MS2DISCOVERY SEMINAR SERIES **MS2DISCOVERY.WLU.CA**

(The list of 2014 - 2020 seminars with abstracts)

2020

Research in the Environmental, Physical and Interfacial Chemistry (EPIC) Lab

How The Phase and Quantity of Water Affect Atmospheric Chemistry

Speaker: Hind Al-Abadleh, Professor at Wilfrid Laurier University

Date and Time: Friday, September 25, 2020 | 3:30 p.m.

Location: Online

Research in water sustainability in the era of climate change demands an innovative and integrated approach to thinking at multiple scales, all phases of matter, and at the interface of different phases of matter. One can think of water scales to range from the macro (oceans, lakes, rivers, groundwater) to the micro and nano (rain drops, ice flakes, fog) to the molecular scale (hydrogen bonding network). As the 'environmental solvent', water influences chemical reactions in the bulk gas and liquid phases, and at the surfaces of solid materials. In this talk, results will be presented on (a) efficient new pathway for organic and organometallic polymeric particle formation from aqueous phase iron-catalyzed reactions with aromatic and aliphatic dicarboxylic acid compounds, and (b) ice nucleation efficiency of fresh versus reacted dust particles. The significance of these results will be presented in relation to the chemical processing of iron-containing dust in the presence of organics and how it changes dust optical and hygroscopic properties.

Threshold Parameters in Ecology and Epidemiology

Speaker: Pauline van den Driessche, University of Victoria

Date and Time: Wednesday, September 23, 2020 | 3:00 p.m.

Location: Online

Target reproduction numbers are defined and shown to unify threshold parameters in population biology, including the net reproductive value used in ecology and the basic reproduction number used in epidemiology. Both algebraic (using matrices) and graphical (using weighted digraphs) approaches to computing target reproduction numbers are developed. Knowledge of these target reproduction numbers is demonstrated to aid in measuring the change of certain model parameters in order to protect endangered species (e.g., salmonoids), control invasive species (e.g., scentless camomile) and to determine disease control strategies (e.g., for cholera).

Formulation and solution of stochastic inverse problems for science and engineering models

Speaker: Don Estep, Simon Fraser University

Date and Time: Wednesday, March 4, 2020 | 3:00 p.m.

Location: P327, Peters Building

Determining information about the state of a complex physical system from observations of its behavior is a fundamental problem in scientific inference and engineering design. Often, this can be formulated as the stochastic inverse problem of determining probability structures on parameters for a physics model corresponding to a probability structure on the output of the model. We describe a formulation and solution method for stochastic inverse problems that is based on functional analysis, differential geometry, and probability/measure theory. This approach yields a computationally tractable problem while avoiding alterations of the model like regularization and ad hoc assumptions about the probability structures. We present several examples, including a high-dimensional application to determination of parameter fields in storm surge models. We also describe work aimed at defining a notion of condition for stochastic inverse problems and tackling the related problem of designing sets of optimal observable quantities.

When does the Perron Frobenius result hold for correlation matrices?

Speaker: Phelym Boyle

Date and Time: Friday, January 24, 2020 | 3:00 p.m.

Location: LH 2064 (Lazaridis Hall)

This talk investigates conditions under which correlation matrices have a strictly positive dominant eigenvector. The sufficient conditions, from the Perron-Frobenius theorem, are that all the matrix entries are positive. The conditions for a correlation matrix with some negative entries to have a strictly positive dominant eigenvector are explored. The special structure of correlation matrices permits us to obtain analytical results for low dimensional matrices. Some specific results for the n-by-n case are also derived. This problem was motivated by an application in portfolio theory.

Enrich Data Analysis with Deep Learning

Speaker: Michael Chen, York University

Date and Time: TBA (talk was cancelled due to inclement weather. To be rescheduled)

Location: TBA

Drinking water quality has been a global concern for long. With the advancement of sensor hardware, monitoring devices which are small enough for home use are emerging, and the classification of drinking water containment based on the sensor data is the intelligent kernel. For example, we expect such a device to tell whether the faucet water is polluted by one of CaCO3, Sodium Chloride, Lead, K12 E.Coli, and Fungal. In our study, we analyzed spectrum data and applied several common classification models, including Logistic Regression, SVM and Decision Tree, without satisfactory accuracy. The problem exhibits very high noise-to-signal ratio due to the limitation of the sensor, various environmental factors, and many known and unknown other containments in the drinking water. The data is also highly nonlinear due to the spectrum technology itself. We adapt the Convoluted Neural Network (CNN) deep learning model into our data analysis, and immediately see a significant improvement of the accuracy to 93%. This success, as well as other success as reported by multiple literatures, convinced the speaker that deep learning models should be in the toolbox of every data scientist.

2019

Applying Machine Learning in Vehicle Manufacturing

Speaker: Jean-Christophe Petkovich, Acerta Analytics Solutions

Date and Time: Friday, November 29, 2019 | 3:00 p.m.

Location: LH 2066, (Lazaridis Hall)

Vehicles are very complex systems, with a huge intersection of mechanical and electrical components and built in software control functions. As a result, there is a huge amount of data being generated from the systems within a car, much more than can be handled by most diagnostic tools. To continue ensuring a high level of quality and operational efficiency, manufacturers are turning to AI. However, there are numerous challenges that make application of approaches that work well in research difficult in a real-life manufacturing environment.

