ABSTRACTS OF TALKS PRESENTED TO THE INDIANA SECTION OF THE MAA

1. Introduction

The Fall 2015 meeting of the Indiana Section of the Mathematical Association of America is at Purdue University North Central, in Westville, October 17. 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: Annalisa Crannell, Franklin & Marshall College

In the Shadow of Desargues

Those of us who teach projective geometry often nod to perspective art as the spark from which projective geometry caught fire and grew. This talk looks directly at projective geometry as a tool to illuminate the workings of perspective artists. We will particularly shine the light on Desargues' triangle theorem (which says that any pair of triangles that is perspective from a point is perspective from a line), together with an even simpler theorem (you have to see it to believe it!). Given any convoluted, complicated polygonal object, these theorems allow us to draw that object together with something that is related to it — its shadow, reflection, or other rigid symmetries — and we'll show how this works. (If you enjoy doodling or sketching, bring your pencil, a good eraser, and a straightedge.)

Presenters: Kay Roebuck and Sheryl Stump, Ball State University

The Common Core and its Fate in Indiana

A history of the design and implementation of mathematics standards including the Common Core State Standards. Discussion about the fate and legacy of the Common Core in Indiana and the implications for reform in mathematics education.

3. Indiana Project NExT Panel Discussion

Panelists:

- Craig Cullen, Illinois State University
- Josh Holden, Rose-Hulman Institute of Technology
- Gerard Venema, Calvin College

Moderator: Stacy Hoehn, Franklin College

Effectively Incorporating Technology in the Classroom

In this panel, we will discuss strategies for using technology within the classroom to aid student learning. Our panelists will first each give an overview of their ideas about how to incorporate software and other technologies into the classroom, and then there will be time for Q&A from the audience.

4. Contributed Talks

Presenters: Eric Ader and Adrea Ayres, Trine University, undergraduate students
Faculty Advisor: Haseeb Kazi, Trine University
Twenty-five years of the MAA student chapters

Twenty-five years have passed since the inception of the MAA Student Chapters Program in January 1989. During this period, numerous new trends and positive changes might have been introduced and implemented in the S.T.E.M. fields, particularly in mathematics. Likewise, the MAA Student Chapters might also have gone through various phases of development, and growth. Obviously, wherever appropriate and applicable, the accomplishments deserve to be recognized, and improvements need be suggested. We sincerely believe that MAA's central Committee on Undergraduate Student Activities and Chapters continues to analyze and monitor their overall progress and also provides guideline for best practices. We have conducted an independent study by individually contacting and collecting responses from almost all of the student chapters listed on MAA's web, and based on these findings, we plan to share our analysis and recommendations.

Presenter: Josh Beal, Indiana University East
The convex hull of Markov distributions

We seek to describe the space of distributions for a discrete process X taking values only in a finite set. We would like to match (in the sense of equal marginals) the process X with a martingale or Markov process, but this is often not possible. Our goal here is to relate a process X with a wider class of probability distributions, namely, the convex hull of all distributions under which X is Markov.

Presenter: David Benko, University of South Alabama, and visiting IPFW
Comparing sporting events
MSC 2010: 60

If two people play a game, the better player does not always win. Luck plays an important role. I reveal a method to calculate the probability that the better player wins using results of tournaments. In particular, I apply the method to tennis tournaments and find out which playing surface is the best in order to maximize the above chance.

Presenter: Betsy Berry, IPFW
Why would anyone ever use portfolio assessment in a mathematics course?

The presentation will describe an alternative assessment strategy that the author uses in a three-semester sequence of mathematics content courses required of pre-service elementary education majors at IPFW. Each of the courses in the sequence focuses on different content areas, including number sense, data analysis, algebraic thinking, geometry and measurement. In courses like these, students usually encounter traditional assessment instruments consisting of tests, quizzes, and textbook homework exercises, however this integrated assessment and instructional approach includes a portfolio assessment strategy based on performance task solutions and extensive explanations, as well as frequent journal entries. This classroom practice has inspired an on-going inquiry that is investigating the following questions:

(1) To what extent do participating students reveal evidence of attitudinal changes about themselves and about mathematics?
(2) How and to what extent do students reveal evidence of learning and deep understanding of the mathematics of the course in their portfolio entries?

Presenter: Adam Coffman, IPFW
Joint work with: Yuan Zhang, IPFW
Examples for Green's Theorem with discontinuous partial derivatives
MSC 2010: 26B20

At my talk about Green's Theorem at the Fall 2014 Indiana MAA meeting at Trine University, I posed the question "does there exist a function $v(x, y)$, so that v and $\frac{\partial v}{\partial x} + i\frac{\partial v}{\partial y}$ are continuous, but $\frac{\partial v}{\partial x} - i\frac{\partial v}{\partial y}$ is discontinuous?" An audience member asked me to conjecture whether the answer was yes or no. In this talk I will resolve that conjecture.

