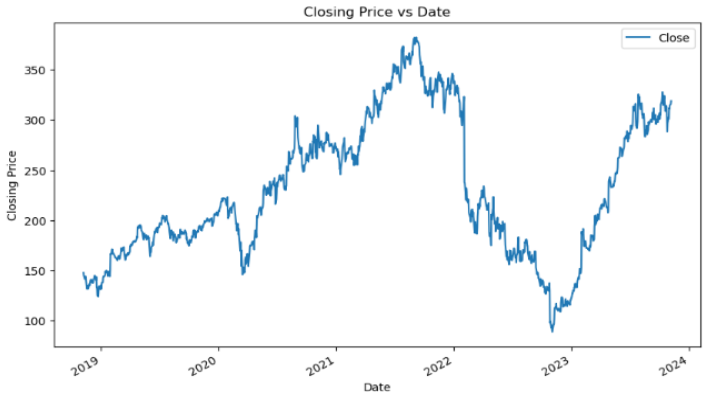
For our investment portfolio we selected 5 stocks namely Apple, Meta, Amazon, Tesla and Netflix. We chose these stocks based on their strong performance and reputation in the market. Apple is a renowned technology company known for its innovative products, while Meta (formerly Facebook) is a dominant player in the social media industry. Amazon is a global e-commerce giant that has consistently shown growth, and Tesla is a leading electric vehicle manufacturer with a visionary CEO. Lastly, Netflix revolutionized the entertainment industry with its streaming platform and original content. By diversifying our portfolio with these well-established companies, we aim to achieve high returns and reduce the risk of relying on a single industry or sector. These companies have proven track records of success and are well positioned to adapt to changing market conditions, making them attractive long-term investments.

1. Descriptive Analysis:

Descriptive analytics involves data preprocessing, exploration, and visualization, unveiling the underlying patterns and trends within the dataset. Through statistical measures and visualizations, the project offers a clear snapshot of the past, aiding investors in understanding the historical performance of their selected stocks.

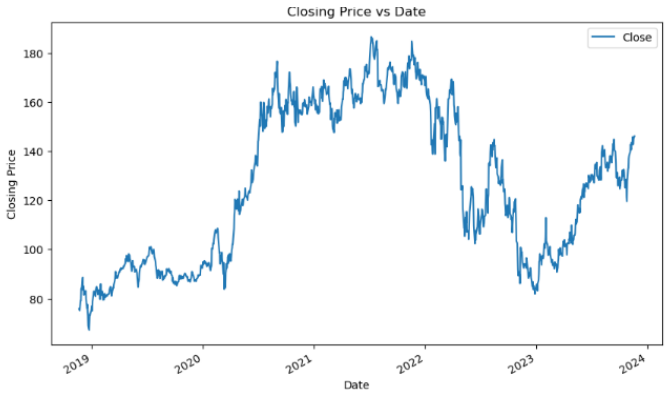


A historical view of APPL's closing price is plotted against dates, offering an overview of the stock's performance.

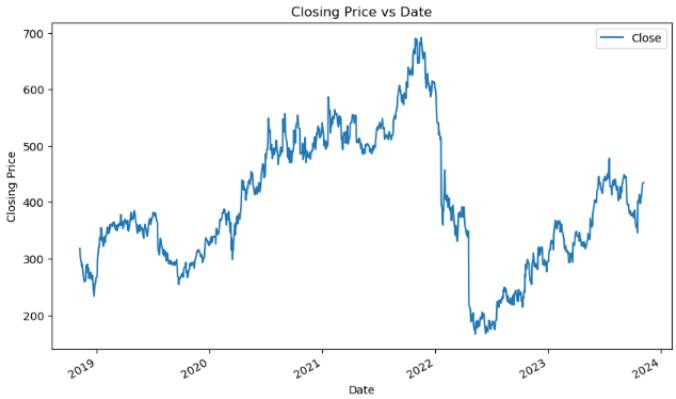


A historical view of META's closing price is plotted against dates, offering an overview of the stock's performance.

A historical view of TSLA's closing price is plotted against dates, offering an overview of the stock's performance.



