PIMS YRC 2016

University of Alberta, June 13 – 16

Programme

Pacific Institute for the Mathematical Sciences

UNIVERSITY OF ALBERTA

Applied Mathematics Institute

Faculty of SCIENCE University of Alberta

STUDC CMS SMC

SiGMAS

AMI . . . the backbone of science!

www.pimsyrc2016.ca

Contents

1 Welcome

The PIMS YRC is a collaborative effort of graduate students from PIMS universities. The 2016 PIMS YRC organizing committee members are:

- Jean Auger
- Benjamin Bernard (Chair)
- Valerie Budd
- Quinton Farr
- Jude Kong
- Prachi Loliencar
- Michelle Michelle
- Amir Nosrati
- Oluwole Olobatuyi
- Jody Reimer
- Zsolt Tanko
- Xinling Wang

We are grateful to our sponsors for making this conference possible! Contributing to our event are:

- Pacific Institute for the Mathematical Sciences (PIMS)
- Faculty of Science of the University of Alberta
- Student's Union of the University of Alberta
- Applied Mathematics Institute (AMI)
- Canadian Mathematical Society (CMS) Student Committee
- Department of Mathematical and Statistical Sciences of the University of Alberta
- SIGMAS

We would also like to thank MapleSoft for sponsoring Maple certificates for raffling amongst our participants. Raffling will occur during the banquet.

Welcome to the PIMS YRC 2016! The inaugural PIMS Young Researchers Conference (YRC) was hosted in 2004 at the University of Alberta in an effort to encourage collaboration amongst graduate students in mathematics and statistics at the Universities of Alberta and Calgary. The PIMS YRC has since evolved into a well-attended and highly anticipated event bringing together graduate students from universities within and outside of the PIMS consortium.

This year's YRC continues the tradition, with our highlights being - our distinguished plenary speakers, our workshops on networking and academic writing, our panel discussion on "Industry vs. Academia", and of course, your talks! To encourage social engagement, we are also doing an outdoor barbecue and hosting a banquet. Coffee and refreshments will be provided between talk sessions.

This booklet contains the schedule information for events, as well as a map of University of Alberta campus. All participants are requested to fill out our PIMS survey form for submission at the end of the event.

We hope you enjoy this year's conference!

2 Locations

The conference uses two main buildings - the **Centennial Centre for Interdisciplinary Sciences** (CCIS), and the **Central Academic Building** (CAB).

- The "default" location will be **CAB 528**. This is where our **Registration**, **Welcome**, **Coffee Breaks**, **Workshops** and **Farewell** will take place.
- Within CAB 528 are located **CAB 528-B** and **CAB 528-C**, where the **Student Talks** will occur in parallel sessions.
- The **Panel Discussion** will be held in **CAB 265**.
- All the **Plenary Talks** will be hosted in the large room **CCIS 1-140**.
- In front of the Central Academic Building is a grassy area called the **Main Quad** - this is where our outdoor **Barbecue Mixer** will be held. We encourage you to bring outdoor games of your choice!
- Lastly, our **Banquet** will be held in the beautiful **Winspear Dining Room** at the **Faculty Club**.

All the locations have been marked on the maps at the end of this programme.

3 Schedule

	June 13	June 14	June 15	June 16
9:00-9:30		Student talks 5	Student talks 10	
9:30-10:00				
10:00-10:30		Student talks 6	Student talks 11	Student talks 15
10:30-11:00		Coffee break	Coffee break	Coffee break
11:00-11:30	Registration CAB 528	Workshop CAB 528	Panel Discussion CAB 265	Workshop CAB 528
11:30-12:00				
12:00-12:30				
12:30-1:00	Welcome			
1:00-1:30	Yuan Lou CCIS 1-140	Jeff Rosenthal CCIS 1-140	Brian Forrest CCIS 1-140	V. Putkaradze CCIS 1-140
1:30-2:00				
2:00-2:30	Student talks 1	Student talks 7	Student talks 12	Farewell
2:30-3:00				
3:00-3:30	Student talks 2	Student talks 8	Student talks 13	
3:30-4:00	Coffee break	Coffee break	Coffee break	
4:00-4:30	Student talks 3	Student talks 9	Student talks 14	
4:30-5:00				
5:00-5:30	Student talks 4	Thomas Creutzig CCIS 1-140		
5:30-6:00				
6:00-6:30	Barbecue Mixer Quad			
6:30-7:00				
7:00-7:30			Banquet Faculty Club	
7:30-8:00				
8:00-8:30				
8:30-9:00				
9:00-9:30				
9:30-10:00				

	Session A **CAB 528-B**	**Session B** **CAB 528-C**
Student Talks 1	Fahmida Yeasmin	Ali Nadaf
Student Talks 2	Arfan Afzal	Frédéric Paquin-Lefebvre
Student Talks 3	Fatima Davelouis	Jean Auger
Student Talks 4	Zsolt Tanko	N/A
Student Talks 5	Eman Aldabbas	Aghil Alaee
Student Talks 6	Weston Roda	Jordan Kostiuk
Student Talks 7	Ievgen Bilokopytov	Su Min Leem
Student Talks 8	Tyler Cassidy	Arnab Bose
Student Talks 9	Trisha Lawrence	Jeremy Eng
Student Talks 10	Wei Tu	Jody Reimer
Student Talks 11	Sergii Tsaturian	Md Mahsin
Student Talks 12	Zijia Wang	Andreas Buttenschoen
Student Talks 13	Benjamin Bernard	Arianna Bianchi
Student Talks 14	Stuart Rogers	Bebart Janbek
Student Talks 15	Ning Zhang	Dean Koch

4 Plenary Talks

Monday, June 13 1:00-2:00pm CCIS 1-140

Three Small Stories in Spatial Ecology

Dr. Yuan Lou, Ohio State University

How can organisms persist in rivers without being washed out? Why does the distribution of some species suddenly change while the environmental conditions changes gradually? How does the movement of organisms evolve? I will use some differential equation models to address these questions.

