Project Proposal: Portfolio Optimization of Large Institutional Investors

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1 Objective

Create a voila based web application which helps the users add homeowner equity to their existing portfolio and use robust optimization algorithms for optimal allocation. The tool would also help visualize various risk metrics and the back test results. The user would also be able to customize the weights and visualize it.

2 Inputs and Outputs

Inputs:

- Time series of returns for the assets (can be extended to fetch the data from Yahoo Finance/Bloomberg etc.) .
- Inputs for optimization constraints
- User-customized weights

Outputs:

- Correlation matrix
- Time Series plots
- Optimization outputs such as Efficient Frontier, Optimal Weights, Comparison between various optimization strategies (such as min-vol, max-sharpe)
- Pie charts to show the optimal weight allocations.
- Backtesting results
- Risk metrics such as risk, returns, vol, var, cvar etc.

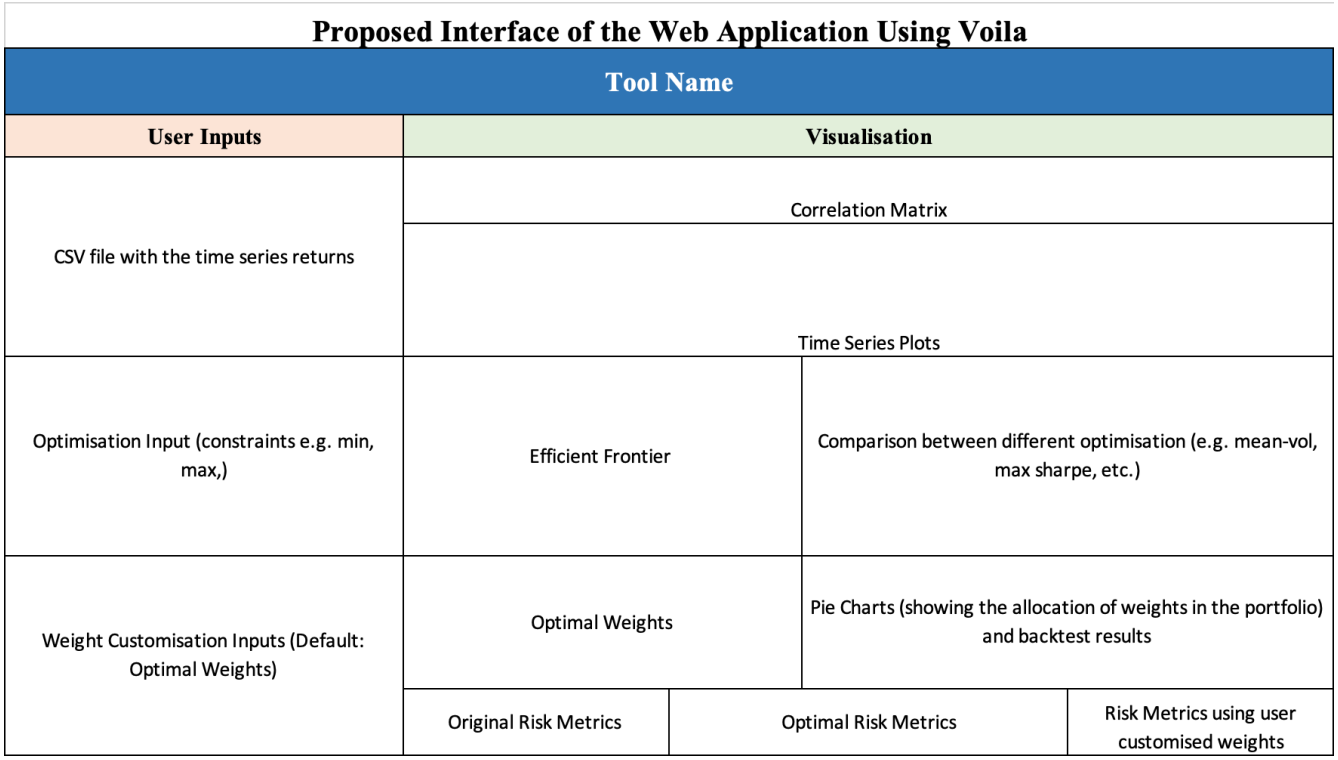

Figure 1: Web Based Application using Voila

3 Model

To develop the portfolio optimization tool, we will use Markowitz's mean-variance analysis. As input we will be taking in n assets and $[w_i]$ vector of corresponding portfolio weights from the user. To these n assets, the user would be able to add k more securities representing homeowner equities. Now we have $n + k$ risky securities with return vector R generated from CSV file of time series returns, such that

$$R \sim MVN_n(\mu, \Sigma)$$

Using the new asset the mean-variance optimization problem can be framed as:

$$\begin{aligned} \min_{w} \quad & \frac{1}{2} w' \Sigma w \\ \text{s.t.} \quad & w' \geq 0 \\ \text{and} \quad & w'1 = 1 \end{aligned}$$

Above optimization problem can be solved using Lagrange multiplier methods. We would use CVXOPT, a widely used python package for convex optimization, to generate more than 500 solutions to generate the efficient frontier. The portfolio with the highest Sharpe ratio will be chosen as the optimal portfolio. Moreover, users would also have the functionality to add asset and group level constraints(max, min, etc.). This would allow them to decide how far they want to take the new portfolio from the original weights while adding the new asset.