Spring 2023 MD-DC-VA Section Meeting Abstracts

Abstracts are in chronological order. All talks are Saturday, except the workshop and banquet talk.

Workshop

Authentic assessment in mathematics: expanding student opportunities while minimizing faculty workload

Marcella Torres (on behalf of MD-DC-VA COMMIT), University of Richmond
4:00-6:00, HMD 150W

We all know that "real" math doesn't involve producing known answers to prompts in a timed setting, yet this is the skill we most commonly test in our students. Authentic assessments are an equitable and inclusive alternative, in which students apply knowledge gained in the classroom to meaningful tasks with real world applications. In mathematics courses, for example, an authentic assessment might be one that addresses skills such as communicating technical material or generating original problems. In this workshop, we will explore ways to expand our assessment toolbox, beginning by reflecting on what skills we want students to demonstrate at the end of our courses and beyond, and using these outcomes to guide the development of assessments. We will discuss how to build flexibility into grading schemes for these non-traditional assessments, and the inclusion of peer review and opportunities to revise in response to feedback. I will provide some examples of alternative assessments, rubrics, and student work in calculus, created as part of an ongoing study of the impact of alternative versus traditional assessment on student self-efficacy, time management, stress, engagement, and perceived learning. I will also share some of the ways I have reduced my workload while moving away from traditional exams – a process that has not been without missteps and pitfalls along the way! The goal will be to spend some time developing a rough outline for an authentic assessment of one learning objective or student outcome for your course.

Banquet Talk

Cutting corners: you* miter *enjoy this talk

Karen Bliss, SIAM & Greg Hartman, Virginia Military Institute
8:00-9:00, Gateway Dining Hall

What happens when a math nerd reads the manual for a compound miter saw and spots a graph? He shares it with another woodshop-loving math nerd who is equally curious, and down the rabbit hole they go. We'll start with what a compound miter saw is and what it's used for, and talk about how we used calculus-level principles to explore some interesting ideas that come up when exploring the math of making boxes with a compound miter saw.

The Calendar Reuse Problem
Dan Kalman, American University
8:20-8:40, EB 202

In spite of ubiquitous calendar-apps on smart phones, various organizations insist on sending me wall calendars. If you are like me, you start each year with a stack of unused calendars from the preceding year. Have you ever asked yourself, "When will such calendars again be useable?". The answer is not difficult to discover, but is surprisingly elegant: For n between 1901 and 2072, the calendar for year n will next be usable in 28 years if n=0 mod 4, in 6 years if n=1 mod 4, and in 11 years otherwise. Details, proofs, and extensions will be discussed in this talk.

Connection Problems in Graphs
Jason Rosenhouse, James Madison University
8:20-8:40, EB 204

Mathematicians have devised a number of methods for measuring the resiliency of a graph. One such method is the isoperimetric number, which, roughly, measures how many edges need to be cut to splinter off a large number of vertices. We will consider isoperimetric problems related to certain graphs that arise from number theory and geometry. We will also introduce some basic ideas in algebraic graph theory.

A Reflection on Project Based Learning in Calc I
Chase Mathison, Shenandoah University
8:20-8:40, EB 205

Project Based Learning (PBL) is a model of education in which learning is motivated through big, real world problems or projects that students have an extended amount of time to complete. These projects serve as a vehicle for introducing new ideas, not just for practicing skills that have already been learned. This model of instruction and learning is not new, however there are not a lot of concrete examples of how to implement PBL in practice in a mathematics classroom, especially in higher education. This talk is a reflection on using PBL in a Calculus I class in the Fall of 2022: what worked, what didn't, and some ideas for how PBL can be implemented in mathematics classes in higher education.

Primary resonance analysis for the Duffing equation with delay
D'Angelo Holder, Virginia Commonwealth University
8:20-8:40, EB 210
(student talk)

Duffing equation is a common model used in the study of Micro Electro Mechanical Systems (MEMS). If one wants to remotely adjust the parameters of this system, this introduces the time delay in it. In this talk we will analytically describe the primary resonance phenomenon for the Duffing equation with cubic nonlinearity and with the delay in zero's and the first derivative terms.

Generalizations for Maxwell's Equations to Yang-Mills Equations
Abigail Swanson, University of Mary Washington
8:20-8:40, EB 211
(student talk)

Maxwell's equations create the basis of the theory of electromagnetism, showing how magnetic fields and electric fields relate to each other as they move through space and time. We reformulate Maxwell's equations in the aspect of differential geometry. We then generalize Maxwell's equations on space-time manifolds to Yang-Mills equations on the lifting bundles of the space-time manifolds using connections, curvatures, and Gauge transformations.

