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 take their posters to 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  
auditorium 2301

Join Dr. Heather Coltman, Provost and Senior Vice President of Academic Affairs for James Madison University, and the conference organizers as we welcome you to the SUMS 2017 extravaganza.

10:10 - 11:00 Opening Address  
auditorium 2301

Mathematical Modeling in Cancer Research

Suzanne Weekes  
Worcester Polytechnic Institute

Cancer research is no longer solely the domain of biologists, oncologists, and other physicians and bench scientists. Mathematicians use modeling and computer simulation to further the understanding of these diseases by developing quantitative descriptions to biological theories at various scales. The analytical and numerical results of these models can be compared to clinical and laboratory data to gain further insights. Results from these models can also be used to drive the design of in vitro or in vivo experiments and are used to develop new paradigms or to challenge existing theories. In this talk, the speaker will give a taste of some mathematical and computational models used by quantitative scientists working to understand the biology and dynamics of cancer.
2203 **Anti-Games on Steiner Triple Systems**  
*Sophie Mancini, James Madison University*  
Steiner Triple Systems (STSSs) are a category of combinatorial objects with features that have proven useful in determining winning strategies for various games. In this talk, I use geometric properties of these systems to describe a winning strategy for anti-games, variations of conventional games, played on STSSs.

2204 **Rheology of nematic liquid crystals and magnetic fields**  
*Jacob Britton, Radford University*  
We explore how the linear response of a nematic liquid crystal to small amplitude oscillatory shear is affected by the presence of a static magnetic field. The magnetic field forces an equilibrium alignment of the liquid crystal of our choosing, and the flow causes the orientation to oscillate around this equilibrium.

2208 **Model Theory & Geometry Without the SAS Axiom**  
*Stephen Davis, University of Virginia*  
We survey non-SAS geometries and axiom equivalences in the context of Hilbert’s modern axiomatization of Euclidean geometry. Our perspective is informed by mathematical logic. Our main result is a novel proof that Euclid’s parallel postulate is not equivalent to Playfair’s axiom in the non-SAS context.

2209 **Discrete Moment Problems and the News Vendor Application**  
*David Allen, The College of William and Mary*  
Solving discrete moment problems can give sharp bounds for functions of discrete random variables. Bounds come from optimizing the linear programs, using estimated moments of functions of discrete random variables as constraints. We structure the bases used to solve the programs and apply it to inventory management.

2210 **Panel Session on Graduate School in Math, Stats and Math Ed**  
*Mike Lam, James Madison University*  
*Zev Woodstock, NC State University*  
*Nicholas Granered, University of Pittsburgh*  
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 grad students!
11:30 - 11:45 Parallel Talks Session II

2203 Eulerian Numbers in Cryptography
Jenna Foster, Radford University
In our research, we have given a new proof through combinatorial methods that the number of increasing pairs is equal to Eulerian numbers for a permutation. We have used methods similar to Bellaso to encode messages into binary strings and discovered that this process is producing balanced, pseudorandom binary sequence.

2204 Observing the Behavior of Quasiperiodic Orbits
Arsah Rahman, George Mason University
Quasiperiodicity is a dynamical behavior often seen in planetary motion. Referencing Das et al’s, and Levnajic’s and Mezic’s work, we observed the standard map’s dynamics for an understanding of the quasiperiodic orbits behavior and are extending it for the Froeschle map, and viewing new parameters for other equations.

2208 Families of Laplacians on Fractals
Dylan King, Wake Forest University
Using a modified construction of the Sierpinski Gasket we were able to construct and analyze non-standard Laplacians that maintain symmetry and self-similarity. Our chief subject of analysis is the spectrum of the Laplacian, culminating in the formulation of spectral decimation for spectra of modified Laplacians.

2209 Machine Learning Approach for selecting a Signature Gene Set
Garrett Fuselier, James Madison University
MacLean Koslowski, James Madison University
Parkinson’s disease (PD) is a degenerative disorder of the central nervous system that affects motor function. Our goal is to develop a diagnostic criteria for early detection of PD based on a subject’s genetic makeup. We use supervised learning methods to identify a set of genes linked to the development of PD.

2210 Panel Session on Graduate School in Math, Stats and Math Ed
Mike Lam, James Madison University
Zev Woodstock, NC State University
Nicholas Granered, University of Pittsburgh
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 grad students!
2203 **Finding Periods of Linear Recurrence Relations**  
*Heather Switzer, Longwood University*

The goal for this research is to find an efficient algorithm to determine period lengths of the Fibonacci Sequence under modular arithmetic. These periods also known as the Pisano Period. We developed an algorithm for improving efficiency and empirically compared it to a traditional linear search.

