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

Program and Abstracts

March 29th, 2025

Acknowledgements

The Southern California-Nevada Section of the MAA welcomes participants to our 2025 Spring Meeting. We would like to thank our invited speakers and our poster session presenters for their participation in the meeting. Our student volunteers play a vital role in the running of the meeting. Many thanks to our volunteers from Pepperdine University for this meeting.

The Section thanks the Mathematics Faculty and the Office of the Provost at Pepperdine University, the Seaver Dean's Office, and the Natural Science Division for their generous hospitality in hosting the meeting. We would like to especially thank Kevin Iga who handled the local arrangements for the meeting. We also extend a special thank you to the Office of Sponsored Research which sponsored the poster session.

Please recycle your name tags at the end of the conference using the boxes provided.

Section Officers, 2024-2025

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Section NExT Liaison: Matthew Gherman
Las Vegas Liasion: Zhijian Wu
Web Page Editor: Karrolyne Fogel

Looking for a way to engage with and support our math community? Our officer positions rotate frequently. Current openings are the Student Chapters Coordinator who runs our Student Poster Session at the spring meeting (appointed) and the Newsletter Editor (which entails reviving our defunct online newsletter). Also, each spring we elect a new Section Vice-Chair and 2nd Program Vice-Chair, who serve on the board for three years. If you are interested in serving in any of the Section Officer positions, but especially one of these that will be open soon, please contact the Past Section Chair (Shanna Dobson).

Schedule

Pepperdine University, Elkins Auditorium

8:30-12:30	Registration	Elkins Aud. Courtyard
8:30-10:30	Poster Presentation Check-In	Elkins Aud. Courtyard
9:00-9:15	Welcome Remarks Welcome by Section Chair Kim Ayers, CSU San Marcos Welcome by Pepperdine University Provost Jay Brewster	Elkins Auditorium
9:15-10:15	Invited Address **Tim Lucas**, Pepperdine University *From Ecology to Modeling Apps - Newts, Crayfish, and Slopes*	Elkins Auditorium
10:15-10:45	Section Business Meeting	Elkins Auditorium
11:00-12:00	Student Poster Session	Mullins Town Square
12:00-1:00	Lunch Break	
1:00-2:00	Section NExT Workshop **Matthew Gherman**, California Institute of Technology *Embodied Mathematics Interactive Session*	BPC 191
2:00-3:00	Invited Address **Shoo Seto**, CSU Fullerton *Hearing Shapes with the Spectrum of the Laplacian*	Elkins Auditorium
3:00-3:30	Meeting Photo and 100th Birthday Refreshments	
3:30-3:45	Closing Remarks	Elkins Auditorium

Invited Addresses

Pavneet Kaur Bharaj, CSU Long Beach
Unpacking Mathematics Education Research: Insights from Multiple Perspectives

In this keynote session, I will explore various aspects of mathematics education research that contribute to a comprehensive understanding of the field. With a focus on teacher education, I will discuss different avenues I have examined—including mathematics pre-service teachers, mathematics in-service teachers, mathematics teacher educators, and the review of existing documentation in the mathematics education field—to identify both the strengths and areas for growth within each. Grounding my work in Bronfenbrenner's Ecological Systems Theory, I will highlight how different factors shape mathematics teachers' learning, instructional decisions, and professional identities. I will share insights from my research journey as a mathematics teacher educator, reflecting on the evolving landscape of the field and the key considerations for fostering meaningful learning experiences. This session aims to spark dialogue on how we can collectively build a more robust understanding to mathematics education research and practice.

Timothy Lucas, Pepperdine University
From Ecology to Modeling Apps - Newts, Crayfish, and Slopes

This talk presents two simultaneous, interdisciplinary, student-driven projects in the areas of ecological modeling and educational tools. I will introduce a model for studying the population dynamics of the California newt (Taricha torosa), a species of special concern in California, which have been decimated by invasive crayfish (Procambarus clarkii) in Santa Monica Mountain streams. Jointly with Courtney Davis, we evaluated either the persistence or time to extinction for newt populations under crayfish trapping regimes when varying the trapping capacity, frequency of trapping implementation, and susceptibility of crayfish to trapping. These models of crayfish management also present interesting examples for differential equations students. I will introduce in-class activities that emphasize a visual understanding of these models to reinforce key concepts such as bifurcations. The primary tool for these investigations is Slopes, a mobile application with an intuitive interface that is designed to visualize solutions to differential equations and support active learning in the classroom. By making slopefields, phase planes and numerical solutions more accessible, students can engage in higher level discussions of mathematical models that incorporate differential equations. Slopes is available for iPads, iPhones, and Android phones, which are highly portable and feature larger touch screens that allow students to view and manipulate content easily. In a recent study, Krista Lucas and I found that students used Slopes to visualize solutions, aid in discussion and cooperation, build prototype models, and demonstrate understanding of differential equations concepts. I will conclude with examples of semester-long modeling projects enhanced by the use of Slopes.

Shoo Seto, CSU Fullerton
Hearing Shapes with the Spectrum of the Laplacian

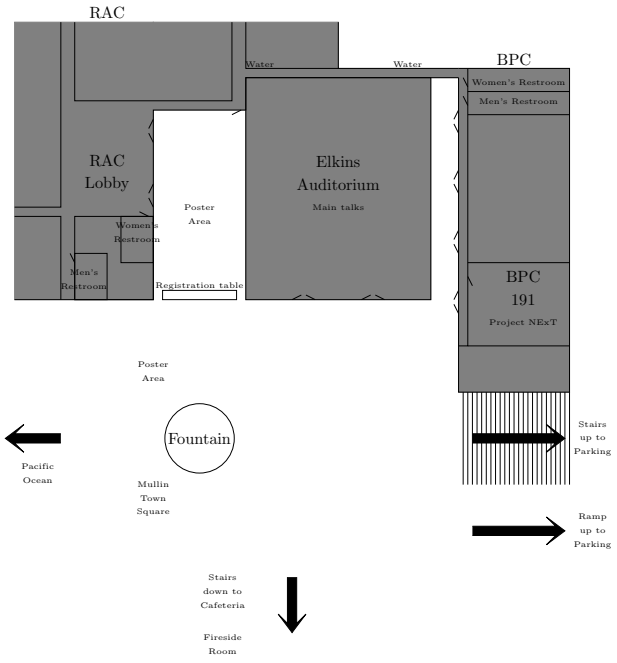
In this talk, we will introduce a differential operator called the Laplacian which plays an important role in many fields of mathematics and has many applications outside of mathematics as well. By studying its spectrum (or eigenvalues) we can determine the way the Laplacian behaves and how the underlying geometry plays a role in solutions to equations involving the Laplacian. The materials will be self-contained and only some familiarity with calculus concepts will be assumed.

