ABSTRACTS OF TALKS PRESENTED TO THE INDIANA SECTION OF THE MAA

1. Introduction

The Spring 2012 meeting of the Indiana Section of the Mathematical Association of America is at Ball State University, March 23–24. 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: Matthias Weber, Indiana University

An invitation to minimal surfaces

In a visual tour, we will explore how new examples have triggered the development of the theory of minimal surfaces, and how open conjectures have led to the discovery of new examples in turn.

Presenter: Michael Pearson, Mathematical Association of America

Stirling's Formula: A Monthly *Habit*

Stirling's formula provides a remarkably accurate asymptotic estimate for the growth of the factorial $n!$ for large values of n. James Stirling provided a proof in 1730. Perhaps because of the simplicity of the formula and the ease of observing the basic form of the estimate, it's been attracting mathematicians ever since. In fact, it seems that there has been an average of at least three proofs per decade published in the American Mathematical Monthly over the last 70 years, as well as various other notes and articles that build on or expand Stirling's work. We'll take a discursive look at a few of these notes, with a bit of history of some of the contributors.

Presenter: Jeffrey Diller, University of Notre Dame

Imaginary numbers, unsolvable equations, and Newton's method

You might have been led to believe that math is all about solving equations. Sadly, however, most equations can't actually be solved. The best one can do is to try to approximate their solutions. Newton's method, usually taught in calculus, is one of the oldest and best methods for accomplishing this. The weakness to the method is that it depends on already having a reasonable guess at where the solution lies. In this talk, we look at what happens when you apply Newton's method with no clue about the solution and even allow yourself to use imaginary numbers as starting guesses. Despite the unpromising premise, this story has a happy ending and some nice pictures.

3. Student Workshop

Presenter: David Housman, Goshen College

Fair Allocation

This workshop, intended for students but open to all, will examine four problems involving the distribution of resources such as money, goods, voting power, and jobs. During each half hour, workshop participants will act as negotiators or arbitrators for a problem and then learn about some of the relevant mathematics. Participants can come to any or all of the four half-hour segments.

Problems will be selected from among the following. By collaborating, several cities can save money on upgrading their water treatment facilities. What is a fair way of allocating the savings? Several people have inherited an estate, but they differ in their opinions about the worth of each item in the estate. What is a fair way of allocating the estate? Government representation is sometimes required to be proportional to the population served. How should rounding be done when fractional representatives is the unattainable ideal? At one time, hospitals were making offers to medical students to fill residency positions years before graduation. How did one simple change in the method for allocating these positions result in a more efficient and less destructively competitive environment for this labor market? A firm goes bankrupt. What does the Talmud have to say about a fair way to pay off creditors?

4. Contributed Talks

Presenter: James Carter, Indianapolis University - Purdue University Indianapolis graduate student

Difference equations and Fibonacci numbers

A recurrence relation describes the values of a sequence (function on integers) in terms of previous values and some initial conditions. Once the relation and conditions are known, the entire sequence is determined. When the relation is linear and homogeneous, it can be written as a difference equation, coupled with a number of other relations and oftentimes solved using matrix methods to get an explicit (closed) formula for the general term in the sequence. The archetype of linear homogeneous recurrence relations is given by the Fibonacci sequence. In this talk the method of converting a given problem to a difference equation and finding a closed form solution will be examined.

Presenter: Adam Coffman, Indiana University - Purdue University Fort Wayne
MSC2010: 51N15

Generalizing Eves' Theorem

A 2011 article by Marc Frantz in Mathematics Magazine demonstrated some applications of Eves' Theorem, which states that certain ratios of Euclidean distances are invariant under projective transformations (a non-Euclidean notion) of the plane. The theorem can be generalized to higher dimensions, and some of the results on invariant ratios of areas pre-date Eves.

Presenter: José Contreras, Ball State University

The surrender of infinite: A finite journey to conquer this enigmatic concept

One of the greatest and most original contributions to mathematics has been the concept of the infinite. In this talk I trace some of the major difficulties and controversies faced by scholars in the development of this "disturbing" concept. Our journey will start with the ancient Greeks and will conclude with some of the contributions of the incontestable conqueror of infinite: Cantor. In our exhilarating journey, we will encounter Aristotle, T. Aquinas, Galileo, and Gauss, among others.

Presenter: Melissa A. Desjarlais, Valparaiso University

MSC2010: 01A70, 97A30

Sophie Germain and Fermat's Last Theorem

Sophie Germain (1776–1831) was a talented mathematician who overcame personal and professional challenges to make significant contributions to mathematics and physics. Growing up in Paris at the time of the French Revolution, she spent most of her time at home reading books in her father's library. This began her fascination with mathematics, and she went to great lengths to study it since her family was not supportive. Although she had little formal education, Sophie eventually proved one of the first general results about Fermat's Last Theorem. This presentation will give a brief overview of Sophie Germain's life, describe some of her work on Fermat's Last Theorem, and conclude with some advantages and examples of including history in mathematics courses. Time permitting, a History of Women in Mathematics course being offered at Valparaiso University this semester will be discussed.

