Mathematical Association of America
MD-DC-VA Section, November 2 & 3, 2018
University of Mary Washington, Fredericksburg, VA
Abstracts

Abstracts for the workshop and invited addresses are listed first, in chronological order, followed by faculty and graduate student abstracts, alphabetized by submitting presenter's last name. Undergraduate student presentation abstracts follow, also alphabetized by submitting presenter's last name.

Invited Addresses

FRIDAY WORKSHOP

Ryan Gantner, St. John Fisher College

Developing Classroom Culture With Inquiry-Based Learning

4:00 PM Colonnade Room, University Center

In this two-hour workshop, we will explore ways to help foster a culture of learning in your course. We do this through an inquiry-based learning (IBL) approach. Acknowledging that each instructor has a different style, different goals (both stated and unstated) for the course, and a different set of physical and environmental constraints, we will discuss a variety of IBL approaches and when they might be most appropriate. Through these approaches, we will determine the aspects of classroom culture we seek to bring out and develop a strategy for doing so. All are welcome to attend this workshop: those who are experienced practitioners of IBL methods, those who are curious about what this means, and anywhere in between.

BANQUET ADDRESS

Eve Torrence, Randolph-Macon College

A Mathematical Art Gallery Tour

8:00 PM Chandler Ballroom, University Center

Over the past several decades there has been a revolution in using the arts to express, display and explain mathematical concepts. The international Bridges Organization organizes annual conferences that celebrate connections between mathematics, art, music, architecture, education and culture. There are wonderful exhibits of mathematical art at these conferences and at the Joint Mathematics Meetings every year. We will take a tour of some of my favorite pieces from these shows and see the incredibly creative ways mathematicians and artists are making mathematics visible.

SATURDAY INVITED ADDRESSES

Kira Hamman, Penn State, Mont Alto

How Much is Too Much? Axiomatic Systems and Reverse Mathematics

10:00 AM Dodd Auditorium, GW Hall

What are we assuming when we do mathematics? This is the foundational question that underlies mathematical logic and is at the root of its many crises and schisms. At least as far back as Euclid, mathematicians have sought to identify and justify the precise axiomatic foundation upon which they are building; their success has been, shall we say, mixed. From Russell's Paradox to Gödel's theorems to the Axiom of Choice, the question has taken on increasing complexity over time. But not every proof requires a full complement of set-theoretic axioms. Some require just a few, while others are more demanding. A relatively new area of research, Reverse Mathematics, seeks to calibrate the axiomatic needs of individual theorems and compare them to those of other theorems. The result is a hierarchy of proof-theoretic strength that can be thought of as a partial solution to Hilbert's Program. We will introduce that project and discuss a few of its more surprising results.

Dominic Lanphier, Western Kentucky University
Unexpected Zetas!
3:00 PM Dodd Auditorium, GW Hall
Zeta functions, such as the Riemann zeta function, are subjects of some of the most difficult problems in mathematics. Indeed, two of the seven millennium problems (the Riemann Hypothesis and the Birch-Swinnerton-Dyer Conjecture) involve zeta functions. Ever since Euler solved the celebrated Basel problem, values of zeta functions have seemed surprising, mysterious, and deep. Nevertheless, zeta functions and their values can and do show up naturally in undergraduate-level problems. We will review some history of zeta functions and their values. Along the way, we will become acquainted with some unexpected appearances of zeta functions.

Contributed Faculty Papers by Author

Abdinur Ali, Norfolk State University
Mushtaq Khan, Norfolk State University
Information Leak and Dispersion of AES Algorithms
9:25 AM Trinkle 140
The central issue of any cryptosystem is how resistant the algorithm is to cryptanalysis. The Advanced Encryption Standard (AES) system uses linear and non-linear mapping for reasons of efficiency and security. The security of the AES symmetric ciphers is strong. However, repeated attacks are made on the physical implementation of these ciphers. These attacks are not exhaustive search attacks and are computationally feasible. In this paper, we study statistical uniformity and dispersion properties of AES ciphers. We have used simulation tests to gauge the security properties of different block methods. The test results indicate that the vulnerability of the AES system is based on lack of efficient distributions.

Content Area: Applied Mathematics
Recommended for Students: Yes

Tauqir Bibi, South University
Loretta Alsop, South University
Making Theoretical Polynomials Real
11:10 AM Trinkle 106A
We have been teaching Algebra I classes for several years. This course includes arithmetic operations and factoring of polynomials. Usually, the students can perform these operation on the given polynomials, but they have difficulty in setting up polynomial functions for the real word problems. In this presentation, we will introduce a few projects to help the students in making polynomials for the area, volume and distance problems.

