The Twentieth Annual Nebraska Conference for Undergraduate Women in Mathematics

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POSTER ABSTRACTS

Posters by Undergraduate Students

Gabrielle Angeloro, State University of New York at Geneseo
Cusp Density in Nested Octahdral Links

This research studies link invariants on a specific class of hyperbolic links. We focus on nested octahedral links, and outline the process of augmenting and nesting a link. To study hyperbolic links, we will geometrically realize the complement of a link as hyperbolic polyhedra. We complete this process using a cell decomposition given by Purcell. Finally, we present a result concerning cusp density of the aforementioned class of links.

Erica Bajo Calderon, University of Central Oklahoma
Spatial Reasoning at the Central Oklahoma Math Circle

The Central Oklahoma Math Circle is a partnership between US Grant High School in OKC, and the University of Central Oklahoma. Numerous studies have shown that higher levels of spatial reasoning correlate to success in mathematics, and it is usually the males that have a better grasp of spatial reasoning. Since our Circle's target audience is females, we like to incorporate at least one lesson on spatial reasoning. For this poster, we will present a progression of activities that incorporate spatial reasoning, like quick draw and think cards, with the final activity being Blokus Trigon. We will describe our conversation with the participants about spacial reasoning and its importance. Finally, we will present variations for the activities.

Leah Bayer, Youngstown State University
Modeling the Effects of Crayfish Invasion and Drought on Hypothetical Crayfish Population Dynamics

North American crayfish species face several environmental and ecological threats including limited natural ranges, invasive species, and intensified drought. Our objectives were to model the population dynamics of potential crayfish species with theoretical life histories and assess how these populations could be affected by the impacts of invasive species and drought. We used RAMAS-Metapop to construct stage-based demographic models using data obtained from various literature sources. We assessed population viability under various disturbance scenarios using estimates of terminal extinction risk, median time to quasi-extinction, and metapopulation occupancy. Better estimates of stage-specific survival and fecundity could reinforce our findings and more accurately predict species outcomes. By constructing models that explore a wide variety of life histories and disturbance scenarios, we hope to provide managers with tools to develop broadly applicable conservation strategies.

Luna Bozeman, Clemson University
Improving Patient Flow through Optimal Allocation of Nurses

Maintaining efficiency in residency clinics while assuring adequate training of residents can be challenging due to the differences in skill levels of residents and attending physicians. To avoid prolonged waiting times experienced by the patients, it is critical to optimally allocate resources among these physicians. Through our collaboration with the Greenville Health System Family Medicine residency program, we study the allocation of nurses to physicians in a residency clinic. Assuming exponential task times and non-homogeneous servers, we develop a queueing model for the clinic. We analyze the resulting Markov chain to generate allocation policies to improve long-run average throughput and reduce patient wait times. We then use a simulation study to conduct a sensitivity analysis to evaluate the robustness of the proposed allocation policies. Our results show that careful allocation of nurses to physicians can lead to increased throughput, shorter wait times, and improved patient satisfaction.

Maria Briseno Martinez, Carleton College
Hanna Crowe, Macalester College
Sophia Hui, Pomona College
The Gender Gap In Special Math Classes

The disparity between the number of men and women in STEM fields is a phenomena that extends beyond the mean. There are consistently fewer girls among the top performers in mathematics, whether as participants in competitions, students in advanced classes, or professionals in the field. Is there a lack of interest in higher math topics, or simply a cognitive difference between girls and boys? Do women experience increased anxiety, which negatively affects their math performance? Or are teachers demonstrating an unconscious bias against girls? These questions provide possible explanations for the gender gap, so naturally our goal was to answer them. While studying abroad, we visited a number of "special math classes" – classes that are problem based instead of following the standard curriculum – in Hungary to gain insight from young girls in the field. With this research as a baseline, we then used our own interviews with Hungarian teachers and students as well as data collected on the ratio between boys and girls in three Hungarian schools that offer special math classes and from national competitions to create awareness about the persistence of the gender gap in mathematics, explain why it is a problem, and give possible advice on how to increase female participation and success in math, especially among top performers.

Amanda Burkhart, Eastern Connecticut State University
Patterns among Prime-Centered Triples

Around 1640, Fermat discovered that a prime could be written as a sum of two squares if and only if p is congruent to 1 modulo 4. In our research project, we study prime-centered triples. A prime-centered triple is three consecutive integers $p-1$, p, $p+1$, with p prime, such that each be written as a sum of two squares. Such triples are sparse and we will discuss our computational approach to analyzing them, in particular finding patterns that can predict larger triples. One notable pattern that has been found consists of primes of the form $72k^2+1$.

Cinthia Yazmin Calvo Martinez, University of Texas Rio Grande Valley
Mathematical and Logical Approach to Introduction of Proof in Electrical Engineering

Logic is the structure which all proofs are build. Proof is the principal demonstration without conjectures when we want to give evidence to trust or distrust. In order to trust any statement, we must give evidence with arguments for validation. Logical operators are the proper symbolic interpretation and connection that exists in mathematics and a useful tool that will use to prove statements.

To make proofs easier to comprehend, I will introduce the physical phenomena of electricity in Electrical Engineering as an example to examine a circuit with pure materials and prove if there is a flow of electrical power or not. Several mathematical techniques as the truth tables, logical equivalences, and different types of conditional statements will be a very important stage during the analysis. The goal is to illustrate the way of connecting logic and follow the right direction to construct a mathematical representation by using the proper techniques to give the assertion an essential evidence that a specific statement is true.

Jasmine Camero, California State University, Fullerton
A Ladder of Curvatures in the Geometry of Surfaces

In the classical differential geometry of surfaces there are two curvature invariants: the Gaussian curvature (introduced by Gauss in 1827) and the mean curvature (introduced by Sophie Germain in 1831). At the end of the 19th century Casorati investigated another curvature invariant. In the present work we introduce a new curvature invariant, the tangential curvature, and we investigate its fundamental properties.

Claudia Sofia Carrillo Vazquez, University of Rochester
The Sortability of Graphs and Matrices Under Context Directed Swaps

The context directed swap, cds, is a sorting operation performed on permutations. It models a process used by ciliates during gene decryption. While cds is the most efficient type of block swap for sorting some permutations, it can fail on others by reaching fixed points – unsorted permutations on which cds cannot be performed. Prior work characterized which permutations are sortable by the cds operation. We present extensions of prior results for permutations through a novel graph theoretical and linear algebraic framework for cds. This framework applies also to graphs and matrices that do not correspond to any permutations. Our results include sortability criteria for graphs and matrices for these generalizations of cds, implying the prior findings for the special case of permutations.