Section NExT Workshop: Embodied Mathematics Interactive Session

Embodied mathematics activities involve students engaging in physical actions to help them better understand mathematics concepts. Current research shows these types of activities have great potential to help students develop conceptual understanding. Matthew Gherman, the Section NExT liaison, will lead an interactive session to introduce embodied mathematics, attempt some examples, and brainstorm potential embodied activities in your classroom.

Pepperdine Campus Map

Conference Map



Speaker Biographies

Pavneet Kaur Bharaj, CSU Long Beach

Dr. Pavneet Kaur Bharaj is an Assistant Professor of Mathematics Education in the Department of Mathematics and Statistics at California State University, Long Beach. Before joining CSULB, she was an Assistant Professor in the Teacher Education Department at California State University, Bakersfield. She completed her postdoctoral studies at the University of Massachusetts Boston and earned her Ph.D. in Mathematics Education from Indiana University Bloomington. She also holds a double master's degree in Mathematics and Education from India.

Dr. Kaur Bharaj is particularly interested in unpacking different aspects of mathematics education—whether through exploring the experiences of teacher educators, in-service teachers, and pre-service teachers, or through critically analyzing existing documentation that shapes discourse in the field. Her work extends to various aspects of mathematics teacher education, particularly examining ways to enhance teacher preparation and professional development. Outside of academia, Dr. Kaur Bharaj enjoys spending time with her husband and toddler, embracing family moments alongside her professional pursuits.

Timothy Lucas, Pepperdine University

Tim Lucas is a Professor of Mathematics at Pepperdine University. He earned his Ph.D. in mathematics at Duke University in 2006. In his research, Dr. Lucas collaborates with undergraduates to construct and analyze mathematical models of biological processes. This includes a discrete-time population model of chaparral vegetation response to frequent wildfires and an agent-based model that incorporates plant growth and competition for resources. He has also used discrete-time population models and agent-based models to predict whether California newt populations can persist given severe drought and the invasion of non-native crayfish. Dr. Lucas has also researched how using iPads in the classroom transforms the learning space and facilitates social interaction. Inspired by that work, he developed two mobile apps for visualizing solutions to ordinary and partial differential equations called Slopes and Waves.

Shoo Seto, CSU Fullerton

Dr. Seto is an assistant professor at CSU Fullerton working on problems in geometric analysis. In particular, his interests are in the spectrum of the Laplacian as well as parabolic and elliptic equations involving the Laplacian. He received his Ph.D. at UC Irvine, and held positions both as a postdoc at UC Santa Barbara and as a lecturer at UC Irvine, before beginning his position at CSUF.

Poster Session Abstracts

Presenter(s): Alex Holland, California Lutheran University
Title: *A Graph-Theoretical Analysis of Triads in Western Music*
Authors(s): Alex Holland, John Villapando, California Lutheran University
Abstract: Music provides a unique connection between a very clear objective structure, and a fairly consistent subjective structure based on the listener's experience. This connection allows us to build a structured and predictive model that we can then analyze these subjective things mathematically to find information that would otherwise be difficult to obtain. In this project, we build a simple model based on chords, scales, and some widely accepted music theory principles, to describe some aspects of harmonic motion. We then Analyze this model to find patterns that can be used for exercises, songwriting, or music analysis, such as efficient methods to see what's possible with a particular number of chord changes, some important structures in how the chords relate to each other, and some chord progressions that highlight those important structures and relationships.
Advisor: John Villalpando
Poster Area(s): Graph Theory/Combinatorics, Interdisciplinary Topics

Presenter(s): Heydar Amanov, California State University, Channel Islands
Title: *Algebraic properties of Quasistabilizers of Quandles*
Authors(s): Heydar Amanov, California State University, Channel Islands
Abstract: *Quandles* are magmas that axiomatically mimic the Reidemeister moves on a knot embedded in $\mathbb{R}^3$. In a recent paper, M. Elhamdadi and E. Moutuou introduced elements of a quandle that are known as stabilizers. In this paper, we localize this concept of stabilizers to what we call *quasistabilizers*, which is a less restrictive counterpart of stabilizers. This gives us a way to study quandles elementwise instead of studying it in its entirety. We then give results relating quasistabilizers of quandles to symmetric spaces, and how quasistabilizers behave in multi-quandles.
Poster Area(s): Algebra, Topology

Presenter(s): Gabriel Dalton, Pomona College
Title: *American Indians and the Gingles Criteria*
Authors(s): Gabriel Dalton, Pomona College
Abstract: American Indians are seldom discussed as a political mover within the United States despite their incredible uniqueness and heterogeneity, whether that be the myriad of different tribal groups, the reservation system, or their differences in voting patterns. This will be an analysis of Indigenous peoples, specifically American Indians, that being people indigenous to the 48 contiguous states, employing a variety of quantitative techniques including ensemble analysis and ecological inference. This analysis is in terms of the "Gingles criteria," a set of criteria established by the Supreme Court in 1986 to determine whether a challenge may be brought to a districting plan under Section 2 of the Voting Rights Act. I focus predominantly on state legislature districting plans. I argue both that American Indians do satisfy the Gingles criteria, in most states, on the legislative map and that they also have some relative advantages when it comes to obtaining majority-minority districts.
Advisor: Sarah Cannon
Poster Area(s): Applied Mathematics, Interdisciplinary Topics

