Mathematical Association of America
MD-DC-VA Section, April 12-13, 2019
Frederick County Community College
and Hood College, Frederick, Maryland
Abstracts

Abstracts for the workshop and invited addresses are listed first, in chronological order, followed by faculty and student abstracts, alphabetized by submitting presenter's last name. Student presentation abstracts follow, with student poster abstracts at the end (also alphabetized by submitting presenter's last name). Friday events are at Hood College, while Saturday events are at Frederick Country Community College.

Invited Addresses

FRIDAY WORKSHOP

Amy Shell-Gellasch

Smithsonian Learning Lab: A Hands-On Workshop

4:00 PM, Room 131, Hodson Science and Technology Center,

The Smithsonian Learning Lab is an online resource platform for educators. Launched in 2016, the Learning Lab is ideal for object-based learning in and outside of class. College educators have used this platform in all courses of study. Choose from over two million images and resources at the Smithsonian or import materials from other sources. Create a collection of items and resources for your course that students then access in class or at home for discussion or assignments. Students can also create their own collections for assignments or portfolios. In this workshop, you will be introduced to different ways to use the Learning lab and get started creating your own collections. NOTE: Attendees will need to bring a laptop with Internet access.

BANQUET ADDRESS

Brian Lins, Hampden-Sydney College

e in a Box of Cereal: Surprising Places to Find Exponentials and Logarithms in Everyday Life

8:00 PM, Whitaker Campus Commons, First Floor, Whitaker Campus Center

From boxes of cereal and folding laundry, to catching tax fraud and the United States House of Representatives, we will explore some interesting and surprising places where exponential and logarithmic functions turn up. Along the way, we'll discuss some of the history and applications of these functions, and even get a glimpse of some very deep mathematical ideas.

SATURDAY INVITED ADDRESSES

Jennifer Beineke, Western New England University

Splendor in the Graphs

9:55 AM, Student Center, Cougar Grille, Room 115L

Graph theory can provide an entertaining analysis of certain games and puzzles. Using elementary results, we will explore brainteasers such as Dots-and-Boxes, Bridg-It, Paradoxical Pennies, and Clever Convicts. That should be preparation enough to set us off on a mathematical sort of safari.

Brant Jones, James Madison University

Seeing the (Game) Trees for the Forest

3:45PM, Conference Center, Room 126 ABC

Imagine taking your favorite game and trying to encode it as a combinatorial graph of moves (=edges) between positions (=vertices), by playing through the game in all possible ways. Depending on your point of view, this structure probably seems either extremely specific (e.g. after 18 years, in 2007, more than 50 computers working together succeeded in solving the game tree for Checkers) or else so abstract as to be almost useless (e.g. one can easily prove that there is a winning strategy for the first player in the game of Hex, but no one knows how to describe it). We will survey a few game trees that are planted in the middle ground, with fascinating patterns that invite exploration and proof (often with undergraduates).

Contributed Faculty Papers by Author

Abdinur Ali, Mushtaq Khan, Norfolk State University
Emulation and Quantum Cryptography
9:25 AM, Braddock Hall 111
The security of modern cryptography is based on computational complexity. For instance, RSA relies on the complexity of integer factorization, AES uses substitution-permutation complexity and the elliptic curves uses curves over finite fields. However, security of quantum cryptography is based on the laws of physics. Quantum cryptography uses conjugate variables which makes emulation of the information content of the qubits impossible. In this paper, we will cover the internal structure of qubits and how quantum cryptography can solve number of eavesdropping attacks.
Content Area: Applied Mathematics
Recommended for Students: Yes

Alfred Beebe, Salisbury University
Pythagorean Triples
8:10 AM, Braddock Hall 111
New formulas for all reduced Pythagorean triples are derived in the spirit of Dickson's Method, using the differences between the hypotenuse and the legs. Every pair of relatively prime natural numbers *(F,G)*, with *G* odd, corresponds to a unique reduced Pythagorean triple *(a,b,c)*, with $a^2+b^2=c^2$, given by $(a=G^2+2FG,\ b=2F^2+2FG,\ c=G^2+2F^2+2FG)$. An alternate proof of Hall's generation of all reduced Pythagorean triples from *(3,4,5)* is given using these formulas.
Content Area: Number Theory
Recommended for Students: Yes

