SUMS 2019 TIMETABLE

When	What & Where				
9:00-10:00	Registration 2nd floor hallway				
10:00 - 10:10	Welcome Dr. David Carothers (JMU) 2301				
10:10 - 11:00	Opening Talk Dr. Karen Saxe (American Mathematical Society) 2301				
11:15 - 11:30	Parallel Session I				
	Frederick 1204	REU panel 1208	Wagner 1209	Crank 1210	Olorode 2210
11:35 - 11:50	Parallel Session II				
	Bezbaruah 1204	Grad Panel 1208	Shi 1209	Sawyer 1210	Sathe 2210
11:55 - 12:10	Parallel Session III				
	Hain 1204	Grad Panel 1208	Xu 1209	Goodrich 1210	Lefler 2210
12:15 - 12:30	Parallel Session IV				
	Venkat 1204	Saxe 1208	Gransbury 1209	Baldridge 1210	Engelbrecht 2210
12:30-1:45	Lunch and Poster Session Hallway				
1:45-2:00	Parallel Session V				
	Baxley 1204	Saxe 1208	Morris 1209	Luo 1210	Gontmacher 2210
2:05-2:20	Parallel Session VI				
	Schmelling 1204	Career Panel 1208	Kumar 1209	Hamakiotes 1210	Ding 2210
2:25-2:40	Parallel Session VII				
	Padgett 1204	Career Panel 1208	Valencia 1209	Castellano-Macias 1210	King 2210
2:45-3:00	Parallel Session VIII				
	. Finlay 1204	REU Panel 1208	Yan 1209	Ahrens 1210	Matthews 2210
3:05 - 3:25	Afternoon tea Hallway				
3:30-3:45	Prize session 2301				
3:50 - 4:40	Closing Talk Dr. David Richeson (Dickinson College) 2301				

9:00 - 10:00 Registration and Breakfast

<div align="right">2nd floor hallway</div>

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 take their posters to room EnGeo 2201 for check in.

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

<div align="right">auditorium 2301</div>

Join Dr. David Carothers, JMU Department of Mathematics and Statistics, and the conference organizers as we welcome you to the SUMS 2019 extravaganza.

10:10 - 11:00 Opening Address

<div align="right">auditorium 2301</div>

Gerrymandering and a redistricting outlook for 2020

Karen Saxe
Director of Government Relations for the American Mathematical Society

Every ten years each state redraws its congressional district maps. Many map-makers are accused of partisan gerrymandering, and these challenges have been gaining traction in our courts, including in the Supreme Court. This talk will give background on how redistricting is done by the states, an update on how mathematics and statistics is being called on by the courts in their deliberations, and what changes to look for when the states start drawing in 2020.

1204 **Using Circulant Matrices for Sharing Secret Matrices**
Hannah Frederick, University of Mary Washington
We demonstrate a method for sharing matrices from the non-abelian group of invertible matrices over a finite field by conjugating by elements from the abelian subgroup of circulant matrices. We then count the number of invertible circulants and show this increases exponentially in the dimension of the matrices.

1208 **Panel Session on REUs and Summer Programs**
David Duncan, REU mentor, James Madison University
Asimina Hamakiotes, Macaulay Honors at Baruch College
Dylan King, Wake Forest University
Wesley Engelbrecht, 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!

1209 **Two Lotka-Volterra Systems with Nonlinear Competition**
Grant Wagner, James Madison University
We examine two modifications of the classical Lotka-Volterra competitive equations to account for nonlinear interspecific and intraspecific interactions, by performing a complete analysis of the critical points of both systems. Interesting new behavior can be seen in our second model.

1210 **Dynamical System of an Analog to the $3n+1$ Problem**
Kyler Crank, St. Mary's College of Maryland
This project analyzes a modulo 3 analog of the $3n+1$ problem, also known as the Collatz conjecture. In this paper, we analyze the characteristics of this analog with respect to preimages in this dynamical system. We show that all first order preimages are determined by the input's congruence class modulo 8.

