Fall 2025 MD-DC-VA Section Meeting Abstracts

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

Workshop

Elementary Math Models: A hybrid alternative to College Algebra/Liberal Arts Math/Quantitative Literacy courses

Dan Kalman , American University (ret)

4:00-6:00, Chandler Ballroom B

This workshop will present an innovative curriculum that is a hybrid of the standard courses mentioned in the title. The mathematical focus is on discrete models defined by difference equations, and the continuous models that they reveal. Instructional goals include: (1) give students a realistic sense of how math actually gets applied, (2) Present each topic in a meaningful context, (3) Emphasize patterns and applications based on actual data, (4) Review many of the skills covered in standard college algebra courses. *Participants are requested to bring a device to the workshop that can open excel files (.xls).*

The presentation will follow this outline:

1. Motivation for the course: dissatisfaction with standard curricular options.
2. Progression of mathematical ideas from arithmetic to logistic growth, climaxing with a new discrete version of logistic growth.
3. Technology. Available suite of excel-based exploratory tools.
4. Pedagogy; Instructional approaches.

Banquet Talk

A Classroom Journey into Islamic Geometric Patterns

Rebin Muhammad , Montgomery College

8:00-9:00, Chandler Ballroom C

This talk explores the mathematical foundations and cultural significance of Islamic geometric patterns, showing how symmetry, proportion, and repetition generate intricate yet harmonious designs. Drawing on examples from historical architecture and manuscripts, the presentation connects mathematical reasoning with artistic and cultural expression. It also highlights an interdisciplinary course between the Math and Art departments at Montgomery College where students recreate patterns using traditional tools and modern technologies such as 3D printing and digital modeling.

Currie's Mysterious Pattern and Iterated Functions, Part 1

Dan Kalman, American University (Ret.)

10:00-10:25, Monroe 110

The remarkable fact that $2^n\sqrt{2-\sqrt{2+\sqrt{2+\cdots+\sqrt{2}}}} \to \pi$ as $n \to \infty$ where n is the number of nested radicals, inspires an obvious question. What other similar sorts of results hold? In this talk I will discuss a general framework for results like the mysterious pattern in the context of iterated functions, defining a collection of sequences analogous to the one with nested radicals above. Results include a sufficient condition for convergence, limits that arise in connection with Möbius functions, and a continued fraction analog of the nested radical example.

Excerpted from a paper available here: https://arxiv.org/pdf/2509.21409">https://arxiv.org/pdf/2509.21409.

The Helen of Geometry and other Fateful Mathematical Shapes

Suzanne Sumner, Marie Sheckels, University of Mary Washington

10:00-10:25, Monroe 111

Certain geometric shapes were revolutionary and impactful throughout the history of mathematics. These shapes motivated new mathematical solutions to problems and inspired and enriched the development of new mathematical areas. For example, right triangles and the Pythagorean theorem solved an uncountable (!) number of problems. Likewise, Thales' use of similar triangles allowed him to measure the height of the Great Pyramid without direct measurement.

Conic Sections helped unlock the secrets of the universe once in the hands of Kepler and Newton. Similarly, Huygens' catenary curve appeared in unexpected places. Furthermore, Pascal's research on the cycloid curve, the so-called "Helen of Geometry," was directly responsible for Leibniz's independent invention of calculus. Although Euler invented graph theory, he did not see how his polyhedral formula for the Platonic solids connects to graph theory, where it still has implications.

Moreover, specific shapes such as the Saccheri quadrilateral, orthogonal circles, and the pseudosphere validated Non-Euclidean geometry. In conclusion, Mandelbrot's radical departure from Euclidean geometry gave us intricate fractal shapes such as the Sierpinski Triangle, Mandelbrot Set, and Julia Sets. This presentation will highlight a sample of shapes that have been particularly central in the history of mathematics, along with illustrating some of their applications.

