Mathematical Association of America
MD-DC-VA Section, November 5-6, 2021
Salisbury University, Salisbury, MD
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.

Invited Addresses

FRIDAY WORKSHOP

MD-DC-VA COMMIT
Facilitated by Dr. Jessica Kelly, Department of Mathematics, Christopher Newport University
Creatively using our campuses: using everyday places and spaces to inspire mathematical problem formulation
4:00 PM, Conway Hall 156
How many of our students really believe the adage "mathematics is everywhere"? In this workshop, we will focus on how to get our students out of the classroom to explore the places and spaces in their lives where mathematics may be found. Imagine students taking their mathematics knowledge beyond our classroom walls, exploring, measuring, and photographing their world while formulating their own word problems.

During this interactive workshop, we will see examples of and brainstorm ways that our individual campuses can be used as the setting for mathematical inquiry. Additionally, we will discuss logistics---what types of courses and topics lend themselves to this type of exploration; how to provide students with clear instructions and expectations, while still allowing students to have creative ownership; how to guide students through the problem formulation process, and diverse ways to have students write and present their projects.

BANQUET ADDRESS

Dan Kalman, American University
Minute Math
8:00 PM, Worcester Room, Commons Dining Hall
In this talk I will present an assortment of favorite mathematical morsels: short and simple, delightful to the tastebuds, and like Bud Brown's biscuits, easy to digest. Some sample topics:

- o A universal solution of the four 9's puzzle
- o Getting an angle on a regular heptagram
- o Fraction addition made difficult
- o Keypad symmetric path numbers
- o Beholden to Bhaskara: addition identities for sine and cosine
- o The ghost of Pythagoras discourages Starbucks gluttony

Attendees who wish to take part in some audience participation activities should bring a scientific calculator or equivalent app to this presentation.

SATURDAY INVITED ADDRESSES

Dawn Lott, Delaware State University
Optimizing Uncertainty of Information in Decision Making via the LRM Method
9:45 AM, Perdue Hall 156
The importance of decision making cannot be overstated. Problems with decision-making exist in many fields such as mathematics, the sciences, business, agriculture, as well as in the military. Numerous challenges are present when information is provided to the decision-maker throughout the decision-making process. There are several sources of data needed and utilized in this process and decision-makers rely on the status of these sources when making a decision. In many cases, the challenges include the dependence and inter-dependence of sources/devices and the uncertainty of information (UoI) obtained from these sources. Any uncertainty of information significantly affects the decision-making process and expressing this concept to humans can highlight the underlying reasons for uncertainty in making decisions. In this work, a novel method called the LRM (Lott, Raglin & Metu) Method is formally introduced. The LRM method transforms the UoI concept into a linear optimization problem that is maximized using tools of operations research. The results yield the maximum value of uncertainty due to several sources of uncertainty and their relationship defined by a set of taxonomies selected as important to humans in support of decision making.

Minah Oh, James Madison University
Linear Algebra and its Amazing Applications
***3:00* PM, Perdue Hall 156**
Linear algebra is one of the first upper-level math courses that we take. Whether it happens in this class or later down the road, all mathematicians realize the beauty and significance of linear algebra. In this talk, I will talk about my favorite topic in linear algebra: the Singular Value Decomposition (SVD). The applications of SVD are almost like magic. For example, SVD can be used to remove the background of a video from a security camera (capturing only the important objects, the moving objects). We will also investigate other fascinating topics in linear algebra that have many cool applications.

