Afternoon Contributed Paper Session Abstracts

Abstracts are listed by session

Golden Eagle Ballroom (across bridge) (Mathematics Education II)

1:00-1:15 in Golden Eagle Ballroom (across bridge)
Presenter(s): Satish C. Bhatnagar , University of Nevada Las Vegas (UNLV)
Title: *PERSPECTIVES ON STUDY GUIDES ?!*
Abstract: Over the last five decades at UNLV, whenever a test or final exam approaches, students start inquiring about the Study Guide for it. Lately, the demand has increased. Two weeks ago, when I heard this call from quite a few students, I decided to put my thoughts together on the subject of study guides, and shared it with my colleagues and students. This paper is an outcome of that serial encounter - like fresh from the oven

The US is undergoing a cultural shift and math pedagogy cannot escape from it. Some of the offshoots of cultural shift may be politically sensitive. But if we do not discuss it, then what good is academic freedom that we champion about in the US especially. In the nuts and bolts of the paper, the paper describes what is a study guide and what is not.

1:20-1:35 in Golden Eagle Ballroom (across bridge)
Presenter(s): Tim McEldowney
Title: *Knowledge-GAP: Barriers to Applying to Graduate School in Mathematics*
Abstract: Entry into graduate education in mathematics is governed by an application process which serves as a barrier for students looking to advance in our discipline. How permeable this barrier is depends on a great number of factors, many of which are inherent in the lives and demographics of potential applications. In the 2022/2023 academic year, I sent a survey to undergraduate mathematics majors at institutions across the US as part of the Undergraduate Knowledge of the Mathematics Graduate School Application Process (Knowledge-GAP) project. This survey asked participants about their knowledge of the application process, barriers they may face in applying to graduate school, and a wide range of demographics questions. Using data from over 500 responses I have published four conference papers and have another four articles in progress. This presentation will be a greatest hits album of our results focusing on themes of interest to faculty looking to support their students applying to graduate school in mathematics like: the cost of applying, the Graduate Record Examination (GRE), and the impact of mentoring and advising. *Math Education/Pedagogy*

1:40-1:55 in Golden Eagle Ballroom (across bridge)
Presenter(s): Snow (Patil) Kaptanian, Cal Poly Pomona
Title: *Beyond Graphs: Exploring Instructors' Beliefs and Their use of Multiple Representations*
Abstract: The introduction of functions is an important opportunity to adequately prepare students for future mathematics courses. Considering multiple representations, this study is framed through the five strands of mathematical proficiency (Kilpatrick et al., 2001). I analyze how instructors' beliefs of and instructional practices in using representations shape a student's learning opportunity. In this study, I observed college algebra instructors' introductory lessons of functions and interviewed them to understand their beliefs and values on different representations. Findings show that emphasis of certain representations found in practice were intentional, relating to the instructors' goals for the course. However, the instructors' uses of representations and the connections made between them partly aligned with their beliefs, with some notions not reflected in practice. Introducing functions with an emphasis on one representation, without demonstrating other connections, can present a challenge for students in the subsequent lessons or mathematics course. *Algebra, Math Education/Pedagogy*

San Gabriel Room 313 (Graph Theory)

1:00-1:15 in San Gabriel Room 313
Presenter(s): John Clairmont, None
Title: *Toward a new proof of the four Color theorem*
Abstract: A new alternating chain algorithm is presented for vertex coloring planar graphs which overcomes difficulties which have stymied previous algorithms. *Graph Theory/Combinatorics*

1:20-1:35 in San Gabriel Room 313
Presenter(s): Tutlalee Wines, California Institute of Technology
Title: *Path Enumeration and Cyclotomic Factorizations on Finite Hexagonal Tessellations*
Abstract: This project explores a novel, graph-theoretic interpretation of the Fibonacci sequence. We begin with a 2-row hexagonal tessellation, with hexagons indexed by (n) beginning at 1, from top to bottom then left to right. We then determine the number of non-recursive paths to each hexagon (n), where hexagons indexed greater than (n) cannot be used. The Fibonacci sequence is identical to the sequence formed from the sequence of numbers of paths. This research focuses on extending past 2 rows to (r) rows. We derive a recurrence for the total count of acceptable paths and find that they are determined by a finite-dimensional transfer matrix. The characteristic polynomial of this matrix establishes a factorization into cyclotomic polynomials which are indexed by the divisors of $(r + 1)$, offering an explicit expression of the structure underlying the recurrences. We ultimately conclude with an explicit formula for the number of paths to each hexagon given arbitrary (n) and (r) and explore various number-theoretic properties of the sequences and their structures. *Graph Theory/Combinatorics, Number Theory*

