ISMAA 2025 Abstracts
University of St. Francis
March 28 & 29, 2025

Pre-conference Workshop

Jim Kulich, Elmhurst University, *Bring Your Data to Life*
In this workshop, we will explore ways to use interactive data visualization tools and techniques to create impactful stories from data. While standard statistical presentations of data have real value, a new level can be achieved when taking a more dynamic, visual, and interactive approach. We'll begin with an exploration, as a group, of how some common data on movies can come to life using Tableau, a popular data visualization tool. Next, we'll see what today's AI can offer in this realm. You'll then have a chance to explore possibilities for using some of your own data. These are methods you can apply in classes at any level, in your own research, and in your engagements with professionals across many fields. No background is needed. Just bring some good data, your laptop, and if you have one, a copy of Tableau.

Plenary Talks

Jim Kulich, Elmhurst University, *Do You Know Where Your Data Comes From?*
The pace of AI's evolution is dizzying, with all the attendant possibilities and pitfalls. In this presentation, we'll explore focused ways to use generative AI to advance some goals we, our students, and those for whom they will work have. We'll walk down the path that takes us from basic use of AI to a more mature approach that taps the best of what AI can offer with support and guardrails in place. We'll consider the possibilities AI assistants have for improving student performance and for equipping our students to better meet the needs of the workforce. You'll get a sense of how you can develop your own basic AI assistants. Simply turning over the keys to AI is rarely a good strategy. Using AI to give your efforts a tailwind can be a great path forward.

Cindy Wyels, CSU Chanel Islands, *Data Science for and by Pure Mathematicians*
Consider the skills and habits of mind developed through studying pure mathematics. These — and some basic statistical techniques — are enough to address some questions of interest given a small data set. With a larger investment of time for individual learning, a healthy dose of humility, and perhaps some collaborators, people whose preparation focused on pure mathematics can produce data-based studies of interest to many audiences. Join me for a story involving a years-long transition, a cast of dozens, some alluring marine megafauna and much serendipity as I argue for the value of all types of research for and by all types of researchers.

Greg Larnell, University of Illinois Chicago, *The Principle, Perils, and Persecution of Equity in Mathematics Education*
Over the past 40 years, equity in mathematics education has developed from a marginal idea into a mainstream principle. Yet, in the current political moment, the term has become a political target in national discourse and policy. What does equity mean now? In this talk, I explore the evolution of equity as a concept within mathematics education scholarship. I argue that equity discourse has a decades-long and distinctive history in U.S. mathematics education — a history that is accentuated by national status concerns. The talk highlights the developments and dangers of equity as a discourse and is punctuated by the following questions: For whom and for what purposes? Who benefits? Where do we go from here?

Deanna Haunsperger Carleton College *A Glimpse at the Horizon*
What do a square-wheeled bicycle, a 17th-century French painting, and the Indiana legislature all have in common? They appear among the many bright stars on the mathematical horizon, or, um, in Math Horizons. Math Horizons, the undergraduate magazine started by the MAA in 1994 publishes articles to introduce students to the world of mathematics outside the classroom. Some of mathematics' best expositors have written for MH over the years; here is an idiosyncratic tour of the first ten years of Horizons.

Contributed Talks—Friday

Animesa Puri(+) with Sai Manohar(+) and Sai Charan(+) Roosevelt University, *Optimizing Class Scheduling for Student-Athletes at Roosevelt University*
Utilizing data analysis in Python and visualization tools such as Tableau, our approach ensures that scheduling decisions are data-driven, equitable, and efficient. This initiative aims to reduce scheduling conflicts, improve class accessibility, and enhance both academic success and resource management at Roosevelt University.

Enrique Treviño, Lake Forest College, *Selecting Balls from urns with partial replacement rules*
Consider an urn with an initial state of $R \geq 1$ red balls and $W \geq 1$ white balls.
Draw a ball from the urn, uniformly at random, and note its color. If the ball is white, do not replace it; if the ball is red, do replace it. Define this sampling rule to be the "Preferential sampling". We study the random variable denoting the number of white balls drawn under preferential sampling for a sample size n. It is known that the expected value is bounded below by 3/4 nW/N and bounded above by nW/N. In this talk we talk about improvements we made to the lower bound, and give a heuristic for the best possible lower bound.