Contributed Faculty Papers by Author

Emad Abdurasul, James Madison University
Exact Bias and Variance of the Product Limit Estimator using Saddlepoint Approximation under the Proportional Hazards Model
1:10PM, Perdue Hall 258
In this presentation, a saddlepoint-based method is developed for generating small sample confidence bands and compare the exact mean, bias, and variance for the product limit(PL) survival function estimator, under the proportional hazards model. In the process the exact distribution of these estimator is derived and developed mid-population tolerance bands for PL estimator. The proposed saddlepoint method depends upon the Mellin transform of the zero-truncated survival estimator which is derived PL estimator and this distribution function are inverted to produce saddlepoint confidence bands. The saddlepoint confidence bands for PL estimator is compared with those obtained from competing large sample methods as well as those obtained from the exact distribution. In the simulation studies it is found that the saddlepoint confidence bands are very close to the confidence bands derived from the exact distribution, while being much easier to compute. Furthermore, we study the bias of the PL estimator, and compare the exact variance of the PL estimator to its asymptotic variance from a saddelpoint approximation and we find that under proportional hazards the true mean gets closer to the asymptotically correct value of product limit survival function as sample size(n) gets large. In addition, the bias increases as time(t) increases and the asymptotic bounds are seen to be reasonably close to the true value of bounds. Also, for fixed(t) and fixed(n), the approximate variance increases as censoring times rate increases.

Content Area: Survival analysis
Recommended for Students: No

Jenn Bergner, Salisbury University
TBD: Adventures in Pre-service Teacher Education During a Pandemic
2:00PM, Perdue Hall 263
In spring 2020 when school systems shut down for "2 weeks", existing grant projects had to adapt. Procedures, projects and all activities related to education had to be approached in ways that were never conceived of before the shut-down and the ensuing restrictions that followed. The Noyce NSF grant project at SU was among those affected. One of its purposes was to engage university faculty, pre-service math teachers, and local K-12 educators and their students in lesson study. All previous plans had to be reworked and to be determined became the modus operandi. In this talk I will share how we were still able to involve all parties in lesson study while adjusting to new norms.

David Carothers, James Madison University
Littlewood, Periodic Functions, and the Evolution of Undergraduate Research
2:25PM, Perdue Hall 249
One of the Littlewood's Three Principles of analysis asserts that every measurable function is nearly continuous. We will consider this principle as related to the result in an award-winning paper written by an undergraduate 36 years ago, and include a brief discussion about how research in mathematics by undergraduates has grown and evolved since that time.

Content Area: Real Analysis
Recommended for Students: Yes

Hongwei Chen, Christopher Newport University
Some Ramanujan-like Series Associated with Powers of Central Binomial Coefficients
1:10PM, Perdue Hall 249
In contrast to the traditional hypergeometric function approach, using the Fourier-Legendre series expansions via specialization, inner product and Parseval's identity, we find various Ramanujan-like series which involve central binomial coefficients. Several classical identities are recovered as particular cases.

Content Area: Analysis
Recommended for Students: Yes

Mehmet Dagli, Amasya University, Turkey
Nonlinear Loop Transversal Codes
***2*:25PM, Perdue Hall 263**
Loop-transversal codes provide an alternative approach to the error-correcting codes. It puts the initial emphasis on the set of errors to be corrected. Then the algebraic structure introduced on this set combined with the inherent structure of the channel yields the code itself. The goal of this talk is to present new nonlinear codes obtained from certain wreath product graphs.

Kubilay Dagtoros, Norfolk State University
Intermittent search strategies: exploring vs. exploiting
1:35PM, Perdue Hall 251
We will talk about applying optimum intermittent search probabilities to an agent's policy of exploring vs. exploiting. Our focus will mainly be on comparing the short-term and long-term performances of deterministic practices and probabilistic approaches.

Content Area: reinforcement learning, intermittent search, random walks
Recommended for Students: Yes

Donna Dietz, American University
Simpson's meta-Paradox
1:10PM, Perdue Hall 263
Do you like Simpson's Paradox? Do you know what Simpson actually said in his original paper? You might be surprised! You may only be getting half the story. What a paradox!

Content Area: Basic Statistics, Probability
Recommended for Students: Yes

Ming Fang, Norfolk State University
Renormalization of a Biochemistry System
9:10AM, Perdue Hall 249
We apply the Renormalization Group theory to enzyme-substrate-inhibitor kinetics.