A historical view of AMZN's closing price is plotted against dates, offering an overview of the stock's performance.



A historical view of NFLX's closing price is plotted against dates, offering an overview of the stock's performance.

High: In descriptive analytics for an investment portfolio, a "high" point could represent periods of significant positive returns or peaks in the portfolio value. This might indicate successful investment decisions or positive market conditions during those periods.

Low: Conversely, "low" points might indicate periods of poor performance or downturns in the portfolio value. It could highlight challenges or losses during specific time frames.

Stability: Stability in descriptive analytics could suggest periods where the portfolio shows consistent, steady growth or relatively stable performance without significant fluctuations.

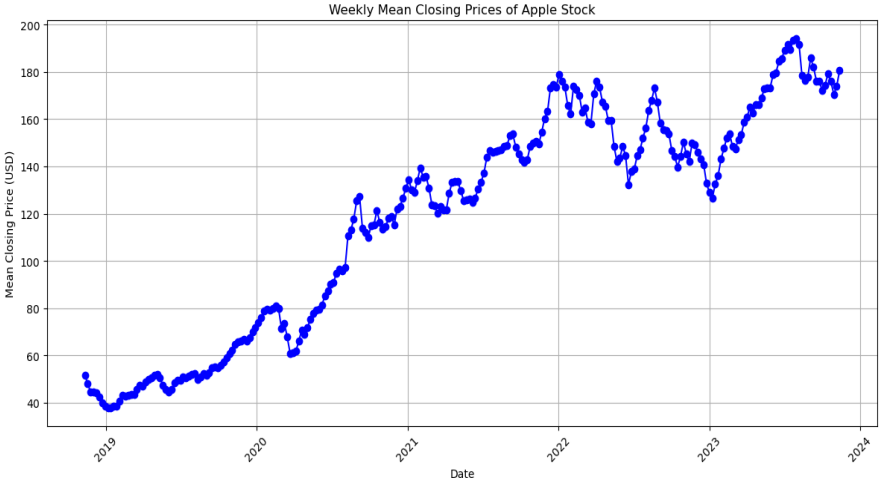
Predictive Analytics

Problem Statement: To forecast the prices of 5 stocks.

Predictive analytics utilizes historical data and statistical algorithms to forecast future stock prices. By analyzing patterns and trends, it can provide insights into the potential price movements of five specific stocks.

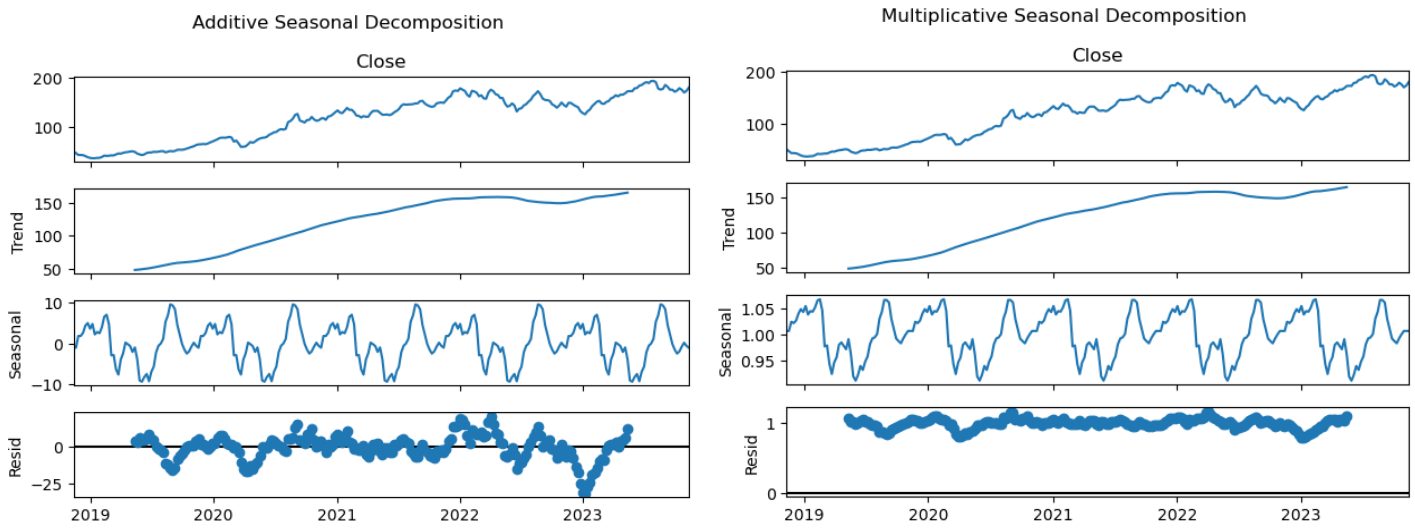
To forecast the prices of 5 stocks we use time series analysis. Time series analysis aims to uncover patterns in historical data and use them to make predictions about future stock prices. Time series analysis allows for the identification of seasonality, trends, and cyclical patterns, providing a comprehensive understanding of the factors influencing stock prices. However, it is important to note that time series analysis has its limitations. It may not account for unexpected events or external factors that can significantly impact stock prices, such as economic crises or political instability.

