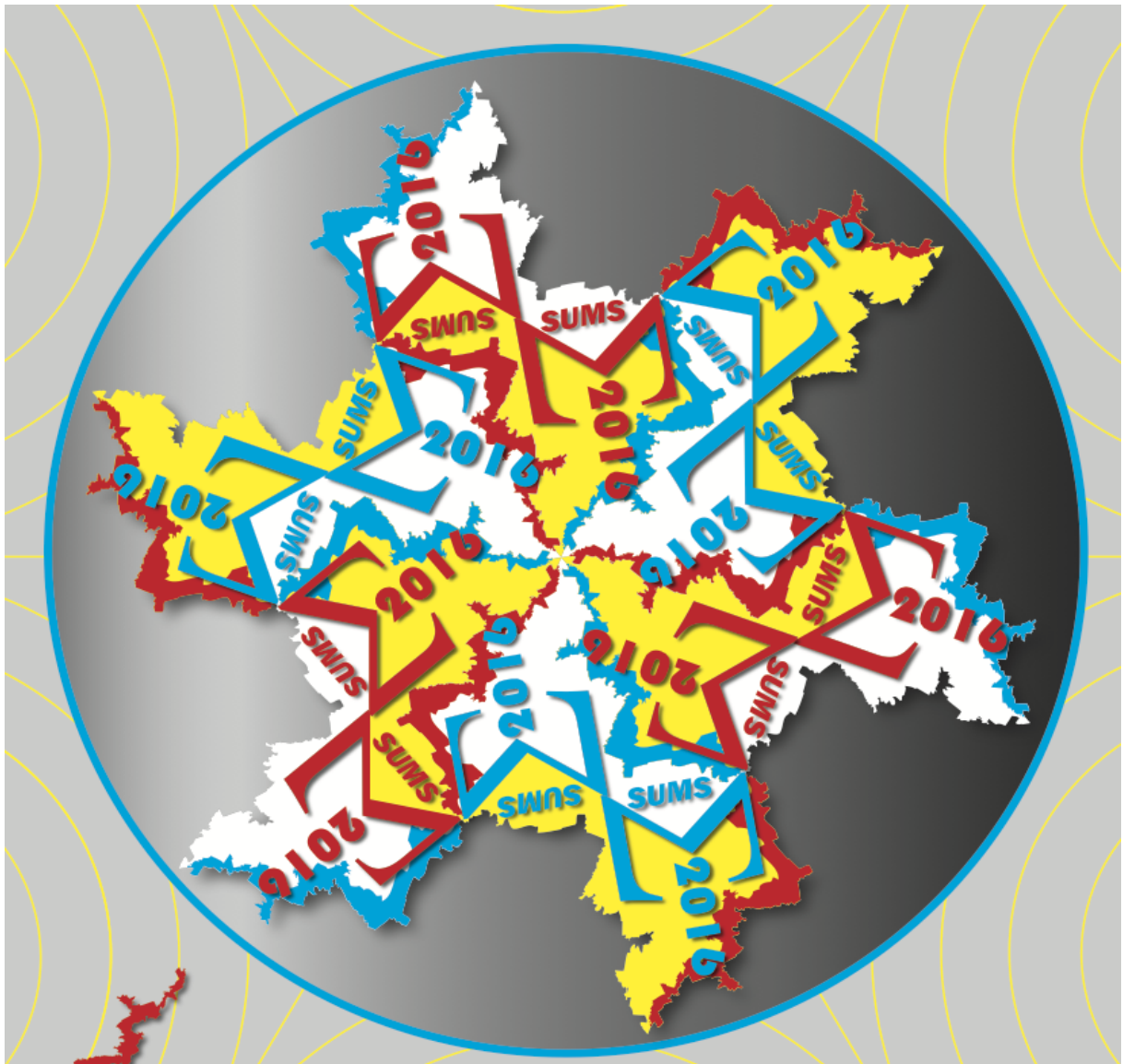
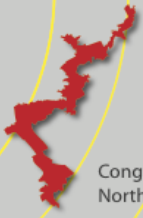


