Plenary Speakers Title and Abstracts

Alicia Prieto-Langarica, Youngstown State University and Associate Director of Project NExT

Making undergraduate research work for faculty and students: an examples driven talk
Getting involved in research has become a most for all undergraduate students. In this talk we will address questions such as: Why is this so important to do research? What exactly counts as research in mathematics? How do we make it work best for our students? How do we make it work for our faculty members? This will be an interactive talk and questions and audience participation will not only be welcome but encouraged!

Jose Perea, Northeastern University

The Underlying Topology of Data
Topology, and particularly algebraic topology, seeks to develop computable invariants to quantify the shape of abstract spaces. This talk will be about how such invariants can be used to analyze scientific data sets, in tasks like time series analysis, semi-supervised learning and dimensionality reduction. I will use several examples to illustrate real applications of these ideas.

Invited Speakers Title and Abstracts

David Austin, Grand Valley State University

A project-based mathematics capstone course
Grand Valley recently created a project-based applied math capstone course, which grew out of the MAA's PIC Math program and is now in its fourth year. In this course, students work in teams paired with a community partner on a large-scale semester-long project. Part of this talk aims to share some of the challenges in leading this course as well as some of the many rewards. I'll also describe the broader impact this experience has had on my work with all my students as well as my understanding of the role of mathematics in our society.

Stacy DeRuiter, Calvin University

Assessing beaked whale behavioral response to naval sonar using a hierarchical hidden Markov model
Animal-borne tags provide large, complex datasets on whale behavior; one application is to use tag data to understand how whales respond to naval sonar sounds, which have previously been

associated with stranding events. To glean information from many varying-resolution data-streams and assess behavior at two time-scales, we formulated a hierarchical hidden Markov model (HHMM) to model beaked whale behavioral responses to sonar simultaneously at coarse (foraging-dive-cycle) and fine (5-minute-interval) time scales. In the model, acoustic exposure covariates modulate probability of transition into a "response" state at the coarse scale, with distinct state-dependent distributions during response. Preliminary results from the HHMM fitted to tags deployed on Cuvier's beaked whales identify responses to sonar: longer intervals between feeding dives, shorter echolocation bouts and greater occupancy of the highest- and lowest-activity non-foraging states at the fine time-scale. Areas of ongoing work include incorporation of individual differences in responsiveness and a Bayesian formulation to better incorporate measurement uncertainty.

Julie Gunkelman, MichMATYC President

Fired Up About Academic Integrity
Would you rather spend your time encouraging academic honesty or punishing students who chose to cheat? Honestly, nothing will eliminate all cheating. However, you can significantly reduce it with a multifaceted approach. Strategies used to promote honest work and reduce unsavory student behavior will be shared in this session.

Victor Piercey, Ferris State University

Reflections on an Interdisciplinary Teaching Partnerships
Working with interdisciplinary partners to improve teaching is a rewarding experience and makes for better student learning environments. The SUMMIT-P consortium is an NSF-sponsored collection of 12 institutions where mathematics faculty are working with partner discipline faculty to revise and improve course offerings in the first two years of undergraduate education. Their work is based on research entitled "The Curriculum Foundations" conducted by the MAA Committee on Curriculum Renewal Across the First Two Years.

In this talk I will share reflections on the SUMMIT-P experience, including both what we have done at Ferris and what has taken place at other institutions. I will also discuss ways other institutions could implement what we have learned from SUMMIT-P.

Friday Workshop

David Clark, Grand Valley State University

Grading for Growth
What is the purpose of grades? Do grades do what we want them to? We will learn about alternatives to the traditional "pile of points" approach to grading, and see how these alternatives can support learning, provide clarity, and encourage perseverance and growth. A large part of this workshop will be hands-on practice with these more equitable assessment methods. Please bring a syllabus and a typical assignment from a class you've taught at least once.

Contributed Talks Title and Abstracts

Feryal Alayont, Grand Valley State University

Testing the Testing Effect
In education and psychology research, a well-known learning strategy suggested to improve the retention of the material being studied in the long-term memory is the testing effect. In this strategy, during part of the learning period, the learner is tested on the topic using the test as a learning tool, and hence the name. As an educator, when I was faced with the challenge of individual accountability during the online switch due to COVID-19 in March 2020 and later, I opted for timed and multiple-attempt online quizzes through our university's learning management system. This decision has led to an informal evaluation of the testing effect strategy. In this talk I will describe both an evaluation of the different models of online quizzes I used and some suggestions on how to effectively use these quizzes, including a discussion on limitations. I will include a summary of the student response to these quizzes, my evaluation of the overall effectiveness of the quizzes and some specific tips on the format of the quizzes to make them more manageable and effective.

