

Part 1: Implement Investment Strategies in Python

Rounding procedure: After determining the optimal weight and determining the number of stocks in the portfolio, we use the numpy round function to round each stock to the nearest integer. We run a while loop, in which in the first run, if there isn't enough cash in the account only those units that were rounded up will go down by 1. If there still isn't enough account, we overestimate and decrease all stocks by 1 (stocks that are not 0). We then add a unit to each stock that should be rounded up until we go through all the stocks.

Output:

Period 1: start date 01/02/2020, end date 02/28/2020

Strategy "Buy and Hold", value begin = \$ 1000012.93, value end = \$ 893956.75

Strategy "Equally Weighted Portfolio", value begin = \$ 990881.80, value end = \$ 892363.31

Strategy "Minimum Variance Portfolio", value begin = \$ 992756.25, value end = \$ 915852.04

Strategy "Maximum Sharpe Ratio Portfolio", value begin = \$ 990063.24, value end = \$ 922013.36

Period 2: start date 03/02/2020, end date 04/30/2020

Strategy "Buy and Hold", value begin = \$ 945076.08, value end = \$ 949228.39

Strategy "Equally Weighted Portfolio", value begin = \$ 930689.62, value end = \$ 862184.18

Strategy "Minimum Variance Portfolio", value begin = \$ 955715.61, value end = \$ 850657.72

Strategy "Maximum Sharpe Ratio Portfolio", value begin = \$ 961925.43, value end = \$ 1017080.07

Period 3: start date 05/01/2020, end date 06/30/2020

Strategy "Buy and Hold", value begin = \$ 937916.81, value end = \$ 913415.30

Strategy "Equally Weighted Portfolio", value begin = \$ 830743.43, value end = \$ 933833.25

Strategy "Minimum Variance Portfolio", value begin = \$ 826389.23, value end = \$ 853450.05

Strategy "Maximum Sharpe Ratio Portfolio", value begin = \$ 974232.81, value end = \$ 1175637.10

Period 4: start date 07/01/2020, end date 08/31/2020

Strategy "Buy and Hold", value begin = \$ 905419.63, value end = \$ 994693.42

Strategy "Equally Weighted Portfolio", value begin = \$ 927429.17, value end = \$ 1060410.21

Strategy "Minimum Variance Portfolio", value begin = \$ 855755.18, value end = \$ 980881.46

MIE1622: Assignment #1 = Mean-Variance Portfolio Selection Strategies

Name: Alexander Cheng, Student Number: 1001634298, Date: Sunday, February 12th, 2022

Strategy "Maximum Sharpe Ratio Portfolio", value begin = \$ 1219488.39, value end = \$ 1607469.19

Period 5: start date 09/01/2020, end date 10/30/2020

Strategy "Buy and Hold", value begin = \$ 993194.54, value end = \$ 971914.18

Strategy "Equally Weighted Portfolio", value begin = \$ 1068021.21, value end = \$ 998794.62

Strategy "Minimum Variance Portfolio", value begin = \$ 982633.87, value end = \$ 942078.51

Strategy "Maximum Sharpe Ratio Portfolio", value begin = \$ 1641557.55, value end = \$ 1554610.60

Period 6: start date 11/02/2020, end date 12/31/2020

Strategy "Buy and Hold", value begin = \$ 983801.02, value end = \$ 1004435.67

Strategy "Equally Weighted Portfolio", value begin = \$ 1007615.85, value end = \$ 1194009.60

Strategy "Minimum Variance Portfolio", value begin = \$ 950554.50, value end = \$ 1005254.15

Strategy "Maximum Sharpe Ratio Portfolio", value begin = \$ 1553253.21, value end = \$ 1790621.51

Period 7: start date 01/04/2021, end date 02/26/2021

Strategy "Buy and Hold", value begin = \$ 1005601.39, value end = \$ 956244.15

Strategy "Equally Weighted Portfolio", value begin = \$ 1180423.17, value end = \$ 1266799.62

Strategy "Minimum Variance Portfolio", value begin = \$ 1003280.29, value end = \$ 974347.05

Strategy "Maximum Sharpe Ratio Portfolio", value begin = \$ 1738740.17, value end = \$ 1854215.24