Tuesday, June 14 1:00-2:00pm CCIS 1-140

The Mathematics of MCMC

Dr. Jeffrey Rosenthal, University of Toronto

Markov chain Monte Carlo (MCMC) algorithms, such as the Metropolis Algorithm and the Gibbs Sampler, are extremely useful and popular for approximately sampling from complicated probability distributions by using repeated randomness. They are frequently applied to such diverse areas as Bayesian statistics, physical chemistry, medical research, financial modelling, numerical integration, and more. Using simple graphical simulations, and analogies to casino gambling and public opinion polls, this talk will explain how these algorithms work, why they are useful, and how mathematical analysis can provide deeper insights into their workings. We will also discuss the mathematical challenges of "adaptive" MCMC, which modifies the algorithm while it runs in an effort to improve its performance on the fly.

Tuesday, June 14 5:00-6:00pm CCIS 1-140

A Modular Story

Dr. Thomas Creutzig, University of Alberta

Modular functions are functions on the upper half of the complex plane that are invariant with respect to an action of a certain discrete group, the modular group. These objects appear all over many interesting areas of pure mathematics and quantum physics. A famous example is the monster moonshine, relating modular functions and physics to the largest simple sporadic group, the monster. But this is only one instance of a connection between modular forms, physics and representation theory and I plan to give an overview on this topic.

Wednesday, June 15 1:00-2:00pm CCIS 1-140

Banach Algebras Arising in Abstract Harmonic Analysis

Dr. Brian Forrest, University of Waterloo

In abstract harmonic analysis one of our key goals is to study the structure of a locally compact group G via the various Banach algebras that arise from the group. In this talk I will give a brief introduction to some of the core players in this story, namely the group algebra, the Fourier algebra and the Fourier-Stieltjes algebras. I will also present some structural properties of groups that can be readily deduced from these algebras. Specifically, we will focus on discreteness, compactness and amenability for G.

Thursday, June 16 1:00-2:00pm CCIS 1-140

Dynamics and Control of Flexible Solar Towers

Dr. Vakhtang Putkaradze, University of Alberta

The use of solar chimneys for energy production has been suggested more than 100 years ago. Unfortunately, this technology has not been realized on a commercial scale, in large part due to the high cost of erecting tall towers using traditional methods of construction. Recent works have suggested a radical decrease in tower cost by using an inflatable self-supported tower consisting of stacked toroidal bladders. While the statics deflections of such towers under constant wind have been investigated before, the key for further development of this technology lies in the analysis of dynamics, which is the main point of this talk. Using Lagrangian reduction by symmetry, we develop a fully three dimensional theory of motion for such towers and study the tower's stability and dynamics. Next, we derive a geometric theory of optimal control for the tower dynamics using variable pressure inside the bladders, and perform detailed analytical and numerical studies of the control in two dimensions. Finally, we report on the results of experiments demonstrating the remarkable stability of the tower in real-life conditions, showing good agreement with theoretical results. This work has been supported by NSERC and the University of Alberta.

5 Student Talks

Student Talks 1 Monday, 2:00-2:40 pm

Session A CAB 528-B

Analysis of Serially Dependent Multivariate Longitudinal Non-Gaussian Continuous Data

Fahmida Yeasmin, University of Calgary

Serially dependent multivariate longitudinal non-Gaussian outcome data are commonly encountered in many fields of study, especially in biomedical sciences, finance, and so on. However, flexible methodologies for joint analysis of these outcomes are not well developed. Recently, Wu and de Leon (2014) and Withanage and de Leon (2015) introduced the class of Gaussian copula mixed models (GCMMs) for joint analysis of non-Gaussian outcomes. We adapt and extend the GCMM to settings that involve conditional as well as serial dependencies among longitudinal observations on the same or on different outcomes. We investigate the impact of failing to account for these dependencies via simulations.

Session B CAB 528-C

The Structure of Robust Chaos in Two-dimensional Discontinuous Piecewise Maps With One and Two Switching Manifolds

Ali Nadaf, Simon Fraser University

Many natural systems that occur in the real world can be described by piecewise maps. Since piecewise maps have specific bifurcations that differ in many fundamental aspects to those in smooth systems, the investigation of the bifurcations of these maps has attracted a great deal of interest. Extensive research has been carried out to identify and analyze the dynamical behaviour of chaos of these maps. This study centers on those chaotic attractors which are robust to small parameter changes and do not contain periodic windows or coexisting attractors. This behaviour is termed robust chaos. In this research, we use a piecewise linear normal form for two-dimensional piecewise discontinuous maps to determine regions of parameter space where a bifurcation leading to robust chaos might occur. We study the intricate structure of the chaotic attractors and present detailed analytical heuristics for determining parameter values for boundary crises leading the onset or termination of robust chaos. In addition, we propose an extension to a new map with an added second switching manifold and three linear branches. This map has application to a simple financial market model. We discuss our normal form map, under the assumption that the outer branches are the same, and present a systematic analysis of bifurcations leading to robust chaos. We develop analytical procedures to identify the underlying generating mechanism of robust chaos in the vicinity of each of the switching manifolds and determine associated parameter space regimes. Our results include the discovery of particular regions for which robust chaos occurs in the vicinity of both the switching manifolds simultaneously. We also investigate phenomena observed in the system when two boundary crises collide as the discontinuity parameter changes. This collision is a new type of double crisis, and we calculate its values for different regions of the parameter space.