Lora Bailey, Grand Valley State University

The resilience of healthy feedback networks against cancerous mutations
In healthy tissue, cell fate decisions such as division, differentiation, and cell death may be controlled by cell populations through cell-to-cell signaling, or feedback, to keep the system in a state of equilibrium. By examining different feedback networks mathematically, we can determine not only which feedback networks are possible, but which have greater resilience against cancerous mutations. While networks with exactly one feedback loop are sufficient for maintaining equilibrium, they are all equally vulnerable to dangerous mutations that alter the present feedback and can lead to unlimited growth of cancerous populations. Therefore, a network with multiple, redundant feedback loops appears evolutionarily advantageous. We discovered that these redundant networks have varying degrees of resilience against mutations.

For some redundant networks, any mutation that weakens or eliminates one of the existing feedback loops results in the growth of the cancerous stem cell population, while for other redundant networks this same type of alteration can lead to a depletion of the cancerous stem cell population and may slow down further unwanted evolution.

Erik Brown*, Eastern Michigan University

Did the change work? Using statistical analysis to track student success data.
This presentation incorporates student outcomes data from Fall 2011 to Winter 2021 at Jackson College (JC). We explore the impact of demographic characteristics on the academic performance of JC students enrolled in mathematics courses. Preliminary bivariate analysis suggests that gender, race, age group, term session, and term length are related to students' success. Given these facts, we investigate any differential in students' success due to the underlying factors by implementing adjusted analysis. We evaluate the differential in students' success via logistic-regression model. Finally, we propose a model for collecting and analyzing data to track the effectiveness of departmental and institutional changes.

Arthur Clark*, Grand Valley State University

A Mathematical Analysis of Uno with Cheating Scenarios
Atticus and Bartholomew have always wondered why they lose more games of Uno compared to Chad. After their last miserable game night, they finally decided to hire us as consultants to help them with the situation. We were hired to analyze various possible cheating scenarios that Chad might have employed, such as switching a card in his hand or playing two cards at once, and to determine how each of these cheating methods impacted the outcome of the Uno games using simulation and other techniques. In this presentation, we will report on our mathematical analysis of these cheating methods.

Robert Dolan*, Grand Valley State University

The Existence of Finite Bifurcus Semigroups
When algebraic objects such as rings are bifurcus the exhibit the strong property that every non-atom, non-unit of the object may be factored into two irreducible elements. We investigate finite semigroups of matrices whose entries belong to congruence classes and expound on their properties. We then use this type of semigroup to construct the first verified finite bifurcus semigroup and subsequently use the Cartesian Product to construct other examples of finite bifurcus semigroups from non-bifurcus, atomic semigroups of this form.

Abe Edwards, Michigan State University

Mathematics isn't beautiful, it's sublime: For students, the difference matters.
Many instructors discuss beautiful aspects of mathematics in our classrooms. While notions of beauty are important, they do little to capture the terrifying emotions some students feel with respect to mathematics. I this talk I suggest that we would be better served by invoking a different aesthetic: The Sublime. Sublimity has long been valued in art and literature but has

been less present in discussions of mathematics. Imagine standing on a rugged coastline, watching a storm blow across the darkened sky, feeling the spray against your face, and hearing the thunder echo across the horizon. When viewed from a place of relative safety, a storm can be frightening and pleasurable. The sublime captures the unusual capacity of humans to derive pleasure from powerful and potentially destructive objects. Drawing on aesthetic theory and taking examples from literature, philosophy, and art, this talk will show how mathematics isn't just beautiful, it's sublime. The difference is important and can be used to help students take greater pleasure in what is, for many, a frightening subject.

Jack Graham*, Hillsdale College

A Surprising Property of the Discrete Brachistochrone
The problem of finding a curve of fastest descent (called the brachistochrone) sparked the development of the calculus of variations and led to many interesting connections and problems. One variation on the classical brachistochrone is the discrete brachistochronea rigid, multi-segmented ramp of fastest descent. Recently, this discrete brachistochrone was discovered to have an unexpected propertythe optimal ramp always has segments with equal slide times. This equal time property can be shown through a new short proof, using one of the discrete brachistochrones significant featurespleochronic angles.

