SoCal-Nevada MAA Fall Sectional

CONTRIBUTED TALKS ABSTRACTS

Presenter(s): Louis Burns, Pomona College
Other Author(s): Research advisor: Konrad Aguilar, Pomona College
Title: Sharp equivalence constants between standard deviation and maximum slope
Abstract: Given a real-valued function, its standard deviation and maximum slope both calculate how far the function is from not being constant. One can find many examples of functions for which the standard deviation and maximum slope disagree. However, if we consider a fixed finite subset of the reals and the family of real-valued functions on that set, its standard deviation and maximum slope must be equivalent as seminorms by finite-dimensionality. In this talk we will present equivalence constants for any fixed finite subset of the reals. Furthermore, we will present various settings where we have found the best/sharpest equivalence constants (joint work with K. Aguilar).
Talk theme(s): Analysis
Audience: Some real analysis

Presenter(s): Julia Carrigan, Occidental College
Other Author(s): Eric Rowland, Hofstra University; Isaiah Hollars, Belmont University
Title: Bijective Proofs of Word Avoidance Identities
Abstract: Our object of study is the set of length-n words on a given alphabet that all avoid a particular contiguous subword p. We call this set an avoidance set and denote it as $A_n(p)$. For certain subwords p and q, the avoidance sets $A_n(p)$ and $A_n(q)$ are the same size for all $n \in \mathbb{N}$. We call such p and q avoidant equivalent subwords. It has been proven that if p and q have similar border patterns, then they are avoidant equivalent subwords. A proof of this via generating functions is credited to a 1966 paper of Solov'ev. Generating function approaches to counting word avoidances have since improved, but a bijective proof of this theorem is nowhere to be found. Does there exist some natural correspondence between the avoidance sets of avoidant equivalent subwords? In other words, how are the individual words of these avoidance sets related? Our talk discusses examples of avoidant equivalent subwords, the condition of similar border patterns, and the main result of our research: a natural correspondence between avoidance sets in many cases.
Talk theme(s): Combinatorics on Words
Audience: No prior knowledge needed except basic understanding of bijections

Presenter(s): Claire Chang, Harvey Mudd College
Other Author(s): Research advisor: Dr. Jamie Haddock, Harvey Mudd College
Title: Fairness and Manipulability of Ranking Methods in Sports
Abstract: Ranking is a well-studied task where a set of alternatives is ordered by importance. One subset of ranking problems is ranking from pairwise comparisons, which involves combining potentially incomplete or contradictory information into a single list. This group of problems has applications as diverse as choosing political candidates, ranking web pages, providing movie recommendations, and comparing sports teams. In this work, we focus on the sensitivity of a family of ranking methods which encompasses the Massey, Colley, and Markov methods. We will accomplish two objectives. First, we will create a general framework to analyze the sensitivity of this family and determine how more robust methods can be created. Second, we will consider our results on sensitivity under the lens of a network diffusion interpretation. Through these analyses, we will build intuition to answer the question what are the characteristics of robust ranking methods? to ensure fair rankings in a variety of applications.
Talk theme(s): Applied Mathematics, Linear Algebra
Audience: Linear Algebra (some basic graph theory will help)

Presenter(s): Chelsea Huynh and Michael Strand, UC Irvine
Title: Block-missing data in linear systems: An unbiased stochastic gradient descent approach

Abstract: Achieving accurate approximations to solutions of large linear systems is crucial, especially when those systems utilize real-world data. A consequence of using real-world data is that there will inevitably be missingness. Current approaches in dealing with missing data such as deletion and imputation can introduce bias. Recent studies proposed an adaptation of stochastic gradient descent (SGD) for unbiased approximations in specific missing-data models. Our algorithm $\ell-$tuple mSGD is one such adaptation that modifies the iterates of SGD when data is missing in a block-wise, tuple pattern. In this paper, we prove that our proposed method uses unbiased estimates of the gradient of the least squares objective in the presence of tuple missing data and remark on the comparison of $\ell-$tuple mSGD and its parent algorithm, mSGD. Furthermore, we empirically demonstrate the convergence ability of $\ell-$tuple mSGD in comparison to mSGD and contemporary imputation methods using synthetic data. Lastly, we evaluate $\ell-$tuple mSGD as an application to blood glucose levels in the presence of missing continuous glucose monitoring device (CGM) data.
Talk theme(s): Applied Mathematics
Audience: Numerical Analysis, Data Science, Linear Algebra

