

Python Project: Portfolio Analysis and Sharpe Ratio Optimization

Yanis Calvo

November 2024

1 Project Summary

Portfolio Analysis and Sharpe Ratio Optimization is a project applying quantitative finance and data science techniques to analyze the performance of several major tech stocks (AAPL, MSFT, GOOGL, AMZN, TSLA) and optimize a portfolio based on the Sharpe Ratio.

2 Main Features

- Automatic stock data download via yfinance.
- Data cleaning and transformation: extraction of Close, Open, and Volume columns.
- Integration of US holidays to filter out non-trading days.
- Financial calculations:
 - Simple and logarithmic returns;
 - Cumulative returns;
 - Annualized volatility (30-day rolling window);
 - Sharpe Ratio per stock.
- Portfolio optimization using scipy.optimize:
 - Sharpe Ratio maximization;
 - Constraints: sum of weights = 1, no short selling.
- Visualizations with matplotlib:
 - Normalized performance (base 100);
 - Cumulative returns;
 - Annualized volatility;
 - Sharpe Ratio bar chart.

3 Technologies Used

- Language: Python 3.x
- Main libraries:
 - yfinance
 - pandas
 - numpy
 - matplotlib
 - scipy
 - holidays

4 Analysis Methodology

4.1 Data Acquisition and Cleaning

Historical data (prices and volume) is collected for the selected stocks between 2022-01-01 and 2025-01-01. US holidays are filtered using the holidays module to keep only actual trading days.

4.2 Financial Indicators Calculation

Simple Return:

$$R_t = (P_t - P_{t-1}) / P_{t-1}$$

Logarithmic Return:

$$R_{\log,t} = \ln(P_t / P_{t-1})$$

Cumulative Return:

$$R_{\text{cum}} = \prod (1 + R_i) \text{ for } i = 1 \text{ to } t$$

Annualized Volatility:

$$\sigma_{\text{ann},t} = \text{std}(R_{t-29}, \dots, R_t) \times \sqrt{252}$$

4.3 Sharpe Ratio Calculation

The Sharpe Ratio evaluates the risk-adjusted performance of an asset:

$$\text{Sharpe Ratio} = (R_a - R_f) / \sigma_a$$

Where:

- R_a : annualized average return of the asset;
- $R_f = 0.02$: risk-free rate (2%);
- σ_a : annualized volatility of the asset.

4.4 Analysis Results (Example)

Symbol	Sharpe Ratio
AAPL	0.522149
GOOGL	0.414737
MSFT	0.407857
TSLA	0.308741

Interpretation: A higher Sharpe Ratio indicates better return per unit of risk. Over this period, AAPL shows the best risk-adjusted performance.

5 Portfolio Optimization

The optimization aims to find the weights w_i that maximize the portfolio's Sharpe Ratio:

$$\max_w (E[R_p] - R_f) / \sigma_p$$

Subject to constraints:

- $\sum w_i = 1$ (fully invested)
- $w_i \geq 0$ (no short selling)

The solution is computed using the `minimize()` function from the `scipy.optimize` module, by inverting the sign of the Sharpe Ratio to achieve maximization.

6 Visualizations

The charts include:

- Normalized price evolution (base 100);

- Cumulative returns;
- Annualized volatility (30-day window);
- Sharpe Ratio bar chart.

7 Possible Improvements

- Add more stocks or sectors for diversified analysis;
- Test different calculation frequencies (weekly, monthly);
- Compare multiple optimization methods (Markowitz, Black-Litterman, etc.);
- Create an interactive interface using Dash or Streamlit.