1:40-1:55 in San Gabriel Room 313
Presenter(s): Kevin Iga, Pepperdine University
Title: *A human studies an AI proof of the Cycle Double Cover conjecture*
Abstract: On July 10 2026, OpenAI announced a proof of the Cycle Double Cover conjecture in graph theory, which states that every finite bridgeless undirected graph has a multiset of cycles in which every edge appears exactly twice. I will present an overview of this proof, and reflect on the human readability of the paper. *Graph Theory/Combinatorics, AI*

Montebello Room 309
(Geometry, Topology, and Graph Theory)

1:00-1:15 in Montebello Room 309
Presenter(s): Kyle Hansen, Westmont College
Title: *Simple Tilings of Nilpotent Lie Groups*
Abstract: We define simple tilings in the general context of a G-tiling on a Riemannian homogeneous space M to be tilings by Riemannian simplices. As evidence that this definition is natural, we prove that a large class of tilings of M are MLD to simple ones. We demonstrate the utility of this definition by generalizing previously known results about simple tilings of $\mathbf{R}^n$. In particular, it is shown that there is an isomorphism between Čech cohomology and pattern equivariant cohomology of simple tilings in connected, simply connected, nilpotent Lie groups. *Geometry, Topology*

1:20-1:35 in Montebello Room 309
Presenter(s): Matthew Paek, Harvey Mudd College
Title: *A Computational Tool for Link/Topological Graph Invariants*
Abstract: Knot theory is interested in algebraic invariants of knot-like structures embedded in space, well-defined up to ambient isotopy. Link invariants such as the bracket, Jones, and HOMFLY polynomial are well-studied. Yokota's invariant is concerned with topological 4-regular graphs with arbitrary weighting. With constant weights, the computational difficulty reduces to computing various bracket polynomials associated with the graph. This case is used to construct a tight lower bound of the number of crossings n in *any* diagram of a topological graph G. Unlike well-known invariants like the Jones polynomial, it appears there are no computational tools to compute the constant-weight invariant of an arbitrary graph diagram. As an early step in ongoing research, the authors developed Python code to directly compute constant-weight Yokota invariant of an admissible graph diagram, along with a visual editor allowing the user to construct those graphs. The package stores data for each topological object with information akin to planar codes. Indeed, the functionality extends generally to knots and links, and supports the computation of Kauffman's bracket and the Jones polynomials. *Algebra, Topology, Knot Theory*

1:40-1:55 in Montebello Room 309
Presenter(s): Max Hlavacek, Pomona College
Title: *Probability distributions of lattice polytopes*
Abstract: Every polynomial with real non-negative coefficients yields a finite probability distribution after normalization. The Ehrhart h^*-polynomial of a lattice polytope P is a non-negative integer polynomial that encodes the integer-point counts for positive integer dilations of P. We study the corresponding finite distributions, which we call h^*-distributions. We determine the mean and variance of these distributions, establish a connection between higher moments and Ehrhart polynomial coefficients, and study their cluster points in the$d$-dimensional probability simplex. Throughout, we will look towards some well-studied polyhedra as examples. *Graph Theory/Combinatorics, Probability/Statistics*

Los Angeles Room 308
(Analysis and Mathematical Explorations)

1:00-1:15 in Los Angeles Room 308
Presenter(s): John Rock, Cal Poly Pomona
Title: *JEOPARDY! and Arbitrarily Close*
Abstract: A formal definition for arbitrarily close provides a fresh perspective on concepts in topology and analysis: A point is arbitrarily close to a set if every neighborhood of the point intersects the set. In the setting of a complete metric space, a point is arbitrarily close to a set if and only if there is a sequence in the set whose limit is the point. With this notion for arbitrarily close in mind, let's play a round of JEOPARDY! to see classic concepts in a new light. *Analysis, Math Education/Pedagogy, Topology*