Trimodal Deep Learning for Micro and SME Credit Scoring

Speaker: Cristián Bravo, Western University

Date and Time: Friday, November 15, 2019 | 3:00 p.m.

Location: SB 203 (Schlegel Bldg.)

In recent times there has been a rapid development of Deep Learning techniques capable of extracting information from unstructured sources of data such as images, sound and text. In our presentation, we explore the application of the latest Deep Learning techniques to assess the feasibility of automating some of the Micro and SME lending process. We apply the most recent developments from the field of Deep Learning including the current state of the art in Natural Language Processing (NLP), the Google BERT model, for the prediction of loan default over 40,000 Micro and SME loans. Our initial results suggest that the text loan assessment are surprisingly predictive; however, when combined with traditional credit scoring variables, no additional performance improvement is gained in terms of AUC of Accuracy. Despite no observed increase in the performance metrics, we find that the inclusion of the text results in better-calibrated predicted probability outputs, which in practice leads to more robust and interpretable results for credit lenders.

Unstable Interfaces and Plumes

Speaker: Larry Forbes, University of Tasmania, Australia

Date and Time: Monday, November 4, 2019 | 3:00 p.m.

Location: LH 3058 (Lazaridis Hall, Math boardroom)

Cybersecurity 2019 and Beyond

In many applications involving waves at the surface of a fluid, it is often sufficient just to consider steady-state situations, where the wave pattern does not change noticeably with time. Waves behind moving ships are one such example. There is an enormous literature on such situations, and at least for two-dimensional flow, steady waves can be computed reasonably accurately.

As computers have developed, it has now become possible to look at 2D and even 3D unsteady problems, where the fluid interface evolves with time. These unsteady flows have some surprising behaviour, both analytically and numerically. If fluid viscosity is ignored, it is now known that classical flows such as the Rayleigh-Taylor Instability fail within finite time, when the curvature of the free surface becomes infinite at certain points. This appears to be a common feature in unsteady inviscid flows. In other geometries, such as the initially spherical outflow from a source, unsteady effects can lead to the surprising result that the lowest mode is the most unstable, so that a one-sided outflow jet evolves.

How the race to digitally transform business increases cyber risk

Speakers: J. Haynes and Eldon Sprickerhoff, eSentire

Date and Time: Friday, October 11, 2019 | 3:00 p.m.

Room: LH 2066 (Lazaridis Hall)

Register via the following link: http://mdr.esentire.com/ms2seminarserieslaurier

Hidden Networks: From Trump to Harry Potter to Bitcoin

Speaker: Anthony Bonato, Ryerson University

Date and Time: Thursday, October 3, 2019, 7:00 pm

Location: Kitchener Public Library, 85 Queen Street North, Kitchener, ON

Room: Theatre room

Networks, or graphs as they are also called, are mathematical objects that quantify how systems interact. From protein networks in living cells, to bitcoin transactions, to keywords in Donald Trump's tweets, networks reside in every aspect of our lives and nature.

Although networks are everywhere, many are invisible. Mathematicians and data scientists are only beginning to reveal these hidden networks and unlock their secrets. We give a guided tour of the modern field of network science, with insights along the way into what makes networks tick.

Following the Pied Piper of Pensioners

Speaker: Dan Bernhardt, University of Illinois and University of Warwick

Date & Time: September 19, 2:00 to 3:15 pm

Location: LSBE Dean's Boardroom (4th floor Lazaridis Hall)

Demagogues and the Fragility of Democracy

Speaker: Dan Bernhardt, University of Illinois and University of Warwick

Date & Time: September 20, 11:00-12:20 pm

Location: LH 3098

Quantum Computing and Cybersecurity: Challenges and Opportunities

Speaker: Michele Mosca, University of Waterloo

Date: Wednesday, May 29, 2019, 4:00pm

Room: LH2064 (Lazaridis Hall)

Quantum computer algorithms can solve certain computation problems much more efficiently than we believe we can with any classical computer.

How close are we to harnessing this apparent computational power in practice? I will give some examples of how mathematical tools bring us closer to useful quantum computers.

Quantum computers would however break the currently deployed public key cryptography, which is a pillar of cybersecurity. The consequences of not fixing this vulnerability properly in time would be devastating.

While we are likely still many years away from practical quantum cryptanalysis, it also takes many years to properly deploy new cryptography designed to defend against quantum attacks.

One of the major challenges is building confidence in the difficulty of the underlying mathematical problems even for quantum computers.

These challenges offer a range of opportunities that I will discuss, including research problems and economic opportunities.

Mathematical Medicine: From Neurosurgery to Oncology to PK Modelling of Chemotherapeutic Drugs

Speaker: Sivabal Sivaloganathan, University of Waterloo

Date: Friday, April 5, 2019, 3:00pm

Room: LH2062 (Lazaridis Hall)

In the last two to three decades, the nascent field of Mathematical Medicine has expanded dramatically, and advances have been made on many fronts. In this talk, we focus on two problems that occur in clinical medicine (one drawn from the field of neurosurgery and the other from oncology). We hope to show how closer synergy and interaction between the Biomedical and Mathematical Sciences, can lead to dramatic advances in clinical medicine. The

unifying aim of mathematical modelling and experimental studies in the biomedical sciences is the elucidation of the underlying biological mechanisms and processes that lead to particular observed phenomena (eg brain tissue compression in hydrocephalus, brain tumours etc.) It is (of course) clear that mathematical descriptions of biological phenomena are not biological explanations. Apart from its explanatory power, the true test of any mathematical description or theory is in its predictions.