The mean closing prices per week are plotted against the Date. We have Set Date as the index, and we choose the closing price values to make the future predictions. By analyzing the mean closing prices per week and plotting them against the Date, investors can gain insights into the historical trends and patterns of stock prices.



Weekly mean closing prices of the Apple stock.

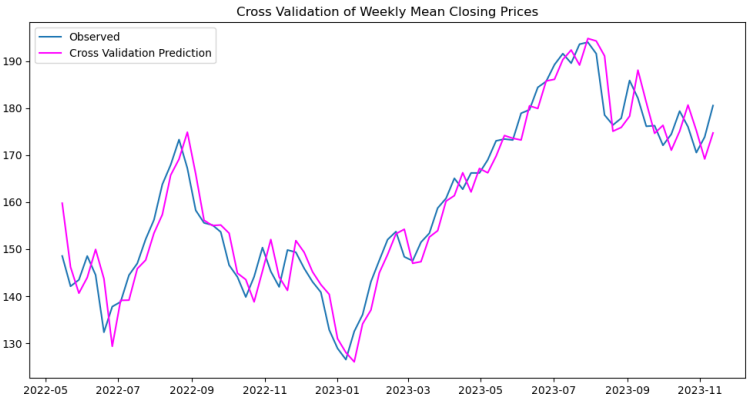
We perform Seasonality decomposition to break down a time series data set into its underlying components, typically comprising three main elements: trend, seasonality, and residual. Seasonality decomposition is a useful technique as it allows investors to identify recurring patterns or cycles in stock prices over time. By understanding these components, investors can better understand the factors that drive stock price movements and make more accurate predictions.

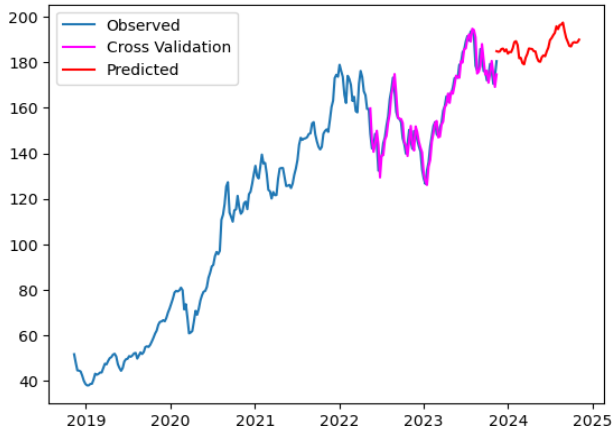


Seasonality decomposition of the Apple stock

In our data we can see that the apple stock follows an upward trend, and the residual component follows an almost constant pattern around a specific mean. This suggests that there may be underlying factors driving the consistent upward movement of Apple stock, such as strong company performance or positive market sentiment. The constant pattern of the residual component around a specific mean indicates that there are minimal random or unpredictable fluctuations in the stock's price, further supporting the notion of a stable and predictable behavior in Apple's stock.