Period 8: start date 03/01/2021, end date 04/30/2021

Strategy "Buy and Hold", value begin = \$ 957791.42, value end = \$ 1019731.31

Strategy "Equally Weighted Portfolio", value begin = \$ 1297147.46, value end = \$ 1398677.74

Strategy "Minimum Variance Portfolio", value begin = \$ 974665.13, value end = \$ 1087408.87

Strategy "Maximum Sharpe Ratio Portfolio", value begin = \$ 1902650.82, value end = \$ 2061862.75

Period 9: start date 05/03/2021, end date 06/30/2021

Strategy "Buy and Hold", value begin = \$ 1022204.61, value end = \$ 987842.85

MIE1622: Assignment #1 = Mean-Variance Portfolio Selection Strategies

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Strategy "Equally Weighted Portfolio", value begin = \$ 1397454.10, value end = \$ 1459030.32

Strategy "Minimum Variance Portfolio", value begin = \$ 1087214.87, value end = \$ 1076065.34

Strategy "Maximum Sharpe Ratio Portfolio", value begin = \$ 2053359.96, value end = \$ 2015852.83

Period 10: start date 07/01/2021, end date 08/31/2021

Strategy "Buy and Hold", value begin = \$ 993283.49, value end = \$ 975250.12

Strategy "Equally Weighted Portfolio", value begin = \$ 1466439.38, value end = \$ 1517538.82

Strategy "Minimum Variance Portfolio", value begin = \$ 1076108.30, value end = \$ 1085948.88

Strategy "Maximum Sharpe Ratio Portfolio", value begin = \$ 2014854.33, value end = \$ 2120429.10

Period 11: start date 09/01/2021, end date 10/29/2021

Strategy "Buy and Hold", value begin = \$ 974520.08, value end = \$ 949068.41

Strategy "Equally Weighted Portfolio", value begin = \$ 1513305.17, value end = \$ 1563148.29

Strategy "Minimum Variance Portfolio", value begin = \$ 1080422.13, value end = \$ 1056577.04

Strategy "Maximum Sharpe Ratio Portfolio", value begin = \$ 2101168.08, value end = \$ 2143099.77

Period 12: start date 11/01/2021, end date 12/31/2021

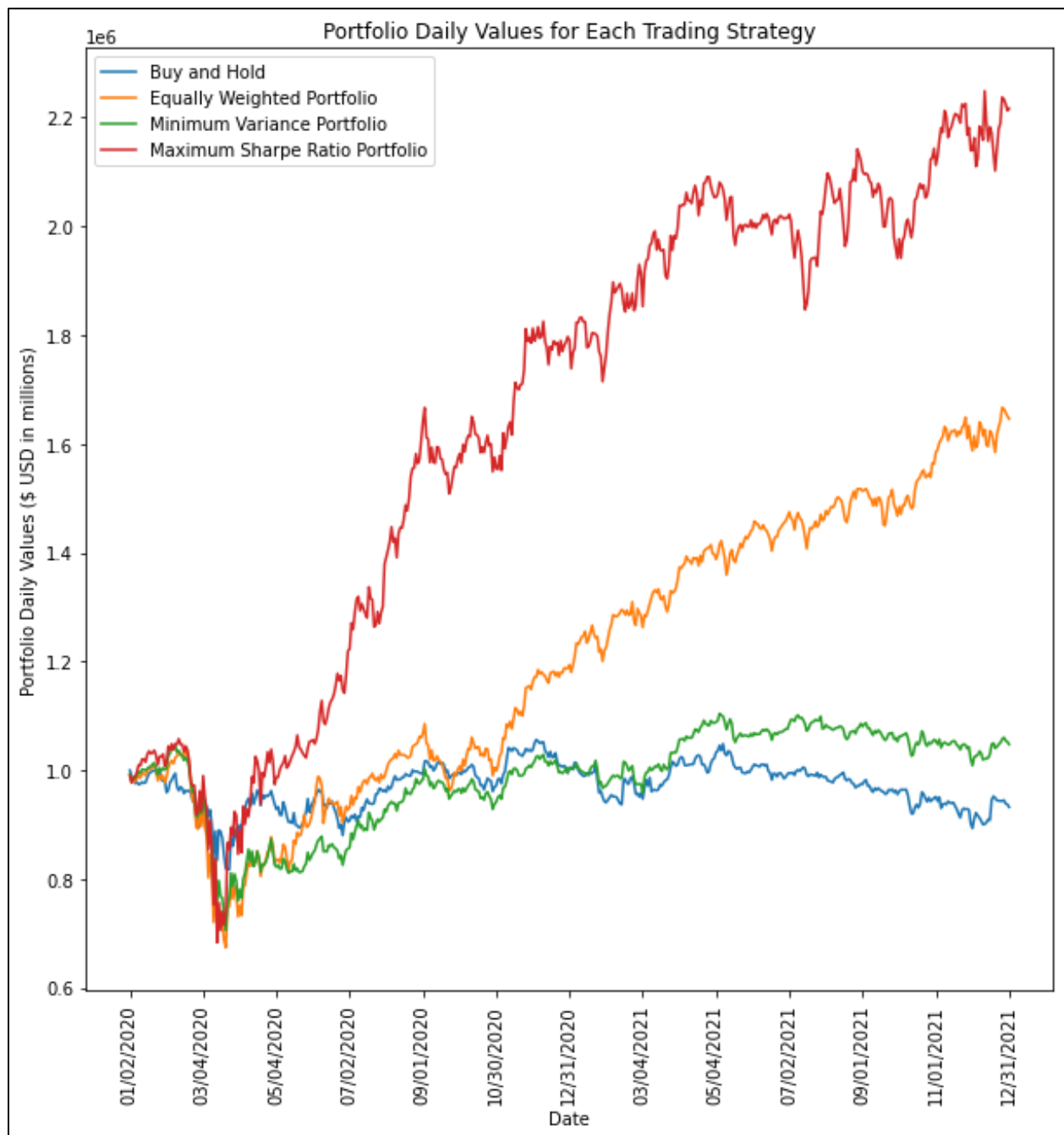
Strategy "Buy and Hold", value begin = \$ 951350.41, value end = \$ 932471.35