Content Area: Mathematics Education
Recommended for Students: Yes

Neal Bushaw, Virginia Commonwealth University
Automated Conjecturing and Hamiltonicity
2:00 PM Trinkle 204
The Graph Brain Project is an experiment in how the use of automated mathematical discovery software, databases, large collaboration, and systematic investigation provide an experimental model for collaborative mathematics, with mathematicians and students of varying backgrounds. During the summer of 2018, a group of undergraduates, graduate students, and faculty made use of a program capable of generating invariant-relation and property-relation conjectures in many areas of mathematics. Our focus was on conjecturing about Hamiltonian cycles in graphs. In this talk we'll give a short overview of the conjecturing framework, as well as present our (somewhat limited) results about Hamiltonian graphs. This is joint work with Craig Larson and a small army of project collaborators.

Content Area: Graph Theory
Recommended for Students: Yes

Jiacheng Cai, Salisbury University
A Finite Volume Alternating Direction Implicit Method for the Valuation of American Options Under the Heston Model
2:25 PM Trinkle 140
A finite volume alternating direction implicit method is proposed for the numerical valuation of the American options under the Heston model. It is based on decoupling the correlated stock price process and the volatility process so that the corresponding partial differential operator does not contain the mixed partial derivative term. Hence, the proposed method is numerically simple and fast. Numerical results are presented to examine the accuracy of the proposed method and to compare it with the others.

Content Area: Computational Mathematics
Recommended for Students: Yes

Kubilay Dagtoros, Norfolk State University
Large Deviation Results for Random Walks in a Sparse Random Environment
9:00 Trinkle 204
Basic asymptotic properties of the random walks in a sparse random environment (RWSRE) on integer lattices were investigated by Matzavinos, Roitershtein and Seol (2016). The purpose of this work is to prove large deviation principles accompanying laws of large numbers for the position of the particle and first hitting times, which have been established in previous work. In this work we obtain quenched and annealed LDP for the RWSRE using a relation between the underlying RWSRE and a random walk in a dual stationary environment which was introduced by Matzavinos, Roitershtein, and Seol. We first investigate a relation between the sparse environment and its stationary dual, and then obtain LDP's for a random walk in the stationary (and ergodic) dual environment. Next, we transform the quenched LDP in the dual setting to obtain a quenched LDP for the corresponding RWSRE and give a description of the rate function. Finally, we show that the annealed LDP in the dual setting is directly related to an annealed LDP for the RWSRE when the lengths of the cycles are bounded. Our study of the rate functions relies on the approach of Comets, Dembo, Gantert and Zeitouni (2000, 2004).

Content Area: Probability Theory and its Applications
Recommended for Students: No

Ming Fang, Norfolk State University
Alternative Approaches to Rate Models
2:00 PM Trinkle 210
Discrete compounding $y = (1 + r)^t$ is often taught with continuous compounding $y = e^{rt}$ as examples of exponential functions. In this talk, we will give a reason why it is better to study discrete compounding as a power function.

Content Area: Applied Mathematics
Recommended for Students: Yes

Anne M. Fernando, Norfolk State University
Modeling the Seasonal Re-emerging P. vivax Malaria in Korea
9:00 AM Trinkle 140
The study of malaria transmission is essential for public health issues. Domestic animals attract mosquitoes, with a consequent decrease in mosquito bite rate on humans. This implies a different dynamic on malaria transmission. This research discusses how much the number of domestic animals influences the rate of malaria transmission. An SEIS model without morbidity is applied. The mosquito population data is represented in the model as distributed like a Gaussian curve. As the seasonal mosquito population peaks during July and August, including variable as opposed to average mosquito population improves the model. This work goes on to include the simulation analysis of the seasonal reproduction number, as model parameters vary with the mosquito population a time dependent or seasonal parameter.

Dynamics or sensitivity analysis is also performed as model parameters vary. This model also include of long and short incubation periods of plasmodium vivax Malaria in Korea. In this work, the long and short incubation periods of plasmodium vivax Malaria in Korea are also considered to make the model robust.