Hongwei Chen, Christopher Newport University
A Real Variable Proof for an Intriguing Log-Cosine Integral
9:25 AM, Braddock Hall 103
By using a contour integral and the digamma function, Borweins proved that a certain integral involving the logarithm of the cosine function was related to the Riemann zeta function. In this talk, we will present an elementary real variable proof for this identity.
Content Area: Analysis
Recommended for Students: Yes

Ray Cheng, Old Dominion University
A Fun Exercise in Probability
2:25 PM, Braddock Hall 112
We'll look at 5 dramatically different solutions to a fun probability problem that came up in the MAA section meeting a year ago
Content Area: Elementary Probability
Recommended for Students: Yes

Abstracts

Jeb Collins, University of Mary Washington
A Posteriori Error Estimation for the Spectral Deferred Correction Method
2:25 PM, Braddock Hall 102
The spectral deferred correction method is a relatively new method for solving systems of ordinary differential equations. This method utilizes basic finite difference methods and iterates on them to obtain higher accuracy than the original method can provide. This talk will discuss methods to estimate the error in this method a posteriori using adjoint-based methods. This necessitates finding a nodally equivalent finite element method, which essentially fills in the holes between the nodes of the finite difference approximation. A standard adjoint-based error representation formula is then used to find the error in a particular quantity of interest.
Content Area: Computational Mathematics
Recommended for Students: No

Ming Fang, Norfolk State University
Choosing the Initial Value for Newton's Method
9:25 AM, Braddock Hall 110
As it is well known, Newton's method can not guarantee its convergence unless the initial approximation is sufficiently close to a true solution. In this talk we will study a random nonlinear demand function. We will use Newton's method to find the inverse demand function. We will demonstrate how to use economic intuition and mathematical intuition to select initial values.
Content Area: Numerical Analysis and Applied Mathematics
Recommended for Students: Yes
Other Needs: MATLAB

Gabe Feinberg, Washington College
Fully Commutative Elements in Coxeter Groups and Complex Reflection Groups
3:15 PM, Braddock Hall 110
A fully commutative element of a Coxeter group is one for which any reduced word can be obtained from another by swapping commuting reflections. For example, in the symmetric group, these are exactly the 321-avoiding permutations, known to be counted by the Catalan numbers. For other types, these fully commutative elements have been studied and enumerated by John Stembridge, and have been found to be related to Temperley-Lieb algebras and Khovanov-Lauda-Rouquier algebras. In this talk, we'll discover some Coxeter groups, and identify their fully commutative elements. We'll extend the theory to more general complex reflection groups and see some interesting combinatorial structures, including the related Catalan triangle.
Content Area: Abstract Algebra, Combinatorics
Recommended for Students: Yes

Susan Goldstine, St. Mary's College of Maryland
Color Swaps in Mosaic Knitting
2:50 PM, Braddock Hall 111
In collaboration with Carolyn Yackel, I have been studying the theory of mosaic knitting, a relatively new form of two-color hand knitting. Mosaic knitting has gained popularity because it is easier for the knitter than most traditional forms of color work. The price of this ease is an unusual set of restrictions on color placement, and the core of our work is a classification of the bichromatic symmetries that are possible within these constraints.
Content Area: Symmetry Groups, Mathematical Art, Knitting
Recommended for Students: Yes

Abstracts

Marshall Gordon, Retired Independent Mathematician
Textbook Presentations and Student Inquiry---Bridging the Divide
8:10 AM, Braddock Hall 112
Practitioners of mathematics are aware that the aesthetic that informs the discipline is one of concision, represented by the formal reasoned argument. As such, formal arguments tend to be limited with regard to providing insights for students toward gaining an understanding of how the proofs came to be as they are the polished conclusions of the inquiries. The talk to be presented will look at formal arguments that the harmonic series diverges through the lens of a heuristic perspective, one considering problem-clarifying strategies that may have led to the concluding arguments. The discussion will also include other elements in mathematics textbooks that could make student understanding difficult due to the presentation aesthetic of efficiency.
Content Area: Harmonic series, Mathematical Heuristics
Recommended for Students: Yes