Dana Casabella, California State University, Fullerton
Victoria Meza, California State University, Fullerton
Home Run Expedition

Finding the best path for a road trip can be overwhelming when there are ample variables to take into consideration. In this work, we take into consideration the data from Major League Baseball (MLB) from 2016, to calculate the best route to visit all 30 Major League Baseball stadiums in the United States, and watch a game at each stadium. Major League Baseball (MLB) consists of 30 teams total separated into two leagues: the National League (NL) and the American League (AL). Each league consists of 15 teams and each team has their own stadium. Using the data from 2016, we have calculated the best route in order to see a game at every stadium within a specific number of dates considering multiple restrictions, such as travel limits, budget, and required game time. We modify Nghiem's method for scheduling band concert tours to produce an algorithm that lets us calculate the best route possible.

Ariana Cavazos, California State University, Fresno
An Analysis of Obesity and Climate Change in the United States

Obesity and climate change have become a major issue in the United States. To gain a better understanding on how obesity impacts the environment, we analyzed Edwards and Roberts' study (2009), Population adiposity and climate change. They made very strict assumptions regarding the United Kingdom in the 1970s and in 2010. To better represent the United States, we made our own assumptions so we could grasp an understanding on how changes in BMI are affecting greenhouse gas emissions. Specifically, the study focuses on greenhouse gases emitted from food production, vehicle transportation, and air travel. We found that their assumptions were relatively consistent with our normal weight population. However, Edwards and Roberts' predicted 2010 population had greatly underrepresented estimates compared to our hypothetical overweight population. Thus suggesting that a raise in BMI is indeed causing greater emissions to be emitted due to food production, vehicle emissions, and aviation fuel demands.

Aria Chaderjian, Scripps College
Margrethe Jebsen, Claremont McKenna College
Modeling Cultural Dissemination in Rural vs. Urban Regions

We adapt Axelrod's Adaptive Culture Model to mathematically model cultural dissemination across rural and urban regions. We assume that agents in urban regions interact with a wider range of agents and interact more frequently than their rural counterparts. We find that increasing urban interaction frequency and/or interaction range leads to cultural homogeneity in urban regions. Increasing the interaction range in the urban regions leads to cultural homogeneity in rural regions, while increasing the frequency of interaction in urban regions has the effect of driving rural regions toward heterogeneity. Our results are significant because this is one of the first agent-based studies to consider how range of interaction and interaction frequency influence the dissemination of culture in urban vs. rural areas.

Alice Chudnovsky, University of Illinois at Urbana-Champaign
Irreducible is the New Prime

Some polynomials cannot be factored, so what? These polynomials are called irreducible, much like their integer counterparts, which are called prime. We care about irreducible polynomials because it is a fundamental purpose of mathematics to break concepts into smallest units possible. This talk will survey several irreducibility criteria such as the Cohn Theorem and the Eisenstein criterion, providing a historical context as well as an efficiency comparison. Currently, there is no existing universal irreducibility criterion, and the domains over which each acts have never been compared. In addition to a survey of the criteria, some hypotheses on a more efficient approach will be made.

Maria Contreras, California State University, Channel Islands
Nathalie Huerta, California State University, Channel Islands
Kayla Roberts, California State University, Channel Islands
Exploring survival on the RMS Titanic with Machine Learning

Recently, there has been a surge in available data describing phenomenon from genomics to astronomy and high-energy physics. Additionally, access to data has resulted in the development of new information-based industries according to Frontiers in Massive Data Analysis, National Research Council of the National Academies. Accordingly, statistical rigor is imperative to justifying any gains in knowledge obtained from a given data set. In our project, we will investigate and develop supervised machine learning algorithms that predict the classification of survival of passengers aboard the Titanic. We analyze certain attributes such as class, gender, age, family, and fare that are given in the data set. The main challenge is determining the most significant attributes that clearly distinguish the survivors and the nonsurvivors. Along with attempting to manually create our own attributes using feature engineering, we will use Principle Component Analysis together with the k-nearest neighbors scheme to accurately classify passenger survival on the Titanic.

Amanda Cowell, University of Michigan-Dearborn
Sarah Strikwerda, Calvin College
Linear Fraction Transformations of the Bidisc

We will address linear fractional transformations in the complex plane as they act on the bidisc. A linear fractional transformation (LFT) is a holomorphic function from the complex plane to the complex plane defined by

$$f(z_1, z_2) = \frac{Az + B}{C^* z + d}$$

where A is a 2 by 2 complex matrix, B and C are vectors, and d is a complex number. Linear fractional transformations are self-maps of the open unit ball in multiple complex dimensions have been recently studied by Cowen and MacCluer. Through our investigation, we prove a necessary condition for an LFT to be a self-map of the bidisc. We also show forms of LFT's where the image of the bidisc is a disc cross a disc. In further exploration, we study the amount of fixed points LFTs have and determine a method for finding these fixed points. Finally, we use these ideas to construct LFT's with prescribed fixed points.

Hanna Crowe, Macalester College
see **Maria Briseno Martinez**

Niyousha Davachi, University of Texas at Arlington
Auxiliary Conditions To The Euler-Lagrange Equations For A New Class Of Non-Standard Lagrangians

A new class of non-standard Lagrangians that explicitly depend on the special functions of mathematical physics is discovered and this requires adding some auxiliary conditions to the Euler-Lagrange equations. Several examples with applications of the new non-standard Lagrangians are presented and discussed. Moreover, the relationships between the obtained results and Lie algebras and Lie groups are also briefly addressed.

Jeannie Dees, Wartburg College
Historical Roots Of Math and Physics in the British Isles

In this presentation, you will find there were many self- taught mathematicians that lived in what is now called the British Isles. For twenty-three days, I have had the pleasure of back-packing around the United Kingdom and Scotland to see where, how, and why these brilliant minds came across some of Math and Physics greatest topics. From Sir Isaac Newton's discovery of gravity and Theory of Light to Sir William R Hamilton's notebook containing the work for classical mechanics and mathematical equations. The most general take away you should receive from this poster is that these great minds struggled with some of the same things that we all struggle with today.