Student Talks 2 Monday, 2:45-3:25 pm

Session A CAB 528-B

Group Selection in the Linear Part of a Partly Linear Additive Hazards Model with Right Censored Data

Arfan Raheen Afzal, University of Calgary

In many applications, natural grouping of the covariates is a common phenomenon. For example, in the analysis of gene expression data, genes belonging to the same pathway can be viewed as a group. In this talk, we propose a variable selection approach for censored survival data in the linear part of a partly linear additive hazards model when there is a group structure among covariates. Majority of the current variable selection methods deal with either individual variable selection or group selection, but not both. Our proposed method is capable of simultaneous group selection and individual variable selection within selected groups. Computational algorithms are developed for the proposed bi-level selection methods. Simulation studies indicate that the proposed methods work well and one example is provided to illustrate the applications of the proposed methods to scientific problems.

Session B CAB 528-C

Complex Dynamics and Patterns Arising From a Coupled Model of Bulk Diffusion and Surface Reaction

Frédéric Paquin-Lefebvre, University of British Columbia

It is well-known that the Turing instability in general reaction-diffusion systems can trigger the formation of patterns. However, few studies have focused on systems with localized reactions, where the reactions occur on the boundary of a bulk domain. In this talk, we present a preliminary nonlinear analysis of a coupled model of bulk diffusion and surface reaction of two chemical species (Levine and Rappel, Membrane-bound Turing patterns. Phys. Rev. E., 2005), that is, the diffusion happens within the bulk, which is modeled by a system of PDEs, while nonlinear chemical reactions occur on the boundary, which is modeled by a system of ODEs. Both processes are linearly coupled through a boundary condition on the flux. We identify a parameter regime at which the system undergoes a Hopf bifurcation. Its criticality is determined through a weakly nonlinear analysis close to the bifurcation point, namely by deriving an amplitude equation from a formal two time-scale asymptotic expansion. The main challenge in this analysis comes from the linearization of the coupled PDE-ODE system, which leads to a nonstandard eigenvalue problem with eigenvalues appearing in the boundary condition. This is a work in progress in collaboration with Michael Ward and Wayne Nagata, UBC.

Student Talks 3 Monday, 4:00-4:40 pm

Session A CAB 528-B

An Introduction to the Single and Double-Exponential Sinc Collocation Method

Fatima Davelouis, University of Alberta

We introduce the Sinc collocation method (SCM) combined with the single and double-exponential transformations (SESCM and DESCM respectively). Compared to other methods, the SCM is robust, highly accurate, and its error rate decays much faster as the number of collocation points increases. Overall, the SESCM and DESCM are powerful tools that can be applied to solve many numerical problems in physics, chemistry and engineering. For instance, an important application of the DESCM is to solve singular Sturm-Liouville eigenvalue problems, such as computing the energy eigenvalues of quantum anharmonic oscillators, which have been studied as potentials in the Schrodinger equation. In terms of methods, we numerically computed continuous functions and their Sinc approximation in Python. We compare the accuracy of the DESCM vs. that of the SESCM.

Session B CAB 528-C

On the Amenability and Weak Amenability of the Banach Algebra $\mathcal{B}(E)$

Eman Aldabbas, University of Alberta

The problem of charecterizing the amenable members of the class of Banach algebras $\mathcal{B}(X)$, the algebras of bounded operators on a Banach space X, is still wide open ever since Johnson published his memoir. In 2009, Runde proved that for any $p \in (1, \infty)$ and for any $\mathcal{L}^p$-space E such that $E \simeq l^p(E)$, the Banach algebra $\mathcal{B}(E)$ is not amenable. I will show that for any $p \in (1, \infty)$ and for any $\mathcal{L}^p$-space E such that $E = \mathcal{H} \oplus l^p$ for some Hilbert space $\mathcal{H}$, the Banach algebra $\mathcal{B}(E)$ is not amenable, and that $\mathcal{B}(E)$ is weakly amenable for any $\mathcal{L}^p$-space E with $p \in [1, \infty]$.

Student Talks 4 Monday, 4:45-5:25 pm

CAB 528-B

What is a noncommutative topological space?

Zsolt Tanko, University of Alberta

The theory of topological spaces can be expressed in the language of algebras of functions with certain properties, which turn out to be (and historically motivated) the axioms of a commutative C*-algebra. We will define C*-algebras and show how many familiar notions from topology, e.g. compactness and connectedness, are captured in the reformulation. Motivated by this success, we will boldly claim that general C*-algebras are "noncommutative topological spaces" and defend this thesis by showing that some fundamental results in topology, e.g. Urysohn's lemma, admit useful generalizations.

Student Talks 5 Tuesday, 9:00-9:40 am

Session A CAB 528-B

How I Became the Master of Sins

Jean Auger, University of Alberta

In this talk I wish to present some simple trigonometric identities and talk about my sins. I will explain how they came about in some intriguing modular forms and representation theory settings.

Session B CAB 528-C

Geometric Inequalities and Black Holes

Aghil Alee, University of Alberta

One of the interesting problem in mathematical relativity is the geometric inequalities for black holes, such as Penrose inequality and Mass-Angular momentum-Charge inequality. I this talk I'll give a brief review of these inequalities in 4 and higher dimensions.

