Risk & Ruin

A conference to celebrate Gord's contributions to the field of Actuarial Science

Scientific Program

July 5

8:45 – 9:30 Registration

9:30 – 9:45 Opening Remarks
Words from Christiane Lemieux (Associate Dean, Operations and Academic)

9:45 – 10:45 **Keynote 1** (Chair: David Landriault)
Sheldon Lin (University of Toronto)
Mixture Modelling for Insurance: From Risk Theory to Real Data Applications

10:45 – 11:00 Coffee Break

Invited talks - Session 1 (Chair: Mario Ghossoub)

11:00 – 11:30 Kristina Sendova (Western University)
Beyond Ruin Theory: A Case Study of Modelling Big-Picture Cashflows in Retirement

11:30 – 12:00 Yunran Wei (Carleton University)
Vulnerability Conditional Risk Measures

12:00 – 12:30 Eric Cheung (University of New South Wales)
Review of Some Path-Dependent Ruin Quantities

12:30 – 14:00 Lunch

14:00 – 15:00 **Keynote 2** (Chair: Jun Cai)
Hailiang Yang (Xi'an Jiaotong-Liverpool University)
Insurance Fraud Detection using Deep Learning

15:00 – 15:15 Coffee Break

Invited talks – Session 2 (Chair: Jae Kyung Woo)

15:15 – 15:45 Andrei Badescu (University of Toronto)
A Population Sampling Approach to Claim Reserving and a Micro-Level Chain-Ladder Method

15:45 – 16:15 Shu Li (Western University)
The Structure of The Number of Claims until First Passage Times

16:15 – 16:45 Tim Shi (Temple University)
Pension Fund Management with a Machine Learning Strategy

Group photo – conference attendees

17:15 – 18:15 Reception

18:15 – 20:30 Banquet

July 6

Invited Talks – Session 3 (Chair: Andrei Badescu)

9:30 – 10:00 Zijia Wang (Chinese University of Hong Kong)
Last Passage Times for Generalized Drawdown Processes with Applications

10:00 – 10:30 Jae Kyung Woo (University of New South Wales)
Analysis of Various Quantities through Random Sum

10:30 – 10:45 Coffee Break

10:45 – 11: 45 **Keynote 3** (Chair : Steve Drekic)
Hansjoerg Albrecher (Université de Lausanne)
Divide(nds) et Impera: Gordian Knots and Some Recent Developments in Risk Theory

11:45 – 12:00 Closing Remarks

12:00 – 13:30 Lunch

Abstracts

Keynote talks

Hansjoerg Albrecher

Divide(nds) et Impera: Gordian Knots and Some Recent Developments in Risk Theory

In this talk we discuss a few recent advances concerning optimal dividend strategies in the context of risk theory. This includes the consideration of ratcheting and drawdown constraints in the dividend payment stream as well as the situation when claims occur according to a shot-noise Cox process. Concerning the typically conflicting criteria of profitability and safety, we also discuss a class of dividend strategies that satisfies substantial ruin probability constraints, but still leads to almost the same expected aggregate discounted dividend payments as the optimal unconstrained solutions.

Sheldon Lin

Mixture Modelling for Insurance: From Risk Theory to Real Data Applications

This research was motivated by my early collaborations with Gord Willmot on insurance risk theory, where we considered the use of the mixture of Erlangs to model individual insurance claims due to its desirable properties.

Property and casualty (P&C) insurance is always policy specific. Since policyholders possess different risk characteristics, a P&C insurance portfolio is highly heterogeneous. As a result, modelling and analyzing the claims (frequency and severity), risk classification, ratemaking and reserve determination entail many challenges, especially from a data-driven modelling perspective. In this presentation, I will share the works our group on how to use mixture models to address these challenges. In particular, we propose the use of mixture of experts regression models that are very flexible, are capable of incorporating policy attributes in a nonlinear manner and can leverage policyholders' claim history when adding random effects. Furthermore, the mixture structure of the models allows to classify policyholders into groups with similar risk profiles. Parameter estimation can be performed through EM algorithms. In the case that random effects are incorporated, the estimation can be obtained by a stochastic variational algorithm, which is numerically efficient and scalable to large insurance portfolios. Real data applications

show that such an approach outperforms the approaches commonly used in practice in many ways.

Hailiang Yang

Insurance Fraud Detection using Deep Learning

In this talk, I will present a deep learning methodology to gain pragmatic insights into the behavior of an insured person using unsupervised variable importance. Starting with a preliminary investigation of the limitations of the existing fraud detection models, we propose a variable importance methodology incorporated with two prominent unsupervised deep learning models, namely, the autoencoder and the variational autoencoder. Both qualitative and quantitative performance evaluations are conducted. Real data sets are used to illustrate the idea and methodology. I will mention some related recent work at the end of the talk.

Contributed talks

Andrei Badescu

A Population Sampling Approach to Claim Reserving and a Micro-Level Chain-Ladder Method

Claim reserving primarily relies on macro-level models, with the Chain-Ladder method being the most widely adopted. These methods were heuristically developed without solid statistical foundations, relying on oversimplified data assumptions and neglecting policyholder heterogeneity, often resulting in conservative reserve predictions. Micro-level reserving, utilizing stochastic modeling with granular information, can improve predictions but tends to involve less attractive and complex models for practitioners. This talk aims to strike a practical balance between aggregate and individual models by introducing a methodology that enables the Chain-Ladder method to incorporate individual information. We achieve this by proposing a novel framework, formulating the claim reserving problem within a population sampling context. We introduce a reserve estimator in a frequency and severity distribution-free manner that utilizes inverse probability weights (IPW) driven by individual information, akin to propensity scores. We demonstrate that the Chain-Ladder method emerges as a particular case of such IPW estimator, thereby inheriting a statistically sound foundation based on population sampling theory that enable the use of granular information, and other extensions.

