BIRD'S EYE CONFERENCE

MARCH 1-2 @ BAHEN CENTRE

Get a bird's eye view of current research in the mathematics department through accessible survey talks given by fellow graduate students. Lunch, coffee and snacks will be provided.

Topics include:

- Geometry and Topology
- Number Theory
- Analysis & Applied Math
- Set Theory & Combinatorics
- Probability & Optimal Transport
- Algebraic Geometry

For more info:

birdseyeconference.ca

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Information Hub for the Bird's Eye Conference 2025

This page contains up-to-date public information about the conference.
Last updated: February 27, 2025

Special Events

Plenary: How to get the most out of math talks - Asif Zaman

We are happy to welcome Asif Zaman to start our conference with an interactive talk about how to get the most out of math talks as an audience member. This is deeply related to the mission of the Bird's Eye Conference.

Panel Discussion: Graduate Research Experiences and Advice

Join us on Sunday for a panel discussion about our journeys in graduate research. This includes finding our way to our research interests, and finding our advisor. It also includes our experiences during the research process, and our aspirations going forward. The audience will have a chance to ask our panelists questions.

Moderator: Fardin Syed
Panelists: Jonathan Sejr Pedersen, Luciano Salvetti, Turner Silverthorne, Waleed Qaisar, Narmada Varadarajan

Locations and Room Numbers

Saturday rooms:

Main room:	BA 1190
Session room A:	BA 1180
Session room B:	BA 1220
Food:	Bahen Atrium

Sunday rooms:

Main room:	BA 1190
Session room A:	BA 2185
Session room B:	BA 2195
Food:	Bahen Atrium

Overview

The Bird's Eye Conference is a conference organized by graduate students from the Department of Mathematics, with a focus on the accessibility of mathematical content. It is a platform for graduate students to share "bird's-eye views" of their mathematical interests, free from technicalities that are unnecessary for an intuitive understanding. This conference aims to

1. Help graduate students improve their mathematical communication skills.
2. Showcase talks that achieve a high standard of mathematical accessibility.
3. Encourage the attendees to learn about mathematics beyond their fields of interest.
4. Introduce new graduate students to the department's research landscape.
5. Build and strengthen connections among the graduate student community.

Date: March 1 and 2, 2025
Location: Bahen Centre **Cost:** Free of Charge

What kind of talks will there be?

Each speaker at this conference will give a **20-minute survey talk** that will introduce their field in an accessible and non-technical way. No original results are required to be presented. For more details, see the Guidelines for Preparing a Talk.

Acknowledgements

We are grateful for the kind sponsorship of this conference by the Mathematics Graduate Student Association (MGSA), the UTSG, UTM, and UTSC Departments of Mathematics, the Canadian Mathematical Society, and our faculty sponsor Professor Bálint Virág.

Poster design by Isabel Beach.

Diversity Statement

As the organizers of this conference, we strive for a climate supportive and inclusive of everyone, and that is free of discrimination, harassment and retaliation. All participants are welcome regardless of their race, gender identity or expression, national origin, sexual orientation, religion, caste, physical abledness, learning ability, age, parental status, or any other aspect of identity. We affirm that the mental and physical well-being of our community, especially of underrepresented and marginalized students, is of utmost importance. If you have experienced discrimination or harassment at this conference, you are welcome to reach out to us at birdseye.conference@gmail.com for support and assistance. You can also reach out to us if you need other forms of support to improve your experience of attending this conference.

Code of Conduct

We expect all speakers and attendees to abide by the University of Toronto Code of Student Conduct.

Mental Health Resources and Other Crisis Supports

Sexual Violence Prevention and Support Center:
Confidential, non-judgmental consultations are available by phone, e-mail, and video conferencing.
Phone: 416-978-2266 Email: svpscentre@utoronto.ca

Good2Talk Student Helpline (available 24/7):
Professional counselling, information and referrals helpline for mental health, addictions and students well-being
Phone: 1-866-925-5454

Assaulted Women's Helpline (available 24/7)
Provides counselling, emotional support, information and referrals
Phone: 1-866-863-0511

Abstracts

Number Theory

Should you believe in the Riemann hypothesis?
Alexander Slamen

The Riemann hypothesis is one of mathematics's most important conjectures. For over 150 years, it has resisted the best efforts of analytic number theorists. It is also widely believed to be true. But why? And on what grounds was this conjecture even made? In this talk, I will introduce Riemann's hypothesis, explore its history, and discuss why it is believed to be true (and whether or not these reasons are compelling). This talk will require no prerequisites and will avoid technical details.

