ABSTRACTS OF TALKS PRESENTED TO THE INDIANA SECTION OF THE MAA

1. Introduction

The Spring 2022 meeting of the Indiana Section of the Mathematical Association of America is being held at Indiana Wesleyan University, April 9. 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: Talithia Williams, Harvey Mudd College, MAA Pólya Lecturer

Power in Numbers: The Rebel Women of Mathematics

The movie *Hidden Figures* brought visibility to the lives of African American women who served as NASA "human computers" in the 1960s, women who dreamed the impossible in a field where their presence was lacking. When it comes to inspiring the future productivity and innovation of our nation, we are all on the front lines. In this talk, I'll discuss my personal journey as a woman of color in mathematics and share ways we can excite public interest in STEAM, building upon the rich legacy of the Hidden Figures that have come before us. As we shift the fixed mindset around scientific ability, we can begin conversations that improve public perception of STEAM and bring people from all backgrounds into this important work.

Presenter: Rodrigo Pérez, IUPUI

Joint work with: Stefano Silvestri, Rome

MSC 2020: 01A20

The geometric series in Greek mathematics

Is there a center, a navel, to the mathematical universe? An excellent candidate would be the Pythagorean Theorem. In this talk we will make the case for a less conspicuous concept: the Geometric Series.

Every famous computation done by the modern founders of Calculus, when developing their theory, relied on the GS. It was the only way to deal with infinite processes before heavy duty techniques were invented.

Similarly, the Greeks, taking the first primitive steps toward a form of Calculus (the Method of Exhaustion), relied on the first Proposition of Book 10 of Euclid's *Elements*; this was their version of the GS.

We will trace the development of Greek Mathematical thought through its most famous episodes: musical theory, Pythagorean means, the discovery of irrationality, cube duplication, the Euclidean algorithm, perfect numbers.... Our goal is to show how each of these illustrates a stage of the evolution of ideas leading to Proposition 10.1. We conclude with the only attestation of a true GS computation in any known ancient civilization document.

3. Indiana Project NExT Panel Discussion

Panelists:

- Zsuzsanna Szaniszló, Valparaiso University
- Dan Callon, Franklin College
- Lee Trent, Rose-Hulman Institute of Technology undergraduate student

Moderator:

- Justin Lambright, Anderson University

Mentoring Undergraduates

Dr. Szaniszló will lead us in a discussion about a systematic approach to mentoring and share from a handbook on this she helped create at Valparaiso. Dr. Callon will share Franklin's noteworthy approach to career guidance where the emphasis is on professional skills and dispositions, integrated into course structure, activities, and assessments. Lee Trent from Rose-Hulman will share her experience mentoring through the Online Undergraduate Resource Fair for the Advancement and Alliance of Marginalized Mathematicians.

4. Contributed Talks

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

Binary octahedral group as consciousness template

This paper discusses features of the binary octahedral group (order 48) as a template for consciousness in the brain. Following up on the book *The Blind Mindmaker* by C. S. Morrison, it is supposed that an organism or organization that can organize qualia (whatever they are), such as colors, to advantage will have a better chance of survival, and that mathematical groups, such as the symmetric group S_4 (order 24) and the binary octahedral group (order 48) can provide such organization. Here as examples colors and airplane orientations are matched to quaternions. Researchers, such as Louis Kauffman, and Martin Hay, have studied similar questions. The author has created a set of wooden blocks to illustrate.

Presenters: Matt DeLong, Marian University, and Lara Pudwell, Valparaiso University

MathPath and its Indiana connections

MathPath is a four-week residential summer program for students ages 11–14 showing high promise and interest in mathematics. Similar to the several such camps for high-school-aged students (Canada/USA Mathcamp, Ross, PROMYS, etc.), MathPath is the only camp for middle-school-aged students of its kind. Now entering its third decade, the camp is led by a Senior Staff of five, two of whom (Lara Pudwell, Executive Director and Matt DeLong, Academic Director) are members of the Indiana Section. In this talk we will give an overview of the camp and its history as well as discuss opportunities for involvement by faculty and undergraduate students.

