Mathematical Association of America
MD-DC-VA Section, April 15 & 16, 2016
Montgomery College
Abstracts

Abstracts for the workshop and invited addresses are listed first, in chronological order, followed by faculty and graduate student abstracts, alphabetized by submitting presenter's last name. Faculty panel abstracts are next, alphabetized by the organizer's last name. Student presentation abstracts follow, with student poster abstracts at the end (also alphabetized by submitting presenter's last name).

Invited Addresses

FRIDAY WORKSHOP

Laurie Lenz, Marymount University

Introduction to Process Oriented Guided Inquiry Learning (POGIL) in Mathematics Classrooms

4:00 PM, Rooms 151/152, Bioscience Education Center

A pressing question for the improvement of education is, "If not lecture, then what?" There has recently been much research into inquiry-based learning (IBL) as a way to engage and stimulate student interest in many disciplines, including mathematics. This workshop will introduce faculty to an IBL method of instruction called POGIL (Process Oriented Guided Inquiry Learning). The workshop will provide participants with a basic introduction to facilitation techniques and insight into the structure of a POGIL activity. Participants will use hands-on methods to learn the crucial elements in a successful guided inquiry classroom.

BANQUET ADDRESS

John Adam, Old Dominion University

Rays, Waves and Rainbows: A brief tour through some mathematical history.

8:00 PM, Rooms 151/152, Bioscience Education Center

Rainbows are exquisitely beautiful both optically and mathematically. This very informal (and rainbow-illustrated!) talk will be an attempt to summarize some of the history of 'rainbow theory' from the time of Descartes and Newton onwards. This will involve us in some elementary geometry, trigonometry and calculus to the more sophisticated treatment of the 'rainbow integral' (related to Airy functions) introduced by Sir George Biddle Airy, in his celebrated 1838 paper "On the Intensity of Light in the Neighbourhood of a Caustic". But the theory of the rainbow was not placed on a completely satisfactory mathematical basis until the mid-1970's, when, via the theory of complex variables, deep connections were made with this beautiful optical phenomenon and molecular, atomic and nuclear scattering theory. Most recently, the theory of diffraction catastrophes has played a role in the understanding of multiple bows of various orders. There are many connections here with 'deep' mathematics (at least they are deep as far as the speaker is concerned!)

SATURDAY INVITED ADDRESSES

David Taylor, Roanoke College

A Potpourri of Mathematics in Popular Games

9:55 AM, Rooms 151/152, Bioscience Education Center

Mathematics plays an ever-increasing role in today's world, whether it be in modeling complex processes in the body, predicting winners for March Madness, or showing that a particular chemistry study has validity. Mathematics can also be used to study many games where random chance, perhaps through the rolls of dice or the drawing of cards, plays a role, providing a way to make decisions that advance your quest to win. While a quick read of any introduction to probability book can provide the basis of rolling a few dice or grabbing a few cards, topics such as multinomial coefficients, stochastic matrices, and integer partition analysis are neat, easily understood, topics that can advance our study and understanding of games; in this talk, we apply these topics to games such as Yahtzee, Monopoly, and Blackjack. The speaker reserves the right to add more games and mathematical topics as his whimsical mind allows.

Timothy Feeman, Villanova University
The ART of Tomography
3:35 PM, Rooms 151/152, Bioscience Education Center
We will look at how an algorithm from linear algebra, called Kaczmarz's Method, can be used to create a CAT scan image from X-ray data.

Contributed Faculty Papers by Author

Abdinur Ali, Norfolk State University
Chung-Chu (George) Hsieh, Norfolk State University
Mushtaq Khan, Norfolk State University
Hardware Security Vulnerabilities and Cryptanalysis of Modern Data Encryption Algorithms
9:25 AM, Room 110, Bioscience Education Center
Recently, there were seemingly endless strings of headlines about how to unlock encrypted smart phones. However, there was confusion about the difference between the software-based and hardware-based encryption systems. Software-based encryption systems store encryption keys and passwords in random access memory and it can be defeated using password guessing software or imaging the encrypted data and using parallel off-line attacks. However, hardware encryption based systems prevent copying the contents of the flash drives into a computer without correct authentication. Even if the attacker tries to remove the encryption and memory chips from the device, the chips are embedded in tamper-resisting material. This paper covers hardware security and how to prevent the use of improper encryption modes. This material is based on research sponsored by the Office of the Assistant Secretary of Defense for Research and Engineering (OASD(R&E)) under agreement number FAB750-15-2-0120.