Rachel Grotheer, Goucher College
Streaming isn't Just for Netflix: How to Deal with Corrupt Signals in Medical Imaging
8:35 AM, Braddock Hall 102
In this talk we look at new algorithms developed to handle different applications of signal processing, where multiple signals that share a commonality are being processed. These signals can be assumed to be streaming in at different times. We will investigate how to deal with large corruptions in the data and look at an application in medical image processing.
Content Area: Applied Mathematics, Signal Processing
Recommended for Students: Yes

Randall D. Helmstutler, University of Mary Washington
Circulant Matrices in Non-Commutative Cryptography
3:15 PM, Braddock Hall 111
Circulant matrices with complex entries have been employed for decades in engineering applications involving the Discrete Fourier Transform, while in characteristic 2 they make an appearance in the MixColumns step of the Advanced Encryption Standard/Rijndael cipher. We will establish general facts about circulant matrices that hold over any finite field, generalizing many of the well-known complex results. In particular, we will obtain information on the number of invertible circulants over a finite field, gauged against the order of the general linear group. We then examine how circulant matrices may be implemented in several commonly studied protocols in non-commutative cryptography, highlighting some potential pitfalls.
Content Area: Algebra, Cryptography
Recommended for Students: Yes

Steven Hetzler, Robert Barber, Salisbury University
Holistic Approach to Business Calculus
8:35 AM, Braddock Hall, 111
It's not news that students in Applied Calculus courses often miss the point of calculus because the algebraic details of solving calculus problems requires all their attention. We suggest that a holistic approach with a spiral structure to the content might improve the situation. This talk will outline the content in an Applied Calculus course, primarily for business majors. Highlights include early exposure to calculus applications, early introduction to direction/concavity and turning/inflection points, spiraling the content so that we review calculus fundamentals often throughout the semester, and a wealth of business applications including a business model and new elasticities from calculus motivation.
Content Area: Undergraduate Mathematics Education
Recommended for Students: Yes

Abstracts

Dan Kalman, American University
Use Calculus to Investigate Price Yield Function
2:50 PM, Braddock Hall 103
If one delays the start of social security payments, the monthly payment amount is adjusted upward. So you receive fewer payments at a higher amount. Where is the break-even point? In my short presentation (ten minutes or less) I will share a curious aspect of this problem. Only math at the level of high school algebra will be used.
Content Area: Financial Math
Recommended for Students: Yes

Minah Oh, James Madison University
Susanne Brenner, Li-yeng Sung, Louisiana State University
Using Mathematics to Solve Real-World Problems
9:25 AM, Braddock Hall 112
Suppose an object is to be heated or cooled with a heat source (the control) in such a way that the corresponding temperature distribution (the state) is the best possible approximation to the desired stationary temperature distribution. Furthermore, the state must always stay below another given temperature distribution as well. Such kind of situation can be formulated in a mathematical problem called an optimal control problem. In this talk, I will talk about my current research on efficient numerical methods to solve state-constrained elliptic optimal control problems with Neumann boundary conditions. This talk will be accessible (and fun!) to undergraduate students.
Content Area: Numerical Analysis
Recommended for Students: Yes

Laura Taalman, James Madison University
Hands-on Discovery Math with 3D Design
9:00 AM, Braddock Hall 112
How can you use 3D printing and design to support a college mathematics course? In this talk we'll discuss one example of a hands-on inquiry-based mathematics course in JMU 3SPACE, a 3D printing classroom at James Madison University. In this course students directed their own explorations of fractals, mathematical cake cutting, knots, polyhedral graphs, infinite geometric series, and other mathematical topics while at the same time using 3D design programs like Tinkercad, OpenSCAD, Meshmixer, and Fusion 360 to construct and 3D print models to support those explorations.
Content Area: Teaching, Technology, Liberal Arts Math, 3D Printing
Recommended for Students: No

Ryan Shifler, Erika Gerhold, Salisbury University
Calculus Readiness
3:15 PM, Braddock Hall 102
We will be discussing a department wide initiative to decrease the number of students receiving a D,F, or W in Calculus I. Our approach to improve student success is based on students significantly lacking algebra and trigonometry skills. The initiative includes weekly student lead precalculus review sessions and weekly assessments on topics that are relevant to the material that students are currently learning in Calculus I. We will present the initiative's motivation, implementation, and preliminary results.
Content Area: Pedagogy
Recommended for Students: No