Putting Machine Learning to Work for Digital Forensics

Speaker: Jeff LeJeune and Bazyli Debowski, Magnet Forensics

Date: Friday, March 15, 2019, 2:00pm

Room: LH3058 (Lazaridis Hall)

Digital devices and connectivity are creating a data tsunami for investigators in the law enforcement and corporate communities. Not only has the popularity of chat and email applications resulted in a massive spike of text-based conversations; but an increasing number of devices (smartphones, digital cameras, other IoT devices, etc.) also facilitate the easy capture of photos and videos. As a result, the number of pictures and messages that may appear in a case has grown exponentially, making it difficult for forensic examiners, investigators and analysts to keep up. The manual analysis of the evidence for context and relevance, combined with report building, can add significant time to an investigation. Magnet.AI allows an examiner or investigator to better prioritize their time in an investigation, and find potentially relevant evidence faster than they could through manual review.

Clustering via Hypergraph Modularity

Speaker: Pawel Pralat, Ryerson

Date: January 25th 2019, 1:00pm

Room: SB204 (Schlegel Bldg.)

Modularity is designed to measure the strength of division of a network into clusters (known also as communities). Networks with high modularity have dense connections between the vertices within clusters but sparse connections between vertices of different clusters. As a result, modularity is often used in optimization methods for detecting community structure in networks, and so it is an important graph parameter from a practical point of view. In fact, many important problems (including clustering) can be described using more general combinatorial objects, hypergraphs. Unfortunately, theoretical foundations as well as practical algorithms using hypergraphs are not well developed yet. Hence, we propose a hypergraph modularity function that generalizes its well established and widely used graph counterpart measure of how clustered a network is.

2018

Honeybees, Varroa destructor, the Acute Bee Paralysis Virus, Neonics …: A Differential Equations Perspective

Speaker: Hermann Eberl, University of Guelph

Date: December 5th, 2018 4:00 pm

Room: LH2066 (Lazaridis Hall)

Hermann Eberl is a Professor in the Department of Mathematics and Statistics at the University of Guelph, and the Director of the Biophysics Interdepartmental Graduate Program. His primary research area is the application of differential equations and scientific computing methods in microbiology and bioengineering, in particular biofilms.

Mathematical apiculture has become a second strand in his research program in recent years.

Three Pillars of Data Science

Speaker: Cameron Davidson-Pilon

Date and time: Nov. 14, 2018, 4 p.m.

Location: Lazaridis Hall, room LH2066

Cameron Davidson-Pilon has worked in many areas of applied statistics, from the evolutionary dynamics of genes to modelling of financial prices. His contributions to the community include lifelines, an implementation of survival analysis in Python, lifetimes, and Bayesian Methods for Hackers, an open source book and printed book on Bayesian analysis. His previous education was at Wilfrid Laurier University, University of Waterloo and the Independent University of Moscow, and he currently works as a Director of Data Science at Shopify in Ottawa, Ontario.

Data Analysis with Terry Hickey

Speaker: Terry Hickey

Date and time: Oct. 31, 2018, 4 p.m.

Location: Lazaridis Hall, room LH2066

Terry Hickey is the Chief Analytics Officer at CIBC and part of the Direct Banking, Innovation and Analytics team. In this role, Mr. Hickey and his team are responsible for leading and accelerating the adoption of AI and analytics and curation of client data within CIBC.

Prior to joining CIBC, Mr. Hickey was the Vice President and Partner that lead AI, Analytics and Quantum Computing for IBM GBS Globally. He has also lead digital, contact centres, and outsourcing for IBM in Canada. Mr. Hickey is a member of CIBC's Innovation Council, and the CIBC lead for Catalyst Canada. He is an active speaker and presenter globally on AI, digital and user experience.

Mr. Hickey holds an MBA from the Rotman School of Management and received his first patent earlier this year for Blockwise extraction of document metadata.

Recursive Inspection Games

Speaker: Bernhard von Stengel

Date and time: July 24, 2018, 4 p.m.

We consider a sequential inspection game where an inspector uses a limited number of inspections over a larger number of stages to detect an illegal act of an inspectee. Compared with earlier models, we allow varying "rewards" to the inspectee for successful illegal acts. As one possible example, the inspectee may target a certain amount of stealing nuclear material that he accumulates over several stages, where the stage where he completes that target of stolen material gives him the highest reward. The players' information about the game is important in how to solve it, in particular since the inspector does not know what the inspectee does in an uninspected time period. Under reasonable assumptions for the payoffs, the inspector's strategy is independent of the number of successful illegal actions, so that a recursive description of the game can be used even though this assumes a fully informed inspector. We give an explicit solution for the optimal randomized strategies in this game, and describe how the inspector can induce legal behaviour (as long as inspections remain) by committing to his strategy.

Singular Periodic Brake Orbits in the Planar Pairwise Symmetric Four-Body Problem

Speaker: Lennard Bakker

Date and time: March 28, 2018, 4 p.m.

