Mathematical Association of America
MD-DC-VA Section, April 13-14, 2012
Stevenson University
Abstracts

Invited Addresses

FRIDAY WORKSHOP

David Kung, St. Mary's College of Maryland

Closer to Fair: Social Justice in Mathematics, Mathematics for Social Justice

4:00 pm, Rockland Center A

The world is an unfair, unjust place. What can math teachers do about it? This talk will focus on two specific ways mathematicians have worked to address issues of social justice both in our classrooms and in our world. The first half of the workshop will focus on the inequalities that pervade mathematics and science classrooms and what people have done to help level the playing field, especially in college math classrooms. In the second half, we will look at how math teachers are using innovative curricula to raise awareness of social justice issues while simultaneously teaching math content. These courses ask students to use the tools of mathematics to study, understand, and even address issues ranging from economic inequity to environmental impacts. Sample classroom activities will illustrate the types of content that might replace the algebra-intensive curriculum for many humanities students.

BANQUET ADDRESS

Peggy Aldrich Kidwell, Smithsonian Institute

Mathematical Recreations and the History of American Mathematics

8:00 pm, Rockland Center Banquet Room

A museum curator sees objects as part of stories. Over the past few years, I have been working to place mathematical recreations within the larger context of the history of American mathematics and of the history more generally. The stories of three recreations first produced in the United States in the nineteenth century - word problems posed in journals, the Chinese tangram, and the fifteen puzzle - suggest the enduring influence of puzzles and reveal aspects of American mathematical practice and mathematical communities.

SATURDAY INVITED ADDRESSES

Alissa Crans, Loyola Marymount

Cracking the Cubic: Cardano, Controversy and Creasing

9:20 am, Blackwell Auditorium

We are all familiar with the solution to a general quadratic equation-some of us even learn songs or mnemonics in school to help us remember the famous formula. But have you heard about analogous formulas for the cubic, quartic, or quintic equations? It turns out that the solution of the cubic didn't become familiar to mathematicians quite so easily! There's a real story here, filled with challenges, drama, and controversy! After hearing this tale and learning a bit about the solution, we will see how the Italian mathematician Margherita Beloch solved the cubic using origami in the 1930's.

David Kung, St. Mary's College of Maryland

How Math Made Modern Music ~~Mad~~ Irrational

3:35 pm, School of Business, Pugh Courtroom

The scale used by 20th century classical musicians is strikingly different from that used in Bach's time. In fact, over the past 500 years, a wide variety of scales have permeated Western music. Amazingly, none of them was "in tune"! In fact, in some sense, no piano is **ever** in tune. The reason for this is purely mathematical. Starting with a single vibrating string, we'll use some physics and some advanced mathematics to make sense of the various sounds a violin can make. Add to the mix a little music theory and some basic arithmetic, and we'll be able to construct several different scales and see what's "wrong" with each one. Finally, by constructing the modern scale, we'll be able to answer the question posed in the title.

Contributed Faculty Papers by Author

Ezra Brown, Virginia Tech
Sums of eight squares, the octonions, and (7,3,1)
9:10 am, Room 302
A sum of n squares times a sum of n squares is again a sum of n squares if and only if n = 1, 2, 4, or 8. The rules for multiplication in four different systems underlie these four sums-of-squares identities. We'll talk about these systems, both familiar (real and complex numbers), less familiar (the quaternions), and not at all familiar (the octonions). Finally, we'll see what the (7,3,1) block design -- a/k/a the Fano plane -- has to do with multiplication of octonions.

Melanie Butler, Mount St. Mary's University
Using Service Learning in Mathematics Courses
8:20 am, Room 302
In this presentation, ideas for mathematics service projects will be discussed. Practical suggestions for incorporating such projects into courses will be given.

David Carothers, James Madison University
Every Proof is a Proof by Picture (In honor of G. Edgar Parker on the occasion of his retirement.)
8:45 am, Room 304
Professor Ed Parker enjoys few things more than a lively mathematical discussion of ideas with which he disagrees. The hyperbolic (so to speak) title of this talk is one he will especially enjoy mocking. A brief partial justification for the title will be supplied, but the primary focus will be the efficacy, utility, and desirability of visual communication of mathematical argument and mathematical proof.

Jerome Dancis, University of Maryland
Needed courses, with Stress On Analytical Reasoning (SOAR)
9:10 am, Room 307
Suggested courses for College freshmen and Grade 12, with Stress On Analytical Reasoning (SOAR). The big bugaboo for students is word problems. Solving word problems, with a stress on analytical reasoning (SOAR), develops basic life skills of reasoning and analysis. Colleges should require very basic math courses with a stress on analytical reasoning. Four courses, which are more useful than “math for poets” courses will be suggested.

