

Advancing Student Participation in Research
Experiences Conference Abstracts 2021

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1 Tipsy Cop and Robber Game on Graphs

Viktoriya Bardenova
Florida Gulf Coast University

”In this project we explore a variation of the cops and robbers game, first introduced independently by Quilliot [1], and Nowakowski and Winkler [3]. In the original game, a cop and a robber alternate turns moving from vertex to adjacent vertex on a connected graph with the cop trying to catch the robber and the robber trying to evade the cop. In our variant we assume that the cop and robber are tipsy, meaning that a proportion of both their moves are random, and rather than forcing the players to alternate moves, we use a spinner wheel to determine whether the next move will be a sober cop move, a sober robber move, or a tipsy move by either player. We model this scenario on vertex-transitive and non-vertex transitive graphs using the theory of Markov chains. Given a specified set of initial conditions on the players’ distance and tipsiness, we consider the following questions: What is the probability that the game lasts at least M rounds if the players start distance d away? What is the expected number of rounds the game should last if the players start distance d away?

One inspiration for this game is to model the biological scenario illustrated in the [YouTube video](#) [2], where a neutrophil chases a bacteria cell moving in random directions. While the bacteria’s movement seems mostly random, the neutrophil appears slightly more purposeful.”

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2 Tippy Cops and Robbers: The Modeling of Pursuit Scenarios on Various Graphs

Peter Phan
Florida Gulf Coast University

”With the guidance of FGCU professor, Erik Insko and fellow students Viktoriya Bardenova and Vincent Ciarcia, a variation of the cops and robbers game on graphs based on the models they constructed in Spring 2020 was built.

In the game of cops and robbers, players move independently from vertices along edges in various connected graphs; the cop pursuing and the robber fleeing. The cop wins if they catch the robber and the robber wins if they can avoid the cop forever or if they can get a certain distance away from the cop. A random movement chance, flavored as tipsiness, is included for both players, limiting their ability to execute winning strategies. In this iteration, both players move simultaneously in rounds and are not aware of the move the other player will make.

Markov chain and transition matrices were used to model these games. A markov chain is a model that describes a sequence of all possible changes to a system based on the previous state of that system and are excellent for presenting conditions with discrete states. Transition matrices allow us to analyze the probability of end states.

Cycle graphs, the Petersen graph, a friendship graph, and an infinite tree of variable size have been modeled. Further variation in tipsiness and introduction of obstacles are being analyzed for interesting results and/or emergent patterns.

These models have applications to real world scenarios such as how a white blood cell tracks down and eliminates bacteria in an organism.”

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3 Estimating Kurdish Population in Turkey: population modeling with regression and leslie matrices

Zevi Altus
Stetson University

”Kurds are a major ethnic group in Turkey, comprising somewhere between 10% and 35% of the country’s population. Estimates vary wildly as there is no official data – Turkey has not recorded Kurdish population in a census since 1965. Issues of human rights, sectarian violence, and geopolitics revolve around this population, so estimating accurately is important for policymakers and activists.

This project uses several mathematical approaches to model Kurdish population change in Turkey over the past 30 years. Population data are analyzed using growth functions, regression analysis, and Leslie matrices. Finally, this paper estimates current and near-future population of Kurds in Turkey and evaluates the mathematical techniques and their utility in demography. Initial results indicate a Kurdish growth rate that is decreasing but still higher than for the rest of Turkey and a Kurdish population that is roughly the same proportion of Turkey’s population as in past decades.”

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4 The Statistics of the Oscars: What type of nominee will win?

Jacqueline Carlton
Florida Southern College

The trends and correlations in the Academy Awards have been in the public eye for years. These trends may lead to the ability to eventually predict winners out of a group of nominees in each category, if we can identify enough trends. This study will analyze the Oscars, and identify the type of nominee that is most likely to win in each category. This study strives to understand trends in the Oscars, and find correlations between a winning entity and different variables (examples include genre, gender, number of previous nominations, etc). The study will be using statistical methods such as ANOVA analysis, and logistic regression along with other statistical tests to calculate the trends that will be the most effective in predicting the winners in each category. Its goal is to explain the different factors that go into an Oscar nominee becoming an Oscar winner, and be able to predict those winners given information about the nominees.