Fun with L(2,1)-labeling
Brian Heinold, Mount St. Mary's University
8:45-9:05, EB 202

L(2,1)-labeling involves labeling the vertices of a a graph with integers to satisfy two rules: (1) adjacent vertices have labels that differ by at least two; (2) vertices at distance two from each other get different labels. It's a well-studied problem, and also surprisingly fun as a puzzle. I've used it in a liberal arts math class, and I built a simple online app to play L(2,1) "puzzles". This talk will be about what's known about L(2,1)-labeling, how I've used it in classes, and the app.

The geothmetic meandian and other topical functions
Brian Lins, Hampden-Sydney College
8:45-9:05, EB 204

The geothmetic meandian is a made up function introduced as a joke in the comic XKCD by Randall Munroe. It is also a nice example of what are known as topical functions in nonlinear Perron-Frobenius theory. We'll talk about the properties of the geothmetic meandian and other topical functions. We'll also look at some cool applications of these functions and give a very brief introduction to nonlinear Perron-Frobenius theory.

An easy on-ramp to mastery-based grading
Jay Daigle, The George Washington University
8:45-9:05, EB 205

Mastery grading schemes seek to evaluate whether students master the material by the end of the course, rather than demanding flawless performances from the beginning. At their best, they keeps students motivated to learn and grow, while minimizing the stress surrounding assessments.

But it can be labor-intensive to start using mastery grading, and difficult to reconcile it with external expectations for assessment. In this talk I'll describe the simple, low-effort on-ramp I used to begin mastery grading, describe some benefits and drawbacks, and compare it to the more sophisticated approach I use after a few years of development.

Strong Homotopy Lie Algebras

Samuel Bevins, Virgina Commonwealth University
8:45-9:05, EB 210
(student talk)

We describe a procedure to attach a nilpotent strong homotopy Lie algebra to every simple hypergraph and prove that two hypergraphs are isomorphic if and only if the corresponding strong homotopy Lie algebras are isomorphic. As an application, we characterize hypergraphs admitting a system of distinct representatives in terms of symplectic forms on the corresponding strong homotopy Lie algebra. We conclude with a combinatorial description of the cohomology of these strong homotopy Lie algebras in low degree.

The effects of grazing functions on mixotrophic plankton populations during seasonal blooms

James Ripple, St. Mary's College of Maryland
8:45-9:05, EB 211
(student talk)

We use a system of ordinary differential equations to simulate phytoplankton blooms in the presence of mixotrophic zooplankton (zooplankton that can both photosynthesize and graze on other plankton). A common problem with such models lacking mixotrophy is unrealistically low levels of zooplankton during a bloom. To address this issue we incorporate mixotrophic zooplankton and incorporate a logistic function describing zooplankton grazing behavior. We compare the logistic grazing function to the commonly used Sigmoidal grazing function and their effects on the system's solutions. Accounting for a limited food (phytoplankton) supply and its effect on zooplankton grazing, we attempt to model more realistic plankton bloom behavior. Our aim is to achieve a more realistic zooplankton population during phytoplankton shortages. We test these grazing functions for their effects on blooming behavior to improve our model of the ecosystem.

Bookstores, Bake Sales, and Binary Balance

Alex Meadows, St. Mary's College of Maryland
9:10-9:30, EB 202

Suppose that you and your adversary are the only customers at the local bookstore, and you take turns buying books, but each of you always buy from one of the five shelves in the store. The goal is to be the last one to buy books before the store closes, and the store has a policy that it will close when there are two empty shelves. This game, which we call Bookstore, is a version of a classical combinatorial game called Gale's Nim, which is itself a variant on the ultimate classical game Nim. We will discuss winning strategies for Bookstore and its close relative, Bake Sale, and reflect on the symmetries at the heart of such strategies.

Debias Random Forest Regression Predictors

Lihua Chen, James Madison University
9:10-9:30, EB 204

The random forest can reduce the variance of regression predictors through bagging while leaving the bias mostly unchanged. In general, the bias is not negligible and consequently bias correction is necessary. The default bias correction method implemented in the R package randomForest often works poorly. In this work, we explore and compare several alternative approaches which in general outperform the R default substantially. We further developed practical suggestions on the application of the winner of these methods and proposed a visualization technique to help users decide when bias correction is needed.