2210 **Effects of edge subdivision on the cop number of a graph**
Oluwadamilola Olorode, Rutgers University - New Brunswick
Abigail Preiwisch, Franciscan University of Steubenville
Cops and Robber is a two-player complete information game played on discrete graph. We investigate how the cop number is affected by subdividing edges. In particular, for each positive integer k, we construct a graph with cop number one that becomes cop number at least k after edge subdivision.

1204 Plasmon Polariton on Graphene
Manaswinee Bezbaruah, Texas A&M University
A plasmon is a quantum of plasma oscillation, which are oscillations of electron density. Plasmons have a high confinement at the graphene surface, and graphene plasmons are potentially more cost-effective than plasmons on traditional noble metals. We tried to simulate the propagation of a plasmon on a graphene sheet.

1208 Panel Session on Graduate School in Math & Stats
John Harnois, University of Virginia
Zev Woodstock, North Carolina State University
Noah Watson, Georgetown University
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 grad students!

1209 Maximum Potential of Rotational Grazing
Jessica Shi, Jamestown High School
Rotational grazing is a popular sustainable farming practice in which the animals are moved between paddocks. Agent-based modeling is used in a computer simulation, created in NetLogo, to show the dynamical change and interaction of the cows and the grass in different paddock situations and rotation periods over time.

1210 An Investigation of Midy Sequences in Sequences of Exponents
Simon Sawyer, Bridgewater College
Countless patterns exist within our number systems, and we will never discover all of them. This research uncovers a numeric pattern originally found in fractions that also exists within sequences of exponents and explains everywhere that it appears in the base 10 number system.

2210 Computing and Visualizing Graphs of Vertex Colorings
Aalok Sathe, University of Richmond
Wesley Su, University of Richmond
The k-coloring graph of graph G is the graph of proper k-colorings of G with edges between colorings with Hamming distance 1. We write software to construct and visualize k-coloring graphs to aid in the study of their connectivity properties.

1204 Companion Matrices for Recursively Defined Polynomials
Tyler Hain, James Madison University
Given a degree n monic polynomial $p(z)$, a companion matrix for p is an $n \times n$ matrix A such that $\det(zI - A) = p(z)$. In this talk, we'll discuss iterative methods for constructing companion matrices for recursively defined monic polynomials and explore applications of these matrices.

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1209 Population Dynamics of the Blue Crab in Chesapeake Bay
Fangming Xu, College of William and Mary
A dynamic population model is built for blue crab in Chesapeake Bay using ordinary differential equations. Factors such as reproduction, cannibalism and predation are considered, trying to predict the long term stable state. This model would be useful to show the effects of disease, climate change and over-harvesting.

1210 Verifying a representation of the Erdös-Straus Conjecture
Olivia Goodrich, University of Virginia
Using a computer algorithm, my research verifies the existence of coprime natural numbers a, b such that $4ab$ divides $p(a+b) - 1$ for the first $50,000$ prime numbers p. Such pairs generate individual solutions to the Erdös-Straus conjecture, and the program steps suggest similar approaches for extensions of the conjecture.

2210 Counting Single Small Atom Numerical Semigroups and Sets
Jessica Lefler, Slippery Rock University of Pennsylvania
Jeremy Marzuola and Andy Miller proved that approximately 48% of numerical sets with Frobenius number g mapped to numerical semigroups with no small atoms. This research looks at counting the number of numerical sets that will map to numerical semigroups that have a single small atom and methods to count these sets.

1204 **Orthogonal Polynomials on the Sierpinski Gasket**
Sreeram Venkat, North Carolina State University
Shashank Sule, Amherst College
Qingxuan (Max) Jiang, Cornell University
Xioduo Wang, University of Wisconsin, Madison
Building on the theory of Legendre orthogonal polynomials on the Sierpinski Gasket (SG), we develop a theory of Sobolev orthogonal polynomials on SG. We find general recurrence relations connecting the Sobolev polynomials to the Legendre polynomials on SG. Finally, we develop fast computational tools to study SG.

1208 **A Conversation with Karen Saxe**
Karen Saxe, AMS
Join the conversation with Karen Saxe, keynote speaker and Director of Government Relations for the American Mathematical Society.