Presenter(s): Jules Rodriguez, CSU Channel Islands
Title: *An Investigation of Gaussian Integers Modulo p*
Authors(s): Jules Rodriguez, CSU Channel Islands
Abstract: This research investigates the structure and properties of Zp[i], the set of Gaussian integers modulo a prime p. We look at its algebraic framework, including addition and multiplication operations, and explore conditions under which it forms a field. Key topics include the classification of zero divisors, the application of modular arithmetic in the complex plane, and the existence of Fermat's Little Theorem. We aim to develop a deeper understanding of modular arithmetic in the complex plane and related number theory. We explore potential applications in coding theory and cryptography.
Advisor: Ivona Grzegorczyk
Poster Area(s): Number Theory, Algebra

Presenter(s): Jasmine Wright, Miles O'Brien, California State University Channel Islands
Title: *Bio-Marker Discovery by Non-Canonical Polyadic Decomposition*
Authors(s): Johnathan Harrell, Morgan McMurray, Miles O'Brien, Jasmine Wright, California State University, Channel Islands
Abstract: Biomarkers are important for scientists to detect, classify, and measure the type of cancer present in a patient. Discovering the relationship between specific genes and proteins occurring with certain cancer types is an important part of knowing where and how treatments can be applied, given data from a patient. Our work continues with results obtained in a Master's thesis by Sheena Mogan titled "Biomarker Discovery by Semi-Supervised Non-NegativeMatrix Factorization". Our goal is to apply Non-Negative Non-Canonical Polyadic Decomposition (NNCPD) to the data sets used in her research and compare results. Furthermore, we will confirm the links between the genetic information and cancer types found by NNCPD in the data sets in comparison to the results that have been confirmed in the peer-reviewed publications. We chose NNCPD because of its ability to process multi-omics data tensors, unlike other algorithms limited by their inability to analyze data in more than two dimensions.
Advisor: Alona Kryshchenko
Poster Area(s): Probability/Statistics, Interdisciplinary Topics

Presenter(s): Yolanda Ba, Cole Plepel, Harvey Mudd College
Title: *Column Space Convergence of ALS Tensor Decomposition Factors*
Authors(s): Yolanda Ba, Cole Plepel, Harvey Mudd College
Abstract: Tensors are high-dimensional generalizations of vectors and matrices that can be thought of as n-dimensional arrays of numbers. Many applications, from chemometrics to medical imaging, benefit from tensor decompositions, such as the CP decomposition, in which an arbitrary tensor is expressed as a sum of rank-one tensors, allowing for easier analysis and interpretation. CP decompositions are typically computed via the Alternating Least Squares (ALS) algorithm, which reduces tensor decomposition to solving repeated linear least squares problems. Under mild conditions, we show that the column space of predicted factors after one ALS iteration matches the column space of the corresponding true factor, when the tensor has an exact decomposition. Further, we make progress towards showing these conditions are met with high probability.
Advisor: Jamie Haddock
Poster Area(s): Applied Mathematics

Presenter(s): Elizabeth Rogers, Elizabeth Hernandez, Nicole Ge, Harvey Mudd College
Title: *Column-Robust Column-Action Method: Quantile-based Randomized Gauss-Seidel*
Authors(s): Jamie Haddock, Elizabeth Rogers, Elizabeth Heranndez, Nicole Ge, Harvey Mudd College
Abstract: In large-scale computational problems where data cannot be read or entirely held in working memory, randomized iterative projection methods provide a way forward, with guarantees for convergence in expectation. Quantile-based, randomized Kaczmarz methods are well-established row-action methods that avoid adversarially corrupted data, and guarantees of convergence in expectation exist. We build on this work by proposing a quantile-based, randomized column-action method based upon the Gauss-Seidel method, chosen for its computational advantage over randomized Kaczmarz. Numerical results when testing our algorithm with overdetermined, corrupted systems show promise. In particular, we see consistent convergence for quantile values less than or equal to the fraction of uncorrupted equations. These experiments motivate theoretical results which we are currently pursuing.
Advisor: Jamie Haddock
Poster Area(s): Probability/Statistics, Applied Mathematics

Presenter(s): Stephannie Abbey, California State University Channel Islands
Title: *Comparison of Two Worlds: The Academic and Professional Transitions of Black Mathematicians Between Africa and the African American Community*
Authors(s): Stephannie Abbey, California State University Channel Islands
Abstract: This study examines the academic and professional migration of Black mathematicians between Africa and the African-American community, highlighting their contributions, challenges, and opportunities. It explores the factors driving African mathematicians to pursue higher education in the U.S., the racial and cultural barriers they face, and the impact of mentorship and collaboration on their careers. By documenting these experiences, this research challenges Western-dominated narratives, informs policies on diversity and inclusion, and fosters connections between African and African-American mathematical communities to support future generations.
Advisor: Dr. Ivona Grzegorczyk
Poster Area(s): History/Philosophy of Mathematics, Education/Pedagogy

Presenter(s): Claire Zhang, Pomona College
Title: *Continuity of Density Spaces in Hausdorff Distance*
Authors(s): Claire Zhang, Pomona College
Abstract: Density spaces arise in the quantum information theory literature for the purpose of understanding quantum states and their interactions. These spaces are in fact constructed by quantum states themselves, and each quantum state produces a different density space. Quantum states have a natural notion of convergence given by the operator norm, and we studied the behavior this convergence has on the associated density spaces. In particular, the Hausdorff distance produces a notion of convergence of sets, and our work proved that convergence in the operator norm of quantum states provides convergence of the associated density spaces in the Hausdorff distance.
Advisor: Konrad Aguilar
Poster Area(s): Analysis

