Student Talk Abstracts

Madeleine Burkhart, Skidmore College
Jonathan Doane, SUNY Potsdam
Cristopher Negron, SUNY Potsdam
Andrew Castillo, Texas A&M
Instrinsically Spherical Linked Graphs

Abstract: A *spherical n-link* is a disjoint collection of $(n-m)$ 1-spheres and m 0-spheres, embedded into S^2. We say a spherical n-link, ℓ, is *split* if there exists an S^1 embedded in $S^2 - \ell$ that bounds only part of ℓ. We say that a spherical embedding of a graph, G, is *linked* if it contains a non-split link of one S^1 and one S^0. We begin with a characterization of intrinsically spherical linked graphs; that is, planar graphs that have every spherical embedding being linked. In fact, we have found the complete set of minor minimal intrinsically spherical linked graphs, which consists of $K_4 \dot{\bigcup} \{v\}, K_{3,2} \dot{\bigcup} \{v\}$, and $K_{3,1,1}$. In addition, we also exhibit several families of graphs that are minor minimal intrinsically spherical n-linked, for $n \geq 2$.

Kristen N. Bales, East Tennessee State University
Zachary D. Eager, Rochester Institute of Technology
Anthony A. Harkin, Rochester Institute of Technology
Efficiency Modularity for Finding Communities and Anticommunities in Networks

Abstract: The increasing availability of large-scale data sets in the last decade has produced a tremendous amount of interest and progress in the field of network science. A community in a network is a group of nodes more tightly connected to each other than with nodes outside the group. Detecting community structure within networks is important in a variety of real-world settings, including social networks, metabolic networks, computer networks, and more. The modularity quality function commonly employed for finding community structure in complex networks is generalized in this work to a one-parameter family of quality functions. The generalization of network modularity discussed in this talk is based on the concept of graph efficiency, a metric first proposed by Latora and Marchiori. We define the *efficiency modularity* of a partition and demonstrate that it can be used to find either community or anticommunity structure within a network.

Megan Brunner, SUNY Geneseo
Continuity Properties of the Modulus Function of Walk Families

Abstract: The modulus of a family of walks on a weighted undirected graph provides a quantitative assessment of the "richness" of the family. The modulus is computed by minimizing an energy function over a set of admissible metrics on the graph. In certain special cases, the modulus has been shown to generalize the concepts of shortest path, minimum cut, and effective resistance. We will explore continuity properties of the modulus and the associated extremal graph metrics. This talk will be understandable for an undergraduate with a small amount of background knowledge of graph theory.

Ashley Colopy, SUNY Brockport
Separating & Reassembling Circular Inequalities

Abstract: Certain circular inequalities are obtained by summing simpler inequalities. To prove, we find which simple inequality was written repeatedly for many groups of variables which were then assembled together by summation to form the circular inequality.

Amy Hannahan, SUNY Oswego
Programming the Chermak-Delgado Lattice

Abstract: What is the Chermak-Delgado lattice of a finite group? This sublattice of the subgroup lattice is simple enough to define that it could be discussed in an introductory course in group theory ... and yet, it's the focus of active research in group theory. This talk will introduce the Chermak-Delgado lattice and discuss the algorithm I wrote in Sage to compute the Chermak-Delgado lattice for a family of finite groups.

Brianna Lindsay, Elmira College
The Interpolated Medians of Self-Reported Counts of Same-Sex Partners Based On Gender And Age

Abstract: NHANES is the National Health and National Examination Survey, conducted by the National Center for Health Statistic (NCHS). The main focus of this organization is to assess the overall health of the United States. Using NHANES data, we estimate the number of opposite-sex sexual partners based on age and gender and report this as interpolated medians. The formulas to calculate the interpolated medians for weighted data were based on Woodruff (1952), Gross (1980), Maritz and Jarret (1978), and Francisco and Fuller (1991). The interpolated medians fluctuated as each gender aged. Subsamples of ages in each gender were followed through the years for comparison. The same fluctuation occurred in each subsample for both genders.

Julia Martin, SUNY Oswego
Epidemiology of Rabies

Abstract: Rabies is a disease spread to humans primarily from animals, but we don't know much about rabies cases with in animal populations and trends in transition to humans. In this talk I will discuss changes in the bat population due to white nose syndrome and the relationship to the number of rabies tests performed on bats by the New York State Wadsworth Center Rabies Laboratory, as well as the number of positive bat rabies cases identified. I'll also discuss the relationship between the number of rabies tests conducted across all animal species and human population density in New York.

Tamalika Mukherjee, Rochester Institute of Technology
Inverse Limits Applied to Economic Theory

Abstract: Tools from Topology and Dynamical Systems are used to analyze the structural solutions to implicitly defined equations that arise in economic theory. This talk will summarize our study of inverse limits and its connections to economics.