1:20-1:35 in Los Angeles Room 308
Presenter(s): Brandon Miranda, Omar Garcia, Nathan Hicks, Mark Mun and Andy Zhang, Cal Poly Pomona
Title: *Finding the limit of the recurrent sequence:* $a(1) = 0,\ a(2) = 1,\ a(3) = 1/2,\ a(4) = 3/4,\ a(5) = 5/8,\ a(6) = 11/16, \ldots$ *where* $a(n) = [a(n-2) + a(n-1)]/2$ *for* $n = 3, 4, 5, \ldots$
Abstract: Since the preceding sequence is a Cauchy sequence of real numbers, the sequence converges to a finite limit, a, using results from undergraduate real analysis. We determine the limit a, without using an explicit formula for the nth term of this sequence (usually found by using an eigenvalue approach). Our method also applies for more general recurrent sequences. We will share some of these examples during our talk. *Analysis, Probability/Statistics*

1:40-1:55 in Los Angeles Room 308
Presenter(s): Armando Pena, Adrienne Robertson , California State University San Marcos
Title: *Attacking ECDSA with Fourier Analysis*
Abstract: The Elliptic Curve Digital Signature Algorithm (ECDSA) is a widely used cryptographic protocol for generating and verifying digital signatures. Its security depends on a secret signing key d, which must remain hidden. Fourier analysis provides a way to identify dominant frequencies within complex signals. A frequency is the number of times a pattern repeats within a specified time frame. Breitner and Heninger showed empirically that Fourier analysis can be used to detect frequencies in ECDSA signatures and, under certain conditions, recover information about the secret key. *Analysis, Applied Math, Cryptography*

Pasadena Room 307 (Counting and Random Walks)

1:00-1:15 in Pasadena Room 307
Presenter(s): Omid Khormali, Harvey Mudd College
Other Author(s): Ghaya Mtimet, University of Evansville; Nuh Aydin, Kenyon College
Title: *Who Stays on the Ship? A Medieval Counting Puzzle, Secret Sentences, and the Automata That Find Them*
Abstract: Centuries-old Arabic texts tell of thirty passengers on a sinking ship, seated in a circle, with every ninth person removed until fifteen remain. Seats are assigned by the letters of a verse whose dotted and dotless Arabic letters are arranged so that exactly the intended fifteen survive. In this talk, we unpack the mathematics hidden in such verses. We first show that circular stepping with any step size k can split n objects into r groups using both elimination and non-elimination procedures. We then record a sentence's alternation pattern as a generalized run-length encoding and count these encodings using Stirling numbers of the second kind and multinomial coefficients. Finally, given a dictionary, a grammar, and a prescribed block pattern, we ask whether a meaningful sentence exists. Using finite automata and context-free parsing, we show this is decidable in polynomial time, and we present English sentences, built from straight-line and curved letters, that reproduce the historical solution. *Graph Theory/Combinatorics, History/Philosophy of Mathematics*
Audience: General audience; no background beyond basic counting needed

1:20-1:35 in Pasadena Room 307
Presenter(s): Elizabeth DeWitt, University of Southern California
Title: *Counting Leading Shifted Tableaux*
Abstract: From two partitions of distinct parts with one contained in the other, we can create a skew shifted tableau by filling the cells of the difference of the diagrams with marked and unmarked positive integers. The number of assignments that give the leading content according to lexicographic order has long been known to be a power of two and is easy to find for a given pair of partitions by filling the diagram by hand. After an introduction to shifted tableaux, we will discuss a closed formula for this exponent based only on the partitions. *Graph Theory/Combinatorics*

1:40-1:55 in Pasadena Room 307
Presenter(s): Owen Xu, Caltech
Title: *Recurrence and transience of excited random walks on trees and lamplighter groups*
Abstract: Multi-excited random walks on a graph $G$are random walks in which the transition probabilities at any particular vertex x in G depend on the number of times x has been previously visited. A (usually finite) number of cookies $\omega(x, i)$ are placed on each vertex x of G, each with their own specified transition probabilities $\omega(x, e, i)$. At the ith visit of the vertex x, the random walker moves according to the transition probabilities $\omega(x, e, i)$ and consumes the cookie shortly afterward. After all cookies are consumed at a vertex, the walker moves from that vertex with transition probabilities equivalent to that of a simple random walk.