Presenter(s): Allison Hilliard, Pepperdine University
Title: *Counting Hamiltonian cycles in quartic circulant graphs*
Authors(s): Allison Hilliard, Pepperdine University
Abstract: We consider the problem of counting Hamiltonian cycles in circulant graphs $C_n^{1,k}$. Our method is to partition the set of Hamiltonian cycles according to their winding numbers. Then, we construct a weighted digraph that allows us to produce a generating function that counts the number of Hamiltonian cycles for each winding number. Summing these generating functions derives a formula for the total number of Hamiltonian cycles in a circulant graph with n vertices.
Advisor: Joshua Bowman
Poster Area(s): Graph Theory/Combinatorics

Presenter(s): Kurtis Heer, Alexander Bonillo, California State University Channel Islands
Title: *Dots and Boxes Game*
Authors(s): Kurtis Hee and Alexander Bonillo, California State University Channel Islands
Abstract: In the Dots and Boxes game, players try to capture as many 1×1 boxes on a grid of vertices (dots) by adding horizontal or vertical edges to adjacent vertices. A player captures the box if they add the last line to a box or surround several boxes on their turn. In our project, using graph theory, we explain and analyze different strategies that can be used to win the game depending on the size of the board and the number of players.
Advisor: Ivona Grzegorczyk, Professor of Mathematics, CSUCI
Poster Area(s): Graph Theory/Combinatorics

Presenter(s): Greta Voshege, Hannah Einhoff, California State University Channel Islands
Title: *Escher type tessellations of the plane and their symmetry groups*
Authors(s): Greta Voshege, CSUCI
Abstract: We study geometric patterns on the plane with various symmetries. There are 17 possible types of designs with various symmetry groups including reflections, rotations, translations and glides. These patterns can be found all around us, in nature on plants and animals, on clothing, in the human body, in science or even in architecture and art and designs. MC Escher is a well-known Dutch graphic artist who created artwork that was inspired by mathematics. His patterns explore different perspectives, angles and even illusions. In our project we tried to put ourselves in his shoes and we created various plane tessellations with different symmetries.
Advisor: Ivona Grzegorczyk
Poster Area(s): Geometry, Applied Mathematics

Presenter(s): Hill Zhang, Justin Son, Claremont McKenna College
Title: *Exceptional Collections for Toric Fano Fourfolds*
Authors(s): Yang (Hill) Zhang, Justin Son, Jumari Querimit Ramirez, Claremont McKenna College
Abstract: In 1978, Beilinson resolved the diagonal for projective n-space over the complex numbers. By 2000, Bayer-Popescu-Sturmfels generalized Beilinson's resolution to unimodular toric varieties, a more restrictive class than smooth varieties. This also extends to a virtual, generally non-minimal, resolution of the diagonal for smooth projective toric varieties. In recent developments, Hanlon-Hicks-Lazarev (H-H-L) provided a minimal resolution of any toric subvariety of any smooth projective toric variety. We investigate implications of the H-H-L resolution of the diagonal for smooth projective toric Fano varieties in dimension 4. Our analysis reveals that for 74 out of 124 such varieties, the H-H-L resolution yields a full strong exceptional collection of line bundles.
Advisor: Dr. Reginald Anderson, Claremont McKenna College
Poster Area(s): Geometry, Algebra

Presenter(s): Carmen Day, California State University Channel Islands
Title: *Exploring Octonions and their Pseudo-Matrix Representations*
Authors(s): Carmen Day, California State University Channel Islands
Abstract: Octonions are a normed division algebra over the reals that have several interesting properties and applications. Unlike other common number systems, the octonions are not associative. Consequently, it is a challenge to devise a matrix representation of octonions. This project explores basic properties of octonions and some already proposed pseudo-matrix representations of octonions.
Advisor: Ivona Grzegorczyk
Poster Area(s): Number Theory, Algebra

Presenter(s): Hannah Einhoff, Greta Voshege, California State University Channel Islands
Title: *Exploring the 17 Plane Symmetry Groups*
Authors(s): Hannah Einhoff, California State University Channel Islands
Abstract: The 17 plane symmetry groups, also known as "wallpaper groups," classify all possible two-dimensional repetitive patterns based on their symmetries. Each group is defined by a unique combination of transformations: rotations, reflections, translations, and glide reflections. Plane patterns appear everywhere — in nature, art, mathematics, architecture, and everyday objects like tiles, rugs, and wallpaper. Among the most celebrated artistic explorations of these symmetry groups are the works of M.C. Escher, a Dutch artist renowned for his mathematically inspired designs. His artistic tessellations, demonstrate his intuitive grasp of symmetry, seamlessly blending animals and shapes into continuous, interlocking patterns that follow specific symmetry groups. We design our own Escher-type designs, one for each of the symmetry types.
Advisor: Ivona Grzegorczyk
Poster Area(s): Geometry, Applied Mathematics

Presenter(s): Jacob Rosales, California State University Channel Islands
Title: *Fermat's Little Theorem and Issues to Generalizing Carmichael Numbers*
Authors(s): Jacob Rosales, California State University Channel Islands
Abstract: This poster investigates Fermat's Little Theorem and its failure to have a converse, through Carmichael numbers. We provide one of many proofs of Fermat's Little Theorem to showcase how the Carmichael numbers are a counterexample. We then discuss the notion of primality in algebraic number rings and the issues to directly generalizing Carmichael Numbers to these rings. The motivation for this poster came from a desire to understand Jordan Schettler's Paper on "Lehmer's Totient Problem and Carmichael Numbers in a PID" with hopes to extend his work in PIDs to algebraic number rings.
Advisor: Brian Sittinger
Poster Area(s): Number Theory, Algebra

Presenter(s): Darren Okura, Laguna Hills High School and Fullerton Mathematical Circle
Title: *From a Ladder of Means to Limiting Processes: Solutions to Recent Problems from Gazeta matematică*
Authors(s): Darren Okura, Laguna Hills High School and Fullerton Mathematical Circle
Abstract: The first meeting of the Fullerton Mathematical Circle was held on September 24, 2011, and many other meetings have been held since. These sessions are inspired by events developed around the monthly publication Gazeta matematic ă, a journal established in 1895. In this poster I present the solutions of several problems proposed in the December 2024 and January 2025 issues of Gazeta matematică, which range from inequalities to complex numbers to limits and sequences.
Advisor: Dr. Shoo Seto and Dr. Bogdan Suceavă
Poster Area(s): Analysis, Algebra

