Financial and Actuarial Mathematics
Mathématiques financières et actuarielles
(Org: **Petar Jevtic** (McMaster University), **Adam Metzler** (Wilfred Laurier University) and/et **Traian Pirvu** (McMaster University))

TAEHAN BAE, University of Regina
On the limit of a conditional Spearman's rho coefficient under the common factor model

In this talk, I will discuss the limit of a conditional Spearman's rho coefficient under the common factor structural model of credit risk. The considered conditioning event is that the common systemic factor stays below a threshold and the limit is taken as the threshold tends to negative infinity. The main result, established through a relation with the classical theory of regular variation, is that the limiting Spearman's rho is determined by the tail thickness of the distribution function of the systemic factor. Specifically, conditions for the limiting Spearman's rho to be strictly less than one or equal one, are obtained. As an illustration, the calculation of Stress Value-at-Risk for the loss ratio of a homogeneous loan portfolio will be presented.

ABEL CADENILLAS, University of Alberta
Optimal Investment and Liability Ratio Policies in a Multidimensional Regime Switching Model

We consider an insurer who faces an external jump-diffusion risk that is negatively correlated with the capital returns in a multidimensional regime switching model. The insurer selects investment and liability ratio policies continuously to maximize her/his expected utility of terminal wealth. We obtain explicit solutions of optimal investment and liability ratio policies for logarithmic and power utility functions. We study the impact of the insurer's risk attitude, the negative correlation between the external risk and the capital returns, and the regime of the economy, on optimal policy.[This is a joint work with Bin Zou].

TAHIR CHOULLI, University of Alberta
Risk Decomposition with Application to Mortality/Longevity Securitization

In this talk, I consider a market model where there are two flows of information. One flow is the public information, while the other flow contains additional information generated by a death time of an insured. I am interested in addressing the mortality/longevity risk and its securitization. This securitisation requires the dynamics' specification for the prices of the mortality/longevity-linked derivatives such as longevity bonds. Thus, one can ask the following: Can we get these prices without any assumption on the time of death and its connection to the market model? Can we decompose any mortality-linked risk into pure financial risks, pure mortality risks and correlated risk(s) from these two kind of risks?

In my talk, I will answer these questions and I will highlight the key innovative stochastic ideas behind our answers. Our results are useful for a much broader scope of applications, even though they are essentially motivated and applied to longevity/mortality risks. In fact, by using the progressive enlargement of filtration with the death time, we introduce new classes of martingales. Then, via these new spaces of martingales, we derive a complete, precise and explicit optional decomposition for martingales stopped at the death time. Afterwards, we elaborate the "dual" decomposition of our optional decomposition for any risk up to the death time. These two decompositions are vital for addressing numerous problems in risk management and portfolio analysis under mortality.

This talk is based on two joint works with C. Daveloose/M. Vanmaele (Belgium) and with Sina Yansori (UofA) respectively.

MATT DAVISON, Western University
Approximating the Value of Oil Storage Options using Forward Dynamic Optimization

Joint work with Behzad Ghafouri

Under some market circumstances it is popular to rent unused oil tankers as floating storage platforms. The holder of this or other similar storage facilities for crude oil controls a real option, the value of which is a complicated functional of the time evolution of the oil forward curve. The problem of valuing this option is complicated by the many degrees of freedom held by the option holder, who can trade in a wide variety of forward contracts. An approximation to the value of this option can be made by fixing a class of trading strategies and optimizing over their values. In this work we present the outcome of one such valuation process, Forward Dynamic Optimization, on a fairly realistic model both of forward curve dynamics and oil tanker markets. Conclusions are drawn on the key drivers of value for this trading strategy and whether this is a good way to think about this complicated problem.

ED FURMAN, York University
Gini-Type Measures of Risk and Variability: Gini Shortfall, Capital Allocations, and Heavy-Tailed Risks

I will introduce a new tail-based risk measure - the Gini Shortfall (GS), and discuss its properties and links to the Solvency II Accord. The GS risk measure aims to catch the variability along the (right) tail of the risk's distribution, but unlike the Tail Standard Deviation risk measure ([Furman, E. and Landsman, Z. (2006). Tail variance premium with applications for Elliptical portfolios of risks. ASTIN Bulletin, 36(2), 433 - 462]), the GS risk measure is coherent and only requires the finiteness of the first moment. I will suggest an economic capital allocation rule induced by the GS risk measure and show explicit expressions in the context of risk portfolios with jointly elliptical risk components. This is a joint work with Ruodu Wang of the University of Waterloo and Ricardas Zitikis of Western University.