Presenter: Dennis G. Collins, University of Puerto Rico, Mayagüez (retired)
"Tropical" generalized gravity

Gravity has to do with how and to what extent things are pulled together. "Entropic Gravity" studies if gravity can be considered to maximize some form of entropy. Generalized gravity can consider how different entities besides masses can be pulled together, for example words can attract different meanings to themselves via Zipf's Law. Mathematically the different entities can be considered as Gaussian pulses and properties of their sums, such as Fisher information, computed. "Tropical" generalized gravity can represent a simplified static problem versus dynamics, say as a function of scale. Here it is shown that Fisher information goes from a maximum to a minimum back to the same maximum as scale is decreased to zero, wherein the minimum would represent the clumping due to gravity. Attempts to study "affinity" in human relations go back to Goethe.

Presenter: Craig Cullen, Illinois State University
A geometric interpretation of trigonometry

In this talk we will discuss a geometric interpretation of the six trigonometric functions. This will include a discussion of the connections between the geometric interpretations of the words chord, secant, and tangent to the trigonometry of sine, secant, and tangent. During this discussion we will explore definitions for the six trigonometric functions that will allow us to reason about each of the six functions as its own object rather than as an algebraic manipulation of other functions. In this presentation I will highlight the use of technology as a tool to connect multiple representations.

Presenter: Paul Fonstad, Franklin College
Jumping Cars: A game of discrete, dense, and continuous motions on a plane

Inspired by a math puzzle that was originally published in *Discover* magazine in 1989, we will examine a game between two players, one who is trying to stay on a closed region of a certain size, and one who is trying to force them out of the region. Using geometry, trigonometry, and computer programs like Geogebra, we will examine the answers to the original questions posed by the puzzle and then go beyond to explore the generalized problem for all discrete and dense motions on the Euclidean plane.

Presenter: William B. Frye, Ball State University

Mathematics in a non-math course

Most courses labeled as something other than math or science contain little or no mathematics. Sometimes, however, courses that do not appear to be math related can, and perhaps should, include a significant discussion of one or more math topics. The example to be discussed here is an Honors colloquium on Social Security. Some math topics that were included are piecewise linear benefit formulas, indexing for inflation, compound interest and annuity values, use of life tables for calculating survival probabilities, and population projection matrices.

Presenters: Rebecca Grable and A. Andaz Ahmad, Ivy Tech Community College Northeast

Maximizing learning through utilizing learning styles

Teaching mathematics to the non-mathematician is often as stressful for the professor of mathematics as it is for the student. Students, who do not demonstrate a precise inclination for success in mathematics, often get lost in the details of the algorithms. Trying to grasp these details often results in an overpowering drive to ask "why" questions. These "why" questions eat-up valuable classroom time, while the professor is striving to present the lesson in terms of mastering new material as to what the students need to know, and how the students should perform the necessary mathematical algorithms.

This presentation is designed to give the professor of mathematics an overall view of identifying student learning styles while gathering an understanding of why the learning experience in mathematics may be threatening to the non-mathematician. Specific and precise teaching strategies will be given in this workshop to ease the anxiety of the non-mathematician, allowing for a successful experience in the math classroom.

Presenter: Stacy Hoehn, Franklin College

Using Crazy Eights to teach programming and conjecture skills to math majors

MSC 2010: 97D50

The Crazy Eights card game is an effective context for teaching freshmen or sophomore level math majors some important skills, including the ability to use basic computer programming for simulation and the experiment-conjecture-proof process. In this talk, I will describe a capstone project involving this card game that I assigned to freshmen in a Computer Tools for Problem Solving course, as well as what makes this game a particularly good one for teaching introductory students about the utility of if/else statements, for loops, and function structure in computer programming. I will also describe variations on this project that could be used in other courses to teach students about how using computer simulations to model complex processes can be useful for recognizing trends and developing conjectures about general phenomena.

Presenter: Ramesh Karki, Indiana University East

A variational type method for solving nonlinear pseudo-differential equations

We present a method for solving a special type of nonlinear pseudo-differential equation. This method is analogous to the direct method of calculus of variations for solving nonlinear partial differential equations. First, we consider a suitable energy type functional defined on a Sobolev space with a property that its Euler-Lagrange equation is a nonlinear pseudo-differential equation that we want to solve. Using our method, we prove the existence of minimizers of the functional and thus obtain solutions to our pseudo-differential equation as such minimizers.

Presenters: Haseeb Kazi, Trine University, and Alexandra Slick, Trine University undergraduate student

Finding order in learning disorder: How to go the extra mile for the students that face learning challenges

Learning higher mathematics is a challenging and demanding field that causes even the most brilliant minds to struggle. Effective communication between the instructor and the student plays a key role in enhancing both the teaching and the learning experiences. In some cases, though, communication can be clouded in many ways by disabilities, thereby adding to the challenges of the affected student. Academic accommodations are offered by colleges to help students with various learning disorders. We plan to explore how the learning of higher mathematics can be made a pleasant and productive experience for the students that face these challenges every day. A minor, but appropriate adaptation to instructional strategy can often be all it takes to play a great role in leading them to success.