We prove the existence of the periodic brake orbits that experience two distinct regularizable simultaneous binary collisions per period, in the planar pairwise symmetric four-body problem with equal masses and full symmetry among the positions of the four bodies. The analytic existence of the singular periodic brake orbits is based on differential inequalities, qualitative

techniques, and the gradient-like flow on the total collision manifold obtained by the blow-up coordinates of McGehee. Before outlining the proof (through many pictures), we review some of the 44 year history of the many applications of McGehee blow-up coordinates to various N-body problems.

Commodity Derivatives

Speaker: Joe DiCesare

Date and time: March 6, 2018, 2:30-3:20 p.m.

This talk will serve as an introduction to Commodity Derivatives. We will begin by exploring the world of Commodity futures contracts, providing background on classical futures curve concepts and how they relate to spot markets. Next, we will examine how Commodity futures are referenced in hedging structures ranging from typical vanilla swaps to highly bespoke structured products. Finally, the role of Commodities in an investment portfolio is discussed along with typical methods used to gain Commodity exposure and potential investment alpha.

Geometric Theory of Separation of Variables, Integrability, Superintegrability and Quantization

Speaker: Giovanni Rastelli, University of Torino

Date and time: Feb. 14, 2018, 4 p.m.

The solution of the Hamilton-Jacobi equation of natural Hamiltonian systems, a PDE, can be sometimes obtained by solving a system of separated ODEs in suitable coordinate systems. The geometric theory of separation of variables investigates necessary and sufficient conditions for this task. The same theory characterizes the separability of Helmholtz, Laplace, Schroedinger and Dirac equations. A result of the theory is the characterization of separability in terms of polynomial constants of motion in involution, determining the Liouville integrability of any separable system. The separability in different coordinate systems is often associated with superintegrability, the existence of more constants of motion than necessary for integrability. In recent years, the superintegrability of Hamiltonian systems, and its behaviour in the process of quantization of classical constants of motion, is attracting the interest of many researchers. We review the basis of the theory of separation of variables and its application in recent studies about superintegrabilty and quantization.

2017

Simulations of Fluid Pulses in an Artificial Artery with Active Walls

Speaker: Dmitry Strunin, University of Southern Queensland, Australia

Date: Nov. 28, 2017

We present numerical solutions of the semi-empirical model of self-propagating fluid pulses (auto-pulses) through the channel simulating an artificial artery. The key mechanism behind the model is the active motion of the walls in line with the earlier model of Roberts. Our model is autonomous, nonlinear and is based on the partial differential equation describing the displacement of the wall in time and along the channel. A theoretical plane configuration is adopted for the walls at rest. For solving the equation we used the One-dimensional Integrated Radial Basis Function Network (1D-IRBFN) method. We demonstrated that different initial conditions always lead to the settling of pulse trains where an individual pulse has certain speed and amplitude controlled by the governing equation. A variety of pulse solutions is obtained using homogeneous and periodic boundary conditions. The dynamics of one, two and three pulses per period are explored. The fluid mass flux due to the pulses is calculated.

Partial Inventory Pooling by Independent Firms

Speaker: Yigal Gerchak, Department of Industrial Engineering, Tel-Aviv University

Date: Nov. 13, 2017

Inventory pooling (sharing) is a well-known strategy for reducing the negative effect of demand uncertainty. As a risk-pooling strategy, its rationale is analogous to those of banking and insurance. Recently there has been interest in extending the idea of inventory pooling to independent firms, such as airlines using the same hub deciding to pool spare parts that are needed only rarely.

We consider the effectiveness of partial inventory pooling, whereby only a certain proportion of the inventory is pooled. We make use of a scheme, previously proposed in the context of complete inventory pooling, where each firm contributes to a pool, as well as ordering for itself. A firm then has priority for units it contributed to the pool, but the units it does not need become available to the other firm, possibly at cost. We analyze the resulting non-cooperative game. We consider an example with discrete independent demands, and then explore a symmetric continuous independent demands model, eventually specialized to uniform distributions. This work is joint with Dr. Lena Silbermayr of WU Vienna.

Pricing Individual Stock Options Using Both Stock and Market Index Information

Speaker: Lars Stentoft, University of Western Ontario

Date: Oct. 17, 2017

When it comes to individual stock option pricing, most, if not all, applications consider a univariate framework in which the dynamics of the underlying asset is considered without taking the evolution of the market or any other risk factors into consideration. From a theoretical point of view this is clearly unsatisfactory as we know, i.e. from the Capital Asset Pricing Model, that the expected return of any asset is closely related to the exposure to the market risk factor. On top of this theoretical inconsistency in empirical applications it is often difficult to precisely assess and appropriately measure risk premia from individual stock returns alone. To address these shortcomings, we model the evolution of the individual stock returns together with the market index returns in a bivariate model that allows us to estimate risk premia in line with the theory. We assess the performance of the model by pricing individual stock options on the constituent stocks in the Dow Jones Industrial Average over a long time period including the recent Global Financial Crisis.

Variational Discretizations of Gauge Field Theories Using Group-Equivariant Interpolation Spaces

Speaker: Melvin Leok, University of California, San Diego

Date: Sept. 19, 2017

Variational integrators are geometric structure-preserving numerical methods that preserve the symplectic structure, satisfy a discrete Noether's theorem, and exhibit exhibit excellent long-time energy stability properties. An exact discrete Lagrangian arises from Jacobi's solution of the Hamilton-Jacobi equation, and it generates the exact flow of a Lagrangian system. By approximating the exact discrete Lagrangian using an appropriate choice of interpolation space and quadrature rule, we obtain a systematic approach for constructing variational integrators. The convergence rates of such variational integrators are related to the best approximation properties of the interpolation space.