Presenter(s): Mitchell Agris, Caltech
Title: *Graham's Conjecture for the Lexicographical and Rooted Product*
Authors(s): Mitchell Agris, Jack Dawson, Grace To, Matthew Gherman, Caltech
Abstract: Graham's Conjecture states that the pebbling number of the Cartesian product of two graphs is at most the product of the pebbling numbers of the graphs. Graham's Conjecture is the most significant open problem in the theory of graph pebbling. We prove Graham's Conjecture for the lexicographical product of two graphs and provide an example to show that Graham's Conjecture does not always hold for the rooted product of two graphs. We then determine a sharp upper bound for the pebbling number of a rooted product of two graphs in terms of their respective pebbling numbers.
Advisor: Matthew Gherman
Poster Area(s): Graph Theory/Combinatorics

Presenter(s): Margarette Grace Bajar, Cal Poly Pomona
Title: *How Undergraduate STEM Students with Math Anxiety Persist through their Academic Careers*
Authors(s): Margarette Grace Bajar, Cal Poly Pomona
Abstract: Math anxiety is a significant barrier for students pursuing STEM degrees, often leading to avoidance of math-intensive courses. This study investigates the persistence of under- graduate STEM students with math anxiety through their academic careers. Utilizing semi- structured interviews with ten STEM students currently enrolled in Calculus II, the research explores the factors contributing to their math anxiety, the strategies they employ to suc- ceed, and their motivations for continuing in their chosen field despite their anxiety. Findings indicate that math anxiety stems from various sources, including teacher influence and self- imposed pressures. Despite these challenges, students persist due to motivations such as job security and a passion for STEM fields. The study highlights the importance of understand- ing and addressing math anxiety to support STEM students' academic success.
Advisor: Jessica O Perez
Poster Area(s): Education/Pedagogy, Math Anxiety

Presenter(s): Sandra Moreno Cristóbal, Cal Poly Pomona
Title: *Instant Insanity*
Authors(s): Dylan Brown, Jade Estrada, Moises Gonzalez, and Sandra Moreno Cristóbal, Cal Poly Pomona
Abstract: Instant Insanity is a well-known combinatorial puzzle that challenges players to stack four cubes such that each of the four visible faces of the resulting prism displays all four colors exactly once. Originally introduced in 1900 and later popularized by Franz Ambruster in 1965, the puzzle serves as an engaging tool for exploring permutations and graph theory concepts. In this poster, we employ graph theory methods to analyze and solve the puzzle. Each cube is represented as a pseudograph, where vertices correspond to colors and edges represent opposite cube faces. By constructing a composite pseudograph and identifying two disjoint 2-regular spanning subgraphs, we determine a valid stacking solution. We also demonstrate cases where no solution exists by analyzing the restrictions of some composite pseudographs. This approach provides a systematic and efficient method for solving the puzzle, highlighting the power of graph theory in combinatorial problem-solving.
Advisor: Dr. Emily Heath
Poster Area(s): Graph Theory/Combinatorics

Presenter(s): Paul Schulteis, Concordia University Irvine
Title: *K-mer Expected Value Algorithms*
Authors(s): Paul Schulteis, Concordia University Irvine
Abstract: In the relatively new world of DNA genome research, scientists are discovering more about how specific sequences of DNA nucleotides, or motifs, can have biological significance. To identify these motifs, k-mers within genome sequences are observed and compared to their expected value of occurrence. Since k-mers can be counted using technology (like the software jellyfish), the key to discovering biological significance is finding the expected value. This paper analyzes various mathematical algorithms for expected value and compares them to a proposed probabilistic method. Using the mathematical approaches of combinations, recursive relations, and traditional expected value, this paper shows how these methods can solve for k-mer expected value, compares them to the probabilistic method, and reviews the advantages of having these different algorithms. The algorithms of this paper can be extended for continued genome research.
Advisor: Dr. Melinda Schulteis, Dr. Matthew Cserhati
Poster Area(s): Probability/Statistics, Interdisciplinary Topics

Presenter(s): Evan Knee, Caylee Walker, Azusa Pacific University
Title: *Learning Assistants Impact on STEM Identity*
Authors(s): Evan Knee, Caylee Walker, Karstin Dupont, Peanut McCoy, Elijah Roth and Kaitlyn Fitzgerald, Azusa Pacific University
Abstract: Equity in STEM opportunities and outcomes is a concern for universities. Prior research, largely focused on physics, suggests that Learning Assistant (LA) programs reduce DFW rates, increase retention, and support curricular transformation. To investigate the potential benefits of LAs in 100-level STEM courses, we analyze survey data collected in Fall 2023 and Spring 2024 via the STEM Professional Identity Overlap 4 (PIO-4) and the STEM Career Interest Survey (CIS) instruments as well as administrative data on student outcomes and demographics. Results suggest LAs may help increase STEM-major retention rates and decrease DFW rates but do not significantly impact STEM career interest or professional identity. While male students reported greater overlap with STEM professionals, females reported higher confidence and career interest. No significant PIO-4 differences emerged between Hispanic and non-Hispanic students, though CIS responses varied. These findings inform improvements to LA programs and provide insight into our STEM student population.
Advisor: Kaitlyn Fitzgerald
Poster Area(s): Education/Pedagogy, Probability/Statistics

Presenter(s): Gage White, California State University- Channel Islands
Title: *Mathematical model of COVID*
Authors(s): Gage White, California State University- Channel Islands
Abstract: This project presents a comprehensive quantitative analysis of mathematical models used to describe and predict the spread of COVID-19. The significance of epidemiological modeling is emphasized, highlighting its role in understanding disease dynamics and informing public health decisions. The evolution of COVID-19 models—from compartmental to stochastic and deterministic approaches—is examined, illustrating how advancements in data integration have improved accuracy. Various studies are analyzed to identify limitations within each model. By tracing the development of these models from 2020 to 2024, this study provides insights into the virus's characteristics and the refinement of predictive methodologies.
Advisor: Ivona Grzegorczyk
Poster Area(s): Applied Mathematics