Student Talks 6 Tuesday, 9:45-10:25 am

Session A CAB 528-B

Modeling Brain Lentiviral Infections During Antiretroviral Therapy in AIDS

Weston Roda, University of Alberta

Understanding HIV-1 replication and latency in different reservoirs is an ongoing challenge in the care of patients with HIV/AIDS. A mathematical model was created that predicted HIV-1 and SIV infection dynamics within the brain during effective combination antiretroviral therapy (cART). In this talk, I will present our work in developing a predictive two-compartment ordinary differential equation model generated from existing empiric data. Based on previous reports quantifying total viral DNA levels in brain from HIV-1 and SIV infections, estimates of proviral DNA burden were made and were fit to this mathematical model by Bayesian inference predicting viral accrual in brain macrophages from primary infection. I compare the estimated HIV-1 transmission rate for brain macrophages for cART-treated HIV-infected patients with and without neurological disorders, and for SIV infection among untreated macaques. The basic reproduction number R_0 (the average number of newly infected cells caused by a single infected cell during its infectious lifetime in an entirely susceptible cell population) and the control reproduction number R_ε will be used to evaluate the minimum improvement in antiretroviral therapy needed to inhibit replication in the brain. Lastly, the estimated eradication time of HIV-1 brain infection given different efficacies of antiretroviral therapy will be displayed. Our study concludes that HIV-1 and SIV provirus burdens in the brain increase over time, and a moderately efficacious antiretroviral therapy regimen could eradicate HIV-1 infection in the brain that was dependent on brain macrophage lifespan and the presence of neurological comorbidity.

Session B CAB 528-C

Geometrization of Adinkras

Jordan Kostiuk, University of Alberta

Bipartite graphs with additional decorations known as Adinkras are used by physicists to encode the structure of certain supersymmetry algebras. Motivated by the classification of such graphs, I will explain some work in progress that attaches a Riemann surface to an Adinkra in such a way that the additional graph decorations have geometric significance.

Student Talks 7 Tuesday, 2:00-2:40 pm

Session A CAB 528-B

Invariant Riemannian Metrics on a Hilbert Space

Ievgen Bilokopytov, University of Manitoba

Consider an open subset of an Inner Product Space endowed with Riemannian Metric, such that the restrictions of all unitary operators are isometries with respect to these metrics. It turns out that any such metric is of a very specific form. In this talk I will present this result and discuss some of its developments.

Session B CAB 528-C

An Introduction to Arithmetic of Hyperelliptic Curves

Sumin Leem, University of Calgary

As generalization of elliptic curves, hyperelliptic curves can be also considered to be used in cryptography especially in portable devices having limited source of battery and operators because of compactness. For cryptographical use, it is important to investigate arithmetic of hyperelliptic curve. While elliptic curves do arithmetic with their rational points, hyperelliptic curves arithmetic is defined on Jacobians. In this talk, we discuss arithmetic of hyperelliptic curves as analogy of arithmetic of elliptic curves.

Student Talks 8 Tuesday, 2:45-3:25 pm

Session A CAB 528-B

Mathematical Modelling Based Hypothesis for the Origins of Cyclical Neutropenia

Tyler Cassidy, McGill University

Cyclical neutropenia is a dynamical disease resulting in oscillations in circulating neutrophil populations. Previous mathematical models predict that the disease results from decreased amplification of maturing cells, but modelled the amplification process in limited complexity and did not offer an explicit physiological defect responsible for the decrease. We study a new model which differentiates between the different mechanisms involved in amplification and produce a hypothesis for the specific physiological process leading to the oscillations.

Session B CAB 528-C

Investigations on Some Exponential Congruences

Arnab Bose, University of Lethbridge

Around 1981, Selfridge asked for what positive integers a and b with $a > b$, does $2^a - 2^b$ divide $n^a - n^b$ for all $n \in \mathbb{N}$. The problem was independently solved by various people in different contexts, notably C. Pomerance (1977), Sun Qi and Zhang Ming Zhi (1985). In this talk, we study their ideas and prove a generalization of the problem, in the elementary number theoretic sense and also in algebraic number fields. Further, we develop ideas to give a conditional resolution and generalizations to another problem by H.Ruderman which is closely related to Selfridge's problem.

Student Talks 9 Tuesday, 4:45-5:25 pm

Session A CAB 528-B

Stochastic Dynamic Programming Model for Revenue Optimization in Social Networks

Trisha Lawrence, University of Saskatchewan

The rapid increase in the global availability and use of the Internet has made it the most effective platform for the distribution of product information and advertising when compared to the traditional media such as print, television and radio. In addition, in the case of Online Social Networks (OSN), one can take advantage of the influences that one's actions has on other users and, in particular, one's friends. Even if a user does not purchase a product, their online mention of the product can have positive or negative influences. This social behaviour can be used to improve advertising strategies. For example, if a user is given an advertisement impression (a linked icon) and clicks on it then it is more likely that their friends (if told of the action) will also click if they are subsequently given the impression. In this research we provide a Stochastic Dynamic Programming formulation of this problem together with its solution. Because of the computational complexity of the solution we aim to provide a simple heuristic that we will show to be computationally much faster.

Session B CAB 528-C

A Transfer Matrix Approach to Self-Avoiding Polygons in Lattice Tubes

Jeremy Eng, University of Saskatchewan

Self-Avoiding Polygons (SAPs) have proven to be a simple, yet effective model for studying ring polymers, such as circular DNA. Here, we take a transfer matrix approach to examining SAPs confined in lattice tubes, a tubular sublattice of the simple cubic lattice. This results in both theoretical and numerical results, as well as providing a useful tool for polygon generation. Hamiltonian SAPs, as well as SAPs subject to an external force, are also examined in a similar manner via transfer matrices. For some small tube sizes, all SAPs are generated (for both the general and Hamiltonian case) and their knot types are identified.

