Mathematical Association of America
MD-DC-VA Section, November 8-9, 2019
Norfolk State University, Norfolk, VA
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. In what follows, the abbreviation NGE refers to the Nursing and General Education Building.

Invited Addresses

FRIDAY WORKSHOP

The Maryland—DC—Virginia IBL Consortium

Building on Strengths, and Building out Community of Inquiry-Based Learning and Teaching

4:00 PM, 316 Nursing and General Education Building

In inquiry-based learning and other forms of active learning, instructors get a chance to see student work in progress, ask questions, and give feedback. Many instructors have a lot of practice looking at student work from a deficit perspective: what did the student do wrong? How can I help them correct their misconceptions? (Or, how many points should I take off?) In the first hour of this workshop, we will practice looking at student work from an asset model instead: What does the student know? What can the student do? How can I help them build on that? How can the rest of the class use these ideas and insights? We will look at some interesting examples of student work, and discuss various ways of responding and building on its strengths.

The second hour of this workshop will be devoted to brainstorming and planning activities and events for the Maryland-DC-Virginia Inquiry-Based Learning Consortium. Thanks to a new NSF grant, we have an opportunity to increase our level of peer collaboration activity and support. Some possibilities include classroom observations, small group collaboration on course materials, lesson study, reading groups, etc. What would you like to be involved in? What topics would you like to see addressed in future workshops? We invite everyone who is even a little bit interested to join us and help us plan for the future.

BANQUET ADDRESS

David Clark, Randolph-Macon College

Samurai, Kissing Circles, and the Geometry of Shinto Shrines

8:00 PM, 149 Student Center

During the Tokugawa Period (1603-1868), Japan was almost completely isolated from the West, including the products of the Western revolutions in math and science. At the same time, the Japanese witnessed a cultural renaissance in the visual and performing arts, music, fashion, ceremony … and mathematics. New problems and solutions appeared in Buddhist temples and Shinto shrines across the Japanese landscape. In this talk, we'll explore how *wasan* ("wa"=Japanese, "san"=mathematics) became so delicately folded into 18th century Japanese culture.

SATURDAY INVITED ADDRESSES

Bonita Saunders, National Institute of Standards and Technology (NIST)

Mathematics, Mesh Generation, and 3D Graphics on the Web, and Finding a Career at the NIST

9:45 AM, 205 Nursing and General Education Building

This multilevel talk will discuss my work at the National Institute of Standards and Technology (NIST), but also look at other research projects that may be found throughout the Applied and Computational Mathematics Division and the rest of NIST. We will describe contributions in mesh generation, scientific visualization, and mathematical reference data motivated by the development of the NIST Digital Library of Mathematical Functions and reveal some interesting tidbits from the history of the original handbook, considered one of the most cited mathematical references of all time. This discussion will provide insight into the journey from my original research and dissertation to using that knowledge in my career at a federal research laboratory.

The mention or discussion of other projects in fields such as quantum information theory, materials science, graph theory, cybersecurity and nanotechnology will provide a wider view of the research that goes on at NIST. Some tips for succeeding at such a place and opportunities for internships and postdocs will also be discussed.

Kenan Ince, Westminster College
The Untwisting Number of a Knot
3:30 PM, NGE 205

In Greek legend, Alexander the Great was confronted with the problem of untying a very complicated knot and gave up, instead deciding to cut the knot with his sword. The *unknotting number* of a knot is the minimum number of times one must cut two strands of a knot, pass one strand through the other, and re-glue the knot in order to untie it. We work with a generalization of the unknotting number due to Mathieu-Domergue which we call the *untwisting number*, the minimum number of times one must cut a knot and twist all the loose strands around each other in order to untie it. We show that, algebraically (i.e. up to our best algebraic approximation), the unknotting and untwisting numbers are the same, while geometrically they can differ arbitrarily.

Contributed Faculty Papers by Author

Abdinur Ali, Mushtaq Khan, Norfolk State University
DNA Cryptography and New Directions in Cryptographic Paradigms
8:45 AM, NGE 212
Today, significant advances are made in DNA synthesis and DNA sequencing machines. Using these new techniques, cryptography at the bio-molecular level is feasible and can be performed more quickly than before. DNA cryptosystem removes the security features based on statistical correlations, avalanche effects and larger key spaces. It is inevitable that these new cryptographic paradigms will change the current methodology of risk analysis and information security. In this paper, we will cover fundamental issues of this emerging new research field.