Many gauge field theories can be formulated variationally using a multisymplectic Lagrangian formulation, and we will present a characterization of the exact generating functionals that generate the multisymplectic relation. By discretizing these using group-equivariant spacetime finite element spaces, we obtain methods that exhibit a discrete multi-momentum conservation law. We will then briefly describe an approach for constructing group-equivariant interpolation spaces that take values in the space of Lorentzian metrics that can be efficiently computed using a generalized polar decomposition. The goal is to eventually apply this to the construction of variational discretizations of general relativity, which is a second-order gauge field theory whose configuration manifold is the space of Lorentzian metrics.

Systemic Risk and Stochastic Games with Delay

Speaker: Jean-Pierre Fouque, University of California at Santa Barbara

Date: May 11, 2017

We propose a model of inter-bank lending and borrowing which takes into account clearing debt obligations. The evolution of log-monetary reserves of N banks is described by coupled diffusions driven by controls with delay in their drifts. Banks are minimizing their finite-horizon objective functions which take into account a quadratic cost for lending or borrowing and a linear incentive to borrow if the reserve is low or lend if the reserve is high relative to the average capitalization of the system. As such, our problem is a linear-quadratic stochastic game with delay between N players. A unique open-loop Nash equilibrium is obtained using a system of fully coupled forward and advanced backward stochastic differential equations. We then describe how the delay affects liquidity and systemic risk characterized by a large number of defaults. We also derive a close-loop Nash equilibrium using an HJB approach to this stochastic game with delay and we analyze its mean field limit. Joint work with R. Carmona, M. Mousavi and L.H. Sun.

Novel Applications of Generalized Nash Games

Speaker: Monica Cojocaru, University of Guelph

Date: April 28, 2017

In this talk we introduce the audience to the concept of generalized Nash games; these are a class of Nash games introduced in the 50's, currently undergoing a sustained interest from the mathematics and engineering communities, due to advances in possible solution techniques, as well as their potential for applications.

We therefore will focus our talk in two directions: one more theoretical, where we introduce a parametrization technique for the purpose of describing entire solution sets of generalized Nash games with shared constraints. We prove two theoretical results and, based on these, we introduce a computational method that practitioners can implement in applied problems modelled as generalized Nash games with shared constraints, as long as the applied problems are satisfying several assumptions present in the current optimization literature.

We then move into the second direction, where we give many illustrative examples of how our computational technique is used to compute the solution sets of known generalized Nash games previously not solved by other existing techniques. We close with the presentation of

two very different applied problems formulated as a generalized Nash game: a model of an environmental accord between countries sharing geographic proximity, and another model of several HIV+ and HIV- individuals engaged in casual encounters which may lead to the spread of HIV. We highlight the possible advantages of modelling these problems as generalized Nash games, as well as the diversity of applications that could be targeted with this modelling framework.

Critical Transitions in Coupled Behaviour-Disease Systems: Applying Dynamical Systems Theory to Data Science Problems

Speaker: Chris Bauch, University of Waterloo

Date: March 27, 2017

Data science is a field of growing interest amongst both the public and scientific communities. However, data science methodology does not use the insights of dynamical systems theory as much as it could, compared to widespread applications of conventional statistics. In this talk I will describe an application of dynamical systems theory to a data science problem. In particular, vaccine scares are of great concern to population health, because they can enable renewed infectious disease outbreaks and delay global eradication by many years. Vaccine scares often entail coupled dynamics between social vaccinating behaviour and disease transmission dynamics that can be captured by simple systems of nonlinear differential equations. These equations exhibit bifurcations that are often termed “critical transitions”, where the state of the system shifts abruptly to a contrasting state as a parameter is moved beyond a bifurcation point. While apparently occurring without warning, in stochastic systems these transitions are often preceded by an increase in time series autocorrelation and variance prior to the transition, caused by the dominant eigenvalue approaching zero. Therefore, it is possible that critical transitions may be predicted ahead of time by such early warning signals. If vaccine scares can be modelled as critical transitions, then we may be able to predict them by looking for early warning signals. In this talk I will describe and characterize some theory for critical transitions and early warning signals in coupled behaviour-disease systems. I will also present analyses of data during the 2014/15 Disneyland, California measles outbreak. The data consist of time series of measles-related Google searches, and measles-related tweets that have been sentiment-classified into pro- and anti-vaccine tweets using machine-learning algorithms. The data reveal the telltale signatures of early warning signals before the 2014/15 Disneyland, California outbreaks. Such methods may improve the ability of health authorities to anticipate growing vaccine refusal, and focus messaging strategies accordingly. We suggest that data science can benefit from greater interaction with dynamical systems theory.

Data, Science, Computers, and Math as Ingredients of Today’s Business

Speaker: Ivan Sergienko, Scotiabank

Date: March 24, 2017

Buzz about data science and artificial intelligence is everywhere. Under the hood is a tremendous success of Statistics and Computer Science. We discuss how the scientific method is quickly becoming essential in many industries, and banking in particularly. We explore how students with developed research skills can benefit from this. We present examples of models and tools our group has built to measure customer value and predict their behaviour.