Student Talks 10 Wednesday, 9:00-9:40 am

Session A CAB 528-B

Non-local Fuzzy C-Means Clustering with Application to Automatic Brain Hematoma Edema Segmentation Using CT

Wei Tu, University of Alberta

Relative perihematomal edema volume (edema volume divided by hematoma volume) has been reported to be a potential predictor of functional outcome in patients with hyperacute spontaneous Intracerebral Hemorrhage (ICH). The hematoma edema segmentation on Computed Tomography (CT) is very challenging due to substantial overlapping between the edema and surrounding brain tissues, and also image noise. An automatic segmentation algorithm is presented. The algorithm first applies a threshold value based approach to segment the hematoma in each 2D slice. And then the edema segmentation part applies a non-local fuzzy c-means clustering algorithm on the 3D region of interest (ROI) volume by combing the selected 2D hematoma area acquired in the first step. The proposed algorithm has been applied to the CT head images of 4 patients with ICH, and it provides reliable and reproducible segmentations that are similar to the manual segmentation of physicians. This is joint work with Dr. Linglong Kong, Dr. Rohana Karunamuni, Dr. Ken Butcher, Lili Zheng and Rebecca McCourt.

Session B CAB 528-C

The Critical Domain Size of Stochastic Population Models

Jody Reimer, University of Alberta

Identifying the critical domain size necessary for a population to persist is an important question in ecology. Both demographic and environmental stochasticity impact a population's ability to persist. Here we explore ways of including this variability. We study populations with distinct dispersal and sedentary stages, which have traditionally been modelled using a deterministic integrodifference equation (IDE) framework. Individual-based models (IBMs) are the most intuitive stochastic analogues to IDEs but yield few analytic insights. We explore an alternate approach uses a branching process framework. These branching process models closely approximate the IBM and yield insight into the factors determining the critical domain size for a given population subject to stochasticity.

Student Talks 11 Wednesday, 9:45-10:25 am

Session A CAB 528-B

Triangle-Free Graphs with the Maximum Number of Cycles

Sergei Tsaturian, University of Manitoba

One of the central questions in extremal graph theory is determining maximal possible number of edges in a graph with given number of vertices that doesn't contain a specific subgraph. Examples of such statements are famous Mantel's and Turan's theorems. More general questions can be considered - determining how many copies of some fixed subgraphs (or collections of subgraphs) can be there in a graph that satisfies some conditions. I will talk about some results of that kind. In particular, I will show the result of our recent work with A.Arman and D.Gunderson about maximal number of cycles in a graph that doesn't contain triangles, and

discuss possible generalizations and open questions.

Session B CAB 528-C

Bayesian Disease Mapping in Applications to Public Health and Epidemiology

Md Mahsin, University of Calgary

Disease mapping is the area of epidemiology that estimates the spatial pattern in disease risk over an extended geographical region, so that areas with elevated risk levels can be identified. Bayesian hierarchical models are typically used in this context, which represent the risk surface using a combination of available covariate data and a set of spatial random effects. These random effects are included to model any overdispersion or spatial correlation in the disease data, that has not been accounted for by the available covariate information. The random effects are typically modelled by a conditional autoregressive (CAR) prior distribution, and a number of alternative specifications have been proposed. These models are then applied to a study that uses age and sex standardized expected counts of incidence cases of oral cavity and lung cancer in 126 electoral wards in the West Yorkshire region of England between 1986 and 1991.

Student Talks 12 Wednesday, 2:00-2:40 pm

Session A CAB 528-B

Financial Modeling and Option Pricing With Lévy Processes

Zijia Wang, University of Calgary

Lévy processes are extremely important in mathematical finance because it can describe the real financial market accurately, especially the asset prices have jumps. In this talk, we will present several important facts about Lévy processes and focus on its application in financial modeling. We will discuss the change of probability measure andthe fast Fourier transforms for pricing European options on assets driven by general exponential Lévy processes. The calibration of exponential Lévy model will be discussed, and numerical example (WTI future options) will also be presented.

Session B CAB 528-C

A Space-Jump Derivation for Non-Local Models of Cell-Cell Adhesion

Andreas Buttenschn, University of Alberta

Cellular adhesions are one of the fundamental biological interactions between cells and their surroundings. However, the continuum modelling of cellular adhesions has remained mathematically challenging. In 2006 Armstrong et. al. proposed a mathematical model in the form of an integro-partial differential equation. This model was successful at replicating Steinberg's cell sorting experiments and since has been used in models of cancer invasion and morphogenesis. In this talk we derive models of cell-cell adhesion from an underlying stochastic random walk. Through this derivation we are able to include micro biological properties in the model. It is shown that a particular choice of these properties yields the original Armstrong model.

Student Talks 13 Wednesday, 2:45-3:25 pm

Session A CAB 528-B

Continuous-Time Repeated Games with Imperfect Information

Benjamin Bernard, Columbia University

Repeated games model the interactions between parties (players) that face each other repeatedly. In these situations, players must take into account what responses their actions trigger before they make their decisions: the fearoffuture retaliation often enforces cooperative behaviour even if players act in self-interest. In games with imperfect information, players cannot directly observe each others' actions and instead see only the impactsofthe chosen actions on a random signal. As a result, it is possible for players to get away with cheating undetectedly and it is more difficult to sustain cooperative behaviour. The purpose of this thesis is to characterize the outcomes that are possible in equilibrium and to find conditions under which outcomes arbitrarily close to the efficient frontier are enforceable. The continuous-time techniques give rise to a clean decompositionofthe available information and lead to explicit characterizations in two-player games.