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5 An Introduction to Parking Functions

Kimberly Hadaway
Williams College

In 1966, Alan G. Konheim and Benjamin Weiss defined “parking functions” as follows: We have a one-way, one-lane street with n parking spaces, numbered in consecutive order from 1 to n , and we have n cars in line waiting to park. Each driver has a favorite (not necessarily distinct) parking spot, which we call its *preference*. We order these preferences in a *preference vector*. As each car parks, it drives to its preferred spot. If that spot is open, the car parks there; if not, it parks in the next available spot. If a preference vector allows all cars to park, we call it a *parking function*. In 1974, Henry O. Pollak proved the total number of parking functions of length n , meaning there are n parking spots and n cars, to be $(n + 1)^{n-1}$. In this presentation, we describe a recursive formula, expound Pollak’s succinct six-sentence proof of an explicit formula, and conclude with a discussion of other parking function generalizations.

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6 Discrete Fourier Transform and Tiling \mathbb{Z}_M

Lauren LaRue
Flagler College

Tiling has a long history in geometry and the architectural art. An example of such is that of the tiling in Islamic architecture. One can study tiling arithmetically as well. For example, one can visualize any consecutive subsets of the integers \mathbb{Z} as connected blocks that can cover all of \mathbb{Z} by simply sliding or translating the connected blocks. Let d be a positive integer and Ω a subset of \mathbb{R}^d , where \mathbb{R} is the set of real numbers. Ω is called spectral if there exists another subset Λ of \mathbb{R}^d such that the set $\{\exp(2\pi\lambda \cdot x)\}$, $\lambda \in \Lambda$, forms an orthonormal basis for $L^2(\Omega)$. Bent Fuglede conjectured in 1974 that Ω is spectral if and only if it tiles \mathbb{R}^d by translation. Denote Φ to be the $N \times N$ discrete Fourier transform and suppose m is a divisor of N . We present a method to find an $m \times m$ submatrix Γ of Φ such that the rows of Γ form an orthonormal basis for \mathbb{R}^m . Moreover, we show that the set of m row indices of Γ tiles \mathbb{Z}_N , thus providing a new approach to Fuglede's conjecture. We aim to prove the one-dimensional Fuglede's conjecture for all square-free positive integers N by showing that any spectral set also tiles \mathbb{R} .

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7 Predicting Math Anxiety in Preservice Teachers by Looking at Key Predictors

Annaliese Bradford
Florida Southern College

The negative effects of math anxiety are an issue that the educational system continues to experience. Math anxiety can have a major impact on student achievement, but the effect it can have on teachers can be disastrous. Therefore, it is vital that teachers be assessed to see if they have or may develop math anxiety as early as their preservice years. This presentation discusses three predictors that, if found present in preservice teachers, is an indicator of math anxiety. The method for gathering this information is based on extensive research and information from peer reviewed articles. The three predictors are past negative experiences in the math classroom, specific learning styles, and particular Myers Briggs personality types. Previously, these predictors have all been assessed individually through established test/questionnaires. I propose that these three established predictors are all interconnected, and that there may be a better method of predicting a preservice teacher's math anxiety by creating one assessment tool that assesses each predictor collectively.

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8 On the Difference of Two Numbers Raised to the Same Power

Nathan Hallmark
Florida Southern College

In this talk, I will present two formulas I discovered for the difference of two numbers raised to the same power. The two base numbers are given the constraint of only having a difference of 1, which leads to the expressions that are the main theme of my work. The resulting formulas from this one constraint can be applied to a multitude of number theory problems, including the sum of three cubes, congrua, and Pythagorean triples. The purpose of this presentation is to highlight some of the pure mathematics I have had to learn in order to prove my formulas, and highlight how far down the rabbit hole one can dive when given an interesting topic.

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