Content Area: Applied Mathematics, Epidemiology, Modeling
Recommended for Students: Yes

Erika Gerhold, Salisbury University
Ryan M. Shifler, Salisbury University
Calculus Readiness
11:35 AM Trinkle 106A
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-led 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: Mathematical Pedagogy
Recommended for Students: No

Carl Giuffre, St. Mary's College of Maryland
Viral Load Alters Behavior of Bee Parasite Varroa Destructor
2:00 PM Trinkle 140
The invasive mite Varroa destructor has negatively impacted global apiculture, by being a vector for many viruses of the honey bee (Apis mellifera). Until now, most studies have been limited to varroa-honey bee or virus-honey bee interactions. The aim of this study is to bridge the important research gap of varroa-virus interactions by correlating varroa behavior with viral load. Ten-minute video recordings of 200 varroa mites were analyzed, and average speeds of the mites were compared to individual qPCR viral loads for deformed wing virus (DWV) and sacbrood virus (SBV). Statistical models reveal that colony, DWV, and SBV all play a significant role in mite behavior, suggesting that the varroa-virus interaction needs to be an integral part of future studies on honey bee pathogens.

Content Area: Biomathematics, Statistical Regression Models
Recommended for Students: Yes

Spencer Hamblen, McDaniel College
Inquiry-Based Learning in Developmental Mathematics
2:00 PM Trinkle 106A
This talk will discuss my experience this semester with implementing IBL techniques in non-credit developmental mathematics courses.

Content Area: Mathematical Pedagogy
Recommended for Students: No

Ilhan M. Izmirli, George Mason University
Group Theory and Atonal Music
9:25 AM Trinkle 204
There are very interesting applications of group theory in general (and the Klein four-group) in particular in twelve-tone compositions. In this talk, we will analyze some of these applications.

Content Area: Algebra
Recommended for Students: Yes

Abstracts

Minah Oh, James Madison University
The Value of Solid Mathematics for Computer Algorithms
11:35 Trinkle 210
In this talk, I will discuss the importance of mathematics behind computer algorithms and present some examples that show what problems a mathematical error or an incomplete mathematical analysis can cause.

Content Area: Numerical Analysis
Recommended for Students: Yes

Sujan Pant, Norfolk State University
Classification of Group von Neumann Algebras
11:10 AM Trinkle 204
I will survey recent classification results and open problems in the area of group von Neumann algebra classification. Also, we will briefly present product rigidity results for II_1 factors of a large class of von Neumann algebras, where all tensor product decompositions of these II_1 factors are in one-to-one correspondence with a direct product decomposition of the generating group.

Content Area: Functional Analysis, Operator Algebras
Recommended for Students: No

Katie Quertermous, James Madison University
Using Online Videos in Upper-Level Mathematics Courses
2:25 PM Trinkle 106A
Over the past few years, I have started creating online videos for several of my upper-level courses, including linear algebra and real analysis, to help students more fully understand the definitions and basic examples from the textbook reading before they come to class. This talk will discuss the motivations behind creating these videos, how they are integrated into my courses as supplementary materials, and some of the lessons I have learned along the way. Practical tips for those interested in creating their own videos as well as software/equipment recommendations will be included.

Content Area: Teaching
Recommended for Students: No

Elliott Rickenbaker, Falls Church, VA
Analysis of Parabolas
2:25 PM Trinkle 204
The study of mathematics and its history are intertwined. Modern mathematics is best understood by knowing the history of its development. I researched the contributions of the Greeks to geometry and studied the writings of Apollonius and Euclid. I studied parabolas and did an analysis using the basic algebra and geometrical properties of parabolas to find the vertex, focus, and directrix without using rotation of axes and coordinate transformation for a parabola not oriented parallel to the *x* or *y* axes.

Content Area: Basic Algebra, Fundamental Geometry, Calculus
Recommended for Students: Yes

Bob Sachs, George Mason University
A Transition/Proofs Course Based on the Complex Numbers
9:00 AM Trinkle 106A
This talk will describe an alternative transition/proofs course offered for the first time last spring. The unifying theme is the complex number system. The basic algebra, analysis, and geometry that develops also includes some discrete math, number theory, and topology. Students were introduced to a connected body of mathematics that simultaneously stimulated interest in the further content of upper-level courses. Furthermore, it motivated a need for proof, attention to definitions and notation, a variety of proof techniques, prior content in a new context, and some surprising results.

Student feedback and some preliminary data about their performance in subsequent courses this past fall will be discussed.

Content Area: Teaching
Recommended for Students: Yes

Ivan C. Sterling, St. Mary's College of Maryland
3D Printing and Math: Two Courses and Many Senior Projects
11:35 AM Trinkle 204
I'll describe some of my favorite projects past and present. I'll bring some prints that inform open problems in mathematics. Some that could be used in teaching mathematics, or biology, or chemistry ... and some that are just nice!

Content Area: Many different areas of math, science and dance.
Recommended for Students: Yes

Ann Stewart, Hood College
It must be Noyce, it must be Noyce, to have NSF on your side!
2:25 PM Trinkle 210
We are now in our second year of funding for the Hood Noyce STEM Teacher Education Partnership (N-STEP), DUE 1660640. I will share information about the structure of our program and the grant application process from the perspective of a small college.