Extended Theories of Gravitation

Speaker: Lorenzo Fatibene, University of Turin

Date: Feb. 28, 2017

We shall introduce Extended Theories of Gravitation which extend standard General Relativity by allowing geometries on space time more general than the usual Lorentzian metric structure. Palatini f(R)-theories are considered as an example and application. Their ability to model dark matter and dark energy as the effect of modified dynamics of gravitational field rather than fundamental matter fields and applications to cosmology will be discussed.

Representation Theory of Finite Groups and the Factorization of Stability Polynomials of Relative Equilibria in Celestial Mechanics

Speaker: Eduardo Leandro, University of Minnesota

Date: Jan. 25, 2017

The representation theory of finite groups provides tools for factorizing the characteristic polyonomials of the matrices which appear when one studies the linear stability of symmetrical relative equilibria of the N-body problem. Such factorizations go back to the work of J. C. Maxwell on the nature and stability of Saturn rings, and it is interesting to notice that Maxwell's work appeared decades before the pioneering works of Frobenius and Burnside on group representation theory. In the talk we will present the basic concepts which permit to understand and systematize Maxwell's factorization, and provide a view on how to proceed for general symmetric relative equilibria.

2016

Building Industrial Support for Interdisciplinary Research

Speaker: John Kelly, Chief Executive Officer of KeliRo Company, Adjunct Professor at University of Guelph

Date: Dec. 1, 2016

Developing relationships between universities and industry is not static, and does require an comprehensive, long-term view which creates benefit for both parties. A key challenge is to identify those challenges which address "pain-points" for industry and also help industry look to the future, while at the same time bringing benefit back to the university. There becomes an ebb and flow of interaction with the industry and academia, hopefully leading to a fulfilling and lasting collaboration. University - Industry partnerships are not new, but there is a growing need for these interactions to become more strategic and thoughtful because of the growth of the knowledge-based economy. The objective of this session is to identify key objectives and opportunities to develop such relationships, starting with initiating projects leading to long-term credibility and traction.

The Demand and Supply for Favours in Dynamic Relationships

Speaker: Jean Guillaume Forand, University of Waterloo

Date: Nov. 18, 2016

We characterise the optimal demand and supply for favours in a dynamic principal-agent model of joint production, in which heterogeneous project opportunities are stochastically generated and publicly observed upon arrival. Our results characterise the optimal dynamic contract, and we establish that the principal's supply of favours (the production of projects that bene_t the agent but not the principal) is backloaded, while the principal's demand for favours (the production of projects that bene_t the principal but not the agent) is frontloaded. Furthermore, we provide an exact construction of the optimal contract when project opportunities follow a Markov process.

Oil Sands Operations as a Large Source of Secondary Organic Aerosols

Speaker: Craig Stroud, Environment and Climate Change Canada

Date: Nov. 4, 2016

Worldwide heavy oil and bitumen deposits amount to 9 trillion barrels of oil distributed in over 280 basins around the world, with Canada home to oil sands deposits of 1.7 trillion barrels. The global development of this resource and the increase in oil production from oil sands has caused environmental concerns over the presence of toxic compounds in nearby ecosystems and acid deposition. The contribution of oil sands exploration to secondary organic aerosol

formation, an important component of atmospheric particulate matter that affects air quality and climate, remains poorly understood. In this seminar, we present data from airborne measurements over the Canadian oil sands and laboratory smog chamber experiments and results from a chemistry numerical model to provide a quantitative assessment of the magnitude of secondary organic aerosol production from oil sands emissions. We find that the evaporation and atmospheric oxidation of low-volatility organic vapours from the mined oil sands material is directly responsible for the majority of the observed secondary organic aerosol mass. The resultant production rates of 45–84 tonnes per day make the oil sands one of the largest sources of anthropogenic secondary organic aerosols in North America. Our findings suggest that the production of the more viscous crude oils could be a large source of secondary organic aerosols in many production and refining regions around the world.

Guaranteed Renewable Insurance Under Demand Uncertainty

Speaker: Michael Hoy, University of Guelph

Date: Oct. 28, 2016

Guaranteed renewability is a prominent feature in health and life insurance markets in a number of countries. It is generally thought to be a way for individuals to insure themselves against reclassification risk. We investigate how the presence of unpredictable fluctuations in demand for life insurance over an individual's life-time (1) affects the pricing and structure of such contracts and (2) can compromise the effectiveness of guaranteed renewability to achieve the goal of insuring against reclassification risk. We find that spot markets for insurance deliver ex post efficient allocations but are not ex ante efficient. Introduction of guaranteed renewable insurance contracts destroys ex post efficiency, but nevertheless improves overall welfare from an ex ante perspective.

The Dark Side of the Vote: Biased Voters, Social Information, and Information Aggregation Through Majority Voting

Speaker: Rebecca Morton, New York University

Date: Oct. 3, 2016

We experimentally investigate information aggregation through majority voting when some voters are biased. In such situations, majority voting can have a "dark side," that is, result in groups making choices inferior to those made by individuals acting alone. In line with theoretical predictions, information on the popularity of policy choices is beneficial when a minority of voters is biased, but harmful when a majority is biased. In theory, information on the success of policy choices elsewhere de-biases voters and alleviates the inefficiency.

However, in the experiment, providing social information on success is ineffective and does not de-bias voters.