Strategy "Equally Weighted Portfolio", value begin = \$ 1584369.08, value end = \$ 1646240.36

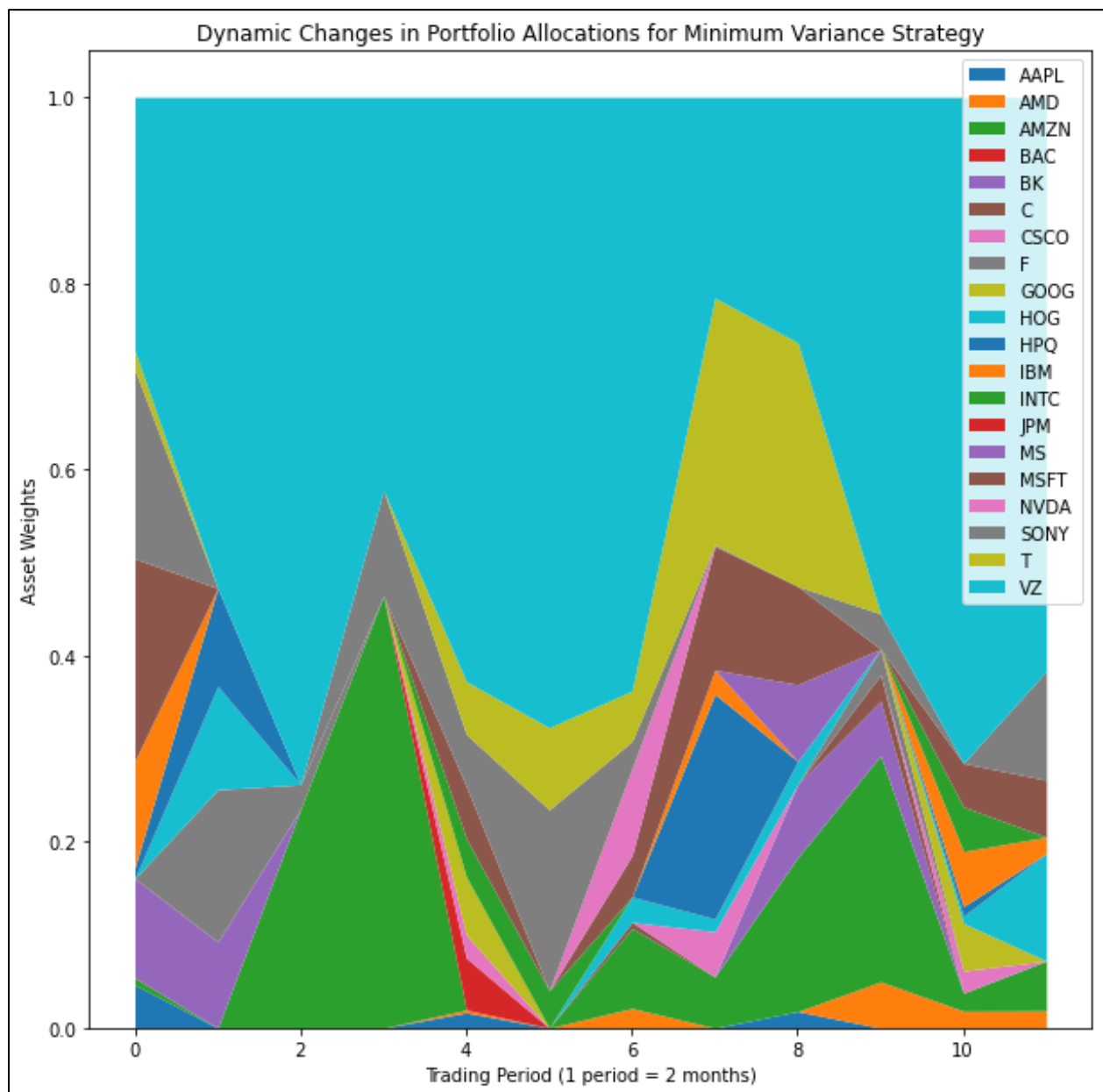
Strategy "Minimum Variance Portfolio", value begin = \$ 1053830.53, value end = \$ 1047872.09