Jathan Austin, Salisbury University
A Problem in Three-Digit Addition
9:00 AM, Room 157, Bioscience Education Center
In this talk, I will discuss mathematics that sprung from a problem involving the sum of two three-digit numbers. Although the mathematics from the original problem is accessible to elementary school students, the mathematics I will focus on in the talk is suitable for use in undergraduate courses. In particular, I will mention connections to combinatorics, number theory, and computer science.

Bud Brown, Virginia Tech
Monthly Problem 3173, Samuel Beatty, and 1/p + 1/q = 1
2:40 PM, Room 157, Bioscience Education Center
One of the most frequently cited problems ever posed in the Monthly is Problem 3173 from March of 1926, in which the reader is asked to prove the following remarkable result: Prove that if p and q are irrational numbers greater than 1 such that 1/p + 1/q = 1, then the sequences {Floor[n*p]:n=1,2,3,...} and {Floor[n*q]:n=1,2,3,...} contain between them each positive integer without repetition.
We'll talk about some of the people involved with the history of this problem, including the English physicist Lord Rayleigh, the Dutch game theorist W. A. Wythoff, and the Canadian mathematician Samuel Beatty, who posed the problem and for whom these so-called Beatty sequences are named. Oh, and we'll also give a proof of this remarkable result.

Hongwei Chen, Christopher Newport University
MAA Journal Problem Solving --- The great value in teaching, learning and research
8:10 AM, Room 110, Bioscience Education Center
Posing and solving math problems has a rich history. This tradition has been carried on in today's MAA math journals. In this talk, based on personal journal problem solving experience, we demonstrate how MAA journal problems solving continues to inspire and enhance teaching, learning and research.

Abstracts

Randall E. Cone, Salisbury University
Video Games and Mathematics: Visualizing Automata
8:35 AM, Room 158, Bioscience Education Center
From Conway's Game of Life to Wolfram's classification rules, automata have become fascinating objects of study for mathematicians and computer scientists alike. In this talk, we examine finite cellular automata in low dimensions using the Unity Game Engine.

Jerome Dancis, University of Maryland
The international PISA Math Test shows that students need instruction in multi-step Arithmetic word problems.
9:00 AM, Room 110, Bioscience Education Center
This talk is based on my article, "What [do students' answers on] the International PISA Math Test Really Tell Us?", which appeared in the American Association of School Administrators Journal of Scholarship and Practice on Pages 31-42 at http://www.aasa.org/uploadedFiles/Publications/Journals/AASA_Journal_of_Scholarship_and_Practice/JPS-Winter2014-FINAL.pdf
Education policy experts pay attention to the Programme for International Student Assessment's (PISA) international comparison tests for 15 year-old students. This talk will use problems from PISA to demonstrate that students need instruction in multi-step Arithmetic word problems and the opportunity to develop "number sense".
Is PISA valid? The question rarely asked. Answer: NO!
It's Finland Beware – NOT Beware of Finland.

Paul Janiczek, Virginia Military Institute
John Conway's Game of Life Implemented in MS Excel
8:10 AM, Room 158, Bioscience Education Center
In 1970 John Conway created the "Game of Life" using very simple rules based on the number of "live" neighbors a cell has. By selecting an initial configuration of cells in an Excel spread sheet and using the four simple rules for the game, users can watch the population evolve. In Excel, this amounts to using conditional formatting to visually differentiate "living" cells from "dead" cells. The use of page scrolling simulates the population evolution.

Brant Jones, James Madison University
Developing problems for a history of math course
2:40 PM, Room 110, Bioscience Education Center
This talk will share some experiences refining a course on mathematical history for future secondary teachers to incorporate active learning elements. In particular, we will showcase some in-class exercises to supplement the text "Journey Through Genius" by William Dunham.

Jennifer Magee, University of Mary Washington
Calculus: something fun for high school students to do on a Saturday
8:35 AM, Room 110, Bioscience Education Center
Each spring for the past 9 years the University of Mary Washington has hosted an annual Calculus Tournament for local high school students. The event typically brings about 45 students (and often a handful of spectators) to campus for fierce mathematical competition and a chance to win coveted prizes. We will discuss what the tournament is, how it is organized, and tips for hosting your own tournament.

Nicholas Martin, Shepherd University
An elementary approach to linear recursions
9:25 AM, Room 157, Bioscience Education Center
The paper presents a totally elementary approach to the well known formulas for linear recursions with constant coefficients. The only prerequisite is the geometric sequence.

Caroline Melles, United States Naval Academy
Non-special divisors on graphs
2:15 PM, Room 157, Bioscience Education Center
The concept of a non-special divisor on a graph is central to Baker and Norine's proof of the Riemann-Roch theorem for graphs. Non-special divisors also have beautiful connections with other areas of graph theory and combinatorics. An ordered Dhar's algorithm due to Cori and Le Borgne can be used to show that the number of non-special divisors on a graph is the value of the Tutte polynomial T(x,y) evaluated at x=1, y=0. Several interpretations of non-special divisors will be discussed, with simple examples.