Presenter(s): Relena Pattison, Pepperdine University
Title: *Mathematically modeling how trapping specific crayfish life stages impacts removal efficacy*
Authors(s): Relena Pattison, Dr. Courtney Davis, Pepperdine University
Abstract: The red swamp crayfish is an invasive species introduced into several streams within the Santa Monica Mountains (SMM). Crayfish predation decimates native aquatic species. The Mountains Restoration Trust (MRT) has worked to remove crayfish through regular trapping in Malibu Creek. A prior student created a crayfish life cycle model with trapping, which we expand to better predict the efficacy of crayfish removal efforts in the SMM. We separate crayfish based upon life stages and sizes. We construct and parameterize this discrete crayfish population model with and without trapping. We use literature and crayfish removal data from MRT to fit the model to two regions of Malibu Creek. By numerically simulating crayfish population changes over time, we find that model dynamics are highly sensitive to cannibalism. We determine the best crayfish life stages to trap to most efficiently decrease crayfish population size.
Advisor: Dr. Courtney Davis
Poster Area(s): Applied Mathematics, Interdisciplinary Topics

Presenter(s): Gazi Sultan, California State University - Channel Islands
Title: *MATLAB Implementation of Gray-Scale Image Encryption and Decryption using Elliptic Curve ElGamal Cryptosystem*
Authors(s): Gazi Sultan, California State University - Channel Islands
Abstract: Elliptic curve algorithms have gained prominence in modern cryptography due to their superior computational efficiency and security, offering a robust alternative to classical schemes like RSA. Their adoption enables smaller chip sizes, lower power consumption, and faster computation, making them ideal for resource-constrained environments. We developed a MATLAB-based grayscale image encryption and decryption system using the elliptic curve variant of the ElGamal Cryptosystem. The implementation includes optimized MATLAB code and a user-friendly graphical interface, allowing users to adjust elliptic curve parameters, the prime modulus p, and private keys. To enhance efficiency, we leveraged the Weierstrass cubic equation and incorporated LUTs and fast exponentiation techniques in modular arithmetic. The system produces high-quality cipher images with low mean square error and high peak signal-to-noise ratio. Our algorithm addresses key challenges in Elliptic Curve ElGamal encryption, significantly reducing both encryption and decryption times while minimizing the size of the transmitted cipher image.
Advisor: Ivona Grzegorczyk
Poster Area(s): Number Theory, Applied Mathematics

Presenter(s): Alexandra Castelazo, Cal Poly Pomona
Title: *Mobility of Underserved Students in STEM*
Authors(s): Alexandra Castelazo, Dr. Jimmy Risk, Cal Poly Pomona
Abstract: Diversity in STEM has been difficult to achieve due to the lack of diversity in higher education (Lord, Layton, & Ohland, 2011). A major contributor to the lack of diversity in STEM is the unevenness of student mobility for underserved students in STEM (Guillermo-Wann, Hurtado, & Lua Alvarez, 2013). To get a better understanding of this diversity problem, this research will track the pathways of students who are enrolled in 4-year universities with the use of multi-state Markov modeling. To approach student mobility with multi-state Markov modeling, states such as Math, STEM (Non-Math), and Non-STEM, Graduated, and Leave were created. The dataset used to evaluate student mobility pathways is the MIDFIELD dataset, which was collected from 1988 to 2018 and contains 90 thousand observations. Variables chosen for this approach were selected to consider underserved students to detect whether a relationship between an underserved demographic and student mobility pathways exist.
Advisor: Dr. Jimmy Risk
Poster Area(s): Education/Pedagogy, Probability/Statistics

Presenter(s): Liam Moran, CSU Channel Islands
Title: *Number systems beyond Complex (Coquaternions)*
Authors(s): Liam Moran, CSU Channel Islands
Abstract: Coquaternions, or Split Quaternions, are an extension of Quaternions, which were originally developed to understand automorphisms of three- and four-dimensional spaces. While Quaternions have gained widespread application in mathematics, coquaternions have their own unique properties that distinguish them. Notably, coquaternions can be represented as an isomorphism with 2x2 real coefficient matrices. The focus of this research is to explore whether coquaternions can be understood as a Clifford algebra. In my presentation, I will discuss the distinct properties of coquaternions, outline a strategy for understanding, and reflect on the contributions this line of thought has made to the advancement of mathematics.
Advisor: Ivona Grzegorczyk
Poster Area(s): Algebra

Presenter(s): Ruilin Zhu, Troy High School
Title: *One problem, Three Solutions: A Gem from Gazeta Matematică*
Authors(s): Ruilin Zhu, Troy High School
Abstract: A geometry problem (29035) from a recent issue of Gazeta Matematică illustrates a fundamental principle in mathematics: a problem can often be solved in multiple ways. In this study, I present three different solutions to this problem, each employing a distinct approach: trigonometry identities, the complex plane, and pure geometry. While the trigonometric and complex plane methods offer straightforward, systematic solutions, they involve extensive computation. In contrast, the geometric approach, though requiring creativity and the introduction of an auxiliary line (and a circle), results in a simpler and more elegant solution.
Advisor: Dr. Bogdan Suceavă, Dr. Shoo Seto
Poster Area(s): Geometry, Algebra