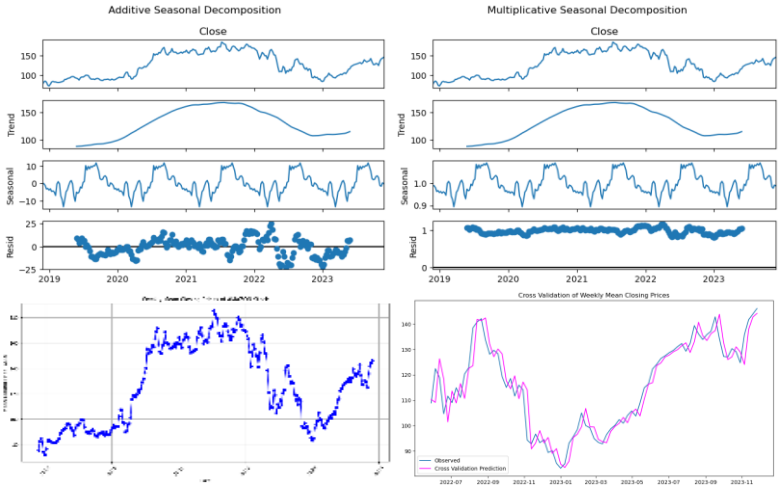
For cross validation the data is split into training and test sets. The training set is used to build and train a predictive model, while the test set is used to evaluate the performance of the model on unseen data. This process helps to ensure that the model's predictions are accurate and reliable. Autoregressive models are trained on the training set. These models use the historical data in the training set to make predictions based on previous observations. The models are then used to predict future values on the test set.

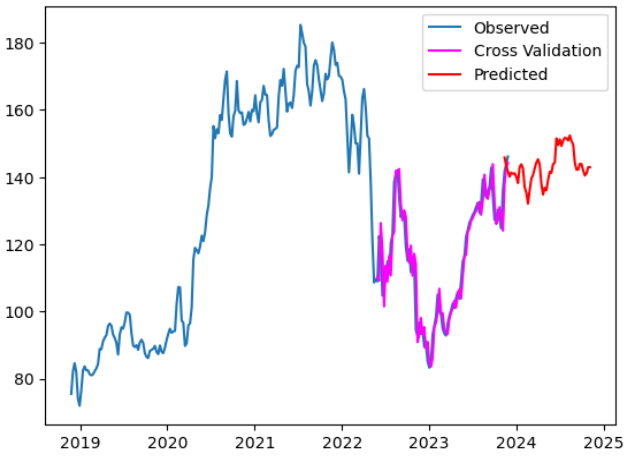




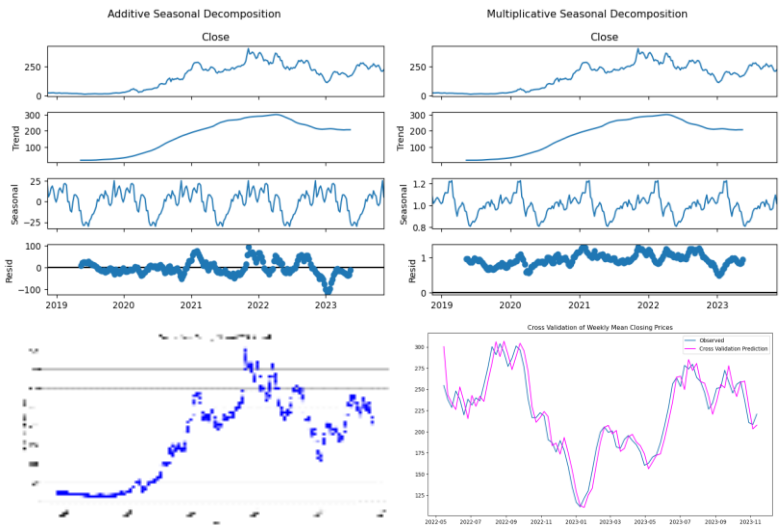
Cross Validation and Prediction of the Apple stock. **RMSE: 4.69**