Roland Minton, Roanoke College
Modeling March Madness
2:15 PM, Room 158, Bioscience Education Center
The NCAA Men's Basketball Tournament is known as March Madness because of the unpredictable upsets that occur each year. Despite this, there are surprising regularities in the results over the years. Two models of the probability of seed i defeating seed j are developed, and used to evaluate the accuracy of the tournament committee's seeding, and to explain why it is better to be a #10 seed than a #8 seed.

Heather Moon, St. Mary's College of Maryland
Heat Flow Inspiring Eigenstuff and Diagonalizability
3:05 PM, Room 110, Bioscience Education Center
In this talk, I will discuss a classroom module created by my collaborators and I. In these modules we use Diffusion Welding and heat flow to inspire topics in Linear Algebra such as Eigenvectors and Eigenvalues. I will also discuss how using this modules has my students wanting to diagonalize a matrix.

Raina Robeva, Randolph-Macon College
Boolean models in population biology? You better believe it!
9:00 AM, Room 158, Bioscience Education Center
Boolean and polynomial models of biological systems have emerged recently as viable companions to differential equations models. It is not immediately clear however whether such models are capable of capturing multi-stability: this behavior is often sensitive to changes in the values of the model parameters, while Boolean and polynomial models are qualitative in nature. In the past few years, Boolean models of gene regulatory systems have been shown to capture multi-stability at the molecular level, confirming that such models can be used when precise information regarding its parameters may not be available. The talk presents Boolean models of budworm outbreaks in a forest and demonstrates that these models exhibit a qualitative behavior consistent with that derived from ODE models. The models can also capture the bistable nature of insect population outbreaks, thus showing that Boolean models can be utilized successfully beyond the molecular level.

Prasad Senesi, The Catholic University of America
An algebraic approach to voting manipulation
8:35 AM, Room 157, Bioscience Education Center
The Borda Count method is commonly used to determine an aggregate social choice of an election when candidates are fully ranked. But it is not without its faults. This voting method violates a compelling voting criterion known as Independence of Irrelevant Alternatives. In this talk we present an algebraic/geometric method of describing this criterion and its violations, using some elementary representation theory of the symmetric group. This algebraic approach adapts to linear generalizations of the Borda Count method, which we will describe as well.

Amy Shell-Gellasch, Montgomery College
Descriptive Geometry and the Jullien Models
2:15 PM, Room 110, Bioscience Education Center

Descriptive Geometry was developed by Gaspard Monge in the 18th century and quickly became an important part of the education of engineers and architects, as well as mathematicians. This area of geometry uses projections to exhibit the properties of three-dimensional objects on the plane. French mathematician A. Jullien wrote a popular text book on descriptive geometry at the start of the 19th century. As an aide to learning, he also developed a set of thirty physical models to exhibit how the projections are made. In this talk I will give a brief history and overview of descriptive geometry. We will also take a look at a few of the Jullien models and see how they bridge the gap between three dimensional objects and two-dimensional projections.

Thomas Sonnabend, Montgomery College
The (Imaginary) History of (the Until Now Unknown) QED Bernoulli
3:05 PM, Room 157, Bioscience Education Center
In the spirit of PDQ Bach, the speaker looks at the imaginary and silly mathematical ideas of QED Bernoulli. As you may not know, QED Bernoulli had unique ideas about algebra, geometry, trigonometry, and calculus. His collected work includes Quadrometry, Differential Inequalities, and Unrelated Rates Problems as well as disproving Fermat's Last Theorem.

Eva Strawbridge, James Madison University
Transport of fluid by rotating helices at a microscale Level
9:25 AM, Room 158, Bioscience Education Center
We modeled fluid flow induced by helical flagella attached to a plane wall, rotating in a viscous (stokesian) fluid using the method of regularized stokelets with the method of images to account for the presence of a plane wall. The purpose of this work was to study the transport of fluid and well as nonzero volume particles by bacterial carpets. This work has applications to biology as well as microfluidics.

Mary Wall, Montgomery College
Calculating the Surface Area of Smooth Manifolds Embedded in 4 Dimensions
8:10 AM, Room 157, Bioscience Education Center
Surface integrals are almost always presented to undergraduate students in the context of surfaces embedded in R^3, which leads some curious students to wonder about the more general case. In this expository talk I will discuss surface integrals in dimensions greater than 3 (without introducing the complex topic of differential forms), using the idea of the Gram matrix to construct differential surface area elements.