2204 **Dynamics of red coral populations**  
*Hye Kim, George Mason University*

Coral is an animal that plays an important role in the marine ecosystem. We analyze a discrete time model for red coral populations, which exhibits fixed points and a Hopf bifurcation, as a function of the basic reproductive number. The numerical results have been verified through computer assisted proofs.

2208 **Metrics of Gerrymandering**  
*Rachel Koch, James Madison University*

A metric for determining the extent of gerrymandering, the Efficiency Gap (EG), is facing the Supreme Court. We analyze EG’s strengths, weaknesses, and challenges to become court doctrine. We examine past court rulings and the metrics which these have spurred. Finally, we present some initial findings for a new metric.

2209 **Geometric Distribution of order r and the Stock Market**  
*Grace Malcom, Salisbury University*

The market estimates that the daily return change of the stock market is followed by the normal distribution. After deriving the geometric distribution of order r, we used simulated and theoretical data from both distributions to prove that the normal distribution is not an accurate model for the stock market.

2210 **Panel Session on REUs and Summer Programs**  
*Brant Jones, James Madison University*  
*Channing Parker, University of Pittsburgh*  
*John Harnois, The University of Virginia*

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!
2203  **The Sortability of Permutations under Context Directed Swaps**  
*Colby Brown, University of Arizona*

Context Directed Swaps (CDS) is a sorting operation utilized by ciliates, single celled organisms. CDS is the most efficient of sorting operations utilizing swaps; however, not all permutations are sortable under CDS. We utilize linear algebra and graph theory concepts to determine sortability criterion.

2204  **A Differentiable Exact Approximation to Brownian Motion**  
*Adam Diehl, James Madison University*

Brownian motion is a continuous, nowhere-differentiable random process that drives many stochastic differential equations. The Karhunen-Loeve theorem provides a differentiable approximation to this process. We present a modification of the KL transform that corrects for the error introduced by the approximation.

2208  **Variational Data Assimilation for Neuronal Network Models**  
*Jiajing Guan, George Mason University*

Understanding neuronal networks is a great challenge. We use Fitzhugh-Nagumo model to simulate a chaotic neuronal network. Through Levenberg-Marquardt method, we assimilate the behavior given the data of a few neurons in the network and assign each neuron a condition number describing the difficulty to reconstruct.

2209  **Distributed Algorithms for Constrained NMF**  
*Matthew Dyer, Longwood University*

Three new distributed computing algorithms were developed for constrained non-negative matrix factorization (NMF). All three algorithms were tested on a set of gene expression data. The developed algorithms were able to accurately reconstruct the original matrices with less error than standard NMF algorithms.

2210  **Panel Session on REUs and Summer Programs**  
*Brant Jones, James Madison University*  
*Channing Parker, University of Pittsburgh*  
*John Harnois, The University of Virginia*

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!
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

Sortability of Permutations under Context Directed Swaps  
Colby Brown, University of Arizona

Eulerian Numbers In Cryptography  
Jenna Foster, Radford University

Effects of Spring Damping in a Mother Machine (◊)  
Austin Fullmer, University of Houston

Using Big Data to Save Premature Babies  
Joel Goddot, Virginia State University

Oncogenic pathways and iron phenotypes in breast cancer  
Sergio Guerra Abril, Viktor Belay, Jacqueline Adams. and Linoy Kotler  
American University

Enigma: What Made The Cipher So Difficult to Break (◊)  
Rebecca Journigan, Radford University

Lorentzian Geometry on Finite Dimensional Lie Algebras  
Nicole Marzolf, Longwood University

Secret Sum Numbers  
Max Misterka, Homeschool

Predicting Biofilm Dynamics with a Spatial Simulation  
Aparajita Sur, William and Mary

Stability Switches of a Square Matrix  
Gabrielle Tauscheck, College of William and Mary

The 3-Dimensional Heisenberg Lie Algebra  
Sarah Williams, Virginia Commonwealth University

Numerical Analysis on Peakon Collisions  
Zachary Zhao, Gilman School
2203 **Potential Stability of Matrix Sign Patterns**  
*Christopher Hambric, College of William and Mary*  
The study of stable matrices has several applications for understanding the long term behavior of a system. In our research, we examine irreducible matrix sign patterns, and we expand on prior results regarding the minimum number of non-zero entries necessary for such a matrix to be potentially stable.

2204 **Generalizing the Symmetric Groups as Weyl Groups**  
*Ethan Zell, The University of Virginia*  
Motivated by an investigation into cases of the Lusztig Character Formula, one can generalize the Symmetric Groups to their relatives, the Weyl Groups, in order to gain a deeper understanding of their symmetries. By the end of the talk, undergrads will have access to further resources for these questions.

2208 **Oncogenic pathways and iron phenotypes in breast cancer I**  
*Jacqueline Adams, American University*  
*Viktor Belay, American University*  
Iron plays a major role in DNA synthesis and cell proliferation; however, it is also positively correlated with breast cancer. By expanding Dr. Chifman’s time- and state-discrete mathematical model, we integrated additional biochemical pathways to understand iron regulation and its relationship to breast cancer.