A Partial Mastery Grading Approach for Calculus

Benjamin Wilson, Stevenson University
9:10-9:30, EB 205

In this talk we will explore a partial mastery-based grading approach that I have used in Calculus and Precalculus involving a set of Core Learning Targets that students can attempt to master on weekly quizzes, exams, or outside of class if needed.

Application of Image Compression using SVD

Isaac Edwards, Virginia State University
9:10-9:30, EB 210
(student talk)

Large digital images can be represented by large matrices which required huge memory space to store. For example, an m-by-n image can be represented as an m-by-n matrix A, where the entry (i, j) is interpreted as the brightness of pixel (i, j). In order to save memory space, we often prefer to compress the image from which we can still approximately reconstruct the original image. This can be achieved by computing the SVD of A and expressing it as a sum of rank-1 matrices. We will remove the smallest singular values that contribute the least to the image matrix without losing much of the overall quality of the image. Then we will convert the image by adding some of the singular values to observe the clarity of the image. This process of removing the smaller singular values will result in a loss of some of the image refinement, but overall, we will return most of the features of the full image. This will be implemented in MATLAB.

Dietary Habits and Physical Activity Levels in Roanoke, Virginia and Buenos Aires, Argentina: A Comparative Analysis Using Surveillance Data

Claire Williams, Roanoke College
9:10-9:30, EB 211
(student talk)

Both the United States and Argentina struggle with weight-related issues, despite the fact that they have different cultures of diet and physical behavior. Two different public elementary schools were surveyed in order to further examine their food habits and physical behaviors. Round Hill Elementary School is located in Roanoke, Virginia, and was surveyed for the Roanoke Valley Community Healthy Living Index in 2021. Gervasio Posadas Nº 25 – D.E. 3º is located in Buenos Aires, Argentina, and was surveyed for this comparative analysis in 2022. There were statistically significant differences in food habits and physical activity levels between the locations, for example, accessibility to healthy food, home food preparation, and how frequent children are active during the week.

Maple Learn: Teaching, learning, and doing math online just got easier!

Jennifer Iorgulescu, Maple

9:10-9:30, EB 104

Maple Learn: Teaching, learning, and doing math online just got easier! Maplesoft created Maple Learn to help schools amplify their mathematics teaching excellence and provide engaging, interactive experiences for their students. This presentation illustrates how Maple Learn provides a flexible interactive environment for solving problems, a great platform for conceptual learning, and incredibly simple content development and deployment solutions.

Invited address

Can we make grace the norm in our classrooms?

Candice R. Price, Smith College

9:45-10:50, EB 120 Auditorium

For much of my life, I was always confused about the way that people perceived the relationship between students and instructors in the classroom, especially in mathematics. There is such an adversarial relationship that even sharing my career choice with strangers leads to groans and stories of trauma. I believe this is what happens in a classroom without grace. So when we add grace the opposite should happen, right? During our time together, I hope to discuss with you the ways that I incorporate grace in my classroom and why many people think it is radical. I invite everyone to come and reflect on ways they can make grace the norm in their classrooms and spaces.

Invited address

Growing MADDER: Building the "Mathematicians of the African Diaspora Database's Ensemble of Researchers"

Edray Goins, Pomona College

2:15-3:15, EB 120 Auditorium

In 1997, Scott Williams (SUNY Buffalo) founded the website "Mathematicians of the African Diaspora," which has since become widely known as the MAD Pages. Williams built the site over the course of 11 years, creating over 1,000 pages by himself as a personal labor of love. The site features more than 700 African Americans in mathematics, computer science, and physics as a way to showcase the intellectual prowess of those from the Diaspora. Soon after Williams retired in 2008, Edray Goins (Pomona College), Donald King (Northeastern University), Asamoah Nkwanta (Morgan State University), and Weaver (Varsity Software) have been working since 2015 to update the Pages. Edray Goins and Robin Wilson (Cal Poly Pomona) led a research group of 13 undergraduates during the 2021-22 academic year to write more biographies for the new MAD Pages.¡br¿ In this talk, we discuss the results from MADDER (Mathematicians of the African Diaspora Database's Ensemble of Researchers), recalling some stories of the various biographies of previously unknown African American mathematical scientists, and reflecting on some of the challenges of running a math history REU. This project is funded by the Center for Undergraduate Research in Mathematics (CURM).

