Towson University
Department of Computer & Information Sciences
COSC880/AIT 880

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Tentative Project Title: Probabilistic Financial Risk Framework

Graduate Credits Completed: 21

Semester to Register: Fall ____ Spring **X** Summer____ Year 2025

Advisor's Name: Dr. Akshita Maradapu Vera Venkata Sai

Project Description/Abstract:

With the growing complexity of financial markets, accurate risk assessment is crucial for investors aiming to optimize portfolio performance while managing potential downsides. This project proposes a software solution designed to assist users in generating financial risk calculations based on their unique portfolio data. Leveraging established financial risk models and data analytics, the system accepts portfolio information as input, processes it through a suite of risk assessment algorithms, and outputs comprehensive risk indicators tailored to the user's assets. The primary objective of this software is to provide personalized risk metrics, incorporating various risk factors such as volatility, correlation, and potential loss estimates. By facilitating data-driven insights, this system aims to equip investors with the knowledge to make informed decisions in an increasingly dynamic financial landscape. This approach includes aspects from the fields of computational finance and software development by offering a user-oriented tool for financial risk assessment.

Project Topics to be Studied:

1. Financial risk management and quantitative finance
2. Algorithmic approaches in risk modeling
    a. Monte Carlo simulations
    b. Markov Chain Monte Carlo simulations
    c. Metropolis-Hastings algorithm
    d. Value at Risk (VaR) and Conditional Value at Risk (CVaR)
3. Probabilistic machine learning models for finance and investing
4. Parallel computation

Project Objectives:

1. Understand Financial Risk Modeling Techniques -understand financial risk modeling, including key metrics like Value at Risk (VaR), Conditional Value at Risk (CVaR), and volatility.

2. Apply Bayesian and Probabilistic Machine Learning Approaches for Risk Assessment - Bayesian methods and probabilistic models may enhance the accuracy and robustness of risk predictions by incorporating uncertainty and adaptive learning into risk assessments.

3. Exercise data analysis skills - develop skills in processing, cleaning, and analyzing financial data to prepare it for input into the risk model (e.g. understanding time-series data, outlier detection, financial data visualization, etc. for accurate model performance)

Deliverables:

1. Source Code
   a. Complete Source Code
   b. Version Control Repository: Access to Git repository hosting the source code with detailed commit history demonstrating development progress
2. Documentation
   a. Requirements Documentation: A detailed document outlining the project requirements, including functional and non-functional requirements.
   b. Design Documentation: System architecture diagrams, API design specifications, and risk model specifications.
3. Application
   a. Deployed Application: Application deployed on a hosted server
   b. Live Demo: A live demonstration of the application during the project presentation.

Anticipated Project Timeline:

Task	***Start Date***	***Notes***
Review meeting 1	27 Jan	Review project progress
Review theoretical underpinnings of risk modeling	3 Feb	Review the theory of algorithms for complete understanding to allow for ease of implementation
Data collection and preprocessing	10 Feb	Determine which data to be used to test the system and which data will be valid
Review meeting 2	17 Feb	Review project progress
Begin MCS implementation	24 Feb	Start implementing necessary code for MCS trials
Review Meeting 3	10 Mar	Review project progress
Complete MCS implementation	17 Mar	Complete the necessary code for implementing MCS trial

Implement risk models	24 Mar	Implement models the system will use for modeling risk
Analysis of application results	31 Mar	Analyze results of implemented models and trials to make sure the results are valid
Complete Application Development	14 Apr	Complete any remaining code and bug fixes
Documentation	21 Apr	Prepare all necessary documentation
Review Meeting 4	28 Apr	Final review of the project and documentation
Final Submission	5 May	Submission of final deliverables
Presentation	TBD	Final demo and presentation

Reading/References List:

[1] T. Bodnar, M. Lindholm, V. Niklasson, and E. Thorsén, "Bayesian portfolio selection using VaR and CVaR," Applied Mathematics and Computation, vol. 427, p. 127120, Aug. 2022, doi: 10.1016/j.amc.2022.127120.

[2] R. Tunaru and T. Zheng, "Parameter estimation risk in asset pricing and risk management: A Bayesian approach," International Review of Financial Analysis, vol. 53, pp. 80–93, Oct. 2017, doi: 10.1016/j.irfa.2017.08.004.

[3] A. Mashrur, W. Luo, N. A. Zaidi, and A. Robles-Kelly, "Machine Learning for Financial Risk Management: A Survey," IEEE Access, vol. 8, pp. 203203–203223, 2020, doi: 10.1109/ACCESS.2020.3036322.

[4] V. Nikalasson, "Bayesian portfolio selection and risk estimation," Department of Mathematics, Stockholm University, : Matematiska Institutionen, Stockholms Universitet, 106 91 Stockholm, 2022. [Online]. Available: https://www.diva-portal.org/smash/get/diva2:1657357/FULLTEXT01.pdf

[5] J. Martín, M. I. Parra, M. M. Pizarro, and E. L. Sanjuán, "A new Bayesian method for estimation of value at risk and conditional value at risk," Empir Econ, Oct. 2024, doi: 10.1007/s00181-024-02664-2.

[6] G. M. Martin et al., "Bayesian forecasting in economics and finance: A modern review," International Journal of Forecasting, vol. 40, no. 2, pp. 811–839, Apr. 2024, doi: 10.1016/j.ijforecast.2023.05.002.

[7] J. Hull, Risk management and financial institutions, Sixth edition. in Wiley finance. Hoboken, New Jersey: Wiley, 2023.

[8] M. Sekerke, Bayesian risk management: a guide to model risk and sequential learning in financial markets. in The Wiley finance series. Hoboken, New Jersey: John Wiley & Sons, Inc, 2015.

Completed Graduate Courses:

Number	*Course Name*	*Semester*	*Grade*
COSC 600	Advanced Data Structures and Algorithms	Fall 2023	A-
COSC 612	Software Engineering I	Fall 2023	A
COSC 650	Computer Networks	Fall 2023	A-
COSC 519	Operating System Principles	Spring 2024	B
COSC 578	Database Management Systems I	Spring 2024	B
COSC 670	Special Topics: Cryptocurrencies and Blockchain	Spring 2024	A
COSC 695	Independent Study in Computer Science	Summer 2024	A

Projects Done in Other Courses:

Course Number	*Project Description*
COSC 612	Web application interface for a coffee inventory management system.
COSC 578	GUI application for managing a database for a law firm.
COSC 670	Web application leveraging blockchain technology for decentralized voting.

Project Requirements and Evaluation:

1. Reading and presentation 15%
2. Implementation 25%
4. Written report to the instructor 30%
5. Presentation * 30%

* The instructor/student will announce the presentation time and place to the Department faculty and students. Those interested in the topic may attend the presentation.

I, Devere Anthony Weaver, propose to complete this project during the Spring semester of 2025 and understand that this project and its derived materials (e.g., source code, written reports, presentation slides) are to reflect my own work unless explicitly and appropriately referenced. Furthermore, I understand that plagiarism or other unattributed use of material not written by me is completely unacceptable, and **will be considered sufficient cause for a failing grade on the project.** For additional information on the academic integrity policy at Towson University, I will visit www.towson.edu/provost/resources/studentacademic.asp .

Student's Signature: 

Instructor's Signature: 

Graduate Program Director's Signature: _____