Evan Henning*, Grand Valley State University

Graph Edge Cover Sequences
A graph, composed of vertices (dots) and edges (lines connecting vertices), is a visual representation of relationships between objects. Vertices represent objects and an edge connecting two vertices shows a relationship between the two objects vertices represent. An edge cover of a graph is a selection of edges such that each vertex in the graph connects to at least one edge. The total number of edge covers in families of graphs such as path and cycle graphs turn out to be the famous Fibonacci and Lucas numbers. In this talk, we will investigate other families of graphs and the sequences generated by the amount of distinct edge covers each graph has.

Firas Hindeleh, Grand Valley State University

Classification of the Automorphism group for some special Lie algebras
Lie algebra automorphisms have many applications. For example, they were used to find a complete set of vacuum solutions to Einstein's field equations for Bianchi-type spacetime geometries. In this talk, we outline the classification problem for the automorphism group of the 2n+1 dimensional Heisenberg, the n-dimensional Filiorm, and the n-dimensional standard solvable algebras.

Aaron Jacobson*, Hillsdale College

The Spectral Properties of Directed Barabási-Albert Networks
The object of this research is to explore the spectral properties of the adjacency matrices of directed Barabási-Albert networks. Because the spectrum of adjacency matrices is permutation-

invariant, models which rely on them can be especially useful to experimentalists who discover network structures but lack a meaningful way to index the components thereof. This research begins with the generation of a set of directed Barabási-Albert networks and proceeds to analyze the spectral properties of these networks with the goal of developing a spectrum-based model for their generating parameters.

Lauren Keough, Grand Valley State University

How symmetric is a graph? Determining and Distinguishing Numbers
One way to measure the symmetry of a graph is through determining and distinguishing numbers. The determining number is, roughly how many vertices you have to "pin down" so that there are no nontrivial automorphisms. The distinguishing number of a graph *G* is the fewest number of colors needed so that there are no non-trivial automorphisms that preserve the colors. We'll talk about these numbers for various graphs. This is joint work with Debra Boutin, Sally Cockburn, Sarah Loeb, Kat Perry, and Puck Rombach.

Mirza Komic*, Grand Valley State University

A Mathematical Analysis of Uno with Cheating Scenarios
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miserable game night, they finally decided to hire us as consultants to help them with the situation. We were hired to analyze possible cheating scenarios that Chad might have employed, such as switching a card in his hand or playing two cards at once, and to determine how each of these cheating methods impacted the outcome of the UNO games using simulation and other techniques. In this presentation, we will report on our mathematical analysis of these cheating methods.

David McClendon, Ferris State University

Analyzing methods used to measure recruiting classes of major college football programs and assign star ratings to recruits

Previous studies have found correlation between the overall quality of a college football program's recruiting class and its performance on the field. These studies use as their measurement of a program's recruiting class either the "total points accrued by the class, or the numbers of players in the class with various star ratings".

In this talk, I will discuss work with recent Ferris State graduate Michael Nadrowski where we study the mathematical formulas used by 247Sports.com to produce the "total points" and "star rating" metrics. I will discuss how these formulas can be improved, and what this means about the efficacy of recruiting ratings in general.

Grace McClurkin, Saginaw Valley State University

Redesigning Developmental Math at SVSU
I will describe the design and implementation of a new developmental math course at Saginaw Valley State University (SVSU). The course is designed to expand student understanding of developmental math ideas through active learning, group work, and reflection while preparing them to be successful in a general education statistics course in their second semester.

This work is supported by a Department of Education Title III grant.

Abigail Price*, Hillsdale College

Monomials of Eisenstein Series
Eisenstein series are a type of modular form important in the study of number theory. Recently, relationships between products of Eisenstein series have been of interest to the mathematical community; Duke and Ghate each proved that products of two Eisenstein series only equal another Eisenstein series when forced by dimension considerations, and Emmons and Lanphier extended their result, classifying all cases in which products of arbitrarily many Eisenstein series can equal another Eisenstein series. This presentation develops a novel application of methods developed by Nozaki to study the location of zeros of Eisenstein series to present a complete classification of monomial relations between Eisenstein series.