Abigayle Dirdak, California State University, Fresno
Zeros of polynomials generated by quadratic-factor denominator

This project is a part of the research on the zeros of a sequence of polynomials $\{H_m(z)\}_{m=0}^{\infty}$ satisfying a recurrence of order n

$$\sum_{k=0}^{n} A_k(z) H_{m-k}(z) = 0,$$

where $A_k(z)$, $1 \leq k \leq n$, are complex polynomials and $A_0(z) = 1$. We focus on the special generating function

$$\sum_{m=0}^{\infty} H_m(z) t^m = \frac{1}{(1 + b_1 B(z) t + a_1 A(z) t^2)\,(1 + b_2 B(z) t + a_2 A(z) t^2)},$$

where $a_1, b_1, a_2, b_2 \in \mathbb{R}$ and $A(z), B(z) \in \mathbb{C}[z]$. If $a_1 = a_2 \neq 0$ then the zeros of $H_m(z)$ lie on the curve $\mathcal{C}$ whose equation is given by

$$Im\left(\frac{B^2(z)}{A(z)}\right) = 0 \qquad and \qquad a_1\, Re\left(\frac{B^2(z)}{A(z)}\right) \geq 0.$$

We also study other quadruples of real numbers (a_1, b_1, a_2, b_2) so that the zeros of $H_m(z)$ lie on $\mathcal{C}$.

Xinying Fang, University of Illinois at Urbana-Champaign
Mathematics of Poker: Skill vs. Luck

Is Poker a game mostly based on skill or is it a type of gambling that is prohibited by many states? Motivated by this long-lasting debate, we consider John von Neumann's classical poker model and its subsequent generalizations by others including noted economists and professional poker players. We classify players according to their skill levels and seek to quantify the relative effects and profit returns of skill and chance to determine which factor dominates in each poker model. Using game theoretic methods and Mathematica simulations and visualizations, we determine the long-time behavior of the profits for different levels of skill and different poker models.

Dominique Forbes, Coastal Carolina University
Tyler Sullivan, Coastal Carolina University
Analysis of Modified Fibonacci Sequences, Generalized Golden Ratios and Their Convergence

We determine a family of recursively defined sequences and their growth rates. We prove that these growth rates converge to generalized 'golden ratios', and from there we prove that these resulting sequences of generalized 'golden ratios' converge as well. We also present how these recursive sequences can arise by modifying certain assumptions that generated the famous Fibonacci sequence.

Kelley France, University of Central Oklahoma
Modeling the Treatment of HIV in Children

We build a differential equations model to study how the length of HIV treatment in young children affects the treatment success. The recent news of remission in some children who had been treated briefly for the virus early in life, shows that understanding the dynamics of the treatment at this stage of life is crucial to uncovering the potential for remission. Taking into account the uninfected T cell population, drug sensitive and drug resistant infected productive T cell populations, drug sensitive and drug resistant infected T cells in the eclipse phase, and drug sensitive and drug resistant free virus, we build a differential equations model of HIV treatment reflective of treatment in young children. We present our model and the results, identifying conditions under which the child would enter remission. We conclude by discussing how this information can be used to minimize the risks to other children/patients.

Abigail Genereau, College of St. Benedict/St. John's University
Modeling the Relationship between White-tailed deer and Blacklegged ticks

Tick-borne diseases pose a greater public health risk than they did since their discovery about two decades ago. To efficiently be able to predict and prevent the disease cases, it is necessary to understand how the blacklegged deer tick, or lxodes scapularis, population grows. This was done by developing a model that shows the effect of harvesting, or hunting, rates of male and female white-tailed deer populations on the tick populations. White-tailed deer are the primary host of adult lxodes scapularis, the reproductive stage of the tick lifecycle (Patnaude and Mather, University of Florida). The model is broken down into the deer life stages to better show the effect of host prevalence on tick population.

Seraphina Gibson, Oberlin College
Path Planning in Approximations to 3D and 4D Configuration Spaces

We considers the problem of path planning for robots with two or three degrees of translational freedom and one axis of rotational freedom. We create and implement computationally a heuristic method for the problem's solution. This work was done at the Summer 2017 University of Miami REU.

Ellen Grove, Grand Valley State University
Mikaela Wyatt, Grand Valley State University
King of the Coop: A Graphical Investigation of Chicken Pecking Orders

Stephen B. Maurer's essay The King Chicken Theorems is a prominent publication in graph theory that relies heavily on the use of directed graphs to describe the pecking interactions between chickens in a random coop. One of Maurer's principle endeavors was to derive a method to determine the most dominant chicken, or chickens, in a coop–regardless of its size. Our own exploration of this topic led us to define new classes of "chickens," such as the "Senator Chicken," the "Boss Chicken," and the "Most Efficient Chicken," which were represented by vertices with given attributes in a directed graph. After studying the behavior of a variety of different graphs, we developed theorems about these different classes of "chickens" that revealed a number of interesting properties about directed complete graphs.

Waverly Harden, Bowdoin College
Dispersive Shock Waves in Strain-softening Material

Strain-softening materials have gained interest in the physics, mathematics and material science communities. These materials become easier to deform as they deform. The dynamics of strain-softening materials in an experimental setting have been rarely studied. I have been modeling and simulating a system that exhibits such behavior. It consists of a chain of hollow elliptical cylinders. An initial force given to the first particle of the chain puts the wave in motion. This dispersive shock wave has a peak that propagates slower than the rest of the wave, causing it to eventually disperse. When the wave breaks, it causes drastic changes in the surrounding atmosphere. Thus, using Hertzian contact laws to model this with an ordinary differential equation would help us anticipate the crash.

Qixuan Hou, Georgia Institute of Technology
Monitoring of High-Dimensional Functional Data Steams via Deep Learning

Most of manufacturing processes are equipped with sensors to monitor the performance and the quality of the system. Researchers attempt to use rich data streams provided by the sensors to realize real-time process monitoring and control, accurate fault diagnosis, and online product inspection. We are proposing realizing real-time monitoring of high dimensional functional data streams via deep learning strategies.

Nathalie Huerta, California State University, Channel Islands
see **Maria Contreras**

Sophia Hui, Pomona College
see **Maria Briseno Martinez**

Lauren Hux, Virginia Commonwealth University
Enhancing Passenger Preclearance via the Flexible Facilitation Model Technical Analysis of Alternatives

The passenger preclearance process allows international passengers to go through security screening operations overseas before boarding a U.S. bound flight. The purpose of EPPC AoA was to identify and evaluate potential technology solutions that could be employed to enhance current CBP preclearance operations. The AoA focuses on technologies that can serve as a 'digital key,' aiming to validate that an individual matches his identity and to produce a record that they have passed the appropriate security checkpoints. A successful digital key portfolio must meet all three goals of binding, information sharing, and attestation, which are discussed further in the poster. A Multi-Criteria Decision Making (MCDM) methodology was used to score and rank technologies within each goal to produce an overall weighted score and associated rank. Using those scores, portfolios were obtained by considering the permutations of technologies under each goal. We used the MCDM method to obtain the best performing individual technology solutions and the overall best performing portfolios.