James Myer, SUNY Potsdam
Quantum Walk, State Transfer, and Graph Laplacians

Abstract: A quantum walk on a graph $G = (V, E)$ is given by the unitary matrix $U(t) = e^{-itM}$, where M is a Hermitian matrix whose definition depends on G. We say that G has perfect state transfer (PST) between vertices a and b if for some time $t \in \mathbb{R}_{\geq 0}$, the magnitude of $U(t)_{a,b}$ is 1. The concept of the quantum walk on graphs is important due to its powerful applications to universal quantum computation and information transfer in quantum networks.

We investigate the various flavors of the quantum walk on a graph G when M is of the Laplacian family. Let A and D be the adjacency and diagonal degree matrices of G, respectively. With respect to the standard Laplacian $\mathcal{L} = D - A$, the graph complement operator preserves PST under mild assumptions. As a consequence, we obtain PST on double cones and graph joins. In contrast, this phenomenon does not hold when M is the adjacency matrix. These observations were independently proven by Y. Xu and H. Zhan (personal communication with Chris Godsil).

With respect to the signless Laplacian $\mathcal{L}_+ = D + A$, there exist families of irregular and non-bipartite graphs with PST. However, these families do not necessarily exhibit PST in the quantum walk on the standard Laplacian.

Finally, regarding the normalized Laplacian $\tilde{\mathcal{L}} = I - \tilde{A}$, where $\tilde{A}$ is the normalized adjacency matrix, the weak of product of P_3 (3-vertex path) and either particular complete graphs or hypercubes will admit PST. This result is reliant on the fact that P_3 exhibits PST with respect to the normalized Laplacian (and yet not in the other Laplacian schemes).

This is joint work with R. Alvir, S. Dever, B. Lovitz, and C. Tamon.

Sara Schleissmann, SUNY Oneonta
Certain Properties of Linear Transformations In Regard With Fixed Points

Abstract: Linear transformations form an essential chapter in mathematical studies. In particular, understanding the set of their fixed points brings more light into understanding some of their properties. In this presentation, we look at fixed points from an algebraic as well as a geometric point of view. We also look at fixed points of certain products (compositions) of linear transformations and discuss how translations and rotations, which can be seen as products of reflections, behave with respect to fixed points.

Ryan Vogt, Rochester Institute of Technology
Compressible Reactive Flow and the Godunov Method

Abstract: In fluid mechanics the system of nonlinear partial differential equations known as the Navier-Stokes equations has long been studied both analytically and numerically. Over the past half century the evolution of computers has made it possible to compute solutions of complicated mathematical models. Even so, it is often computationally costly to adequately resolve solutions of large-scale scientific problems, especially in higher spatial dimensions. Assumptions are often made to reduce the Navier-Stokes equations to a simpler system. In the absence of viscosity and diffusion the equations simplify to a set conservation laws, known as the Euler equations of high-speed gas dynamics. The Euler equations give rise to shocks, rarefactions and contact discontinuities. Finite differencing methods are not well-suited for computing such features due to the discontinuities and large gradients. The Godunov method is a conservative method specifically formulated to accurately capture shocks and other discontinuities.

$$\begin{aligned} \text{Conservation Law:} u_t + f(u)_x &= 0 \\ \text{Euler Gas Law:} \rho_t + (\rho v)_x &= 0 \\ (\rho v)_t + (\rho v^2 + P)_x &= 0 \\ (\rho E)_t + (v(\rho E + P))_x &= 0 \end{aligned}$$

In this talk I will discuss conservation laws. The 1-D Burger equation will be used to introduce the Riemann problem and the associated shocks and rarefaction that may arise. The introduction of the 1-D Euler equations and the corresponding Riemann problem will then be considered. The Godunov method will be discussed and numerical solutions of the Euler equations will be shown. We implement a parallel algorithm in the programming language Haskell. Lastly, a comparison of the power of functional programming languages, such as Haskell, for computing solutions of partial differential equations more efficiently, will be made with longstanding languages, such as C and Fortran.

Christina Wahl, SUNY Potsdam
Uniquely Bipancylic Graphs

Abstract: In mathematics, a graph consists of a collection of vertices and a collection of edges. We are surrounded by graphs on a daily basis; from the World Wide Web to the network of friendships we have on campus. A bipartite graph on $2n$ vertices, is said to be uniquely bipancyclic (UBPC) if it contains precisely one cycle of length $2m$ for all $2 \leq m \leq n$. There have been recent results by W. Wallis on UBPC graphs with order at most 30. We will present our extension of Walliss findings based on our research at the University of West Georgia.

Evan Witz, Rochester Institute of Technology
Symmetric Products of Graphs

Abstract: In this paper, we describe several new hyperspace graphs (the simultaneous and non-simultaneous symmetric product graphs, as well as their respective layers), establishing several theorems dealing with their planarity, order, size and classification.