In this project, we examine multi-excited random walks on trees of exponential growth; in particular, we show that on a tree of exponential growth, there exists a recurrent multi-excited random walk with finitely many cookies on each vertex. Separately, we also look at the once-excited random walk on the lamplighter group $\mathbb{Z}/2\mathbb{Z} \wr \mathbb{Z}$— we provide a streamlined proof of the transience of the simple random walk on the lamplighter group, and we modify this proof to show transience of the once-excited random walk on the lamplighter group. *Probability/Statistics*

Alhambra Room 305
(Modeling, Prediction, and Dynamical Systems)

1:00-1:15 in Alhambra Room 305
Presenter(s): Christopher Wang, Scripps College
Title: *The quality of a reservoir computer is determined by its relationship to causal states*
Abstract: We show that if a reservoir computer makes the best possible prediction, its internal states must contain an accessible representation of the causal states (minimal sufficient statistics of prediction) of the input. In doing so, we develop multiple expressions for the best possible prediction in terms of the causal states depending on the cardinality of the data-generating Hidden Markov Model, input space, and whether time is discrete or continuous assuming we aim to minimize mean-square error. We show that the reservoir's causal state representation must be unique — distinct causal states are prohibited from mapping onto the same reservoir state for optimal prediction. We quantify how well a reservoir predicts in cases where it does not make the best possible prediction and show that it is related to how well the reservoir represents the causal states. We also show that reservoirs with similar prediction functions have similar representations of causal states. These results establish a new bridge between dynamics and computation. *Applied Math, Mathematical Modeling, Probability/Statistics*

1:20-1:35 in Alhambra Room 305
Presenter(s): Yi-Szen Tang, Cal Poly Pomona
Title: *From Least Squares Regression to Sensor Fusion: A Mathematical Derivation and Application of the Kalman Filter*
Abstract: The Kalman filter is commonly introduced as a recursive prediction-correction algorithm. But its connection to least-squares estimation provides useful interpretations of both its equations and practical behavior. Condensing previous information as additional, uncertainty-weighted observations reveals a more practical estimation method than a least-squares solution. This is known as a state-space model and is the basis for Kalman filtering. As an application, we consider one-dimensional position estimation using an inertial measurement unit (IMU) and an ultrasonic distance sensor. By augmenting the state-space model, we can take advantage of the cross-variance between position and acceleration bias to indirectly improve the accelerometer-bias estimate. Experimental data compare IMU-only, ultrasonic-only, and fused estimates to examine estimation error, innovation behavior, and uncertainty propagation. *Applied Math, Mathematical Modeling, Probability/Statistics*
Audience: Linear Algebra and Multivariate Calculus (some basics physics will help)

1:40-1:55 in Alhambra Room 305
Presenter(s): Marcelo Amaral, Scripps College
Title: *Memory, Prediction, and Energy Cost in Spiking Neural Networks*
Abstract: How well do neural networks predict, and how efficiently do they use memory and energy? We study two spiking-network models with fixed long-term weights, driven by a binary continuous-time Markov stimulus. An exact information-theoretic frontier specifies the greatest prediction possible at each memory budget, while firing activity supplies an energy-cost estimate. For this source, the current state is sufficient for prediction; elapsed time in that state provides no additional predictive information. In small recurrent networks, stronger coupling beyond an intermediate regime increases estimated energy cost while reducing average estimated predictive information. The association between estimated memory and energy cost also changes with activity regime. In a larger biologically motivated model, stronger afterhyperpolarization reduces firing by approximately 46% without reducing observed current-state decoding in matched comparisons. Reading recent spike history improves decoding, and slower stimuli favor longer readout windows. These results distinguish predictive performance, memory efficiency, and energy cost, and support time scale matching among stimulus, network, and readout as a design principle for predictive neural systems. *Applied Math, Mathematical Modeling, Probability/Statistics*