Presenter(s): Pi Danger James, CSU Channel Islands
Other Author(s): Research advisor: Dr. Ivona Grzegorczyk, CSU Channel Islands
Title: Mathematically Modeling Poi (Or How to Create Really Cool Spinning Lights)
Abstract: Think of the fire dancers of Hawaii and Polynesia. Imagine the beautiful performers expertly swirling flames in the night sky. Now imagine putting some mathematics to it.
The motions of fire spinning create universal shapes fundamentally based on lines and circles. We will look at these fundamental shapes and explore parametric equations that describe their motion in a simplified model. We will then go further and apply this model to expand the current abilities of LED visual spinning tools and improve the digital images that can be shown to audiences.
Talk theme(s): Applied Mathematics and Modeling
Audience: All levels of math welcome. Knowledge of trigonometry and vectors helps.

Presenter(s): Brian P Katz (BK), CSU Long Beach
Title: Why should that convince me?
Abstract: Toulmin analysis, a framework for understanding the structure of arguments, has been used to study proof validation in mathematics since at least 1995. In 2005, Weber and Alcock called for mathematics instructors to include proof validation in their teaching. My collaborators and I have been teaching undergraduate students to use Toulmin analysis as a way of teaching them to understand some of the disciplinary practices of mathematics. In this session, I will share ideas about Toulmin analysis, how I use it in my teaching to support student learning of proof, and how I have used it in my research to investigate the teaching and learning of proof.
Talk theme(s): Mathematics Education
Audience: Some experience with proof will help but is not necessary

Presenter(s): Nikolay Maslov, CSU San Bernardino
Title: Reverse Mathematics of Kőnig's Lemma and Ramsey Theorem for Pairs
Abstract: Reverse mathematics aim to determine which set theoretic axioms are necessary to prove the theorems outside of the set theory. Since the 1970s, there has been an interest in applying reverse mathematics to study combinatorial principles like Ramseys theorem to analyze its strength and relation to other theorems. Ramseys theorem for pairs states that for any infinite complete graph with a finite coloring on edges, there is an infinite subset of nodes all of whose edges share one color. In this expository talk, we will introduce the basics of reverse mathematics, highlight the equivalence of Kőnig's lemma to $\mathbf{ACA}_0$ over $\mathbf{RCA}_0$, and survey the foundational reverse mathematics results concerning Ramseys theorem.
Talk theme(s): Combinatorics/Logic

Presenter(s): Meha Patel and Chupeng Zheng, UC Irvine
Other Author(s): Research advisor: Dr. Anna Ma, anna.ma@uci.edu, UC Irvine
Title: Mean Imputation and Stochastic Coordinate Descent for Linear Systems with Missing Data

Abstract: As big data problems become more prevalent, the need to accurately approximate solutions to large-scale linear systems increases. Many real-world big data problems are also accompanied with the risk of data being missing or incomplete, which further complicates the linear models assigned to them. Current methods used to address missing data involve deletion or zero imputation, which introduces bias to the model. In this talk, we will introduce our proposed model that adapts Stochastic Coordinate Descent (SCD) to address missing data in linear systems and utilizes μ- imputation to retrieve a better approximation of the original data. We will show that in expectation, our proposed algorithm, μ- imputation mSCD utilizes an unbiased estimator of the gradient of the least-squares objective function when using mean imputation in the absence of data. Finally, we will present experimental results on synthetic and real world data to demonstrate the usefulness and viability of our proposed algorithm.
Talk theme(s): Applied Math

Presenter(s): Melinda Schulteis, Concordia University Irvine
Title: Raising Calculus to the Surface Providing Students with a Deeper Understanding of Multivariable Calculus
Abstract: Come and see how envisioning 3D surfaces as real life objects such as parks, hot plates, putting greens, cake, roller coasters, and berry filled paths, leads to a deep understanding of multivariable Calculus concepts like partial derivatives, gradient, multiple integrals, surface area, Lagrange multipliers, and line integrals. The Raising Calculus to the Surface curriculum pairs a series of discovery activities with 3D surfaces to enable students to learn key ideas in the study of multivariable Calculus, and merges seamlessly with the Vector Calculus Bridge Project which emphasizes the geometry behind vector Calculus. Information about a joint Instructor's Workshop taking place this summer (where you can receive free training and a set of materials) will be provided. This material is based on work supported by the National Science Foundation under Grant No. DUE-1246094, DUE-0088901, DUE-0231032, and DUE-1914631.
Talk theme(s): Math Education