Abstracts

Will Traves, U. S. Naval Academy
An Invariant Version of the Power of a Point Theorem
3:15 PM, Braddock Hall 103
The Power of a Point theorem is a wonderful little gem that plays an important role in lots of mathematical contest problems involving circles. I'll explain a generalization of the theorem that applies to conics. Along the way we'll see how Cramer's rule implies a key identity, a Grassmann-Plucker relation. This talk will be pitched at an accessible level.
Content Area: Geometry
Recommended for Students: Yes

Jill Tysse, Hood College
Using R Studio Cloud and the Mosaic Package in an Introductory Statistics Course for Math Majors: Lessons Learned so Far
8:35 AM, Braddock Hall 112
This semester, I'm teaching our introductory statistics class for math and science majors for the first time, incorporating R via the free, web-based, next-to-no-setup R Studio Cloud and making heavy use of the Mosaic package. I will speak about successes and pitfalls I've encountered along the way, lessons learned, and resources for anyone interested in taking this approach in their own classes.
Content Area: Teaching, Statistics, R
Recommended for Students: No

Mary Walkins, The Community College of Baltimore County
Contemplative Practices: Breathe and Behold the Mathematics
2:25 PM, Braddock Hall 111
Since enrolling in a three-session Mindfulness Workshop in the spring 2016 at the Community College of Baltimore County (CCBC), for my professional growth, I have intentionally incorporated contemplative practices in my mathematics classes. I constantly encourage my students to breathe deeply and be more mindful, focused and present in the mathematics classroom using innovative techniques. Also, I embolden my students to take a hard look at each mathematical problem posed in the exercises for each section covered in class, and I challenge them to write down what they behold. This is an interactive session, and I will share the activities used to boost student learning/reflection and give results from responses students wrote on a Questionnaire and a Student Survey.
Content Area: Innovative Classroom Techniques
Recommended for Students: Yes.

Jia Wan, Randolph College
Using Programming Tools in Introductory Mathematics Classes at a Liberal Arts College
8:10 AM, Braddock Hall 102
While programming is believed to be bridged with mathematics as both developing critical thinking and problem solving, introducing coding in math classes isn't easy. Lots of higher-education institutions have their own versions of mathematical programming lab classes. I would like to share our experience at Randolph College on constructing hybrid courses involving both programming and math. I will also talk about the outcomes, strengths and limitations of such applications.
Content Area: Mathematics Education
Recommended for Students: Yes

Student Abstracts by Author

Kayla Alderman, Shenandoah University
Impact of Heat on Heart Rate
3:15 PM, Braddock Hall 112
Before I started my research project, I looked at research that was already completed and came to see that the common consensus was that the colder the temperature the lower the heart rate. So I looked at the field hockey team and took their heart rate and temperature for each time of the practice. After comparing that data, there was no correlation no matter how I looked at it. I then looked at individual athletes to see if there was any correlation when I took the average of the individual and used that as a baseline. Then I took how far the data points were from each baseline to see if there was a correlation there with the heat index. I got inconsistent results from this for a variety of reasons. Therefore, I do not have a conclusion to support prior research.

Elizabeth Beller, Shenandoah University
The Fibonacci Sequence in Music
9:00 AM, Braddock Hall 112
The Fibonacci Sequence and the Golden Ratio have long been regarded as mathematical wonders of the natural world. Examples of this set of numbers can be found in many things, ranging from flowers and leaves to pinecones. However, the Fibonacci numbers can also be found in areas other than nature, like music. This talk will explore the uses of the Fibonacci sequence and the Golden Ratio in musical compositions, and discuss if compositions using Fibonacci techniques sound better than those done with traditional techniques.

Kyler Crank, St. Mary's College of Maryland
Modeling Poetic Thought with the Bolzano-Weierstrass Theorem
2:25 PM, Braddock Hall 110
Mathematics is a form of language and language is a form of mathematics. This congruence can be seen particularly with calculus and poetry over the topic of cognition. In terms of methodology, both calculus and poetry utilize precise approximations to produce valuable insights about information and life itself. Calculus has the idea of limits which mark the inferred ends to infinite sequences. The Bolanzo-Weierstrass theorem of advanced calculus allows mathematicians to take any bounded sequence and find a convergent subsequence contained within. Likewise, cognitive poetry has metaphor and metonymy that produce nuanced understandings of an idea through correlation. Arguably, poetry is a medium for ordering abstractions from a bounded reality that converge onto an idea. This paper will explicate the similarities between the Bolanzo-Weierstrass theorem and cognitive poetry, presenting a procedural model to be used for generating poetic thought leveraging mathematical logic.