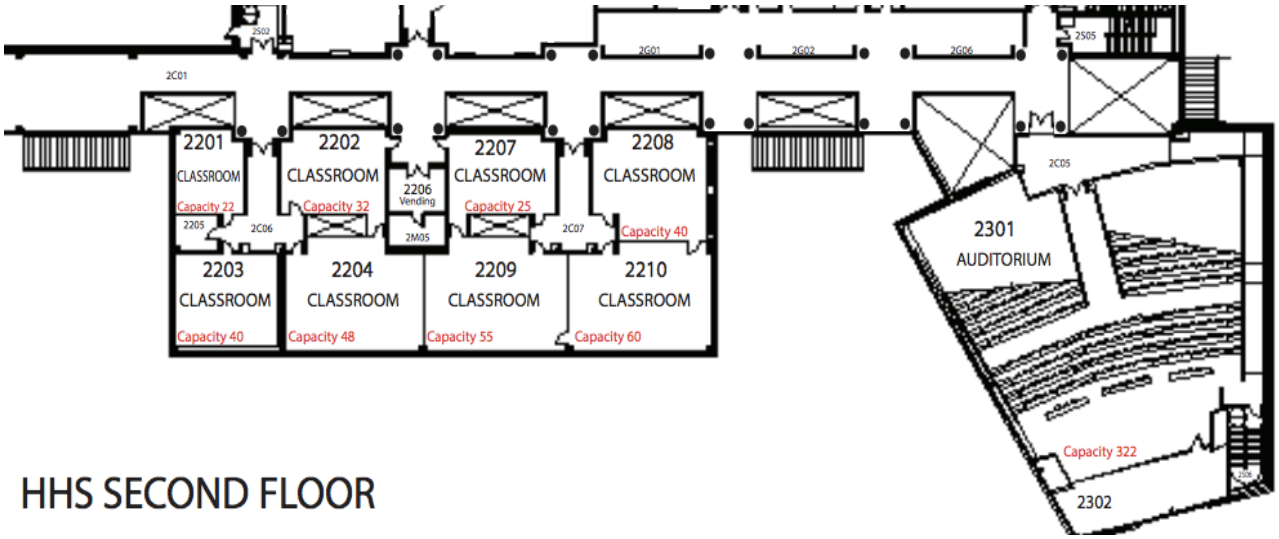


Congressional District 12
North Carolina

12th Annual
Shenanandoah Undergraduate Mathematics and Statistics Conference

Saturday, September 24th, 2016

All events are on the second floor of the JMU EnGeo (formerly HHS) building.



Financial support for the Shenandoah Undergraduate Mathematics and Statistics Conference is provided by:

James Madison University and the Department of Mathematics and Statistics, College of Science and Mathematics, Pi Mu Epsilon, and the Mathematics and Statistics Club.

We would also like to offer thanks to the volunteers who make the conference possible. We are very grateful for the generous contributions of books, puzzles, games, and other prizes from the sponsors of SUMS:

9:00 - 10:00 Registration and Breakfast 2nd floor hallway

If you registered online, you should pick up your name tag at the registration table. If you still need to register, please do so at the same table.

Poster presenters should check in to room HHS 2201.

Be sure to come to the Prize Session at the end of the day; all presenters and volunteers will be awarded prizes!

10:00 - 10:10 Opening Remarks auditorium 2301

Join Dr. Cynthia Bauerle, Dean of the College of Science and Mathematics, and the conference organizers as we welcome you to the SUMS 2016 extravaganza.

10:10 - 11:00 Opening Address auditorium 2301

Why can't the process be fair? From Presidential elections to picking a movie.

Tommy Ratliff
Wheaton College

It seems as if every four years in the United States the public realizes that there are serious flaws in the Presidential election process. 2016 is certainly no exception. Voters of all political stripes are keenly aware that if we had used a different process then we might have different choices in the election this November. And they are right! Different election methods can select different winners even if no voters have changed their preferences. However, many people do not realize that these same issues arise in our daily lives whenever a group of people get together to make a decision, from the math department selecting which calculus text to use, to a group of friends deciding what movie to watch. We will see that there is a rich geometric structure underlying decision procedures that can aid in systematically analyzing their properties. This structure can help explain why different voting methods give different outcomes and why our intuition on fairness may lead us astray.

2202 **(q,t) Symmetry in Macdonald Polynomial**
Jacob Coleman, West Virginia Wesleyan College
We examine (q,t) symmetry in a particular Macdonald polynomial using combinatorial methods. We present two maps between subsets of the standard fillings of a Ferrers diagram of an integer partition and a set of sub ballot words to obtain (q,t) symmetry for some shapes.

2203 **Asymmetric two-patch model with Logistic Growth/Allee Effect**
Jasper Short, Virginia State University
Modeling asymmetric two-patch populations was used by two differential equations with Logistic Growth and Allee Effect and their dispersal between each other. Through the use of a Lyapunov function, mathematical computations, and theorems developed, it can be proven whether oyster populations will survive or go extinct.

