BCI Quantitative Equity Take-Home Assignment

Please answer the questions below and submit the following items by email:

- A report (PDF or PowerPoint file) that describes your findings
- The Python code (Jupyter notebook) that you used to perform your analysis
- A python package specification file (requirements.txt) generated via pip package manager highlighting package dependencies in your code

If any of the instructions seem unclear, please outline your assumptions in your responses.

Please obtain daily Close prices for the following 10 stock tickers from Yahoo Finance over the period from January 1, 2012 – December 31, 2021 (in USD): AAPL, AMZN, GOOG, INTC, ORCL, XOM, CVX, COP, HES, OXY.

You may wish to use the free yfinance Python package (**https://pypi.org/project/yfinance/**) to extract the data from Yahoo Finance.

We will be evaluating your submission for correctness and quality. Note that high quality code is legible, standard-conformant, testable, and well-documented.

This is your opportunity to demonstrate your research intuition and creativity!

1. Generate daily returns using the Close prices over this period for AAPL. Are the daily returns normally distributed? Provide some evidence to support your answer.

2. A colleague is interested in creating a model to predict the future price of AAPL stock using ordinary least squares to regress the price on day *t* on the price at day *t-1* and a constant:

   $$P_t = a + b\, p_{t-1} + e_t$$

   Is this a suitable model to predict the future price of AAPL? Do you think OLS is appropriate for estimating the parameters *a* and *b*? If so, estimate the parameters *a* and *b* using your data. If not, please explain why it is inappropriate.

3. Compute the correlations of daily returns for the 10 stocks over the period and comment on your findings.

4. A colleague of yours is curious whether the 10 stocks exhibited similar behaviour during the pandemic. You think that the performance was different across two groups of stocks. Generate quarterly returns over this period for all 10 stocks. Perform a K-means clustering with two groups using quarterly returns from Q2 2020 to Q4 2021 (7 features for each stock) for each of the 10 stocks. Comment on your findings.

5. You are deciding how to weight the 10 stocks in creating a suitable portfolio. Calculate the set of optimal portfolio weights across the 10 stocks such that you minimize the variance of portfolio returns. Comment on the optimal portfolio weights and potential issues.

Given

- Q is the daily return covariance matrix across the 10 stocks in 2021
- x is the vector of portfolio weights.

Global Minimum Variance Portfolio (GMVP) is the solution to the following optimization problem

$$arg \min_{x} x^T Q x$$

Subject to the following constraints:

1. All portfolio weights are positive
2. "Budget constraint" that portfolio weights sum to 1