Homework Assignment: Constrained Portfolio Optimization

Background:
Portfolio optimization is a financial strategy where an investor chooses allocations for a set of assets to maximize potential returns and minimize risk. This task will involve creating a portfolio that is a combination of risk-free and risky assets, aiming to achieve a specified level of return while considering the volatility of the portfolio. Read carefully the **Readme** file.

Objectives:
Understand the principles of the Markowitz Portfolio Optimization model.
Apply constrained least squares optimization to find the optimal portfolio weights.
Analyze the trade-off between portfolio return and risk.
Implement a two-fund theorem approach for portfolio allocation.

Theoretical Understanding:
Review the material on portfolio optimization, risk, and return. Understand the role of a risk-free asset in a portfolio.
Study the two-fund theorem and how it applies to portfolio optimization.

Tasks:
In this problem you will optimize a set of holdings to minimize risk for various average returns. You will find the files portfolio_data.txt which contains 20 columns. The first 19 are returns for 19 stocks and the last column is for a risk-free asset. Use as training set (R_train) the first 2000 rows, daily returns over a period of 2000 days, and the last ~500 rows as test data (daily returns over a different period).
Using R_train to find asset allocation weights for the portfolios that minimize risk for annualized returns of 10%, 20% and 40%. (To obtain annualized return multiply the daily return by P = 250 trading days.)

- Calculate and plot the cumulative value of the portfolio over time for the training and testing datasets, starting with an initial investment of $10,000.
- Report the annualized return, risk, asset with minimum and maximum allocation, and leverage for each portfolio.
- Comment on the difference in portfolio performance between the training and testing sets.

Additional Challenge (Optional) [5 more points]:

Extend the optimization to include transaction costs or other real-world considerations such as taxes or liquidity constraints.

Consider the effects of adding constraints on investment concentration or industry exposure

Evaluation Criteria:

Correctness of theoretical understanding and calculations.
Successful implementation of the constrained optimization.
Quality of code and clarity of the report.

.