Caren Diefenderfer, Hollins University
MAA Tensor and Dolciani Grant Programs
8:45 am, Room 307
I am the currently the director of the MAA's Tensor for women and mathematics grant program. This talk will describe a few of the 2011-2012 and 2012-2013 grant and offer hints on programs that may be of interest. The talk will also describe the differences between the two Tensor programs (WAM and SUMMA) and the Dolciani program.

John Hamman, Montgomery College
New Directions in Developmental Math
2:40 pm, Room 303
Many developmental math courses have implemented course redesign and it has taken many shapes in the colleges of Maryland. We will take an in-depth view of what has worked at Montgomery College and a brief overview of several programs at other schools in the state.

Abstracts

Gregory Hartman, Virginia Military Institute
APEX Calculus: A Progress Report
2:40 pm, Room 302
VMI recently awarded the presenter with course releases so he could collaboratively write an open source Calculus text. This talk provides a progress report on this project. A few of the currently implemented innovations will be highlighted. Ample opportunity for suggestions and discussion will be given.

Laxman Hegde, Frostburg State University
Correspondence Analysis
2:40 pm, Room 304
Any rectangular matrix A can be factored as $(W_1)PDQ\'(W_2)$. This type of factorization is known as weighted singular value decomposition. It is very useful in analyzing contingency table consisting of frequencies. In many research applications, this type of analysis is called correspondence analysis. We will show how to perform a simple correspondence analysis and interpret the results.

Brian Heinold, Mount St. Mary's University
Some bizarre mathematical images
2:15 pm, Room 303
At the last two section meetings, I gave talks about some images I've created by iterating functions in the complex plane. This talk will focus on some of the most bizarre images I have, ones that are far different from the usual Mandelbrot and Julia sets. I will try to explain mathematically why the images look the way they do.

Daniel Joseph, Virginia Military Institute
Gregory Hartman, Virginia Military Institute
Focally Reflective Curves
3:05 pm, Room 302
In previous talks we introduced the generalized parabola - the locus of points equidistant from a point (focus) and a not necessarily linear curve (directrix). In this talk we will briefly review these interesting curves and then show how they can be used to prove that the only focally reflective curves are the conic sections or parts thereof.

Kathryn Linehan, Montgomery College
Singular Value Decomposition and Cool Applications
8:20 am, Room 304
Matrices contain two-dimensional data such as an image, a time-dependent signal, or even a collection of documents. Sometimes instead of operating with the matrix, we would like to decompose the matrix into factors and then operate with those factors. In this talk we focus on the Singular Value Decomposition (SVD) and its applications which include: How much of an image do we actually need so that it appears clear to the eye? If we have a noisy signal, how do we reconstruct the original signal? How can we process a query for a document database? And, how can we solve cryptograms?

Betty Mayfield, Hood College
Jon Scott, Montgomery College
Digging up the History of our Section
2:15pm, Room 307
As we approach the centennial of the MAA (2015) and our Section (2016), a Section History Committee is gathering information so that we can begin to write our history. Come see what we have found out so far and how you can become part of this adventure!

Abstracts

James Parson, Hood College
Ye Olde Fundamental Theorem of Algebra
2:15 pm, Room 302
I will discuss the history and substance of one of the main 18th-century proofs of the Fundamental Theorem of Algebra. The argument is constructive, and I will demonstrate it by factoring a tricky degree-6 polynomial. The idea goes back to a commentary by Hudde on Descartes, and it was later developed by Euler, Forenex, and Lagrange. Finally Gauss filled in some missing details, and we now know it as "Gauss's second proof." Its essence, rephrased using field theory and stripped of its constructive content, survives in many abstract-algebra textbooks.

Wendy Hageman Smith, Longwood University
The Impact of Post-Secondary Teaching Methods in Gen-Ed Math Courses
2:40pm, Room 307
The findings of a case-control study constrasting lecture-recitation methods against constructivist methods in a required general education math course indicate that several considerations can enhance student success. Principally, analyzing students' math anxiety and math-resistance into components encompassing attitude, competency, and comprehension and designing methods that overcome these barriers is critical to the success of many students. The findings also confirm that constructivist methods are more effective with students with such barriers to learning.

Jeff Suzuki, Brooklyn College
Occupy Phase Space: The Mathematics of Dissent and Suppression
3:05 pm, Room 304
In recent years, mathematical models from biology have been adapted to model the various interactions between regimes and opposition groups, or between security forces and terrorist organizations. These models predict some surprising results, with policy implications. We'll examine some of these models; see what they tell us about the interaction between groups; and consider extensions.

