Seventh Annual Canadian Young Researchers Conference in Mathematics and Statistics (CYRC 2010)

University of Alberta, Edmonton AB
May 18-20, 2010

Schedule

The page on which the speakers abstract appears is given in parenthesis after the speakers name. Abstracts are sorted alphabetically, according to the speakers name.

Tuesday, May 18

11:30 to 13:00: Lunch and registration in CAB 269.
13:00 to 14:30: Concurrent sessions on the second floor of CAB.
14:30 to 15:00: Coffee and refreshments in CAB 269.
15:00 to 16:30: Concurrent sessions on the second floor of CAB.
18:00: BBQ in the Quad.

Jasper Session, CAB 265

13:00	U. of Alberta	Caterpillars and Climate Change	Jeanette Wheeler (9)
13:30	U. of Alberta	Statistical Approaches to Length of Reign	Boyko Zlatev (6)
14:00	U. of Alberta	The flow of static metrics on manifolds with boundary	Cody Holder (7)
14:30		Coffee break	
15:00	U. of Calgary	Qualitative models of Neural activity using Carleman Embedding technique	Azamed Gezahagne (6)
15:30	U. of Alberta	Python for Scientific Computing	Matthew Emmett (12)
16:00	UBC	Introduction to Stochastic Differential Equations	Nicole Jinn (14)

Banff Session, CAB 243

13:00	U. of Alberta	Realization of Homology Classes by Manifolds with Singularity	Saeed Rahmati (16)
13:30	U. of Alberta	A Characterization of the Euclidean ball associated to the volume ratio of packing cone of a convex body.	Long Yu (12)
14:00	U. of Calgary	The Largest k-Ball in an n-Box	Ryan Trelford (15)
14:30		Coffee break	
15:00	Queen's	Embeddings of flag varieties and pullback maps	Valdemar Tsanov (17)
15:30	U. of Alberta	Representability of Algebraic Chow Groups	Serhan Tuncer (16)
16:00	U. of Alberta	Extensions of Skorohod's almost sure representation theorem	Nancy Hernandez-Ceron (13)

Wednesday, May 19

08:00 to 09:00: Breakfast in CAB 269
09:00 to 11:00: Concurrent sessions on the second floor of CAB.
11:00 to 11:30: Coffee and refreshments in CAB 269.
11:30 to 12:30: **Plenary speaker: Jon Jacobsen** in CAB 243.
12:30 to 13:00: Lunch in CAB 269.
13:00 to 14:30: Concurrent sessions on the second floor of CAB.
14:30 to 15:00: Coffee and refreshments in CAB 269.
15:00 to 16:00: Concurrent sessions on the second floor of CAB.
18:00: Banquet and **Plenary speaker: John McKay** in The Room at the Top (RATT).

Jasper Session, CAB 265

09:00	U. of Alberta	Bistable traveling waves for a reaction-diffusion system	Yu Jin (18)
09:30	U. of Alberta	Study of Animal Movement and Group Formation with a Lagrangian Model	Rita Wong (15)
10:00	U. of Alberta	Approximation Algorithms for Travelling Salesmen Problems	Zac Friggstad (18)
10:30	U. of Alberta	Backward Bifurcation in an SIR Model	Rebecca de Boer (15)
11:00		Coffee break	
11:30		Plenary speaker: Jon Jacobsen	
13:00	U. de Sherbrooke	Quotients of Minkowski Spacetime	Jean-Philippe Burelle (9)
13:30	U. of Alberta	Mathematical Modelling of HTLV-I Infection: A Look at Viral Persistence *in vivo*	Aaron Lim (4)
14:00	U. of Calgary	Embedded eigenvalues and similarity problem for nonself-adjoint Sturm-Liouville operators	Illia Karabash (8)
14:30		Coffee break	
15:00	U. of Waterloo	Hysteresis and its Applications	Amenda Chow (5)
15:30	U. of Alberta	The role of motility and nutrients in bacterial colony formation and competition	Silogini Thanarajah (16)

Banff Session, CAB 243

09:00	U. of Alberta	A simplified approach to Fredholm index theory	Niushan Gao (14)
09:30	U. of Toronto	On moments of class numbers of real quadratic fields	Alexander Dahl (5)
10:00	UBC	Comparison of the methods of finding sectional complements	Athena Nguyen (6)
10:30	UBC	Grothendieck Topologies	Kevin Luk (11)
11:00		Coffee break	
11:30		Plenary speaker: Jon Jacobsen	
13:00	Al-Mustansiriyah	Skew Commuting and Commuting Derivations of Semiprime Rings	Dalal Ibraheem Resan (7)
13:30	UBC	When is an infinitesimal isometry on a Hermitian manifold holomorphic?	Kael Dixon (10)
14:00	Grant MacEwan	Fixed Point Factorization	Elaine Beltaos (8)
14:30		Coffee break	
15:00	Al-Mustansiriyah	Permuting 3-Derivations of Semiprime Rings	Mehsin Jabel Atteya (13)
15:30	U. of Alberta	An introduction to C^*-algebras	Cristian Ivanescu (7)

Thursday, May 20

08:00 to 09:00: Breakfast in CAB 273
09:00 to 10:30: Concurrent sessions on the second floor of CAB.
10:30 to 11:00: Coffee and refreshments in CAB 273.
11:00 to 13:00: Concurrent sessions on the second floor of CAB.
13:00: Lunch and farewell in CAB 273.