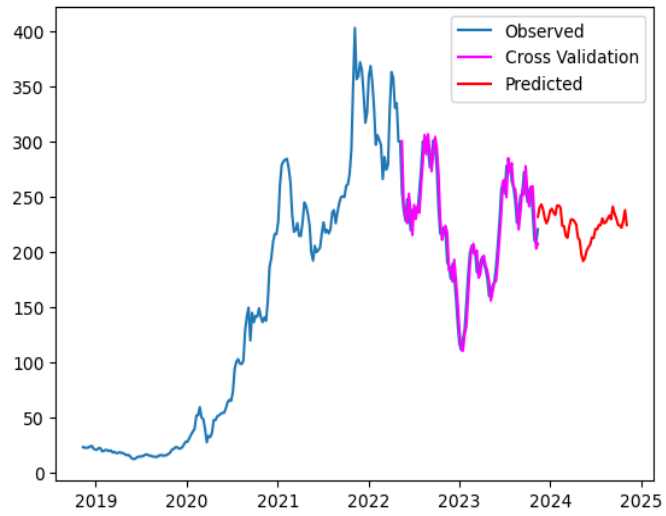
The predictions closely match the actual observations, it indicates that the model is performing well and is not suffering from overfitting or underfitting. The Root Mean Squared Error (RMSE) is calculated as a measure of prediction accuracy. It measures the average difference between the predicted values and the actual values, considering both the magnitude and direction of the errors. A lower RMSE indicates better prediction accuracy, while a higher RMSE suggests poorer performance of the model. For our apple stock we had an **RMSE of 4.69.** The results, including observed values, cross-validation predictions, and future predictions, are visualized.



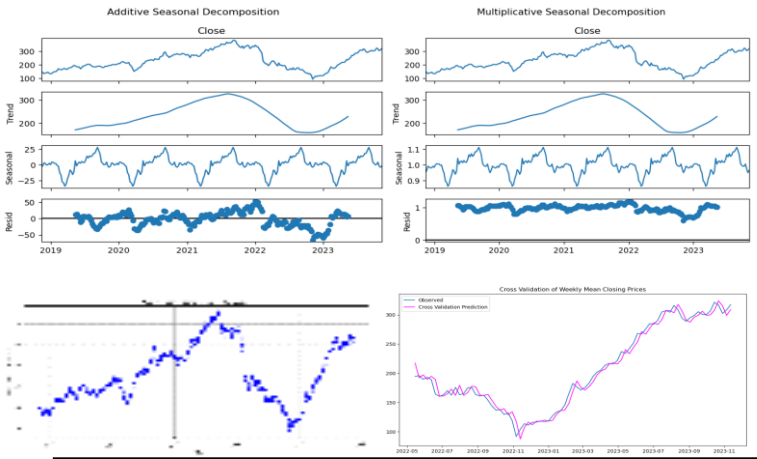


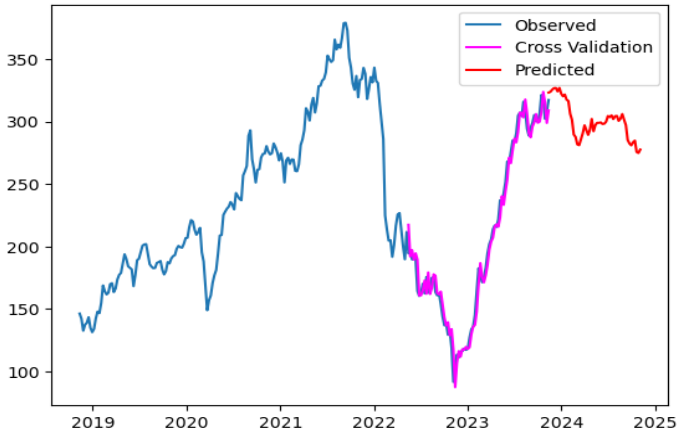
Weekly mean closing prices, Seasonality Decomposition, Cross Validation and Prediction of the Amazon stock. **RMSE: 5.56**