Maria Cummings, Randolph-Macon College
Investigations into the Discrete Arithmetic-Geometric Mean
8:35 AM, Braddock Hall 110
In this presentation we will discuss the development and derivation of the Discrete Arithmetic-Geometric Mean. The continuous Arithmetic-Geometric Mean converges for any two positive real numbers, and its properties extend similarly to negative real numbers and complex numbers. We investigate the extension of the Arithmetic-Geometric Mean to discrete sets of numbers. We first define arithmetic and geometric means modulo p, with p prime, for discrete sets by applying parallels from the continuous and complex Arithmetic-Geometric Means. Then we analyze patterns and properties shared with the continuous Arithmetic-Geometric Mean and those independent of its continuous counterpart. Lastly, we pose several questions and conjectures concerning the discrete Arithmetic-Geometric Mean for further research and development on the topic.

Abstracts

Garrett Fowler, Salisbury University
Conjecture O Holds for Some Horospherical Varieties of Picard Rank 1
2:50 PM, Braddock Hall 112
Property O for an arbitrary complex, Fano manifold X is a statement about the eigenvalues of the linear operator obtained from the quantum multiplication of the anticanonical class of X. Pasquier listed the non-homogenous horospherical varieties of Picard rank 1 into five classes. Property O has already been shown to hold for one class, the odd symplectic Grassmannian. We will show that Property O holds for two more classes and an example in a third class of Pasquier's list. The theory of Perron-Frobenius reduces our proofs to be graph theoretic.

Will Hankins, St. Mary's College of Maryland
Constant Negative Curvature Non-Orientable Surfaces
2:50 PM, Braddock Hall 103
A long-standing open question in differentiable geometry is whether or not there exists a Mobius strip whose curvature *K* is always -1. We will discuss our attempts to find examples via computer searches over the last year. Basic definitions with pictures will be reviewed and sample simulations will be shown and discussed.

Martha Hartt, Randolph-Macon College
A Proof of Bertrand's Postulate
8:10 AM, Braddock Hall 103
In this presentation we prove that there is a prime number between *n* and *2n* for all natural numbers. This proof is done in a style similar to that of Erdos. However, whereas Erdos originally proved the result for all integers greater than 4000, we prove it for all *n* greater than 32.

Elen Khachatryan, Randolph-Macon College
Riemann Hypothesis: The Zeta Function and its Trivial Zeros
9:00 AM, Braddock Hall 103
The Riemann Hypothesis is one of the Millennium problems published by the Clay Mathematics Institute. First given in 1859 by German mathematician Bernard Riemann, it remains an open problem. The hypothesis states that all non-trivial zeros of the Riemann Zeta function are located on the so-called critical line. This talk will first present a related function, the Gamma function, also known as Euler's Integral. After demonstrating and proving several interesting properties regarding the Gamma function, the Zeta function will be introduced. The calculation of trivial zeros will be demonstrated through one of the functional equations of the Zeta function.

Kyle Morien, Shenandoah University
Modeling the Potential Energy of a Piece of Paper
8:10 AM, Braddock Hall 110
In this talk the elastic potential energy properties of paper will be examined. We attempted to find an accurate function to describe the curve of a piece of paper taking into account gravitational potential energy and energy from the curvature of the paper. By means of calculus of variations and the common equation for gravitational potential energy, an equation was derived and then optimized to minimize potential energy. Using various methods, a differential equation was created and the solution gave us the equation of the curve of the paper. This research can be continued to understand the complex nature of materials made from similar structures of pulps.

Eric Murphy, Old Domain University
A Modern Approach to Identifying Bottlenecks in a Queueing System

for a Non-Profit Organization
9:00 AM, Braddock Hall 111
Every blood drive's main goal is to maximize donations by ensuring prospective donors are able to donate without facing excessive or prohibitive wait times. Blood drives are in a constant need of donors due to the increased demands put on a modern healthcare system. As such, many people are willing to meet that demand. However, donors often leave drives without donating due to excessive wait times. As a general principle, donor turnout varies widely depending on where the blood donation site is located. This work aims to address the problem of predicting when "bottlenecks" occur in the donation process by combining a time series approach with a decision tree to allow resources to be allocated efficiently.