The Price of Religion: Experiments in Willingness to Bear Risks for Others in Islamic Communities

Speaker: Rebecca Morton, New York University

Date: Oct. 4, 2016

In this talk we investigate the effects of religion and religiosity on prosocial actions that involve bearing risks for others (joining a social movement, funding a project with an uncertain outcome). In particular, we focus on the effect of the Islamic prohibition against lending with interest on the choice of Muslims to lend through a profit sharing arrangement (PLS) that protects borrowers against bankruptcy instead of using westernized interest based financing (IB). We report on an incentivized experiment that resembles the choice between IB and PLS to analyze how a direct quote from Qur'an on the prohibition affects choices of Muslims in three extremely different countries (Indonesia, China, and UAE). Interestingly, the religious frame has little effect on the choice of PLS when the alternative is charging low interest rates, but has a large positive effect when the alternative is charging high interest rates. These results suggests the limits of the influence of religious framing: it is only particularly effective in encouraging individuals to bear risk for others when the choice between self interest and others' well-being is stark.

Making Math Essential to IBM's Past, Current, and Future Strategy

Speaker: Chid Apte, IBM Research, T. J. Watson Research Center

Date: Sept. 29, 2016

Mathematical Sciences in IBM Research is one of it's longest running departments, having been in existence for over 50 continuous years. It has been instrumental to some of IBM's major innovations, and has proved to be resilient in being essential to the company, even as IBM's business and strategy has periodically transformed, sometimes disruptively, to meet the changing needs of the Information Technology marketplace. I will highlight the history of this department, and discuss how we evolve the applied nature of "Math Sciences" to ensure that it remains indispensable to the company's future strategy.

The Wrong Number to Plug Into the Wrong Formula to Get the Right Price of a Stock Option

Speaker: Roger Lee, University of Chicago

Date: June 23, 2016

Traders of stock options often quote prices not in dollars and cents, but rather in "implied volatility" – sometimes described as "the wrong number to plug into the wrong formula to get the right price." We define what this means and explore why this makes sense, in the context of stochastic models of financial asset prices.

Multi-Period Portfolio Selection and Bayesian Dynamic Models

Speaker: Petter Kolm, Courant Institute, New York University

Date: May 31, 2016

We describe a novel approach to the study of multi-period portfolio selection problems with time varying alphas, trading costs, and constraints. We show that, to each multi-period portfolio optimization problem, one may associate a “dual” Bayesian dynamic model. The dual model is constructed so that the most likely sequence of hidden states is the trading path which optimizes expected utility of the portfolio. The existence of such a model has numerous implications, both theoretical and computational. Sophisticated computational tools developed for Bayesian state estimation can be brought to bear on the problem, and the intuitive theoretical structure attained by recasting the problem as a hidden state estimation problem allows for easy generalization to other problems in finance. Time permitting, we discuss several applications to this approach. This is joint work with Gordon Ritter.

“Programmable” Ecosystems: Engineered Environments for the Study of Biosystems Development

Speaker: Ludovico Cademartiri, Iowa State University

Date: April 27, 2016

The necessity of understanding the role of the abiotic and biotic environment on the development of plants and ecosystems is challenged by a lack of tools capable of providing simple and controllable model systems with which to test hypotheses. While biology has made great strides in the implementation of sophisticated methods for the characterization of the various -omics, relatively little has been done to improve and standardize the tools available for the growing of plants in controlled environments.

Dr. Cademartiri's group is interested in creating a set of integrated tools to allow the scientific community to create completely customizable environments with which to conduct plant

biology and plant ecology experiments. He will highlight the possibilities offered by these experimental tools to investigate:

The role of ecosystem topology on its stress response.

The role of local physico-chemical heterogeneities on the topology of individual root systems.

From Decision Support Systems to Recommender Systems

Speaker: Pascale Zaraté, Institut de Recherche en Informatique de Toulouse, France

Date: Jan. 14, 2016

Decision Support Systems are designed to support decision makers facing unstructured problems. They were developed to interactively simulate the problem in order to propose to the user part of the solution. Recently, they have evolved into recommender systems, for which a user profile is defined. Recommender systems aim at mining users' preferences dynamically, in order to propose to the decision makers solutions which are as near as possible to their needs. For this purpose, machine learning techniques are applied.

2015

Noisy Rolling Ball: Non-Holonomic Constraints Perturbed by the Noise, Conservation of Integrals of Motion and Rolling Friction

Speaker: Vakhtang Putkaradze, University of Alberta

Date: Oct. 28, 2015

We will discuss some examples of mechanical systems with non-holonomic constraints are modified by the presence of noise. The modification introduces and interesting type of stochasticity in the equations of motion, which will be illustrated on the example of a Routh (Chaplygin) sphere rolling on a flat surface. This is a classical example of a non-holonomic system possessing three integrals of motion, namely the energy, Jellet and Routh. We will show that depending on the type of noise introduced in the rolling constraint, one can either preserve either energy only, both energy and Jellet, or only Jellet integrals. We also derive the general theory of motion of non-holonomic systems of the semi-direct product type, and discuss general results on energy preservation. We conclude with a discussion of the relevance of this work for rolling friction in dynamics due to random slipping as originally suggested by Reynolds (1876).

Joint work with Francois Gay-Balmaz (CNRS). This work has been partially supported by NSERC and the University of Alberta.