Brooke Randazzo, Augustana College, *Student Partial Meanings for Homomorphisms*
Group isomorphisms and homomorphisms are concepts central to the undergraduate abstract algebra course. While extensive research has been done on student understandings of isomorphisms, homomorphisms have received less attention, especially regarding how students generate them and understand them using the properties and structure of the groups involved.

This study involved interviews with six students from two different institutions, asking them how they understood homomorphisms. Additionally, they were asked to describe their thinking while completing problems where they generated homomorphisms and constructed proofs involving homomorphisms. Thematic analysis was used on the transcripts to look for "partial meanings" for homomorphisms that students used in their thinking. Here we present five of these partial meanings that seemed to differentiate success on these tasks. In particular, students created both element-to-element maps as well as algebraic maps, determined the size of preimages of the maps by partitioning the domain, and used shared substructures between the domain and codomain to generate their homomorphisms. However, use of same properties (e.g., order of an element) was generally a hinderance, or at least a distraction, to creating these maps. Implications for teaching include a greater focus on how to generate algebraic maps based on element-to-element maps, how to use substructures to determine possible homomorphisms, and which properties are actually preserved by homomorphisms.

Delaney Balmer*, Millikin University, *Metric Spaces and Urban Design: A Mathematical Perspective*
This presentation explores metric spaces and their applications in civil infrastructure and urban design. It begins with an overview of metric spaces, including their definition, key properties, and examples of different types. The discussion then focuses on four cities: Paris, Barcelona, Brasília, and Manhattan—analyzing the metrics that characterize their layouts. By examining these metrics, the presentation highlights how different spatial structures influence both the visual aesthetics and functional efficiency of urban environments.

Wilfredo Urbina-Romero, Roosevelt University, *On Rademacher, Walsh and Haar functions*
In this talk we will study the Rademacher, Haar, and Walsh functions, along with several key results involving them. The main goal is to present these foundational results that later played a significant role in the development of Martingale Theory.

Kevin Murphy Dominican University, *Incorporating Writing Projects in Pre-calculus and Calculus Courses*
Pre-calculus and Calculus courses need a solid foundation of formulaic manipulation and investment in developing rules and practice using those rules. This talk will provide examples of writing projects created to assess students' understanding of how to apply those rules to assist in problem-solving through optimization, and most importantly, require students to communicate the reasoning behind how these tools are implemented.

Brendan Miller(+), Northern Illinois University, *Dynamical Sampling: An Overview and Recent Results*
Dynamical Sampling refers to an area of applied analysis which studies the theory and applications of signals evolving in time. In this talk, we will discuss the so-called "dynamical sampling problem," which is to determine precisely when an evolving signal can be stably recovered from linear measurements. We briefly discuss the solution to the problem for finite dimensional signals, and then we will move to the more complicated setting of signals residing in

infinite dimensional Hilbert spaces and show that the problem has deep connections to classical results in harmonic and functional analysis.

Tony Bedenikovic, Bradley University, *The Music of the Spheres, and Other Orientable Surfaces*
Triangulation and orientation --- two iconic concepts in the canon of low-dimensional topology --- form the understory of this talk. Classic topology tells us that all two-dimensional surfaces allow a triangulation and, further, that some but not all surfaces allow a consistent notion of orientation. The new idea in this talk is the introduction of time as a factor when considering orientation. In particular, edges of triangles can be ordered (first, second, third), which in turn allows triangle edges to be regarded as beats in a musical composition. By assigning musical frequencies to triangles and settling on a few sensible rules for the interactions of the frequencies, surfaces can become musical instruments. Full disclosure: I've only ever made awful music, or utter silence. This bit of whimsy started with an undergraduate capstone project. It is hoped that the talk will inspire other, more melodious explorations.

Abigail Hoit, Elmhurst University, *The Frequency of Fiven Numbers*
A natural number is classified as “fiven” if it is a multiple of the sum of the digits in its factoradic (or factorial-base) representation. This term was coined by Dalenberg and Edgar in 2018 as an extension of the more well-known Niven numbers defined by D.R. Kapreker using the ordinary decimal representation of numbers. In this talk, we begin with an exploration of unusual base systems, move on to some classifications of numbers using their representations in those systems, and finally present an upper bound on the asymptotic frequency of fiven numbers within the set of natural numbers.