Ryan Rhoades, St. Mary's College of Maryland
Exploration of the Inverse Galois Problem Using SageMath
9:25 AM, Braddock Hall 102
With the goal of coming to a more comprehensive understanding of Galois theory, we approach the Inverse Galois problem using the program SageMath. Through this process, we solidify the basics of Galois theory, explain reasons for investigating the Inverse Galois problem, discuss the use of generic polynomials, and the implementation of Sage to quickly construct and identify Galois groups of particular interest. In Sage, we run through examples of Galois groups provided various irreducible polynomials, and through enough examples form the optimal techniques for identifying any Galois groups produced in Sage. We then explore what information generic polynomials can provide within the program, and finish summarizing the limits of what Sage can compute given a specific Galois group or its corresponding irreducible polynomial.

Mariel Santos, Beth Thomas, St, Mary's College of Maryland
Carpenter Ant Grooming Rates
2:25 PM, Braddock Hall 103
Through Image and Video Processing in MATLAB, we analyzed the grooming rates of major and minor worker Carpenter ants. We looked at the relationship between grooming rates and communication.

Danealia Simmons, Shenandoah University
Catching a Killer: The Mathematics Behind Geographical Profiling
9:00 AM, Braddock Hall 102
Have you ever wondered how the police narrow down the search area for a killer? Geographical Profiling is a method used to triangulate an offenders anchor point based on the locations of the crimes he/she has committed. Many algorithms are used in geographical profiling and each has their own set of strengths and weaknesses. This presentation will explore the different algorithms used in geographical profiling and discuss whether or not they can be combined in order to produce a more efficient and accurate way of calculating a search area.

Maxwell Stribula, Jessica O'Shaughnessy, Shenandoah University
Why was Six Afraid of Seven? Because Six had Math Anxiety!
8:35 AM, Braddock Hall 103
Did you hate math in school? Do you struggle with those "math challenges" on Facebook? Then you might just have math anxiety! Math anxiety has been around for decades with Its origins dating back to as early as an old 16th century nursery rhyme. This study will use the Revised Math Anxiety Rating Scale (RMARS) to evaluate the level of math anxiety in 13 Pre-calculus students. The result of the RMARS will be compared to a secondary survey in which the subjects will select about how often they utilized certain "external resources." These resources include going to their professor's office hours to ask questions, completing extra nongraded homework assignments, asking a friend for help with studying or an assignment, or going to the on-campus math enrichment center for tutoring. At the end of the study, subjects will also be given the RMARS a second time to identify any changes in their respective levels of math anxiety. Preliminary results showed that the subjects had much lower average math anxiety than expected.

Alfred Williams, Jennifer Kirk, Kirsten Locker, James Madison University
Modeling Shock-Associated Noise Using the Parker-Sochacki Method
2:50-3:10 PM, Braddock Hall 102
Turbulent jets generate two main types of noise; turbulent mixing noise (TMN) and Shock associated noise (SAN). The latter is generated by the interaction between the turbulence in a jet and the shock cells that are typically formed in turbulent jets, such as those found in the exhaust plume of a rocket. Mathematicians have tried to model the shock associated noise that is produced as a rocket launches using a number of different methods, particularly different numerical methods. The governing equations are the gas dynamic equations, which must be solved numerically. The Euler Predictor-Corrector Method, or EPCM, is a relatively effective way to determine the shock waves typically formed in a turbulent jet. However, its accuracy is short lived, and a more accurate, longer-lasting method of modelling these shock waves is needed. The Parker-Sochacki Method, or PSM, is an incredibly effective numerical method for solving systems of ordinary differential equations. This method yields a set of Maclaurin Series solutions for the given ordinary differential equation. This paper describes the replacement of the EPMC by the PSM. Through the implementation of the PSM the shock waves produced by a turbulent jet can be properly modeled and predicted.

Student Poster Abstracts by Author

Matthew D. Brem, Hood College
Fourier's Transformation: An Equation Ahead of its Time
Using Fourier's transformation as a specific case, what happens when math is ahead of its time? Can we still use it as an analytical tool if it hasn't been proven? We will explore what math came about directly because of Fourier's famous equation in his paper "The analytical theory of heat" written in 1822.

