ABSTRACTS OF TALKS SUBMITTED TO THE INDIANA SECTION OF THE MAA

1. Introduction

The Spring 2020 meeting of the Indiana Section of the Mathematical Association of America planned to meet in Indianapolis, jointly with 14 other state academic societies, as part of the Beyond Boundaries: Indiana Academies Symposium, on the occasion of the Indiana University Bicentennial. The entire event was canceled due to the COVID–19 public health crisis.

This document lists abstracts of talks that were approved by the organizers to appear in the printed Symposium program and the online INMAA meeting schedule. After the event cancellation, the organizers approved posting the titles and abstracts on the INMAA web site. These abstracts for the Indiana MAA talks are based on text electronically submitted by the presenters, with contributed talks listed in alphabetical order by presenter.

2. Invited MAA Talk (CANCELED)

Presenter: Suzanne Dorée, Augsburg University

Writing Numbers as the Sum of Factorials

In standard decimal notation, we write each integer as the linear combination of powers of 10. In binary, we use powers of 2. What if we used factorials instead of exponentials? How can we express each integer as the sum of factorials in a minimal way? This talk will explore the factorial representation of integers, including historical connections to permutations, a fast algorithm for conversion, and the secret of the "third proof by mathematical induction." Next we'll extend this representation to rational and then real numbers, ending with some remaining open questions.

3. Indiana MAA Project NExT Discussion (CANCELED)

Panelist:

- Suzanne Dorée, Augsburg University

Turning Routine Exercises into Activities that Teach Mathematical Inquiry

Asking questions, checking examples, making conjectures, and constructing counterexamples are part of any mathematician's toolkit and important skills for our students to learn. The MAA CUPM curriculum guide agrees, calling us to "include activities designed to promote student's progress in learning to ... assess the correctness of solutions, create and explore examples, carry out mathematical experiments, and devise and test conjectures" with the goal that "students should develop mathematical independence and experience open-ended inquiry." How do we help students develop inquiry skills and ignite their curiosity about mathematics? In this professional development workshop we explore some practical strategies you can use to transform routine textbook exercises emphasizing procedural fluency and basic conceptual understanding into activities that teach inquiry. Come ready to try your hand at creating inquiry-based activities.

4. Contributed Talks (CANCELED)

Presenters: Drew Anderson and Jordan Crawford, Taylor University undergraduate students

Faculty Advisor: Derek Thompson, Taylor University

Explorations with 3-ellipses

The 3-ellipse (an extension of an ellipse with three foci instead of two) is a fascinating geometric shape about which little is known. In this talk, we explore 3-ellipses both in general and in relationship to the numerical range of 3×3 matrices. Giving several detailed explanations and examples along the way, we examine whether or not the numerical range of a 3×3 matrix is a 3-ellipse, when the foci of a 3-ellipse are inside the convex hull of the 3-ellipse, and a few other relationships of aspects of 3-ellipses.

Presenters: Levi Cain and Kara Godsey, Grace College undergraduate students

Sabermetrics applied to the Crossroads League

We attempted to apply basic sabermetrics to the Crossroads League men's baseball teams using freely available data. We also implemented a basic ELO method for predicting wins and losses.

Presenter: Zijian Diao, Ohio University

MSC 2020: 03E10

How do snakes multiply?

Can snakes teach us how to do arithmetic? The answer is yes, as there exists a special type of numbers that we can interpret as snakes. In particular, we can construct a set of arithmetic operations on them, which are similar to the everyday ones but full of surprising twists. We will reveal that these snake-like numbers and operations actually offer a rudimentary perspective to a topic originated in Cantor's study of infinity.

Presenter: Paul Fonstad, Franklin College

Teaching the mathematics of voting and representation

In the past two years, I have taught two separate courses related to the mathematics of voting and representation; one aimed at a general audience, and one as a topics course for math majors. This talk will examine the materials, topics, and ideas covered in each course.

Presenter: Joshua Holden, Rose-Hulman Institute of Technology

Markov Chains, Coptic Bananas, and Egyptian Tombs: Generating 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 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. Such a process has been applied to the technique known as "Coptic Diamonds", with very good results. Application to another technique, called "Egyptian Diagonals", is still a work in progress.

Presenter: David Housman, Goshen College
MSC 2020: 91B32

The mathematics of congressional apportionment

The United States Constitution mandates a census every ten years to determine the number of seats each of the fifty states will hold in the House of Representatives. This might seem to be an elementary exercise in arithmetic, requiring merely a simple rounding of fractions. This has not been the case, however. Apportionment methods have been debated frequently and at length. Alexander Hamilton, Thomas Jefferson, Daniel Webster, and Edward Huntington are among the many who have recommended different methods. History and common sense suggest that any apportionment method should satisfy certain fairness properties. For example, (1) if a state deserves 6.3 seats, it should receive 6 or 7; (2) if the total number of seats available is increased, no state should lose a seat; (3) there should be no systematic bias between small and large states; and (4) if state A's population grows faster than state B's population, then it should not be the case that state A loses a seat while state B gains a seat. Unfortunately, no apportionment method can satisfy all fairness properties that have been suggested. Different apportionment methods can be characterized using different sets of fairness properties. The selection of an apportionment method can then be based upon arguments about what constitutes fairness rather than what affords the greatest political advantage.