Jasper Session, CAB 265

09:00	U. of Alberta	A new intersection graph game	Jessica Enright (10)
09:30	UBC	Favard length of Cantor type sets	Kelan Zhai (11)
10:00	UBC	Galois Cohomology; an introduction to the ideas of	Jerome Lefebvre (10)
10:30		Coffee break	
11:00	U. of Alberta	The Indiana Bat and the White Nose Syndrome	Khalid Lemzouji (11)
11:30	U. of Calgary	Which graphs can we draw if edges must cross at right angles?	Karin Arikushi (11)
12:00	UBC	Autoregressive Trading Rule Visualization	Peter Bell (14)
12:30	U. of Alberta	The Fastest Convolution in the West	Malcolm Roberts (12)

Banff Session, CAB 243

09:00	U. of Alberta	Minimum degree spanning trees	Jacqueline Smith (9)
09:30	U. of Calgary	Cover attack friendly extensions	Syed Lavasani (17)
10:00	U. of Calgary	Cops and Robber with Road Blocks	Matt Musson (13)
10:30		Coffee break	
11:00	U. of Calgary	Computations in real quadratic number fields: How the universe is out to stop my research	Alan Silvester (4)
11:30	U. of Alberta	Searching for new Calabi-Yau threefolds	Andrey Novoseltsev (5)
12:00	U. of Alberta	T-stable surfaces in G/P	Valerie Cheng (17)
12:30	U. of Calgary	Constructing Global Fields with a Fixed Discriminant	Colin Weir (7)

Sponsors

The organisers would like to thank Dr. Thomas Hillen, Dana McCallum, and Leona Guthrie for their support in hosting this conference. We would also like to thank the following sponsors:

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- U of Alberta - Department of Mathematical and Statistical Sciences
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Organisers

The *Seventh Annual Canadian Young Researchers Conference in Mathematics and Statistics (CYRC 2010)* was organised by: Cody Holder, Dr. Thomas Hillen, Matthew Musson, Hannah Mckenzie, Diana White, Rem Kooistra, Jaime Ashander, Matthew Emmett, Malcolm Roberts, Matthew Mazowita, Jitendra Bajpai, Jonathan Martin, Jeanette Wheeler, and Rita Wong.

Abstracts

Mathematical Modelling of HTLV-I Infection: A Look at Viral Persistence *in vivo*

Presenter: Aaron Lim
Email: agl@ualberta.ca
Affiliation: University of Alberta

Human T-lymphotropic virus type I (HTLV-I) is the first discovered human retrovirus and it infects an estimated 10 to 20 million individuals world wide. The infection is endemic in several regions around the world and there is no cure. HTLV-I infection has been linked to the development of Adult T-cell Leukaemia (ATL), an aggressive blood cancer, and HTLV-I-associated myelopathy (HAM), a slowly progressive neurological disease, along with a wide range of inflammatory afflictions.

Motivated by an experimental hypothesis for the mechanism of HTLV-I pathogenesis, a three dimensional compartmental model of ordinary differential equations is constructed that describes the *in vivo* infection dynamics among populations of healthy, latently infected, and actively infected target cells. Mathematical analysis of the model reveals the existence of a backward bifurcation resulting in a region of bi-stability: the infection-free equilibrium and a chronic infection equilibrium co-exist and are both stable. Consequences are that the long-term outcome of the HTLV-I infection may depend on the initial viral dosage at the time of infection, and challenges to effective treatment strategies are encountered.

Computations in real quadratic number fields: How the universe is out to stop my research

Presenter: Alan Silvester
Email: aksilves@math.ucalgary.ca
Affiliation: University of Calgary

One of my main research interests is the computation of invariants of algebraic number fields and their application to cryptographic settings. In particular, I work with quadratic number fields. For real quadratic fields, a very important invariant is the log of the fundamental unit, known as the regulator. Over the years, a number of algorithms have been presented to compute this number and for the first part of my talk, I will discuss the best-known algorithm and some improvements that I am developing. For my thesis, a large part of the work I do involves actual computations with, benchmarking of, and improvements to these algorithms. Not only do I need to test these improvements against the previously best-known versions, but I need to push my implementation to see just how large of numbers it can practically handle. Unfortunately, a single run of some of these calculations can last for days or even weeks. The second part of my talk will be from a more computer science based viewpoint. I will show a number of real-world problems that anyone performing long-running computations should be aware of and how they affect my research.