Presenter: Brianna Kozemzak, Saint Mary's College, Notre Dame, undergraduate student

Faculty Advisor: Elizabeth Wolf, Saint Mary's College

Modeling mumps outbreaks: Incorporating delay in stochastic, continuous time models

Mumps is a single stranded RNA virus that is transmittable through respiratory secretions. A review of the literature reveals a delay of approximately 2–4 weeks between exposure to mumps virus and the onset of parotitis and other associated symptoms. We create and explore various stochastic, continuous time models adapted from the SIR disease model, some of which satisfy the Markov property and others of which incorporate fixed or normally distributed delay. Such models are developed for simulation of mumps outbreaks among small communities to investigate the significance of incorporating delay in disease models and to address questions concerning mumps outbreaks among highly vaccinated populations. Preliminary results show significant differences in the course of mumps outbreaks in mathematical models that incorporate delay and those that do not.

Presenter: Jason Lucas, Purdue University, graduate student
Faculty Advisor: Ralph Kaufmann, Purdue University
Decorated Feynman categories
MSC 2010: 55, 18

The combinatorial structure of graphs provides a basic tool in describing and studying structures and relations. For instance, graphs can be used to capture interactions between individuals in a network, bonds between atoms in a molecule, or the behavior of subatomic particles. Graphs are also very well-suited for describing algebraic structures and relations. Operads (and related ideas) codify these, and Feynman categories provide a natural framework for studying these notions. We will discuss decorated Feynman categories, a new construction which allows for the easy generation of the types of operadic structures that Feynman categories are set up to handle.

Presenter: Rodney Lynch, IUPUC
Lattice integral right triangles without vertical or horizontal sides
MSC2010: 11

Starting with a Pythagorean triple of positive integers (a, b, c), I will show that there is a positive integer k for which each of $(ka)^2$, $(kb)^2$, $(kc)^2$ becomes a sum of two squares. Geometrically, we obtain a placement of a right triangle on a square lattice with no sides vertical or horizontal.

Presenter: Daniel Maxin, Valparaiso University
The cumulative risk-taking behavior and its role in epidemics
MSC 2010: 92D30

In this presentation I will describe a recent result that shows how risk-taking behavior in response to a partially effective vaccine may be responsible for causing an epidemic. If transmission happens between two high risk individuals (one susceptible and one infected but not diagnosed) the resulting cumulative risk-taking effect may be the sole driver of the epidemic. In this scenario, unexpectedly, the self quarantine of the diagnosed group may actually be a contributing factor in the epidemic rather than a preventing measure.

Presenter: Jennifer Pajda-De La O, University of Illinois at Chicago, graduate student
Electric networks: An introduction to one application of random walks

Random walks have many applications and uses. One particular application of a random walk is with electric networks. I give an introduction to random walks in one dimension and show how this can be applied to electric networks using voltage, resistance and currents. This can be extended into two dimensions using Markov chains and a transition probability matrix, provided that we can create a connected graph out of the electric network. Probabilistic interpretations of voltage and current are also discussed. This talk is based on the book *Random Walks and Electric Networks* by Doyle and Snell (1984).

Presenter: Adam Salminen, University of Evansville

Residual smallness in commutative algebra

In this talk, we will introduce the concept of residual smallness for commutative rings and modules. An infinite commutative ring R is *residually small* if for every $r \in R\backslash\{0\}$, there exists an ideal I_r such that $r \notin I_r$ and $|R/I_r| < |R|$. This generalizes the notion of residual finiteness (of rings and groups) to other cardinalities. We will investigate rings with this property and discuss the relationship between residually small and homomorphically small rings.

Presenter: Elizabeth Wolf, Saint Mary's College, Notre Dame

Ellipses, polynomials, and a most marvelous theorem

MSC 2010: 30, 51

In this talk, we'll explore some interesting facts about ellipses, as well as some interesting facts about polynomials and their derivatives. We'll also formulate two questions that, at first glance, appear to be completely unrelated. Finally, I'll answer both of our questions with the help of a theorem that has been described as the "most marvelous" in all of mathematics.

Presenter: Young Hwan You, Indiana University East

On Hölder estimates for the Cauchy-Riemann equation on pseudoconvex domains in $\mathbb{C}^n$

Let Ω be a smoothly bounded pseudoconvex domain in $\mathbb{C}^n$ and assume there is a smooth holomorphic curve V whose order of contact with $b\Omega$ is larger than or equal to η. In this talk, I will discuss the maximal gain in Hölder regularity for solutions of the Cauchy-Riemann equation under different assumptions.