1209 **Approximating Differential Equations Using Quadratic Bases**
Isabella Gransbury, University of Mary Washington
There are numerous methods to approximate the solution to a differential equation. My research considers using the finite element method to determine a system of polynomials from the weak form of the differential. I also use the weak form as filter to disregard extraneous approximations of the differential equation.

1210 **It's Sierpinski time with the RANCID Group**
Maia Baldridge, Washington and Lee University
Katie Sue Cones, Washington and Lee University
Do you contemplate coverings of the integers? Dare to dabble in periodicity? Research recurrences? Well, our project - finding new and different types of Sierpinski and Reisel numbers - has all of that and more, plus all the satisfying number theory your heart desires.

2210 **Indivisible Sandpiles**
Wesley Engelbrecht, James Madison University
Graph theory is a mathematical field that may be studied in the abstract sense, or used to model networks and dynamical systems. Sandpiles are one such type of model. We study and classify indivisible sandpiles and give explicit formulas for multiple classes of graphs, including path graphs and complete graphs.

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.

French Word Gender Prediction with Machine Learning
Ryan Baxley, Old Dominion University

RMSE-MINIMIZING CONFIDENCE INTERVAL
Kexin Feng, College of William and Mary

Explicit Upper Bounds on the Anti-Waring Numbers
Justin Haenel, University of Vermont Carson Wood,Clemson

Investigating and Modeling Air Resistance in Baseball
Tiba Hamza, Prince Edward County High School

Big Data: Compression and Clustering of Leukemia Patient Genomic Profiles *Noah Hitchcock, Regent University*

Codes from Difference Sets
*Connor Kissane & Calvin Reedy, University of Richmond
and Scarlet Sun, University of Richmond*

Mean Curvature Zero Surfaces in the Heisenberg Group
Brady Knight, Longwood University

Mathematical Modeling for the Opioid Crisis
Kirthi Kumar, Thomas Jefferson High School for Science and Technology

Dimension Formulas for Spaces of Holomorphic Modular Forms
Spencer Martin & William Donahoe, University of Virginia

Analysis on Large Data Set of Prostate Cancer Patients Genetic Information *Jehu Osegbe, Virginia State University*

Anticommutative Quaternions and The Binomial Theorem
Ashley Scurlock, University of Mary Washington

Mathematical Model on trend and prediction of Movie Revenue
Susan Shang, College of William & Mary

Redefining Compactness to Combat Gerrymandering
Maria Stuebner, Governor's School for Science and Technology

United States Metro/Non-Metro Population Model
Chase Thibeault & Michael Mullen & and Guinevere Hodge, Hood College

Technological Rehabilitation for Opioid Addiction Patients
Diego Valencia, Thomas Jefferson High School for Science and Technology

RANCID Group Explores Spirolateral Graphs and Bounding Boxes
John Coleman Ward, Washington and Lee

1204 **French Word Gender Prediction with Machine Learning**
Ryan Baxley, Old Dominion University
This presentation walks through the mathematics of low-level machine learning as applied to the Natural Language Processing problem of predicting gender in French words. Machine learning novices and veterans alike will benefit from this presentation.

1208 **A Conversation with Karen Saxe**
Karen Saxe, AMS
Join the conversation with Karen Saxe, keynote speaker and Director of Government Relations for the American Mathematical Society.

1209 **Building Phylogenetic Networks**
Rachel Morris, University of Richmond
We generalize supertree methods for reconstructing evolutionary trees to build phylogenetic networks from complete sets of 4-leaf networks called quarnets. The sequential method begins with a single quarnet adds on one leaf at a time until all leaves have been placed.

1210 **Partitions over Real Quadratic Fields**
David Luo, Emory University
A partition of a positive integer is a way of writing it as a sum of a non-increasing sequence of positive integers. We extend this concept to real quadratic fields K by considering partitions whose parts are in the ring of integers in K. In this talk, we explore properties of these quadratic partitions.

2210 **Automorphism Locus of Moduli Space of Rational Functions**
Brandon Gontmacher, Stony Brook University
Srinjoy Srimani, Brown University
We describe the automorphism locus of the moduli space of degree 3 and degree 4 rational functions. We show conjectural uniform boundedness results on the rational preperiodic structure of several families of functions. In addition, we look at applications of the automorphisms to statistics over finite fields.