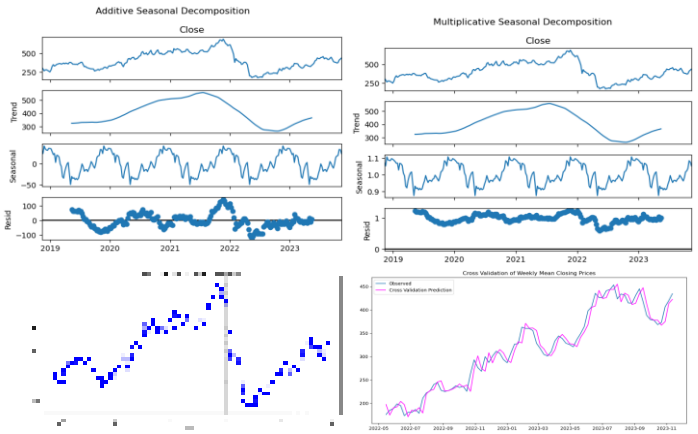


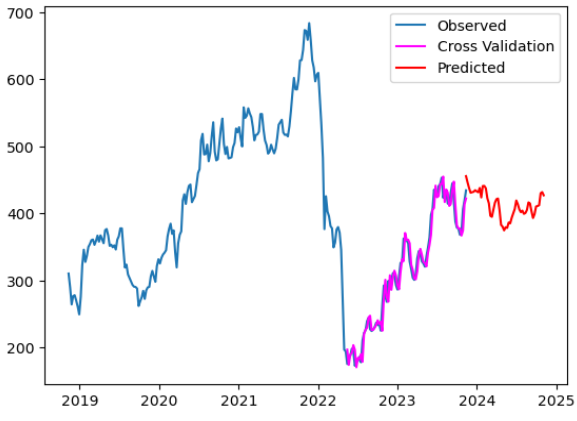
Weekly mean closing prices, Seasonality Decomposition, Cross Validation and Prediction of the Tesla stock.
RMSE: 14.94





Weekly mean closing prices, Seasonality Decomposition, Cross Validation and Prediction of the META stock.
RMSE: 9.32





Weekly mean closing prices, Seasonality Decomposition, Cross Validation and Prediction of the NETFLIX stock.
RMSE: 15.35

Prescriptive Analytics:

Problem Statement: What are the optimal weights of the five stocks in your portfolio given a specific return? You need to minimize the risk here. [Optimization]

- **Weight** is the input to a function and represents the allocation or weights assigned to each set in a portfolio.
- We assume a target return of 6%
- **Objective function** is defined to establish a relationship of decision variables and its most frequent objective is to minimize the risk.
- **Constraints** ensure that some of the weights equal to one which represents a fully invested portfolio. It also ensures all available capital is invested in the portfolio, the product of sum of weights and the expected returns should be equal to target return.

The diagonal elements of a correlation Matrix represent the correlation of an asset with itself which is always the highest possible value this represents a strong positive correlation between the assets.

The off-diagonal elements denote the correlation between different assets in the portfolio.

Correlation Matrix: $\begin{pmatrix} 1 & 0.003623 & 0.584575 & 0.482989 & 0.466155 \\ 0.003623 & 1 & 0.004601 & 0.006442 & 0.466155 \\ 0.584575 & 0.004601 & 1 & 0.525794 & 0.339746 \\ 0.482989 & 00.006442 & 0.525794 & 1 & 0.381368 \\ 0.466155 & 0.025071 & 0.339746 & 0.381368 & 1 \end{pmatrix}$

It represents the pairwise correlations between the daily returns of selected stocks.

The expected returns represent the average daily returns over the historical period, while standard deviation quantifies the level of risk or volatility associated with each stock.

Stocks	Expected Returns	Standard Deviation
AAPL	0.001141	0.021094
AMZ	-0.000711	0.028310
META	0.000056	0.027233
NFLX	0.000773	0.030067
TSLA	0.002243	0.041287

The minimize function is being used in the SciPy Library using SLSQP method. SLSQP is the sequential least squares programming and it's a famous optimization algorithm to solve non-linear optimization problems we use minimize function for a constrained optimization. The optimal weights retrieve the optimal allocation of weights obtained from the optimization process.