On moments of class numbers of real quadratic fields

Presenter: Alexander Dahl
Email: a.dahl@utoronto.ca
Affiliation: University of Toronto

Class numbes of algebraic number fields are central invariants. Once the underlying field has an infinite unit group they behave very irregularly due to a non-trivial regulator. This phenomenon occurs already in the simplest case of real quadratic number fields of which very little is known.

There are numerous conjectures concerning the size and structure of these class numbers, the most prominent being Gauss' conjecture that there are infinitely many real quadratic fields of class number one, and the Cohen-Lenstra heuristics concerning the statistics of the p-part of the class group.

Hooley derived a conjectural formula for the average of class numbers of real quadratic fields. We have extended his methods to obtain conjectural formulae and bounds for the average of an arbitrary real power of the class number (i.e., any moment of the class number). Our formulae and bounds are based on similar (quite reasonable) assumptions of Hooley's work.

Finally, we consider the case of the -1 moment from a numerical point of view and develop an efficient algorithm to compute it without computing class numbers.

Hysteresis and its Applications

Presenter: Amenda Chow
Email: anchow@ualberta.ca
Affiliation: University of Waterloo

Hysteresis is a phenomenon that occurs in a variety of applications. A precise mathematical definition of hysteresis will be presented. Two examples of hysteretic systems will be discussed: a predator prey model and a flexible beam in a magnetic field.

Searching for new Calabi-Yau threefolds

Presenter: Andrey Novoseltsev
Email: novoselt@ualberta.ca
Affiliation: University of Alberta

A few years ago Charles Doran and John Morgan classified integral variations of Hodge structure which can correspond to one-parameter families of Calabi-Yau threefolds. There were two cases for which the existence of a geometric realization was not clear. This talk will report on the recent progress (joint work with Charles Doran and Jacob Lewis) towards constructing these missing examples using singular subfamilies of hypersurfaces and complete intersections in toric varieties. We will try to communicate the general feel of the topic, rather than concentrate on technical details.

Comparison of the methods of finding sectional complements

Presenter: Athena Nguyen
Email: athena@math.ubc.ca
Affiliation: University of British Columbia

A lattice L is a partially ordered set in which every pair of elements has a unique supremum and infimum. If L has a maximal (resp. minimal) element, then it is unique, and we denote it by 1 (resp. 0). An element u in L is called a sectional complement of another element v in L if $\sup(u, v) = 1$ and $\inf(u, v) = 0$ in L. Clearly, sectional complements are not necessarily unique. More generally, we call a lattice sectionally complemented if for every sublattice L' of L and element u of L', there exists a sectional complement of u in L'.

In 1960, G. Gratzer and E. T. Schmidt proved that every finite distributive lattice can be represented as the congruence lattice of a sectionally complemented finite lattice L. For u in a sublattice L' of L, they constructed a sectional complement, referred to as the 1960 sectional complement. Later in 2006, G. Gratzer and M. Roddy introduced another method of constructing sectional complements given by an algorithm and allowed some degree of freedom as to how it can be carried out.

In this talk, we show that the output of the 2006 algorithm is independent of how it is carried out. In fact, it produces precisely the 1960 sectional complement.

Qualitative models of Neural activity using Carleman Embedding technique

Presenter: Azamed Gezahagne
Email: aygezaha@math.ucalgary.ca
Affiliation: University of Calgary

The two variable Fitzhugh Nagumo model behaves qualitatively like the four variable Hodgkin-Huxley space clamped system and is more mathematically tractable than the Hodgkin Huxley model, thus allowing the action potential and other properties of the Hodgkin Huxley system to be more readily be visualized. In this talk, it is shown that the Carleman Embedding Technique can be applied to both the Fitzhugh Nagumo model and to Van der Pol's model of nonlinear oscillation, which are both finite nonlinear systems of differential equations. The Carleman technique can thus be used to obtain approximate solutions of the Fitzhugh Nagumo model and to study neural activity such as excitability.

Statistical Approaches to Length of Reign

Presenter: Boyko Zlatev
Email: bzlatev@math.ualberta.ca
Affiliation: University of Alberta

Since the beginning of 18th century, when Sir Isaac Newton in his "Chronology of Ancient Kingdoms Amended" questioned the generally accepted date of the founding of Rome, the estimation of parameters of the distributions of lengths of reign in monarchies continues to attract attention of both statisticians and chronologists.

The talk contains an overview of the main results (starting from those of I. Newton and up to nowadays), analysis of some interesting data and a brief discussion of the main difficulties and possible further directions of research on this topic.