Session B CAB 528-C

Modelling the cross-talk between tumour and nerve cells

Arianna Bianchi, University of Alberta

Primary tumours infrequently lead to the demise of cancer patients; rather, mortality often results from the growth of secondary tumours in distant organs (metastasis). Malignant tumours induce the formation of both lymphatic and blood vessels around themselves, through two specific processes termed lymphangiogenesis and angiogenesis, respectively. In addition, recent experimental evidence shows that tumours also initiate their own innervation (neoneurogenesis). The relationship between tumour progression and the nervous system is a complex and poorly understood part of cancer pathogenesis. It is likely that this process is regulated by a multitude of factors in the tumour/nerve microenvironment; these pathways are even further complicated by treatment and psychological factors. It is therefore important to study the interactions between the nervous system and tumour cells through mathematical/computational modelling: in this way we will take into account the most significant elements of the plethora of interacting pathways regulating this process. The present work is a first attempt to model the neurobiological aspect of cancer development through a system of differential equations.

Student Talks 14 Wednesday, 4:00-4:40 pm

Session A CAB 528-B

Optimal Control of a Nonholonomic Mechanical System

Stuart Rogers, University of Alberta

This talk investigates the optimal control of a mechanical system with nonholonomic constraints. Suslov's problem is an algebraically simple and classical example of a nonholonomic mechanical system. This mechanical system considers the motion of a rigid body rotating about its center of mass subject to the constraint $\Omega(t) \cdot \xi(t) = 0$, where $\Omega(t)$ denotes the rigid body's angular velocity and $\xi(t)$ is a prescribed time-varying vector, both expressed in the rigid body's body

frame. First, the pure equations of motion of this nonholonomic mechanical system are derived. Next, letting $\xi(t)$ serve as the control, the optimal control equations of motion are derived that obey the pure equations of motion, satisfy prescribed initial and terminal boundary conditions, and minimize the time integral of a prescribed cost function $C(t, \Omega(t), \dot{\Omega}(t), \xi(t), \dot{\xi}(t))$. Finally, numerical solutions of the optimal control equations are presented.

Session B CAB 528-C

Tree Hydraulics: 2D Axisymmetric Porous Medium Model (Analysis and Simulations)

Bebart Janbek, Simon Fraser University

Many models have been proposed to describe the flow of sap in trees from the roots to the leaves. Two famous models are: circuit models and porous medium models. Both try to capture the essential properties of the flow, including resistance, storage and gravity. In this talk, we adopt the porous medium model; starting from Chuang and Bertozzi 2006 paper, we generalize to the 2D axially symmetric case, with general anisotropic hydraulic conductivity with spatial variation, and with general tree radius variation and transpiration spatial and temporal variation. We extract the essential non dimensional parameters that describe the varying flow regimes; Through asymptotic analysis, we manage to get formulas for the saturation and velocities distribution in the tree. We also tackle the inverse problem of transpiration estimation through sap flow measurements. We validate our analysis through a second order numerical scheme.

Student Talks 15 Thursday, 9:45-10:25 am

Session A CAB 528-B

Grunbaum's inequality and centroid position for projections

Ning Zhang, University of Alberta

Asymptotic geometry expresses various properties of geometric objects as quantities dependent on the dimension. In this talk, we gives the best constant for general Grunbaum's inequality and interpret Bonnesen and Fenchel's one-dimensional Grunbaum's inequality as an upper bound for the distance ratio.

Session B CAB 528-C

Discrete-time Dynamical Systems Describing Mountain Pine Beetle Outbreaks

Dean Koch, University of Alberta

In mathematical ecology, systems of difference equations are often used to explore the dynamics of populations with discrete non-overlapping generations. The mountain pine beetle is particularly suited to this kind of model, having a 1-year life cycle with synchronized aggregation and reproduction events in the summer. I introduce a 2D system of nonlinear first-order difference equations, similar to the Beverton-Holt and Hassel models, to describe yearly changes in pine beetle populations. I show how to derive explicit solutions to these equations, and characterize the transient dynamics by thresholds defined in terms of biological parameters. These threshold dynamics offer an explanation for the episodic outbreaks that are typical of the mountain pine beetle, and which in recent years have occurred at an unprecedented scale and severity across forests of Western North America.

6 Panel Discussion

Wednesday, June 15 11:00am-12:00pm CAB 265

Most YRC participants are at the stage of their career in which they will soon decide whether to pursue academia or move into industry. The discussion panel "Academia vs. Industry – which way to go?" will debate the pros and cons of both avenues, bringing together experts from industry who hold academic credentials - ones who have made a similar choice themselves - along with professors from the University of Alberta to hold a spirited and good natured discussion that will, we hope, give the audience some food for thought.

Our panelists are:

- Dr. Gerda de Vries - Professor at the Main Campus, University of Alberta
- Dr. Jochen Kuttler - Professor at the Main Campus, University of Alberta
- Khalid Lemzouij - WorleyParsons, an Australian engineering firm
- Dr. Hassan Safouhi - Professor at Campus Saint-Jean, University of Alberta
- Dr. Kimberley Simmonds - Alberta Health
- William Van't Veld - ATB Financial, Mitacs internship manager