Formally Verifying Run-time Assurance

J Tanner Slagel, NASA Langley Research Center
3:30-3:50, EB 202

Runtime assurance is a control framework where a complex controller operates under the observation of a monitor. If the monitor detects the controller exhibiting undesirable behavior, control is passed off to a trusted controller until a desirable state is regained.

The runtime assurance architecture provides a layer of assurance to the system being controlled, but special care must be taken that the resulting overall system, consisting of the monitors and controllers, is behaving as intended.

This talk aims to rigorously model and reason about runtime assurance-equipped systems as hybrid programs- which are models that consist of both discrete and continuous components. Using the verification tool Plaidypvs, safety properties of an aircraft flying in a geofenced environment is shown.

Using student constructed data sets to their fullest potential

Allen (Gregg) Harbaugh-Schattenkirk, Longwood University
3:30-3:50, EB 204

In this talk, I will present a student built data set that multiple sections of different classes contributed to. Along with describing the data and how the students went about collecting it, I will also show how I was able to use the data in various formats for a variety of student assessments and instructional moments. In this talk, I will also demonstrate how an open education resource like MyOpenMath can help support our use of collaboratively constructed data sets in the undergraduate statistics and data science classrooms.

MAA's NREUP and Howard's Program

Dennis Davenport, Howard University
3:30-3:50, EB 205

Each summer, through grants provided by NSF, MAA funds small REU programs that are designed to give summer enrichment for undergraduate students who attend the host institution and are interested in studying mathematics. MAA's program is called the National Research Experience for Undergraduates Program (NREUP). In this presentation, we describe MAA's program and provide some funding rate data. Included in the presentation will be data used when the NREUP program was developed. In 2021 Howard University received an NREUP grant. In this presentation, we will also describe Howard's program.

The Critical Group of Hypercube Graphs

Colby Sherwood, James Madison University
3:30-3:50, EB 210
(student talk)

The critical group of a graph is an important invariant in algebraic graph theory. For hypercube graphs, the structure of the critical group is known except for the 2-Sylow subgroup. However, using the representation theory of symmetric groups, we can build a framework to understand this

2-Sylow subgroup in terms of the dimensions of Specht modules.

Looking At Chaos With Triple Pendulums

Cameron Veach, Shenandoah University
3:30-3:50, EB 211
(student talk)

This presentation will look into chaos modeled by multiple pendulums. by changing the parameters, we study how chaos is created and evolved.

Geometric Vertex Decomposition and Toric Ideals of Graphs

Agnieszka Nachman, Virginia State University
3:55-4:15, EB 202

For any finite simple graph, we can define an algebraic structure using certain polynomials defined by the closed even walks of the graph. Using this structure, we can study the properties of the graph using tools from algebra. One of these tools is called geometric vertex decomposition, and it is currently unknown which graphs possess a geometric vertex decomposition. In an attempt to classify all graphs which have this structure, we investigate techniques which help simplify the problem, and apply these methods to an infinite family of graphs.

Understanding false positives: an undergraduate application of conditional probability

Alice Petillo, Marymount University
3:55-4:15, EB 204

Having an understanding of false positives a few decades back was a great comfort to me personally when a blood donation triggered an early detection HIV test. I knew intellectually that it was more likely to be a false positive than a true positive. Medical testing is an example of conditional probability that almost everyone encounters. Given the recent COVID pandemic, understanding how medical testing works is an important and relevant skill. We demonstrate the difference between: 1) If I have the disease, what is the probability I will test positive? 2) If I test positive, what is the probability I have the disease?

I include this type of problem in our Statistical Analysis course which many undergraduates take to satisfy their math requirement. Examples and explanations will be provided.

Middle School Math Modeling Outreach Day

Meagan Herald, VMI; Gregory Hartman, VMI; Karen Bliss, SIAM
3:55-4:15, EB 205

This winter we developed and ran our inaugural middle school mathematical modeling contest for local eighth grade students. We will describe why we decided to do this outreach, the logistics of the event from start to finish, and the positive feedback we received. Our hope is to expand this modeling outreach day to other colleges/universities.