2204 **Positron Emission Tomography Image Reconstruction**
Samuel Jugus, George Mason University
Positron Emission Tomography (PET) is an important medical tool used to discover abnormalities in the body. We investigated on improving the algorithms behind the PET by replacing most instances of the Hessian with the Fast Projection Gradient. The algorithm was tested using a data generator that simulates a 2D PET.

2208 **TP/TN Completability of Fully Bordered Patterns**
Haoge Chang, The College of William and Mary
An $m \times n$ matrix is totally positive (totally nonnegative) if every minor of it is positive (nonnegative). We will show that a partial matrix with border patterns (only the entries at the border are specified and the remaining entries are free to be chosen) is both TP completable and TN completable.

2210 **Panel Session on Graduate School in Math, Stats and Math Ed**
Chris Willingham, James Madison University
Mike Lam, James Madison University
Zev, Woodstock
What is graduate school really like? How do you apply? What schools should you consider? How important is the GRE subject test? Find out from this panel of faculty members and a current graduate student!

11:30 - 11:45 Parallel Talks Session II

2202 **Pattern Avoidance in the Secretary Problem**
Aaron Fowlkes, James Madison University
The classic secretary problem is a combinatorics optimization problem that has been thoroughly researched and solved. In this presentation we will introduce pattern avoidance to the permutations in our problem and explore how this changes the optimal strategies.

2203 **(Un)Stable Manifold Computation via Fixed Point Iteration**
Dmitriy Zhigunov, The College of William and Mary
The stable manifold of an autonomous differential equation can be shown to satisfy a boundary value problem (BVP) on an infinite interval. To approximate the manifold, we truncate the interval and discretize the BVP, leading to a fixed point iteration scheme for manifold computation. Numerical error is discussed.

2204 **Solving a Tear Film Model with a Spectral Method**
Tim Reid, George Mason University
This research computes numerical solution to a tear film thickness model. The model is a partial differential equation that approximates the thickness of a tear film on a contact lens in a blinking eye where the contact lens motion is influenced by blinking. A modified Chebyshev spectral method is used in the calculation.

2208 **Periods of Linear Recurrence Sequences**
Maximilian Rezek, Washington and Lee University
Sequences defined by linear recurrences over finite algebraic structures exhibit periodicities. We will report on our investigation this summer of the periods of sequences defined by recurrences over finite matrix algebras. This is joint work with Mithra Muthukrishnan and Professor Michael Bush.

2210 **Panel Session on Graduate School in Math, Stats and Math Ed**
Chris Willingham, James Madison University
Mike Lam, James Madison University
Zev, Woodstock
What is graduate school really like? How do you apply? What schools should you consider? How important is the GRE subject test? Find out from this panel of faculty members and a current graduate student!

11:50 - 12:05 Parallel Talks Session III

2202 **Rigid Triominos**
Bethany Alloway, Morehead State University
A Triomino is formed by joining three equally-sized squares so that any two squares are connected by a shared edge. This talk looks into the possibility of placing eight right-triominos on an 8×8 grid so that if the grid were rotated in any direction none of the pieces would change position.

2203 **Dynamics of the Fisher-KPP Equation on a Network**
Robert Truong, George Mason University
We define and study a system of ODEs that models population dynamics on a graph. We consider the cases of a uniform tree and an Erdös-Rényi graph. Numerical simulations and analytic results are used to describe the spreading speed of the population viewed as a front.

2204 **Reducing Channel Interaction in Cochlear Implants**
Ellen Orie, James Madison University
Aydee Ferrufino, James Madison University
Processing strategies in cochlear implants have yet to fully mimic natural hearing. Simultaneous stimulation is potentially better, but is not favored over interleaved due to high interactions between the channels. We tested different configurations to reduce this interaction and better simulate natural hearing.

2208 **Lorentzian Geometry on Lie Algebras**
Sabrina Walker, Longwood University
We present a preliminary report on the investigation of Lorentzian scalar products on Lie algebras. We make use of the automorphism group of a Lie algebra to establish canonical forms of Lorentzian scalar products. We then use the canonical forms to find scalar products that correspond to algebraic solitons.

2210 **Panel Session on REUs and Summer Programs**
Len Van Wyk, James Madison University
Eva Strawbridge, James Madison University
Jonathan Gerhard, James Madison University
Channing Parker, James Madison Unversity
Want to learn more about Research Experience for Undergraduates programs and other summer opportunities in mathematics? Come ask this panel of students and faculty your questions!