The flow of static metrics on manifolds with boundary

Presenter: Cody Holder
Email: holder@math.ualberta.ca
Affiliation: University of Alberta

We investigate a system of geometric differential equations on asymptotically flat Riemannian n-manifolds with interior boundary. Fixed points correspond to solutions of the static Einstein equations in an $n+1$- dimensional vacuum. Preliminary estimates in the case of rotational symmetry suggest a method for addressing a conjecture of Bartnik on the definition of quasi-local mass in general relativity.

Constructing Global Fields with a Fixed Discriminant

Presenter: Colin Weir
Email: cjweir@ucalgary.ca
Affiliation: University of Calgary

In this talk we will be interested in constructing number fields with a fixed discriminant. Classical results accomplish this for quadratic and cubic extensions so we will attempt this feat for quartic fields. I will show (with props hopefully) how with a little imagination, and the magic of Wikipedia, we can create such fields. I will do my best to provide a lot of the number theoretic background.

An introduction to C^*-algebras

Presenter: Cristian Ivanescu
Email: civanescu@math.ualberta.ca
Affiliation: University of Alberta

The starting point is a theorem of Gelfand that states that any commutative C^*-algebra with unit is isomorphic to $C(X)$, where X is compact Hausdorff space. The stategy is now that basic tools in the topology of X are translated into tools pertinant to the C^*-algebra $C(X)$ that subsequently are generalized to non-commutative C^*-algebras.

This strategy has been successful in K-theory, whose non-commutative version is even simpler than its usual incarnation.

The theory of C^*-algebras (i.e. quantum topological spaces) turned out to be interesting both for intrinsic reasons(structure and representations theory), as well as because of its connections with a number of other fields of mathematics.

Skew Commuting and Commuting Derivations of Semiprime Rings

Presenter: Dalal Ibraheem Resan and Mehsin Jabel Atteya
Email: dalalresan@yahoo.com
Affiliation: Al-Mustansiriyah University-College of Education

The main purpose of this paper is to investigate various properties of the derivations d and g on a semiprime ring R. In particular, we show the derivations are commuting (resp. centralizing) and skew-commuting (skew-centralizing) on R. The history of commuting and centralizing mappings goes back to 1955 when Divinsky proved that a simple Artinian ring is commutative if it has a commuting nontrivial automorphism.

Fixed Point Factorization

Presenter: Elaine Beltaos
Email: beltaose@macewan.ca
Affiliation: Grant MacEwan University

Conformal field theories can be considered to be toy models for quantum field theories. An important fingerprint of a conformal field theory is its so-called modular data. Modular data comprises two matrices S and T, the former being the more important of the two. In this talk, we discuss a remarkable simplification of the S-matrix entries at certain 'fixed points' for a well-studied class of conformal field theories (the Wess-Zumino-Witten models).

A new perspective on population persistence in rivers using R_0

Presenter: Hannah Mckenzie
Email: hmckenzie@math.ualberta.ca
Affiliation: University of Alberta

Water is a limited resource that requires management in many parts of the world, including Canada. Management actions often take the form of changes to the natural flow regime, which impact the river ecosystem. In addition to the current decision-making tools available to water managers (e.g. habitat suitability models), a class of mathematical models called advection-diffusion-reaction equations has provided insight into the effect of water flow on population persistence. In this talk I will present a new mathematical framework for studying population persistence in rivers that introduces a "basic reproductive number R_0" for these spatiotemporal models. I will demonstrate the potential of this framework to inform water management decisions by applying it to a scenario where water flow and nutrient availability interact to impact population persistence. This work lays the groundwork for connecting R_0 to more complex population and community models, as well as more detailed habitat and hydrological data.

Embedded eigenvalues and similarity problem for nonself-adjoint Sturm-Liouville operators

Presenter: Illia Karabash
Email: karabash@math.ucalgary.ca
Affiliation: University of Calgary (Canada) and Institute of Applied Math. and Mech. (Ukraine)

Eigenvalues in the essential spectrum of a weighted J-self-adjoint Sturm-Liouville operator are studied under the assumption that the weight function has one turning point. An abstract approach to the problem is given via a functional model. The method allows us to find algebraic multiplicities of eigenvalues including eigenvalues embedded into the essential spectrum. A nontrivial class of J-nonnegative Sturm-Liouville operators non-similar to self-adjoint operators is constructed. We plan also to discuss connection with other related results in the field.

Minimum degree spanning trees

Presenter: Jacqueline Smith
Email: jesmith@ualberta.ca
Affiliation: University of Alberta

A spanning tree is a subgraph of a graph that connects all vertices with the smallest number of edges. A minimum degree spanning tree has the added constraint that the maximum degree of any vertex in the subgraph is minimized, and finding one is NP-hard. I will discuss some work related to solving this problem on restricted graph classes where polynomial time algorithms exist.