Presenter(s): Ji Y. Son, CSU Los Angeles
Title: Modeling First: Teaching Introductory Statistics as a Celebration of Functions
Abstract: In K12 math courses, students spend more time evaluating algebraic functions than using functions to model real-world phenomena. Then in higher education, introductory statistics is typically taught with no connection to functions with the exception of the regression line (e.g., expressed in the notation of the General Linear Model, GLM, as $Y = \beta_0 + \beta_1 X_i$). Other statistics concepts (central tendency, standard deviation, t-tests, etc.) are taught as separate ideas unrelated to regression. However, the GLM provides a conceptual framework that can bring coherence to high school math and college statistics. What if students experienced statistics as a domain where algebraic functions (e.g., constant, linear, polynomial) could be used to model patterns of data? To make this shift, we must begin to teach introductory statistics as an enterprise of building models using algebraic functions and evaluating their fit. We've taken this "modeling first" approach in designing an interactive statistics textbook used by thousands of students (see CourseKata.org). Our data shows that teaching students statistics in this interconnected way leads to better transfer and preparation for future learning.
Talk theme(s): Math Education

Presenter(s): Siki Wang, Caltech
Other Author(s): Research advisor: Dr. Helen Wong, Claremont McKenna College
Title: Fast Multiplication Algorithm on a Once-Punctured Torus
Abstract: This talk will be an introduction to the Kauffman bracket skein algebra of a surface, which is a generalization of the Jones polynomial for knots and links in S^3. Frohman and Gelca captured the multiplicative structure of the skein algebra on a torus using an elegant product-to-sum formula involving Chebyshev polynomials, but a description for the once-punctured torus is not known. In this talk, I will outline a general algorithm that computes multiplication on the once-punctured torus in quadratic time. This sheds light on obtaining a general recursive formula for the algebra.
Talk theme(s): Topology
Audience: Some background in low dimensional topology and knot theory will help, but no background is necessary

Presenter(s): Lily Natasha Wartman, Scripps College
Other Author(s): Chris O'Neill at San Diego State University
Title: Geometric characteristics of symmetric numerical semigroups in the Kunz cone
Abstract: A numerical semigroup is a subset of the nonnegative integers closed under addition; a Kunz cone is a geometric representation of related numerical semigroups. We will explore a specific type of numerical semigroup called symmetric numerical semigroups that lie on certain faces of the Kunz cone. We will describe these faces including their dimension, symmetry, and the characterization of their facets.
Talk theme(s): Number Theory

Presenter(s): Michael Williams, CSU Channel Islands
Other Author(s): Research advisor: Dr. Ivona Grzegorczyk
Title: Inverted Cassini Surfaces
Abstract: We show new results on Cassini surfaces and inverted Cassini ovals treated as algebraic varieties. When considered as a family, the locus of points where two segments are viewed at oriented angels that sum to a given constant, result in a surface called a disoptic surface. We show that these surfaces are generally irreducible and non-singular. They have at least four lines and interesting cross sections. Moreover, we classify them into 13 different types. Finally, studying forms of the equations of these surfaces, we can conclude the positions of the two segments that generate the family.
Talk theme(s): Geometry
Audience: Geometry, Algebraic Geometry, Differential Geometry

Presenter(s): Jiahui Yu, Pomona College
Title: Convergence of ideals and modules
Abstract: Given a unital AF-algebra A equipped with a faithful tracial state, we equip each (norm-closed two-sided) ideal of A with a metrized quantum vector bundle structure, when canonically viewed as a module over A, in the sense of Latrémolière using previous work of the first author and Latrémolière. Moreover, we show that convergence of ideals in the Fell topology implies convergence of the associated metrized quantum vector bundles in the modular Gromov-Hausdorff propinquity of Latrémolière. In a similar vein but requiring a different approach, given a compact metric space (X, d), we equip each ideal of $C(X)$ with a metrized quantum vector bundle structure, and show that convergence in the Fell topology implies convergence in the modular Gromov-Hausdorff propinquity (joint work with K. Aguilar).
Talk theme(s): Analysis