MELISSA BUTLER

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RESEARCH INTERESTS

Computational and Applied Mathematics, Data Science, Scientific Computing, Machine Learning, Network Science, Anomaly Detection, Modeling, Random Matrix Theory, Human Mobility Patterns

EDUCATION

PhD in Mathematics | University of Wyoming — Anticipated Graduation May 2026

* Dissertation: Anomaly detection algorithms for human mobility and complex networks
* Committee: Dr. Dane Taylor (Chair/Advisor), Dr. Victor Ginting, Dr. Bryan Shader, Dr. Long Lee, Dr. Chen Xu

MS in Mathematics | University of Wyoming — December 2022

* Concentration: Numerical Methods and Mathematical Modeling

BS in Mathematics | University of Wyoming — May 2019

* Minor: Computer Science

PUBLICATIONS

* M. Butler, A. Khan, F. Afrifa, Y. Hu, and D. Taylor (2026). ***Multilayer networks characterize human-mobility patterns by industry sector for the 2021 Texas winter storm.*** Accepted to NPJ Complexity. https://arxiv.org/abs/2509.03642
* M. Butler, and D. Taylor. ***Detecting small anomalous communities in networks with background structure.*** In preparation. https://github.com/butlerm0405/spectral_methods_for_community_detection
* M. Butler, V. Ginting. ***Uncertainty in boundary values of Richards Equation.*** In preparation. https://github.com/butlerm0405/uncertainty-in-boundary-values-Richards-Equation
* M. Sejunti, M. Butler, Y. Hu, and D. Taylor. ***Predictability of human movement in multilayer mobility networks.*** In preparation.

RESEARCH AND PROJECTS

PhD Research | University of Wyoming

Detecting Anomalous Temporal and Community Structures in Complex Networks. I developed methods for detecting and quantifying the impact of anomalous temporal and community structures within complex networks using spectral methods and statistical analysis. I applied this to human mobility data.
https://github.com/butlerm0405/spectral_methods_for_community_detection

MS Research | University of Wyoming

Uncertainty in Boundary Values of Richards Equation. I applied a finite volume method to derive a numerical solution of Richards Equation, governing semi-saturated fluid flow, and incorporated stochastic boundary conditions to quantify precipitation uncertainty.
https://github.com/butlerm0405/uncertainty-in-boundary-values-Richards-Equation

Graduate Course Projects | University of Wyoming

Scientific Machine Learning. (1) I developed AutoML meta-learning algorithms for pipeline optimization (model selection, preprocessing, hyperparameter tuning); (2) I implemented PINN-based solvers for initial value problems; and (3) I applied machine learning estimators to fluid dynamics data.
https://github.com/butlerm0405/scientific-machine-learning

Numerical Methods and Scientific Computing. (1) I developed object-oriented finite element software for two-point boundary value problems; (2) I implemented a conjugate gradient solver; and (3) I built a suite of computational methods for approximation, interpolation, and numerical analysis.

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PRESENTATIONS

September 25, 2025	*Multilayer networks characterize human-mobility patterns by industry sector for a Texas winter storm.* Wyoming Computing Symposium: AI For WY Industries, Laramie, WY
June 24, 2025	*Multilayer networks characterize human-mobility patterns by industry sector for a Texas winter storm.* 2025 UCGIS Symposium: Navigating the Geospatial Frontier, Future Directions for Academia and Its Partners, Laramie, WY
October 15, 2024	*Characterizing anomalous human mobility patterns during the 2021 Texas winter storm.* I-GUIDE Forum 2024: Convergence Science and Geospatial AI for Environmental Sustainability, Jackson, WY
March 12, 2022	*Quantifying uncertainty in Richards equation through Brownian Motion.* SIAM 18th Front Range Applied Mathematics Student Conference, Denver, CO (virtual participation)

SOFTWARE AND COMPUTING EXPERTISE

Languages

Python	Anomaly Detection in Networks, Machine Learning, Data Science
C++	Finite Volume Method, Stochastic Gradient Descent, Iterative Techniques
MATLAB	Finite Element Method, Scientific Computing Techniques
OpenMP	Parallel Computing, Decentralized Computing Network
Mathematica	Mathematical Modeling

Professional Development Workshops

2022	*Fundamentals of Accelerated Computing with CUDA C/C++* | NVIDIA DLI
2022	*Fundamentals of Deep Learning* | NVIDIA DLI
2022	*Parallel Computing Workshop* | MATLAB

GRADUATE COURSEWORK

2023 - 2024	Random Matrix Theory for Anomaly Detection, Combinatorial Matrix Theory, Advanced Topics in AI, Computational Methods III, Practical Applications of Machine Learning, Machine Learning for Fluid Dynamics
2021 – 2022	Multiscale Modeling, Permutation Groups, Introduction to Machine Learning, Advanced High-Performance Computing, Computational Methods II, Functional Analysis, Bayesian Numerical Analysis, Real Variables
2019 – 2020	Stochastic Processes, Advanced Partial Differential Equations, Computational Methods I, Introduction to High Performance Computing, Abstract Algebra, Advanced Linear Algebra, Methods of Applied Mathematics, Complex Variable

TEACHING EXPERIENCE

2024-2025	Undergraduate Research Mentor | University of Wyoming Topic: Network science for human mobility patterns
2020-2023	Instructor of Record | University of Wyoming Courses: Differential Equations, Calculus I, Math Apps for Business, Trigonometry
2018-2023	Teaching Assistant | University of Wyoming Courses: Scientific Computing, Calculus II, College Algebra
2017-2023	Tutor | University of Wyoming Center for Assistance in Statistics and Mathematics