ABSTRACTS OF TALKS PRESENTED TO THE INDIANA SECTION OF THE MAA

1. Introduction

The Fall 2020 meeting of the Indiana Section of the Mathematical Association of America is being held virtually, hosted by the MAA, October 3. 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 Beineke, Western New England University
Great Moments of the Riemann Zeta Function
Movies have great moments and sports have great moments, but mathematics has the greatest moments of all. In this talk, we will explore moments of the Riemann zeta function (also known as mean values), and we will revisit the momentous discoveries of Hardy, Littlewood, and Ingham in the 1920s. We will also discuss memorable moments that today's number theorists have encountered as they work on open problems related to the Riemann Hypothesis.

Presenter: Amanda Harsay, Lewis University
Wouldn't It Be Nice?
When I was growing up, mathematics was not my best subject, but it was my favorite. I had a great short term memory and could memorize and apply mathematical procedures quickly and effectively. I didn't care where these methods came from or why they worked, as long as I could carry out my steps and get the right answer. This turned out to be problematic for me when I was asked to apply mathematical methods to new problems and conduct research.

Now as an educator, I see myself in my students. They see mathematics as a long list of seemingly disconnected methods and rules without seeing the creative problem-solving behind each technique.

One of my goals for my students is for them to see the bigger picture of mathematics and appreciate the creativity that gave rise to the methods we use over and over again in mathematics. In this presentation, I will share one of my favorite problem-solving techniques, "wishful thinking," and how it can help connect the mathematics curriculum we teach and the problem-solving techniques used by mathematicians and scientists alike.

Presenter: Talitha Washington, Clark Atlanta University
Indiana: The Genesis of Black PhD Mathematicians
In 1925, Elbert Frank Cox became the first Black to earn a PhD in Mathematics. Cox was born in Evansville, Indiana and went on to earn his undergraduate degree in Mathematics from Indiana University in 1917. At a time when Indiana had erupting race riots and the Indiana Klan had risen to a peak of power, how did Cox circumvent the odds? Dr. Talitha Washington, an Evansville native, will tell the story of Cox, the racial struggles of Indiana, and how other Black mathematicians navigate through racial barriers.

3. INDIANA PROJECT NEXT PANEL DISCUSSION

Panelists:

- Karen Holmes, Butler University
- Kristin Kuter, Saint Mary's College

Moderator:

- Justin Lambright, Anderson University

What is Essential? A discussion in two parts.
In the first part, we will hear briefly from Karen Holmes about what makes a course meet the standards to be an Analytic Reasoning course at Butler University, then open this for a broader discussion about the mathematics topics that should be included in these types of general education requirements. Then, we will turn our attention to the topic of Data Science. Kristin Kuter, who was instrumental in the design of Data Science courses at Saint Mary's College, will lead us in a discussion about what topics from Data Science are essential.

4. CONTRIBUTED TALKS

Presenter: Frankie Chan, Purdue University West Lafayette graduate student
Joint work with: Ryan Spitler, McMaster University
MSC 2020: 20, 22, 51, 53
Finite quotients of triangle groups
A result by Bridson, Conder, and Reid shows that two distinct triangle groups are distinguishable by their finite quotients. Given two distinct triangle groups, we utilize the algebraic and geometric properties of Fuchsian groups to construct and effectivize upper bounds for the sizes of finding such finite quotients.

Presenter: Dennis G. Collins, University of Puerto Rico, Mayagüez (retired)
Convexity of symmetry measures for discrete n-point patterns

Following up on the author's 2011 symmetry patent, it is possible to measure the maximum symmetry MAXSYM of an n-point pattern as $(n+1)n(n-1)(n-2)/8$ and by the second derivative test for convex functions, to show this function is convex for $n \geq 2$. On the other hand, 2-dimensional grid growth is generally not convex. Thus to obtain maximum symmetry growth, other methods of organization beyond 2-dim grid growth (such as 3-dim stacking) are required, as possibly related to punctuated evolution. Other examples are discussed.

Presenter: José Contreras, Ball State University
Integrating GeoGebra and deductive reasoning to model and solve problems: The treasure problem as an example

In this presentation, I will illustrate how my students and I have used GeoGebra to represent and model the treasure problem. In addition, synthetic and analytic approaches will be discussed to justify deductively the plausible solution suggested by GeoGebra.

Presenter: José Contreras, Ball State University
Investigating special, general, extended, and converse Varignon Problems with GeoGebra

In this presentation, I will illustrate how my students and I have used a problem-posing framework and GeoGebra to pose and solve Varignon problems using four main strategies: Specializing, generalizing, extending, and reversing. To enrich the students' experience, I start the investigation with the following version of the Varignon's problem: Let E, F, G, and H be the midpoints of the consecutive sides of a parallelogram $ABCD$. What type of quadrilateral is $EFGH$?