Quotients of Minkowski Spacetime

Presenter: Jean-Philippe Burelle
Email: j-p.burelle@usherbrooke.ca
Affiliation: Université de Sherbrooke

The setting of Einstein's special relativity is Minkowski spacetime, which is the affine space associated to the Lorentz vector space. Structures that are locally like Minkowski spacetime are consequently possible physical models. I will discuss one of the ways of constructing such spaces : taking the quotient of Minkowski Space by a group of affine isometries.

Caterpillars and Climate Change

Presenter: Jeanette Wheeler
Email: jwheeler@ualberta.ca
Affiliation: University of Alberta

Climate change is currently a central problem in ecology, with far-reaching effects on species that may be difficult to quantify. Cold-blooded species such as insects, which rely on environmental cues to complete successive stages of their life history, are especially sensitive to temperature changes and so are good indicators of the impacts of climate change on ecosystems.

In this talk, I present a novel mathematical model to study developmental rate in larval insects. The movement of an individual through larval classes is treated as a discrete-time four-outcome Markov process, where class transition and death are assigned temperature-dependent probabilities. Time evolution in the system is governed by a set of discrete-time master equations, the solution of which generates the time-dependent probability that an individual larva resides in a given larval class on a given day. From here, probability distributions for adult emergence are derived.

Transition and mortality probabilities are estimated using modified maximum likelihood estimation techniques, based on data collected in growth experiments for alpine butterfly species Parnassius smintheus (Rocky Mountain Apollo). I use the model results to discuss implications of climate change for the population dynamics of this alpine butterfly, as well as the broader effects such changes may have on Rocky Mountain alpine meadow ecosystems.

Galois Cohomology; an introduction to the ideas of

Presenter: Jerome Lefebvre
Email: jlefebvre@math.ubc.ca
Affiliation: University of British Columbia

There is a constant battle when doing algebra, between rigidity and diversity, between control and flexibility; a battle that could be phrased in: "how much are you willing to give up to be able to talk about much more?". A form of this question shows up early in our studies, but never goes away, it is the question of which field one should work in. A great deal of algebra courses follow the general pattern of "let's work over an arbitrary field, then go over characteristic zero to be able to divide by any integer, then an algebraic closed field to solve polynomials and have eigenvalues, then go over $\mathbb{C}$ for its nicely behaved topology". Then the hard path is to be able to go back; i.e. once you solved your problem over your favourite field how do you go back to more general fields? Galois cohomology is one answer to this problem. I'll quickly present the ideas of galois cohomology and the main points of view related to it: it is a cohomology theory so that there is hope in computing the related object and its main used in classifying forms of algebraic objects over various fields.

A new intersection graph game

Presenter: Jessica Enright
Email: enright@cs.ualberta.ca
Affiliation: University of Alberta

Games are fun. Combinatorics is fun. Combinatorial games are therefore double-fun. I will survey some introductory combinatorial game theory and then describe a new combinatorial game played on intersection representations of graphs.

When is an infinitesimal isometry on a Hermitian manifold holomorphic?

Presenter: Kael Dixon
Email: kael@alumni.uwaterloo.ca
Affiliation: University of British Columbia

I will present this open problem in complex geometry via the example of a Hopf surface. This is (roughly) the only compact Hermitian surface that admits infinitesimal isometries which are not holomorphic, and it exhibits some interesting behaviour which is indicative of some known results in higher dimensions. This talk will not require very much knowledge of differential geometry, with most of the discussion on the more intuitive level of group actions by Lie groups.

Which graphs can we draw if edges must cross at right angles?

Presenter: Karin Arikushi
Email: karikush@math.ucalgary.ca
Affiliation: University of Calgary

This talk will cover *right angle crossing* (RAC) graph drawings in the plane: graphs whose edges are straight or polygonal lines and any crossing edges intersect at right angles. We will give a partial answer to the question above by showing how many edges a graph with an RAC drawing can have depending on whether the edges are straight lines or polygonal lines with one, two or three bends per edge. We'll also show that these classes of graphs are inequivalent.

Favard length of Cantor type sets

Presenter: Kelan Zhai
Email: zkelan@math.ubc.ca
Affiliation: University of British Columbia

For a two dimensional set Ω, the Favard length is defined as the integral over all directions of the its projection onto lines. Nazarov, Peres and Volberg proved that the Favard length of the n^{th} iteration of the four-corner Cantor set is bounded from above by n^c for an appropriate c. In a joint work with Izabella Laba, we generalize this result to all product Cantor sets whose projection in some direction has positive 1-dimensional measure.