Presenters: Gyuri Kim and Echo Wu, DePauw University undergraduate students
Faculty Advisor: Seonguk Kim, DePauw University

The method to estimate the hitting time for a random walk

We consider a random walk on the vertices of a finite graph G. First we think a probability matrix coming from the adjacent matrix associated with a graph G. We will show the probability matrix is diagonalizable and has only real eigenvalues. Using the fact, we estimate the hitting time or access time, which is the expected number of steps for a random walk starting at a vertex to reach another vertex for the first time. Finally, using the statistical program R, we show how it can be evaluated for any specific graph.

Presenter: Crystal Lorch, Ball State University

Implementing portfolio assignments featuring proofs and applications

It is a challenge to facilitate productive struggle for students learning to write proofs. Likewise, incorporating meaningful technology-based applications for students to master is difficult. We present an idea for portfolio assignments in proofs and applications to foster student understanding in these areas and showcase their best efforts. We provide examples of such assignments for Linear Algebra and discuss the success of this endeavor.

Presenter: John Lorch, Ball State University
MSC 2020: 05B15
Generalizing Franklin's magic squares
In the mid 1730's Benjamin Franklin was a clerk in the Pennsylvania Assembly. As a boredom-reducing form of amusement during long sessions of the Assembly, Franklin constructed interesting semi-magic squares. One such square, along with a cryptic indication of its magic properties, is shown below.

52	61	4	13	20	29	36	45
14	3	62	51	46	35	30	19
53	60	5	12	21	28	37	44
11	6	59	54	43	38	27	22
55	58	7	10	23	26	39	42
9	8	57	56	41	40	25	24
50	63	2	15	18	31	34	47
16	1	64	49	48	33	32	17

			13	20			
14			51	46			19
	60					37	
		59			38		
			10	23		39	
						25	
50	63	2	15			34	
						32	

Franklin is known to have produced two such squares of order 8 (i.e., 8×8 arrays) and one square of order 16 with similar properties. In fact, semi-magic squares possessing the special properties exhibited in Franklin's squares exist in order $8k$, where k is any positive integer. In this presentation we review Franklin's magic squares, we identify magic properties that should be possessed by a Franklin square of order kp^3 where p is an odd prime, and we construct such squares.

Presenter: Daniele Rosso, Indiana University Northwest
Joint work with: Jonas T. Hartwig, Iowa State University
MSC 2020: 16S35
A consistency equation, cylindrical paths, and twisted generalized Weyl algebras
Given two complex numbers a and b, how can we find all pairs of polynomials (p, q) such that $p(u - a/2)q(u - b/2) = p(u + a/2)q(u + b/2)$? I will explain how to describe solutions to this problem in terms of lattice paths on a cylinder and some consequences for the theory of twisted generalized Weyl algebras.

Presenter: Ryan Solava, Saint Mary's College
Joint work with: Mark N. Ellingham, Vanderbilt University; Songling Shan, Illinois State University; Xiaowei Yu, Shandong University
MSC 2020: 05C
New bounds on the locally irregular chromatic index
A graph is locally irregular if the degree of every vertex is distinct from the degrees of all of its neighbors. A locally irregular edge-coloring of a graph G is an (improper) edge-coloring such that the graph consisting of the edges of any color class is locally irregular. It is conjectured that every graph has a locally irregular edge-coloring using at most three colors. Recently, Bensmail et al. proved that 328 colors sufficed, the first constant upper bound for the problem. Borut et al. later improved this result to 220. We improve the bound on bipartite graphs to five and as a consequence improve the upper bound on general graphs to 183.

Presenter: Christopher Wedrychowicz, Saint Mary's College
Joint work with: Anna Savvopoulou, Indiana University South Bend

Finding the smallest number with exactly n divisors

Let n be a positive integer and let $A(n)$ be the smallest positive integer with exactly n divisors. We will examine an approach which will, with very high probability, yield $A(n)$. When this approach works for a number n, n will be called Ordinary, if not, it is called Extraordinary. Additionally we might ask: given a large positive integer N, about how many numbers less than N are Ordinary?

Presenter: Uditha Wijesuriya, University of Southern Indiana
MSC 2020: 62

Two novel hypothesis tests for comparing several means

Among the most outstanding hypothesis tests, the two-sample t-test concludes whether the two population means are equal, whereas the F-test in ANOVA determines whether more than two population means are equal at a given significance level, assuming both equal population variances and normality. Herein two new statistical procedures for testing hypotheses are introduced. The first procedure tests whether two populations have a specified-common mean, and the second procedure, the generalization of the first, finds whether more than two populations have a specified-common mean, holding the same assumptions. The results gained by employing these two statistical procedures for both simulated and real data will be reported including the p-values.