## Mathematics in Business Modeling, Optimization, Risk, and Decision Making
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**JEAN-FRANÇOIS BÉGIN**, Simon Fraser University
*Benefit volatility-targeting strategies in lifetime pension pools*

Lifetime pension pools—also known as group self-annuitization plans, pooled annuity funds, and retirement tontines in the literature—allow retirees to convert a lump sum into lifelong income, with payouts linked to investment performance and the collective mortality experience of the pool. Existing literature on these pools has predominantly examined basic investment strategies like constant allocations and investments solely in risk-free assets. Recent studies, however, proposed volatility targeting, aiming to enhance risk-adjusted returns and minimize downside risk. Yet they only considered investment risk in the volatility target, neglecting the impact of mortality risk on the strategy. This study thus aims to address this gap by investigating volatility-targeting strategies for both investment and mortality risks, offering a solution that keeps the risk associated with benefit variation as constant as possible through time. Specifically, we derive a new asset allocation strategy that targets both investment and mortality risks, and we provide insights about it. Practical investigations of the strategy demonstrate the effectiveness and robustness of the new dynamic volatility-targeting approach, ultimately leading to enhanced lifetime pension benefits.

**CHRISTOPH FREI**, University of Alberta
*Bayesian Clustering for Portfolio Credit Risk*

In this work, we develop a Bayesian clustering approach to address the limitations of traditional credit risk models used in loan portfolios, which typically group loans into predefined homogeneous buckets based on observable characteristics like credit ratings or industries. Our method leverages time series data of predicted default probabilities to dynamically cluster loans, allowing for a more flexible assignment of loans to multiple buckets through weighted vectors, rather than restricting them to a single category.

By integrating Bayesian inference, we estimate posterior distributions for the weight matrices, correlations, and default probabilities, which provides a more nuanced understanding of portfolio risk. We demonstrate the feasibility of this approach through simulated data and real-world credit risk data, analyzing its impact on key risk measures such as value at risk and expected shortfall. The results indicate that our method improves the accuracy of portfolio loss simulations, providing a robust framework for managing credit risk.

The talk is based on joint work with Bohdan Horak (University of Alberta).

**MAHBOOBEH (MARY) HOSSEINYAZDI**, Kwantlen Polytechnic University

**CODY HYNDMAN**, Concordia University

**MASOMEH JAMSHID-NEJAD**, Kwantlen Polytechnic University
*The Impact of Excel-Based Instruction on Business Students' Understanding of the Normal Distribution in Statistics*

Statistics is an indispensable field of study that plays a pivotal role in various academic disciplines and real-world applications. The ability to analyze, interpret, and draw meaningful conclusions from data is a fundamental skill for students pursuing degrees in science, social sciences, business, and many other fields. However, the intricate nature of statistical analysis often poses a

formidable challenge for students, both novice and experienced, who grapple with complex mathematical concepts and intricate statistical methodologies. One key tool that has been increasingly integrated into statistics education is Microsoft Excel. Excel, a widely used spreadsheet software, offers a user-friendly platform for data entry, organization, and basic statistical analysis. Its ubiquity in both educational and professional settings has made it an attractive candidate for assisting students in their journey to comprehend and apply statistical concepts. The combination of Excel's user-friendliness and its powerful data analysis features provides an environment that bridges the gap between theoretical statistical concepts and practical implementation. This study investigates the impact of using Excel on students' understanding of statistics, with a focus on the fundamental concept of the normal distribution. We explore how integrating Excel into statistics education influences students' ability to comprehend and apply the normal distribution in practical contexts. By evaluating the benefits, limitations, and pedagogical strategies associated with Excel as an instructional tool, this research highlights its role in enhancing statistical learning and its potential implications for students' academic performance and future professional success.

**ALEXANDER MELNIKOV**, University of Alberta

**MEHDI SALIMI**, Kwantlen Polytechnic University
*Decision-Making Strategies for Pursuers with Speed and Energy Constraints in a Pursuit-Evasion Differential Game*

Pursuit-evasion differential games provide a mathematical framework for studying decision-making in dynamic scenarios involving two opposing agents: pursuers and evaders. Governed by differential equations, these games model the strategic decision processes of both sides, with pursuers aiming to capture evaders under specific constraints. This presentation focuses on the development of decision-making strategies for pursuers, particularly when faced with limitations such as speed and energy resources. A key element is the identification of admissible regions—areas where players can make feasible decisions and operate effectively. Additionally, the concept of parallel strategies, where pursuers adapt their decisions in real-time based on the movements of evaders, is explored as a way to enhance the capture process. By examining these decision-making strategies within complex constraints, this analysis provides deeper insights into pursuit-evasion dynamics and offers practical solutions for optimizing real-world applications.

**DAVID SAUNDERS**, University of Waterloo