ABSTRACTS OF TALKS PRESENTED TO THE INDIANA SECTION OF THE MAA

1. Introduction

The Spring 2014 meeting of the Indiana Section of the Mathematical Association of America is at Indiana University–Purdue University Fort Wayne, April 4–5. 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: Sarah Greenwald, Appalachian State University

Mathematical Morsels from Futurama and The Simpsons

Did you know that *The Simpsons* and *Futurama* contain hundreds of humorous mathematical and scientific references? The only prerequisite for this talk is an open mind, so come find out!

We'll explore the mathematical content and educational value of some favorite moments, including some references in honor of Mathematics Awareness Month, along with the motivations and backgrounds of the writers during an interactive talk. Popular culture can reveal, reflect, and even shape how society views mathematics, and with careful consideration of the benefits and challenges, these programs can be an ideal source of fun ways to introduce important concepts and to reduce math anxiety. In the process we'll look at related, recent work in geometry and computational number theory so a calculator and writing utensil will be useful. For more information, check out `SimpsonsMath.com`.

Presenter: Stephen Kennedy, Carleton College, and Senior Acquisitions Editor for MAA Books

Two Heads Are Better Than None

Every question in probability has seventeen plausible answers. The sixteen incorrect answers always occur to you before the correct one. In this talk a very simple question of probability — If I intend to flip a coin until I see two consecutive heads, when, if ever, should I expect to stop? — leads to a morass, a muddle, and then one seeming miracle. We'll resolve the muddle and explain the miracle and, in true mathematical fashion, leave ourselves with a new unresolved puzzle.

3. Indiana Project NExT Panel Discussion

Panelists: Melissa Desjarlais, Valparaiso; Angie Walls, Franklin; Jeff Watt, IUPUI

Goals and Pedagogy for Remedial Mathematics

We will discuss two aspects of planning remedial mathematics classes: setting goals for the course and designing pedagogy and policies to support students. Panelists will each give an introduction to their experiences with remedial mathematics courses, then there will be an extended time of Q&A with the audience. The panel is open to all meeting participants.

4. Student Workshop

Presenter: Josh Holden, Rose-Hulman Institute of Technology

An Interactive Tour of Public Key Cryptography (and of Number Theory)

Like other branches of mathematics, number theory has seen many surprising developments in the last 50 years. One of the most surprising is the fact that number theory, long considered the most "useless" of any field of mathematics, has become vital to the development of modern codes and ciphers. We will take a hands-on tour of some of these ciphers, focusing on the "public key" ciphers — ciphers which answer the question "Can two persons who have never had a secret in common, by a public discussion agree upon a common secret?" (Beutelspacher) For perhaps the first time in history, the answer is yes in practical terms. The ideas are very easy to understand, and yet underlie large portions of both modern number theory and modern cryptography.

5. Contributed Talks

Presenter: Dan Callon, Franklin College

Student-centered assessment

Good mathematics educators know that not all students learn the same way. Yet we typically apply the same assessment structure to all students. Besides assessing content mastery, we usually also have certain skills or dispositions we would like the students to acquire. Yet the student who actually acquires that skill but not until near the end of the course may have a poor grade because of low scores on early assessments. I have used a two-pronged approach in sophomore-level courses. As part of assessment in multivariable calculus I have used periodic learning reports in which students document their content mastery in whatever way they can. These reports also ask for evidence of preparation for and engagement in class and of contributions to others' learning. Each report is evaluated using a rubric, and a final score assigned based on overall semester accomplishments but also whether the trend is upward or downward. In linear algebra each student earned part of the final grade by negotiating a personal learning plan with me. That plan was designed to address the areas in which that student is weakest. I will discuss my experiences and the advantages and disadvantages I have encountered.

Presenter: Todor Cooklev, IPFW Department of Engineering, Director of the Center for Wireless Technology

On the diagonalization of certain Toeplitz matrices in multicarrier modulation

Multicarrier modulation is the foundation of modern high-data-rate wireless systems. There is a tradeoff between computational complexity and bit-error-rate performance for transmission over multipath wireless channels, and, as a result, several fundamental design techniques exist. Transmitter and receiver designs that are based on the diagonalization of Toeplitz and circulant matrices are well-known, and one design based on skew-circulant matrices was recently proposed by the author. We review these techniques and then present two novel designs based on the diagonalization of certain skew-circulant matrices, together with a simple optimization of the skew parameter.

Presenter: Alexander Diaz Lopez, University of Notre Dame graduate student

W-graphs over non-commutative rings

In 1979, Kazhdan and Lusztig studied Hecke algebras, which arise as endomorphism algebras of representations of groups induced by representations of subgroups. Later, they define representations of Hecke algebras indexed by left cells of Coxeter groups. In my talk, I will construct representations of Hecke algebras on quotient path algebras over suitable quivers (coming from W-graphs), and discuss their relation with the representations indexed by left cells.