1204 Similarity for binary data and application to psychological profiles
Tashia Schmelling, James Madison University
Matching patient profiles with theoretical personality disorder profiles as well as clustering patients by profile is explored. To best determine matches, we look at various measures of similarity for binary vectors.

1208 Career & Industry Panel

Mary Morsch, Director JMU Career & Academic Planning

Paul Boisen, Department of Defense

Brent Wooduff, 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 questions!

1209 Mathematical Modeling for the Opioid Crisis
Kirthi Kumar, Thomas Jefferson High School for Science and Technology
Padmanabhan Seshaiyer, George Mason University
Mathematical modeling for drug addiction as an infectious disease can be a novel approach for the opioid crisis. This project explores dynamics of addiction via prescription and social mathematical models. Further analyses are done on these models, along with numerical simulation of each model, and a GUI is developed.

1210 Asymptotic Distribution of the Partition Crank
Asimina Hamakiotes, Macaulay Honors at Baruch College
We prove that the crank is asymptotically equidistributed modulo Q, for any odd number Q. To prove this, we obtain effective bounds on the error term from Rolon's asymptotic estimate for the crank function. We then use those bounds to prove the surjectivity and strict log-subadditivity of the crank function.

2210 Uniformly Sparse Graphs
Wenxuan Ding, College of William and Mary
Yuqiao Li, College of William and Mary
Abigail Eget, James Madison Univeristy
Uniformly sparse (US) graph is an interesting class of graphs whose adjacency matrices are equivalent to some matrix with off-diagonal entries 1. This diagonal equivalence preserves rank, which makes the calculation of maximum geometric multiplicity easier. Also, trees are a subset of US graphs.

1204 Eguchi-Hanson Double Copy
Michael Padgett, James Madison University
Out of the many tools we have to study space-time geometries, the one that I want to study is a theory known as Double Copy. This suggests that there exists a duality between gravity and gauge theory. This allows us to find a gauge theory in one geometry and connect it with a gravity solution in another geometry.

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Mary Morsch, Director JMU Career & Academic Planning
Adam Diehl, Department of Defense
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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 questions!

1209 Technological Rehabilitation for Opioid Addiction Patients
Diego Valencia, Thomas Jefferson High School for Science and Technology
Padmanabhan Seshaiyer, George Mason University
The goal of this project is to develop a discrete, wearable device that determines whether a recovering opioid addict is having a response to a stressor, indicating the potential for a relapse event. Machine learning was used to perform data analysis that evaluated Heart Rate Variability (HRV) from just the heart rate.

1210 The tunnel number of all 11 and 12 crossing alternating knots
Felipe Castellano-Macias, Northeastern University
Using exhaustive techniques and results from Lackenby and many others, we compute the tunnel number of all 1655 alternating 11 and 12 crossing knots. We also use these methods to compute the tunnel number of 142 non-alternating 11 and 12 crossing knots.

2210 The Distribution of Sumset Size for Nonuniform Subsets
Dylan King, Wake Forest University
Given $0 < p < 1$, we examine the random variable $|A + A|$, where each integer from 0 to $n - 1$ is included in A with probability p. Previously, Lazarev and others computed the expected value of $|A + A|$ for the case $p = 0.5$. We extend the framework developed there to handle any choice of p, computing the expected value in general.

1204 **An Efficient R Package for Bivariate Interval-Censored Data**
Hailey Finlay, James Madison University
Interval-censored data commonly arise in many clinical and health-related studies. This work focuses on creating an R package for a recently developed method to analyze bivariate interval-censored data. Simulation studies show that the R package is computationally efficient, numerically robust, and performs well.

1208 **Panel Session on REUs and Summer Programs**
Edwin O'Shea, REU mentor, James Madison University
David Luo, Emory University
Abigail Eget, 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!

1209 **Population Biology, Pest Management and Cooperative game**
Ran Yan, University of Richmond
Tengjie Tang, University of Richmond
This project focused on population dynamics, dispersion, management, and cooperation among parties addressing the problems posed by invasive species. Source material for the project focused on the Potato Tuber Moth which affects crop yields severely.