Grothendieck Topologies

Presenter: Kevin Luk
Email: kevinluk6@hotmail.com
Affiliation: University of British Columbia

Here we will introduce a much more abstract but powerful topology known as the Grothendieck topology introduced by Alexander Grothendieck in the early sixties. In my talk, I will briefly discuss the basic constructions and ideas behind this topology; for example, the parallels between standard point set/metric topology to the Grothendieck topology. I will also discuss the applications of this topology and why it is an indispensible tool to algebraic geometers and topologists. If time permits, I will discuss a few things about the Grothendieck approach to Galois theory.

The Indiana Bat and the White Nose Syndrome

Presenter: Khalid Lemzouji
Email: klemzou@math.ualberta.ca
Affiliation: University of Alberta

The Indiana Bat (Myotis sodalis) population had decreased by 56% between 1967 and 2006. In summer 2006, a mysterious disease called "White Nose Syndrome" was first identified. Since then, the disease killed almost one million bats in North America. Many Biologists believe that both the population decreasing and WNS are associated with climate change. As a collaboration with Yellowstone Ecological Research Center (YERC), USFW and NASA Terrestrial Observation and Prediction System (TOPS), our study aims to establishes a link between bat population dynamic and climate change.

A Characterization of the Euclidean ball associated to the volume ratio of packing cone of a convex body.

Presenter: Long Yu
Email: longyu@math.ualberta.ca
Affiliation: University of Alberta

Given a convex body $K \subset \mathbb{R}^n$ and $\mathbf{u} \in S^{n-1}$,where $n \geq 1$, we introduce a new volume ratio $r(K, \mathbf{u})$ of the packing cone associated to K. We prove that if K is an $\mathbf{o}$-symmetric convex body in $\mathbb{R}^n$ and $r(K, \mathbf{u})$ is a constant function of $\mathbf{u}$, then K must be a Euclidean ball.

The Fastest Convolution in the West

Presenter: Malcolm Roberts
Email: mroberts@math.ualberta.ca
Affiliation: University of Alberta

Efficient algorithms have recently been developed for calculating dealiased linear convolution sums without the expense of conventional zero-padding or phase-shift techniques. For one-dimensional in-place convolutions, the memory requirements are identical with the zero-padding technique, with the important distinction that the additional work memory need not be contiguous with the input data. This decoupling of data and work arrays dramatically reduces the memory and computation time required to evaluate higher-dimensional in-place convolutions. The memory savings is achieved by computing the in-place Fourier transform of the data set in blocks, rather than all at once. The technique also allows one to dealias the hyperconvolutions that arise on Fourier transforming cubic and higher powers.

Implicitly dealiased convolutions can be built on top of state-of-the-art adaptive fast Fourier transform libraries like FFTW. Vectorized multidimensional implementations for the complex and centered Hermitian (pseudospectral) cases have already been implemented in the open-source software FFTW++. With the advent of this library, writing a high-performance dealiased pseudospectral code for solving nonlinear partial differential equations has now become a relatively straightforward exercise.

Python for Scientific Computing

Presenter: Matthew Emmett
Email: memmett@math.ualberta.ca
Affiliation: University of Alberta

The Python programming language is becoming quite popular in various scientific fields. In this talk I will introduce various Python packages that have been quite helpful to me throughout my own research. Topics will include root finding, optimisation, differential equations, partial differential equations, interpolation, storage, parallel processing, and visualisation.

Cops and Robber with Road Blocks

Presenter: Matt Musson
Email: mmusson@math.ucalgary.ca
Affiliation: University of Calgary

In this paper we examine the game of Cops and Robber with a new approach. This new approach will be the use of what we call road blocks for the Cops to use in their pursuit of the Robber. We present results for several trivial cases, provide a classification for trees which require zero road blocks, trees that require only one road block, extend the work to determine the road block number for complete bipartite graphs $K_{m,n}$, discuss the problems and obstacles of extending this work to arbitrary graphs, and discuss obstacles in developing an algorithm for searching trees. This is Joint work with Adrian Tang.

Permuting 3-Derivations of Semiprime Rings

Presenter: Mehsin Jabel Atteya
Email: mehsinatteya@yahoo.com
Affiliation: Al-Mustansiriyah University-College of Education

We study certain properties of permuting 3-derivations on semiprime rings. Let R be a 3-torsion free semiprime ring and U be a non-zero two-sided ideal of R. Suppose that there exists a permuting 3-derivation $\Delta : R \times R \times R :\to R$ where δ is the trace of Δ. In this talk we present some theorems and results regarding permuting 3-derivations.

Extensions of Skorohod's almost sure representation theorem

Presenter: Nancy Hernandez-Ceron
Email: nhernan@math.ualberta.ca
Affiliation: University of Alberta

A Polish space S is a complete, metrizable and separable space. We consider the space $\mathcal{M}(S)$ of all probability measures on $(S, \mathcal{B}(S))$. A well known result in probability is that convergence a.s. of the S-valued random variables $\{X_n\}_n$ implies weak convergence of their laws in $\mathcal{M}(S)$. The Skorohod a.s. representation theorem is a partial converse of this result.

