Prof. Man

CPE 322 HW4

Portfolio-Risk Benchmark Selection Software

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I pledge my honor that I have abided by the Stevens Honor System.

Project Abstract

The general idea of the project is a software that can select an appropriate risk exposure level (benchmark) for a given portfolio according to different clients' risk preferences. We want to start with a simple portfolio then different risk exposure level will be generated by different parameters (total cash, risk preference etc).Different risk models will be tested in the project. Those models will be obtained from some of the top quality papers in the field of risk management. There will be also improvement(from us) on these models, if possible. Now there are two members in the group: **Nirali Shah and Zixuan(Shin) Liu.** However, we are looking add more group members from the quantitative finance majors next year when the senior design cycle starts.

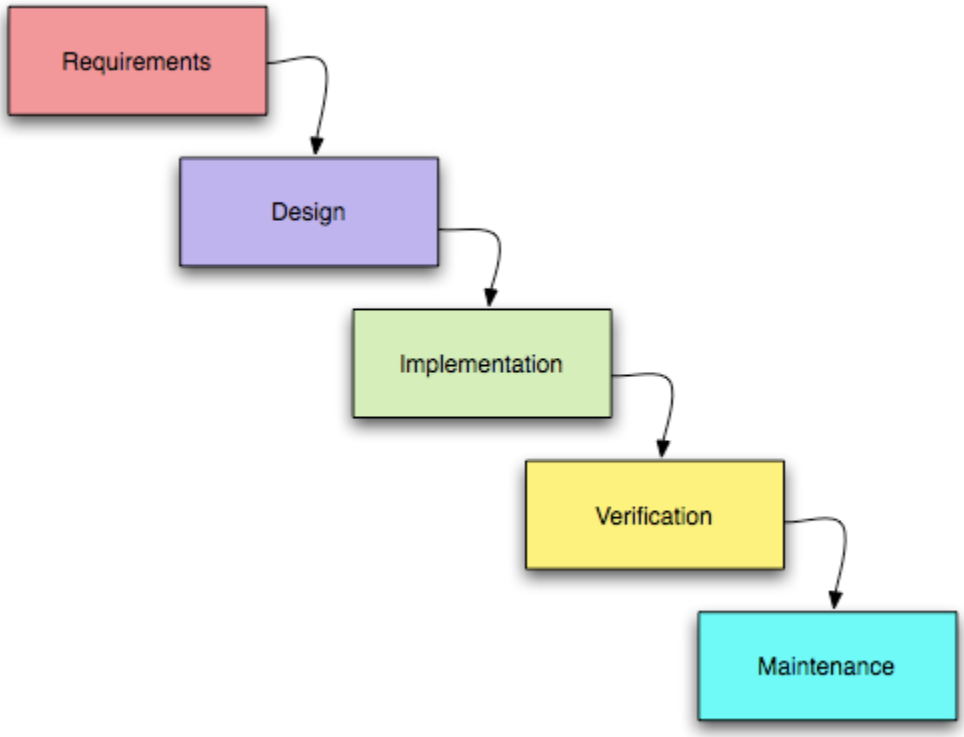
Project Inception

The inception of this project comes from our strong interest in the subject of quantitative finance. For the 1st homework assignment, both of the group members wrote quantitative finance related proposals. Nirali proposed a trading algorithm software while Zixuan proposed a risk management data aggregate reporter. Though these two proposals are not completely related, it brought to students together to write a cohesive financial engineering related software project. There is going be be heavy modelings and simulations in the project and the CPE 345(Modeling and Simulation) will be particular useful for this project. Meanwhile, the group met with Prof. Calhoun who is the director of Stevens quantitative finance program to discuss possible collaborations with senior QF students and he said yes. So despite we only have 2 people in the team right now, more students will join next semester to form 4 or 5 people team.

Project Structure & Development Cycle

Our current idea of the project is to develop an user interface where clients and construct simple portfolios and their risk preferences. Through the parameters they input the software can generate an appropriate maximum risk exposure(benchmark) of the portfolio. The results will be converted into cohesive presentation format if needed. The most critical component of the project will be the interface programming and mathematical modelings. Different risk evaluations techniques will use through out the project.

The project employs heavy quantitative components and simulations but after all it is still a software project so it will follow a typical software project development cycle. Please refer the chart as a simple software life development cycle:



These 5 steps are crucial for the project. In other words, they are the milestones of the project:

- **Requirement**: We need to identify clients' need and how they want the product to be like. A product which doesn't meet clients' requirements will soon be kicked out of the market. This requirement could be done by surveying some selected hedge fund and

asset management firms.

- **Design:** This part involves heavy mathematical modeling. We need to investigate the theory behind every formula we use.
- **Implementation:** In this phase we need to translate mathematical language into programming languages.
- **Verification**: In this phase we need to work on debugging and and refine the requirements of the project.
- **Maintenance**: Make sure they system run smoothly as a whole.

Mathematical Models

Here is the definition of a simple portfolio .We assume that $E[|R_j|] < \infty$ for all $j = 1, \ldots, n$. Our objective is to shape the distribution of the total return rate on the investment. Denoting by $x1, x2, \ldots, xn$ the fractions of the initial capital invested in assets $1, 2, \ldots, n$ we derive the formula for the total return rate:

$$R(x) = R1x1 + R2x2 + \cdots + Rn\,xn.$$

The set of possible asset allocations is defined as follows:

$$X = \{x \in Rn : x1 + x2 + \cdots + xn = 1, x_j \geq 0, j = 1, 2, \ldots, n\}.$$

Here we introduce the mean risk model:
The mean–risk portfolio optimization problem is formulated as follows:

$$\textbf{maximize } x \in X \rightarrow E[R(x)] - \lambda \upsilon[R(x)].$$

Here, λ is a nonnegative parameter representing our desirable exchange rate of mean for risk. If $\lambda = 0$, the risk has no value and the problem reduces to the problem of maximizing the mean. If$\lambda > 0$ we look for a compromise between the mean and the risk.

