Fall 2023 | 99th Series

SONOMA STATE UNIVERSITY

M*A*T*H COLLOQUIUM

Sonoma State University Department of Mathematics & Statistics presents a series of informal talks open to the public.

Wednesdays at 4:00 PM | In Person: Darwin 103 | Virtual: bit.ly/FA23_math_talks

"The book of nature is written in the language of mathematics." - Galileo

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Aug 30

THE WAVE EQUATION ON FLRW SPACETIMES
Jesús Oliver, CSU East Bay

The Friedman-Lemaitre-Robertson-Walker (FLRW) spacetime is often called the Standard Model of modern cosmology (the study of the universe at the largest scale). In this talk we will discuss the decay properties of solutions to the linear wave equation propagating on FLRW spacetimes where k, t > 0, $\phi : \mathbb{R} \times \mathbb{R}^3 \to \mathbb{R}$

$$-\frac{\partial^2\phi}{\partial t^2} - \frac{3k}{t}\frac{\partial\phi}{\partial t} + \frac{1}{t^{2k}}\sum_{i=1}^{3}\frac{\partial^2\phi}{\partial x_i^2} = 0$$

By pairing calculus methods and geometric insight, we show how one can provide a precise description of the long-time behavior of solutions to this equation. We also show how this analysis can be extended to study the propagation of nonlinear waves. This research is relevant for the development of improved models of fluid propagation in our universe.

Sept 06

GEOLOGIC MAPPING: REPRESENTING A 3D WORLD IN 2D
Marissa Mnich, Geology, Sonoma State

The world we live in is three-dimensional, including all geologic features, from the highest mountains to the deepest ocean basins. Geologic features and structures, both in the large and small scale, are imperative for geologic understanding, which makes mapping a critical component. Mapping involves representing three-dimensional features in a two-dimensional manner, which subsequently means that map interpretation involves converting back to 3D. There are many different techniques to not only aid in the 2D representation of features, but also to help in the visualization of how these relate back to the true 3D world. For example, topographic maps involve representing elevation in 2D, which can be visualized in a virtual sandbox, then taken back to 2D. My work has focused on mapping lava flows in the Springerville Volcanic Field in Arizona. Lava flows are a unique type of mapping because the flow geometry reveals important information about the nature of the lava, as well as relative timing of eruptions. The detailed mapping forms the basis for the understanding of the evolution of the volcanic field through time.

Sept 13

THE MATHEMATICS OF CARD SHUFFLING
Cornelia Van Cott, University of San Francisco

A classic card shuffling technique used by both magicians and gamblers is the so-called perfect shuffle. A perfect shuffle splits a deck of cards into two equal stacks and then perfectly interlaces the cards from the two stacks. The mathematics behind the perfect shuffle has a rich history, including everything from mathematical card tricks to sophisticated research. We will explore all of this, and we'll extend our discussion to a few other card shuffling techniques, as well.

Sept 20

THE MAGIC OF STEINER TRIPLE SYSTEMS
Guillermo Alesandroni, CSU Chico

Steiner triple systems (STSs) are a charming combinatorial topic consisting of points and sets of points that display a certain symmetry. A distinctive mark of STSs is the fact that their study feels like playing a game: a successful completion to the game generates an STS and, conversely, an STS provides a winning strategy to the game. In this talk, we introduce STSs as a combinatorial game and then we give a tour through the main concepts and results in this area. Finally, we discuss some research projects that are within reach of students who may lack combinatorial expertise but have a surplus of curiosity and enthusiasm. Undergraduate students are especially encouraged to attend. In fact, this talk has been designed for them.

Sept 27

SKATEBOARD TRICKS AND TOPOLOGICAL FLIPS
Gabriel de Oliveira Martins, Sacramento State

We analyze the continuous deformations between different skateboard tricks, and we show that up to deformation there are only four flip tricks. This is accomplished by describing the motion of skateboard flip tricks as continuous curves in the matrix group SO(3). We will also present animations and visualizations developed in Python for this project. Our strategy can be seen as an application of Dirac's belt trick to a system with additional symmetries.

Oct 04

LEVERAGING IMMERSIVE EXPERIENTIAL LEARNING IN VIRTUAL REALITY TO ACCELERATE MATH PROFICIENCY
Dane Lancaster, XRMarin

A team of former math educators are building an innovative learning system based upon sound pedagogy and immersive VR technology. This presentation will introduce new methods to support teaching math concepts... methods that incorporate problem-driven, tactile, and visual learning techniques. By grounding abstract math concepts in tangible experiences, the system aims to unlock deeper understanding and lasting retention through movement, hands-on experience, and meaningful discovery.