The local-global principle
Sara Sajadi

The local-global principle is a fundamental concept in mathematics that connects local behavior with global properties. In this talk, we explore this phenomenon through concrete examples over integers and polynomial rings, illustrating how local information can sometimes—but not always—determine global behavior. By examining these cases, we gain insight into both the power and the limitations of the principle.

Shimura varieties by example
Kevin Watmough

The goal of this talk is to explain what a Shimura variety is. I will do this by looking at a few examples, and in particular by looking at modular curves, which are moduli spaces for elliptic curves (in other words, their points parametrize elliptic curves). I will explain how to construct modular curves, and how Shimura varieties generalize modular curves.

On special values of Shintani zeta functions
Matias Bruna

Since Riemann's groundbreaking work with his zeta function, many other zeta functions have been introduced, which have made important appearances in various areas of mathematics. In this talk we will see some examples of how the study of special values of zeta functions associated to an object can help understand the object, and also show some recent results in this direction.

The Langlands program
Nischay Reddy

The infinite dimensional representation theory of Lie groups places strong constraints on arithmetic phenomena. This unlikely sounding claim is one of the central thrusts of a vast web of interrelated conjectures at the heart of modern number theory collectively known as the Langlands Program. We will explain, in a particular case and from a particular angle, how this is true.

Geometry & Topology

<u>The joy of the Alexander polynomial</u>
Kevin Santos

The Alexander polynomial is one of the most fundamental invariants in knot theory. In this talk, I hope to convince you of the preceding statement. I will go over some ways to calculate and define the Alexander polynomial, and I will discuss its historical significance, as well as its relevance in current research.

<u>Signatures of knots and how to compute them</u>
Jessica Liu

The Levine-Tristram signature of a knot is a classical invariant with many definitions and applications – it has characterizations using 4 manifolds, is related to the Burau representation, and it is almost-everywhere a concordance invariant. In 2018 Kashaev introduced a new knot invariant using a simple algorithm on knot diagrams which he conjectured also computes the Levine-Tristram signature. His conjecture turns out to be true. In this talk we discuss the Levine-Tristram signature and Kashaev's method for computing it. As a bonus, we also get a new formula for computing the Alexander polynomial.

<u>Spheres in the Curve Complex</u>
Richard Cao

The curve complex of a surface is a simplicial complex that is intertwined with the mapping class group and Teichmüller space. We examine its local topology, by answering the question: for which surfaces are spheres in its curve complex connected? We present some known results about the curve complex and current research directions.

<u>Topology ties things together</u>
Jonathan Sejr Pedersen

Are there other real vector spaces that are fields beside the reals and the complex numbers? Which spheres are Lie groups? Is the Hopf fibration special? We show that all these questions are deeply linked to each other, and outline the tools from topology used to finally determine the answers to all of them.

<u>Stable vector bundles and semi-simple quiver representations</u>
Yukai Zhang

We would like to point out the correspondence between stable vector bundles and semi-simple quiver representation. This analogy between quiver-representation and vector bundles will provide some example and intuition for metric equations on vector bundles.

Quantum entanglement and signalling
Emily Patterson

"Quantum entanglement" has been known and experimentally confirmed for many years. This refers to correlations among variables which are 'inexplicable' in a certain precise sense. Superficially, the correlations present a possible communications channel; closer inspection renders signaling impossible. Their inexplicability, yet inability to signal, can be interpreted as a failure of the sheaf condition.

Algebra & Algebraic Geometry

Some themes in the research of the Toronto algebraic geometry group
Waleed Qaisar

We will discuss some themes and name some important objects occurring in the research of the algebraic geometry group in the department.

p-adic integration
Alisa Chistopolskaia

One of the frequent questions in algebraic geometry is how to construct invariants that distinguish classes of equivalent (in some sense) varieties. One tool that proved to be immensely useful for finding such invariants is p-adic integration. Using this technique one can find a collection of invariants called p-adic volumes. In a surprising application, Batyrev used p-adic integration to show that the Betti numbers of birational Calabi-Yau varieties coincide. p-adic integration has many other interesting applications as well: for example, one can use it to show the rationality of the Igusa zeta function (a generating function for the number of solutions of a polynomial modulo p^k).

