

## **Project : Mean-Variance Optimal Risky Portfolio Using Simulation**

### *Concept:*

Portfolio optimization is an important task done by portfolio managers. Not to be confused with portfolio selection, this task is about finding optimal weights for each of the selected securities in such a way that the portfolio is mean-variance efficient. That is, if there are multiple ways to structure the portfolio, find the optimal way such that the portfolio selected dominates (or is not dominated by) other choices.

While there are analytical ways to determine the optimal portfolio, a particularly simple yet sound method is the simulation method. Using a random sampling of portfolio weights, portfolios are constructed and compared in mean-variance space. From this comparison, an optimal portfolio is chosen. Please note that the optimal portfolio is the point of tangency in the risky set when a line is plotted between the risk-free rate and feasible portfolios; most finance text books have this graphic. Computationally, the optimal portfolio is the one with the highest Sharpe ratio.

There are two components to this project. First, you create an R function to analyze stock-return data to output mean-variance metrics for a collection of stocks as well as information about simulated portfolios. Second, you plot the simulated portfolios and identify the optimal portfolio – use ggplot2 and format appropriately.

### **Requirement (Must meet all):**

1. Write an R function (name it myMeanVarPort) to solve for mean-variance optimal risky portfolio and depict it in a plot.
  - a. *Inputs:* file containing vector of TICKERs, a begin date, an end date, risk-free rate.
  - b. *Output:* an appropriately formatted list containing (a) the vector of stock means; (b) the covariance matrix; (c) relevant information (weights, mean, sigma) for each simulated portfolio. Use monthly values in your calculations.
2. Using the output from the above function produce a plot of the portfolios and clearly identify with annotation the optimal portfolio.
3. Your code should reflect a procedure discussed in a lecture video wherein you simulate portfolio weights to construct 100N portfolios (that is, number of securities times 100) with random positive weights. Please use set.seed value (12).
4. Run your function using the following inputs: c("GE", "XOM", "GBX", "SBUX", "PFE", "HMC", "NVDA"); 20140101; 20171231; 0.
5. Use R Markdown to construct your report. Reporting requirements are cumulative – address issues identified in previous work.
6. Create a pdf file for submission of length  $\leq 7$ -8 pages (no less than 7 and no more than 8!!!!).

7. Must explain each code line (why are you using that formula, and what is the outcome), must explain the results.

8. You must include a report format, which means you will need an introduction, body and conclusion with different analysis on the results.

*Submission: pdf file, html file and a page of the code so that I could run it myself.*

**Additional explanation:**

1. Use getSymbols to obtain monthly adjusted prices and use periodReturns to calculate returns.

**Grading Rubric:**

1. Analysis: Accesses data/information and processes appropriately. Codes/analyzes clearly, completely, and correctly. Documents clearly. Goes beyond benchmark and displays excellence.
2. Reporting: Writes (structure, content) clearly and effectively. Articulates task, approach, analysis, and alternatives. Draws valid conclusions or inferences. Provides insight appropriate to the assignment. Completely clear.