ABSTRACTS

of Papers Presented to the Old Dominion University Math Awareness Conference

Hosted by:
The Old Dominion University Math and Stat Club
The Old Dominion University SIAM Student Chapter

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ABSTRACTS PRESENTED are those submitted by authors who intend to present them at ODU Math Awareness Conference April 19th, 2025.

THE SUITABILITY OF A PAPER for presentation at the conference is judged by the editorial committee to promote mathematical understanding to the committee. In addition, the editors of the abstracts have adopted the following policy: In order to be accepted for publication, an abstract must have mathematical content. It should not contain libelous, defamatory, or tasteless remarks, commercial promotions, nor political or religious arguments. ODU assumes no responsibility for the content or inappropriate remarks in any published abstract.

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THE ABSTRACT RECEIPT DEADLINES FOR ALL MEETINGS will be strictly enforced. Late papers cannot be accommodated. When all talks have been scheduled for a given meeting, the attendant abstracts will be available for viewing once the editorial committee has published all information.

1 ► *Invited Speakers*

09:00 OCNPS 200   **Xuping Xie** (xxie@odu.edu) Department of Mathematics and Statistics, Old Dominion University. *Data-driven Model Reduction for Complex Physical Systems*

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. I will discuss the data-driven ROM closure strategies for turbulent flows, and non-intrusive deep reduced physics model with autoencoder for fusion disruption mitigation.

Biography: Dr. Xie is an Assistant Professor in the Department of Mathematics & Statistics at ODU. Before joining ODU, he was a postdoctoral researcher at LANL in the Applied Mathematics and Plasma Physics (T-5) Group. He received a Ph.D. in Mathematics from Virginia Tech. His research focuses on scientific machine learning (SciML) and AI for physical sciences, with an emphasis on data-driven discovery of latent dynamics and applications in plasma physics and fluid dynamics.

10:00 OCNPS 200   **John Gounley** (gounleyjp@ornl.gov) Oak Ridge National Laboratory. *Scalable Biomedical Modeling.*

As part of the Department of Energy's partnership with the National Cancer Institute (NCI), the Modeling Outcomes using Surveillance Data and Scalable AI for Cancer (MOS-SAIC) project aims to develop deep learning models to facilitate near-real-time cancer surveillance at the population level. Through the NCI's Surveillance, Epidemiology, and End Results (SEER) program, we deploy models for the automated coding of cancer cases across state and regional cancer registries throughout the U.S. However, a key challenge in developing AI models for clinical and health applications is the scarcity of shareable datasets, largely due to privacy concerns and regulations. While traditional privacy approaches, such as redaction and de-identification, are limited, synthetic data generation offers a promising alternative to address this need more effectively. In this presentation, we evaluate the potential of generative AI to produce high-fidelity synthetic pathology reports while preserving privacy and maintaining high utility.

Biography: John Gounley is a computational scientist in the Computational Sciences and Engineering Division at Oak Ridge National Laboratory, where he leads the Scalable Biomedical Modeling group.

Prior to joining ORNL, John held postdoctoral positions in Laboratoire M2P2 at Ecole Centrale Marseille and in the Department of Biomedical Engineering at Duke University. While at Duke, he had postdoctoral fellowships with the Hartwell Foundation and with the Big Data-Scientist Training Enhancement Program (BD-STEP) of the National Cancer Institute (NCI) and the Veterans Health Administration. John received his PhD in Computational & Applied Mathematics at Old Dominion University.

John's research focuses on scalability of algorithms for biomedical simulations and data. He contributes to MOSSAIC, a collaboration with the NCI to develop deep learning models for cancer surveillance, and EHRLICH, a DOE Biopreparedness Research Virtual Environment (BRaVE) project to integrate heterogeneous data streams and agent-based modeling to facilitate data-driven, real-time simulation of biothreat scenarios. His research interests also include language models, distributed deep learning, and lattice Boltzmann methods.