Rachel Rupnow, Augustana College, with Kristen Vroom, Mik Mieczkowski(+), & Seth Ricarte(+), *Supporting Mathematical Instruction Around Definitions Through Values-Centered Collaboration*
Undergraduate students and mathematicians often value different aspects of mathematical definitions (such as rigor or precision) differently. Understanding the norms and values that mathematicians prioritize for definitions would enhance student understanding of the purpose and usage of definitions in proof-based courses. However, there are various barriers in communicating these values, and research shows that there is a disconnect between the instructor's and student's understanding. We collaborated with mathematics instructors from two institutions to discover what these barriers are and to brainstorm and experiment with short activities that explicitly introduce these definition norms and values to students. This project integrates focus groups, class observations, surveys, and interviews with instructors and students with the goal of developing a toolkit of strategies for instructors to better communicate norms and values for definitions. During this talk, we will discuss some relatively successful activities we found which were tested in the classroom. We will also share instructors’ perceived barriers for communicating these norms such as the constraints of highly coordinated courses and the difficulty in translating between students’ informal and technical understandings of definitions.

Tung T. Nguyen, Lake Forest College, and Nguyen Duy Tan *Integral Cayley graphs over a finite symmetric algebra*
A graph is called integral if its eigenvalues are integers. In this talk, we will discuss the necessary and sufficient conditions for a Cayley graph over a finite symmetric algebra R to be integral. This generalizes the work of So who studies the case where R is the ring of integers modulo n.

Jon L. Johnson, Elmhurst University, *Pascal and the Tower of Hanoi*
The classical Tower of Hanoi puzzle involves 3 pegs and moving a stack of disks from one peg to another following certain rules. To obtain a solution for any number of pegs and any number of disks we first find Pascal's triangle in rectangular form. We use an augmented Pascal's "rectangle" to guide us to a solution in the multi-peg case.

Career Panel-Saturday
Career Panel for Undergraduate Students: Preparation for Careers in Mathematical Sciences

Matt Albaugh got his Bachelor's degree from Roosevelt University. He worked for three years as a corporate statistician for DirectBuy in Merrillville, Indiana. He is currently a TA and Ph.D. Student at Northern Illinois University (NIU) in DeKalb.

Seth Cohen earned Bachelor's degrees in Computer Science and Mathematics from Roosevelt University. He has been working as a programmer for the real estate company @Properties for more than ten years. Seth is currently a Senior Programming Engineer at @Properties.

Arielle Fujiwara received her bachelor's degree in Math with concentration in Secondary Education from Roosevelt University. She has been teaching math in middle school for the past 10 years and is currently teaching 8th grade at Gompers Junior High School in Joliet Public Schools District 86.

Josh Torres earned his Bachelor's and Master's degrees in Actuarial Science from Roosevelt University. He is currently an Analytical Pricing Data Analyst with Core Specialty Insurance Holdings, Inc.

Section Next—Saturday
Christine Jamroz, University of St. Francis
Round-table discussion of all things related to early career faculty.

Contributed Talks—Saturday

Jim Olsen, Western Illinois University, *Hands-on Division with Fractions for Understanding*
The goal is to enhance student understanding (in grades 4-8) of division, fractions, & division involving fractions. The challenge with modeling division in elementary and middle school

classrooms comes when there are remainders, fractional groups, and group-sizes involving fractions. We still want to do things visually and with hands-on materials to build conceptual understanding. In this teacher education session, I will share two ways to model division: with physical manipulatives & with a online tool (Polypad), and also a progression of problems (in real-world contexts) spanning a range of problem types.

Zachary Campbell*, Lewis University, *Mathematically Modeling Recurrent C. difficile Infections in Long-Term Care Facilities*

Clostridioides difficile (C. difficile) is the leading cause of healthcare-acquired infections in the United States. Infected individuals shed endospores that persist on surfaces for extended periods and are the primary form of transmission. While most individuals mount an immune response, older and immunocompromised populations face a higher risk of colonization and recurrence. Recurrent C. difficile infections (rCDI) lead to worsening symptoms and higher mortality rates and present a significant challenge in long-term care facilities (LTCFs). Most mathematical models focus on C. difficile infections in hospitals, with few addressing LTCFs, and almost none implementing rCDIs.