1210 **Minimal Surfaces and Their Geometric Interpretations**
Benjamin Ahrens, University of Mary Washington
Corinne Rydgren, University of Mary Washington
We will first introduce various concepts of surfaces. Then we will compute the first and second fundamental forms, as well as the Gaussian and mean curvatures. A minimal surface occurs when the mean curvature of that surface equals zero. We will then sketch and discuss the geometric interpretations of minimal surfaces.

2210 **RANCID Group Explores Spirolateral Graphs and Bounding Boxes**
Emily Matthews, Washington and Lee University
Jacob Kintzing, Washington and Lee University
What started as a simple question, "Where should I (while drawing spirolateral graphs) start so I never run off the page?" began an inquiry into how arithmetic operations on a permutation reveal facts about the bounding box size, center, and other properties of the resulting graph. Hint: it's a pattern finder's dream.

3:05 - 3:30 Afternoon tea

2nd floor hallway

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

3:30 - 3:45 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!

3:50 - 4:40 Closing Address

auditorium 2301

Tales of Impossibility

David Richeson
Dickinson College

"Nothing is impossible!" It is comforting to believe this greeting card sentiment; it is the American dream. Yet there are impossible things, and it is possible to prove that they are so. In this talk we will look at some of the most famous impossibility theorems – the so-called "problems of antiquity." The ancient Greek geometers and future generations of mathematicians tried and failed to square circles, trisect angles, double cubes, and construct regular polygons using only a compass and straightedge. It took two thousand years to prove conclusively that all four of these are mathematically impossible.

SPONSORS

We would first like to thank the volunteers who make the conference possible!
Financial support for the Shenandoah Undergraduate Mathematics and Statistics Conference is provided by: James Madison University's Department of Mathematics and Statistics and Office of Access and Inclusion , Pi Mu Epsilon, the Mathematics and Statistics Club, and Cengage Publishing.

We are extremely grateful for the generous contributions of books, puzzles, games, and other prizes from the sponsors of SUMS:

In order to maintain funding for SUMS, to improve the conference, and to fund student awards in the future, we must show SUMS is meeting its goals. Providing us with the following demographic information and feedback would be greatly appreciated.

Current Position: □High school Student   □Undergraduate Student   □Graduate Student,
□Professor   □ Other:_____

Gender: □Male   □Female,   □Non-Binary   □Other:_____

Race/Ethnicity (choose all that apply):   □African American / Black

□Asian: Filipino, Hmong, Vietnamese   □Asian: Other   □Hispanic / Latinx

□Native American / Alaskan Native   □Native Hawaiian / Other Pacific Islander

□Non-Hispanic White   □Other: _____

Parent's education: □Less than High School □High School   □Some College
□4 Year College Degree   □Professional degree, Masters or PhD.

In the past, have you participated undergraduate mathematics or statistics research, either as a student or faculty mentor?   □Yes   □No

In the coming year will you be looking to participate in undergraduate mathematics or statistics research, either as a student or faculty mentor?   □Yes   □No

If you are an undergraduate student, do you intend to go to grad school in mathematics or statistics?
□Yes   □No   □Still Deciding

If you presented a poster or gave a talk was this (choose all that apply):
□Practice for another conference   □Required by mentor/for a class
□To share my work   □For fun   □For my resume   □Other:_____

In order to attend SUMS did you have to drive for more than 3 hours or fly?   □Yes   □No

Did you have to stay overnight in Harrisonburg?   □Yes   □No

Additional questions on reverse

Rate each of the following statements using the scale:

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

I felt welcome and comfortable at SUMS	1	2	3	4	5
I met new people in the mathematics and/or statistics community	1	2	3	4	5
I would like to learn more about a topic I heard about today	1	2	3	4	5
I would come back to SUMS	1	2	3	4	5
I would encourage undergraduate students to attend SUMS	1	2	3	4	5
The opening speaker was understandable for undergraduates	1	2	3	4	5
The closing speaker was understandable for undergraduates	1	2	3	4	5

Any other feedback you would like to provide the organizers?