Presenter(s): Nathaniel Hall, University of Southern California
Title: *Optimal Pebbling of Lollipop, Spider, and Tadpole Graphs*
Authors(s): Nathaniel Hall, University of Southern California
Abstract: Graph pebbling involves assigning a non-negative integer to every vertex of a connected graph. Each integer represents the number of "pebbles" on that vertex. A pebbling move redistributes one pebble from a vertex to a neighboring vertex and removes a single pebble from the starting vertex. The constraints were developed to prove specific conjectures in number theory. In our work, we focus on a specific variation in which we optimize the pebbling of various types of graphs. We compute the optimal pebbling number of lollipop and tadpole graphs and verify the optimal pebbling of spider graphs.
Advisor: Matthew Gherman
Poster Area(s): Graph Theory/Combinatorics

Presenter(s): Alexander Eul, The Electrochemical Society (CSUCI)
Title: *Organ Model Production System*
Authors(s): Alexander Eul
Abstract: Described is a novel process and a system to produce an organ model providing the nuances of tissue variousness and complex internal and external features present in the original biological organ.
Poster Area(s): Topology

Presenter(s): Stephanie Atherton, Otis College of Art and Design
Title: *Origami Methods for Finite Cyclic Groups and the Infinity Cube*
Authors(s): Stephanie Atherton, Otis College of Art and Design
Abstract: Origami is a paper-folding pastime that has previously been used to prove classical constructions in geometry. One subgenre of origami is action origami toys, where paper-folding methods can be used as a kinesthetic and visualization tool in exploring their *algebraic* underpinnings. The finite cyclic group $\mathbb{Z}/n\mathbb{Z}$ is generated by a single generator $\langle g \rangle = \{g^k \mid k \in \mathbb{Z}\}$ that cycles through $\text{ord}(g)$ elements via its integer powers $k \in \mathbb{Z}$. Given the square nature of origami paper and Latin square property of the Cayley table for a group, one can fold a structure encoding properties of cyclic (and further) groups that can be useful in visualizing isomorphism classification. A fully functional infinity cube toy can also be constructed via origami methods, and its group isomorphism demonstrated via such a Cayley table.
Poster Area(s): Algebra, Interdisciplinary Topics

Presenter(s): Salam Khalaf, California State University Channel Islands
Title: *Quaternions: Where Math Meets Motion*
Authors(s): Salam Khalaf, California State University Channel Islands
Abstract: We study the properties of quaternions. These numbers redefine how we think about algebra and transformations of space. They are not commutative under multiplication, unlike real or complex numbers. This makes them indispensable for various modern applications. In this research, we examine the properties of quaternions and show that they form a normed division algebra and a Clifford algebra. Quaternions have become a powerful tool in aerospace engineering, computer graphics, and robotics, performing efficient singular-free 3D rotations. Spanning the gaps between the abstractness of mathematics and front-line technology, quaternions vary from theoretic elegance to applicative problem-solving. We provide examples of applications of quaternionic multiplication, such as its use for three-dimensional rotations.
Advisor: Ivona Grzegorczyk
Poster Area(s): Geometry, Algebra

Presenter(s): Alexandra Castelazo and Yohali Silva Hernández or Adriana Enriquez, Cal Poly Pomona
Title: *Sophisms and Erroneous Resolutions in Analysis—Discussions in a Collaborative Classroom*
Authors(s): Adriana Enriquez, Alexandra Castelazo, Ooi Yiwen Fayre-Ella, and Yohali Silva Hernández, California State Polytechnic University Pomona, and Solange Pitronaci and Luciana Sagari, Instituto del Desarrollo Humano - Universidad Nacional de Gral. Sarmiento
Abstract: Current methods for education in mathematics emphasize correctly worked examples while undermining and sometimes punishing mistakes (positive knowledge). The opposite (negative knowledge) is the use of mistakes to supplement and better understand mathematics. With the use of negative knowledge and famous paradoxes in mathematics, our global classroom involves discussions and critical thinking between students from the Universidad Nacional de Gral. Sarmiento and California Polytechnic University, Pomona, to research and develop ways to learn about the convergence of sequences of real numbers and functions. This international experience allowed the participants to build connections with each other, highlighting their diversity and cultural differences in both their understanding of mathematics and as students, as well as deepening their understanding of uniform and pointwise convergence through analyzing famous sophisms and paradoxes in mathematics. This poster presents two sophisms that explore the convergence of functions and arc-length, specifically uniform convergence and the preservation of arc-length. It also shares some of the participants' thoughts and feelings about this international experience through written and recorded student testimonies.
Advisor: Dr. Fernando López-García (CPP) and Dr. Roberto Ben (UNGS)
Poster Area(s): Education/Pedagogy, Analysis

Presenter(s): Heba Ayeda, Dylan Stover, Sean Kanne, Konstantin Victoria, Sergio V. Navia, California State Polytechnic University, Pomona
Title: *Steady State Distributions of Generalized Markov Chains*
Authors(s): Alan Krinik, Heba Ayeda, Sean Kanne, Nhan Nguyen, Ashwin Rajesh, Joshua Ward, California State Polytechnic University, Pomona
Abstract: Our research group studied the visualization of regions, R, of steady state . distributions of generalized birth-death chains. This means that the real one-step transition matrix, P, have only transitions of size 0 or t 1 and are somewhat stochastic, that is, each row of P sums to leven though an individual entry of P may be negative or greater than 1. These generalized birth-death chains produce a larger set of steady state distributions than the conventional birth-death Markov chains. The boundaries of our steady- state distributions R are determined by the eigenvalues of P. For simplicity, we restrict our consideration of generalized birth-death chains to have at most three states, where one-step transitions are functions of a or b. Even under these simplifying assumptions, we obtain an interesting variety of open, bounded and unbounded regions R that have conic section boundaries. Elements of R that have the same steady state distributions are geometrically identified as lying upon certain line segments within R.
Advisor: Dr. Alan Krinik
Poster Area(s): Probability/Statistics, Applied Mathematics

