Fall 2024 MD-DC-VA Section Meeting Abstracts

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

Workshop

Strategies for Making Mathematics Engaging and Relevant

Aaron Trocki (on behalf of MAA MD-DC-VA COMMIT) , Elon University

4:00-6:00, Constant Hall 1002

Throughout my twenty plus years of teaching mathematics, I have been struck by the need to engage students in this rich discipline and help them see its relevance to their lives. This realization has led to numerous pedagogical experiments and collaborations to promote the teaching and learning of mathematics. In this workshop, I will share three recent efforts in undergraduate mathematics with goals that included increasing the relevance of math to students' lives; promoting reflection and engagement with student multimodal writing; and utilizing generative artificial intelligence to connect mathematics to other disciplines. Workshop participants will learn about these efforts and engage with others to develop actionable strategies for transforming mathematics teaching and learning for the students we serve.

Banquet Talk

The Hypercube Pop-Up Book

Richard Hammack , Virginia Commonwealth University

8:00-9:00, North and Center Cafeteria at Webb University Center

I explain and demonstrate (with video clips) my latest project, a pop-up book about how to visualize the tesseract and other n-dimensional cubes. I also discuss the mathematics that underlies some of the book's pop-up mechanisms.

Experiential Learning and 3-D PRINTING

Pallavi Bhale, Montgomery College

8:50-9:10, Constant Hall 1009

Abstract: My teaching philosophy is to have an interactive classroom and engage students through experiential learning. Experiential Learning in mathematics is a hands-on approach to learning. It has remarkable benefits for students and instructors. I attempted 3-D printing in my Multivariable calculus classes where students learned some coding, various software, and the process of 3-D printing. My students enjoyed the teamwork, printing various shapes they learned in their multivariable class, and learning new skills they can apply in their internships and workplaces.

Active Learning using Geometry In and Out of the Classroom

Beth Claire Branman, University of Virginia

8:50-9:10, Constant Hall 1037

Active learning is an important pedagogical method, but it can be tricky to implement in an upper-level math class. In this talk, we talk about some ways I have successfully implemented active learning to explain topics such as isometry groups both in the classroom and in outreach, as well as some of the challenges.

Data-driven reduced order modeling

Xuping Xie, Old Dominion University

8:50-9:10, Constant Hall 1042

Many complex physics applications and engineering design processes often require models that capture the predictive power of first-principles simulations yet are computationally less demanding by many orders of magnitude. Reduced order modeling (ROM) provides an efficient solution, striking a balance between high-fidelity simulations and accurate surrogate models. Artificial Intelligence (AI), promises a revolution in how physics and engineering can be bridged for authentic predictive control and design of engineering systems with ROM. Our work focuses on developing efficient ROM techniques, combined mathematical principles, and scientific machine learning (SciML) methods, to enable predictive design and control in complex systems such as fluids and plasma physics. In this talk, I will introduce contemporary ROM approaches for nonlinear systems in fluids and plasma physics.

Lord Rayleigh: A Quintessential Classical Applied Mathematician and Mathematical Physicist

John Adam, Old Dominion University

8:50-9:10, Constant Hall 1052

After providing a brief overview of his family and academic background, I will explore his numerous contributions to applied mathematics and classical mathematical physics. I will briefly mention three fundamental areas: (i) the principle of similitude, (ii) criteria for determining hydrodynamic stability or instability in plane-parallel and cylindrical shear flow, and (iii) Rayleigh scattering, which explains why the sky appears blue, as well as his frequently unnoticed contributions to the scattering of plane acoustic waves from spherical obstacles, which essentially served as a precursor to the theory of electromagnetic scattering of plane waves from a transparent sphere.

Providing Visual Feedback for Integration Problems Using GeoGebra

Przemyslaw Bogacki, Old Dominion University

9:15-9:35, Constant Hall 1009

Determining volumes of solids of revolution and areas of regions bounded by polar curves are among the types of problems that many calculus students find challenging. Also, in multivariable calculus, students often struggle when setting up limits of iterated integrals, or when solving problems involving surface integrals (e.g., those arising in the context of the Divergence Theorem or Stokes' Theorem). In this talk, we present interactive GeoGebra activities designed to help students improve their understanding of these topics by providing them with visual feedback conveying the object (a region in the plane, a surface, or a solid region) corresponding to their solution. If the student made some mistake(s), then this feedback helps to guide the student to revise their solution. (Note that our focus is on the geometric setup of these problems, rather than the subsequent antidifferentiation.)

A Year at the Air Force Academy

Jason Rosenhouse, James Madison University
9:15-9:35, Constant Hall 1037

I spent the 2023-2024 school year as the "Distinguished Visiting Professor" (DVP) in the Department of Mathematical Sciences at the US Air Force Academy in Colorado Springs. In this talk, I will recount a few of my experiences while I was there.