2202 **Completing Partial Latin Squares Arising from Latin Arrays**

Stacie Baumann, West Virginia Wesleyan College

Recently, Kuhl and Schroeder looked at a problem concerning when an $r \times r$ array A is copied n times down the diagonal of a blank array. Call this partial Latin square nA. They proved results for $n > r$ and $n < r$. This presentation will discuss improvements used to prove that rA is completable for every $r \times r$ array A.

2203 **ODE Modeling of Zika Virus**

Aneesh Malhotra, George Mason University

This research develops a delay differential equation (DDE) to model the spread of Zika virus. It is based on malaria models and the SIR model, but takes into account the multiple modes of transmission of Zika. Numerical methods are used to analyze the DDE model to compare it to Zika dynamics shown in literature.

2208 **An introduction to Surreal numbers**

Asa Kaplan, Virginia Commonwealth University

An introduction and brief history on the topic of surreal numbers. Topics covered include the foundation/motivation, manipulation, and applications.

2210 **Panel Session on REUs and Summer Programs**

Len Van Wyk, James Madison University
Eva Strawbridge, James Madison University
Jonathan Gerhard, James Madison University
Channing Parker, James Madison University

Want to learn more about Research Experience for Undergraduates programs and other summer opportunities in mathematics? Come ask this panel of students and faculty your questions!

12:30 - 1:55 Lunch and Poster Session hallway

LUNCH: If you have a star on your name tag, pick up your boxed lunch near the registration table at 12:30. (If you do not have a star, you may check for unclaimed lunches after 1:00).

POSTER SESSION: Students will be near their posters during lunch. Please stop by to see their excellent work! Poster judging will start by 12:40.

Posters ($\diamondsuit$) indicates expository work.

The Math of Music ($\diamondsuit$)
Victoria Arce, Mountain Vista Governor's School

Completing Partial Latin Squares Arising from Latin Arrays
Stacie Baumann, West Virginia Wesleyan College

(q,t) **Symmetry in Macdonald Polynomials**
Jacob Coleman, West Virginia Wesleyan College

RSA Encryption ($\diamondsuit$)
John Naylor, Mountain Vista Governor's School

Influence of preventive measures on the eradication of Zika
Pradyuta Padmanabhan, The Foxcroft School

Bootstrapping Regression Models Using Examples in R ($\diamondsuit$)
Isabela Reeves, James Madison University

The Math Behind Ballistics
Myra Richardson, Mountain Vista Governor's School

Center Manifolds via Lyapunov-Perron
Emily Schaal, The College of William and Mary

Predicting Enrollment Using Time Series Models
Kelley Swenson, University of Mary Washington

Mathematical Solution to Poisson's Equation
Aaron Thomas, University of Mary Washington

Compartment Syndrome: Dynamical Systems Model and Analysis
Jacob Williams, University of Maryland, College Park

2:00 - 2:15 Parallel Talks Session V

2202 **Exploring Spirolateral Graphs**
Holly Paige Chaos, Washington and Lee University
In this presentation we will explore the various properties of spirolateral graphs produced by permutations.

2203 **Compartment Syndrome: Dynamical Systems Model and Analysis**
Jacob Williams, Frostburg State University
The goal is to develop a mathematical model for a medical condition (that I have) called compartment syndrome. A differential equation is created, a bifurcation is found and analyzed, and the model is implemented in MATLAB. The program can be used to more effectively analyze a patient and predict the effect of surgery.

2204 **Computational modeling of spread of Zika in 2016 Olympics**
Pradyuta Padmanabhan, Foxcroft School
Zika Virus has been shown to be transmitted to humans, not only through a vector, but also through sexual contact. In this work, we formulate, analyze and implement an enhanced SEIR compartmental epidemic model describing the mathematical interaction of three sub populations in the 2016 summer Olympics.

2207 **Dimension Reduction of Gene Expression Data**
Jaylen Lee, James Madison University
This study compares elastic net regression models to principal component regression, supervised principal component regression, Y-aware principal component regression, and partial least squares regression models and their ability to predict tissue age based on DNA methylation levels.

2208 **Applications of Coverings to Sierpiński & Riesel Numbers**
Phillip Harmon, Washington and Lee University
Matt Dodson, Washington and Lee University
Hans Riesel and Waclaw Sierpiński each showed a special property of infinitely many odd positive integers. In this talk, we present results and work concerning Sierpiński and Riesel numbers that also appear in other sequences of numbers, such as the sequence of Nexus numbers and generalized Fibonacci numbers.