Faculty Panels by Organizer

Calculus and the HS/College Interface
Organizer: Bob Sachs, George Mason University
Panelists:
Caren Diefenderfer, Hollins University
Roland Minton, Roanoke College
Mary Nelson, George Mason University
2:55 PM, Room 107, Bioscience Education Center
How do high school calculus and college/university calculus impact each other? Is calculus at crisis (D. Bressoud MAA Leitzel Lecture)? Is the second(?) wave of calculus reform happening now? Bring your perspective and experience.

The Mathematical Preparation of Future High School Math Teachers
Organizer: Bob Sachs, George Mason University
Panelists:
David Carothers, James Madison University
Mary Nelson, George Mason University
Katherine Socha, Park School, Baltimore MD
2:15 PM, Room 107, Bioscience Education Center

We will have a lively conversation on the preparation of future HS teachers viewed from multiple perspectives. What are essential mathematical experiences for future teachers? How is the changing interface between high school and college mathematics impacting future teachers? How do we balance content knowledge for teaching with pedagogy? We hope the audience comes with lots of ideas and questions!

Inquiry Based Learning in the MD-DC-VA Section
Organizer: Cassie Williams, James Madison University
Organizer: Amy Ksir, United States Naval Academy
Panelists:
Mitch Keller, Washington and Lee University
Amy Ksir, United States Naval Academy
Pádraig McLoughlin, Kutztown University of Pennsylvania
Cassie Williams, James Madison University
9:05 AM, Room 107, Bioscience Education Center
Whether you employ inquiry-based activities via POGIL, in a flipped classroom, using project-based learning, or in some other context, it's all good! This panel will be a swap session for those who use or are intrigued by any or all of the above. We are interested in sharing and hearing stories of enthusiasms, frustrations, and triumphs associated with inquiry-based learning. "Inquiry-based learning" in undergraduate mathematics is a method of teaching where students routinely solve non-routine problems, and the primary mode of content delivery is through problem-solving tasks and presentations. In some IBL classes, students spend most of their class time working in small groups to develop the key ideas in a course. In others, students spend most of their class time presenting their ideas to each other. If any of this sounds like your classroom, or what you would hope for your classroom, please join us!

Student Abstracts by Author

Emily Adams, Virginia Military Institute
Will Johnston, Virginia Military Institute
Space Junk Removal
9:00 AM, Room 160, Bioscience Education Center
The amount of debris, whether it is artificial or natural, caught in Earth's orbit is a rapidly growing concern due to the damage done to space craft upon collision. The extremely high velocity of the debris makes it difficult to capture and remove. There have been multiple propositions for removal methods but they have not been implemented. We have analyzed various methods that have already been proposed as well came up with our own solution to the problem.

Christopher Broll, Loyola University Maryland
Exact Values of Gamma Star Function
8:35 AM, Room 163, Bioscience Education Center
Note that this project investigates a topic in number theory, a subject of pure mathematics. The function Γ^* (k) represents the fewest number of variables such that the congruence
a_1 x_1^k+ a_2 x_2^k+ a_3 x_3^k+⋯+a_n x_n^k ≡0 (mod m) has nontrivial solutions, that is at least one variable is not equal to zero (i.e., at least one variable is relatively prime to the modulus m) for all integers m and integer choices a_i. In 1963, Davenport and Lewis found the upper bound Γ^* (k)≤ k^2+1, which has equality when the integer k + 1 is a prime number. Additionally, they proved that Γ^* (3)=7 and Γ^* (5)=16. Four years later, in 1967, using their results, Dodson proved that Γ^* (7)=22 and Γ^* (9)=37; and in 1974, Bovey proved that Γ^* (8)=39. In 1966, Norton showed that
Γ^* (11)=45. Γ^* (k) has been evaluated for every degree k less than 37. Accordingly, in this paper, we are interested in finding the next three values, that is Γ^* (37),Γ^* (38) and Γ^* (39). We will prove the following: Theorem Γ^* (37)=186, Γ^* (38)=229, and Γ^* (39)=235.
See the following webpage for a general, non-technical research description of Dr. Knapp's research, which is related to this project: http://evergreen.loyola.edu/mpknapp/www/research.html

Chelsey Clement, Salisbury University
Emily Marinucci, Salisbury University
Analysis of Best Subsets for Transfer Payloads
2:15 PM, Room 163, Bioscience Education Center
Our research aims to investigate how to maximize profit and shipment net weights for a large international company. We use sample data to determine which variables are correlated in order for the company to achieve their goal of better understanding: shipment net weight, number of shipment pallets, cost per mile, cost per pound per mile and the average weight of the pallets. We perform a regression analysis, order to determine which variables are correlated to maximize profits. There is enough evidence to suggest that our explanatory variables, the number of shipment pallets and cost per pound per mile, are significant predictors of shipment net weight. This surprising result suggests that increasing the average weight of the pallets will maximize the company's overall profit.