Lucas Smielewski*, Grand Valley State University

Simulation Analysis of a Major Crisis Facing Americas Favorite Pastime: Major League Baseballs Rising Game Duration
Major League Baseball (MLB) has seen a decline of viewership and fan ratings in recent years attributed to the steady increase in the duration of the average baseball game, limited action on the field, and the slow pace of play. While changes to increase viewership are inevitable, they are often opposed by lifelong fans, warranting a complete investigation of any intended or unintended effects to the current game. Recent proposed rule changes include defensive shifting limitations so that players in the field are more restricted in their alignment encouraging more action on the field, pitch clocks to ensure pitchers throw the next pitch within a specific amount of time, and an automated strike calling system to remove the human error when calling balls and strikes. While experimental rule changes have been tested in minor league play during the 2021 season, there is currently no mathematical model available to predict the effects at the major league level. We explore the effect that these proposals have on game duration, activity on the bases, offensive changes, and the number of balls in play by applying the Monte Carlo Method, a well-established mathematical technique that measures the probability of different outcomes for real situations that are not easily predictable such as the complex system of a baseball game. We use the programming language Python to simulate a detailed, realistic MLB baseball game, gather MLB data to determine parameters, probabilities, and outcomes used in the simulation, code in the proposed rule changes, and perform repeated simulations to analyze their impact. Through quantitative analysis, we hope to demonstrate the overall effect on the average MLB game and determine the best strategy for MLB officials to increase viewership without harming the integrity of the game and alienating stalwart fans who oppose significant changes to their beloved pastime.

Adam Stacey*, Hillsdale College

Determining the Functional Role of L and S in the Sparse, Low-Rank Decomposition.
Although mapping the architecture of neuronal networks is of interest to neuroscientists, the minute scale of said architecture generally prohibits experimentalists from doing so. Instead, models of the network's architecture are often produced using some measure of the network's functional connectivity. Our work seeks to achieve this by applying the sparse, low-rank matrix decomposition to reconstruction matrices produced from the cross-correlation of simulated neuronal spike-trains. More specifically, we use a number of algorithms and regressions to extract data from the sparse and low-rank components to estimate parameters related to the salient features of the simulated network's true architecture. From there, we use these parameters to transform the non-binary reconstruction matrix into a binary representation of the network's true architecture.

Zachary Stewart*, Michigan State University

Cops and Robbers on Cactus Graphs and Products
Cops and Robbers is a two-player, pursuit-evasion game played on graphs. Player 1 (called the cop player) controls some number of cops and Player 2 (called the robber player) controls a single robber. The cops and robber occupy vertices of the graph and move to adjacent vertices along edges on their turn. The cop player wins if at least one of their cops occupies the same vertex as the robber and the robber player wins if they can always avoid this. The minimum number of cops needed to guarantee a victory for the cop player on a graph G is called the graph's cop number $c(G)$. Much research has been devoted to studying $c(G)$ for various graphs G. It is well-known that $c(T)=1$ for all trees T and $c(G) \leq 3$ for all planar graphs G. With these results as inspiration, we characterize the cop-number for cactus graphs in terms of the cycles they contain and compute the cop-number of the Cartesian product of a cactus and a tree.

Paulina Volosov, Hillsdale College

A Mathematical Reconstruction of Observed Brain Networks
We investigate the relationship between functional and architectural connectivity in the cerebral cortex by means of network reconstruction via time-delayed spike-train correlation. We begin by reconstructing the entire network, and then we sample the matrix randomly and use the tool of matrix completion to fill-in the rest of the network. To be more experimentally valid, we next examine a small sliceor submatrix of the network and determine how much information we can deduce about the whole network from this small piece. An examination of the spectral properties of connectivity matrices forms a major part of this analysis.

Special Session Abstracts

Title: *Career and advising panel with alumni students*

Abstract: In this panel, GVSU math major alumni and student panelists will discuss their experiences in the BIG (business, industry, government) world as a mathematician. They will share how a mathematics major helped with their career paths, how they utilized the skills they gained during their undergraduate studies in their positions, what they wish they had known before they started working in the BIG world and their tips for current students. The panel will include a Q&A portion to give the audience a chance to ask questions.

Title: *AMiIBL "Share and Mingle" (90 minute interactive session)*

Abstract: AMiIBL (Alliance for Michigan IBLers) is a community of college math instructors around the state using student-centered, interactive, inclusive, inquiry-oriented teaching methods in their classrooms. In this session, members of AMiIBL will present "lightning" talks (~3 - 7 minutes) on their teaching over the past year. Talks may focus on particular challenges or successes, new ideas they tried, facilitating active learning online, etc. In addition to (approximately) 6-8 planned talks, there will be some "open mic" time for audience members to improvise their own 2-3 minute lightning talk. Time permitting, the session will end with open discussion time in small groups.