An introduction of inverse problems and Dirichlet to Neumann Map

Md Ibrahim Kholil, Norfolk State University
9:15-9:35, Constant Hall 1042

In this talk, we explore the basic form of the inverse boundary value problem for both isotropic and anisotropic cases using the Dirichlet-to-Neumann map. Furthermore, we investigate whether it is possible to uniquely determine a scalar quasilinear conductivity in an anisotropic medium by conducting voltage and current measurements at the boundary.

csrnaseq: Identifying relevant covariates in RNA-seq analysis by pseudo-variable augmentation

Yet Nguyen, Old Dominion University
9:15-9:35, Constant Hall 1052

RNA-sequencing (RNA-seq) technology allows for the identification of differentially expressed genes, which are genes whose mean transcript abundance levels vary across conditions. In practice, RNA-seq datasets often include covariates that are of primary interest in addition to a set of covariates that are subject to selection. Some of these covariates may be relevant to gene expression levels, while others may be irrelevant. Ignoring relevant covariates or attempting to adjust for the effect of irrelevant covariates can compromise the identification of differentially expressed genes. To address this issue, we propose a variable selection method that uses pseudovariables to control the expected proportion of selected covariates that are irrelevant. Our method accurately selects relevant covariates while keeping the false selection rate below a specified level. We demonstrate that our method outperforms existing methods for detecting differentially expressed genes when working with available covariates. Our method is implemented in FSRAnalysisBS function of the R package csrnaseq, which is available at www.github.com/ntyet/csrnaseq. The analysis and simulation are available at www.github.com/ntyet/csrnaseq/tree/main/analysis.

Teaching Exchange

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11:05-11:25, 11:30-11:50, Constant Hall 1009

If you are looking for a small, but impactful way to liven up your classroom teaching, please join us for the Teaching Exchange. This event is designed for presenters to share their "good ideas" of things they do in the classroom with participants in a fun and engaging venue. Participants will rotate "speed-dating style" around the classroom, having the opportunity to learn about an innovative topic, teaching strategy, or activity from each presenter. Presenters will provide a handout with additional information and resources, and at the end of the rotations, they will be available for further discussion. The Teaching Exchange is organized by the MD-DC-VA chapter of the COMmunity for Mathematics Inquiry in Teaching.

Introducing Proofs of Theorems in Vector Calculus

Cherng-tiao Perng, Norfolk State University
11:05-11:25, Constant Hall 1037

We made attempts for making standard theorems in Vector Calculus more accessible to the students. In this talk, we will focus on Green's Theorem and Stokes' Theorem.

Adaptive location and scale estimation with kernel-weighted averages

Michael Pokojovy, Old Dominion University
11:05-11:25, Constant Hall 1042

A wide variety of location and scale estimators have been developed for light-tailed distributions. Despite indisputable importance in business, finance, cybersecurity, etc., statistical estimation and inference in the presence of heavy tails have received less attention in the literature. We adopt the Kernel-Weighted Average (KWA) approach to location and scale estimation and present a set of extensive comparisons with five prominent competitors. Unlike nonparametric kernel density estimation, the optimally tuned bandwidth for KWA estimators does not necessarily converge to zero as sample size grows. We also perform a large-scale Monte Carlo simulation to search for the optimal bandwidth that minimizes the mean squared error (MSE) of KWA location and scale estimators with simulated samples from Student's t-distribution with degrees of freedom (df) 1,2,...,30. We further develop an adaptive technique to estimate the df that best match the observed samples using Cramér-von Mises test of goodness-of-fit. Unlike many existing methodologies, our approach is data-driven and exhibits excellent statistical performance. To illustrate this, we apply it to three real-world financial datasets containing daily closing prices of AMC Entertainment (AMC), GameStop (GME) and Meta Platforms (META) stocks to calibrate a geometric random walk model with Student's t log-increments.

Pythagorean n-ples

Dan Kalman, American University (Ret)
11:05-11:25, Constant Hall 1052

Pythagorean Triples such as (3,4,5) and (5,12,13) are a familiar topic in college mathematics. They represent integer sided right triangles, as well as rational points on the unit circle (eg (3/5,4/5), (5/13, 12/13)) and integer vectors with integer lengths (eg (3,4), (5,12)). This talk discusses extensions of these ideas to higher dimensions: Pythagorean 4-ples, 5-ples, n-ples. Though these extensions are not new (for example they can be found in wikipedia), they are not nearly as well known as they deserve to be.

Roots of Unity as a topic for student mathematical maturity

Bob Sachs, George Mason University
11:30-11:50, Constant Hall 1037

The topic of Roots of Unity has many beautiful and useful aspects that help students develop mathematically. This talk will highlight several of these used in a Transition to Advanced Mathematics course centered on complex number ideas. These are readily accessible for students but lead to big payoffs and serve as useful examples of general concepts.