James Dean, Hood College
Optimal Digital Filtering Techniques for the Analysis of Pore Water Pressure
2:40 PM, Room 162, Bioscience Education Center
Debris flows are a geological phenomenon that occur in mountainous landscapes and consist of a complex mixture of saturated sediments ranging from silt to boulders. It has been theorized that pore pressure, the pressure exerted by interstitial fluid, is a contributor to the levels of entrained sediments in a debris flow and to overall flow behavior. In laboratory flume experiments using 3 m. flume apparatus at the University of Minnesota, machine noise and particle collisions caused a great amount of noise in pore pressure data. For this reason, it is necessary to establish the most efficient method of data filtration. This study tests the efficiency of the Butterworth and Chebyshev 1 digital filters of increasing order n. The Butterworth filter has maximally flat pass and stop bands and a smooth transition period at a defined cutoff frequency ωc that steepens as n increases. The Chebyshev 1 filter has a steeper roll-off, reducing the length of the transition period, but has a ripple effect in the pass band as an artifact of the Chebyshev polynomial, which may cause data distortion. These are implemented as low-pass filters to remove system white noise and stop-band filters to remove wave-forms that occur as a result of flume vibrations at the onset of each experiment. Establishing the most effective and efficient digital filter can contribute to the standards of small-scale flume experimentation.

Kyle Flanagan, St. Mary's College of Maryland
Algebraic Dynamics of a One-Parameter Family of Cubic Rational Functions
9:00 AM, Room 162, Bioscience Education Center
Dynamical systems have been studied for over a century, and involve the study of iterated functions. The methods used for studying these systems can range from analytic to algebraic. My approach is more algebraic, and uses ideas from number theory and algebraic geometry. A recent paper in algebraic dynamics developed techniques for analyzing cubic polynomials. In this presentation I begin to extend these results to a one-parameter family of cubic rational functions, namely the functions of the form f(x) = (x^3 + c)/x = x^2 + c/x.

Peter Gartland, The Catholic University of America
Jordan Decomposition and Semisimple Lie Algebras
3:05 PM, Room 158, Bioscience Education Center
Jordan decomposition provides a valuable tool in the study of Lie algebras. Some theorems relating to semsimple Lie algebras allow the notion of Jordan decomposition to be extended to all semismiple Lie algebras through 'abstract' Jordan decomposition. In this presentation I will show that if the hypotheses of the theorems are weakened, counterexamples arise, and how this implies that Jordan decomposition cannot be extended to more general classes of Lie algebras.

Jared Gruber, Virginia Military Institute
Connor Norris, Virginia Military Institute
Analysis of Water Conservation and Usage in Drought Areas
8:35 AM, Room 160, Bioscience Education Center
The issue of water scarcity is affecting regions across the globe. A combination of factors such as droughts, lack of snowfall, record high temperatures, and poor water-usage habits have put many areas in a state where their current

water supply dwindles beneath demand, resulting in over-exploitation. The purpose of this model is to show what areas are the main culprits in this water crisis, how to improve conditions, and what can be done to avoid future problems.

Tyler Hoffman, McDaniel College
Hausdorff Dimension of Generalized Fibonacci Word Fractals
8:10 AM, Room 160, Bioscience Education Center
The Fibonacci word fractals are a class of fractals that have been studied recently, though the word they are generated from is more widely studied in combinatorics. The Fibonacci word can be used to draw a curve which possesses self-similarities determined by the recursive structure of the word. The Hausdorff dimension of the scaling limit of the finite Fibonacci word curves is computed and these computations are generalized to a larger family of fractals.

Amos Kern-Perets, St. Mary's College of Maryland
Commercializing Charity: Agent Based Dynamics of Digital Crowdfunding
8:35 AM, Room 162, Bioscience Education Center
We describe a novel agent based model that encapsulates the dynamics of online MFG crowdfunding with NetLogo. Kickstarter is the most successful money for goods (MFG) crowdfunding website in the world, bringing in $7,000,000 in pledges towards projects each month. The motivation for individuals to donate to these projects is a mixture of normal economic motivations and the benefits of donating to charity. The dynamics behind money for goods crowdfunding of driven by economic and charitable motivations together is not well understood and hence deserving of closer examination.