In the talk we discuss the notion of continuous representations of $\mathcal{M}(S)$, which allows us to provide a generalization of Skorohod's theorem.

Introduction to Stochastic Differential Equations

Presenter: Nicole Jinn
Email: nicole.jinn@gmail.com
Affiliation: University of British Columbia

This talk will (mainly) be an introduction to the theory of Stochastic Differential Equations (SDEs), with an emphasis on the connections to Statistics. In any case, I could look at SDEs from two different perspectives: Applied Mathematics and Statistics. The differences between the two perspectives will quickly be explained. I will also briefly mention some of the results of a directed studies project I am close to completing and highlight the connection to SDEs. My project is about modelling diffusion of one particle into a two dimensional system of fixed particles. The eventual goal is to have a working molecular dynamics simulation representative of the system in question, as well as to validate one of two theoretical predictions for the diffusion coefficient and its dependence on spacing between fixed particles.

A simplified approach to Fredholm index theory

Presenter: Niushan Gao
Email: ngao@math.ualberta.ca
Affiliation: University of Alberta

We will review the classical approach to Fredholm index theory (Fredholm Alternative Theorem, Yood's Compact-Stability Theorem, and Dieudonne's Norm- Stability Theorem), and then introduce our new approach. Difficulties are avoided by starting with finite rank operators instead of compact operators as in the classical case.

Autoregressive Trading Rule Visualization

Presenter: Peter Bell
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We share a new way to display risk and return attributes for trading rules. Trading rules that generate profit in financial markets are elusive and our favourite rules are based on two filters with different lengths. These rules are motivated by long memory in financial price series: if autoregressive models have predictive power then the predictive power may be exploited for trading purposes. We share a new way to display attributes for trading rules where a surface, or heat map, is created for each attribute. The domain for the surface is all possible combinations of trading rule specifications. The approach applies to markets of all kinds and gives insight into position sizing rules.

Backward Bifurcation in an SIR Model

Presenter: Rebecca de Boer
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In a simple SIR epidemic model, the amount of disease transmission depends on the total population through the contact function. This talk will introduce some standard choices for the contact function as well as some non-standard options. Stability and equilibria will be discussed in each case, and a backward bifurcation will be demonstrated.

Study of Animal Movement and Group Formation with a Lagrangian Model

Presenter: Rita Wong
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Animal group formation has often been studied by mathematical biologists through PDE models, producing classical results like traveling and stationary waves. Recently, Eftimie et al. introduced a 1-D PDE model that considers three social interactions between individuals in the relevant neighborhoods, specifically repulsion, alignment, and attraction. It takes into account the orientation of the neighbors when considering if they can communicate. This has resulted in exciting new movement behaviors like zig-zag pulses, breathers, and feathers. In this work, we translate the Eftimie model into a Lagrangian implementation. Currently, the results from the Lagrangian formulations do not show the full range displayed by the Eftimie model, producing only patterns like the zig-zag, traveling, and stationary pulses.

The Largest k-Ball in an n-Box

Presenter: Ryan Trelford
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I will develop a formula for the radius of the largest k-dimensional Euclidean ball that can be inscribed inside an n-dimensional box, and show how these results can be extended to find the location of these k-dimensional balls of maximal radius.

Realization of Homology Classes by Manifolds with Singularity

Presenter: Saeed Rahmati
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In 1946, Steenrod asked if any homology class is realizable by a manifold and in 1954 Thom found some positive and negative answers. In 1959, Sullivan showed that in the cases that the answer is negative, we can turn it into positive if we allow a slightly "controlled violation"; he used a long list of "auxiliary manifolds" which would create some "wild creatures" that realize all integral homology classes. In some specific situations, one can increase the precision of Sullivan's list by dropping the unnecessary objects of the list. The question is how we can do it in the general case.

Representability of Algebraic Chow Groups

Presenter: Serhan Tuncer
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Chow groups are formed by algebraic cycles which are geometric objects; however Chow groups may not be represented geometrically. The curiosity arises here; is it possible to represent Chow groups as a geometric object? In this talk I will define the objects such as Chow groups, Algebraic Chow groups, and algebraic cycles and mention my results on the problem of representability.

The role of motility and nutrients in bacterial colony formation and competition

Presenter: Silogini Thanarajah
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We have studied the role motility and nutrients in bacterial colony, using the bacterial species (motile and immotile) as a function of both agar and liquid concentration. We observed different colony patterns. In particular we have observed opposite results for agar and liquid cases. We focused on bacterial competition and determine which strain will "win" in competition with the other strain when the two are mixed in a petri dish. Also we used mathematical simulation to get pattern formation in the bacterial community. Finally, all bacteria go extinct due to 'closed' system.

