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Given a set of assets and a time period, portfolio optimization seeks to find an allocation of funds to assets that maximize performance. We can choose to optimize for one of several different performance metrics, such as cumulative return, volatility/risk, or Sharpe ratio. In this lab we chose to optimize using sharpe ratio, volatility, constant values for asset allocation, and compared them all against SPY.

The SPDR S&P 500 ETF Trust, also known as the SPY ETF, is one of the most popular funds that aims to track the Standard & Poor’s (S&P) 500 Index, which comprises 500 large-cap U.S. stocks. These stocks are selected by a committee based on market size, liquidity, and industry. The S&P 500 serves as one of the main benchmarks of the U.S. equity market and indicates the financial health and stability of the economy.

By comparing our optimizers against SPY, we are able to see how they performed compared to the top 500 US stocks. A lot of financial education currently out on the internet mainly recommends just putting your money into SPY, as it is reliable and consistent. However, this lab was very interesting to do, as even with limited data and knowledge, it is quite easy to beat SPY.

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The Sharpe ratio compares the return of an investment with its risk. It's a mathematical expression of the insight that excess returns over a period of time may signify more volatility and risk, rather than investing skill. A Sharpe ratio less than 1 is considered bad. From 1 to 1.99 is considered adequate/good, from 2 to 2.99 is considered very good, and greater than 3 is considered excellent. The higher a fund's Sharpe ratio, the better its returns have been relative to the amount of investment risk taken.

Volatility is the rate at which the price of a stock increases or decreases over a particular period. Higher stock price volatility often means higher risk and helps an investor to estimate the fluctuations that may happen in the future.

The original four stocks that were used for this project were IBM, X, GLD, and JPM. However, looking back at the alpha, beta, and correlation values in homework 3, there were stocks that performed much better. The stocks that performed better were …

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For the old date range, I chose to use from January first two thousand and ten to December thirty first two thousand and ten. This is a time of one year. I chose to use the stocks that were given for this project which were IBM, X, GLD, and JPM. The Sharpe ratio for these stocks was 2.004015010974459. This is a very good Sharpe ratio, as it is just barely in the range of 2 - 2.99. The volatility of the portfolio was 0.010116382074722775. This is a very small volatility and means that the portfolio has very low risk (and may in turn have lower reward). I picked this portfolio, as it outperforms SPY by an incredible amount. The portfolio that I chose had an Average Daily Return of 0.00127710299463355. The portfolio that I chose had a Cumulative Return of 0.3600907850048875. For these plots, the custom protocol that I chose is performing better than allocation based on volatility, but worse than allocation based on Sharpe Ratio. The optimal allocations for GOOG, GLD, AAPL, and XOM respectively were: [9.20085112e-17 6.03338476e-01 3.96661524e-01 0.00000000e+00].

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When evaluating a more recent date range, I chose to use from January first two thousand and twenty-one to June thirtieth two thousand and twenty one. This is a time of one year. I chose to use the stocks that were given for this project which were GOOG, AAPL, GLD, and XOM. The Sharpe ratio for these stocks was 3.7378542721624206. This is an extremely good Sharpe ratio, as it is well above the range of 2 - 2.99. The volatility of the portfolio was 0.014462016506464545. This is a very small volatility and means that the portfolio has very low risk (and may in turn have lower reward). I picked this portfolio, as it outperforms SPY by an incredible amount. The portfolio that I chose had an Average Daily Return of 0.0034052652616230875. The portfolio that I chose had a Cumulative Return of 0.5000578389257891. For these plots, the custom protocol that I chose is performing better than allocation based on volatility, but worse than allocation based on Sharpe Ratio. The optimal allocations for GOOG, GLD, AAPL, and XOM respectively were: [0.578024 0.000000 0.000000 0.421976]. As can be seen from the Sharpe ratio, these stocks performed much better than the ones I previously analyzed. As you can see, the portfolio value based on Sharpe ratio outperformed all of the others, followed by a constant of 0.25 for all four stocks, and in last place was optimization based on volatility.