ABSTRACTS OF TALKS PRESENTED TO THE INDIANA SECTION OF THE MAA

1. Introduction

The Spring 2017 meeting of the Indiana Section of the Mathematical Association of America is at Earlham College, March 24–25. 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: Jennifer Quinn, University of Washington Tacoma

Epic Math Battles: Counting vs. Matching

Which technique is mathematically superior? The audience will be the judge of this tongue-in-cheek combinatorial competition between the mathematical techniques of counting and matching. Be prepared to explore positive and alternating sums involving binomial coefficients, Fibonacci numbers, and other beautiful combinatorial quantities. How are the terms in each sum concretely interpreted? What is being counted? What is being matched? Which is superior? You decide.

The Combinatorialization of Linear Recurrences

Binet's formula for the n^{th} Fibonacci number,

$$F_n = \frac{1}{\sqrt{5}}\left[\left(\frac{1+\sqrt{5}}{2}\right)^n - \left(\frac{1-\sqrt{5}}{2}\right)^n\right]$$

is a classic example of a closed form solution for a homogeneous linear recurrence with constant coefficients. Proofs range from matrix diagonalization to generating functions to strong induction. Could there possibly be a better way? A more visual approach? A combinatorial method? This talk introduces a combinatorial model using weighted tiles. Coupled with a sign reversing involution, Binet's formula becomes a direct consequence of counting exceptions. But better still, the weightings generalize to find solutions for any homogeneous linear recurrences with constant coefficients.

Presenter: Dave Kung, St. Mary's College of Maryland

Harmonious Equations: an Exploration of Math & Music

Mathematics and music seem to come from different spheres (arts and sciences), yet they share an amazing array of commonalities. We will explore these connections by examining the musical experience from a mathematical perspective. The mathematical study of a single vibrating string unlocks a world of musical overtones and harmonics — and even explains why a clarinet plays so much lower than its similar-sized cousin the flute. Calculus, and the related field of differential equations, shows us how our ears hear differences between two instruments — what musicians call timbre — even when they play the same note at the same loudness. Finally, abstract algebra gives modern language to the structures beneath the surface of Bach's magnificent canons and fugues. Throughout the talk, mathematical concepts will come to life with musical examples played by the speaker, an amateur violinist.

3. Indiana Project NExT Panel Discussion

Panelists:

- Julie Beier, Earlham College
- Sheryl Stump, Ball State University
- Felicia Tabing, Rose-Hulman Institute of Technology

Moderator: Derek Thompson, Taylor University

Teaching to a Bimodal Audience

We often find ourselves with a class that has two clear subgroups: students who are prepared vs. those who are underprepared, motivated majors vs. nonmajors fulfilling a requirement, or even a simple bimodal grade distribution. How do we tailor our teaching to encourage and support both groups and maintain our course standards? Panelists will discuss their past experience with confronting this problem, including concrete examples of tasks designed to help identify and engage a bimodal audience. The audience will be encouraged to discuss their own experiences and classroom techniques and tricks to address during a Q&A and brainstorming session.

4. Student Activities Workshop

Presenter: Michael Karls, Ball State University

The Mathematics of Star Trek

Underlying science fiction series such as *Star Trek* are scientific ideas, both real and imagined. Starting with examples from the popular television and film series, we will look at how science fiction, science, and mathematics go hand-in-hand. Topics will include mathematical ideas related to Red Shirt Survivability, the Transporter, and if time permits, Tribbles!

5. Contributed Talks

Presenter: Kwadwo Antwi-Fordjour, Earlham College

Joint work with: Marius Nkashama, University of Alabama at Birmingham.

Global existence of solutions of the Gierer-Meinhardt system with mixed boundary conditions

One of the famous models studied in biological spacial pattern formation is the Gierer-Meinhardt system based on Turing's idea. This system can be used to model skeletal limb development in humans under certain boundary conditions. In this talk, the Gierer-Meinhardt system will be considered with mixed boundary conditions to ascertain the global in time existence of solutions. Results obtained are based on a priori estimates of solutions.