Predicting the Jet Boundary of a Turbulent Coanda Wall Jet Using Experimental Test Results

Matthew Caulfield, Aidan Chadha, James Madison University
3:55-4:15, EB 210
(student talk)

The Coanda effect is the tendency of a fluid to stay attached, and follow the curvature of a rounded surface. Turbulent Coanda wall jets, often seen in aeronautical and aerospace applications, utilize this effect to enhance flow lift and deflection, and change the location of jet breakaway points. Jet breakaway is the scenario in which the fluid no longer follows the curvature but instead travels tangential to the surface. The relationship between a Coanda jet's fundamental characteristics (such as slot width and operating pressure), its acoustics emission, and the location of jet breakaway is not widely understood. In particular, it is argued that if better predictions of Coanda jet noise were available, the benefits associated with the Coanda effect would be more widely realized. For example, it has been observed that curved jets are often noisier than similar non-curved jets. The work presented herein attempts to rectify the lack of knowledge in this area; specifically addressing the issue of how the Coanda jet boundaries are influenced by jet operating characteristics. A model describing the jet boundary as a function of slot width (w) and operating pressure (p) is determined based on recent experimental data. Predications are then compared with additional experimental results and conclusions drawn. The method of Least-squares Optimization is also applied to the data to improve this model, perhaps yielding more accurate agreement with measurements.

Exploring the Relationship between Elliptic Curves and Discrete Logarithms

Kelsey Ellis, Shenandoah University
3:55-4:15, EB 211
(student talk)

Elliptic curve cryptography is considered one of the most secure methods of encryption because of the difficulty in solving the elliptic curve discrete logarithm problem. Using the cyclic nature of some elliptic curves and polynomial interpolation methods we seek to investigate the relationship between elliptic curves and the Discrete Logarithm problem. By looking at points generated by a cyclic elliptic curve we will interpolate a polynomial to see if it can produce a key for the discrete logarithmic function.

Image reconstruction using an adaptive Kaczmarz method for Electrical Impedance Tomography problems

Sanwar Ahmad, Virginia State University
4:20-4:50, EB 202

Electrical impedance tomography (EIT) is an imaging modality that determines the internal conductivity and permittivity distribution based on the voltage measurements made on an object's surface when currents are applied. Due to its non-invasiveness, non-ionizing characteristics and cost effectiveness, EIT is gaining a lot of attention in recent years. In this presentation, we discuss the implementation of an adaptive iterative Kaczmarz method for solving the inverse EIT problems.

Transforming Technology to Transform your Statistics Class
Marggie Gonzalez-Toledo, Mary Guzman, Frederick Community College
4:20-4:50, EB 204

Have you hear about RGuroo? We will be sharing this amazing tool, all the great features it has and how we use it in our statistics courses. We will also talk about some activities we have adapted using RGuroo and how we have used it to transform our statistical courses.

An Introductory Mathematical Modeling Course without Calculus
Gregory Hartman, Sara Whipple, Virginia Military Institute
4:20-4:50, EB 205

This talk will describe an introductory, two course sequence in mathematical modeling that does not involve calculus created for non-STEM students. We'll talk about the motivation for the sequence creation, the content, and successes and shortcomings we've observed.

FFEM for Elliptic State Constrained Optimal Control Problems
Andre Mas, James Madison University
4:20-4:50, EB 210
(student talk)

Given an elliptic state constrained optimal control problem defined over an axisymmetric domain, Fourier series decomposition can be used to turn this 3D problem into a sequence of weighted 2D problems. We describe a Fourier finite element method for this problem, and display various numerical examples.

Mosquito Surveillance and Population Dynamics with Impact on Human Epidemiology
Caleb Rivers, Shenandoah University
4:20-4:50, EB 211
(student talk)

Aedes mosquitoes use artificial containers filled with water to reproduce1,2,3 . Aedes japonicus is a newly invasive species from Japan in the 1990s, Aedes albopictus was established Ae. albopictus Ae. japonicus Culex in North America in the 1980s, and Aedes aegypti during the 15th century4,5, 6. Ae. albopictus may be outcompeting Ae. aegypti in Virginia but the prevalence of Ae. japonicus is largely unknown5,6. Ae. albopictus found in Sri Lanka were found to have a salinity tolerance of 8-12ppt salinity2. Ae. aegypti mosquitoes show larval physiological tolerance-adaptations to salinity, such as changes to larval cuticles and an increase Ssk expression in midgut2,7. Salinity-tolerance adaptations could result in changes to the mosquito disease vector and arboviral epidemiology, however the impact of salinity-tolerance adaptations is widely unknown in a world facing rising sea levels and increases in freshwater salinity. We predicted that Ae. albopictus and Ae. aegypti would be the two most prevalent Aedes mosquitoes, with different species composition in urban and rural locations. Aedes oviposition will prefer lower salinity and increased salinity will decrease survival. We also predicted not gathering many Culex mosquitoes.