Content Area: Applied Mathematics, Asymptotic Analysis
Recommended for Students: Yes

Anne Fernando, Norfolk State University
Evelyn Thomas, Norfolk State University
Ana Vivas, Norfolk State University
Modeling the Dynamics of COVID-19
2:00PM, Perdue Hall 251
COVID-19 is an infectious disease that still affects the world. Despite the vast efforts worldwide towards controlling its propagation, there remains questions about its dynamics. Several side effects from individuals, who have contracted the disease and recovered, are still unknown. Furthermore, the media has influenced infection rates through encouraging social distancing and possibly increased vaccination rate even though side effects of vaccination have not been completely evaluated. The health implications of the disease motivate modeling to reflect the relevant aspects that influence prevalence. We implement a system of differential equations to model the dynamics of COVID-19, which considers susceptible, asymptomatic, infectious, hospitalized, quarantine, vaccinated, and recovery classes including the influence of media in exposure/ infection rates and vaccination rates. We use the new generation matrix method to find the basic reproduction number, Ro. Some stability results and simulations with specific parameter values are included.

Content Area: Epidemiology
Recommended for Students: Yes

Samuel Ferguson, Metron, Inc.
The IRS forgets continuity...so what's a math student to do?
8:45AM, Perdue Hall 258
What if your friend is denied Obamacare benefits...because the IRS can't calculate them? And what if the IRS can't calculate them because it applies a theorem on continuous functions...to a function that isn't continuous? Share in the hilarious yet true odyssey which springs a paradox in the US tax code on us, and ultimately leads to a math student advising the IRS on how to do taxes. This talk overlaps with my communication on Obamacare and the IRS published in the August 2021 issue of Notices of the AMS.

Content Area: Calculus, Teaching, Analysis
Recommended for Students: Yes

Mozhdeh Forghaniarani, James Madison University
Khalil Shafie, University of Northern Colorado
Bayesian Approach to the Mixture of Gaussian Random Fields and its Application to fMRI data
1:10PM, Perdue Hall 251
When the functional data are not homogeneous and there exist multiple classes of functional curves in the data set, traditional inferential methods may fail. In this study, we propose a new model for signal detection in fMRI data, addressing the heterogeneity nature in such data. We have also applied the Bayesian procedure for hypothesis testing in signal detection problem.

Content Area: Bayesian Statistics, Random Field Theory, fMRI Study
Recommended for Students: Yes

Allen G. Harbaugh, Longwood University
Guiding Aspiring Undergraduate Researchers to Engaging Projects
9:10AM, Perdue Hall 258
If you are an undergraduate student who wants to do research in mathematics or statistics, or if you are mentoring an undergraduate student who wants to do this type of research, this talk is just for you. Based on my experience running undergraduate research teams at different institutions, this talk will present a number of strategies to guide students to engaging and insightful research projects that can produce substantive results in the short time span of such projects (usually 2-4 semesters in length). Using the 5-M's framework for research project planning, I will present a number of points-of-entry for students interested in pragmatic or theoretical quantitative research. Ranging from the students with full formed research questions to students who are just beginning to explore how mathematics and statistics can be used to answer research questions, this talk will provide a workable roadmap to interesting projects (for both the student and the mentor).

Content Area: undergraduate research (statistics & data science)
Recommended for Students: Yes

Dan Kalman, American University
Dunham's Morley Challenge
8:45AM, Perdue Hall 249
Inspired by Bill Dunham, I recently became interested in Morley's theorem: intersections of angle trisectors of a triangle create an equilateral triangle. Dunham wants an angles-only synthetic proof.

After experimenting with Desmos I nearly rediscovered Conway’a spectacular proof! Dunham's challenge remains open.

