ABSTRACTS OF TALKS PRESENTED TO THE INDIANA SECTION OF THE MAA

1. Introduction

The Spring 2024 meeting of the Indiana Section of the Mathematical Association of America is at Marian University, April 5 – 6. The abstracts appearing here are based on text electronically submitted by the presenters.

Contributed talks are listed in alphabetical order by presenter.

2. Invited Talks

Presenter: Matt Boelkins, Grand Valley State University

Interactive, Accessible, Free, and More: How Open-source Textbooks are Changing the Teaching and Learning of Mathematics.

The mathematics community finds itself at the forefront of an exciting movement that seeks to ensure every student has free access to the learning resources they need to be successful. In the last decade: a significant number of authors have made their textbooks and class materials free and open-source; a new publishing language has made creating high-quality, accessible textbooks easier than ever; a new markup language offers instructors and authors the means to generate interactive exercises for students that offer students immediate feedback; and a new learning engineering analytics platform offers textbooks that students can log into and have their work tracked and saved. We'll briefly discuss the history of the open educational resources movement in mathematics, share a range of exciting recent developments (including the conversion of open-source textbooks to Braille), discuss the promises we see for the future, and point participants to a vibrant, engaging set of resources they can start using immediately with students.

Presenter: Deborah Kent, University of St. Andrews

Mostly in the Zone: Mathematics and 19^{th} Century Eclipse Expeditions

During the late 19^{th} century, high-stakes astronomical expeditions involved a range of individuals and organizations, whose collective experience helped to grow and sustain mathematical communities in the US. Connections forged beneath the Sun's shadow sustained networks of communication and set precedent for government funding to support mathematical activity. On Monday, 8 April 2024, a total solar eclipse will be visible across North America, including directly over Indianapolis. This talk will explore some of the triumphs and tribulations encountered by 19^{th} century scientists that will provide context for and connection to the 21^{st} century experience of eclipse totality.

Presenter: Talea L. Mayo, Emory University

Weathering the Storm: Using Math to Understand Climate Change Impacts on Hurricane Storm Surge Risk

It is widely accepted that climate change will cause global mean sea level rise, increasing coastal flood risk in many places. However, climate change also has significant implications for tropical cyclone climatology. Specifically, hurricane intensity, size, and translation speed are all expected to intensify in the future, and each of these influences storm surge generation and propagation. In this talk, I will discuss probabilistic and deterministic numerical modeling approaches we have taken to understanding what this means for coastal flooding from storm surges.

3. Indiana Project NExT Panel Discussion

Panelists:

- Matt Boelkins, Grand Valley State University
- Naama Lewis, Marian University
- Amish Mishra, Taylor University
- Olga Scrivner, Rose-Hulman Institute of Technology

Moderator:

- Tyler Billingsley, Rose-Hulman Institute of Technology

Recent Technological Advances and the Changing Classroom

You may have heard the sentiment that all we need to do mathematics is our mind and something to write with. In fact, many mathematicians still prefer to use chalk to conduct their classes. This classic approach has worked for centuries, but as technology continues to move and develop, we are presented with new resources for educating the next generation of mathematicians. This panel looks to survey some of these advances and spark conversations about the best ways to reach students who are saturated with the technology of today.

4. Student Activities Workshop

Presenters: Haris Skiadas, Hanover College, and Godfred Yamoah, Trine University

Lagrange's Study of Wilson's Theorem

5. Contributed Talks

Presenter: Matt DeLong, Marian University

Joint work with: Zach Gates, James Highbaugh, Sarah Klanderman, and Naama Lewis, Marian University

Transforming a calculus sequence through a shared vision — Active learning, mastery grading, and OERs

Over the last five years, Marian's calculus sequence (precalculus through multivariable calculus) has undergone substantial transformation. Active learning has replaced traditional lecture. Mastery-based grading has replaced traditional grading schemes. Free online textbooks have replaced traditional, commercially produced tomes. A collaborative effort among the department faculty has resulted in this overhaul. In this talk, we will share the reasons that motivated these changes. We will discuss resulting changes in student engagement and outcomes. We will also discuss challenges and next steps.

Presenter: David Housman, Goshen College

Probability a group element is pivotal

Choose elements of a group at random one at a time without replacement. When the elements chosen first generate the group, the last chosen element is called *pivotal*. We determine the probability that an element is pivotal in a few groups and show some dismal attempts to get help from ChatGPT. I am hopeful that algebraists, probabilists, and linguists can provide helpful suggestions for further steps or direct me to the literature where the question has already been answered.

Presenter: Michael Karls, Ball State University

Cooking a turkey

The goal of this SIMIODE Modeling Scenario is to investigate several models for the cooking time for a turkey based on weight, test these models with data obtained from heating curves for turkeys of various weights, and develop a new model to fit this data.

Presenters: Haseeb A. Kazi, Trine University, Shaheer A. Kazi, Angola Middle School student, and Nabeeha H. Kazi, Angola High School student

MSC 2020: 00A05

Understanding, addressing, and overcoming Math Phobia: Why and when does the issue arise? How does it affect one's growth, interest, and achievement in mathematics? And the burning question: how can we stop math phobia in its tracks, or even better, before it begins?