In this talk, we will introduce p-adic integrals starting from the very beginning, so no prior knowledge of the subject is expected. In particular, if you don't know any of the words in the previous paragraph that's totally fine, I don't really understand some of them either.

Wonderful compactifications: a construction and applications
Jeremy Peters

I will review a paper given by deConcini and Procesi on the wonderful compactification of a family of complements of an arrangement of subspaces. In particular, I will discuss charts on this space, and give related constructions and applications to representation theory and the theory of integrable systems.

Cohomology rings in action - an overview of equivariant cohomology
Austin Sun

In this talk, I will give a survey of equivariant cohomology rings by providing several examples that are useful in algebraic topology and algebraic geometry. I will first introduce the idea of cohomology, and provide some examples to demonstrate the importance of cohomology in modern algebraic topology. Then, I will generalize the idea to equivariant cohomology rings, which may be seen as cohomology rings of spaces under certain group actions. These rings give us information about the topology of the space as well as the representation theory of the group acting on the space, and I will give an overview of both perspectives.

Psychological difficulties of learning and doing algebraic geometry
Grisha Taroyan

Abhyankar was speaking at Mumford's seminar, so Zariski, though long-retired, came to hear his former student speak. Abhyankar began his talk by stating that he would only be working in characteristic 0.

Zariski interrupted to ask "Are there any additional difficulties in characteristic p?"

Abhyankar smiled and said "Only psychological difficulties."

Zariski turned to the audience and stated, most forcefully, "I have NEVER had psychological difficulties."

Canonical bases in the representations of classical Lie algebras
Aleksandr Popkovich

We will discuss two examples of canonical bases in the irreducible representations of classical Lie algebras: the Gelfand-Tsetlin bases and the more recently discovered PBW bases. I will describe their constructions (for algebras in type A), provide some remarks on the connection between them and, time permitting, on the connections to the geometry of flag varieties.

Character varieties
Amalrose Vayalinkal

We will introduce character varieties of surface groups, with particular focus on the SL2-character variety of the punctured torus. Using the mapping class group action, we will attempt to study integral points lying on (Markoff) surfaces within the character variety. No algebraic geometry background required (truly!), but would be useful to Google the definition of fundamental group beforehand.

Can differential equations travel between Riemann surfaces?
Andy Ramirez-Cote
What does it mean for two differential equations to be "essentially the same"? In this talk, I'll explain how deforming a Riemann surface, such as the complex plane minus finitely many points, naturally gives a deformation of any system of ODE on it. To do so, I will going over the notion of monodromy, and explain how the requirement that a deformation of a differential equation preserve the monodromy data uniquely determines what it is. To conclude, I will briefly mention how this can be used to study Riemann surfaces.

Motivic filtrations
Kai Shaikh

This talk will examine some ways in which invariants can be associated to rings, by examining the case of motivic filtrations on several invariants related to K-theory by trace methods (namely THH, TP, TC). After briefly motivating interest in these invariants, I will attempt to sketch how different perspectives (site-theoretic, homotopical, algebro-geometric, module-theoretic) have shaped the understanding of these invariants.

Set Theory & Combinatorics

Counting integer points is hard :(
Narmada Varadarajan

This talk is an introduction to research in discrete geometry, where the problems are easy to state but the solutions are hard to find. Specifically, we'll look at a very simple question: how many integer points can be in an integer polytope? I'll give an overview of what's known, explain the connection to algebraic complexity theory, and try to convince you of what I think the answer should be.

The power of the probabilistic method in graph colouring problems
Lora Hreish

Graph colouring is a famous topic in graph theory that has been studied for many decades. An example is vertex colouring: Colour the vertices of a graph such that no adjacent vertices share the same colour. The chromatic number of a graph is the minimum number of colours needed to achieve a proper vertex colouring.

Analyzing deterministic algorithms to colour graphs is usually not optimal. Erdős was the first to think of colouring graphs "randomly", which was a breakthrough in the field as his work gave better bounds on the chromatic number. Since then, different probabilistic approaches have been developed to study various colouring problems. In this talk, I will introduce a probabilistic argument by C. McDiarmid and B. Reed. to bound the total chromatic number of graphs.

Large cardinals and measure theory
Clement Yung

Most of us are familiar with the Lebesgue measure - but why stop there? Instead of defining a measure on the real line, we can attempt to define a measure on any set, say the power set of the set of real numbers P(R). It turns out that this is deeply related to the existence of large cardinals, i.e. cardinals so large that ZFC can't prove that they exist! In this talk, I'll discuss what large cardinals are, why they're of interest to set theorists, and how defining a measure on P(R) would imply the existence of a large cardinal called a "measurable cardinal".