Eric C.K. Cheung

Review of Some Path-Dependent Ruin Quantities

In this presentation, I will provide a review of some ruin-related quantities that are defined before the time of ruin or depend on the entire sample path of the surplus process leading to ruin. These include, for example, the minimum surplus before ruin, the discounted aggregate claims until ruin, the present value of integrated costs until ruin, and the average surplus before ruin. In the context of a renewal risk model with general interclaim times but specific claim amount distributions that are of mixed exponential or Erlang type, the analysis often relies on (modifications of) a technique in Willmot (2007). In particular, this involves conditioning on the first drop of the surplus below its initial surplus level to obtain a defective renewal equation for the function of interest (e.g. Gerber-Shiu type function). This presentation is based on multiple publications over the years.

Shu Li

The Structure of The Number of Claims until First Passage Times

In this talk, we investigate the first-passage problem of insurance risk processes, considering both up-crossing and down-crossing events. While previous literature has primarily focused on the first passage times and ruin-related quantities, our study expands the scope by identifying the important structures of the number of jumps preceding the first passage times, as well as the number of claims until recovery, through the Lundberg fundamental equations. We further discuss the applications and risk management implications of these identified structure and illustrate them via numerical examples.

Kristina Sendova

Beyond Ruin Theory: A Case Study of Modelling Big-Picture Cashflows in Retirement

We employ a ruin-theory approach to model the inflows and the outflows of retirees' portfolios. We track all transactions within the portfolios of retired clients sourced by a registered investment provider to Canada's Financial Wellness Lab at Western University. By utilizing an advanced ruin model, we calculate the mean and the median time it takes for savings to be exhausted, the probabilities of exhaustion of funds within the retirees' expected lifetime, and the deficit at ruin if a retiree has used up all of their savings. We also account for gender as well as for the risk tolerance of retired clients using a K-Means clustering algorithm. This allows us to compare the financial outcomes for female and male retirees and to enhance some findings in the literature. In the final phase of our study, we compare the results obtained by our methodology to the 4% rule which is a widely used approach for post-retirement spending.

Tianxiang Shi

Pension Fund Management with a Machine Learning Strategy

Managing pension funds has been an increasingly challenging task for defined benefit pension sponsors. Subject to a series of funding regulatory requirements, pension funds are pressured to generate consistent returns to meet their long-term pension liabilities while mitigating the investment risk at the same time in order to avoid pension shortfalls. In this paper, we introduce a novel Autoformer-based approach, a time series prediction method evolved from Transformer, to predict asset returns and design the trading strategies. Subsequently, we employ the Genetic Algorithm, a search and optimization technique based on the mechanics of natural selection and genetics, to further determine the optimal asset allocations among various stocks and bonds, controlling the pension shortfall risk. Our results show that the proposed method significantly outperforms traditional pension fund investment strategies.

Zijia Wang

Last Passage Times for Generalized Drawdown Processes with Applications

In recent years, there has been a significant amount of work dedicated to the study of the generalized drawdown process with its extensive applications in insurance and finance. While existing studies have primarily focused on analyzing the associated first passage times, which signal early warnings, the investigation of last passage times should not be overlooked. Last passage times involve knowledge of the future and can thus offer additional insights. This paper aims to fill this gap in the literature by studying the last passage times for the generalized drawdown process with an independent exponential killing and discussing their applications to insurance risk. Our analysis focuses on the Lévy insurance risk processes, for which we derive the Laplace transforms for these random times. Additionally, we obtain new results on the joint distribution of the duration of the drawdown and the surplus level at killing. As applications, we implement our results in the loss-carry-forward tax and dividend models and investigate the valuation of a European digital drawdown option. Detailed numerical examples are presented for illustrative purposes.

Yunran Wei

Vulnerability Conditional Risk Measures

The paper introduces a novel systemic risk measure, the Vulnerability Conditional Expected Shortfall (VCoES), which is able to capture the ``tail risk" of a risky position in scenarios where at least one of the other market participants is experiencing financial distress. It extends the theory of the newly-proposed systemic risk measure Vulnerability-CoVaR (VCoVaR). We develop a set of systemic risk contribution measures, employing both difference and relative ratio functions to compare VCoVaR and the traditional Value-at-Risk, as well as VCoES against the conventional Expected Shortfall. The study delves into various theoretical properties, including stochastic orders, of VCoVaR, VCoES, multivariate Value-at-Risk (MCoVaR), and multivariate conditional expected shortfall (MCoES), alongside the corresponding risk contribution measures. We further introduce the backtesting procedures of VCoES and MCoES. Through numerical examples, we validate our theoretical insights and further apply our newly proposed risk measures to the empirical analysis of cryptocurrencies, demonstrating their practical relevance and utility in capturing systemic risk. This is a joint work with Tong Pu and Yiying Zhang.

Jae Kyung Woo

Analysis of Various Quantities through Random Sum

This talk includes the study of random sums across actuarial science, applied probability and queueing theory, while also acknowledging the significant influence of my PhD supervisor, Gord Willmot, on my academic development. It explores topics ranging from univariate mixed Erlangs to multivariate renewal-reward processes, emphasizing mathematical techniques and ideas. Key areas of discussion include dependencies between claim times and sizes, discounted compound renewal sums, claims inflation, and multivariate shock models. The results are found from multiple joint research works with various academics.