David Carter, Jacob Wentworth, Virginia Military Institute
Louvre Evacuation Program
Our team developed a computer program that is designed to quickly and efficiently evacuate large buildings. For this demonstration, it is being used to evacuate the Louvre. The program analyzes the floor plan, and will calculate the fastest and safest route out of buildings.

Kara Conway, Hood College
Encryption in World War II: Beyond Enigma
My poster explores the encryption tactics that were used in World War II beyond the famous Enigma machine. I make the argument that the cryptography methods that were used in the war were just as important as the physical component. I will also be explaining the mathematics behind some of these encryption methods.

Alice Craig, Shenandoah University
Unbounded Efficiency for the Room Rental Problem
Fair division has a broad scope that applies to real-world problems within the fields of mathematics, economics, computer science, and political science. A rudimentary example of a fair division is a situation in which a cake must be divided amongst a number of players. For a few decades, there has been a lull in the discovery of any general *n*-player protocols

until just these past couple of years there have been unbounded solutions. In this research, we attempt to uncover the human elements of the mathematical protocol. The question is whether or not the procedure is practical and efficient when implemented. We will examine this by testing a simulated real-life example utilizing the *New York Times* rent calculator. The test case is for three players moving in to two houses, one with similar size rooms and one with three dramatically different size rooms. We will analyze its unbounded efficiency to within six dollars error. The participants will discuss whether they are satisfied with their result after both housing allocations. This examination will serve as an insight into rent partitioning calculators as effective tools to efficiently divide both a desirable and an undesirable good amongst three roommates.

Alexandra Harbord, Hood College

Mathematics and Sundials: Exploring the Influences

In our project, we explored the influence mathematics and sundials had on one another. Around the 5th century B.C., Greek mathematicians used geometry, trigonometry, and physical models to construct sundials to tell time accurately. Conversely, the study of sundials led to the discovery of the conic sections.

Blake Hohman, Barry Thaxton, Virginia Military Institute

What is the Cost of Environmental Degradation?

This poster will cover the basis of our method for solving this problem. Our team created a model that scaled the different environmental impacts that need to be considered when creating infrastructure. The overall score is recorded from -100 to 100. This model gives construction groups the ability to see whether a project is feasible.

DeAndre Johnson, Virginia State University

Topological Structure of Solution of Reaction-Diffusion Systems

We use concepts from algebraic topology to study the spatiotemporal dynamics of a predator-prey system. The spatiotemporal behavior of the system is described by reaction-diffusion equations. We find the numerical solution of the system using Finite Difference Method where we discretize the spatial dimensions to a 400 by 400 mesh grid to find the concentration value of each population. Complicated patterns are formed from the spatial dispersion of the population concentration at each time step. We then quantify the pattern by Betti numbers from cubical homology.

Jennifer Kirk, Kirsten Locker, James Madison University

Modelling Acoustic Loads Generated by Rocket Propulsion

During the take-off or static firing of space launch vehicles, the acoustic loads generated can do serious damage to the function of various vehicle components, such as the rocket payload, and their supporting structures. A model, NASA SP-8072, has been developed to predict the acoustic power generated by a supersonic rocket exhaust. Two different distribution source methods (DSM) are presented; DMS-1 and DSM-2. Each of these model the acoustic loads generated by the propulsion system of a rocket. DSM-2 is a more analytical and complex approach, compared to DSM-1, and it better assess the effect of exhaust shielding and reflections on the acoustic levels and spatial correlations. Therefore, DSM-2 is used within the rocket launch noise model. This paper will examine these, and other, approaches to modeling rocket launch noise, and suggest some improvements to these models.

Christina King, Virginia State University

Classification Model for Prostate Cancer Using a Random Forest Algorithm

Recent study shows Copy Number Variations are associated with the certain cancer diseases. To study this, we obtain prostate cancer data via cBioPortal.org and process data analysis. We use random forest algorithm to perform unsupervised clustering and supervised classification and try to identify the most important gene CNA's that help to detect the metastatic disease in prostate cancer patients.