Strategy "Maximum Sharpe Ratio Portfolio", value begin = \$ 2112466.24, value end = \$ 2216754.37

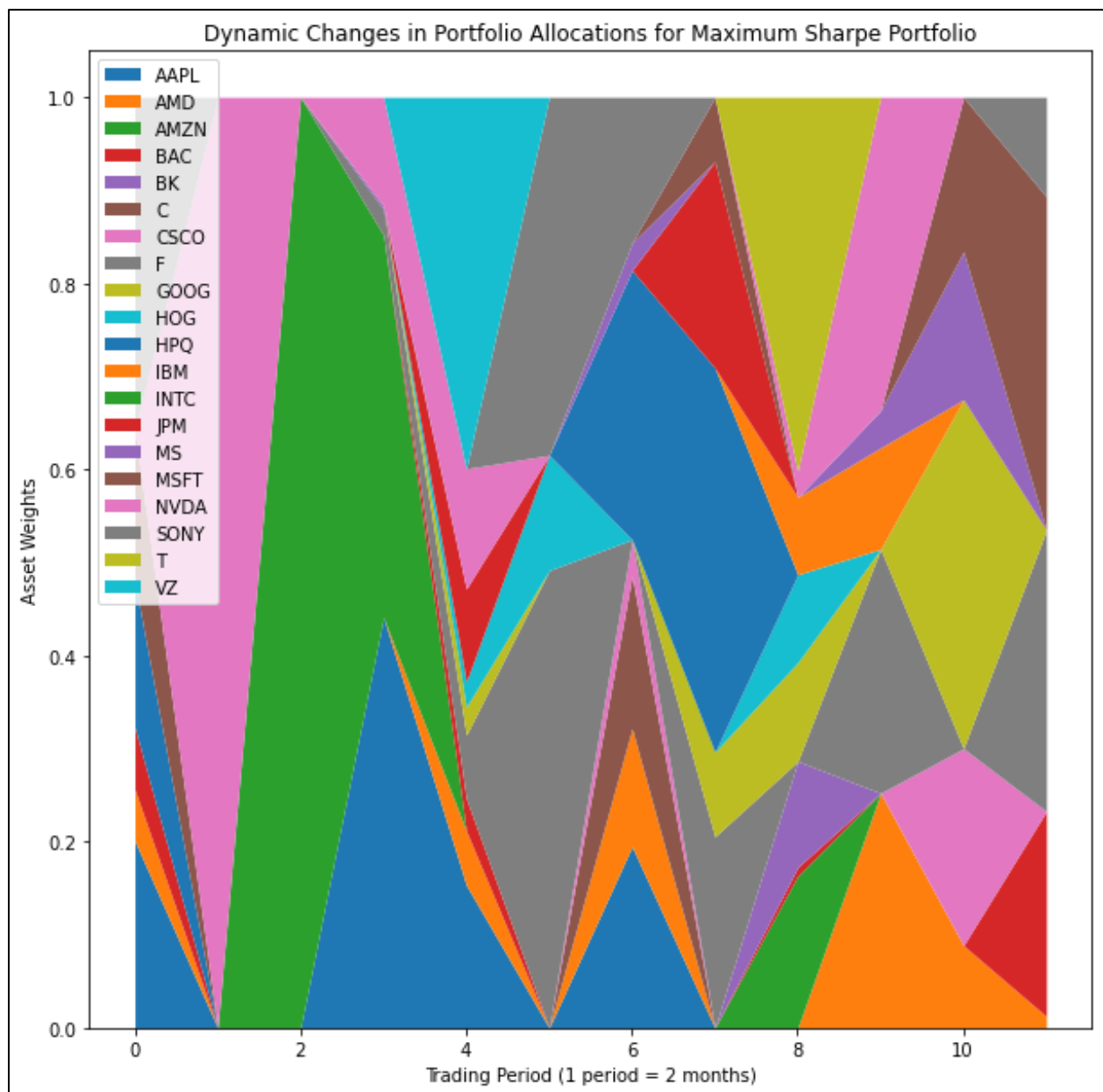
Part 2: Analyze your results.