This study develops an ordinary differential equation (ODE) model to examine C. difficile transmission in LTCFs, incorporating interactions between residents and contaminated surfaces. The model tracks disease spread across seven patient classes and one environmental class, identifying key parameters influencing the incidence of infection.

Baseline results indicate that environmental contamination plays a critical role in outbreaks, emphasizing the need for enhanced disinfection protocols. Sensitivity analysis highlights the impact of transmission rates and rCDIs, suggesting that targeted interventions could significantly reduce infections. Additionally, screening for C. difficile was explored as a mitigation strategy as faster and more accurate diagnostic tests have become available to LTCFs.

Kristen Ess*, Lewis University, *A Mathematical Model of C. difficile Transmission and Control in Healthcare Settings*

Clostridioides difficile, also known as C. difficile, has been the leading cause of infectious diarrhea and one of the most commonly-obtained infections in United States hospitals with nearly a half million cases recorded each year. Those infected could have contracted a C. difficile infection (CDI) due to interactions with a surface or person harboring the spores spread by this bacteria. Patients with a CDI spread endospores which have been proven to be difficult to remove from the hospital environment, so these patients are sometimes placed into an isolation room. Previous mathematical models have only considered patients' interactions with the environment and have not evaluated the effect of hospital employees or the isolation of infected individuals. This work developed a system of ordinary differential equations to examine the impact of different transmission routes such as healthcare workers, doctors, and low- and high-touch frequency fomites, objects likely to carry infection, on the spread of C. difficile in a hospital setting. This model is also one of the first to consider an isolation class for patients with a CDI. Results show an emphasis on increased hand hygiene of hospital staff as well as the application of isolation protocols as the most effective strategies to minimize incidence within a

hospital ward. Healthcare professionals can apply these and other findings to help mitigate the spread of C. difficile in healthcare settings.

Emily Olson, Millikin University, *Human-Centered Teaching: My Experience at the Decatur Correctional Center*
In this talk, I will detail my experience teaching a math course at the Decatur Correctional Center. I offered a 3-credit math course to 10 incarcerated women. After discussing some challenges and advantages to teaching within the State of Illinois Department of Corrections, I will include my perceived impact of the experience on my teaching. While this is not a traditional research talk, I hope it will be especially impactful to those who are curious to know how their teaching can contribute to improving outcomes for highly minoritized populations and what it means to take a human-centered approach in teaching.

Sunil Chebolu and Papa Sissokho Illinois State University, *Hyperplane Arrangements and Zero-sum free sequences.*
A hyperplane in R^n is just a co-dimension one subspace. A collection of hyperplanes in R^n is called a Hyperplane arrangement. These arrangements are important mathematical objects and they arise frequently in algebra, geometry and combinatorics. One can also study these arrangements over finite fields and other rings where not much is known. In joint work with Papa Sissokho, we considered the problem of counting the number of points in the complement of a specific hyperplane arrangement over the field of p elements. This problem is considered intractable and work led to number of interesting connections to the Hadamard problem, zero-sum free sequences, Mathieu-Zhao subspaces, and the distribution of the values of the Euler-phi function. I will build the necessary background in my first talk and in the second talk, I will discuss some of our results.

Jasmine Gillis (+), Roosevelt University, *Exploration of the Problem of Points*
This paper examines the Problem of Points as a catalyst in the development of probability theory, tracing its evolution from a gambling puzzle to a foundational mathematical concept. The problem, which asks how to fairly divide stakes in an interrupted game of chance, sparked a groundbreaking correspondence between Blaise Pascal and Pierre de Fermat in 1654. Their collaboration introduced fundamental concepts such as expected value and combinatorial analysis, marking a shift from deterministic to probabilistic mathematical reasoning. We analyze how their solution methods, including Pascal's triangle and systematic outcome enumeration, became cornerstones of probability theory and statistical analysis. The paper traces these ideas through subsequent developments by mathematicians like Huygens, Bernoulli, and Laplace, demonstrating the evolution into a comprehensive theoretical framework. We argue that this seemingly simple gambling problem catalyzed the development of mathematical tools now underpinning modern applications in fields ranging from quantum physics to financial mathematics. The Problem of Points thus represents a crucial turning point in mathematical history, illustrating how practical questions can lead to profound theoretical advances with lasting cross-disciplinary implications.