Presenter(s): Jasmine Wright, CSU Channel Islands
Title: *Tessarines in Digital Signal Processing: A Mathematical Approach to Understanding Marine Mammal Communication*
Authors(s): Salam Khalaf, Carmen Day, Liam Moran, Jules Rodriguez, CSU Channel Islands
Abstract: We study hypercomplex numbers called tessarines that provide a promising framework for representing multidimensional data especially for digital signal processing (DSP) or in bioacoustic analysis. This research presents the properties of this number system and its applications. We explore how tessarine-based models can be applied to analyzing underwater recordings of whales and porpoises, where traditional DSP techniques often struggle with multidimensional waveforms, overlapping signals, and noise filtering in dynamic marine environments. By leveraging the properties of tessarines, we aim to enhance species detection, classify vocalization patterns, and improve signal decomposition methods, ultimately contributing to computational mathematics and ecological monitoring. This work aligns with my broader interest in applying advanced mathematical frameworks to biological research, demonstrating how abstract algebra and DSP can provide new insights into marine mammal behavior and conservation.
Advisor: Ivona Grzegorczyk
Poster Area(s): Analysis, Algebra

Presenter(s): Miles O'Brien, Alyssa Claro, Samantha Sagasta, CSUCI
Title: *The Black-Scholes Equation and Its Relation to the Heat Equation*
Authors(s): Miles O'Brien, Alyssa Claro, Samantha Sagasta, CSU Channel Islands,
Abstract: We explore the Black-Scholes equation and its connection to the heat equation. Our goal is to simplify option pricing using mathematical transformations and numerical methods. We start by transforming the Black-Scholes PDE into the standard heat equation through a change of variables, making it easier to solve. We then verify that the European call option price is the discounted expected value of the payoff under the risk-neutral measure. Finally, we explore numerical methods such as finite difference and Monte Carlo simulations for solving the equation and show that the Black-Scholes price of a digital option is the partial derivative of the call option price with respect to the strike price.
Advisor: Ivona Grzegorczyk
Poster Area(s): Applied Mathematics

Presenter(s): Gavin Butts, Loyola Marymount University
Title: *Towards describing how Young Quasisymmetric Schur Functions expand into Dual Immaculate Quasisymmetric Functions*
Authors(s): Gavin Butts, Josh Hallam, Loyola Marymount University
Abstract: We study the decomposition of Young quasisymmetric Schur functions into dual immaculate quasisymmetric functions, describing the formula for the decomposition on functions indexed by compositions of length 2. We prove this using an algorithm on standard immaculate tableaux and standard Young composition tableaux, motivated by the cycle lemma. We also count the number of standard immaculate tableaux and standard Young composition tableaux on partition (n+1,n) with respect to the number of descent elements, finding a correspondence with the Narayana Numbers and Catalan Numbers.
Advisor: Joshua Hallam
Poster Area(s): Graph Theory/Combinatorics, Algebra

Presenter(s): Nicole Sonneville, Liza Shchehlik, University of California Irvine
Title: *Using Baby Books to Improve Discipline Practices and Beliefs*
Authors(s): Nicole Sonneville University of California Irvine, Liza Shchehlik, University of California Irvine
Abstract: Baby Books 2 is a bilingual (English/Spanish) parenting intervention using education books to see if they can shift new parent's beliefs and recommended discipline practices. In a randomized control design involving 420 parents of 9-month-old infants, participants were assigned to receive books written from a mother's perspective, a father's perspective, both, or commercially available baby books. Books were distributed at 9, 12, 15, 18, and 24 months, and assessments at 9, 18, 24, and 30 months. Preliminary analyses indicate significant differences in response trajectories over time and across participant subgroups. We're finding that mothers and fathers respond differently to developmentally appropriate belief practices, while cultural differences between U.S.-born and immigrant parents suggest varying patterns of engagement with the materials. By applying generalized estimating equations (GEE) to model intervention effects and estimate odds ratios, providing robust insights into the intervention's potential to enhance anticipatory guidance in pediatric care.
Advisor: Stephanie Reich
Poster Area(s): Education/Pedagogy, Probability/Statistics

Presenter(s): Elijah Busito, Erick Diaz, Jacqueline Ornelas-Ventura, Junior Perez Garcia, Emmanuel Santiago, Pomona College
Title: *Vector-valued functions and slope versus deviation*
Authors(s): Elijah Busito, Erick Diaz, Thejana Jayathilake, Jacqueline Ornelas-Ventura, Junior Perez Garcia, Emmanuel Santiago
Abstract: Vector-valued functions are used to describe many mathematical concepts that appear not only in Mathematics but as well as Physics, Chemistry, Economics, and so on. For example, vector-valued functions describe the path of a projectile (like a soccer ball kicked from the ground) along with its velocity and acceleration. As with many things in mathematics, it's not possible to get exact values, so we must approximate, and the same goes for certain values associated to vector-valued functions like their maximum rate of change and deviation from their average. Quantum metric theory provides an approach for understanding and approximating these values by comparing them to each other. Our project focused on finding theoretical and computational bounds for comparing maximum slope and deviation. And we obtained theorems for the case of 1-dimensional and 2-dimensional vector-valued functions.
Advisor: Konrad Aguilar
Poster Area(s): Analysis

Presenter(s): Sean Kanne, Cal Poly Pomona
Title: *Visualizing Steady State Distributions of Generalized Birth-Death Chains in 3-Space*
Authors(s): Sean Kanne, Sergio Navia, Cal Poly Pomona
Abstract: Birth-death chains are a form of Markov chain used in modeling within fields ranging from biology to systems engineering. These chains are then simplified by using a discrete time-step and generalized by allowing their transition matrix to be somewhat stochastic, each row's entries sum to 1, guaranteeing the existence of the eigenvalue 1. Instead, we bound the other eigenvalues to have complex modulus less than one, enabling the use of Sylvester's Formula to find the steady state as these eigenvalues proceed to zero as their exponent proceeds to infinity. This project sought to visualize in two and three dimensions the open regions wherein these generalized discrete-time birth-death chains have steady-state solutions. Under these assumptions we obtained a number of both bounded and unbounded 3-space regions and bounded 2-space regions for three and four state chains. As time allows, we will discuss a general method to find Gambler's Ruin probabilities.
Advisor: Alan Krinik
Poster Area(s): Probability/Statistics