An ensemble ordinal outcome classifier for high-dimensional data

Heranga Rathnasekara, Old Dominion University

11:30-11:50, Constant Hall 1042

Abstract Several classification techniques for ordinal outcomes in high-dimensional data have been developed throughout the years. However, the performances of these techniques depend heavily on the evaluation criteria used, and it is usually not known a priori which technique will perform the best in any classification application. In this project, we propose an ensemble classifier, constructed by combining bagging and rank aggregation techniques that can provide an optimal classification of the ordinal outcomes in high-dimensional data. Our classifier internally uses several existing ordinal classification algorithms and combines them in a flexible way to adaptively produce results. Our approach optimizes the classification outcomes across multiple performance measures, such as Hamming score, Gamma Statistic, Mean Absolute Error, and Kendall's τb, among others. Through various simulation studies, we will compare the performance of our proposed ensemble classifier with the individual algorithms, included in the ensemble, and illustrate that our more intricate approach achieves enhanced predictive performance. We will also show the utility of our ensemble classifier with applications on real high-dimensional genomics data. We will highlight the fact that when dealing with the complexity of ordinal outcomes in high-dimensional datasets, it might be reasonable to consider an ensemble classification algorithm combining several classifiers rather than relying on a single classifier.

A mathematical model of non-Newtonian power-law fluid flow-induced deformation in porous biological tissues

Asif Mahmood, University of Virginia

11:30-11:50, Constant Hall 1052

We present a mathematical model of non-Newtonian flow-induced deformation in a soft biological tissue. The tissue is modeled as a deformable porous material where the injected power law fluid is absorbed by the tissue at a rate which is proportional to the local pressure. A spherical cavity embedded in an infinite porous medium is used to find the fluid pressure and solid displacement in the tissue as a function of radial distance and time. The governing nonlinear equations are solved numerically to highlight the effects of various emerging parameters.

Serving those truly needing ONLY an introduction to statistics

Allen G. Harbaugh, Longwood University

3:30-3:50, Constant Hall 1009

In this talk, I will share the challenges and successes of the creation of a new course in our statistics program. Wanting to better serve the diverse population of students enrolling in our introductory statistics class, I created a new course based on the model used in a lot of graduate programs. I will present on the guiding philosophy for our new curriculum, the needs of the target student for this course, and I will detail the key aspects of the curriculum, present some of the more innovative assessments, and speak to our (perception) of the success of the program to date.

Using standards-based grading in all classes
Brian Heinold, Mount St. Mary's University
3:30-3:50, Constant Hall 1037

Last year, I switched all my classes to use a standards-based approach. I used it for classes at all undergraduate levels, in both mathematics and computer science. This talk will cover how everything was implemented and and how students did with the new approach.

Predicting the 2024 Presidential Election using Data Science
Jonathan McCurdy, Nadun Kulasekera Mudiyanselage, Mount St. Mary's University
3:30-3:50, Constant Hall 1042

Predicting election outcomes has long been a focal point of both public discourse and scholarly investigation, with a wide range of models developed to forecast electoral results. These models span traditional statistical methods as well as more contemporary machine learning algorithms, including the emergence of so-called "black box" models. In this project, we employed a diverse set of predictive techniques—Linear Regression, Logistic Regression, XGBoost, and Random Forests—to forecast the outcome of the 2024 U.S. Presidential Election. By leveraging historical election data, our models demonstrated an approximate 80% accuracy in predicting past election years.

Eigenmetric Curves: Measuring Perimeter and Area Simultaneously
Alex Meadows, St. Mary's College of Maryland
3:30-3:50, Constant Hall 1052

Kepler described the motion of planets around the sun as planar motion that sweeps out equal areas in equal time. We consider the geometric condition that comes from replacing time with distance. Eigenmetric curves are planar curves that are as long as they are encompassing, enclosing a given area with an equal amount of arc-length. We study these peculiar objects, their existence and properties, including how they change when we measure lengths with an arbitrary norm.

Euler's Partition Theorem
Ray Cheng, Old Dominion University
3:55-4:15, Constant Hall 1009

We'll marvel at one of Euler's most ingenious and original proofs of his theorem on partitions.

Fully-discrete Lyapunov consistent discretizations for parabolic reaction-diffusion equations with r species
Mohammed Sayyari, Old Dominion University
3:55-4:15, Constant Hall 1042

We developed novel fully discrete Lyapunov consistent schemes with the stability properties of the continuous parabolic reaction-diffusion models. The framework provides a systematic procedure for developing fully discrete schemes of arbitrary order in space and time for solving a broad class of equations equipped with a Lyapunov functional. This framework is applied to systems of PDEs arising in epidemiology and oncolytic M1 virotherapy. This computational framework provides physically consistent and accurate results without exhibiting scheme-dependent instabilities nor converging to unphysical solutions.