Oct 11

BEYOND COUNTING GRAPH COLORINGS
Sara Krehbiel, Santa Clara University

The graph coloring problem requires that neighboring vertices in a graph always have different colors. This models constraint satisfaction problems like the scheduling problem, in which several events (vertices) must be scheduled (colored) such that events with overlapping participants may not occur at the same time. For a given graph G and a fixed number of colors k, we can build another called a coloring graph, whose vertices are the colorings of G, with edges between pairs of colorings that differ on a single vertex of G. I will first present a well known result that the number of ways to color G using at most k colors is always polynomial in k. This chromatic polynomial counts the number of vertices in a coloring graph. But how many edges are there? How many in any other induced subgraph? I will outline some of the ideas behind a new result that these quantities are also polynomial in k, with special focus on trees.

Oct 18

SUPPLY CHAIN, WHAT DOES IT MEAN?
Amanda Weddle, Keysight Technologies

During the pandemic you felt the impact of disruptions to the supply chain when you needed toilet paper and lumber. What caused this situation? How can mathematics be used to improve the supply chain? How can it benefit operations, engineering, and customers? We will discuss how you can use mathematical skills to study supply chains and make you a better consumer.

Oct 25

TEAMING UP WITH THE MACHINE: USING DOMAIN KNOWLEDGE TO IMPROVE PREDICTIONS OF MOLECULAR INTERACTIONS
Tomas Rube, UC Merced

Cells rely on millions of highly specific molecular interactions to process information and regulate biological processes. While new experiments can profile such interactions with high throughput, interpreting the resulting data is a major computational challenge. In this seminar, I will describe a flexible machine learning framework that uses such data to define molecular recognition in terms of biophysically rigorous equilibrium binding constants or kinetic rates. Specifically, I will discuss how traditional mathematical modeling based on domain knowledge can be combined with methods from machine learning, and how the resulting hybrid framework makes it meaningful to perform previously uninterpretable experiments.

Nov 01

STATISTICAL CONSULTING FOR MEDICAL RESEARCH
Mouchumi Bhattacharyya, University of the Pacific

For the past several years I have been serving as the statistical consultant for the Graduate Medical Education Department at St. Joseph's Medical Center in Stockton, CA. In this talk, I will detail some of my experiences as a statistical consultant.

Nov 08

DATA-DRIVEN CLASSIFICATION OF CELL SUBTYPES BASED ON TIME-LAPSE MICROSCOPY OF SINGLE CELLS
Manasa Kesapragada, UC Santa Cruz

Single-cell time-lapse microscopy allows researchers to track the dynamic response of cellular processes in real time. Observing these dynamics to external stimuli can help researchers understand the regulation mechanisms underlying complex biological processes. When studying the evolution of cell subtypes, it can become difficult to identify the cell types. Cell size and shape have been used to characterize these cell subtypes, but quality images that can provide cell morphology are difficult to come by. We propose that motility properties can be mapped to cell morphology and, hence, cell subtype. We applied this to macrophages, critical players in our body's defense and wound healing. We found that different types of macrophages move uniquely. We developed methods to track single cells and linked cell movement to its shape using machine learning. Through this study, we demonstrate that mapping migratory patterns and motility properties to cell morphology can inform the classification of cell subtypes.

Nov 15

WHAT WE HAVE TO LEARN FROM OUR STUDENTS
Martha Byrne, Sonoma State

This title could be read in at least two different ways. It could refer to what there is for instructors to learn from students. It could also refer to what it is imperative that instructors learn from students. I want to talk about both. As part of this department's efforts to better serve our Hispanic and Latin* students, a research team has been looking at student and faculty perspectives on servingness. In this talk, I'll feature student perspectives, especially where they differ from the perspective of their faculty.

Nov 22

Thanksgiving Break - No Talk

Nov 29

WHY TEACH? BECOMING A MIDDLE OR HIGH SCHOOL MATH TEACHER
Math Teacher Panel

Representatives from the SSU STEP (STEM Teacher Education Pathways) program will be talking about what it's like to be a middle or high school math teacher and how undergraduate students can become one. We will have a panel of SSU grads who are currently working as math teachers and will discuss their experiences.