

# Portfolio Optimization

## Business Objective

Portfolio optimization is the process of choosing the optimal portfolio (asset distribution) from a set of all possible portfolios based on some criterion. Typically, the goal is to optimise parameters like expected return while minimising variables like financial risk. In financial sense of word, the standard deviation of a time series is referred to as Risk or volatility and the difference between two points in a time series is defined as Return.

Optimizing the weights of asset classes to hold and optimising the weights of assets within the same asset class are two common steps of portfolio optimization. The portfolios we create can be tailored to the preference of any individual. The said preferences are dependent on each person's unique utility function of the form –

$$F(U) = \alpha \text{Returns} - \beta \text{Risk}$$

We can see that the optimal amount of Risk and Return is proportional to the ratio of  $\alpha/\beta$ .

In this project, we will be creating a portfolio from stocks in the Canadian stock market. Log-returns of adjusted closing values of stocks being traded will be extracted using the Yahoo Finance API. We will select the top-performing Stocks next. Here TSX, that is Canada Stock Market Index, is used as a benchmark. We will develop multiple portfolios, learn their investment growth rate compared to TSX and then choose the optimal portfolio by referring to the CAPM analysis on multiple portfolios and the keymatrix.

## Data Description

We will be extracting the list of companies that currently have their stocks up for trading from Wikipedia and log returns of stocks using Yahoo Finance API.

## Aim

To perform CAPM analysis on stocks and find best suited portfolio using portfolio optimization.

## Tech Stack

- Language - R
- Libraries – tidyverse, tidyquant, htmltab, dplyr, rlang

## Approach

1. Importing the required libraries and packages
2. Open the config.ini file. (This is a configuration file which can be edited according to your dataset)
3. Extracting list of stocks currently being traded from Wikipedia
4. Formatting ticker names so that they can be recognized by Yahoo Finance API
5. Extracting log returns of stocks and the Index (XLK)
6. Perform CAPM analysis

7. Finding top stock percentile
8. Creating portfolios based on top performing tickers
9. Creating multiple portfolios using same Tickers as before but multiplied by our desired number of repetitions
10. Performing CAPM analysis on them
11. Calculating Key matrix
12. Deciding suitable portfolio by choosing the portfolio of interest from CAPM analysis and looking it up on the key matrix table

## Modular code overview

```
input
|_config.yml

src
|_engine.R
|_ml_pipeline
|_utils.R

lib
|_Portfolio_Optimization_TSX.R

output
|_keymatrix.csv
|_CAPM_stock.csv
|_CAPM_multiple_portfolio.csv
```

Once you unzip the modular\_code.zip file you can find the following folders within it.

1. input
2. src
3. output
4. lib
  1. input folder - It contains all the data that we will need for analysis.
    - A config file, with some basic configuration parameters which can be edited according to your dataset.
  2. src folder - This is the most important folder of the project. This folder contains all the modularized code for all the above steps in a modularized manner. This folder consists of:
    - engine.R
    - ml\_pipeline

The ml\_pipeline is a folder that contains all the functions put into different python files which are appropriately named. These python functions are then called inside the engine.R file.

3. output folder – The output folder contains the outputs of CAPM analysis for a single portfolio as well as multiple portfolios. It even consists of the keymatrix in CSV format.
4. lib folder - This is a reference folder. It contains the original R notebook that we saw in the videos.

### **Project takeaways**

1. Understanding the problem statement
2. Understanding how financial markets work
3. Understanding the demand and supply mechanism
4. Understanding Returns and Risk
5. Understanding Index and Portfolios
6. Understanding Financial Indicators
7. Learning how to download HTML data
8. Using libraries like tidyverse and tidyquant
9. Using libraries like dplyr, rlang and htmltab
10. Extracting log returns using Yahoo Finance API
11. Finding top performing stocks
12. Finding investment growth rate of the portfolio
13. Understanding investment growth rates via plots
14. Understanding Capital Asset Pricing Model
15. Performing CAPM analysis
16. Finding investment growth rate for multiple portfolios
17. Plotting investment growth rates of multiple portfolios
18. Finding a best suitable portfolio