Optimal Shut the Box

Benjamin Wilson, Stevenson University

10:00-10:25, Monroe 112

Shut the Box is a dice game in which players roll dice and choose which numbered tiles to close, aiming to minimize the sum of the remaining tiles. We model the game as a stochastic process and use dynamic programming to determine optimal strategies for several common rule variations. This work is based on an undergraduate independent research project.

Art Exhibit,
10:00-10:55, 1:00-1:55, Monroe 115

This is an art exhibition of works by students in Rebin Muhammad's Islamic Geometric Patterns course.

Currie's Mysterious Pattern and Iterated Functions, Part 2

Dan Kalman, American University (Ret.)
10:30-10:55, Monroe 110

In this continuation of Part 1, topics include an analog of eigenvectors and eigenvalues under the operation of function composition, complex dynamical systems and Koenigs functions, and inverse Chebyshev polynomials. Regarding the last of these, we can define the Chebyshev nth root (denoted $\sqrt[\langle n \rangle]{x}$) and obtain beautiful analogs of the original nested radical identity. For example,

$$\lim_{n\to\infty} 25^n \left(5 - \sqrt[5]{5 + \sqrt[5]{5 + \sqrt[5]{5 + \cdots + \sqrt[5]{5}}}} \right) = \frac{5\pi^2}{8}.$$

Graph Colorama: a Playful Approach to Math Outreach and Graph Theory

Alexandra Veremeychik, University of Maryland
10:30-10:55, Monroe 111
(student talk)

Graph Colorama is a web-based game we developed to introduce middle school students to graph theory and algorithms through interactive exploration. Created for the Sofya Kovalevskaya Days outreach program at Montgomery College, it has engaged over 200 students from the Montgomery County School District across multiple events. The game engages mathematical ideas such as graph coloring and optimization using an accessible, hands-on approach. By combining play with problem-solving, Graph Colorama encourages creativity, strategic reasoning, and an intuitive understanding of algorithmic thinking.

Statistical and Computer Models for Geophysical Mass Flows

Asif Mahmood, University of Virginia
10:30-10:55, Monroe 112

Volcanic eruptions create hazardous conditions which affect people and human infrastructure near the volcano, in downstream valleys, and hundreds of miles away. PDE models of granular flows are invaluable tools for assessing hazard risks, but they are far from perfect and are expensive to run. Computational costs can be reduced by constructing a statistical emulator, an approximate response surface for selected output variables derived from several full simulator runs. A popular emulator is the Gaussian Separable Process emulator, or GaSP, which is constructed as the mean of a Bayesian posterior distribution over outputs. In this work, we propose an alternative procedure for constructing emulators, one that uses knowledge about the model physics. We model the mass flow as an Ornstein–Uhlenbeck (OU) process for sliding blocks over the topography. We demonstrate how the OU results can be used to predict simulator results.

The Heaven/Hell Puzzle

Jason Rosenhouse, James Madison University

1:00-1:25, Monroe 110

There is a classic logic puzzle that goes like this: You see two doors. One leads to heaven, while the other leads to hell. Each door has a guard standing next to it. One of the guards always lies, while the other always tells the truth. You do not know which is which. You can ask one question of one of the guards, after which you must choose a door. What question should you ask? The standard solution allows you to determine which door is which, but it does not allow you to determine which guard is the liar and which is the truthteller. Is it possible to ask one question that allows you to distinguish both between the doors and the guards? We will discuss this, as well as other surprising nuances of this famous puzzle.

Determining the Maximum Probability Gain in the Birthday Problem

Juniper Creskoff, University of Mary Washington

1:00-1:25, Monroe 111

(student talk)

The birthday problem poses the question: given a group of n people, how likely is it that at least two people have the same birthday? We let $P_b(n)$ denote the probability of a birthday match among a group of n people, where there are b available birthdays. Our project considers properties of the associated first difference or "gain" function $G_b(n) = P_b(n) - P_b(n-1)$. Numerical experimentation shows that these gain functions appear to have a unique maximum as the number of birthdays b varies.