Mayola Mayhew, Virginia State University

Statistical Analysis to Study the Effect of
Organophosphorus Pesticides on Neurotoxicity in Rats

In recent days, humans have been enormously exposed to toxic materials, natural and produced chemicals commonly

used in food production, pharmaceuticals, water, pesticides used in agriculture, or hazardous waste site sediments. This is a major concern due to the adverse effect of such exposure on human health. As a result, there is a growing demand for toxicologists to develop new approaches and models for determining the effects of such exposure on human health, while also reducing the risk of adverse effects associated with such exposure. In this work, we conduct cluster analysis to explore the effect of organophosphorus pesticides on neurotoxicity in rats, considering the organophosphorus pesticides (OP) dataset from Moser et al. (2005), who tried to measure the effect of exposure to pesticides such as acephate, diazinon, dimethoate and malathion, which are commonly used in agriculture on neurotoxicity using lab experiments on rats. Neurotoxicity for rats might be measured in terms of multiple endpoints or responses such as blood cholinesterase, brain cholinesterase, motor activity, and tail pinch, such that a decrease in any of these measurements is considered adverse.

Kyle Moir, Hood College
The "Golden" Ratio
This poster will explore the historical development and credibility of the Golden Ratio. The path of the number dramatically changed between two influential figures: Fibonacci and a psychologist, Adolf Zeising. Before Zeising published a book on the topic, it was just a number that could be found in the Fibonacci Sequence. However, after the psychologist's publication, the Golden Ratio became idolized and appeared everywhere. I argue that idolizing this number has produced more harm than good. To support my claim, I will display myths and flawed applications revolving around this so-called "Golden" value.

Justin Nelson, Hood College
Calculus in Economics
Economics is the study of real-world living. This poster will show how deeply involved calculus is in the world of economics as well as show who introduced calculus to economics.

Susannah Noppenberger, Hood College
The Journey of Mathematical Physics from France to Germany
My poster will examine the split between math and physics in France in the late 18th century. It will discuss the destructive historical events during this period that put an end to scientific research and development. It will argue that advancements in physics shifted to Germany by the early 19th century due to their flourishing education system.

Beth Thomas, St. Mary's College of Maryland
Carpenter Ant Grooming Rates
Through Image and Video Processing in MATLAB, we analyzed the grooming rates of major and minor worker Carpenter ants. We looked at the relationship between the grooming rates and communication.

Amy Vennos, Salisbury University
Cycle Structures for Finite Cellular Automata Generated
Over Groups, Rings, and Fields
We investigated global properties of cellular automata, a type of discrete dynamical system. This was done by representing time evolution with state transition diagrams. The update rule is a linear transformation, and therefore we apply linear algebra and abstract algebra to further understand the properties that cause variation in cycle structure of these state transition diagrams.

Dolan Walsh, Virginia Military Institute
Effects of Socioeconomic Data on the Abuse of Opiods
Correlation between U.S. Census Socioeconomic data and the rise in opioid abuse in the U.S. by evaluating the growth in five states (Virginia, West Virginia, Kentucky, Ohio, Pennsylvania).

Colin Williams, Hood College
The Difficulty of Transcendence

Transcendental numbers are those which cannot be written algebraically, such as pi and e. I will discuss what makes it so hard for us to prove that numbers are transcendental. In order to do so, I'll be looking at transcendental numbers historically and the ways in which their transcendence has been proven, and how we may be able to reuse these methods to expand the set of known transcendental numbers. By pinpointing the difficulties in such proofs, I hope to give mathematicians insight as to what roadblocks need to be overcome and how we could potentially do so.

Evan Williams, Stevenson University

Around the World in 239 Translations: Computing the Entropy Of Written Languages Using the Bible

Every time we speak or write we convey a certain amount of information. Today there are over 6,500 languages each with its own alphabet, characters, words, and phrases. But how complex is each language? Which languages are the most complex, and are there certain ones that convey more information than others? Utilizing entropy, a concept studied in information theory and originally defined by Claude Shannon, we calculate how much information, on average, is produced for a given letter, character, or word in a text. We study 239 languages ranging from specific dialects to natural and constructed languages. We analyze and compare the complexity of each language utilizing translations of the Bible as our common information source and by computing values such as letter and word n-gram frequencies. We also compare whether constructed languages such as Quenya from Lord of the Rings or Esperanto are more or less complex than natural languages such as English.