Skylyn Irby, University of Mississippi
On a Generalization of Lucas Numbers

In this presentation, we will consider a generalization of Lucas numbers. Recall that Lucas numbers are the sequence of integers defined by the recurrence relation: $L_n = L_{n-1} + L_{n-2}$ with the initial conditions $L_1 = 1$ and $L_2 = 3$. That is, the classical Lucas number sequence is $1, 3, 4, 7, 11, 18, \ldots$. The goal of this research is to study properties of the following generalization of the Lucas sequence: $l_n = (-1)^n \cdot l_{n-1} + l_{n-2}$ for $n = 3, 4, 5, \ldots$ with the initial conditions $l_1 = 1$ and $l_2 = 3$. More precisely, we will make numerical simulations and then prove some relations using Principle of Mathematical Induction.

Amy Isvik, Wartburg College
Math in A New Context: A Reflection on the Budapest Semesters in Mathematics Program

Budapest Semesters in Mathematics is rigorous math-based study abroad program for undergraduate students. Studying mathematics in Hungary allows students to experience mathematics in a new context. Participation in this program allows students to gain greater mathematical and cultural understanding by interacting with the host culture as well as through the opportunity to both collaborate with like-minded peers and take rigorous courses of study in areas of mathematics not available at their home institution. This is an analysis of the benefits of participating in such a study-abroad program. To illustrate these results, I will reflect on my own experience in the course as well as that of my peers, discussing how the class and overall program structure provided academic challenges and career insight.

Margrethe Jebsen, Claremont McKenna College
see **Aria Chaderjian**

Tiffany Jenkins, California State University, Channel Islands
Haley Pena, California State University, Channel Islands
Macomb County - A Political Swing County : An Epidemiology Approach

The United States experienced a political shift in the most recent election with the Republican Party winning the election, but the Democratic Party winning the popular vote. This occurred because of the swing states, including Michigan, Ohio, and Iowa. One of the counties within Michigan that was predominantly Democratic in 2012, but switched their vote to Republican in 2016 was Macomb County. To analyze these results, we take an epidemiology approach to model movement between the two parties. To describe the results efficiently, we use a system of ODEs to compare the similarities between politics and an infectious disease.

Elisabeth Jones, State University of New York at Geneseo
Eigenvalue Bounds on Regular Graphs

Graphs are frequently used to represent and analyze complex networks found in the world today, and have tangible and substantial applications in fields such as business, production, and medicine. As the number of vertices n in the graph can quickly grow to be quite large and consequently grow in complexity, we turn to the eigenvalues of a graph in order to analyze the graph; patterns in the values and distribution of these eigenvalues reflect patterns in the structure of the graph. The eigenvalue of a graph with the greatest magnitude, known as the graph's dominant eigenvalue λ_1, may reveal significant information such as the graph's density, diameter, connectivity, and number of components–all of which help to understand a complex system. Since it is known that for any k-regular graph $\lambda_1 = k$, we investigate the two possibilities for the second dominant eigenvalue in regular graphs, $\lambda_{\min}$ and λ_2. Specifically, we look at numerically establishing bounds on these eigenvalues for given n and k and get data to better understand the minimum eigenvalue gap $\lambda_1 - \lambda_2$ for regular graphs.

Lana Kazma, California State University, Northridge
An Investigation on Card Shuffling

The purpose of our project is to determine how many shuffles are needed to get a well -shuffled deck and to determine which shuffle is better. In this project we have studied three kinds of shuffles (The Top-to-Random Shuffle, The Riffle Shuffle, and the Thorp Shuffle). We have defined the three shuffles and we stated some examples using different numbers of cards and different numbers of shuffles to see how the result is affected. Also, we have defined the Markov Chain, Transition Probability, and Transition Matrix. We gave examples about the transition matrix and then we gave more explanation about the transition matrix. For larger deck size, we made many simulations using R program and we used one of the statistical tests which is the Chi-square test. Two Hypotheses are used for this experiment: The null Hypothesis H_0 (the deck is well-shuffled) and The Alternative Hypothesis H_a (the deck is not well shuffled). If the null hypothesis is true then the proportion of p-values < 0.05. Our result shows that it takes less shuffles for a deck of the same size to be well-shuffled using Riffle Shuffle versus the Thorp Shuffle.

Emily Kelting, University of Central Oklahoma
Determining Factors for Elderly Independent Living

We discuss the factors that affect the fitness of independent living for members of a retirement home. Due to the severity of cognitive degradation in the elderly, understanding the factors that impact cognitive ability is key to deciding if a person requires assisted living. Taking into account a lifestyle questionnaire for the elderly and the BCAT (Brief Cognitive Assessment Tool), we build a multiple regression model of the correlation between lifestyle variables and cognitive ability. We present our model and the results, with the long-term goal of solely using the questionnaire to determine whether or not a person is fit to live alone.

Grace Kelting, University of Central Oklahoma
Mathematical Models of the Mammalian Circadian Oscillator and Alcohol Dependency

Circadian rhythms are the body's internal clocks that control brain wave activity, energy production, and other biological activities. When the body is subject to acute or chronic alcohol consumption, the regular circadian rhythm is disrupted and this disturbance affects mood regulation, sleep cycles, blood pressure, and other biological rhythms. This research presents a mathematical model to study the relationship between alcohol dependency and the mammalian circadian oscillator. We build and analyze a differential equations model to show how alcohol dependency disrupts circadian rhythms. We also compare our results to published data and suggest target genes for helping people with alcohol dependency recover their natural circadian rhythm.

Brielle Kwarta, Houghton College
Optimal Growth Allocation in Sarracenia purpurea in Varying Environments

Sarracenia purpurea, also known as the Northern Pitcher plant, is a perennial carnivorous plant found in nutrient poor bogs in the Eastern part of the United States, the Great Lakes region, and most of Canada. S. purpurea has modified pitcher-shaped leaves which collect prey and rainwater for nutrient consumption, with nitrogen being the most important nutrient, and rainwater being the primary means of obtaining it. These modified leaves are photosynthetically less efficient than other leaf structures (phyllodia) that are produced by the plant. S. purpurea is phenotypically plastic, and so the plant can allocate growth between carnivorous and non-carnivorous structures depending on environmental nitrogen conditions. Previous research has shown that an increase in phyllodia production is a direct and rapid response to nitrogen availability. Using optimal control theory, we created a model to show optimal growth allocation of S. purpurea in such a way that plant morphology represents a prediction of atmospheric nitrogen levels. Our model predicted a difference in carnivorous to non-carnivorous biomass ratios given different nitrogen uptake rates.