This chart illustrates the daily value of the portfolio for each trading strategy over the years 2020 and 2021 using the daily prices.



This chart illustrates the weight allocation of each stock in the Minimum variance portfolio for the 12 trading periods. We can observe that the Verizon (VZ) stock dominates the portfolio through the 12 trading periods. This stock offers the lowest variance among all the stocks.



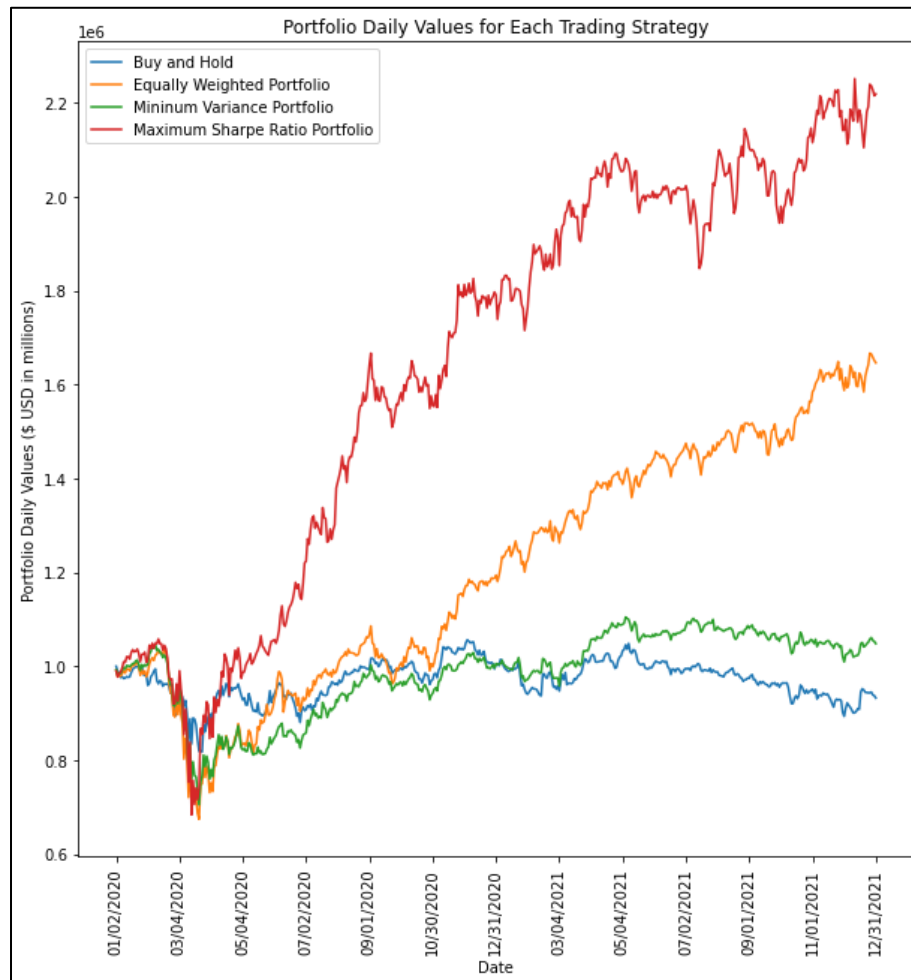
This chart illustrates the weight allocation of each stock in the Maximum Sharpe's Ratio portfolio for the 12 trading periods. We can observe that there is much more fluctuations among the weight allocation of the stocks. This could be a larger issue if there are larger trading costs.

