Department of Mathematics

February 24, 2025

UNDERGRADUATE MATH SEMINAR

This week's seminar will be earlier in the week, but later in the day:

DATE: **Tuesday, February 25**

Time & **4:15** – Refreshments in **Bailey 204**

Location: **4:45 – 5:45** Seminar in **Bailey 207**

Seminar details will be posted around Bailey Hall.

Pieces from Thesis, by Atharv Tekurkar

Atharv wrote his senior thesis this past fall under the guidance of ***Professor Roger Hoerl.***

This Fall term, I had the chance to work on my Math Senior thesis with my classmate **Baibhav Barwal**, under the guidance of **Professor Roger Hoerl**. Our research focused on using machine learning models to predict financial distress in U.S.-based publicly traded banks. With a limited finance background, we approached this project from a mathematical and computational perspective, analyzing trends statistically and predicting future trends using ML models. Given the prevalence of bank failures in recent years and their widespread impact on investors, customers, and the entire financial markets, we wanted to explore how accurate of an ML model could we build using micro- and macro-economic factors to predict such financial distress.

We had a dataset with various macroeconomic factors such as inflation rate, GDP, unemployment rate, etc., and microeconomic factors such as total assets, retained earnings, stock price, etc. for 13 failed and 13 non-failed banks. Through some statistical data analysis, we noticed some common trends among the failed banks, using which we defined "failure". We used two definitions - stock price fluctuations and Altman Z-Score, a financial model that is used to determine if a company is about to go bankrupt. Our goal was to compare various ML models - Decision Trees, Random Forest, XGBoost, and Neural Networks - for those two definitions and determine the best model and the more relevant default definition using metrics such as ROC-AUC, precision, and recall.

Key findings:

- XGBoost outperformed all other models for both definitions, achieving high accuracy in predicting bank failures.
- Altman Z-Score-based models were more effective than the stock price-based ones, highlighting how the financial ratios are more stable than short-term market movements.
- Using macroeconomic factors improved the predictive power, emphasizing the idea that external conditions play a crucial role in financial distress.

This project was a great learning experience, allowing us to apply mathematical and statistical concepts to a real-world issue. We are grateful to Professor Hoerl for his guidance throughout the project, and to **Professors Tomas Dvorak** and **Prateek Arora** from the Economics department for their insights into financial concepts.

For future thesis students, my biggest advice would be to choose a topic that genuinely interests you. Researching a subject that you are passionate about makes it engaging and rewarding. Also, speaking from personal experience, don't feel dejected by setbacks - they are part of the process; learn from them, improvise, and keep refining your approaches to achieve meaningful results.