Kaitlyn Lee, Northern Arizona University
A Complex Version of the Scarpis Hadmard Construction

Hadamard matrices have many applications and play important roles in signal processing, coding theory and cryptography. Sylvester, Scarpis, Paley and Williamson described methods for building Hadamard matrices of specific orders. Our work has focused on modifying these known techniques to construct complex versions of Hadamard matrices.

Laura LeGare, Concordia College
The Calculus of Proportional α-Derivatives

We introduce a new proportional α-derivative with parameter $\alpha \in [0, 1]$, explore its calculus properties, and give several examples of our results. In the first section, we provide an introduction to our proportional α-derivative and some of its basic calculus properties. We next investigate the system of α-lines which make up our curved yet Euclidean geometry, as well as address traditional calculus concepts such as Rolle's Theorem and the Mean Value Theorem in terms of our α-derivative. We also introduce a new α-integral to be paired with our α-derivative, which leads to proofs of the Fundamental Theorem of Calculus Parts I and II, as applied to our formulas. Finally, we provide instructions on how to locate α-maximum and α-minimum values as they are related to our type of Euclidean geometry, including an increasing and decreasing test, concavity test, and first and second α-derivative tests.

Linxin Liu, Saint Mary's College of California
Ranking System for Multiplayer Contest

Sports are one of Americans' favorite topics. Fans want to know whether team A is better than team B. Many ranking systems, such as Jeff Sagarin's rating system, are developed to determine and predict which teams are the best. They are quite helpful for determining teams' behavior in head-to-head contests such as NBA, NCAA Basketball, college football, and World Cup, but it is not clear how head-to-head ranking methods apply in multiplayer contests. This summer, I discovered that a ranking system which was initially developed for rating consumer products could be applied to rank teams in multiplayer contests with a few changes. My new ranking methods for multi-player contests are based on the general ideas of the Star Rating Method.

Xuan Liu, University of Minnesota
A Uniform Approach to Soliton Cellular Automata Using Rigged Configurations

A soliton cellular automaton (SCA) is a dynamical system on a one-dimensional lattice that evolves according to a particular deterministic rule. The key property is the existence of solitons: stable clusters that move proportional to their sizes and their sizes do not change after interaction or scattering. One of the application of solitons and SCA is to model the Korteweg–de Vries equation: a non-linear partial differential equation showing how shallow water waves move and interact in a thin channel. Rigged configurations arose from statistical mechanics and are connected with tensor products of Kirillov–Reshetikhin (KR) crystals through a (conjectural) crystal isomorphism Φ. The isomorphism Φ can be considered as a linearization of the SCA dynamics. In our research, we give a uniform description and proofs of SCA of the solitons, the scattering rule of two solitons, and the phase shift using rigged configurations in a number of special cases.

Llasmin Lopez, California State University, San Bernardino
Stochastic Differential Equation Models of Ascaris (Roundworm) Infection

Ascaris lumbricoidesis is a parasite infects 0.8-1.2 billion people globally. Its greatest impact is on children in developing countries. We developed mathematical models of how Ascaris is transmitted through populations, with the goal of improving the ability of epidemiologists to predict the spread of this neglected tropical disease. First, we developed a differential equation model that describes how Ascaris is transmitted between people. We extended this model to include pigs, which are an important reservoir species for Ascaris. We further extended our models to structure the infected human population by worm burden, because this determines the severity of symptoms and the probability of transmitting worms to others. We developed stochastic differential equation versions of our models that included both demographic and environmental stochasticity. We numerically simulated many realizations of these equations to approximate the dynamics of the means, variances, and probability distributions associated with each disease class. Our results showed that including pig populations and worm burden structure had important impacts on model dynamics, particularly in terms of the duration and severity of outbreaks.

Jiayin Lu, University of Illinois at Urbana-Champaign
Extensions of the Nash-Shapley model for three-player poker games

In 1938 John von Neumann proposed his now famous mathematical model of poker. Over the years, other poker models have been proposed and studied by mathematicians (Borel, Bellman, Blackwell), economists (Kuhn, McAdams), and even professional poker players (Chris Ferguson). However, all of these models focus on the two-player case. It was not until 1950 that the first three-player poker model was proposed by John Nash and Lloyd Shapley, who derived optimal probabilistic strategies for each of the players. Their model remains one of the only mathematical poker models involving more than two players. The Nash-Shapley model assumes there are only two kinds of cards, high and low. At the beginning of the game, each player is dealt a card, chosen at random from the two kinds. The game then proceeds for up to five rounds of betting or passing actions. Nash and Shapley derived optimal betting probabilities for each player and each round of this game. In our research we investigate extensions and variations of the Nash-Shapley model.

Qingyi Lu, Hobart and William Smith Colleges
An Analysis of Statistical Binning

Statistical binning is a technique for species tree reconstruction, which appears in a Science article, but the precise reason why this algorithm works remains unknown. For our research, first we tested the low and high levels of incomplete lineage sorting (ILS) and verified experimentally that this strategy can reduce gene tree estimation error. However, this method can not provide a good classification of which gene trees to bin together based on rules in the paper. To improve the strategy, we used the Booster, which is a new bootstrap computation along with topological constrains, instead of the traditional one. By using this bootstrap computation and the topological constraint we can improve the binning classification in both lower and higher level of ILS data sets.

Genevieve Maalouf, Hofstra University
Infinitely Many Stable Marriages

The Gale-Shapely Algorithm was produced in order to solve the Stable-Marriage problem in the finite case. We analyze the algorithm when the input is infinite and exhibit the conditions needed to guarantee a semi-stable pairing. We then analyze the run time of the algorithm when the men's preference type is in type $\omega + 1$ and conjecture that the supremum of the run times is ω_1.

Anna Marek, Coe College
Laura Schlesinger, Coe College
A Connection Between Quadratic Rational Maps and Linear Fractional Maps

Let φ be a quadratic rational map with real coefficients where φ maps the unit disk to itself. For each such φ, there is a corresponding linear fractional map ζ, found using the coefficients of φ. This ζ can be used to find the kernel of the adjoint composition operator C_φ^*, defined on the Hardy space. In our research, we find all possible forms of ζ to help us investigate the conditions necessary to ensure that φ maps the unit disk to itself. Finally, for a specific φ we search for the kernel of its corresponding composition operator by calculating the matrices of C_φ and of the Toeplitz operator defined by projecting $\frac{-z\zeta\prime(z)}{\zeta(z)}f(z)$ onto the Hardy space.