Presenter: Paul Fonstad, Franklin College
A deeper dive into voting theory

While voting theory is often a topic for college level math exploration courses (particularly in election years), the topics most commonly covered often leave students with the impression that no system or method is perfect, and by extension, that attempts at improving them are futile. While perfection may not be achieved though, in this talk we will consider ways to reframe the mathematical discussion of voting theory with new topics and ideas to leave students with a more optimistic and action driven mindset. Some ideas for how to direct the classroom discussion will be introduced, and samples of classroom projects will be provided.

Presenter: Joshua Holden, Rose-Hulman Institute of Technology
MSC 2020: 00A66

Markov chains and Egyptian tombs: Generating "Egyptian" tablet weaving designs using mean-reverting processes

Tablet weaving, also known as card weaving, is an ancient method of making strips of fabric that is still used by hobbyists and crafters today. One important difference from other sorts of weaving is that the threads are twisted as the cloth is produced, with different design elements producing different directions of twist. It is desirable for this twist to be balanced across the length of the strip, and this feature has inspired the use of a mean-reverting Markov process known as the Ehrenfest model to randomly generate tablet weaving patterns. I applied this process to the technique known as "Egyptian Diagonals", with very good results. For perfectly balanced twist, however, some extra symmetry had to be artificially introduced into the patterns.

Presenter: Xuan (Shwan) Ma, Pi Learning, Indianapolis
Tutor math through visual art

This talk discusses the pedagogical strategies used in math tutoring in the on-line environment. Tutoring math through visual art can be effective in terms of improving learner's engagement with content, remediation of pre-requisite topics and understanding of relevant key concepts. This presentation showcases a sample tutoring session of using fractal art to cover concepts of function, composite function, graphing, sequence, and series. Various technology tools, such as GeoGebra and WolframAlpha are also introduced to provide the learner with hands-on activities to render artworks.

Presenter: Miles Mena, Lewis University undergraduate student
Modeling Mongolian tent graphs in self assembling DNA using graph theory and linear algebra

Self-assembly is a term used to describe the process of a collection of components combining to form an organized structure without external direction. The unique properties of double-stranded DNA molecules make DNA a valuable structural material with which to form nanostructures, and the field of DNA nanotechnology is largely based on this premise. By modeling complexes with discrete graphs, efficient self-assembly of nanostructures becomes a mathematical puzzle which can be solved using methods from graph theory and linear algebra. This research shares the results of applying these techniques to Mongolian tent graphs.

Presenter: Michael R. Pilla, Indiana University Bloomington
MSC 2020: 32

A generalized cross ratio

Known since the time of Euclid, the famed cross ratio has been a subject of great interest for its robust invariance properties. The Wikipedia page for the cross ratio tells us there is not a good generalization to higher dimensions. In this talk, we define a generalized cross ratio and determine some of its basic properties. In particular, it is demonstrated there is a natural way to generalize this quantity to higher dimensions in a way that deserves to be called "the" cross ratio. Come see what I'm talking about!

Presenter: C. Pospisil, undergraduate student
Generalization Theory of Linear Algebra II
This talk continues Generalization Theory of Linear Algebra I (first part was presented at JMM 2019) and provides inverses for non-injective mappings in multiple dimensions, inverses for non-surjective mappings in one and multiple dimensions and introduces a general determinant theory (second part was presented at JMM 2020). In future work there will be further operations and applications to physics and other natural sciences be explored.

Presenter: John Risher, North Walterboro Christian Academy, South Carolina
MSC 2020: 26D15
Generalizing inequalities using power series approach
In 2012, Mortici introduced his proof of the Nesbitt inequality using power series approach. Taking advantage of the convergence of an infinite series, Mortici neatly converted some cyclic fractions into power series, and used that to find the lower bound of the sum of the series. This technique was quickly adopted by other mathematicians to improve many Nesbitt type inequalities in cyclic form. In this talk we will first introduce some old results, introduced by Jeong, Xu, and Lai, using this new technique. We then will generalize two new inequalities using the same technique, along with a generalized Young's inequality.

Presenter: Alessandro M. Selvitella, Purdue University Fort Wayne
On stationary solutions to the Nonlinear Schrödinger Equation on $\mathbb{H}^d$
In this talk, I will discuss some recent results about stationary solutions to the Nonlinear Schrödinger Equation on the hyperbolic space $\mathbb{H}^d$. I will talk about qualitative properties of the ground state, such as: (i) Existence, (ii) Variational Characterization, (iii) Uniqueness, and (iv) Non-degeneracy.

Presenter: Michael Xue, Vroom Laboratory for Advanced Computing, Indianapolis
Solve Kepler's wine barrel problem without calculus
Kepler conducted numerical studies on his "wine barrel problem" in order to find the maximum amount of wine held by cylinder-shaped barrels. This problem was subsequently solved analytically after the invention of calculus. The problem is stated as: for volume $V = \pi d^2 h/4 - \pi h^3/16$, where d stands for a fixed diagonal of the cylinder, what is the positive value of height h that gives the largest volume V? This talk presents an alternative solution to this famous maximization problem by applying a special theorem without using calculus.