Content Area: Applied Mathematics
Recommended for Students: Yes

Bud Brown, Virginia Tech
You Can't Multiply Triples: A Proof Hamilton Missed
1:35 PM, NGE 210
Think of complex numbers as ordered pairs of real numbers. You can add and subtract pairs coordinate-wise. There is even a product formula, namely *(a,b)(c,d)=(ac +/- bd)(ad -/+ bc)*. The latter equality leads to the two-square identity, namely $(a^2+b^2)(c^2+d^2) = (ac -\+ bd)^2 + (ad +\- bc)^2$. This means that the complex numbers form a two-dimensional real algebra--which is a vector space over the real numbers with a multiplication. For most of the decade 1834-1844, William Rowan Hamilton tried to multiply ordered triples of real numbers—but failed to do so. On Monday, October 16, 1844 he had a flash of insight and discovered the quaternions, a four-dimensional real algebra with a perfectly good way to multiply quadruples. In this talk, we will (a) show that Hamilton would not have tried to multiply triples had he known a little bit of number theory and (b) give a short proof that you can't multiply triples using only mathematics known to Hamilton at that time. Come and join us!

Content Area: Number Theory
Recommended for Students: Yes

Maila Brucal-Hallare, Norfolk State University
Valuation Trees for Quadratic Sequences
2:30 PM, NGE 212
The *p*-adic valuation of a natural number is the largest exponent of *p* that divides the number. We review some existing results on the 2-adic valuations of some famous sequences including the factorials (Legendre Formula), Fibonacci, and Stirling numbers. Here, we explore the 2-adic valuations of some quadratic expressions by looking at a tree that we can generate by successive division by 2. The resulting tree is infinite and symmetric. We also look at a random walk of a path along this infinite tree. One application of 2-adic valuation is in the proof of Monsky's Theorem, which says that there is no dissection of a square into an odd number of triangles having equal areas.

Content Area: Number Theory
Recommended for Students: Yes

Beatriz Cuartas, Dept. of Energy, National Nuclear Security Administration
Ana Vivas-Barber, Norfolk State University
Understanding Latin America's Quality of Life, Well-Being, Peace, and Happiness: Advances Towards a New Statistical Index
2:55 PM, NGE 212
Emerging well-being and happiness metrics afford an opportunity for an empirical contribution on how to best capture what really is worth measuring for people around the world. For instance, controversial elevated Latin American well-being country rankings are among the highest in the world; whilst, other empirical regional basic goods measures including access to food, water, peace, and security are lacking for the largest population segments. These empirical observations point to a methodological problem: the more we explore the country quality of life conditions and factors; the more difficult it becomes to underpin an accurate measure to determine and predict well-being for a country. Consequently, in an effort to advance human well-being measurement, this study explores relevant variables, not considered in previous models like the HPI, in a geospatial multivariable model. Thought-provoking findings call for ongoing multidisciplinary research on this topic, in order to develop a new and better model to measure what matters most to people: quality of life, peace, well-being and happiness.

Kubilay Dagtoros, Norfolk State University
Maximum Likelihood Estimators for Random Walks in Parameter Dependent Random Environments
1:10 PM, NGE 212
In this talk, we will consider performances of different likelihood estimators for parameter dependent random environments with various distributions. Finally, we will focus on an application for a specific model of random walks with a parameter dependent sparse random environment.

Content Area: Probability Theory and its Applications
Recommended for Students: Yes

Dennis Davenport, Howard University
MAA's NREUP and Howard's Program
2:30 PM, NGE 210
Each summer, through grants provided by NSF or NSA, MAA funds small REU programs that are designed to give summer enrichment for undergraduate students who attend the host institution and are majoring in mathematics. In this presentation, we describe MAA's program and provide some funding rate data. We will also describe a summer program that was developed at Howard University which started as an NREUP. Included will be a project on combinatorics and some student results.

Content Area: REU Programs
Recommended for Students: No

Greg Dresden, Washington and Lee University
Polynomial Roots with Common Tails
8:45 AM, NGE 213
How many irreducible polynomials have real roots which, when expressed as simple continued fractions, all have common tails? We show how to identify all such polynomials, and we prove they have degree at most six.