7 Workshops

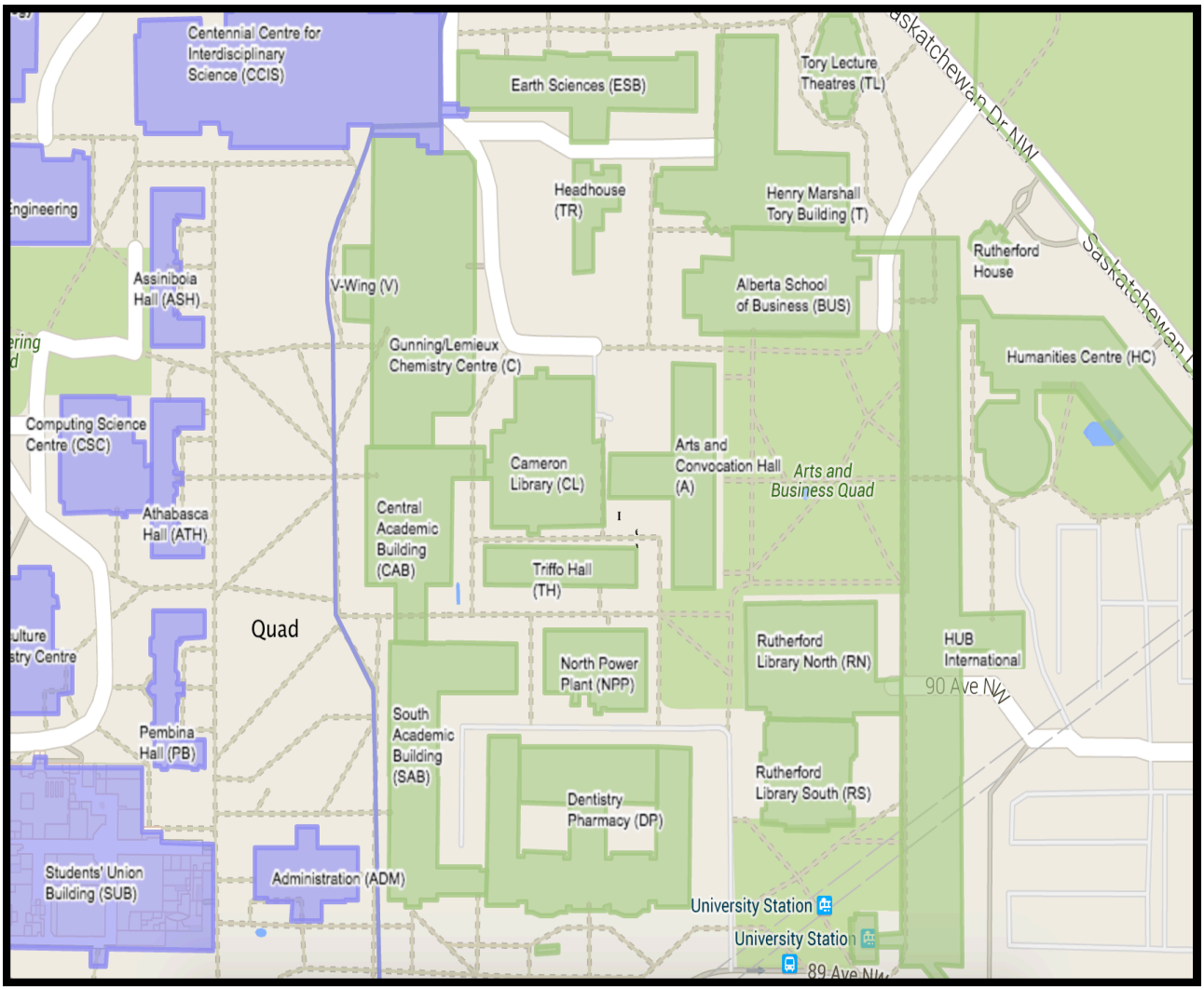
We continue the tradition of offering interactive workshops aimed at developping or improving professional skills that are relevant to young mathematicians and statisticians.

Tuesday, June 14 11:00am-12:00pm CCIS 1-140
This workshop will focus on the increasingly important skill of networking: how to approach people, how to follow up professionally after an encounter and how to keep a business relationship active.

Thursday, June 16 11:00am-12:00pm CCIS 1-140
In this workshop, the focus will be turned to academic writing practices: research papers, grant proposals, scholarship applications and responses to referees.

