We Speak: Inspiring Women in Mathematics Lecture Series
Early-Career Mathematicians Lightning Talks
Friday, September 24, from 3-4:25pm EDT

Association for Women in Mathematics

Association for Women in Mathematics
50th Anniversary
1971 - 2021

This Lightning Session features invited talks from women grad students and postdocs working in all areas of mathematics.

Organizers:
Mirjeta Pasha, Arizona State University
Biji Wong, Max Planck Institute for Mathematics

Schedule:

3:00-3:05 Opening

3:05-3:15: **Corrine Yap**, Rutgers University - Department of Mathematics
Title: Finding Homeomorphs of Hypergraphs
Abstract: A classical problem in extremal combinatorics is the Turán problem: given a graph H, how many edges can an n-vertex graph have while containing no isomorphic copy of H? I'll discuss a higher-dimensional and topological generalization where we ask the same question but replace the words "graph" with "k-dimensional abstract simplicial complex," "edges" with "facets," and "isomorphic" with "homeomorphic."

3:15-3:25: **Micah Henson**, University of Washington - Department of Applied Mathematics
Title: Maximizing Happiness in Marriage
Abstract: Researchers in a variety of fields including psychology, economics, and mathematics have attempted to use mathematics to understand the intricate social structures related to love and marriage. Very few have attempted to do so with optimal control. We propose an optimal control model where we maximize the happiness of one spouse subject to a dynamical system representing the positivity of each spouse. This system contains parameters representing the natural disposition of each spouse, the rate of return to that natural disposition, and a control representing a possible change in level of interaction between spouses. We present some solutions to this model.

3:25-3:35: **Tracey Oellerich**, George Mason University - Department of Mathematics
Title: Singular Jacobians and their effect on adaptation in biological networks
Abstract: In this talk we will discuss conditions under which a biological system will possess a singular Jacobian and its effect on adaptation criteria. First, we will develop the conditions under which a system will contain a singular Jacobian, including systems with monomial-type interaction terms and systems with linear or nonlinear conservation laws. Motivated by these occurrences, we then extend conditions for adaptation in biological networks to include systems with singular Jacobians. The proposed theoretical extension is compatible with the notions of homeostasis and robust perfect adaptation (RPA) and clarifies the relationship between the two. The new condition is derived using the notion of Moore-Penrose pseudoinverse and is implemented using a numerically efficient algorithm. The proposed approach is tested on several synthetic systems that are shown to exhibit homeostatic behavior yet lie outside of the scope of earlier work.

3:35-3:45: **Elaina Aceves**, University of Iowa - Department of Mathematics
Title: Agol cycles of 3-braids
Abstract: In this talk, I introduce 3-braids, invariant train tracks, and Agol cycles. I will also briefly discuss my current research about distinguishing pairs of 3-braids related by a flype using their Agol cycles. This is joint work with Keiko Kawamuro.

3:45-3:55: **Melanie Weber**, University of Oxford - Mathematical Institute
Title: Geometric Methods for Machine Learning and Optimization
Abstract: A key challenge in machine learning and optimization is the identification of geometric structure in high-dimensional data. Such structural understanding is of great value for the design of efficient algorithms and for

developing fundamental guarantees for their performance. In this talk, I will present two lines of my work that utilize Riemannian geometry in machine learning and data science. First, we consider the task of learning a robust classifier in hyperbolic space. Such spaces have received a surge of interest for representing large-scale, hierarchical data, since they achieve better representation accuracy with fewer dimensions. Secondly, we consider the problem of optimizing a function on a Riemannian manifold. Specifically, we will consider classes of optimization problems where exploiting Riemannian geometry can deliver algorithms that are computationally superior to standard (Euclidean) approaches.

3:55-4:05: **Nicolle Gonzalez**, UCLA - Department of Mathematics

Title: Categorification and a revelation of hidden shadows

Abstract: Motivated by the classification of manifolds and topological quantum field theories, Crane and Frenkel developed an innovative method focused on understanding the higher categorical structures rather than the object itself. Categorification, has since proven to be one of the most successful ways of classifying knots and manifolds, giving rise to powerful homological knot invariants that identify topological and algebraic properties of knots and links by studying homological properties of their categorical counterparts. Crucial to the success of these homological theories is the ability to present the categorical data in the language of diagrammatic algebras, which exchanges algebraic relations for topological and combinatorial identities. The interplay of low dimensional topology, representation theory, and combinatorics yields rich and explicit constructions that are unobtainable via more traditional methods. I will explain what a good categorification entails and how combining this structure with diagrammatic algebras and combinatorics reveals the object for what it really is, with many previously hidden structures becoming obvious in the process.

4:05-4:15: **Alice Nadeau**, Cornell University - Department of Mathematics

Title: The Mystery of Earth's Synchronous Glacial Cycles

Abstract: Understanding the behavior of the glaciers over time and the resulting impact on Earth's climate has been a major endeavor across disparate fields of the physical and biological sciences for over a hundred years. However, many questions concerning the Earth's glacial cycles remain unanswered. One persistent mystery is why, on the time scale of a hundred thousand years, the Northern and Southern hemisphere ice caps exhibit synchronous growth and decay. In this talk I'll discuss a new model, developed by me and my

collaborators, showing that coupling of the hemispheres through the annual mean surface temperature can result in Northern and Southern synchrony. Due to the vastly different time scales involved, the model presents a nonsmooth geometric perturbation problem for which we use ad hoc mathematical techniques to show the existence of a unique attracting periodic orbit corresponding to the glacial cycles.

4:15-4:25: **Prerona Dutta**, Ohio State University - Department of Mathematics

Title: Metric entropy and Nonlinear PDEs

Abstract: Inspired by a question posed by Lax in 2002, the study of metric entropy for nonlinear partial differential equations has received increasing attention in recent years. This talk illustrates methods to obtain sharp upper and lower bounds on the metric entropy for a class of real-valued bounded total variation functions and then for a class of bounded total generalized variation functions taking values in a general totally bounded metric space. Thereafter we use each of these results to establish metric entropy estimates for the set of viscosity solutions to the Hamilton-Jacobi equation with uniformly directionally convex Hamiltonian and the set of entropy admissible weak solutions to a scalar conservation law with weak genuinely nonlinear flux, respectively. Estimates of this type could provide a measure of the order of resolution of a numerical method required to solve the corresponding equation.

The AWM 50th Anniversary Organizing Committee

A special thanks to the AWM committee members who have organized the We Speak Lecture Series:

Emille Davie Lawrence (Chair), University of San Francisco
Georgia Benkart, University of Wisconsin-Madison
Malena Español, Arizona State University
Magdalena Luca, Massachusetts College of Pharmacy and Health Sciences
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