Codie Lewis, James Madison University
Numerical Data Regarding the Cohen-Lenstra Conjectures on Real Quadratic Fields
2:15 PM, Room 162, Bioscience Education Center
Class groups of quadratic fields (the rational numbers together with the square root of a nonsquare integer) provide a way to quantify how badly the field violates unique factorization. We performed a numerical investigation into predictions made by Cohen and Lenstra about the frequency of patterns in the distribution of class groups for each such field. Data was obtained up to a discriminant bound of 4 million for the purpose of establishing a baseline from which more complete studies may be performed. The particular heuristic of concern to us predicts that the percentage of class groups of real quadratic fields with square-free discriminant which contain a p-part in their torsion asymptotically approaches a specific infinite product as the bound on the discriminant is taken to infinity. As it has been suggested that there exits a discrepancy between the conjectured probabilities and the data, we calculated the statistics for p=3,5,7 and used curve fitting to explore secondary terms of the form CX^s for each p.

Christopher Lloyd, University of Mary Washington
The Ko-Lee Key Exchange Protocol with Generalized Dihedral Groups
2:40 PM, Room 158, Bioscience Education Center
Given an arbitrary abelian group A, one may form the generalized dihedral group D(A). As D(A) is usually non-abelian, this makes it a possible candidate for use with certain non-commutative key exchange protocols. Specifically, we examine the security of using D(A) with the Ko-Lee key exchange protocol. An appropriate presentation for D(A) is developed alongside computational methods that allow for the effective use of D(A) with Ko-Lee. Lastly we show that under this presentation Ko-Lee is susceptible to a polynomial time attack.

Samantha Maillie, Salisbury University
A Review of Non-Small Cell Lung Cancer Post-Treatment Follow-up Imaging Procedures with PET/CT Scans Versus CT scans and the Effect on Patient Survival
9:25 AM, Room 163, Bioscience Education Center
For Non-Small Cell lung cancer patients, the NCCN guidelines do not currently recommend PET scans to be used in follow-up. PET scans are proven to detect recurrences early than CT scans alone. This has prompted many doctors to begin incorporating PET scans into follow-up. What has not been evaluated yet is whether PET scans being able to detect these recurrences earlier is effecting patient survival. PET scans are significantly more expensive than CT scans, so it is important

to make sure that the money being spent on them is improving patients' survival. This study exams Non-Small Cell lung cancer patients, stages I- III, diagnosed and treated at Peninsula Regional Medical center in 2012 to evaluate the effect of PET scans being used in patient follow-up.

Chris McEligot, St. Mary's College of Maryland
Examining Elliptic Curves for Cryptographic Use
8:10 AM, Room 162, Bioscience Education Center
The emergence of elliptic curve cryptography in the mid-eighties revolutionized public-key cryptographic systems by decreasing computation time while still maintaining a high level of security. In this talk, we examine several standards used in elliptic curve cryptography, subjecting a subset of the curves recommended therein to a battery of security and efficiency tests in order to establish a performance baseline for comparison with elliptic curves generated at random.

Ian Miller, St. Mary's College of Maryland
Ryan Johnson, St. Mary's College of Maryland
Nice Games: Partizan Games With an Impartial Muller Twist
2:40 PM, Room 160, Bioscience Education Center
In this talk we will describe a subset of combinatorial games which we call "nice games". Nice games are a class of impartial comply/constrain games formed by placing a nice twist on a partizan game, where on any move the previous player decides whether the next player will play as left or right for the turn. In this talk we will discuss the nice twist and make some observations on its general form.

Ahmad Nazeri, Randolph-Macon College
Human vs. Machine: Can computers be programmed to play chess?
3:05 PM, Room 162, Bioscience Education Center
Since the dawn of humanity, humans have always wanted to test their limits. With the invention of computers, a new limitation had arrived; allowing computers to think on their own. The board game of chess is an excellent example of testing this limitation. Since 1950, Programming a Computer for Playing Chess by Claude Shannon has been in the forefront of the solving the problem. The paper discusses the different methods, brute-force and game theory, that can be used to program a computer to play chess. Forty-seven years later in 1997, IBM's Deep Blue beat the world champion Garry Kasparvov.

William Oehlbeck, Salisbury University
Jarell Hackett, Salisbury University
Parallel Computation in Graph Traversal Algorithms
2:40 PM, Room 163, Bioscience Education Center
The serial version of modern graph traversal algorithms can be time consuming when applied to large graphs. Parallel computation is a widely used technique for decreasing processing time, when a parallel algorithm exists for the work at hand. In graph theory, the standard Breadth first and Depth first search are serial algorithms, which are limited to navigating a graph one node at a time. The goal of our research is to create a parallel algorithm that visits multiple graph nodes within the same time interval that the serial algorithms would take to visit a single node, and therefore decrease the time required to navigate the graph. Our method for parallelizing graph traversal involves conducting breadth first search in parallel on a linux cluster. The graph nodes are divided by index amongst the compute nodes by the cluster's master node. The compute nodes then conduct breadth first search beginning with the given graph node. In early testing, this method improves graph traversal computation time, and we are testing this hypothesis by comparing runtimes of our parallel algorithm to our serial algorithms.