Presenter: Ryan Johnson, Grace College
MSC 2020: 11R18

Concise cyclotomic sums

Given an algebraic integer such as $\sqrt{n} + \sqrt{m}$, what is the minimal number of roots of unity needed in order to sum to it? A bound has already been known in the simple quadratic case. In this talk we will give a perfect bound in the quadratic case and generalize it for more cyclotomic subfields.

Presenter: Rodney Lynch, Indiana University - Purdue University Columbus
MSC 2020: 11R11

Triples of integers from the Law of Cosines

It is known how to produce all Pythagorean triples. Given a triangle with an angle whose cosine is a rational number, I will show that you can generate triples of integers that represent the lengths of the sides of this triangle. This gives a way to write Law of Cosine problems where the missing third side is an integer. I will also give a trigonometric identity involving the cosines of the three angles of a triangle that may not be well known. This identity leads to the equation of a cubic surface with infinitely many rational points.

Presenter: Drake Olejniczak, Purdue University Fort Wayne

Large, but finite

In elementary school, I remember competing with classmates to give the biggest number that we could name. Of course, once we learned there was such a thing as infinity, the game would typically devolve into a discussion of whether infinity is allowed or whether "infinity plus one" is the same as infinity. Despite the apparent childishness of this game, the challenge of naming exceedingly large numbers can bear fruit when approached from an advanced perspective and by defining the rule that only finite numbers should be considered.

In this talk, we explore some famously large numbers, the limits of our physical universe, and how one can even express and compare these "infinity scrapers." By the end of the talk, we will gain a new perspective on what should be considered a "large number."

Presenter: Ranjan Rohatgi, Saint Mary's College

A mathematician's experience on the Indiana Citizens Redistricting Commission

After the US Census in 2020, each state must redraw boundaries for its state legislature's districts and for its federal districts for the US House of Representatives. In Indiana, as in most other states, the state legislature itself is in charge of this process. The ALL IN for Democracy Coalition created the Indiana Citizens Redistricting Commission (ICRC) to show Hoosiers how redistricting can be done by and for the people of Indiana. I was one of nine members on the ICRC. In this talk, I'll discuss the process the ICRC used to create districts and how it is better than the method currently in use in Indiana.

Presenter: Alessandro M. Selvitella, Purdue University Fort Wayne

A journey through data science research at undergraduate-teaching institutions: Thematic programs, conferences, courses, and partnerships towards expanding computational literacy in local communities

In this talk, I will describe the data science activities that I have led or co-led at Purdue University Fort Wayne. Particular attention will be paid to undergraduate-research experiences and the diffusion of data science knowledge to students, faculty, and the broader communities.

Presenter: Mara Smith, Indiana Wesleyan University undergraduate student
Faculty Advisor: Melvin Royer, Indiana Wesleyan University

Nonlinear Lotka-Volterra competition models

The classical Lotka-Volterra equations that model the interactions between two species competing for a limited resource have many potential modifications to improve biological accuracy; this research explores exponential modifications to the competition term. After an introduction to the behavior of the classical Lotka-Volterra equations is given, a nonlinear modification to the model by Taylor and Crizer is discussed. An extension of this modification is proposed, in which the population variable of the competition term is raised first to the power of small integers and, next, positive real numbers. A proof is offered that isocurves for any positive exponent values can intersect a maximum of 3 times, and additional proofs limit the number of intersection points in relation to exponent and parameter values. Finally, we prove that, in such models, the stability of the equilibria alternates between stable and unstable when considered in a northwest to southeast configuration.

Presenter: Lee Trent, Rose-Hulman Institute of Technology undergraduate student

Structure of number theoretic graphs

Questions about the structure imposed on a set of objects by the relationships between them can be reframed as graph theory questions. In particular, one considers the graph whose vertices are elements of that set and whose edges indicate the relationship of interest, and investigates properties of that graph, such as hamiltonicity. In Matt Parker's *Things to Make and Do in the Fourth Dimension*, the question of whether the integers 1 through n can be ordered linearly so that the sum of each pair of adjacent elements is a square is investigated briefly. For n up to and including 14, n from 18 to 22, and $n = 24$, it can't be done. For all other n less than 200, it can be done, as shown by example. It's suspected but not proved that it can be done for all n greater than 25. This presentation will further discuss relevant properties of the graphs underlying this problem, as well as graphs generated by other number theoretic properties.