Using discrete optimization techniques, we show that each gain function indeed possesses a unique maximum. In particular, we show that the interval $\frac{1}{2} + \sqrt{b + \frac{1}{4}} \leq n \leq \frac{3}{2} + \sqrt{b + \frac{1}{4}}$ contains the location of this maximum. Additionally, we use calculus-based approximations to give accurate estimates for the location of this maximum probability gain.

A Mathematical Model for the Dynamics of Cannabis Consumption in a Population

Ana Vivas, James Tipton, Anne Fernando, Michael Aguadze, NSU / UVA / NC A&T

1:00-1:25, Monroe 112

In this study, a mathematical model describing the dynamics of cannabis consumption within a population is developed and analyzed. The model is formulated as a system of nonlinear ordinary differential equations (ODEs), incorporating key population parameters such as recruitment, transmission, and recovery rates. A rigorous analysis is conducted to establish the positivity and boundedness of the solutions. To further investigate the qualitative behavior of the system, the basic reproduction number, a threshold quantity that determines whether cannabis use can invade and persist in a population, is derived using the next-generation matrix method .The value of the basic reproduction number serves as an indicator for the stability of the cannabis disease-free equilibrium and the potential emergence of endemic levels of use within the community. Comprehensive numerical simulations are performed to explore the sensitivity of the model to variations in key parameters and to illustrate the temporal evolution of each compartment.

Permutation Paths from a Variation of Bulgarian Solitaire

Debra Hydorn, University of Mary Washington

1:30-1:55, Monroe 110

In this talk I will discuss a variation of Bulgarian Solitaire using n distinct (unique) objects that generates a partition of the permutations of the integers 1 to n. I will present artistic representations of the cycles for several values of n and comment on the similarities of the permutation paths and the relationship between the length of the cycle and the value of n.

Using Challenge Index to Quantify Optimization Difficulty with Gradient Descent

Lokesh Sai Dasari, Yousif Aluobaidy, Montgomery College

1:30-1:55, Monroe 111
(student talk)

The Rosenbrock function is commonly used to evaluate optimization algorithms due to its narrow, curved valley that poses convergence challenges. In this study, we examine how a quantitative Challenge Index predicts the difficulty of gradient descent convergence across a grid of starting points. Using a fixed step size and convergence criteria, we tracked iterations to convergence and analyzed their correlation with the Challenge Index. Results indicate that higher Challenge Index values generally correspond to slower convergence and occasional failures. These findings suggest that the Challenge Index is a useful metric for anticipating optimization difficulty in non-convex landscapes.

Simulation of Submarine Earthquakes, Landslides and Subsequent Tsunamis

Aidan Chadha, Virginia Tech

1:30-1:55, Monroe 112
(student talk)

Coupled landslide-tsunami systems are modeled and simulated using the ExaHyPE2 computational framework to capture submarine earthquakes, landslides, and subsequent tsunami generation. The implementation employs coupled shallow water and landslide equations.

Four distinct solver configurations are developed and compared: sole Finite Volume (FV) solver, dual FV solvers, sole ADER-DG solver with FV limiting, and dual ADER-DG solvers with FV limiting. Singular solver approaches utilize a combined PDE system, while dual solver configurations employ separate systems coupled through post-processing data transmission. ADER-DG methods leverage prediction, Riemann solving, and correction steps for higher-order accuracy, with posteriori limiting applied to handle discontinuities and oscillations in the solution.

Simulation results demonstrate successful coupling of landslide dynamics with tsunami propagation across different numerical schemes, validated through visualizations at multiple time steps ($t = 1.5$, 3.2, and 7). The modular solver architecture enables flexible switching between numerical methods while maintaining physical consistency at the landslide-tsunami interface. This work, funded by the Steeneck Experiential Learning Scholarship, advances computational capabilities for natural hazard modeling through the ExaHyPE2 platform.