Content Area: NSF Grant Proposal
Recommended for Students: No

Eva Strawbridge, James Madison University
N-Patch Model of Arabian Oryx Population Dynamics
11:10 AM Trinkle 140
Here we use discrete time modeling to study population level outcomes for species which may be separated into distinct groups which can only interact after migration between metapopulations. In this talk, we will discuss a model for an arbitrary number of geographically separated populations and the existence and stability of equilibria in this system. We then apply this model to the Arabian Oryx.

Content Area: Applied Math
Recommended for Students: Yes

Laura Taalman, James Madison University
Mastery Based Grading: Infinity War
9:25 AM Trinkle 106A
Mastery Based Grading can encourage your students to adopt a growth-mindset mentality, help reduce math anxiety, and give students more control over their own learning. But it also seems like it would take SO MUCH OF YOUR TIME. Mastery Based Grading is at the epicenter of the eternal struggle between teacher and student, learning and test-taking, and figuring out how to do everything in just 24 hours a day. In this talk we'll discuss how to create a simplified, streamlined MBG environment for Calculus based on randomized multiple-choice Mastery Quizzes with embedded coded answer keys generated from (mostly) simple LaTeX documents.

Content Area: Teaching
Recommended for Students: No

Ana Vivas-Barber, Norfolk State University
Anne Fernando, Norfolk State University
Maila Brucal-Hallare, Norfolk State University
Cherng-Tiao Perng, Norfolk State University
Sunmi Lee, Kyung Hee University, Republic of Korea
A Mathematical Model of the Obesity Epidemic
11:35 Trinkle 140
Obesity is one of the biggest health concerns in the U.S. and around the world, because it has increased in the last fifty years not only in adults, but also in children and adolescents. The obesity epidemic deteriorates the quality of human lives, as well as increases medical costs by increasing the risk for other diseases such as diabetes, heart disease and colon cancer, among others. The overall goal of this research is to understand the dynamics of the transmission of the obesity disease through modeling the epidemic. It will be assumed that the total population *N* can be divided into six compartments: *S*-susceptible, *B*-borderline, *O*-obese, *T1*-treatment 1, *T2*-treatment 2, and *R*-recovery classes. The reproduction number and some stability results will be presented; some numerical simulations for the solution of the dynamical system of ordinary differential equations will be included.

Content Area: Applied Mathematics, Mathematical Biology, Epidemics
Recommended for Students: Yes

Undergraduate Student Abstracts by Author

Riley Anderson, University of Mary Washington
Advisor: James Collins
Implementing Machine Learning to Improve Bertini 2.0
9:00 AM Trinkle 210
The purpose of this research is to decrease the run time of Bertini, a program that approximates roots of polynomial systems. Bertini can be run more efficiently if it is known whether a polynomial is singular or non-singular. In this research, we focus on polynomials of one variable. We use a machine learning algorithm to classify polynomials into these two categories. To do so, we create and use a set of polynomials to train a neural network and create a model. Then we create and use a test set to assess the accuracy of the model. Through a process of training, evaluating, and changing the hyper-parameters of the neural network, such as the network architecture and learning rate, the accuracy of the model is increased.

Makenzie Clower, University of Mary Washington
Advisor: James Collins
Predicting Parameters for Bertini Using Neural Networks
9:25 AM Trinkle 210
The purpose of this research is to use machine learning to predict the fastest settings for a program called Bertini. Bertini is a computer program that approximates solutions to systems of polynomial equations. The settings that were focused on were the differential equation predictor methods for step size when tracking the homotopy to the solution of the system. A neural network was used on a training set of data to create a model and then a test set was run through to obtain a percent accuracy for this model. Increased accuracy for the model was obtained by changing hyperparameters of the neural network. Neural networks with training sets of 3,000 and 8,000 were used and results were found.

Abstracts

Jenna Guenther, James Madison University
Morgan Wolf, James Madison University
Advisor: Paul Warne
An Adaptive, Highly Accurate, and Efficient Parker-Sochacki Algorithm for Numerical Solutions to Large Scale Dynamical Systems
11:10 AM Trinkle 210
The Adaptive Parker-Sochacki Method (PSMA) produces better accuracy in less time and fewer steps when contrasted to Runge-Kutta algorithms, including MATLAB's renowned ODE45 solver. Several examples are given, including a 2 degree of freedom example related to missile defense, where it is noted PSMA takes 2 orders of magnitude fewer steps and is 1 order of magnitude faster.