Presenter: John Donnelly, University of Southern Indiana

Overlapping congruent rectangles

Let R_1 and R_2 be two congruent rectangles that intersect in at least one point. Fickett has conjectured that if n denotes the length of the part of the boundary of R_1 that lies inside R_2, and m denotes the length of the part of the boundary of R_2 that lies inside R_1, then the ratio n/m is no smaller than $1/3$ and no larger than 3. We will talk about recent advances and results related to this conjecture.

Presenter: Peter Dragnev, IPFW

MSC 2010: 31B15

On the separation of optimal spherical configurations

Spherical configurations with some optimal properties have wide-ranging application in science. In this talk we shall survey briefly the topic and focus on minimal energy configurations and in particular on their separation properties. Our techniques naturally lead to investigation of optimal configurations in the presence of an external field. Numerical computations will be presented as well.

Presenter: John Lorch, Ball State University

MSC 2010: 05B15

Sudoku and orthogonal arrays

We establish a connection between orthogonal Sudoku grids and ordered orthogonal arrays; this connection is reminiscent of well-known connections that exist for Latin squares. As an application, we obtain existence theorems for certain types of ordered orthogonal arrays.

Presenter: Rachel Rockey, Valparaiso University undergraduate student
Faculty Advisor: Lara Pudwell, Valparaiso University
de Bruijn arrays: the L problem

A *de Bruijn Array* (also called a torus) is a toroidal array of numbers where each filling of a $m \times n$ matrix with digits chosen from $\{0, \ldots, k-1\}$ is present only once. While it is well understood how to find a de Bruijn Array for fillings of a $m \times m$ rectangle (Jackson, Stevens, Hurlbert, 2009), arrays for other shapes are unstudied. I have worked to answer the question: can de Bruijn Arrays be found with different shapes of fillings? In particular, I have considered *The L Problem.* Instead of arranging fillings of a rectangular grid, this problem arranges fillings of a 2×2 grid with one square removed. I have proven that a de Bruijn Array does exist for every alphabet using this pattern.

Presenter: Samuel Roth, IUPUI graduate student
Higher dimensional conic sections

The quadric surfaces (ellipsoid, elliptic and hyperbolic paraboloids, one-sheeted and two-sheeted hyperboloids) are often introduced as higher-dimensional analogues of the conic sections, since both are described by second-degree polynomial equations. But the parabola, hyperbola, and ellipse also have a geometric definition as curves of intersection between a plane and a cone. This talk shows how to obtain the five nondegenerate quadric surfaces as the surfaces of intersection between cones and hyperplanes in $\mathbb{R}^4$.

Presenter: Denise Szecsei, University of Iowa
MSC 2010: 97D99
Developing mathematical apps

Public school teachers are given the task of teaching mathematics to students with diverse backgrounds and abilities. Many students are at least one year behind their grade level in mathematics, and may also have trouble reading (adding more difficulty in discussing applications of mathematics). Teachers are expected to identify and correct a wide range of student deficiencies, and are responsible for bringing all of their students up to grade level by the end of the academic year. Last year, the New York City Department of Education initiated a program to encourage software developers to help address some of the challenges in teaching middle school mathematics. This provided an opportunity for software developers to create apps and games that facilitate teaching and learning mathematics while enhancing student engagement. I would like to share my experience in developing and submitting three apps to the organizers of the NYC Schools Gap App Challenge. These apps are: Math Ops, Got It! and Gap App: Fractions.

Presenter: Feng Tian, Trine University
Harmonic analysis of a class of reproducing kernel Hilbert spaces

With a view to applications, we establish a correspondence between two problems: (i) the problem of finding continuous positive definite extensions of functions F which are defined on open bounded domains Ω in $\mathbb{R}$; and (ii) spectral theory for elliptic differential operators acting on Ω, constant coefficients.

Presenter: Young Hwan You, Indiana University East

Interaction methods and technologies for online math classes

With the rapid growth of online education, finding more effective methods in distance education has been a hot topic in educational areas. In particular, interaction has played a key role in improving an online teaching quality. In this talk, I would like to share the experience of using a variety of the interaction methods and technologies in teaching lower and upper level mathematics.

Presenter: Max Zhou, Indiana University Bloomington undergraduate student

Joint work with: Nicholas Miller, University of Missouri; Prof. Kevin Pilgrim, Indiana University Bloomington

A dynamical version of Smale's Mean Value Conjecture

While polynomials are thought of as simple functions, there are still open problems about them. One is Smale's Mean Value Conjecture: Given a 1-variable complex polynomial that fixes the origin, f, does there exist a critical point of f, c, so that $|f(c)/c| \leq 1$? This conjecture has been verified for polynomials with degree less than or equal to 10 and other special cases, but is open in general. We studied a dynamical version of Smale's Mean Value Conjecture by adding the condition that this critical point, c, also converge to the origin under iteration of f. The dynamical version of the conjecture (dynamical SMVC) becomes related to complex dynamics, where our dynamical system is the orbit of a point in $\mathbb{C}$. The dynamical SMVC has been previously verified for degree 2 and 3 polynomials. We present some partial results confirming the dynamical SMVC in the case of degree 4. From computer experiments, the dynamical SMVC seems to hold in general, although we do not have a proof.