Content Area: Applied Mathematics
Recommended for Students: Yes

Sara Malec, Hood College
Encouraging Mathematical Reading with Perusall
2:00PM, Perdue Hall 258
We tell our students to read their textbook, but reading mathematics is a skill that is difficult to learn and teach, and it can be even harder to encourage students to practice reading effectively. Perusall is a free online platform that turns reading assignments into a social experience, and rewards students for engaging with their text through discussions with their professors and classmates. This talk will show how to use this tool to create interactive reading assignments for students.

Content Area: Math Education
Recommended for Students: No

Abstracts

Christopher Marron, UMBC Computer Science and Electrical Engineering
Is All Math Cyber Math?
8:45AM, Perdue Hall 263
Browse through the mathematics curriculum of a typical College or University. Which courses do you think have applications in Cybersecurity? Maybe there's a course on Cryptography — that's an easy one. Number Theory? That counts. How about Probability and Statistics? Absolutely! We'll say these are "Cyber Math" courses. But Cybersecurity is much more than Cryptography. Maybe every math class is a "Cyber Math" class. We'll walk through this exercise together, highlighting the breadth of mathematics that is relevant to Cybersecurity. Perhaps there is no better preparation for a career in the Mathematics of Cybersecurity than a really solid general math degree!

The speaker was an NSA Mathematician before joining the Computer Science and Electrical Engineering Department at UMBC as a Professor of the Practice.

Content Area: Mathematics of Cybersecurity
Recommended for Students: Yes

Christopher Marron, UMBC Computer Science and Electrical Engineering
The Surprising Benefits of Collaborative Oral Exams
9:10AM, Perdue Hall 263
As we shifted rapidly to online instruction in the Spring of 2019, there was little time to make major changes to assessments. For classes requiring proofs or working open-ended problems, it was difficult or impossible to write appropriate exams using online assessments through an LMS. In my classes, I used tests that had been designed to be taken in-class, delivering them to students as PDFs that they printed, worked on at home, and then scanned and uploaded. Unfortunately, one result of this approach was a large number of Academic Misconduct cases.

Searching for a better way to test my Algorithms students in Fall 2020, I considered oral exams, but with 80 students (two sections of 40) individual oral exams were not practical. A possible solution appeared in a 1999 MAA publication (Assessment Practices in Undergraduate Mathematics, MAA Notes #49) and, in particular, the paper Collaborative Oral Take-Home Exams by Annalisa Crannel. Collaborative Oral Take-Home Exams (COTHEs) met my pragmatic requirements: (1) by testing students in groups of four, I could assess all 80 students in a few days, and (2) by assigning broad, open-ended questions and assessing them on their understanding of the group's solution, I could allow the students to use any resources they liked, eliminating opportunities for cheating. What I had not anticipated was that COTHEs would increase student engagement, strengthen my relationships with students, and improve grades. Although we have returned to (mostly) in-person teaching, I have continued to use COTHEs with my Algorithms classes.

In the talk, I will outline the important elements of COTHEs, the modifications that were necessary, the types of problems that worked best, and plans to improve and use COTHEs in future semesters.

Content Area: Alternative Assessments
Recommended for Students: No

Nicholas Owad, Hood College
Tunnel number of all 12 and 13 alternating crossing knots
1:35PM, Perdue Hall 263
We will define knots, crossing number, and tunnel number. Then we will briefly discuss how we computed the tunnel number of these knots using a program that looks at the geometry of the space around a knot.

Content Area: Topology, knot theory
Recommended for Students: Yes

Maggie Rahmoeller, Roanoke College
Bringing Calculus & Statistics into Lie Algebra Representation Theory
1:35PM, Perdue Hall 258
In collaboration with Pamela Harris and Lisa Schneider, we established a closed formula for the q-analog of Kostant's partition function for a specific family of weights and proved the distribution of the number of positive roots in the decomposition of any of these weights converges to a Normal distribution as rank tends to infinity. Amazingly, our initial approach to this project involved a LOT of calculus - specifically, Taylor series expansions. As a follow-up to this project, I worked with a student to determine families of weights whose distributions would NOT converge to a Normal distribution. I'll share details of both of these projects.