Optimal Weights:

AAPL	*17.98*
AMZ	*-25.39*
META	*-3.48*
NFLX	*3.45*
TSLA	*8.45*

The optimal weights are positive and negative, the negative weight indicates a short position of an asset in the portfolio a positive weight indicates the long position of an asset, and an investor always expects the assets value to increase.

Problem Statement: What are the optimal weights of the five stocks in your portfolio given a specific risk? You need to maximize the return here. [Optimization]

- To calculate the expected risk tolerance using Sharpe ratio as measure of risk adjusted return.
  Sharpe ratio = sum (expected returns) / sum(standard deviations)
  Sharpe-ratio is a widely used metric in finance that helps investors in evaluating the risk adjusted return of an investment or portfolio.
- we can find the expected risk tolerance = Sharpe ratio * sum(standard_deviations). The above calculation gives the Expected Risk Tolerance as 0.0035
- Objective function is defined to establish a relationship of decision variables and its most frequent objective is to maximize the return.
- When it is constraints, **equality constraints** ensure sum of weights equal to one which represents a fully invested portfolio it also ensures all available capital is invested in portfolio. The next **equality constraint** is the product of sum of weights and the expected returns should be equal to target return. The **inequality type constraint** imposes an inequality constraint ensuring portfolio's risk based on the expected risk tolerance should be greater than or equal to the product of sum of weights and standard deviation.

Optimal Weights:

AAPL	*20.88*
AMZ	*-22.28*
META	*-7.33*
NFLX	*0.73*
TSLA	*8.99*

The optimal weights are positive and negative, the negative weight indicates a short position of an asset in the portfolio a positive weight indicates the long position of an asset, and an investor always expects the assets value to increase.

Critical thinking Shortcomings and/or suggestions:

- **Assumptions and Inputs**: Ensure the models are using appropriate assumptions and accurate input data. Often, the quality of results depends on the accuracy of expected returns, volatilities, correlations, and risk-free rates used in the optimization process. Make sure these are based on robust historical data or well-researched estimates.
- **Constraints and Bounds**: Review the constraints used in the optimization. Constraints can heavily influence the optimal weights. For instance, are there any constraints related to individual stock weights or the total portfolio weights? Adjusting these constraints might yield different optimal solutions.
- **Optimization Technique:** Consider different optimization techniques or algorithms. Sometimes, using a different mathematical model or optimization algorithm (such as quadratic programming, mean-variance optimization, or more sophisticated methods like Black-Litterman) might lead to improved results or different trade-offs between risk and return.
- **Scenario Analysis:** Conduct sensitivity analysis to understand how changes in inputs (such as expected returns or volatilities) impact the optimal weights. This can provide insights into the stability of the solution and potential changes in weights under varying market conditions.
- **Diversification and Asset Classes**: Assess if the portfolio is adequately diversified across different asset classes, sectors, or regions. Sometimes, the addition or removal of certain assets can impact the risk-return profile significantly.
- **Regular Rebalancing**: Optimal weights may change over time due to market movements. Regularly reassess and rebalance the portfolio to maintain alignment with the investment objectives and risk tolerance.

- **Risk Measures**: Consider using different risk measures beyond just standard deviation (volatility) such as downside risk, Value at Risk (VaR), or Conditional Value at Risk (CVaR) to capture the true risk exposure of the portfolio.
- **Robustness Testing**: Test the robustness of the results by applying different time periods or market conditions. It helps in understanding if the optimized weights hold up well across different scenarios.

By addressing these aspects and potentially employing different methodologies or refining existing ones, you might refine the optimization process and obtain more robust and reliable optimal weight allocations for your portfolio.

Conclusion:

- This analysis can be valuable for investors and analysts seeking to understand historical stock behavior and make informed decisions based on future predictions.
- This report highlights the importance of considering practical constraints and market dynamics in portfolio optimization for the investors.

Our project provides a comprehensive analysis of stock data, explores patterns and relationships, and utilizes time series forecasting to predict future closing prices. The results are visualized, allowing for a better understanding of each company's stock performance and potential trends in the coming weeks. The RMSE values offer insights into the accuracy of the forecasting models.