Ashley Paul, St.Mary's College Of Maryland
That's Not How I Learned It! Bridging the teacher/parent gap.
2:15 PM, Room 160, Bioscience Education Center
Traditionally mathematics was taught through algorithms and memorization. This method is not supportive of mathematical understanding and thinking. Common Core Mathematics is a set of standards that uses techniques to help

students gain an understanding of mathematics and how it works. However, these techniques look completely different from traditional methods which creates tension with parents trying to help their kids in school. Bridging the gap between how parents remember learning mathematics and why there has been a change to the traditional methods is important to relieve these tensions. We will introduce a website that connects traditional methods of teaching mathematics to Common Core Mathematics and explains why these methods are beneficial to students. This will help bridge the gap about parents' misunderstandings on traditional methods of teaching mathematics versus new Common Core methods.

Zachary Pisano, Loyola University Maryland
A Multivariate Statistical Analysis of Bullet Velocity
8:10 AM, Room 163, Bioscience Education Center
The field of ballistics is marked by significant variability in the form of bullet velocity. Chesapeake Testing in Belcamp, MD has collected several thousand data on bullet velocity across several categorical and numerical variables over the past several years. Primary analysis of this data dealt with determining differences between the categorical variables of gunner, recorder, and barrel as well the construction of a linear mixed effects model to determine the effect of atmospheric conditions on bullet velocity. Comparative boxplots and hypothesis testing revealed that significant differences in bullet velocity do exist between individual gunners, recorders, and barrels. Additionally, interactions between temperature and pressure; pressure and humidity; and temperature, pressure, and humidity were shown to have a significant effect on bullet velocity. However, the extent to which these differences may be understood or predicted is nebulous at best. Chesapeake Testing possesses a great deal of data that may yet be subjected to future analysis and study.

Ryan Poffenbarger, Virginia Military Institute
Hungarian Algorithm and Image Mosaicking
9:25 AM, Room 160, Bioscience Education Center
An analysis of the Hungarian Algorithm and its application in image mosaicking.

Caleb Svobodny, St Mary's College of Maryland
Vennim!: A New Intersection of Sets and Games
9:25 AM, Room 162, Bioscience Education Center
Imagine a Venn Diagram with any number of stones placed in each of the circles and their overlap. Vennim is a variation on the combinatorial game Nim where players take turns removing any number of stones from any of these overlapping piles. In this talk, we analyze outcome classes of Vennim on two piles, and use the Sprague-Grundy Theorem to extend this analysis to the behavior of Vennim on three or more piles.

Noah Watson, James Madison University
Examples of Large Gaps in Contingency Tables
9:00 AM, Room 163, Bioscience Education Center
Integer programming can be used to find upper and lower bounds on the cells of a multi-dimensional using the information from the released margins. It is know that in this context that large gaps between the integer programs and their linear relaxations can occur. However, some of the more notable examples of large gaps have been shown to be rare. Here we provide some results on the rarity of large gaps on small tables.

Dylan Weber, St. Mary's College of Maryland
Raised Turning Sweepers
3:05 PM, Room 160, Bioscience Education Center
Circles sweep out area with respect to their center in an amount that is proportional to the turning of the circle. We study planar curves in R^3 that lie in planes parallel to the xy-plane that sweep out area with respect to the origin in proportion to their turning. We dub such curves "raised turning sweepers" and find that their support functions solve a differential equation. We study the differential equation to establish several limiting behaviors.

Graylon Wright, Salisbury University
A Special Case of the Converse to the Mean Value Theorem
3:05 PM, Room 163, Bioscience Education Center
The Mean Value Theorem is a common topic in both calculus and introductory real analysis. In general, its converse is false. In this paper, we state a conjecture about a special case of the converse and document the current progress made towards its proof.