Meraiah Martinez, Benedictine College
Cara Nix, University of Minnesota
Improving Automated Methods for Cell Identification in Calcium Images

New optical imaging technologies have the potential to revolutionize neuroscience, but are hindered by inaccurate automated cell identification. We are comparing results from current automated cell-sorting methods to careful human judgment. We are investigating the current algorithms which use singular value decomposition and non-negative matrix factorization. We are calculating single pixel statistics which are aiding our efforts to improve the automated methods in identifying neurons. We are exploring the correlations within the background noise of multiple neurons to augment our ability to identify, and then remove, the unnecessary background noise.

Mackenzie Maschka, Nebraska Wesleyan University
Kirkman Packing Designs

A Kirkman Packing Design $KPD(v, n)$ is a collection of n partitions of the set $\{1, \ldots, v\}$ satisfying the condition that any pair of ground elements appear together in at most one block. In this poster we will discuss an upper bound n_{max} on the number of partitions for a given number of elements, along with discussing hill-climbing algorithms we developed to construct a $KPD(v, n)$ for any v and any $n \leq n_{max}$. We will particularly focus on the $KPD(19, 8)$ since 19 is the smallest v for which it is unknown if a design on $n_{max} = 8$ partitions exists.

Monica McGrath, Saint Mary's College
A Fast-Slow Dynamical System Model of Addiction: Predicting Relapse Frequency

Substance use disorders are prevalent and endemic in modern society. A patient of a substance use disorder is likely to have periodic relapses and periods of recovery. We propose a fast-slow dynamical system model which relates the levels of addictive substance to the levels of dopamine in the patient's brain. High levels of dopamine (DA) are responsible for the rewarding effects of using drugs of abuse (DOA). A patient is likely to seek recovery, which is a slow process, but increases in DA lead the patient to recall the rewarding effects of using a DOA. This leads to a very fast relapse, which is characterized by a spike in DOA levels in the brain. Then, the body's liver works to remove the DOA from the system, which is a relatively slow process. Once the DOA is completely removed, the patient has re-entered the recovery phase, and the cycle repeats. We use our model to predict the DA level which triggers a relapse, called the relapse threshold. We also use the fast-slow dynamics (geometric singular perturbation theory) of the system to predict the period of the cycle, which can be interpreted as relapse frequency. Both predictions can indicate when a patient is at risk of relapsing.

Grace McMonagle, Grand Valley State University
The Embeddability of Partial Latin Squares in the Cayley Tables of Dihedral Groups

Latin squares are $n \times n$ matrices with n symbols where each symbol appears exactly once in each row and column. Partial latin squares (PLS) are latin squares that have only some entries filled in; the number of filled entries is referred to as the size. Motivated by results of Wanless and Webb, we are examining an extremal question related to the embeddability of PLS in the Cayley tables of dihedral groups. We will present results on the maximum size of PLS such that each PLS of that size can be embedded in the Cayley table of a given dihedral group.

Victoria Meza, California State University, Fullerton
see **Dana Casabella**

Anna Miller, Seattle University
Taxicab Geometry

What happens when we change how we think about distance? We explore this question by taking Euclidean geometric ideas and analyzing them in terms of the taxicab metric. We begin by introducing taxicab geometry and the new way of measuring distance. Next, we discuss all of the familiar conic sections in terms of distance formulas and compare them to the ones found by slicing cones. Finally, we delve into an exploration of Apollonian sets.

Bridget Minellono, Washburn University
Creating Algorithms to Test Various Expectations Involving Quantitative Modifiable Randomizers (MR)

My focus is calculating expectations regarding conflicts using quantified Modifiable Randomizers (MR). Working within a setting in which we compare the outputs of two or more quantified MR, I developed algorithms, simulations and models that carry out a variety of these dynamics–giving access to empirical data regarding their behavior. A great deal of emphasis is placed on streamlining strategies and comparing fixed strategies with adaptive strategies. Additionally, I present recursive programs that I created to calculate the exact expectations (the probability of any one side 'winning') of outcomes of conflicts in these settings.

Cailin Monroe, University of Montevallo
Ramsey Numbers

Ramsey Theory is a branch of Graph Theory developed in the early 20th century by Frank Plumpton Ramsey. In general, Ramsey Theory asks what minimum number of vertices is required to guarantee that a certain type of subgraph will be present in a graph or it?s complement. My paper addresses a number of theorems that enable us to calculate specific Ramsey numbers, as well as analyzing why Ramsey numbers of higher values are exceedingly difficult to determine.

Bridget Mueller-Brennan, University of Illinois at Urbana-Champaign
A Passive Acoustic Analysis of the Temporal and Spatial Distribution of Madagascar's Omura's Whales

We consider the acoustic behavior of *Balaenoptera omurai*, a species first described in 2003. The first live sighting and in-situ study of a population of these whales began off the coast of Madagascar in 2013. *B. omurai* song is a stereotyped broadband pattern with an average duration of 9 sec and repetition rate of 3 min. This consistency allows the use of passive acoustic monitoring. The goal of this study is to use acoustic data to determine the temporal and spatial distribution of *B. omurai* in the Nosy Be region of Madagascar. Passive acoustic monitoring devices were placed at 4 sites based on previous acoustic and visual data to record from Dec 2015 to Nov 2016. These data were analyzed using a spectrographic display and an automated detector was developed and run over the data from all 4 sites. The detector's performance was verified manually. Our results suggest that *B. omurai* demonstrate distinct variation in habitat utilization but are present and singing in the area all year, indicating that they have no distinct seasonality and are non-migratory. This population of *B. omurai* appears to be resident to Nosy Be, so protecting this region is vital to the conservation of the only studied population of this newly discovered whale. Whales are an important part of the ecosystem, so understanding their ecology and protecting them is key to keeping our oceans healthy.

Sara Myers, University of Scranton
Orthogonality from Group Characters

We explore non-standard orthogonalities arising from the character table of a finite commutative group. These orthogonalities are used in algebraic coding theory to replace the standard Euclidean orthogonality and have a corresponding MacWilliams relations for them. We establish that for a finite commutative group G and any subgroups H and K of G with $|H||K| = |G|$ that there exists an orthogonality with $H^{\perp} = K$. Additionally, we give families of orthogonalities that apply to any finite commutative group. Finally, we give numerous examples of orthogonalities for specific groups.

