**Assignment 6.1**

Quantconnect uses R\* to compute the Sharpe Ratio, which means using averaged daily return when calculating annual return. I think we should use R instead of R\* instead. For example, when the stock price goes up 10% in the first day then go down 10% in the second day: r(t) = 1.1\*0.9 - 1 = -0.01 while r\*(t) = 0.1-0.1 = 0. Our true total return rate is r(t) instead of r\*(t).

QuantConnect likely uses R∗ because it smooths returns and reduces sensitivity to short-term fluctuations, making Sharpe Ratio calculations more stable. This approach works well for long-term performance analysis and avoids extreme values caused by outliers. However, it fails to capture compounding effects and can distort actual profitability, especially in volatile markets. In contrast, R provides a true measure of cumulative returns but may introduce more variability. Since compounding determines actual investment performance, I think using R would give a more accurate representation of returns and a more reliable Sharpe Ratio.

**Assignment 6.2**

Q1 we can compute this allowing or not allowing shorting.

First, we can try compute it not allowing shorting.

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Second, we can try the version with shorting. This greatly increases the range of volatility the portfolio can cover.

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Q2

If we do not allow shorting, we cannot construct a portfolio that can reach a volatility of 1.80%. So we consider solving this problem under the circumstances that shorting is allowed.

Optimal Weights (Allowing Shorting): MS: 1.4098, XOM: -0.4098

Highest Expected Daily Return (Allowing Shorting): 0.1408%

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Q3

SR[XOM] < SR[0.5MS+0.5XOM] < SR[MS] < SR[SPY]

Firstly, we can explain SR[XOM] < SR[0.5MS+0.5XOM] < SR[MS]. This is because MS performs much better than XOM. The return of Portfolio 0.5MS+0.5XOM is the average of Portfolio MS and Portfolio XOM, and in this case, the SR will mainly be affected by the return.

Secondly, we can explain SR[MS] < SR[SPY]. This proves Equation (2), which is the Sharpe Ratio of the market is higher than the SR of a single stock. The S&P 500 includes a diversified set of stocks, which helps reduce overall risk and increase returns in comparison to a single stock.

Backtesting link for the buy-and-hold strategy of MS:

<https://www.quantconnect.com/terminal/processCache?request=embedded_backtest_85ae71484ab9ca563e7928751c4c215f.html>

The Sharpe ratio is 0.925 for MS.

Backtesting link for the buy-and-hold strategy of XOM:

<https://www.quantconnect.com/terminal/processCache?request=embedded_backtest_a9eb2434f38af3ab20647cf329b72c25.html>

The Sharpe ratio is -0.465 for XOM.

Backtesting link for the buy-and-hold strategy of 0.5MS+0.5XOM:

<https://www.quantconnect.com/terminal/processCache?request=embedded_backtest_dc87b6b23f68798462d73a7d1117b326.html>

The Sharpe ratio is 0.505 for 0.5MS+0.5XOM.

Backtesting link for the buy-and-hold strategy of SPY:

<https://www.quantconnect.com/terminal/processCache?request=embedded_backtest_325016dc0aa3152147175f266cfdde98.html>

The Sharpe ratio is 2.229 for SPY.