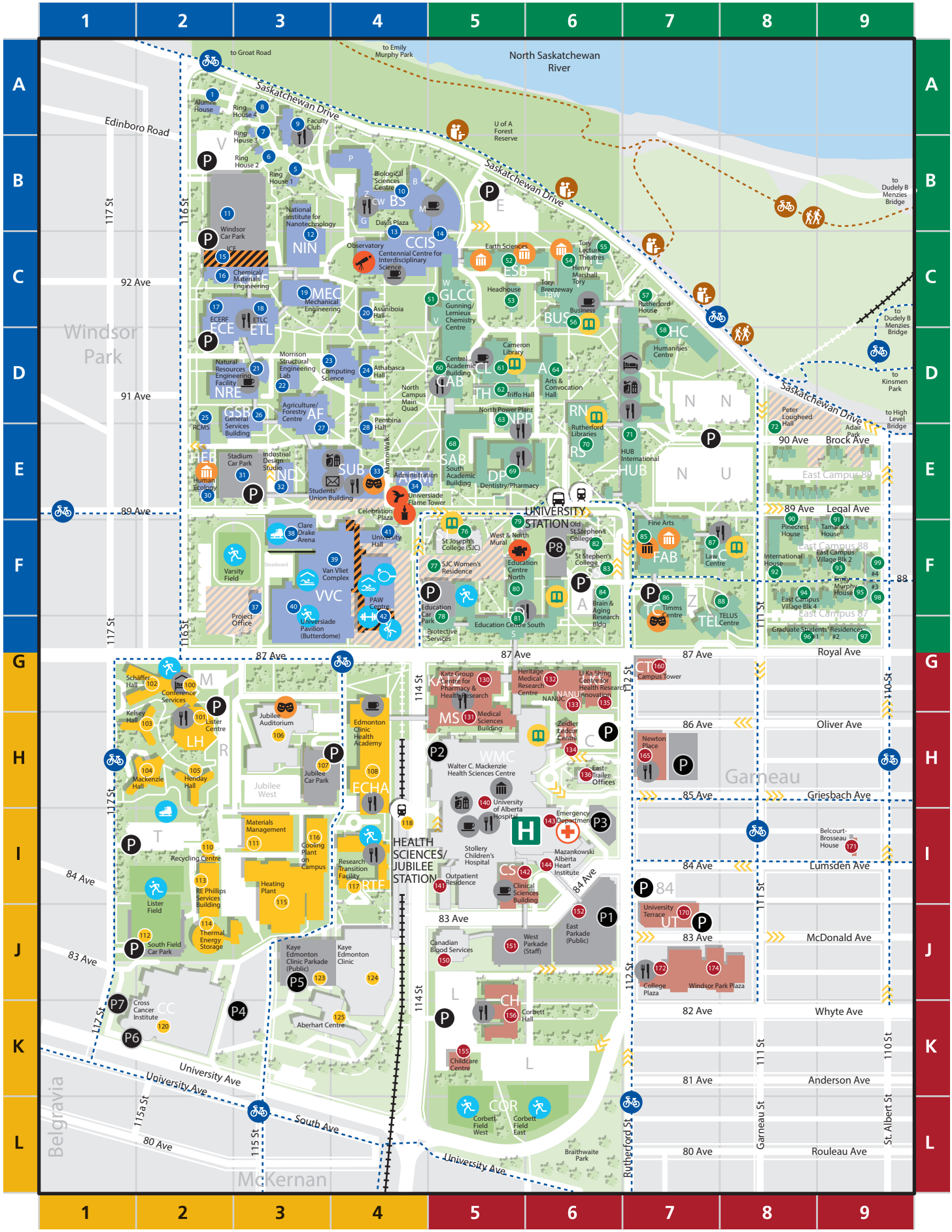
8 Map

Pictured below is a zoomed-in map of the area where most of the conference will be held.



The following is a general map of the campus. Relevant areas are marked as follows:

- A3 - Faculty Club
- C4 - Centennial Centre for Interdisciplinary Science (CCIS)
- D4 - Main Quad
- D5 - Central Academic Building (CAB)
- G7 - Campus Tower
- H2 - Lister Centre


North Saskatchewan River
Saskatchewan Drive
Edinboro Road
Windsor Park
92 Ave
91 Ave
89 Ave
87 Ave
86 Ave
85 Ave
84 Ave
83 Ave
82 Ave
81 Ave
80 Ave
117 St
116 St
115 St
114 St
112 St
111 St
110 St
Belgravia
McKernan
Garneau
University Ave
South Ave
Brock Ave
Legal Ave
Royal Ave
Oliver Ave
Griesbach Ave
Lumsden Ave
McDonald Ave
Whyte Ave
Anderson Ave
Rouleau Ave
UNIVERSITY STATION
HEALTH SCIENCES/ JUBILEE STATION
to Groat Road
to Emily Murphy Park
U of A Forest Reserve
to Dudley B Menzies Bridge
to Kinsmen Park
to High Level Bridge

9 List of Participants

- Arfan Afzal, University of Calgary
- Aghil Alaee, University of Alberta
- Eman Aldabbas, University of Alberta
- Jean Auger, University of Alberta
- Benjamin Bernard, Columbia University
- Arianna Bianchi, University of Alberta
- Ievgen Bilokopytov, University of Manitoba
- Andrew Bishop, University of Alberta
- Arnab Bose, University of Lethbridge
- Valerie Budd, University of Alberta
- Andreas Buttenschoen, University of Alberta
- Tyler Cassidy, McGill University
- Nitin Chidambaram, University of Alberta
- Carlos Contreras, University of Alberta
- Tyler Dauphinee, University of Alberta
- Fatima Davelouis, University of Alberta
- Dakota Duffy, University of Lethbridge
- Jeremy Eng, University of Saskatchewan
- Quinton Farr, University of Alberta
- Francis Forrest, University of Lethbridge
- Jesse Frohlich, University of Alberta
- Roman Frolov, University of Alberta
- Nadia Frolova, University of Alberta
- Alain Gervais, University of Alberta
- Hongyan Guo, University of Alberta
- Meghan Hall, University of Victoria
- Chantelle Hanratty, University of Alberta
- Juan Hernandez, University of Alberta
- Jieliang Hong, University of British Columbia
- Bebart Janbek, Simon Fraser University
- Dean Koch, University of Alberta
- Jude Kong, University of Alberta
- Jordan Kostiuk, University of Alberta
- Trisha Lawrence, University of Saskatchewan
- Hyejung Lee, University of Calgary
- Alexander Liwoch, University of Alberta
- Prachi Loliencar, University of Alberta
- Md Mahsin, University of Calgary
- Joel Makin, University of Alberta
- Michelle Michelle, University of Alberta
- Su Min Leem, University of Calgary
- Ali Nadaf, Simon Fraser University
- Oluwole Olobatuyi, University of Alberta
- Frdric Paquin-Lefebvre, University of BC
- Mingfeng Qiu, University of British Columbia
- Safia Raz , University of Calgary
- Jody Reimer, University of Alberta
- Wolfgang Riedler, University of Alberta
- Weston Roda, University of Alberta
- Stuart Rogers, University of Alberta
- Matthew Rupert, University of Alberta
- Sahar Siavashi, University of Lethbridge
- Marc Sellers, University of Alberta
- Matthew Stephen, University of Alberta
- Zsolt Tanko, University of Alberta
- Bowen Tian, University of Alberta
- Sergii Tsaturian, University of Manitoba
- Wei Tu, University of Alberta
- Xinling Wang, University of Alberta
- Zijia Wang, University of Calgary
- Curtis Wendlandt, University of Alberta
- Samantha Wong, University of Alberta
- Shuangming Yang, University of Alberta
- Omar Yasin, University of Alberta
- Fahmida Yeasmin, University of Calgary
- Roshanak Zabihi, Simon Fraser University
- Ning Zhang, University of Alberta
- Xiaohong Zhang, University of Manitoba