Content Area: Number Theory
Recommended for Students: Yes

David Duncan, James Madison University
Classifying Large, Indivisible Sandpiles
9:10 AM, NGE 210
Indivisible sandpiles are certain integer labelings of the vertices of a graph that arise naturally when modeling various physical phenomena. We will introduce these, describe some of their physical interpretations, and give a simple algebraic condition that is equivalent to indivisibility for a large class of sandpiles whose value at each vertex is sufficiently large. This is joint work with Wes Engelbrecht.

Content Area: Graph Theory
Recommended for Students: Yes

Ming Fang, Norfolk State University
Applying Dimensional Analysis to Lipschitz Conditions
9:10 AM, NGE 213
In this talk we will study the existence and uniqueness of a fixed point to a mean-variance acreage model, *A = alpha(E[p], V [p])*, where *p* is price at harvest time and *E* and *V* are the expectation and variance operators conditional on information known at planting time. We show the convergence of a fixed point iteration by forcing Lipschitz conditions on the model.

Content Area: Numerical Analysis and Applied Mathematics
Recommended for Students: Yes

Anne Fernando, Norfolk State University
Open Discussion Session: Women in Math Academia:
Balancing Mathematics, Life, and Career
8:45 and 9:10 AM, NGE 219
As may be true for any professional who has a family and a career, balancing work and personal responsibilities can be a challenge. The panelists will discuss their experiences as women in academia, in particular in mathematics, addressing the problems of raising families while working fulltime with research, the pressure to publish and procure grants, and the time demands of teaching and earning tenure. Topics discussed include seeking balance among these several demanding and rewarding areas of life. Four panelists to include two from Norfolk State University Math Department and two from other institutions will share their experiences and answer questions posed on pathways to current positions.

Anne Fernando, Ana Vivas-Barber, Norfolk State University
Sunmi Lee, Kyung Hee University, Korea
SEIS Epidemiological Model to Evaluate the Effect of the Inclusion of Domestic Animal Populations on the Transmission of Malaria
1:35 PM, NGE 213
An SEIS (Susceptible-Endemic-Infected-Susceptible) epidemiological model is introduced to investigate the dynamics of malaria transmission when domestic animals cohabitate with human populations. This model studies *Plasmodium vivax* malaria and has variables for animal populations and mosquito attraction to animals. Variables for short and long incubation periods were included on the dynamics transmission. The basic reproduction number of the ODE model with seasonal mosquito population (exponential) is presented and analyzed for various parameters. Some stability results are obtained, and the endemic equilibrium is conducted with conditions on variables. The existing time-independent malaria populations ODE model is extended to a time-dependent model, and differences are justified and explored. Including long and short incubation periods along with seasonal malaria population advances the research on this topic.

Content Area: Mathematical Modeling in Epidemiology
Recommended for Students: Yes

Rhonda Fitzgerald, Anne Fernando, Norfolk State University
Flipping Pre-calculus: The Good, the Bad, and the Ugly
1:10 PM, NGE 219
Successful mastery of concepts taught in mathematics courses proves essential to the pursuit of any STEM degree. Post-Secondary institutions play an important role in producing STEM professionals and Historically Black Colleges and Universities (HBCUs) play a major role in producing minority STEM graduates. Today, many students enter institutions with deficits in mathematical skills and concepts. In addition to the deficit, students lack the knowledge of how to be successful in a college math course. Key patterns noticed in the students who struggle are 1) not consistently and earnestly completing assigned work 2) not utilize resources (i.e. instructor's office hours and tutoring services) and 3) failing to appropriate effective means of study. The flipped classroom approach was implemented in a pre-calculus course with the use of supplemental instructors to bolster student success and enhance students' meta-cognitive skill. Overall, students' who completed the pre-calculus course with the flipped classroom model had a higher GPA each semester in which the grades were collected for the evaluation. More specifically, when an Independent T-Test was conducted between flipped and non-flipped grades at the .05 level of significance, results indicated that there was a statistically significant difference in course grades at the end of the fall 2017 semester and the spring 2019 semester, but not the spring 2018 and fall 2018 semesters.