If you can't bound it - bring containers
Artur Kravtsov

Independent sets play a huge role in Combinatorics and its applications. For certain kinds of graphs, we are able to bound the number of independent sets by constructing a small number of "containers" that describe the independent sets. It allows us to solve various problems from extremal combinatorics to combinatorial number theory.

Easy to solve, impossible to describe
Tonatiuh Matos Wiederhold

I present examples of combinatorial problems for which simple arguments show that solutions exist. Interestingly, these solutions may be impossible to describe in a meaningful way. This raises the question of whether we should impose additional restrictions on the solutions—for example, requiring that they be describable by a formula or computable by an algorithm. Under such constraints, finding a good solution to the same problem can become significantly more difficult. But how much more difficult can it be? Attempts to answer this question form the field of descriptive combinatorics. The second half of the talk is dedicated to highlighting an inspired connection to distributed algorithms, adding to the many reasons you might care about this field.

Probability & Optimal Transport

KPZ is still so mysterious to me
Alex Rodriguez

The KPZ universality class is a collection of models arising from math, physics, and biology that are conjectured to contain the same asymptotic structure despite their potentially different microscopic descriptions. This talk will briefly survey the history of understanding KPZ universality, some recent breakthroughs (many of which happened at the University of Toronto), and some surprising connections to seemingly unrelated areas of math. Particular emphasis will be put on the mysterious and still enigmatic connection of the KPZ fixed point to the Korteweg-De Vries and Kadomtsev-Petviashvili equation.

Optimal transport and a non-smooth formulation of general relativity
Sabrina Lin

We will first introduce General Relativity and discuss why it is not a perfect theory of gravity. Next, we will introduce Optimal Transport and look at the entropic curvature dimension condition on Riemannian spaces. Finally, we will talk about how to formulate a non-smooth theory of General Relativity using optimal transport and look at the current (open) problems in the field.

The Gaussian free field for analysts
William Verreault

A great analyst once asked me "What is the GFF?!". My poor answer must have been close to "Well, it's just a centered Gaussian field whose covariance is the Green function". This talk aims to give a more complete answer by shedding light on the ubiquitous nature of these random generalized functions. This talk is for you, Dominic!

Analysis & Applied Math

The rise and fall of biological oscillations (and the sampling theory from Mars)
Turner Silverthorne

From dogs with a keen internal sense of dinnertime to the regular beating of your own heart, biological rhythms are known to play essential roles in practically all domains of life. Our understanding of the genetic and chemical oscillators responsible for these rhythms has improved considerably over the last several decades, in part through contributions from mathematical modelling, analysis, and optimisation. Focusing on biological rhythms as a main example, this talk will provide an introduction to the opportunities and challenges that arise when working on problems in mathematical biology.

Optimal transport: Just another linear optimization problem?!
Friedemann Krannich
In this talk, we give an introduction to the optimal transport theory and compare it to the standard linear constrained optimization problem. In particular, we discuss issues of solvability and duality and how the optimal transport theory fits in the general framework of linear constrained optimization on R^n.

Closed form expressions for integrating Green's functions on planar triangles
Andrew Zheng

Integrating functions on an arbitrary planar triangle is hard. It is even more difficult when trying to integrate a Green's function. However, it is important to accurately evaluate these integrals in many different numerical algorithms that solve PDEs. In this talk, a method to derive closed form expressions will be presented for the Green's function of the 3D Laplace equation that can be generalized to other Green's functions.

When do maps have the same set of chaotic points?
Reila Zheng
In this talk we will consider iterating a holomorphic map from the Riemann sphere to itself. The Julia set of this map is the set of points with chaotic behaviour, and offers a visually interesting pattern. I will answer the motivating question and relate this to some areas of current research.

The Organizing Team

This conference is organized by graduate students in our department, for our fellow graduate students.

Organizers

Cameron Martin, Fardin Syed, William Verreault

Program Chairs

Alice Rolf (*Geometry & Topology*)
Dominic Shillingford (*Analysis & Applied Math*)
Yun-Chi Tang (*Number Theory*)
Grisha Ta`royan (*Algebra* & *Algebraic Geometry*)
Luciano Salvetti (*Set Theory & Combinatorics*)
Alex Rodriguez (*Probability & Optimal Transport*)

Contact Information

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