13:05 OCNPS 200   **Eve Torrence** (etorrenc@rmc.edu) Department of Mathematics, Randolph-Macon College. *Beading and Folding and Sewing, Oh My! An Adventure in the Marvelous Land of Map Coloring.*

The Famous 4-color Theorem states that four colors are sufficient to color any map on a plane or sphere so that regions sharing a boundary line are different colors. The less well-known Map Coloring Theorem gives a formula for the number of colors needed for a map drawn on a torus with one or more holes. Visualizing such maps is quite difficult. Over the past several years I have been trying to understand maps on these surfaces by constructing models in various media. I have published directions for these models so you can learn how to make your own!

Biography: Eve Torrence is professor emeritus at Randolph-Macon College where she taught from 1994 to 2021. She is the author of Cut and Assemble Icosahedra: Twelve models in White and Color and co-author with her husband and fellow mathematician, Bruce Torrence, of The Student's Introduction to Mathematica. She has served as the chair of the Maryland-DC-Virginia Section of the MAA and President of Pi Mu Epsilon Mathematics Honor Society. Eve is currently a member of the Bridges Organization Board and has served as a Proceedings editor for seven Bridges conferences. She is currently working on a book on topological crochet with Shiying Dong.

14:10 OCNPS 200   **Yuming Sun** (ysun30@wm.edu) Department of Mathematics, William & Mary. *Advancing Prognostic and Diagnostic Insights through Statistical Methods for Medical Imaging.*

Medical images, such as X-rays and CT scans, are fundamental to modern healthcare, offering critical insights into disease diagnosis and progression. This talk highlights the crucial role of statistical analysis in maximizing the diagnostic and prognostic potential of medical imaging. By integrating imaging features with clinical data, we can improve outcome prediction, optimize treatment strategies, and make more informed, data-driven decisions in patient care. Drawing from three distinct studies focusing on COVID-19, occupational lung disease, and lung cancer, I will demonstrate how sophisticated models and analytical approaches can address challenges in data preprocessing, feature selection, and model integration. These case studies exemplify the transformative potential of combining clinical expertise, imaging data, and advanced statistical tools to address complex biomedical questions and improve patient outcomes.

Biography: Dr. Yuming Sun is an Assistant Professor in the Department of Mathematics at the College of William & Mary. His research is motivated by challenges at the intersection of statistics, biomedicine, and public health. He develops and applies methods in statistical learning, survival analysis, and semi- and nonparametric modeling, with an emphasis on interpretability and real-world impact. His work integrates diverse data sources, including clinical records, electronic health data, and medical imaging, to improve risk assessment and decision-making in healthcare. He earned his PhD in Biostatistics from the University of Michigan, Ann Arbor.

2   ► *Contributed Speakers*

11:05 OCNPS 100   **Evelyn Thomas** (ekthomas@nsu.edu) Department of Mathematics, Norfolk State University. *Modeling Cholera Transmission in Haiti: The Impact of Migration and Environmental Reservoirs*

Cholera remains a major global health concern, particularly in regions with inadequate sanitation and high population mobility. This study investigates human migration and environmental reservoirs as key factors influencing disease spread in the mathematical modeling of cholera transmission.

Using a compartmental SEIR model coupled with a hydrodynamic framework, we examine the interactions between susceptible, exposed, infected & recovered subpopulations and cholera bacteria in water sources. The model integrates differential equations to describe bacterial transport via advection and diffusion, alongside human movement driven by socioeconomic and environmental factors. By analyzing the Basic Reproduction Number, R_0, and conducting stability assessments, we determine conditions under which cholera outbreak will persist or die out.

Through numerical simulations, we investigate how variations in migration patterns, water flow dynamics, and intervention strategies impact disease prevalence. Sensitivity analysis highlights the effectiveness of targeted public health measures such as vaccination, improved sanitation, and movement restrictions.

This study underscores the power of mathematical modeling in understanding and mitigating infectious disease outbreaks. By providing insights into cholera dynamics, the findings contribute to evidence-based policymaking and the development of more effective intervention strategies.