The mean risk model is the most simple and popular model regarding to risk measures. We will start to build the project from this model. Further elaborations and more models will be introduced in the future assignments.

Programming Language(s)

We intend to use MATLAB to write our software. MATLAB's interactive programming environment and pre-built computational libraries help develop quantitative applications much faster than in languages like C++ or Visual Basic. The primary advantages of MATLAB are minimal development time therefore faster results and its easily accessible help files and technical assistance. Financial companies like Barclay's Capital, Goldman Sachs and many others use MATLAB to model and analyze risk.

References and Background Information

Wikipedia, YouTube and especially KhanAcademy are good introductory websites to brush the basic financial concepts. Being computer engineers, we don't have extensive knowledge in finance and before we begin reading published articles and core finance books I believe that these websites would be a great resource to understand basic concepts. KhanAcademy was a particularly interesting website because it is developed by an engineer to help average people gain a better understanding of the financial market. Especially its tutorials on mortgage-backed securities, the housing price conundrum, collateralized debt obligation, credit default swaps, bankruptcy and bailout were excellent beginner's materials to understand the finance industry.

Google Scholar has an excellent database of published articles and books so searched its database for relevant books and articles. Active Portfolio Management: A quantitative approach for Providing Superior returns and Controlling Risk by Crinold and Kahn. This book is a must read for anyone interested in the quantitative finance industry. It provides detailed information about active portfolio management, various mathematical models and theories that are being used by professionals, pros and cons of various models, and it finally explains the fundamentals of forecasting. We haven't had a chance to read the entire book but reading various reviews online it seems to be a valuable resource for our project.

Next interesting paper we found: Combining Probability Distributions From Experts in Risk Analysis. This paper presents a combination of experts' probability distributions in risk analysis, discussing a variety of combination methods to highlight the important conceptual and practical issues to be considered in designing a practical risk analysis model. It delves into the pros and cons of different methods and the key issues to consider during the design of a combination process for a specific probabilistic risk analysis. This paper is an excellent summary of the current state of expert opinion regarding the uncertainty of interest.

Our project is primarily risk modeling and we plan on using the Monte Carlo Model for our project. Monte Carlo are a class of computational algorithms that rely on repeated random sampling to compute their results. They are often used in simulating physical and mathematical systems. They are useful for modeling phenomenon with significant uncertainty in inputs, such as the calculation of risk in business. Further, they are often used to calculate the values of companies, to evaluate investements in projects at a business unit or corporate level, or to evaluate financial derivatives. Therefore, Monte Carlo Simulation and Finance by Don McLeish would be another great read as it explain the nuts and bolts of the Monte Carlo Simulation to value derivatives and other securities. The book discusses specialized problems in finance

that Monte Carlo methods can help solve and the different ways Monte Carlo methods can be improved upon. Our current class Modelling and Simulation would also be helpful to our project as it would provide us with the basics of creating and simulating a model.

Prof. Creamer is a Quantitative Finance Professor at Stevens Institute of Technology. Risk Management and Corporate Governance is one of his research interests. He is very learned and has published many related articles and therefore we hope that he would be a great resource for us during this project.

References:

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7. Dentcheva & Ruszczyński
   Portfolio Optimization with Risk Control by Stochastic Dominance Constraints

SWOT Analysis

Strengths: Our project is primarily writing a software and as we intend to use MATLAB to write it, which Stevens provides for free, there isn't a cost issue for this project. As has been mentioned in the background information there are a lot of great books and articles that will help us in our project. Every company and most individuals maintain portfolios. The size and risk level varies vastly though. Irrespective of the size of the portfolio modeled, a successful project would be very marketable. Both team members aer interested in finance and are taking classes which makes it a more practical project considering time and skill set.

Weakness: The length constraint of the senior design curriculum will allow us to only analyze a simple linear portfolio. We will not be able to test a more complex portfolio with swaps, futures and options. As these instruments are traded actively in the real world it will be one of the primary weaknesses of the project.

Opportunities: We intend to begin our project with a relatively simple portfolio with different risk levels. If we can model risk for a simple portfolio with different risk levels then we can move on to more complex portfolios. There is a lot of room for growth and the project has great potential.

Threats: The modeling techniques being used in this project are highly complex. If a bad or inaccurate model is applied to the portfolio then an incorrect benchmark may jeopardize the client's decision making process. In the real world, it could mean a loss of millions of dollars. Therefore, the accuracy of this model is extremely important and an inaccurate model might be one of the biggest threats to the project.

Group Members Assignments

The workload of this group assignment was responsibly shared among the members. Both individuals performed their respective tasks and came up with information essential to this report. Extensive research was conducted to be as accurate as possible. It was understood that the foundation of the project was fundamental principles. As there are only two members each member contributed approximately half of the report.

Zixuan(Shin) Liu: Wrote the first part of the project that included abstract, project inception and project structure and development cycle. Conducted research for the various mathematical models that could be used for the project.

Nirali Shah: Researched various programming languages that could be used for the project. Additionally, researched various websites, articles and books that would be resourceful for the project.