Christina Nguyen, Northeastern University
Cauchy Problem for the Spherically Symmetric Vlasov-Poisson Equation

Plasma can be found pretty much anywhere, from man-made sources such as fluorescent lights and neon signs to natural phenomena such as lightning bolts and the stars. We will focus on the kinetic theory of plasma; it models the behavior of the particles in the plasma over time through an averaging function. The Vlasov-Poisson equations are a system of non-linear partial differential equations which describe the time evolution of a collision-less ensemble of particles within a force field. These equations could describe a self-gravitating system of stars changing over time or on the smaller scale, the evolution of cosmic dust clouds. We will use a this force, the radially symmetric gravitational force, and apply it to a distribution of particles. We will focus on global existence of solutions to the Vlasov-Poisson system with spherical initial data which has been established by J. Batt for a gravitational force in 1977 and for an electromagnetic force by S. Wollman in 1980. We will specialize their results to the case of a spherically symmetric distribution and seek out a solution to the initial value problem for this system.

Cara Nix, University of Minnesota
see **Meraiah Martinez**

Illyssa Overton, University of Montevallo
The Cantor Set

The Cantor Set denoted C is a set of points lying on the closed interval $[0, 1] \subset \mathbb{R}$ constructed by removing the middle thirds of the line segments generated in each step C_n. We will explore its many characteristics – closed, compact, measure 0, perfect, and uncountable, to name a few. We will prove that C has these properties, then compare the properties of a few similar sets to C. Our study is based in topology with elements of measure theory and set theory.

Faith Pearson, University of Utah
Super Edge-Magic Total Labelings

Graph labeling is an important topic in the discipline of graph theory. This expository project is an exploration of super edge-magic total labelings. This project involves a description of some fundamental graph theory concepts, examples of super edge-magic graphs, and other necessary information to approach the conjecture that all trees are super edge-magic.

Haley Pena, California State University, Channel Islands
see **Tiffany Jenkins**

Andira Putri, Georgia State University
Modeling Sporulation Through the Environmentally Regulated Genetic Network in B. Subtilis

Biofilms are colonies of microbial organisms held together by a polymeric extracellular matrix on surfaces. Biofilms are prevalent in natural, industrial, and health settings. Much of the molecular mechanisms for biofilm formation is still unclear, in particular how cells switch their phenotypic behavior within a biofilm. To gain an understanding of phenotypic switch in biofilm, we focus on sporulation in Bacillus subtilis. Empirical evidence shows that Spo0A is the master protein determining cell phenotype: High concentrations of phosphorylated-Spo0A (Spo0A$\sim$P) trigger sporulation while low levels lead to extracellular matrix production. We constructed a genetic network that integrates both nutrient-regulated and quorum-sensing pathways in B. subtilis. We used a system of coupled ordinary differential equations to study the genetic network in response to nutrient availability and surrounding cell density. Dynamical systems analysis of these equations reveal that both starvation and overcrowding can raise Spo0A$\sim$P levels and trigger sporulation. This simple model of the Bacillus subtilis genetic network is the first step in understanding the growth mechanisms of biofilms under varying environmental conditions.

Arsah Rahman, George Mason University
Observing the Behavior of Quasiperiodic Orbits

Quasiperiodicity is one of the three types of observed dynamical behaviors alongside chaos and periodicity and has large applications in Hamiltonian systems, one example being the Solar System, which contains quasiperiodic orbits, that is, orbits that are almost but not periodic. Not only is it used in studying planetary motion, but researchers at NASA have sought this behavior to be a possible fuel-efficient path for a spacecraft to travel further distances. Coding an algorithm based on the work of Das, Saiki, Sander, and Yorke and of Levnajic and Mezic, we observed the dynamics of the two dimensional standard map, that is, how the map's appearance is influenced by different values of the parameter being greater than or equal to zero in the system of equations used in obtaining the map, and also by varying the number of initial conditions and trajectory points, for an understanding of the behavior of quasiperiodic orbits. In addition, we are currently extending the techniques used for obtaining and understanding the standard map to study the four dimensional Froeschle map, and looking at new parameters, which we intend to apply to other equations that have not been studied yet.

Kayla Roberts, California State University, Channel Islands
see **Maria Contreras**

Carmin Robson, Coe College
Majority Judgment as an Alternative American Voting System

In the aftermath of the 2016 election, many of the deficiencies in the American voting system have to come to light. While most mathematicians are in agreement that plurality voting, our current system, is the least likely to meet voters' needs, they're unable to back a single alternative voting method. Currently, majority judgment has the most integrity of proposed alternative voting methods, but the data behind it doesn't have political roots. Using the Pew Research Center's 2014 Political Typology data-set, we simulated potential outcomes for the 2016 election to see if a majority judgment voting system could more accurately reflect the desires of American voters.

Laura Schlesinger, Coe College
see **Anna Marek**

Toluwani Soares, Stephen F. Austin State University
An Optical Mineralogy Inquiry

The challenge of accurately identifying a mineral is one made simpler by the science of mineralogy as known chemical properties take shape in physical form. In optical mineralogy, the search narrows as optical properties can point to a more definitive conclusion. Still, ambiguity persists. This study involved over 60 thin sections of rock samples obtained from a variety of formations in Texas; the origins of the samples were mostly unknown. The thin sections (unlabeled as to avoid bias) were analyzed using petrographic microscopes and described by their observed optical properties including: pleochrism, extinction, relief, birefringence, interference color and optic sign. Using canonical correlation, the relative reliability of optic properties was assessed. To that end, I hope to conclude which properties can be more heavily leaned on (singly or in conjunction) by noting the optics that most strongly correlated to the standard identifying techniques used to classify a mineral.

Jean Springsteen, Coe College
Minimal Fault-Free Tilings on Packed Rectangular Boards with Uniform Rectangular Blocks

Tiling problems seek a way to cover a region using a set of tiles. These problems have applications in art, nature, architecture, and other fields. A special kind of tiling is a fault-free tiling, which is a tiling that does not have a line that runs from one end of the region to the other without interruption from a tile. This research focused on finding the minimal (by area) fault-free tiling for rectangular boards packed with uniform rectangular blocks. By studying how the dimensions of the board can be written as linear combinations of the blocks, patterns arise for determining which dimensions could be fault-free tiled.

Lauren Stanislaw, Scripps College
Integrated Metabolic Regulatory Model (IMRM): Using Statistics and Optimization to Model Bacteria

To determine whether a gene is active or inactive, we fit its expression levels under different conditions to a bimodal Normal mixture model in which one mode is active and the other is inactive. Then, by finding the maximum biomass of a linear model in which reaction rates are our variables, we can predict which reactions are occurring in a cell, and the rates at which they are occurring.

