# 5e atelier de mathématiques actuarielles

Avec une session spéciale sur les mégadonnées et l'apprentissage machine en gestion de risques

# 5th Workshop on Insurance Mathematics

With a special session on big data and machine learning in risk management

● **Résumés / Abstracts** ●

## Comité organisateur / Organizing committee :

Maciej Augustyniak (Université de Montréal)
Manuel Morales (Université de Montréal)

## Commanditaires / sponsors :

Quantact, le Laboratoire de mathématiques actuarielles et financières du Centre de recherches mathématiques
Centre de recherches mathématiques (CRM)
Institut de valorisation des données (IVADO)

# Horaire / Schedule

Vendredi, 23 février 2018 / Friday, February 23rd, 2018
Université de Montréal
Pavillon / Building: Claire-McNicoll
Salle / Room: Z-220 (2e étage / 2nd floor)
Carte du campus / Campus map (#15)
Fiche du pavillon / Building sheet

*Le dîner et le banquet sont inclus dans les frais d'inscription. Il y aura également quelques viennoiseries disponibles pour le déjeuner.*

*The lunch and evening banquet are included in the registration fees. There will also be some pastries available for breakfast.*

**9:00 - 9:30 –** Déjeuner / Breakfast (Salle / Room Z-220, corridor)

**9:30 - 10:00 –** Yang Shen, York University
*Stochastic Stackelberg differential games between an insurer and a reinsurer*
**10:00 - 10:30 –** Mohamed Amine Lkabous, UQAM
*A survey of some recent results on Parisian ruin theory*

**10:30 - 11:00 –** Pause café / Coffee break (Salle / Room Z-220, corridor)

**11:00 - 11:30 –** Fan Yang, University of Waterloo
*Characterizations of risk aversion in cumulative prospect theory*
**11:30 - 12:00 –** Anastasis Kratsios, Concordia University
*Arbitrage-Free Regularization*

**12:00 - 13:30 –** Dîner / Lunch (Salle / Room AA-6225, Pavillon / Building André-Aisenstadt, Carte / Map #20)

~~**13:30 - 14:00 –** Charles Dugas, Element AI~~ ***ANNULÉ / CANCELLED***
~~*Titre disponible bientôt / Title available soon*~~
**14:00 - 14:30 –** Jean-François Larochelle, Intact Assurance
*Using machine learning in the P&C industry*
**14:30 - 15:00 –** Aurélie Labbe, HEC Montréal
*Data analytics for driver behavior profiling: when data science meets actuaries*
**15:00 - 15:30 –** François Laviolette, Université Laval
*Titre disponible bientôt / Title available soon*

**15:30 - 16:00 –** Pause café / Coffee break (Salle / Room Z-220, corridor)

**16:00 - 16:30 –** Marie-Ève Malette, HEC Montréal
*Particle filter performance with high frequency option prices*
**16:30 - 17:00 –** Frédéric Godin, Concordia University
*Removing path dependence in option pricing under regime-switching models*

**18:30 -21:00 –** Banquet au restaurant Le Cercle / Banquet at restaurant Le Cercle

## Stochastic Stackelberg differential games between an insurer and a reinsurer

**Yang Shen**
Department of Mathematics and Statistics, York University

We propose a novel continuous-time framework to analyze optimal reinsurance, in which an insurer and a reinsurer are two players of a stochastic Stackelberg differential game, i.e., a stochastic leader-follower differential game. This allows us to determine optimal reinsurance from joint interests of the insurer and the reinsurer, which is rarely considered in a continuous-time setting. In the Stackelberg game, the reinsurer moves first and the insurer moves subsequently to achieve a Stackelberg equilibrium towards optimal reinsurance arrangement. Speaking more precisely, the reinsurer is the leader of the game and decides on optimal reinsurance premium to charge, while the insurer is the follower of the game and chooses optimal proportional reinsurance to purchase. We solve the game problem in two cases: exponential utility maximization and mean-variance optimization. We find that the reinsurer always applies the variance premium principle to calculate the optimal reinsurance premium and the insurer's optimal ceding/retained proportion of insurance risk depends not only on the risk aversion of itself but also on that of the reinsurer.

## A survey of some recent results on Parisian ruin theory

**Mohamed Amine Lkabous**
Département de mathématiques, UQAM

In the last years, Parisian ruin has attracted a lot of attention. In Parisian ruin models, the insurance company is not immediately liquidated when it defaults: a grace period is granted before liquidation. In this talk, i will give a survey of older and recent results related to other generalizations of Parisian ruin for spectrally negative Lévy processes.