Laura Taalman, James Madison University
16 is not enough: The minimal-clue conjecture for Sudoku
9:10, Room 304
A long-standing conjecture in the mathematics of Sudoku is one of the most basic questions one can ask: What is the fewest number of clues that a valid puzzle can have? Mathematicians and computer scientists have tried for years to prove or disprove the conjecture that the answer to this question is 17. In this talk we will examine the evidence that supports this conjecture, the difficulty in proving or disproving it, and the announcement earlier this year that a mathematician from Ireland claims to have solved this problem with a new hitting set algorithm and over 7 million hours of computing time.

Gwyneth Whieldon, Hood College
How Does the Postal Service Sort Mail?
3:05 pm, Room 307
Bayesian networks are often used the model real-world situations, with applications ranging from diagnosing illnesses, to predicting likelihood of passing on a given trait to ones' offspring, to identifying objects in an image. One neat application of these "probabilistic graphical models" is optical character recognition (OCR). Our goal is to input a photograph of printed (or even handwritten) text, and output the content of the text. This has already been widely used to scan images of printed text (as in Project Gutenburg and the Google Books project) and output eBooks which can be stored more compactly, indexed and searched, and be read or translated by machines. The US Postal Service has been using OCR since 1965 to pre-sort mail, as has the popular magazine Reader's Digest. This talk will detail some of the theory behind optical character recognition (OCR) and will include a demonstration of a somewhat naïve OCR model.

Student Abstracts by Author

Aaron Chotikul (Senior), Towson University

Using Celtic Artwork to Introduce Elementary Knot theory in a Secondary Education Classroom

3:05 pm, Room 303

This will be a workshop presentation. Medieval Celtic artwork is filled with many different types of knots. By enlightening the students on the history, origin, and cultural importance of knot artwork, it will interest them in constructing and learning the properties of the knots used. Students will be shown models and asked to construct knots in 2D and 3D. There will be exercises to see if the students can recognize and replicate certain knots. After learning where the knots are used and how knots are classified, the basics of knot theory will be introduced. As they are introduced, they will be related to algebra concepts that students are already familiar with. This will be a great way to introduce different areas of high order mathematics that most secondary education students would not normally experience.

Michael Donders (Senior), McDaniel College

Independence of Colorings on Graphs

2:15 pm, Room 305

Can two portions of a given graph be colored independently, or can the coloring of one be used to restrict the coloring of other? Consider a graph G=(V,E) and two disjoint sets A and B which are subsets of V. If given any two colorings g_1 and g_2 of V, there exist a coloring f which is equal to g_1 on A and g_2 on B, then we call A independent from B on G. Using this definition we have constructed a set of sound and complete axioms which can determine the consistency of logical statements pertaining to this independence.

Sophie Gorman (Sophomore), The Catholic University of America

Geometrical Representation of Election Results

9:10 am, Room 303

This talk will give a summary of and introduction to voting theory and its paradoxes, with a particular focus on Condorcet cycles, which lie at the heart of Arrow's theorem. As an aid to understanding, this talk will explore geometrical results of voting results. These geometrical representations will then be used to draw conclusions about when Condorcet paradoxes will occur.

Alexia Gourley (Senior), Christopher Newport University

Structure Constants of U(sl_2)

8:20 am, Room 307

We derive the structure constants for the universal enveloping algebra of sl_2 over an algebraically closed field of characteristic zero.

Mark Lotts (Senior), Randolph-Macon College

Structure and randomness of the discrete Lambert map

2:15 pm, Room 304

We investigate the structure and cryptographic applications of the Discrete Lambert Map (DLM), the mapping $x \rightarrow xg^x \mod p$, for p a prime and some fixed g in (Z/pZ)*. The mapping is closely related to the Discrete Log Problem (DLP), but has received far less attention since it is considered to be a more complicated map that is likely even harder to invert. However, this mapping is quite important because it underlies the security of the ElGamal Digital Signature Algorithm. Using functional graphs induced by this mapping, we were able to find non-random properties that could potentially be used to exploit the ElGamal DSA.

Abstracts

Jared Meadows (Senior), Roanoke College
Something About Not Knowing Which Game You Are Playing
8:45 am, Room 302
Some of the harder decisions we make in life are those we have to make before we even know for sure what we're deciding on. Maybe our decision is as simple as whether we should wear a raincoat when there's a 40% chance of showers. Or maybe we have to make investing decisions when new laws may affect our strategies. In this talk, we expand on the work of Robb Koether on using game theory to determine how best to strategize when faced with making a decision in a game where the rules may change. Specifically, we look at what effects different rule sets evoke, and what happens when we're faced with three possible games we may be playing rather than two.