MIE1622: Assignment #1 = Mean-Variance Portfolio Selection Strategies

Name: Alexander Cheng, Student Number: 1001634298, Date: Sunday, February 12th, 2022

Compare trading strategies and discuss their performance relative to each other. Which strategy would you select for managing your own portfolio and why?

Strategy	Final Portfolio Value (in USD)
Buy and Hold	\$ 932471.35
Equally Weighted	\$ 1656226.85
Minimum Variance	\$ 1048387.97
Maximum Sharpe Ratio	\$ 2218942.31



We could see that the maximum Sharpe ratio strategy has significantly outperformed the other three methods over the 12 trading periods (2 years) in terms of portfolio value. The equally weighted portfolio had the second highest portfolio value in which it picked up its growth after a year. Then was the minimum variance portfolio strategy which slightly performed better than the buy and hold strategy. Thus, I would select the maximum Sharpe ratio portfolio to manage my own portfolio. Sharpe ratio allows us to quantify and optimize the return per unit risk. We can observe that there are much more fluctuations among the weight allocation of the stocks so this strategy may not be feasible if there are larger trading costs (i.e. Greater than 0.5%).

Part 3: Discuss possible improvements to your trading strategies.

Test your program for different variations of your strategies. Discuss if you can achieve better results.

Variation 1: Select $1/n$ portfolio at the beginning of period 1 and hold until the end of period 12 (as if the re-balancing strategy requires large transaction costs).

Period 1: start date 01/02/2020, end date 02/28/2020

Strategy "Buy Equally Weighted and Hold", value begin = \$ 990881.80, value end = \$ 892363.31

Period 2: start date 03/02/2020, end date 04/30/2020

Strategy "Buy Equally Weighted and Hold", value begin = \$ 931075.01, value end = \$ 868535.11

Period 3: start date 05/01/2020, end date 06/30/2020

Strategy "Buy Equally Weighted and Hold", value begin = \$ 837765.40, value end = \$ 944421.16

Period 4: start date 07/01/2020, end date 08/31/2020

Strategy "Buy Equally Weighted and Hold", value begin = \$ 940832.47, value end = \$ 1096615.92

Period 5: start date 09/01/2020, end date 10/30/2020

Strategy "Buy Equally Weighted and Hold", value begin = \$ 1107923.32, value end = \$ 1019219.59

Period 6: start date 11/02/2020, end date 12/31/2020

Strategy "Buy Equally Weighted and Hold", value begin = \$ 1026359.89, value end = \$ 1198894.93

Period 7: start date 01/04/2021, end date 02/26/2021

Strategy "Buy Equally Weighted and Hold", value begin = \$ 1186560.87, value end = \$ 1258234.55

Period 8: start date 03/01/2021, end date 04/30/2021

Strategy "Buy Equally Weighted and Hold", value begin = \$ 1288250.80, value end = \$ 1378075.91

Period 9: start date 05/03/2021, end date 06/30/2021

Strategy "Buy Equally Weighted and Hold", value begin = \$ 1374812.44, value end = \$ 1458603.84

Period 10: start date 07/01/2021, end date 08/31/2021

Strategy "Buy Equally Weighted and Hold", value begin = \$ 1466617.35, value end = \$ 1539061.21

Period 11: start date 09/01/2021, end date 10/29/2021

Strategy "Buy Equally Weighted and Hold", value begin = \$ 1536844.85, value end = \$ 1609865.59

Period 12: start date 11/01/2021, end date 12/31/2021

Strategy "Buy Equally Weighted and Hold", value begin = \$ 1630591.70, value end = \$ 1727212.77

MIE1622: Assignment #1 = Mean-Variance Portfolio Selection Strategies

Name: Alexander Cheng, Student Number: 1001634298, Date: Sunday, February 12th, 2022

From the output results, we significantly get better results if we were to equally weigh our stocks and hold them. In the first example, we were only holding 2 stocks. At the end of period 12, our initial buy and hold strategy portfolio returned only \$932471.35 in which we lost money. With our variation strategy, we would have \$ 1727212.77.