11:05 PSII 1100 **Will Witt** (wwitt003@odu.edu) Department of Mathematics and Statistics, Old Dominion University. *A Discourse on Sophie Germain's Legacy*

Sophie Germain (1776–1831) stands as a seminal figure in the history of mathematics whose intellectual tenacity and groundbreaking work defied the social constraints of her time. This presentation examines the formative influences that shaped Germain's mathematical pursuits, beginning with her early exposure to classical works during the turbulence of the French Revolution. Denied formal education due to gender, Germain nonetheless cultivated a deep affinity for mathematics, initiating a clandestine correspondence with leading mathematicians under a male pseudonym. Her perseverance culminated in significant contributions to number theory—most notably her pioneering work on Fermat's Last Theorem—and to the nascent field of elasticity theory, where she laid the groundwork for the theory of elasticity in physics and engineering. Through a careful analysis of her mathematical legacy and the historical context in which she worked, this study reaffirms Germain's enduring impact on the discipline and her role as a trailblazer for women in science.

11:35 OCNPS 100 **Heranga Rathnasekara** (hrath001@odu.edu) Department of Mathematics and Statistics, Old Dominion University. *An Ensemble Ordinal Outcome Classifier for High-Dimensional Data*

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 Accuracy, Gamma Statistic, Mean Absolute Error, and Kendall's τ_b, 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.

11:35 PSII 1100 **Ryan O'Neill** (roneill53@cox.net) Department of Mathematics and Statistics, Old Dominion University. *Sabermetric Dashboards*

Using the R programming language, in conjunction with web development tools, to create a framework for interactive statistical dashboards that help visualize player metrics for ODU's baseball team.

15:20 OCNPS 100 **Mohammed Sayyari** (malsayya@odu.edu) Department of Mathematics and Statistics, Old Dominion University. *Classical maze-solving strategies through the lens of graph theory*

This talk presents classic maze-solving algorithms from inside and outside (whole maze)

perspectives. We compare their efficiency using simple programmatic implementations. Additionally, we provide formal conditions under which these algorithms are guaranteed to solve a maze, using graph theory representations of maze structures. The maze structures can be represented via its path, typically a single graph, or walls, a forest of acyclic-connected graphs (trees). We highlight connections between algorithm behavior and path/wall graph properties to explain their success or failure.

15:20 PSII 1100 **Samit Ghosh** (sghos004@odu.edu) Department of Mathematics and Statistics, Old Dominion University. *On the Convergence Rate of the Least Trimmed Squares Algorithm*

The least trimmed squares (LTS) approach is a popular alternative to ordinary least squares (OLS) commonly used to robustly fit linear regression models in the presence of outliers or other model violations. While a closed-form solution exists for the quadratic optimization problem underlying the OLS estimator, the mixed integer-continuous optimization problem associated with the LTS estimator is typically solved by iteratively applying the so-called concentration or C-step to a set of properly selected warm starts. Although the C-step is known to monotonically reduce the objective function leading to convergences in a finite number of steps, no error estimation mechanisms presently exist in the literature. By studying an equivalent formulation of the problem over a convex domain, we prove that the conventional LTS iteration is a special case of the well-known Frank-Wolfe gradient descent method. This furnishes a square-root convergence of the LTS algorithm to a local minimum of the trimmed sum of squares objective function with respect to a suitable Bregman divergence and provides a convenient error quantification tool.

15:50 OCNPS 100 **Vu Giang** (vgian002@odu.edu) Department of Mathematics and Statistics, Old Dominion University. *Quantum Computing meets Machine Learning*

We will briefly talk about the concept of quantum computing and machine learning and explore its significance, application, and future avenues in this fast growing technological age. Some numerical results will also be presented as an introduction to the work we've been doing.

15:50 PSII 1100 **Nasir Yasin** (nyasi001@odu.edu) Department of Mathematics and Statistics, Old Dominion University. *Flow structures around bluff bodies at low Reynolds numbers*

The characterization of flow structures behind bluff bodies at low Reynolds numbers remains a critical area of research due to its relevance in numerous engineering applications. Wake interactions in such regimes are highly sensitive to body arrangement, leading to a range of distinct flow behaviors. Configurations with larger separations typically exhibit periodic vortex shedding, while reduced spacing promotes complex and unsteady wake interactions. The introduction of an upstream control element has demonstrated effectiveness in attenuating chaotic wake dynamics, presenting a viable passive strategy for enhancing flow stability in low-speed environments.