Cover attack friendly extensions

Presenter: Syed Lavasani
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The idea of the cover attack against curve-based cryptographic problems defined over non-prime fields, was initiated by Frey on 1998 by introducing the Weil-descent attack. This attack was translated to the function field language by Gaudry, Hess and Smart. Since then, many generalization of that attack has been appeared in the literature. Attack against zero-trace variety is another instance of the cover attacks. In this talk, we introduce a general structure of function fields in which a cover attack can be mounted. Then we review the above mentioned attacks in this structure. Finally we see, under what condition, one can hope to be able to mount a new version of these attacks against a curve and its corresponding function field.

Embeddings of flag varieties and pullback maps

Presenter: Valdemar Tsanov
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A coset space $X = G/P$, where G is a semisimple complex algebraic group and P is a parabolic subgroup, is called a flag variety of G. It is known that all complete homogeneous complex varieties admitting an equivariant projective embedding have this form. The classical Borel-Weil-Bott theorem provides realizations for all irreducible finite dimensional G-modules as cohomology spaces of homogeneous vector bundles on flag varieties. We are interested in the functoriality of this construction.

Suppose X is equivariantly embedded into another flag variety $Y = H/Q$. Then any homogeneous vector bundle F on Y restricts to a homogeneous vector bundle E on X, and there is a G-equivariant pullback map $\pi : H(Y, F) \to H(X, E)$. If E is irreducible, the Borel-Weil-Bott theorem and Schur's lemma imply that the pullback is either zero or surjective. Our goal is to find a criterion for nonvanishing. Such a criterion, and more knowledge about the behavior of π, are useful from both representation theoretic and geometric point of view. Relations and applications are found to the study of combinatorics of Weyl groups, moduli of equivariant embeddings, branching laws in representation theory, infinite dimensional ind-groups and varieties.

In this talk, I will sketch the basic concepts and questions, and state a theorem giving a necessary and sufficient condition for nonvanishing of π, in the case when F and E are line bundles.

T-stable surfaces in G/P

Presenter: Valerie Cheng
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The flag variety plays an important role in algebraic geometry. Given an algebraic group G (eg. $G = GL_n(C)$) and a Borel subgroup B (eg. upper triangular matrices), we form the flag variety G/B. We then consider an action of a torus T (eg. for $G = GL_n(C)$, the set of $n \times n$ diagonal matrices with nonzero determinants) contained in B on G/B. The T-stable curves and T-stable surfaces of G/B are known. In this talk, we will examine some properties of a torus, torus actions, and T-orbits and their closures. In particular, we will consider torus actions on vector spaces, which we will relate to actions on G/B. Finally, I will briefly comment on the problem of generalizing this to the Kac-Moody case.

Bistable traveling waves for a reaction-diffusion system

Presenter: Yu Jin
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Affiliation: University of Alberta

In this work, we consider a class of coupled cooperative reaction-diffusion systems, in which one population (or subpopulation) diffuses while the other is sedentary. We use the shooting method to prove the existence of the bistable travelling wave, and then obtain its global attractivity with phase shift and uniqueness (up to translation) via the dynamical system approach. The results are applied to some specific examples of reaction-diffusion population models.

Approximation Algorithms for Travelling Salesmen Problems

Presenter: Zac Friggstad
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In the Travelling Salesman Problem (TSP), we are given a metric space and a finite set of points V in this metric. The problem is to find a tour of these points that minimizes the total distance travelled. The fastest known algorithms for solving this problem run in time that is exponential in $|V|$.

One direction taken to deal with this problem is to find approximate solutions. That is, we want to quickly find feasible solutions that are provably not far from the optimum. For example, a classic algorithm for TSP by Christofides very quickly finds a feasible tour that is no more than a 3/2-factor longer than the optimum tour.

Consider the following two related problems. The first is the Asymmetric Traveling Salesman Problem. The problem is identical to TSP except the underlying metric may not be symmetric. That is, we may have $d(u,v)! = d(v,u)$ even though the "directed triangle inequality" $d(u,v) \leq d(u,w) + d(w,v)$ continues to hold. Another related problem is the Travelling Repairman Problem. It is similar to TSP except the objective is to minimize the average time it takes to reach each point from the start of the tour.

In this talk, I will initially present some of the known results in approximating TSP and the related problems mentioned above. Then I will focus on the "Asymmetric Travling Repairman Problem" and discuss an approximation algorithm that finds a solution with average waiting time no more than $O(\log |V|)$ times the optimum solution. Previous to this work, only a slightly-worse-than $O(\sqrt{|V|})$-approximation was known.