Fall Meeting
of
The Southern California-Nevada Section of
The Mathematical Association of America

Program and Abstracts

California State University San Bernardino
November 21, 2020

Acknowledgements

The Southern California-Nevada Section of the MAA welcomes participants to our 2022 Fall Meeting.

We would like to thank our invited speakers and our contributed paper session presenters for their participation in the meeting.

Our student volunteers pay a vital role in putting on the meeting. Many thanks to our volunteers from CSU San Bernardino for this meeting.

Finally, the Section thanks the CSU San Bernardino for their hospitality in hosting the meeting. We would like to especially thank our program committee who handled the arrangements for the meeting.

Section Officers, 2022-2023

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Schedule

9:30-9:35	Welcome Remarks
	Brian Katz, CSU Long Beach and
	Madeleine Jetter, chair of the Mathematics Department at CSU San Bernardino
9:35-10:35	Invited Address
	Jose Perea, Northeastern University
	The Underlying Topology of Data
10:35-10:45	Break
10:45-11:45	Faculty and Student Contributed Paper Session (Morning Session)
	Organized by **Jim Brown**, Occidental College
11:45-1:15	Lunch
1:15-2:45	Faculty and Student Contributed Paper Session (Afternoon Session)
	Organized by **Jim Brown**, Occidental College
2:45-3:15	Section Business Meeting
3:15-4:15	Invited Address
	Halee Lindo, Harvey Mudd College
	Trace Ideals in Commutative Rings
4:15-4:20	Concluding Remarks
	Brian Katz, CSU Long Beach

Contributed Paper Sessions

10:45-11:45	**Contributed Paper Session (Geometry/Topology)**	Room 1
10:45-11:05	–	
11:15-11:35	Michael Williams (CSU Channel Islands) *Inverted Cassini Surfaces*	

10:45-11:45	**Morning Contributed Paper (Analysis)**	Room 2
10:45-11:05	Louis Burns (Pomona College) *Sharp equivalence constants between standard deviation and maximum slope*	
11:15-11:35	Jiahui Yu (Pomona College) *Convergence of ideals and modules*	

10:45-11:45	**Morning Contributed Paper (Applied Math)**	Room 3
10:45-11:05	Claire Chang (Harvey Mudd College) *Fairness and Manipulability of Ranking Methods in Sports*	
11:15-11:35	Chelsea Huynh and Michael Strand (UC Irvine) *Block-missing data in linear systems: An unbiased stochastic gradient descent approach*	

1:15-11:45	**Afternoon Contributed Paper Session (Math Ed.)**	Room 1
1:15-1:35	Brian P Katz (BK) (CSU Long Beach), *Why should that convince me?*	
1:45-2:05	Melinda Schulteis (Concordia University Irvine) *Raising Calculus to the Surface Providing Students with a Deeper Understanding of Multivariable Calculus*	
2:15-2:35	Ji Y. Son (CSU Los Angeles) *Modeling First: Teaching Introductory Statistics as a Celebration of Functions*	

1:15-11:45	**Contributed Paper Session (Number Theory/Combinatorics)**	Room 2
1:15-1:35	Julia Carrigan (Occidental College) *Bijective Proofs of Word Avoidance Identities*	
1:45-2:05	Nikolay Maslov (CSU San Bernardino) *Reverse Mathematics of Kőnig's Lemma and Ramsey Theorem for Pairs*	
2:15-2:35	Lily Natasha Wartman (Scripps College) *Geometric characteristics of symmetric numerical semigroups in the Kunz cone*	

1:15-11:45	**Afternoon Contributed Paper Session (Applied Math)**	Room 3
1:15-1:35	Pi Danger James (CSU Channel Islands) *Mathematically Modeling Poi (Or How to Create Really Cool Spinning Lights)*	
1:45-2:05	Meha Patel and Chupeng Zheng (UC Irvine) *Mean Imputation and Stochastic Coordinate Descent for Linear Systems with Missing*	
2:15-2:35	–	

Invited Addresses

Invited Address: ***"Trace Ideals in Commutative Rings"***
Haydee Lindo, Harvey Mudd College

The well-known trace map on matrices can be generalized to a map on any module over a commutative ring. The image of such a map is a trace ideal. In particular, given a ring R, the trace ideal of an R-module M is the ideal generated by the homomorphic images of M in R. I will speak on some recent developments in the theory of trace ideals, with some applications to endomorphism rings, rigid modules, and classifications of commutative rings.

Invited Address: ***"The Underlying Topology of Data"***
Jose Perea, Northeastern University

Topology, and particularly algebraic topology, seeks to develop computable invariants to quantify the shape of abstract spaces. This talk will be about how such invariants can be used to analyze scientific data sets, in tasks like time series analysis, semi-supervised learning and dimensionality reduction. I will use several examples to illustrate real applications of these ideas.

Presenter Biographies

Haydee Lindo, Harvey Mudd College

Dr. Haydee Lindo is an assistant professor of mathematics at Harvey Mudd College. Dr. Lindo is from Jamaica and earned her BAs in mathematics and political science. She received her Ph.D. in mathematics from the University of Utah. Dr. Lindo is a commutative algebraist with research interests in homological algebra and representation theory. She focuses on the development and application of the theory of trace modules over commutative rings.

Jose Perea, Northeastern University

Dr. Jose Perea is an associate professor in the department of mathematics and the Khoury college of computer sciences. Prior to Northeastern, he held positions as an assistant professor of CMSE and Mathematics at Michigan State (2015 – 2021), and as a visiting assistant professor of Mathematics at Duke University (2011 – 2015). He holds a PhD in Mathematics from Stanford University (2011) and a BSc in Mathematics from Universidad del Valle, Colombia (Valedictorian, Summa cum laude, 2006). He is an inaugural 2022-2024 lecturer for the Mathematical Association of America and the National Association of Mathematics, a recipient of a 2020 NSF CAREER award, a 2020 honoree of Lathisms, and a 2018 honoree of Mathematically Gifted and Black.

Contributed Paper Session Abstracts

Abstracts are listed alphabetical by author's last name

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). *Analysis*
Audience: Some real analysis
10:45-11:05 Room 2

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. *Combinatorics on Words*
Audience: No prior knowledge needed except basic understanding of bijections
1:15-1:35 Room 2

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. *Applied Mathematics, Linear Algebra*
Audience: Linear Algebra (some basic graph theory will help)
10:45-11:05 Room 3

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. *Applied Mathematics*
Audience: Numerical Analysis, Data Science, Linear Algebra
11:15-11:35 Room 3

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.

Applied Mathematics and Modeling
Audience: All levels of math welcome. Knowledge of trigonometry and vectors helps.
1:15-1:35 Room 3

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. *Mathematics Education*
Audience: Some experience with proof will help but is not necessary
1:15-1:35 Room 1

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 1970's, there has been an interest in applying reverse mathematics to study combinatorial principles like Ramsey's theorem to analyze its strength and relation to other theorems. Ramsey's 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 Ramsey's theorem. *Combinatorics/Logic*
1:45-2:05 Room 2

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. *Applied Math*
1:45-2:05 Room 3

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. *Math Education*
1:45-2:05 Room 1

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. *Math Education*
2:15-2:35 Room 1

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. *Number Theory*
2:15-2:35 Room 2

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. *Geometry*
Audience: Geometry, Algebraic Geometry, Differential Geometry
11:15-11:35 Room 1

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). *Analysis*
11:15-11:35 Room 2