TOM HURD, McMaster University
Symmetric Cascades in Banking Networks

Systemic risk (SR) concerns the possibility of large-scale instability in financial networks. The Eisenberg-Noe 2001 model, because of its simplicity and clarity, has become the paradigmatic treatment of cascading in such systems. This talk will explore some important pieces of the SR puzzle that have been omitted from the EN 2001 model. It then provides a way these effects can be built into a minimally more general framework that shares the spirit of elegant simplicity of the original model.

CODY HYNDMAN, Concordia University
A geometric approach to arbitrage-free modelling, estimation, and prediction

We develop a new approach to stochastic modelling, estimation, and prediction in mathematical and computational finance. In the modelling step, we show how to obtain an optimal model by exploiting the implicit geometry characterizing the class of arbitrage-free models. Since the resulting optimal model is non-Euclidean, estimation and implementation is performed using new manifold learning algorithms. We conclude by showing these models best balance the nonlinearities and financial information present in the data. Moreover, the manifold learning algorithms have greater predictive power than their classical Euclidean counterparts. This talk is based on joint work with **Anastasis Kratsios.**

PETAR JEVTIC, McMaster University
The joint mortality of couples in continuous time

This paper introduces a probabilistic framework for the joint survivorship of couples in the context of dynamic stochastic mortality models. The new framework gives an intuitive and flexible pairwise cohort-based probabilistic mechanism that can accommodate both deterministic and stochastic effects which the death of one member of a couple causes on the other. It is sufficiently flexible to allow modelling of effects that are short-term (called the "broken-heart effect") or long-term (named "life circumstances bereavement"). In addition, it can account for the state of health of both the surviving and dying spouse and can allow for dynamic and asymmetric reactions of varying complexity. Finally, it can accommodate the pairwise dependence of mortality intensities before the first death. Analytical expressions for bivariate survivorship in representative models are given, and their sensitivity analysis is performed for benchmark cases of old and young couples. Simulation and estimation procedures

are provided that are straightforward to implement and lead to consistent parameter estimation on synthetic dataset of 10000 pairs of death times for couples.

ADAM KOLKIEWICZ, Department of Statistics and Actuarial Science, University of Waterloo
Optimal Static Hedging of Path-Dependent Options

We present a novel method of hedging path-dependent options in a discrete time setup. Assuming that prices are given by the Black–Scholes model, we first describe the residual risk when hedging a path-dependent option using only a European option. Then we find the hedging option that minimizes the shortfall risk, which we define as the expectation of the shortfall weighted by some loss function. The payoff function of this option is obtained as a solution of a non-parametric optimization problem. We first illustrate the method using Asian options. Then we discuss a generalization of the method that can be used to characterize optimal ways of risk mitigation for non-traded assets and liabilities.

HYEJIN KU, York University
Portfolio Optimization for a Large Investor under Partial Information and Price Impact

In this talk, we consider a large investor with an objective of expected utility maximization from terminal wealth. The drift of the underlying price process is modeled as a diffusion affected by a continuous-time Markov chain and the actions of the large investor. Using the stochastic filtering theory, we reduce the optimal control problem under partial information to the one with complete observation. For logarithmic and power utility cases we solve the utility maximization problem explicitly and we obtain optimal investment strategies in the feedback form. We compare the value functions to those for the case without price impact, and observe that the investor would be better off due to the presence of a price impact. This is a joint work with Zehra Eksi.

GEORGE LAI, Wilfrid Laurier University
Simulation of Greeks of multiasset options for time-changed Brownian motions by Malliavin calculus

This talk will present simulation of sensitivities or Greeks of multi-asset European style options under a special Lévy process model - the time-changed or subordinated Brownian motions for the asset prices. Malliavin calculus combined with Monte Carlo and quasi-Monte Carlo methods is used in simulations. By using the chain rule, integration by parts, reflection principle, etc. from Malliavin calculus, as well as the tower property of conditional expectation, we are able to derive formulas of option Greeks in terms of the expectations of the option payoff functions multiplied by the weights involving Malliavin derivatives for multi-asset options. Numerical results show that the Malliavin calculus method is usually more efficient than the finite difference method for options with non-smooth payoffs. The superiority of the first over the second is even more significant when both are combined with quasi-Monte Carlo methods.