2209 **Predicting Housing Prices in King County, Washington**  
*Orton Babb, George Mason University*  
We consider the prediction of housing prices using nonparametric methods centered on support vector machines (SVMs), which can generalize from training data using kernel methods, regularization and empirical risk minimization. The obtained numerical results demonstrate the accuracy and potential of the SVM paradigm.

2210 **Career and Industry Panel**  
*Jenny Gibson, James Madison University*  
*Chris Campbell, James Madison University*  
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!
2203 **The Critical Group of KG(n,2)**  
*Ian Hill, James Madison University*  
Let $KG(n,2)$ be the Kneser graph on the 2-subsets of an $n$ element set. We use methods stemming from the representation theory of the symmetric group and algebraic graph theory to find a cyclic decomposition of the critical group for this family of graphs.

2204 **Noise Induced Stabilization of Hamiltonian Systems**  
*Sarah Sparks, Frostburg State University*  
Noise-induced stabilization is the phenomenon in which the addition of randomness to an unstable deterministic system of ordinary differential equations results in a stable system of stochastic differential equations. We studied ways to perturb Hamiltonian systems such that noise-induced stabilization can occur.

2208 **Oncogenic pathways and iron phenotypes in breast cancer II**  
*Sergio Guerra Abril, American University*  
*Linoy Kotler, American University*  
Continuing from part I, we encoded each node in the network using logical update rules, which translated into a polynomial dynamical system. By then simulating this system, we predicted the long-term behavior of our model under different initial conditions, which we then interpreted in the context of iron phenotypes.

2209 **Avoiding Overfitting Evolutionary Models on Time Series Data**  
*Curtis Lamp, Shippensburg University of Pennsylvania*  
We consider two evolutionary algorithms, a GA and PSO, and apply them to the Storage Location Assignment Problem (SLAP). The focus of this talk is not on the algorithms themselves but on preventing them from overfitting. We present preliminary results on quantifying the generalizability of these models to future data.

2210 **Career and Industry Panel**  
*Jenny Gibson, James Madison University*  
*Chris Campbell, James Madison University*  
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!
2203 Lorentzian Geometry of Lie algebras
Nicole Marzolf, Longwood University
In this talk, we will present results related to the classification of Lorentzian scalar products on Lie Algebras. Specifically, we classify Lorentzian scalar products on a Lie algebra up to the notion of equivalence determined by changes of basis corresponding to an automorphism of the Lie algebra.

2204 KMC Dynamics: The Evolution of Crystal Structures
Molly Rowland, James Madison University
Michael Boyle, James Madison University
We consider a solid-on-solid atomistic model for homoepitaxial growth. Atoms evaporate from, condensate on, and diffuse (hop) across the crystal surface. Facets reflect a long-range order of the atoms on the surface. To explore the facet formation, we numerically simulate a 1-D and 2-D silicon on silicon model.

2208 Simplicial Homology and Neural Networks
Mark Agrios, College William and Mary
Concepts from algebraic topology applied to neural networks in understanding their function and behavior. We will look at how simplicial homology can give insight to a network’s topological features and how they can dictate the dynamics of the network.

2209 Analysis of Bank Telemarketing Data Set Using R
Christina King, Virginia State University
Christopher Triplett, Virginia State University
In this project, we use RStudio to analyze the bank telemarketing data set and build a model to predict the success of bank telemarketing by sorting the attributes according to their impact on a client’s decision of subscription to the term deposit or not.

2210 JMU Math Connections Theatre - Integrating Math to Theatre
Connor Kindley, James Madison University
Ellen Orie, James Madison University
Tanner Clark, James Madison University
A primary goal of the Connections Theater is to make headway in “connecting” students who might have traditionally had a negative experience, and now perception, of mathematics once again with this powerful field. We will explain our history, reflect on our previous large scale performance, and share tips for others.
3:00 - 3:15 Afternoon tea  
2nd floor hallway

Please join us for tasty treats in the EnGeo 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

Theory and Practice: Mathematics and Music

Dave Kung
St. Mary’s College of Maryland

The two subjects of math and music are connected in myriad ways, from the rhythm of notes to the frequencies of the pitches. At the advanced level, both mathematical theories and music theories help us understand the other subject. In this talk, we first explore what mathematics tells us about musical instruments, the basic tools of musical practice. In the second half, we flip sides, looking at music theory and how the structure of chords gives us another way to understand topological structures (circles, Möbius strips and higher dimensional tori), some of the basic tools of mathematical practice. Thus the first half connects mathematical theory to musical practice, and the second connects musical theory to mathematical practice. Throughout, examples played on the violin will illustrate all of these beautiful and surprising connections.