Math phobia, also known as mathematical anxiety, is a feeling of tension, apprehension, or fear that interferes with math performance. It has become a widespread, universal phenomenon among individuals of all ages. Bringing students out of the realm of math phobia or preventing it beforehand is a critical task and a much desired goal. Our group of three — an outstanding middle schooler taking high school classes, a hard-working high schooler taking college-level classes, and an experienced math professor teaching college and university-level math for over two

decades — bring to you their first-hand experiences on the topic as well as valuable insight that assists in answering the previously stated pressing questions. Join us in our quest to understand, address, and ultimately overcome math phobia, paving the way for a future where mathematical proficiency is within reach for all.

Presenter: Kai-Chun Lin, Rose-Hulman Institute of Technology undergraduate student

Tight frame and discrete structures

This talk discusses the connection between certain tight frames and discrete structures such as matroids and graphs. The focus of the talk will be on equiangular tight frames as vectorial representations of matroids over fields.

Presenter: Steven Lippold, Taylor University

Permutation-like matrices

Permutation Matrices are a class of matrices which encode row and column swaps as a square $d \times d$ matrix. In this talk, we define a similar class of matrices which are a generalization of Permutation Matrices. We give explicit formulas for the multiplication of these matrices in certain cases and discuss some applications.

Presenter: Rodney Lynch, Indiana University — Purdue University Columbus

Multiplicative inverses of determinant 0 *matrices*

Starting with a 3×3 matrix A that has zero determinant and distinct eigenvalues, I will give a method for producing a group of 3×3 matrices that has an identity that is not the usual identity matrix. The generalized inverse that I produce is not the same as the Moore-Penrose inverse. I will show parallels between this notion of inverse and the usual notion of invertibility for matrices with nonzero determinant.

Presenter: Rodney Lynch, Indiana University — Purdue University Columbus

Outer products, generalized identities, and generalized inverses

This talk takes a different approach from my talk "Multiplicative inverses of determinant 0 matrices" and is independent of it. A product of a column matrix and a row matrix is an example of an outer product. Starting with a 3×3 matrix A that has zero determinant and distinct eigenvalues, I will show how to obtain an identity with determinant 0 and a multiplicative inverse of A. I will show how A, the identity, and its multiplicative inverse can all be written in terms of outer products. I will show that certain idempotent matrices (matrices that satisfy $J^2 = J$) have very nice forms using outer products.

Presenter: Edward Vogel, Rose-Hulman Institute of Technology STEM/Art Educator

Recap of mathematics and art residency at Rose-Hulman

A recap of mathematical and artistic collaborations during my residency at Rose-Hulman Institute of Technology.

Presenter: Michael Xue, Vroom Laboratory for Advanced Computing, Indianapolis

Introducing Feynman's integral method

Richard Feynman, celebrated for his contributions to theoretical physics, left an enduring imprint on mathematical techniques as well. His Integral Method, among his myriad accomplishments, emerges as a profound tool for tackling seemingly insurmountable integrals. This presentation immerses us in the elegance and efficacy of Feynman's approach, employing a series of compelling examples. We commence by laying the groundwork, elucidating the method's core principles and its transformative capacity to simplify intricate integrals. Through a blend of intuition and rigorous analysis, we unravel the method's underlying mechanics, illuminating its remarkable effectiveness. A diverse array of examples showcases the versatility and ingenuity inherent in Feynman's Integral Method, illustrating its wide-ranging applications. Ultimately, this discourse not only demystifies the intricacies of Feynman's approach but also seeks to ignite curiosity and innovation within the realms of mathematics and physics. Join us as we embark on a captivating exploration of integrals, guided by the enduring brilliance of Richard Feynman's insights.

Presenter: Young Hwan You, Indiana University East

Recovering initial temperature profile of a one-dimensional uniform rod via finite linear time sampling under periodic boundary conditions

Building on the Dirichlet boundary framework established by Aryal and Karki, this paper tackles the inverse problem of recovering an initial temperature profile based on temperature measurements at a fixed location and a finite set of linearly spaced later times under periodic boundary conditions by using a complex analytic method.

6. Contributed Posters

Presenter: Zhenisbek "J." Assylbekov, Purdue University Fort Wayne
Joint work with: Rustem Takhanov, Maxat Tezekbayev, Artur Pak, Arman Bolatov, Zhibek Kadyrsizova, Nazarbayev University, Kazakhstan

Intractability of learning the discrete logarithm with gradient-based methods

The discrete logarithm problem is a fundamental challenge in number theory with significant implications for cryptographic protocols. In this paper, we investigate the limitations of gradient-based methods for learning the parity bit of the discrete logarithm in finite cyclic groups of prime order. Our main result, supported by theoretical analysis and empirical verification, reveals the concentration of the gradient of the loss function around a fixed point, independent of the logarithm's base used. This concentration property leads to a restricted ability to learn the parity bit efficiently using gradient-based methods, irrespective of the complexity of the network architecture being trained.

Our proof relies on the Boas-Bellman inequality in inner product spaces and it involves establishing approximate orthogonality of the discrete logarithm's parity bit functions through the spectral norm of certain matrices. Empirical experiments using a neural network-based approach further verify the limitations of gradient-based learning, demonstrating the decreasing success rate in predicting the parity bit as the group order increases.

Presenter: Dennis G. Collins, University of Puerto Rico, Mayagüez (retired)

Further attempts to measure symmetry

This poster covers further attempts to measure symmetry of mathematical objects such as Riemannian manifolds, continuous groups, and drama triangle cycling. Conjectures that allow calculations to proceed are discussed, such as uniform density for entropy.