

MELISSA BUTLER

mbutle15@uwyo.edu | butlerm0405.github.io | 307-705-3184 | Laramie, WY

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 other 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, D. Taylor *Detecting small anomalous communities in networks with background structure*. In preparation.
- * M. Sejunti, M. Butler, Y. Hu, and D. Taylor *Predictability of human movement in multilayer mobility networks*. In preparation.
- * M. Butler, V. Ginting *Uncertainty in boundary values of Richards Equation*. 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.

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 dynamics, and incorporated stochastic boundary conditions to quantify precipitation uncertainty.

Graduate Course Projects | University of Wyoming

Metalearning for Machine Learning Optimization. I created machine learning algorithms to optimize selection of ML learner, data preparation, and hyperparameter selection.

Physics Informed Neural Networks for Initial Value Problems. I adapted code to create a PINN for solving initial value problems and research current literature for PINN's.

Finite Element Method for Solving Two-point Boundary Value Problems. I worked in collaborative group to create objected oriented software in MATLAB for solving BVP's.

Conjugate Gradient Method. I implemented the conjugate gradient method using C++ and applied it to differential equations.

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PRESENTATIONS

September 25, 2025	<i>Multilayer networks characterize human-mobility patterns by industry sector for a Texas winter storm.</i> Wyoming Computing Symposium: AI For WY Industries, Laramie, WY
June 24, 2025	<i>Multilayer networks characterize human-mobility patterns by industry sector for a Texas winter storm.</i> 2025 UCGIS Symposium, Navigating the Geospatial Frontier: Future Directions for Academia and Its Partners, Laramie, WY
October 15, 2024	<i>Characterizing anomalous human mobility patterns during the 2021 Texas winter storm.</i> I-GUIDE Forum 2024, Convergence Science and Geospatial AI for Environmental Sustainability, Jackson, WY
March 12, 2022	<i>Quantifying uncertainty in Richards equation through Brownian Motion.</i> SIAM 18 th 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 Decent, Iterative Techniques
MATLAB	Finite Element Method, Scientific Computing Techniques
OpenMP	Parallel Computing, Decentralized Computing Network
Mathematica	Mathematical Modeling

Professional Development Workshops

2022	<i>Fundamentals of Accelerated Computing with CUDA C/C++</i> NVIDIA DLI
2022	<i>Fundamentals of Deep Learning</i> NVIDIA DLI
2022	<i>Parallel Computing Workshop</i> 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