Boardroom South Room 303B
(Markov Chains and Stochastic Structures)

1:00-1:15 in Boardroom South Room 303B
Presenter(s): Sofia Vasquez, Evelyn Jimenez , Cal Poly Pomona
Title: *Suppose P^n equals a matrix whose rows are constant for all positive integers $n > N - 1$ where P is the one-step transition matrix of a finite chain and N is some fixed integer.*
Abstract: Then the sequence of Markov random variables, $X^n, X^{n+1}, X^{n+2}, ...$ form a sequence of second order stationary random variables. Furthermore, the finite-time gambler's ruin probabilities and the infinite-time gambler's ruin probabilities on the dual Markov chain are the same. *Mathematical Modeling, Probability/Statistics*

1:20-1:35 in Boardroom South Room 303B
Presenter(s): Abel Soto, Cal Poly Pomona
Title: *Creating and Justifying a Metric on Markov Chains*
Abstract: A Markov chain is a random process with the Markov property. Examples include random walks and queuing. we ponder the idea of these types of situations being closely related or "close together". We seek to construct a metric where the objects are the entire Markov chain Itself. A Markov chain can be thought of as a sequence of random variables, a matrix, a multivariate function, and even a graph. Problems that arise include – how should we choose to represent the Markov chain? How should we define the metric? With the help of linear algebra, we argue that there's a natural answer to these questions and that multiple constructions of this topology are actually equivalent. This helps to justify that our construction is the "natural" choice. We do further justification by investigating the structure of the quotient topology, and proving that it takes a somewhat expected form. *Metric Spaces and Probability*
Audience: Linear Algebra, Topology, and Random Processes

1:40-1:55 in Boardroom South Room 303B
Presenter(s): Evan Johnson, Kasper Kajewski, Mark B. Mun, Abdel Somera-Fuentes, Theodore De Santos, Viren Kumar, Milad Khazani, Cal Poly Pomona
Title: *When can a Markov Chain First Reach its Steady-State Matrix in a Finite Number of Time-Steps*
Abstract: Consider all irreducible 3-state Markov Chains that have a steady-state distribution $\vec{\pi} = \begin{bmatrix}\pi_0 & \pi_1 & \pi_2\end{bmatrix}$ then the family of one-step transition probabilities $P = \begin{bmatrix}1-a-b & a & b \\ c & a & 1-a-c \\ 1-a-b & a & b\end{bmatrix}$, where $c \neq 1-a-b$ and all entries are probabilities, represent all 3-state Markov Chains who reach their steady-state distributions in 2 time-steps for the first time. We show there does not exist a 3×3 P matrix such that $P^n = \begin{bmatrix}\pi_0 & \pi_1 & \pi_2 \\ \pi_0 & \pi_1 & \pi_2 \\ \pi_0 & \pi_1 & \pi_2\end{bmatrix}$, for the first time when $n = 3, 4, ...$ We also consider generalizations of this result for higher-dimensional P matrices. *Probability/Statistics, Linear Algebra*

Boardroom North Room 303A (Langlands Conjecture)

1:00-1:15 in Boardroom North Room 303A
Presenter(s): Shanna Dobson, Harvey Mudd College and Cal State LA
Title: *An Introduction to Langlands: A Tale of Two Geometries*
Abstract: The Langlands program reveals unexpected connections between arithmetic and representation theory. How can geometry help us understand these connections? This talk offers a gentle introduction to the local Langlands correspondence, beginning with a simple example involving one-dimensional representations. We then meet two geometries in the Fargues–Scholze program: a geometry of bundles on the Fargues–Fontaine curve and a geometry of Langlands parameters. Drawing on the speaker's survey work, we explore how these two geometric perspectives illuminate the relationship between arithmetic and representation theory. No prior knowledge of the Langlands program is assumed. *Number Theory*