Student (Poster) Abstracts by Author

Christy Bertolaccini, Salisbury University
Alexa Raines, Salisbury University
Optimal Investment Strategy
2:10 PM, Rooms 151/152, Bioscience Education Center
While participating in the four day Mathematical Contest in Modeling, we faced many challenges. Over this four day period we created multiple decision trees based on the school's population size to determine how to donate the grant money in the most efficient way. To figure out how much of the money should go towards tuition and academic software, we created an excel spreadsheet to quickly calculate the return rate for each investment. This model is comprehendible for the average reader and can easily adapt to similar modeling scenarios. Due to time constraints, there were many obstacles our team faced that would be tackled differently after further reflection. This model would benefit by being narrowed down to fewer schools that receive grant money in order to help more students per school. To further support our investment strategy, additional research would be necessary, such as investigating how other foundations invest their grant money and additional variables that may affect the success rate of college students. Using this hindsight knowledge, future MCM participants can better focus their time and efforts in order to create the most successful model in this short period of time.

Madison Gamble, McDaniel College
Blake Schildhauer, McDaniel College
Sums of Third Powers in Quaternion Rings
2:10 PM, Rooms 151/152, Bioscience Education Center
Generalizations of Waring's Problem -- that for every natural number k there exists an integer g(k) such that every natural number can be written as the sum of at most g(k) k-th powers -- have been studied in a variety of contexts from algebraic number fields to non-commutative groups. We extend results on sums of cubes in the complex numbers to give bounds for g(3) for certain quaternion rings.

Cassie Hartley, James Madison University
Analysis of a Metapopulation Model with an Allee Effect
2:10 PM, Rooms 151/152, Bioscience Education Center
A metapopulation is a collection of subpopulations of the same species living in separated habitats (called patches) coupled by migration. We will consider a metapopulation for which each subpopulations has a carrying capacity and an Allee threshold. An Allee threshold for a patch is a population under which the species is not viable in the patch. Other parameters needed for the model are migration probability and migration survival. We develop a model for such a metapopulation in an arbitrary number of patches, and study the dynamics in two patches in detail. We are especially interested in conservation, so we study which combination of parameters and initial populations lead to persistence of the population. Using detailed simulations in MATLAB, Python, and Sage, we describe the basin of attraction for the zero population, that is, the range of initial conditions for which the population goes extinct; these are the initial conditions we want to avoid, and if there are too many of them, the population is more likely to go extinct.

Abstracts

Jillian Kasner, Hood College
Cryptanalysis During World War II: The Allies Succeeded while the Germans Struggled
2:10 PM, Rooms 151/152, Bioscience Education Center
Prior to World War II, Germany was the center of the mathematical community: David Hilbert, Emmy Noether, Oskar Bolza, Felix Hausdorff, Ludwig Bieberbach, and Albert Einstein (amongst others) were significant mathematicians in the 1920's and 1930's. Despite Germany's prewar mathematical strength, it was the Allies who succeeded at mathematical cryptanalysis during World War II. This success lead to the Allied victory. My poster will address the many reasons for Germany's struggle, involving mathematics and the government's reaction to cryptanalysis.

Fiona Lyons, Hood College
The Heliocentric Revolution
2:10 PM, Rooms 151/152, Bioscience Education Center
Nicolaus Copernicus (1473 – 1543) is often credited with sparking the Scientific Revolution with his publication "De revolutionibus orbium coelestium," which argued for a sun-centered (heliocentric) solar system rather than an earth-centered (geocentric) one. However, the beginning of this revolution was slow-going; decades passed before other publications agreeing with Copernicus' world system emerged. In order to better understand this important first step in the Scientific Revolution, we study how mathematicians in the late 16th century converted from geocentricism to heliocentricism, finding that different mathematicians had very unique reactions to this radical publication.

Catherine Traini, Hood College
Invention or Discovery: A Philosophical Discussion of Mathematics Through the Gamma Function
2:10 PM, Rooms 151/152, Bioscience Education Center
Leonard Euler is arguably one of the most seminal mathematicians in history with his breadth of contributions touching not only mathematics, but also physics, astronomy, and logic. His work has contributed to several subfields of mathematics including special functions. The field of special functions is essentially a reserve of formulae that are commonly used in applied mathematics (Temme 2015). One such special function is Euler's gamma function, defined in modern textbooks as for the real numbers (Grattan-Guinness 1994). Numerous other mathematics like Gauss and Legrendre have developed equivalent approximations for the gamma function. This paper will attempt to chart how the function has transformed since its inception to its current rendition. I will argue that the gamma function has changed over time to better suit the applications of the function unlike similar special functions. This historical analysis will in essence prove that the gamma function is a modifiable invention rather than a natural discovery, therein contributing to the philosophical discussion on whether mathematics is invented or discovered.

Sabrina Walker, Longwood University
Introduction to Discrete Dynamical Systems
2:10 PM, Rooms 151/152, Bioscience Education Center
Dynamical systems is a branch of mathematics that attempts to understand the continuous and discrete processes in motion. This study focused on discrete dynamical systems and their general properties, such as orbits, fixed points, and periodic points.