AMS 325 Final Project Proposal

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Final Project Title: Quantitative Finance Portfolio Optimization

Project Summary & Objectives:

Using the skills, libraries, and methods learned in the Python section of AMS 325 - we look to create a quantitative finance driven portfolio optimization algorithm with many features (we look to incorporate as many of these as possible with the time in hand). The project is fueled from a desire in implementing mathematical techniques through code in the world of finance, and developing a tool for potential personal use as well. The user will input the number of stocks they would like to have as part of the portfolio (all must be US equities), and then input what stocks they are (financial data is retrieved from Yahoo Finance - finance library). We look to then generate a visual of the efficient frontier - showing the risk-return trade off as we want a portfolio that is on this frontier line for the sake of optimality. Furthermore, we want to compute the optimal allocation/weights of the stocks in terms of a percent of the "x" amount of capital one has ready to invest that will maximize portfolio returns or minimize risk. Next, we look to implement Monte Carlo simulations to model future performance of the optimal portfolio based on past data + performance, and we want to run many simulations (1000) and then study the expected value, along with standard deviation / volatility of the portfolio given the many simulated "paths", with probabilities displayed to better understand the chance the portfolio is higher or lower than certain numerical thresholds. Along with metrics measuring the overall portfolio's expected annualized return and volatility, we want to calculate these statistics for the individual stock components as well. The visual displays include: efficient frontier, Monte Carlo simulations, portfolio weightage gradient display, and comparison of the portfolio's performance compared to standard indices, such as the S&P 500. The motivation of the project is to create a quantitative approach to creating a portfolio of desired equities, and studying its performance, outlook, and customizing features based on one's risk appetite. We will be using pandas, numpy, matplotlib, scipy, yfinance, and other libraries in Python - and look to test out many sample portfolios with various stock quantities and stocks to see and compare the various outputs - which can be used and developed further for one's personal portfolio or potentially even at a workplace with more sophisticated mathematics and techniques incorporated. We can compare these portfolios to traditional investing strategies and compare the risk and returns of non-traditional investment approaches, and see how the data span used in the model affects outputs. We will be implementing mathematics from Modern Portfolio Theory (covariance matrices, Markowitz mean-variance optimization, and tangent portfolios). Although this project is high in volume, and we have mostly an interest rather than strong background in QF, we look to learn as much as possible and execute as much of these ideas into code in the allotted time.