ABSTRACTS OF TALKS PRESENTED TO THE INDIANA SECTION OF THE MAA

1. Introduction

The Fall 2017 meeting of the Indiana Section of the Mathematical Association of America is at Manchester University, October 7. 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: Ron Gould, Emory University

Some Unusual Applications of Mathematics

In math classes we often see applications of mathematics to other areas such as physics, chemistry, biology, economics, and more. But mathematics has applications in many places we might not expect. This talk will show you a variety of fairly simple applications of basic mathematics to more unusual problems, puzzles, and games.

Math and Marriage — Don't Call a Lawyer Yet

Beginning with Philip Hall's famed "Marriage" Theorem in 1935, the study of marriages (or matchings) has seen significant development, both theoretical and algorithmic. Taking a graph theoretic point of view, we will consider a number of "marriage" questions including:

(1) When can a set of k marriages be found?
(2) When we do find a set of k marriages, are there ways to optimize the pairings? Here we consider the famed stable marriage theorem.
(3) What ways are there to generalize the idea of marriage? The roommate problem and multi-matchings will be considered.
(4) What can we say about these generalizations? Is there an optimum form of marriage?

Presenter: Gene Fiorini, Muhlenberg College

Challenges of Researching Integer Sequences Using the OEIS

Sequences play an important role in number theory, combinatorics, and discrete mathematics, among many other fields. They enumerate objects in sets and define relationships among items or properties shared between them. Integer sequences have inspired mathematicians for centuries. Likewise, they also inspire computer scientists. The quest to compute new, larger terms in important infinite sequences is harnessing the power of computing and promoting the use of new paradigms in distributed and cloud computing as well as Big Data. Current examples include the "Great Internet Mersenne Prime Search" to find Mersenne primes (sequence A000668 in OEIS) and Microsoft's challenge to discover non-Mersenne or "lost" primes (sequence A138837). By gathering sequences — and a wealth of information

about them – together in a common database, the OEIS (Online Encyclopedia of Integer Sequences), established by Neil Sloane, provides the mathematically curious an invaluable resource with which to explore. This talk presents some interesting sequences found in the OEIS along with its role in stimulating new research.

3. Indiana Project NExT Panel Discussion

Panelists:

- Paul Fonstad, Franklin College
- Lara Pudwell, Valparaiso University

Moderator: Livia Hummel, University of Indianapolis

Implementing the 2015 CUPM Content Recommendations

The 2015 CUPM Content Recommendations include elements common across degree programs in the mathematical sciences. The panelists will share their institutional perspectives and experiences regarding implementation of these content recommendations. In particular, they will comment on their experiences with the following recommendations:

- Content Recommendation #3: Mathematical sciences major programs should include concepts and methods from data analysis, computing, and mathematical modeling.
- Content Recommendation #5: All students majoring in the mathematical sciences should experience mathematics from the perspective of another discipline.

However, these perspectives should be viewed only as a starting point for conversation. Thus, this session will encourage discussion and perspectives from attendees regarding the challenges of and successes in implementation in a variety of institutional settings.

4. Workshop

Presenter: Gene Fiorini, Muhlenberg College

Proposal writing workshop

5. Contributed Talks

Presenter: Kwadwo Antwi-Fordjour, Earlham College

Global dynamics of the shadow Gierer-Meinhardt system with mixed boundary conditions

One of the famous models studied in biological pattern formation is the Gierer-Meinhardt system based on Turing's idea. This system can be used to model skeletal limb development in humans under certain boundary conditions. In this talk, the global dynamics of the shadow Gierer-Meinhardt system will be considered with Robin boundary conditions on one concentration and Neumann boundary conditions on the other.

Presenter: Alexander Barrios, Purdue University graduate student
Faculty Advisor: Edray Goins, Purdue University
MSC 2010: 11G

Exceptional elliptic curves with specified torsion subgroups

The ABC conjecture of Masser and Oesterlé proposed in 1985 states that for each $\epsilon > 0$ there are only finitely many relatively prime positive integers A, B, C with $A + B = C$ and $\text{rad}(ABC)^{1+\epsilon} < C$ where $\text{rad}(a)$ denotes the product over all the distinct prime factors of a. If $\epsilon = 0$, it is well known that there are infinitely many triples of integers as above satisfying the inequality. The ABC conjecture is equivalent to the modified Szpiro conjecture which states that for each $\epsilon > 0$ there are only finitely many rational elliptic curves E such that $N_E^{6+\epsilon} < \max\left\{|c_4|^3, |c_6|^2\right\}$ where c_4 and c_6 are the invariants associated to a minimal model of E, and N_E denotes the conductor of E. A rational elliptic curve is said to be exceptional if it satisfies the above inequality with $\epsilon = 0$. By Mazur's Theorem there are only fifteen possible groups T such that $E(\mathbb{Q})_{\text{tors}} \cong T$. We prove that for each T, there are infinitely many exceptional elliptic curves E with $E(\mathbb{Q})_{\text{tors}} \cong T$.