2202 **The Critical Group of $KG(n, 2)$**

Ian Hill, James Madison University

Let $KG(n, k)$ denote the Kneser graph, whose vertices are the subsets of size k of a set of size n, where two vertices are adjacent if disjoint. We will look at the critical group of $KG(n, 2)$ and take a combinatorial approach through a "chip-firing game" to prove it is isomorphic to a direct sum of cyclic groups.

2203 **Introducing Fractional Dynamics to Quantum Random Walks**

Lucas Bouck, George Mason University

Quantum random walks (QRW) are vital for the development of algorithms in quantum computing. We introduce a Fractional Fokker-Planck Equation, a PDE, to describe a QRW and explain current efforts to compute a numerical solution to this PDE. We also explain differences between this model and the current one.

2204 **Topological Data Analysis**

Elena Gavrila, The College of William and Mary

Computational topology is a very powerful tool in the realm of applied mathematics. It can extract useful information and measurements from data that otherwise may be noisy or chaotic. It returns information about the topological features of data which can give us valuable knowledge about the data.

2207 **Analysis of Course Evaluation Response Rates**

Nora Benedetto, University of Mary Washington

The goal of this project was to determine if significant trends existed in the response rates at UMW. Several factors were analyzed using ANOVA tests with the Bonferroni method and cluster analysis. We observed significant differences across course levels, departments, semesters, the years and between the two campuses.

2208 **Sierpiński Numbers and Ruth-Aaron Pairs**
Margaret Kallus, Washington and Lee University
There are infinitely many odd positive integers k with the property that $k \cdot 2^n + 1$ is always composite; such a k is known as a Sierpiński number. Ruth-Aaron pairs are consecutive integers whose prime factors each sum to the same number. In this talk, we present work concerning Sierpiński numbers and Ruth-Aaron pairs.

2210 **Career and Industy Panel**
Rebecca Wasyk, Federal Reserve Board
Phil Riley, BidWrangler
Bryan Osborn, Metron Scientific Consulting
Brent Woodruff, HashiCorp
What can you do with a math or a statistics degree? What kinds of companies and institutions value your talent? This panel of people has experience using mathematics and statistics outside of academia, so come ask them some questions!

2:40 - 2:55 Parallel Talks Session VII

2203 **Numerical Approximation of Poisson's Equation**
Rachelle Dambrose, University of Mary Washington
This research focused on finding numerical solutions to Poisson's equation to approximate heat flow through two-dimensional squares. A computer program was written to solve for a vector of temperatures at internal points. Comparing approximations with actual functions and experiments proves accuracy of the algorithm.

2204 **A Statistical Analysis of the Second Cancer**
Marvin Li, Bennett Middle/High School
I conduct a statistical analysis to quantify the relationship between the first cancer type and the development of the second cancer. I use a t-test to compare the occurrence time of the second cancer for five major types of the first cancer and investigate whether the types of the first and second cancers are related.

2207 **Machine Learning Classification of Toxicological Endpoints**
Channing Parker, James Madison University
The EPA has incomplete data on chemicals and their toxicological endpoints. To avoid animal testing, machine learning methods are used to predict toxic effects. Support Vector Machines and decision tree algorithms are tested and improved through cross-validation, parameter optimization, feature selection, and committee of machines.

2208 **Anomalous Primes and the Elliptic Korselt Criterion**
Gregory Taylor, The College of William and Mary
Elliptic Carmichael numbers are the elliptic curve analogs of classical Carmichael numbers. In particular, there is an elliptic Korselt criterion which implies that a number is Elliptic Carmichael. We investigate numbers which satisfy this criterion and link them to the anomalous primes of that curve.

2210 **Career and Industy Panel**
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What can you do with a math or a statistics degree? What kinds of companies and institutions value your talent? This panel of people has experience using mathematics and statistics outside of academia, so come ask them some questions!

3:00 - 3:15 Afternoon tea 2nd floor hallway

Please join us for tasty treats in the HHS foyer. This is your last chance to enter the candy contest!

3:20 - 3:30 Prize Session auditorium 2301

After tea, please join us in the prize session. Speaker awards, poster competition winners, and the candy contest winner will be announced!

3:30 - 4:20 Closing Address auditorium 2301

Can't Decide? Undecide!

Chaim Goodman-Strauss
University of Arkansas

One of the hallmark achievements of the last century was the recognition that, incredibly, mathematics itself can establish limits on mathematical knowledge: We can *prove* there are true but formally unprovable mathematical statements. Far from an abstract, distant principle, 'undecidability' is intimately bound into every branch of mathematics – in some sense, the generic mathematical statement is not provably true or false: Even in recreational mathematics, examples abound!