Presenter: Timothy Goodrich, Valparaiso University undergraduate student

Joint work with: Drew Groth and Lauren Knop, Valparaiso University undergraduate students

Faculty Advisor: Lara Pudwell, Valparaiso University

Sorting permutations with a finite-depth stack

Donald Knuth first considered stack-sortable permutations using stacks of infinite depth. We extend this work to consider stack-sortable permutations using stacks of specified finite depths. We characterize patterns that sortable permutations must avoid and derive a handy enumeration formula. Exciting future work includes using multiple stacks, different arrangements of stacks, and alternate sorting algorithms. This talk is accessible to all levels of mathematical maturity while still including interesting results.

Presenter: Zachary Keller, Huntington University undergraduate student

The Four Color Theorem

This presentation will look at the history and background behind the four color theorem. It will also take a more in-depth look at a method that was eventually part of the final proof.

Presenter: John Rickert, Rose-Hulman Institute of Technology

Joint work with: Stan Wagon, Macalester College; Jon Grantham, IDA; Witold Jarnicki, Google-Poland

Non-trivial composite sequences through digit appendage

Begin with a number whose base ten representation is $s_0 = a_n a_{n-1} \dots a_0$ and append the digit d n times to obtain the terms $s_n = a_n a_{n-1} \dots a_0 dd \dots d$. For what seed values s_0 is the sequence $\{s_n\}$ always composite? L. Jones showed that when $d = 1$ the seed $s_0 = 37$ produces a composite sequence and provided upper bounds for the smallest seeds that produce composite sequences when for other values of d. Grantham, Jarnicki, Rickert, and Wagon have conjectured minimal seeds for $d = 3, 7, 9$ and have proven the value for $d = 7$, up to certification of some probable primes. We also have conjectures for seed values for the sequences produced when bases other than ten are used, and have found seed values base ten to which any digit can be appended an arbitrary number of times and produce only composite values.

Presenter: Morteza Seddighin, Indiana University East

A dimension reducing optimization theorem and its application to resource allocation problems

We will state a dimension reduction optimization theorem which states under certain conditions optimizing a function of several variables will be reduced to optimizing a function of one or two variables and discuss the application of this theorem to resource allocation problems.

Presenters: Nathan Short, Grace College undergraduate student

Faculty Advisor: Kristin Farwell, Grace College

Michael Jordan vs. Larry Bird one-on-one simulation

Who was the best basketball player of all-time? Debates have raged for many years over this question. We used statistics from some of the best players and simulated multiple one-on-one games between two players. The results were collected and analyzed.

Presenter: Derek Thompson, Indiana University - Purdue University Indianapolis graduate student

The geometry and algebra of linear fractional transformations of the Riemann sphere

Though considered a topic of complex analysis, linear fractional maps have strong ties to algebra as well. The flow of a linear fractional transformation has physical application, and we use algebra techniques to study it. The linear fractional maps of the Riemann sphere to itself form a group under composition, and a single linear fractional map can generate a one-parameter subgroup. We use linear algebra techniques to construct such a one-parameter subgroup associated with a specific map and use the subgroup to discuss the flow of the map under iteration and its applications. We also discuss generalization to higher dimensions.

Presenter: Megan Verhasselt, Huntington University undergraduate student

A more powerful construction

Most mathematicians are familiar with the three "famous problems" of antiquity, and even more so with the problem of trisecting the arbitrary angle. While these problems remain impossible to solve in the traditional method, the search for a solution has led to many interesting mathematical discoveries. My presentation will discuss one particular method of trisection — the art of paper folding.

Presenter: Matthew Wright, Huntington University

Euler integration and applications

Euler characteristic is much more than a number associated with polyhedra — it is a topological invariant that we can extend to an integration theory. I will give an introduction to integration with respect to Euler characteristic. This integration theory has intriguing applications to topological enumeration problems, especially in the context of sensor networks. I will also touch on some current research.

Presenter: Yu Yan, Huntington University

Joint work with: Yifei Pan, Indiana University - Purdue University Fort Wayne; Mei Wang, University of Chicago.

A unique continuation approach to the study of uniqueness of solutions in ODEs

We study ordinary differential equations of the type $u^{(n)}(t) = f(u(t))$ with initial conditions $u(0) = u'(0) = \cdots = u^{(m-1)}(0) = 0$ and $u^{(m)}(0) \neq 0$ where $m \geq n$, no additional assumption is made on f. We establish some uniqueness results and show that f is always Hölder continuous.