Presenter: Dennis G. Collins, University of Puerto Rico, Mayagüez (retired)

Aero Cube S_4 group theory blocks

This talk presents a set of blocks that compute the rotation group of a cube, which is isomorphic to the symmetry group S_4 of order 24. This set may be termed "verb blocks," and follows up on a talk "Math Magic Number Blocks and the Wobble Square Method of Multiplication" presented Oct. 18, 2014 at the MAA Indiana Section Meeting at Trine University and Aug. 5, 2015 at the MAA Mathfest in Washington, D.C., covering what may be termed "noun blocks." The said verb blocks show the equivalence of four major methods of group calculation in this case, namely 1) aero manipulations, 2) group cycle calculation, 3) matrix multiplication, and 4) quaternion multiplication. The blocks can operate either on themselves or on the number blocks and might be termed "religious tolerance blocks" since any of the rather different methods of calculation leads to the same result. There seems to be some kind of "twist" involved in all the methods. However the blocks, based on 90 degree rotations, apparently do not extend to, say, 45 degree rotations as a closed set. Conversations with Glenn Collins are acknowledged.

Presenter: Stacy Hoehn, Franklin College

Ethical considerations in the Era of Big Data

Every time we log on to social media, view a website, use a credit card, or use a loyalty rewards card, someone somewhere is gathering data about us. More and more companies and organizations are turning to big data to better find customers and tailor their marketing to them. Yet for every benign use of big data, there also are ones that are unintentionally discriminatory or, worse, intentionally predatory. Since the use of big data is going to continue to grow, it is important to not only help our students learn how to analyze data but also to make our students aware of possible negative consequences of using data to make decisions that affect people's lives. This talk will provide some suggestions for how to incorporate discussions of the ethics of big data in a variety of undergraduate courses.

Presenter: Seonguk Kim, Depauw University

Solutions of the nonlinear polyharmonic equation with periodic potential

In this talk, we investigate quasi-periodic solutions of a nonlinear periodic polyharmonic equation, which is relevant to the study of a Bose-Einstein condensate loaded into optical lattices. In the first part of this study, we consider the perturbation formulas for a linear operator with periodic potential. To do so, I will introduce simple properties: spectral projection and matrix representation, from linear algebra and complex analysis courses. Second, we use the results for the linear equation to find quasi-periodic solutions for the nonlinear periodic polyharmonic equation.

Presenter: Anmol Lamichhane, Earlham College, undergraduate student

Multilinear algebra and its applications

MSC 2010: 11G

"What is a vector? What does it represent physically?" We will start with the question and then attempt to answer that by using the idea of vector space. We will then extend the notion of linear maps to define multi-linear maps and present an example from physics where one uses the multi-linearity property of tensors to "shrink" a complicated-looking expression into a simpler one.

Presenter: Rodney Lynch, Indiana University - Purdue University Columbus

Set problems involving symmetric difference

Recall the symmetric difference of two sets A and B is given by

$$A \triangle B = (A \setminus B) \cup (B \setminus A).$$

Can you find three sets A, B, and C which satisfy:

$$A \triangle B \triangle C = \{2, 3, 4\}, \quad B \triangle C = \{1, 3, 5\}, \quad A \triangle B = \{1, 2, 3, 5\}.$$

A non-Venn diagram solution will be given, and the appropriate setting for my solution will be discussed.

Presenter: Ryan Morley, Manchester University undergraduate student
Faculty Advisor: Timothy Brauch, Manchester University

Results on regular and nearly regular VE- and EV-degree sequences

We will start this talk with a brief introduction to graph theory followed by definitions and examples of VE-degrees and degree sequences. We present some classic results for degree sequences, such as Havel-Hakimi and show our results identifying graphical ve-degree sequences for complete, nearly complete, and bipartite graphs. We finish the talk by giving definitions, examples, and results for ev-degrees and degree sequences. This work was supported by a Faculty-Student Summer Research Grant at Manchester University.

Presenter: Michael Xue, Vroom Laboratory for Advanced Computing

Refuting a conjecture on $x^n - 1$ using a Computer Algebra System

A conjecture states that the absolute value of non-zero coefficient in the factor of $x^n - 1$ is always 1. This presentation refutes this conjecture by a counter example using a computer algebra system (CAS). Furthermore, this talk will pose a similar problem to either prove or refute another conjecture regarding the uniqueness of a solution found by CAS.

Presenter: Godfred Yamoah, Trine University
Joint work with: Kathleen Fowler, Clarkson University

Addressing conservative issues associated with adaptive simulations

Adaptive simulation problems are often characterized by rapid changes in certain regions of the domain. Spatial adaption involves refining and coarsening the spatial mesh grid based on error estimates. However, significant mass-conservation errors may occur if care is not taken during the coarsening phase of the adaption process. In the case where two elements or cells are merged in particular, nodal information must be re-distributed to preserve mass in the newly merged element. For this work we propose another scheme to preserve mass during the coarsening process and provide results on a one dimensional infiltration problem that has been well studied in the literature. The method seeks to redistribute mass on coarsened elements using solution values from the previous time step.