A Practical Look at Counterparty Credit Risk and xVA

Speaker: Karl Wouterloot, Scotiabank

Date: Sept. 29, 2015

The Counterparty Credit Risk (CCR) Measurement group at Scotiabank Global Risk Management is a multifaceted team serving both front and back-office functions. This team is responsible for computing Potential Future Exposure for over the counter trading facilities, Scotiabank's Internal Model Method for regulatory capital, along with Credit and Funding Value adjustments (xVAs). These risk measures and pricing adjustments are computed in real time, and our analytics platform is a key part of trade pricing and the decision making process. At the core of these analytics is a powerful Monte Carlo simulation engine, which uses a risk-neutral pricing framework to model a market with over 1000 assets. Also, this engine leverages the bank's distributed computing system. This talk will look at the current state of the industry for CCR measurement, along with some of the computational and mathematical challenges faced by practitioners in the field.

A Stock-Flow Consistent Macroeconomic Model for Asset Price Bubbles

Speaker: Matheus Grasselli, McMaster University and Fields Institute

Date: March 5, 2015

In this talk I first describe a stock-flow consistent model for an economy with households, firms, and banks in the form of a three-dimensional dynamical system for wages, employment, and firm debt. This is then extended by a fourth variable representing the flow of borrowing that is used purely for speculation on an existing financial asset, rather than productive capital investment. Finally, the system is augmented by introducing a price dynamics for the financial asset in the form of a standard geometric Brownian motion plus a downward jump modelled as a non-homogenous Poisson process whose intensity is an increasing function of the speculative ratio. The compensator for this downward jump then leads to the super-exponential growth characteristic of asset price bubbles. Moreover, when the bubble bursts the cost of borrowing in the real economy increases, leading to a feedback mechanism from the asset price dynamics to the original system. This is joint work with Bernardo Costa Lima and Adrien Nguyen Huu.

Stability for the Free Multidimensional Rigid Body and Algebraic Curves

Speaker: Anton Izosimov, University of Toronto

Date: Feb. 6, 2015

It is a classical result of Euler that the rotation of a torque-free three-dimensional rigid body about the short or the long axis is stable, while the rotation about the middle axis is unstable. I will show how to use simple ideas from classical algebraic geometry to obtain a multidimensional generalization of this theorem.

Molecular Modelling in Environmental Chemistry

Speaker: James D. Kubicki, The Pennsylvania State University

Date: Jan. 19, 2015

The connection between large scale environmental processes and molecular properties is critical to understanding and managing contaminants, but the complexity of natural systems makes it difficult to scale scientific research over orders of magnitude in the spatial and temporal domains. Collaboration among scientists working at different scales is key to identifying information that can be transferred across the various levels of natural processes. This talk will focus on studies in computational chemistry that have been designed to address questions generated by field and laboratory observations. Myriad techniques exist to simulate environmental chemistry. Verifying the accuracy of these simulations against experimental observables helps to build confidence in the model results and utilize the molecular-scale results to the real world. Two examples of this approach are the adsorption behaviours of phosphorous and polycyclic aromatic hydrocarbons (PAHs).

Title: Disease interventions implemented in social networks

Speaker: Chad Wells, Yale University

Date and Time: Monday, December 1, 2014 | 2:30pm |

Theapplication of networks in infectious disease modelling provides insight into theepidemiological process that occurs in society,as network modelsallowfora natural disease progression throughout the population. In addition, network models providethe opportunity for greater heterogeneity and detailto be incorporated at theindividuallevel, which can haveasubstantialinfluence on the spread ofthe diseaseand thesuccess ofan intervention. Forexample, superspreaders havealargeimpact on thespread of diseaseand by targeting these individuals for vaccination, public health can efficiently reducethespread of diseasecompared to randomvaccination ofthe population. However, wefound that individual behaviourcan underminethe maximumpotential ofatargeted vaccination strategy. Currently, West Africaisexperiencing the worst Ebola outbreak in history.This outbreak hasaffected both urban and ruralcommunities, which have distinguishablesocialstructures. Wefound that ring vaccination could

provide substantial benefit to caseisolation in reducingmortality in both ofthesesettings. In particular, wefound that ring vaccination can bea valuableasset to case isolationwhen contact tracing is logistically challenging. The work discussed will showthat identifying the optimalcontrolstrategy fora diseaseis notalwaysclear because oftheinfluence ofsocial network structureand behaviour. Understanding theimpact ofsocial network structureand behaviour on disease interventions is important in determining the mostefficientand effectivecontrol strategies.

Title: Geospatial Data in Python

Speaker: Carson Farmer, City University of New York

Date and Time: November 21, 2014 | 9:00 - 12:00 |

Geospatial data- datarecorded or representing aspecific geographiclocation - areincreasingly recognized asa key component in decisionmaking atmany levels; fromlocal, regional,and national government, to privatecompanies, notfor-profits,and academia. Theability to collect, store,analyze,and understand geospatial datais key to supporting effective decisionmaking,and requiresa suite ofsoftwaretools to harnessallfacets of geospatial data. Using the wide range oftoolsand librariesavailablefor workingwith geospatial data, it is now possibleto transport geospatial datafroma databaseto a web-interfacein only a fewlines ofcode. In this hands-on tutorial, weexploresome oftheselibraries and work through examples which showcasethe power ofPython for geospatial data.