ROGEMAR MAMON, University of Western Ontario
Putting a price tag on temperature

A model for the evolution of daily average temperatures (DATs) is put forward to support the analysis of weather derivatives. The goal is to capture simultaneously the stochasticity, mean-reversion, and seasonality patterns of the DATs process. An Ornstein-Uhlenbeck (OU) process modulated by a hidden Markov model (HMM) is proposed to model both the mean-reversion and stochasticity of a deseasonalised component. The seasonality part is modelled by a combination of linear and sinusoidal functions. Modified and more efficient OU-HMM filtering algorithms relative to the current ones in the literature are presented for the evolution of adaptive and switching model parameter estimates. Numerical implementation of the estimation technique using a data set compiled by the National Climatic Data Center was conducted. A sensitivity analysis of the option prices with respect to the model parameters is included. This is joint work with PhD student H Xiong.

ADAM METZLER, Wilfrid Laurier University
A Simple and Accurate Approximation to the Early Exercise Boundary for American Put Options

Consider an American put option in the Black-Scholes framework, and suppose that the option is exercised at the first hitting time of the stock price to a given exponential barrier. Omberg (1987) shows that the value of such a strategy can be computed in closed form, and suggests that the option price can be approximated by optimizing this value over all possible exponential barriers. In this talk we show how the Omberg formula can be used as the starting point for an approximation to the optimal exercise barrier. The approximation is remarkable for both its simplicity and accuracy, as well as its intuitive content.

ILIE RADU MITRIC, Université Laval
On the conditional moments of compound renewal sums with discounted claims taking into account the past information

We study the compound renewal present value risk process with constant or variable discount factor, taking into account the past information. The first two conditional moments and the joint moments are found. We show that the mean of future discounted aggregate claims is an increasing (decreasing) function of the difference between the current time and the time of the last claim when the inter-arrival times are IFR (DFR).

TRAIAN PIRVU, McMaster University
One bank problem in the funds market

The model of this talk gives a convenient strategy that a bank in the funds market can use in order to maximize its profit in a contemporaneous reserve requirement (CRR) regime. The reserve requirements are determined by the demand deposit process, modelled as a Brownian motion with drift. We propose a new model in which the cumulative funds purchases and sales are discounted at possible different rates. We formulate and solve the problem of finding the bank's optimal strategy. The model can be extended to involve the bank's asset size and we obtain that, under some conditions, the optimal upper barrier for fund sales is a linear function of the asset size. As a consequence, the bank net purchase amount is linear in the asset size.

JEAN-FRANÇOIS RENAUD, UQAM
Variations on the idea of Parisian ruin for spectrally negative Lévy processes

In the last few years, the idea of Parisian ruin has attracted a lot of attention. In Parisian-type ruin models, the insurance company is not immediately liquidated when it defaults: a grace period is granted before liquidation. Roughly speaking, Parisian ruin occurs if the time spent below a pre-determined critical level is *too long*. In this talk, I will present recent results related to different definitions of Parisian ruin for spectrally negative Lévy processes.

KRISTINA SENDOVA, University of Western Ontario
The Gerber-Shiu function when the claim counting process is a homogeneous compound-birth process

In this paper we introduce a non-homogeneous compound-birth process as the claim-counting process of an insurance company. The main feature of this process is that it may account for batch claim arrivals. As a result, the insurer's detailed record of costs resulting from claim processing may be used for fine-tuning the relative security loading. Further, assuming a homogeneous compound-birth process, we study the Gerber-Shiu function and some of its special cases in more detail.

TUAN TRAN, McMaster University
Asset fire sales and strategic trading by regulated banks

In this paper we study how banking regulatory constraints such as liquidity and capital requirements affect the equilibrium price of assets and the behaviour of financial institutions participating on the open market. We consider a static game theoretic model, where each agent is a regulated bank that aims to maximize their profit while still satisfying a certain liquidity or capital requirements set up by the regulator. Trading is assumed to bear transaction costs and has an impact on the asset price via a aggregate demand function. With this setup, we prove the existence of Nash equilibrium strategies for the game and provide algorithms to find these equilibrium strategies in linear time.

FOIVOS XANTHOS, Ryerson University

Robust representations of risk measures on Orlicz spaces via Orlicz hearts

In 2002, Delbaen proved a robust representation theorem for risk measures on L^∞ via L^1. It has since been an intriguing problem to extend this result to a more general class of underlying spaces. In this talk, we present a solution to this problem for Orlicz spaces.