Content Area: Lie Algebra Representation Theory
Recommended for Students: Yes

Jason Rosenhouse, James Madison University
Lewis Carroll's Barbershop Puzzle
9:10AM, Perdue Hall 251
Late in his career, Lewis Carroll presented a logic puzzle in the academic journal "Mind." Though he presented the puzzle in the form of a humorous short story, his intention was to raise serious questions about the proper interpretation of conditional statements in formal logic. The puzzle led to a heated exchange of papers among several prominent logicians of the time, and even Bertrand Russell later weighed in on it. We will present the puzzle, discuss some of the replies it provoked, and consider its historical significance in the development of the theory of conditionals.

Content Area: Logic, Recreational Mathematics
Recommended for Students: Yes

Jeff Suzuki, Brooklyn College
How I Learned to Stop Worrying and Love Online Examinations
8:45AM, Perdue Hall 251
The shift to distance learning formats caused an existential crisis among mathematicians: How can we give valid online examinations? Online proctoring software and webcam monitoring are the usual answer, but they are too easily circumvented by motivated students. Instead, we relied on a combination of innovative questions and fingerprinted exams. We present an overview of our strategies and their implications beyond the return to campus.

Content Area: pedagogy
Recommended for Students: Yes

Jennifer Szczesniak, Hagerstown Community College
Trying to Stay Ahead of the Apps
2:25PM, Perdue Hall 251
During the last year I noticed more student work was being copied from apps and tutoring sites, including work from proctored exams. I'll share some of the techniques I used to try to reduce this copying and to make my problems easier to find on the tutoring sites.

Content Area: Teaching Calculus
Recommended for Students: No

Jill Tysse, Hood College
Adventures in Statistical Consulting
2:25PM, Perdue Hall 258
I recently had the opportunity to work with our biology department on a consulting project in the Frederick community. A local homeowners association with a recreational lake was interested in developing a model to predict whether lake water E. coli levels were safe enough for swimming. I will discuss my adventures working as a consultant on this project, with a focus on lessons learned about the statistical consultant-client relationship that might be useful for those who are mentoring undergraduate internships, teaching introductory statistics, interested in interdisciplinary collaboration at a small college or furthering relationships between their college and the surrounding community.

Content Area: Interdisciplinary projects, mentoring undergraduates, community involvement
Recommended for Students: No

Student Abstracts by Author

Eric Botti, Washington College
Piecewise Linear Approximations of Lyapunov Fractals
1:35PM, Perdue Hall 249
We create Lyapunov Fractals by exactly solving a system of equations based on a piecewise linear approximation of the original logistic curve. Via experimentation, we show that this approximation precisely models Lyapunov exponents with few exceptions. This talk describes Lyapunov fractals, the piecewise linear approach, timings and challenges.

Gabriel John Wallace Johnson, Washington College
Max Tucker, Washington College
Chloe Sass, Washington College
Unimodality of q-twotorials via alternating gamma vectors
2:00PM, Perdue Hall 249
Products of the form

$$(1+q)(1+q+q^2)(1+q+q^2+q^3)\cdots$$

are known to give *unimodal* polynomials (their coefficients are weakly increasing and then weakly decreasing). There are simple and satisfying proofs of this fact. The closely related polynomials

$$(1+q)(1+q^2)\cdots(1+q^n)$$

are also unimodal, but a combinatorial proof of this fact has been elusive for several decades. Our main result is a proof for certain cases. We follow a suggestion by Brittenham et al. (2016) to exploit the combinatorics of the *gamma coefficients* through domino tilings and ballot paths. Our contribution is a reordering strategy that requires a structure we call an *ordering tree*. We have confirmed this exists for all *n* up to 24, except 11, 13, 16, and 19. Ordering trees also exist for many other cases in a larger family of unimodal polynomials, and can even be modified to give combinatorial proofs of non-unimodality.