MAKO 2023: Abstracts

Invited Talk: "Quiver Representations and Applications"
Dr. Daniel Kline, College of the Ozarks

In this talk, we introduce the basic notions of quivers and their representations. We then explore the role of quiver representations in Machine Learning and Topological Data Analysis, two areas of highly active research.

"Mathemusical: The Pitch-Class Integer Theorem"
C. Scott Alons, Oral Roberts University
Faculty Mentor: Dr. Andrew Lang, Oral Roberts University

Mathematical music theory has assumed without proof that musical notes can be associated with the equivalence classes of the group of integers modulo n. We contest the triviality of this assertion, which we call the Pitch-class Integer Theorem (PCIT). Since the existing literature assumes the PCIT without proof, the mathematical language to rigorously treat the PCIT does not yet exist. We axiomatically construct an abstract study of harmony to generalize its fundamental tenets and to show that the PCIT is proven by this construction. We ultimately verify the PCIT to support the existing mathematical models of music theory.

"Limit Theorems for Fixed Point Biased Permutations Avoiding a Pattern of Length Three"
Aksheytha Chelikavada, Saint Louis University
Faculty Mentor: Dr. Hugo Panzo, Saint Louis University

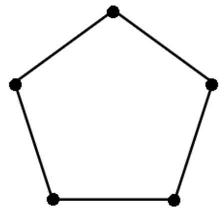
The study of the number of fixed points occurring in a uniformly random permutation has a long history going back to Montmort in the early 1700s. In this talk, we prove limit theorems to help understand the asymptotic behavior of pattern avoiding permutations biased by their number of fixed points. In particular, one case we study features a phase transition where the limiting distribution of fixed points changes abruptly from negative binomial to Rayleigh to normal depending on the bias parameter.

"Deconstructing and Dominating the Game of Hex"
Justin Kroh, Drury University, and Jace Reinke, Drury University
Faculty Mentor: Dr. Bob Robertson, Drury University

The Game of Hex was invented in 1942 and has since taken the world of Game Theory by storm. The game is simple: two players take turns marking tiles on a grid of hexagons. Player one wins by connecting the left and right sides of the grid with a path made of their markings while player two wins by connecting the top and bottom. Using a "strategy stealing" argument, it has been proven that player one has a winning strategy; we hope to prove this with a different argument. We also want to develop our own proof of the Hex Theorem, which states the game cannot end in a draw.

"The Product of the Chromatic Number and Independence Number of a Graph"
Rachel Lee, Missouri State University
Faculty Mentor: Dr. Les Reid, Missouri State University

Given a graph *G*, its chromatic number $\chi(G)$ is the smallest number of colors needed to color its vertices so that no vertices connected by an edge have the same color. Its independence number $\alpha(G)$ is the largest number of vertices such that no two vertices are connected by an edge. For example, the graph shown below has $\chi(G)=3$ and $\alpha(G)=2$.



It is well known that $\chi(G)\alpha(G)\geq n$, where *n* is the number of vertices of *G*. Recently, Hefty and Johnson established an upper bound $f(n)$ for $\chi(G)\alpha(G)$. In this talk, we will discuss this upper bound and determine which values in the range $[n, f(n)]$ can occur.

"Classification of Isogeny-Torsion Graphs over $\mathbb{Q}(\sqrt{213})$"
Michael Logal, University of Arkansas
Faculty Advisor: Dr. Lance Miller, University of Arkansas

Elliptic curves have been a study of interest for over 100 years, and it keeps bearing fruit in research, with front-stage status in the proof of Fermat's Last Theorem. This talk will be about part of the structure of elliptic curves, called the isogeny-torsion graph. The main problem of classifying them has been solved over $\mathbb{Q}$, but no other field—in particular, we will investigate what happens to these graphs when we are allowed to use the dastardly $\sqrt{213}$.

"Using Cheminformatics to Predict Water Solubility"
Anna Price, Oral Roberts University
Faculty Mentor: Dr. Andrew Lang, Oral Roberts University

Water solubility prediction is important to look at especially in the medical field and the production or testing of new drugs. The purpose of this project is to build off previous research and data sets to create a new sub-data set that contains the melting points and water solubilities of a multitude of known compounds. In previous research a data set of compounds and their different properties were compiled and then ran through a random forest model in hopes of obtaining an $R2$ value close to one and an RMSE value close to zero. To build off this existing research, a new data set was created to help predict the water solubility of other compounds that are not contained in the sub-set, and it will also help curate a more reliable data set. This sub-set was also run through a random forest model to accurately compare water solubility prediction. The water solubility prediction of the sub-set that was created produced significant $R2$ values and RMSE values in both the training and test data sets. It is hoped that this research will inspire future researchers to build upon its data and continue to create better prediction models using more refined compound identifiers.

“Using Musical Actions of D12 to Compose Music”

Hannah Ritter, Drury University
Faculty Mentor: Colin T Barker

We present a research paper by Crans *et al*, (2008) that analyzes the correspondence between music and mathematics. In this paper called Musical Actions of Dihedral Groups, they introduce mathematical and musical terms, two mathematical groups (the T/I-group and the PLR group), group actions on a set of musical notes, and an analysis of these group actions on well-known pieces of classical music. Rather than deconstructing math from known music, as is the goal of the paper, we hope to compose a piece based solely on the information and techniques developed within the paper.

“Developing Mathematical Creativity with University Mathematics Majors”

Anna Claire Smith, University of Central Arkansas
Faculty Advisor, Dr. James Fetterly, University of Central Arkansas

From many studies across the world, there has been an established connection between mathematical creativity, problem posing, and divergent-thinking. When these three work in tandem, it is the most effective and efficient method to foster creativity in students throughout the K-16 system. The goal of this study is to examine the possible development of university-level students’ mathematical creativity through problem posing and divergent-thinking teaching and tasks. In using a required course for pre-service secondary mathematics teachers, this study seeks to answer if participants’ mathematical creativity could be strengthened and heightened. Throughout the 16-week course, participants experienced purposeful problem posing and divergent-thinking teaching 3 days a week for 50 minutes each day. Mathematical creativity was measured from pre- to post-test and through 3 sets of Divergent-Thinking Explorations Question tasks throughout the term. In collection of the data, the study will present the possible effects of problem posing and divergent-thinking teaching and assignments on university level students' mathematical creativity.