Minah Oh, James Madison University
Open Discussion Session: How to Increase Collaborations in our MAA Section
2:30 and 2:55, NGE 213
One of my goals as section chair is to facilitate an environment where section members can have more active collaborations in undergraduate education and undergraduate research. We already have numerous talks and workshops about undergraduate education and research at our meetings as well as undergraduate activities in the spring meetings, but I would like to take one step further to find ways to increase collaboration within the section. This will be an informal discussion session where we can share ideas, so please stop by.

Abstracts

Michael A. Parker, Rhonda Fitzgerald, Carolyn Johnson, Norfolk State University
A Bridge for the Future…the Pathway to the STARS Summer Bridge Program
1:35 PM, NGE 212
The Dozoretz National Institute for Mathematics and Applied Sciences (DNIMAS) was established in December 1985. Its goal is to address the severe shortage of minority scientists by producing graduates who are capable of successfully completing graduate studies in the basic and applied sciences, and of entering occupations in industry, government, and education. As a new generation of students enter college, one of the initiatives of the DNIMAS staff is to continue the strong traditions envisioned by the original creators, the late Dr. Harrison B. Wilson and benefactor, Dr. Ronald Dozoretz. The challenge: take away the "physical" calculator and let the "real" calculator do its job.

Content Area: PreCalculus to Calculus Strategies
Recommended for Students: Yes

Cherng-tiao Perng, Norfolk State University
Having Fun with Chains of Circles
2:55 PM, NGE 210
In this talk, we will present solutions to a set of problems proposed by Dao Thanh Oai regarding a special configuration of circles. Dao discovered the configuration in 2013 and asked the set of problems entitled "N-th closed chain of six circles" on the MathOverflow website on July 4, 2018. These problems are related to the Eight Circles Theorem and may be regarded as generalizations of the bundle theorem and the classical Miquel's theorem.

Content Area: Classical Geometry
Recommended for Students: Yes

Charles Samuels, Christopher Newport University
Using Linear Programming to Study Metric Mahler Measures
9:10 AM, NGE 212
Dubickas and Smyth first defined the metric Mahler measure in 2001 as a means of rephrasing Lehmer's problem in topological terms. Since that time, however, their construction has illuminated connections of the Mahler measure to many other areas of mathematics. We provide a brief survey of some of those connections with a particular focus on a recently discovered link to linear programming. This work is joint with Ryan Carpenter.

Content Area: Number Theory, Linear Programming
Recommended for Students: Yes

Eva Strawbridge, James Madison University
Length-Structured, Density-Dependent Model for Fish
1:10 PM, NGE 210
In this talk we will present a length-structured matrix model for fish populations where the probability of growth to the next length class (rather than the traditional age class) is a nonlinear function of the total biomass of the population. We will present the results of the mathematical analysis as well as illustrate these results with numerical simulations representing an invasive white perch population. These results predict the persistence and/or boundedness of the population as well as the equilibrium structure that is dominated by small fish.

Content Area: Mathematical Biology
Recommended for Students: Yes

Benjamin Wilson, Stevenson University
Full Speed Ahead: A Day 1 Calculus Activity
1:10 PM, NGE 213
In this presentation, we will examine an activity intended to introduce first-semester calculus students to some of the big-picture concepts they will encounter in the course, while also building a classroom community where they are comfortable asking questions, working with their peers, thinking outside the box, and trusting their intuition. The focus of the activity is a slow-motion video of a toy car rolling in front of a measuring stick with a timer showing in the background. Students watch many loops of the video and discuss questions they have and answers to those questions. With little input and guidance from me, this activity has always led to excellent discussions on a variety of topics including the difference between average velocity and instantaneous velocity; the relationship between position, velocity, and time; and limits. It also provides a good reference as we more formally study these topics throughout the semester. In addition to introducing students to these concepts, the activity showcases a classroom environment similar to what occurs the rest of the semester, one in which students are mainly working with their peers, asking questions, and presenting solutions.

Content Area: Inquiry-Based/Active Learning
Recommended for Students: No

Student Abstracts by Author

Christina Pospisil, University of Massachusetts, Boston
Generalization Theory of Linear Algebra, Part I
8:45 AM, NGE 210
An algorithm for multiplying and adding matrices regardless of dimensions via an embedding is presented. An equivalent embedding for a general determinant theory is also investigated (Part I: Appropriate Inverses for non-injective mappings in one dimension are presented). In future work, applications to physics and other natural sciences will be explored.