Variation 2: Implement Maximum Sharpe ratio strategy at the beginning of period 1.

Period 1: start date 01/02/2020, end date 02/28/2020

Strategy "Maximum Sharpe Ratio Portfolio from the start", value begin = \$ 990063.05, value end = \$ 937633.11

Period 2: start date 03/02/2020, end date 04/30/2020

Strategy "Maximum Sharpe Ratio Portfolio from the start", value begin = \$ 976204.45, value end = \$ 1032177.75

Period 3: start date 05/01/2020, end date 06/30/2020

Strategy "Maximum Sharpe Ratio Portfolio from the start", value begin = \$ 988698.20, value end = \$ 1192939.18

Period 4: start date 07/01/2020, end date 08/31/2020

Strategy "Maximum Sharpe Ratio Portfolio from the start", value begin = \$ 1237401.70, value end = \$ 1630586.54

Period 5: start date 09/01/2020, end date 10/30/2020

Strategy "Maximum Sharpe Ratio Portfolio from the start", value begin = \$ 1665138.92, value end = \$ 1576949.92

Period 6: start date 11/02/2020, end date 12/31/2020

Strategy "Maximum Sharpe Ratio Portfolio from the start", value begin = \$ 1575564.70, value end = \$ 1816344.79

Period 7: start date 01/04/2021, end date 02/26/2021

Strategy "Maximum Sharpe Ratio Portfolio from the start", value begin = \$ 1763718.74, value end = \$ 1880838.82

Period 8: start date 03/01/2021, end date 04/30/2021

Strategy "Maximum Sharpe Ratio Portfolio from the start", value begin = \$ 1929979.19, value end = \$ 2091429.95

Period 9: start date 05/03/2021, end date 06/30/2021

Strategy "Maximum Sharpe Ratio Portfolio from the start", value begin = \$ 2082818.50, value end = \$ 2044751.04

MIE1622: Assignment #1 = Mean-Variance Portfolio Selection Strategies

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Period 10: start date 07/01/2021, end date 08/31/2021

Strategy "Maximum Sharpe Ratio Portfolio from the start", value begin = \$ 2043744.90, value end = \$ 2150914.51

Period 11: start date 09/01/2021, end date 10/29/2021

Strategy "Maximum Sharpe Ratio Portfolio from the start", value begin = \$ 2131387.36, value end = \$ 2173859.14

Period 12: start date 11/01/2021, end date 12/31/2021

Strategy "Maximum Sharpe Ratio Portfolio from the start", value begin = \$ 2142880.63, value end = \$ 2248665.76

From the output results, we slightly get better results if we were to implement the maximum Sharpe ratio strategy at the end of period 1. In the first example, we were only holding 2 stocks for the first period. At the end of period 12, our initial maximum Sharpe ratio strategy portfolio returned \$2216754.37. With our variation strategy, we would have \$ 2248665.76, slightly more.

Can you suggest any improvement of the trading strategies you have implemented?

Possible improvements can be the trading period, by optimizing the transaction costs and the trading period, we may find a more optimal period. Shorter periods may be beneficial if the transaction costs aren't high and longer periods are preferred if the transaction costs are high.

Another improvement would be to optimize the rounding strategy. Currently the rounding procedure: After determining the optimal weight and determining the number of stocks in the portfolio, we use the numpy round function to round each stock to the nearest integer. We also keep track of the stocks that we rounded up. We run a while loop, in which in the first run, if there isn't enough cash in the account only those units that were rounded up will go down by 1. If there still isn't enough account, we overestimate and decrease all the stocks by 1 (stocks that are not 0). We then add a unit to each stock that should be rounded up until we go through all the stocks.

If we are able to decide which stocks to buy after decreasing all of the stocks, it may give a more optimal portfolio, whether how close it was to be rounded (since any weight after X.5 is rounded to X+1), or by the value of the stock (stocks worth \$2000 vs stocks worth \$200).