Presenter: Josh Beal, Indiana University East

Measuring the predictive strength of asset models

Asset models, or 'alphas', have been implemented as investment tools by savvy investors for decades. In this talk, we present a technique for determining the predictive strength of an asset model.

Presenter: Tiffany Kolba, Valparaiso University

Probabilistic analysis of twin, triplet, and quadruplet zygosity type frequencies

Twins can be either identical, where they derive from the division of a single fertilized egg, or fraternal, where they derive from the fertilization of two separate eggs. In general, the zygosity of a set of multiples is defined as the number of eggs from which they derived. Hence, twins can be either monozygotic (identical) or dizygotic (fraternal), while triplets can be mono-, di-, or trizygotic and quadruplets can be mono-, di-, tri-, or quadrazygotic. In this talk, we present novel estimates for the zygosity type frequencies of twins, triplets, and quadruplets. The estimates rely upon modeling the relative rates of the two distinct biological mechanisms that produce multiple births, namely, division and polyovulation.

Presenters: Melissa Lindsey, Indiana Wesleyan University, and Derek Thompson, Taylor University

Top ten reasons to use plickers

Plickers are "paper clickers" which are an inexpensive, robust tool to have students answer multiple-choice questions without having to buy clickers. We give ten reasons why this is a great tool, both technologically and pedagogically. We will use the technology with the audience throughout the talk.

Presenter: Jacqueline Settles, Franklin College undergraduate student

Is there an unfair advantage among swimmers and runners based on lane assignments?

Have sports where participants compete in different lanes been giving some competitors an unfair advantage all along? Inspired by the Washington Post article, *These Charts Clearly Show How Some Olympic Swimmers May Have Gotten an Unfair Advantage*, this research project examines several scenarios to really see if swimming and track athletes can gain an unfair advantage based on their lane assignment. We will use scatter plots, random samples and statistics to examine Rio's 50m freestyle and 400m track results, as well as the Liberal Arts Champion swim meet that my school and other liberal arts schools compete in to see if there is a correlation between lane assignments and race times.

Presenter: Felicia Tabing, Rose-Hulman Institute of Technology

Mon: Japanese family crests, symmetry, and numbers

MSC 2010: 01A07, 01A27, 00A66

Japanese family crests, called mon, are black and white, usually circular emblems associated with a Japanese family as means of identification. Mon associated with a family is analogous to the modern logo for a company. There are thousands of different designs and variations of mon that commonly feature objects from nature and geometric shapes, with a lot of symmetry. I will discuss my investigation of the types of symmetries that appear in mon designs, and also the possible cultural influence and aesthetics of certain numbers appearing in the designs. I hope to use mon as a way of connecting culture, design, art, and mathematics in my future teaching.

Presenter: William D. Weakley, IPFW

My life with queens

MSC 2010: 05C69

Consider an $n \times n$ chessboard. If we wish each square to be either occupied or attacked by a queen, how many queens are needed?

This problem has attracted mathematicians for more than 150 years, including me for more than 25 years. I survey the history, in particular the interesting directions and people I have encountered along the way, ending with recent generalizations to nonsquare boards.

Presenter: Godfred Yamoah, Trine University

An error based temporal scheme for adaptive simulation

Adaptive temporal integration is needed in the solutions of Richards' Equation (a model for flow simulations) for several reasons. The solution often results in the formation of sharp fronts. Thus a small time step is required during the formation of the front. A fixed time step method is not computationally efficient. Also the user has no control over the accuracy of the solution. Variable time-stepping based on error control improves both the accuracy and robustness of the code and allows the user to supply an error tolerance for desired accuracy.

We consider a basic first-order one-step method which is derived under the assumption that the nonlinearity of RE is smooth. This allows the next time step size to be expressed as a function of the local truncation error in the current step.