Margaret Steiner, The George Washington University
A Comparison of Statistical Methods for Identifying Rare Genetic Variant Associations in Trio Data

Genome wide association studies have identified common single nucleotide polymorphisms (SNPs) associated with several birth defects. However, these common variants account for only a small fraction of disease heritability. Recent evidence suggests that rare genetic variants may contribute to this "missing heritability." Yet, traditional statistical methods are underpowered to identify associated rare variants due to extremely low allele frequencies. The research presented is a part of a larger study with aims of (1) developing a novel Bayesian stochastic search variable selection method for the joint analysis of common and rare variants in trios and (2) comparing the performance of this method to existing collapsing tests using both simulated data and real genetic data. Under Aim 2, the presenter reviewed recent literature to find methods suitable for comparison to the new method and used these methods to analyze simulated data. The selected methods were implemented in R code for 50 simulated data sets, each containing data for 1500 trios over a 250 kbp region. Beyond the current study, future statistical modeling may involve additional factors such as environmental effects, gene-environment interactions, and maternal genetic effects.

Shelby Stowe, Sterling College
Modeling vaccination strategies to control white-nose syndrome in little brown bat colonies

Since 2006, the North American bat population has been in rapid decline due to white-nose syndrome (WNS), which is caused by an invasive fungus (Pseudogymnoascus destructans). The little brown bat (Myotis lucifugus) is the species most affected by this emerging disease. We consider how best to prevent local extinctions of this species using mathematical models. In 2017, development began on a new vaccine for WNS; we analyze the effects of implementing vaccination as a control measure. We create a Susceptible-Exposed-Infectious-Vaccinated hybrid ordinary differential equation and difference equation model informed by the phenology of little brown bats. We compare the effectiveness of annual, biennial, and one-time vaccination programs for multiple durations of immunity length. We also determine the optimal time to vaccinate, if vaccinating only once, as a function of average duration of immunity. Next, we perform a sensitivity analysis to determine the robustness of our results. Finally, we consider other possible control measures together with vaccination to determine the optimal control strategy. We find that if the vaccine offers lifelong immunity, then it will be the most effective control measure considered thus far.

Sarah Strikwerda, Calvin College
see **Amanda Cowell**

Tyler Sullivan, Coastal Carolina University
see **Dominique Forbes**

Hannah Tolson, Gonzaga University
Pentagon to square: the most efficient way to transform one polygon to another

The premise of this research is tracking the fewest number of ways a polygon (in our case, the pentagon), can be cut, rotated, and rearranged to yield a square product. It has previously been proving that a pentagon can be cut 6 ways to yield a square. My research is aimed towards proving that this can, or cannot, be done in 5 ways.

Madison Tung, United States Air Force Academy
A Method for Processing Very Large Data Sets

In this poster we will examine the mathematical techniques involved with my research in neural networks. Specifically, I will demonstrate a technique of iteratively adjusting the decision boundary to eliminate classification error of data in very large data sets. The goal is to model the processes of the human brain and increase data processing power exponentially in order to make useful classifications of large data sets.

Courtney van der Linden, California State University, Northridge
A Tree Of T-Structures On Elliptic Fibrations

Mirror symmetry in physics has driven a great deal of new mathematics in recent years, especially in the field of algebraic geometry. In particular, there are many physical computations on black holes and strings that do not yet have algebro-geometric formulations. In many of these computations, it is crucial to understand the stability of the objects involved; t-structures in algebraic geometry give a crude, first-order approximation of stability. Three-dimensional complex Calabi-Yau manifolds correspond to a string-theoretic model for the physical world in which we live. In this project, we will study a hierarchy of t-structures on Calabi-Yau manifolds that admit the structure of an elliptic fibration. So far we have studied the t-structures corresponding to 0-dimensional and 1-dimensional objects.

Karlee Westrem, University of North Dakota
Winning Stategy for Dice Game Farkle

Analyzing the dice game, Farkle and develop a winning strategy based on expected value and probability. In the game, a player during their turn have the option to stop rolling and earn their current accumulated points, or continue rolling to possibly accumulate additional points with the risk of possibly losing it all. I will show how the playing strategies vary depending on the number of the dice involved.

Melissa Wong, California State University, Fullerton
Concert Tour Optimization: Minimizing the Cost Function

Minimizing cost is a significant objective for any industry that aims to optimize their resources and the efficiency of their operation. Concert tour optimization consider restrictions in travel distance, travel cost, and venue availability. The scheduling of band concert tours is an elaborate task that often results in some loss in the cost function. Researchers have implemented heuristic algorithms to develop optimal band concert schedules that minimize the cost function. Our study simulates a band traveling to and performing in each city once, assessing the importance of each our constraints. We adapt Nghiem's method for scheduling band concert tours to expand and implement an approach that will consider all objectives and violations without compromising the cost function. Since an initial solution was often obtained using a relaxed approach, we attempt to minimize the function with an absolute approach to construct an initial tour. We compare the results of both methods and examine which approach generates an initial solution that minimizes the cost function.

Mikaela Wyatt, Grand Valley State University
see **Ellen Grove**

Valerie Yeutter, William Jewell College
A Probabilistic Analysis of the Card Game "Lost Cities"

We used standard tools of combinatorics and Markov chains to study the card game Lost Cities. Lost Cities, like Monopoly or Risk, is a game with a mixture of chance and strategy that can be modeled via Markov chains and hypergeometric distributions. Applying these tools, we derived formulas assisting in game play strategy by calculating expected wait time for receiving high-scoring cards and by calculating probabilities of accruing certain amounts of points that dictate loss or victory.

Alexandra Yuhas, Berea College
Combinatorial Game Theory: A Game of Aggression

Aggression, a combinatorial game, was created by mathematician Eric Solomon in 1973 to study combinatorial strategies. During my research, I studied a specific problem. In a game of aggression, on an atoll of size n, is there a guaranteed winning strategy? If so, can we determine what that strategy is? To study this, we used combinatorial strategies to create bounds that begin to solve this problem. We made great strides in solving this problem, however this problem is still not quite solved, and we believe our research paves the way for further study.

Renjun Zhu, University of California, Berkeley
Generalized Rainbow Configurations

Given a coloring of a set, classical Ramsey theory looks for various configurations within a color class. Rainbow configurations, also called anti-Ramsey configurations, are configurations that occur across distinct color classes. We present some very general results about the types of colorings that will guarantee various types of rainbow configurations in finite and infinite settings, as well as several illustrative corollaries.