Angela Rose (Sophomore), Salisbury University
Erika Gerhold (Sophomore), Salisbury University
Anamorphic Art with a Tilted Cylinder
8:20 am, Room 303
Anamorphic art is created by taking a distorted image and reflecting it off a mirrored surface so that from the viewer's vantage point the distorted image appears correct. The term anamorphic comes from two words that mean "change again" and dates back to as early as the Renaissance. Leonardo da Vinci created the earliest known examples of anamorphic art. Current day artists, like Kurt Wenner and Julian Beever, use anamorphic art to create three dimensional illusions with sidewalk drawings. This project focused on catoptrics or mirror anamorphous. In mirror anamorphous, the distorted image is placed around a mirrored shape to alter a distorted flat image into a correct three dimensional picture on the object. The techniques used are mainly vector calculus and inverse ray tracing to develop a series of formulas to achieve the illusion. Specifically, start with a mirrored cylinder whose central axis was not perpendicular to the horizontal plane and a viewing position above the plane. For each pixel in the original image, imagine a ray was traced from the viewer to the pixel. Then calculate the induced reflections to both the plane and a containing box, thus resulting in the distorted image. In this paper, the methods and mathematical details of the catoptric anamorphic process for a tilted cylindrical mirror will be discussed.

Erik Schafer (Junior), Hampden-Sydney College
Musical Rendering of Mathematical Objects
8:45 am, Room 305
This project explored methods of applying mathematics to the generation of music, and the methods for analyzing music with mathematics. Music was generated randomly using Markov Chains, with specified start nodes, end nodes, and lengths. We applied specific transition probabilities and were able to generate random melodies with consistent and similar structures. Music was also generated deterministically using a binary operation across pitch patterns called composition. We proved that the composition operation is associative. Green's relations, a set of equivalence relations that describe how a binary operation acts in a semigroup, were scrutinized. Finally, the project has added to a software suite which produces and plays melodies utilizing these methods.

Ke Shang (Junior), Hampden-Sydney College
Mathematical Analysis and Synthesis of Musical Waveforms
8:20 am, Room 305
We present some mathematical and computational means for producing and analyzing novel sound synthesis techniques in this paper. We first develop a new signal analysis method, the energy spectrum with respect to instantaneous frequency. Comparing it with Fourier Transform, the instantaneous frequency spectrum may better represent sound as perceived by the ear. We then prove a theorem that ensures the phase modulated network functions well under the sufficient conditions. The phase modulated network is an important approach for producing sounds. At last, we contribute a few examples and ideas for constructing interesting sounds.

Abstracts

Jay Strosnider (Junior), Hampden-Sydney College
Non Odd-Weighted Payoffs in the Path-Guessing Game
9:10 am, Room 305
We consider a two-player game in which the first player (the Guesser) tries to guess, edge-by-edge, the path that the second player (the Chooser) takes through a directed graph. At each node, the Guesser makes a wager on the correctness of his guess, and either wins or loses that amount depending on the next node chosen by the Chooser. We derive optimal strategies for both players on different types of graphs and explain a theorem that can be used to help attain optimal play.

Alicia Velek (Senior), York College of Pennsylvania
Samantha Tabackin (Senior), York College of Pennsylvania
A Classification of Quadratic Rook Polynomials
2:40 pm, Room 305
Rook theory is the study of permutations described using terminology from the game of chess. In rook theory, a generalized board B is any subset of the squares of an n x n square chessboard for some positive integer n. The rook polynomial for B is a polynomial that counts how many ways one can place different numbers of non-attacking rooks on B. In our research, we classified all quadratic polynomials that are the rook polynomial for some generalized board B.

Matthew Villemarette (Junior), Marymount University
A Stochastic Model of the Spread of Cholera
8:45 am, Room 303
Our project involves the application of mathematics in an epidemiological setting to study the spread of cholera infection in a population. We model disease spread using stochastic simulation techniques such as the Gillespie algorithm and the tau-leap algorithm. We compare the dynamics observed in these stochastic simulations to analogous deterministic models that have traditionally been used. Our methods illustrate notable characteristics of disease outbreaks and provide insights that may not be found via the deterministic methods. Ultimately, our aim is to investigate intervention strategies to help limit the spread of this disease.

Nathan Werth (Senior),York College of Pennsylvania
A Ring of Fibonacci Numbers
3:05 pm, Room 305
The set of Fibonacci numbers is given the structure of a ring. The ring is then shown to be an integral domain, isomorphic to the ring of integers.