## Characterizations of risk aversion in cumulative prospect theory

**Fan Yang**
Department of Statistics and Actuarial Science, University of Waterloo

In this talk, we investigate the necessary and sufficient conditions for a decision maker to be monotone risk averse and left-monotone risk averse, respectively, in cumulative prospect theory (CPT). Our results show that the decision maker is more pessimistic than greedy if she is either monotone or left-monotone risk averse, which is similar to that of Chateauneuf et al. (2005) in the rank-dependent expected utility model. Detailed examples are presented to illustrate the main theorems. With this work, we make a progress in the characterizations of risk aversion in CPT, which is essential in understanding the features of CPT and its applications in finance and insurance.

# Arbitrage-Free Regularization

**Anastasis Kratsios**
Department of Mathematics and Statistics, Concordia University

We introduce a novel framework that generalizes the HJM modeling approach to a wide variety of asset classes. This framework allows us to remove arbitrage-opportunities from a model within a given class using a new regularization procedure that minimally deforms the model subject to an arbitrage penalty. This technique extends classical financial modeling methods by first using interpretable factor-models that fit the data well, and subsequently applying the arbitrage-free regularization procedure. We illustrate the approach through implementations for forward-rate curves and stochastic local volatility surfaces. This talk is based on joint work with Cody Hyndman (Concordia University).

# Using machine learning in the P&C industry

**Jean-François Larochelle**
Intact Assurance

Presentation of the interest for machine learning (ML) for a P&C company with several examples of use cases.

- Presentation of Intact and DataLab
- Reason for its creation: data and ML
- Goal of DataLab: to expand the use of ML in all sphere of the company

Why ML is important:

- Big Data
- Unstructured Data
- New interaction
- Faster results

Problems where we applied ML

1. Rating - why this problem first
    a. Steps to ML
    b. Explain 4 techniques tested and compared (GLM, NN, xgBoost and linear boosting)
    c. Show partial result for Costing Auto Collison Ontario
2. Retention: Explain problematic of elasticity
3. Value of Optimization: Define its complexity (Dynamic - multi-year and multi-product and Stochastic - people evolve)
4. Fraud detection
    a. Small data - explain supervised methods vs unsupervised techniques
    b. Explain importance of Unsupervised in fraud
    c. Ensemble model is the solution
5. Wildfire maps: How we build a wildfire using ML

Intact supports University research through a RDC with CRDM and IVADO.

## Titre disponible bientôt / Title available soon

**Charles Dugas**
Element AI

Available soon / Disponible bientôt

## Data analytics for driver behavior profiling: when data science meets actuaries

**Aurélie Labbe**
HEC Montréal

Nowadays insurance companies offer car usage-based insurance programs designed to leverage data-driven technologies and improve insurance products. This is done by collecting GPS driving data from customers using either a vehicle telematics dongle and/or a smartphone application. In this context, vehicle position and other sensor data is used to characterize driving behavior and, in particular, to detect risky events such as speeding, harsh breaking, hard acceleration and sharp turns. Along with other contextual information, these rich data have the potential to provide better customer segmentation, risk estimation and cost prediction, which in turn could help insurance companies to provide the most competitive pricing to their customers. This talk will review the data analytics challenges brought by this massive amount of data in order to derive meaningful driver behavior profiles.

## Titre disponible bientôt / Title available soon

**François Laviolette**
Département d'informatique, Université Laval

Available soon / Disponible bientôt

## Particle filter performance with high frequency option prices

**Marie-Ève Malette**
HEC Montréal

An important development in the financial econometrics literature has been the use of high frequency observations to assess the daily variability of an asset. This is known as the realized variance. In this article, we apply the concept to high frequency implied volatilities and define a new observable measure: the realized implied volatility variance. We demonstrate that this new measure can be used as a model-free approximation of the implied volatility quadratic variation which can be decomposed into a diffusive and discontinuous part. This separation of risk factors is convenient because it enables us to use the realized implied volatility variance as a latent state detection tool in a particle filtering procedure. We show that it offers incremental information about the return and variance dynamics, and that its value added resembles to that of the realized variance of option prices.

## Removing path dependence in option pricing under regime-switching models

**Frédéric Godin**
Department of Mathematics and Statistics, Concordia University
École d'actuariat, Université Laval

The usual approach for option pricing under regime-switching models based on the extended Girsanov principle leads to path dependent option prices dynamics when regime are latent, even though the underlying asset price can be embedded in a Markov process. The current work develops novel and intuitive risk-neutral measures that can incorporate regime risk-aversion in a simple fashion and which do not lead to such path-dependence.