Todd D. Oberg, Illinios College, *Updates to Rules and Policies in Teacher Education*
The purpose of this session is to update those involved in the work of preparing future math teachers of changes in rules and policies and new rules and policies from ISBE and the State. This will be a quick summary of the key, important changes and additions so that those working with teacher candidates have an awareness of these issues and can research more those items of interest.

Ahmad Abdur Rahman*, University of Illinois Urbana-Champaign, *Modelling the Evolution of Altruistic Norms via Cultural Multilevel Selection*
Evolutionary game theory allows us to model population dynamics through the lens of multiple competing populations be it social groups or animal species. Cultural evolution finds its basis developed in anthropology and the social sciences but it can be used to investigate population structures in an evolutionary context. Cultural evolution allows us to abstract notions of learned behaviour through adoption of societal norms and behavioural traits. We use multilevel selection as a paradigm where we allow for both inter- and intra-group interactions. We apply these ideas in a simulation context where we look to see how altruistic behaviour in groups can propagate to lead to positive or negative changes amongst competing group structures.

Elizabeth DeWitt, Trinity Christian College, *First Experiences with Building Thinking Classrooms*
Hoping to increase the student-to-student interaction and the amount of time students worked on problems in class, I restructured my Calculus I and Calculus II classes using several of the techniques from Liljedahl's Building Thinking Classrooms in Mathematics. I will share my experiences and what I hope to implement next.

Bir Kafle, Purdue University Northwest with Alain Togbé and Florian Luca, *Some Triangular Numbers*
Positive integers of the form $\frac{n(n+1)^2}{2}$ are called the triangular numbers. The first few triangular numbers are $1, 3, 6, 10, 21, 28, 38, 45, 55, 66, 78, 91, \ldots$ A repblock of two digits is a positive integer with repeated blocks of two digits, which has the form of $c\left(\frac{10^{2m}-1}{99}\right), for\ some\ m \geq 1, c \in \{10,11, \ldots 99\}$ This presentation explores some of the triangular numbers which are also the repblocks of two digits. We also state a theorem showing a finiteness of solutions of equations involving repblocks. Our method involves the determining the integer points on elliptic curves over the field of rational numbers, $\boldsymbol{Q}$ for which we used a computational algebra software, Magma.

Chuckie Gentile*, Claire Levis*, Zach Campbell*, Nuvia Hernandez*, Brandon Kemp*, Emilio Vilchis*, Mackenzie Welsh*, Dr. Brittany Stephenson and Dr. Cara Sulyok, Lewis University, *Development of Agent-Based Models for Evaluation of Precision Nutrition Interventions Through a Socioeconomic Lens*
Precision nutrition tailors dietary recommendations at the individual level, rather than applying generalized guidelines. On a larger scale, it enables targeted interventions that address

community health needs. This project uses an agent-based model (ABM) to simulate the overall health dynamics of Broadview, IL, evaluating how socioeconomic factors and access to resources influence overall well-being. The model simulates Broadview residents with demographics and characteristics taken from the U.S. Census and government data. Residents make daily decisions based upon probabilities that are influenced by socioeconomic status, health conditions, and access to resources. Each agent has a health score determined and updated by their decisions. These scores are aggregated into a total population health score, allowing us to gauge the overall health of the community and test intervention strategies. Our model utilizes stochastic decision-making to simulate the randomness of human behavior. By considering various intervention strategies, we can evaluate their effects on both individual and community health. This study aims to identify the relationships between socioeconomic status, daily interactions, and access to resources in shaping overall health. Through simulations, we can determine effective strategies to improve public health in Broadview, particularly for underserved populations. The results can inform policymakers and public health officials to implement interventions that increase community health.

Zsuzsanna Szaniszlo, University of Chicago, *A case Study of an Extended Calculus Course at Valparaiso University*
In this presentation we describe the creation of and first experience with an extended Calculus course at Valparaiso University. The course had no prerequisites, and it used Standard Based Grading.

* Undergraduate Student
(+) Graduate Student