Jacob W. Murri

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Research Interests

My research uses data to build nonlinear PDE models that can produce forward predictions in settings where information or computational resources are limited: when model parameters are unknown, when only part of the state is observable, or when a fully resolved solver is too expensive for the application. I work at the interface of analysis and scientific computing, proving convergence results for the algorithms I develop and implementing them in large-scale numerical simulations. I have particular interest in the following topics:

- Continuous data assimilation and simultaneous state/parameter recovery for dissipative dynamical systems and fluid flows.
- Reduced-order and hybrid models for incompressible flow, with an emphasis on generalization to unseen geometries.
- Inverse problems and PDE-constrained optimization for data-driven modeling in the biological and physical sciences.
- Numerical methods for nonlinear PDEs: finite element, pseudospectral, and projection methods; high-performance scientific computing.

Education

Ph.D. in Mathematics expected 2027
Advisor: Hayden Schaeffer
Department of Mathematics, University of California, Los Angeles
Qualifying examinations passed in Applied Differential Equations, Numerical Analysis, and Optimization and Numerical Linear Algebra

M.S. in Mathematics 2022
Thesis: *Data Assimilation and Parameter Recovery for Rayleigh–Bénard Convection*
Advisor: Jared P. Whitehead
Department of Mathematics, Brigham Young University

BS Mathematics 2021
summa cum laude
Department of Mathematics, Brigham Young University

Experience

Associate in Science 2024
Special Technologies Laboratory, Nevada National Security Sites, Santa Barbara, CA

- Contributed to a Site-Directed Research and Development program in computational fluid dynamics.
- Developed a hybrid reduced-order / full-order model for incompressible flow around obstacles, coupled through a discontinuous Galerkin domain decomposition with $H(\mathrm{div})$-conforming finite elements.
- The collaboration has continued through an NNSS grant to UCLA.

Applied Research Mathematician 2021
National Security Agency, Fort Meade, MD

- Contributed to the security analysis of candidate algorithms for the NIST post-quantum cryptography standardization effort.
- Compiled findings into an internally refereed technical paper.
- Presented results at Institute for Defense Analyses centers in Princeton, NJ and Bowie, MD.
- Held a TS/SI security clearance.

Undergraduate Research Assistant 2019–2021
Department of Mathematics, Brigham Young University

- Studied stability of stochastically switched and time-delayed dynamical systems (with Benjamin Webb).
- Used Markov chain Monte Carlo methods to quantify gerrymandering in Utah redistricting plans (with Tyler J. Jarvis).
- Both projects led to journal publications.

Awards and Honors

2026 Liggett Teaching Award, Department of Mathematics, University of California, Los Angeles

2022 Honorable Mention, National Science Foundation Graduate Research Fellowship Program

2021–2022 Dean's Fellowship, College of Physical and Mathematical Sciences, Brigham Young University

2021 Orson Pratt Prize in Mathematics, Department of Mathematics, Brigham Young University

Teaching and Mentoring

University of California, Los Angeles

Instructor 2026

Instructor of record: prepared and delivered lectures, wrote and graded assessments, and submitted final grades.

- Math 118: Mathematical Methods for Data — Winter 2026

Teaching Assistant 2022–2026

Led discussion sections, held office hours, and graded assignments and examinations.

- Math 131A: Analysis — Fall 2026
- Math 168: Introduction to Networks — Fall 2026
- Math 495: Teaching College Mathematics — Fall 2025
- Math 32B: Calculus of Several Variables — Spring 2025
- Math 33B: Ordinary Differential Equations — Spring 2025
- Math 142: Mathematical Modeling — Winter 2025
- Math 32AH: Honors Calculus of Several Variables — Fall 2024
- Math 266A: Applied Ordinary Differential Equations — Fall 2024
- Math 131B: Analysis — Spring 2024
- Math 118: Mathematical Methods for Data — Winter 2024
- Math 146: Calculus of Variations and Optimal Control — Winter 2024
- Math 156: Machine Learning — Fall 2023
- Math 266A: Applied Ordinary Differential Equations — Fall 2023
- Math 131A: Analysis — Spring 2023
- Math 151A: Applied Numerical Methods — Winter 2023
- Math 134: Linear and Nonlinear Systems of Differential Equations — Fall 2022

Directed Reading Program Graduate Mentor 2025

Quarter-long mentorship program organized by the Department of Mathematics, pairing undergraduates with graduate students for weekly reading meetings and a final presentation. Mentees:

- Lilly Ehrhard, *Asymptotic Analysis for Boundary Layer Problems* — Fall 2025

Research Mentor, Computational and Applied Mathematics REU 2023

Mentored six undergraduates who prototyped image-processing and simulation tools for a nonlocal model of bacterial colony growth.

Brigham Young University

Instructor 2022

Instructor of record: prepared and delivered lectures.

- Math 118: Essentials of Calculus — Spring 2022

Publications

In Preparation

7. **J. W. Murri**, S. Breckling, C. Watkins, and H. Schaeffer. Temperature-only data assimilation in mixed convection: nonmonotone dependence on the relaxation parameter. In preparation.
6. **J. W. Murri**, C. Dudiak, J. N. Wilking, S. G. McCalla, and H. Schaeffer. Learning interaction kernels for nonlocal bacterial growth models. In preparation.
5. **J. W. Murri**, S. Breckling, C. Watkins. Submerged reduced-order models for incompressible flow around obstacles. In preparation.

Journal Articles

4. V. R. Martinez, **J. W. Murri**, and J. P. Whitehead. Relaxation-based schemes for on-the-fly parameter estimation in dissipative dynamical systems. *Inverse Problems*, 41(5):055001, 2025.
3. A. King, **J. W. Murri**, J. Callahan, A. Russell, and T. J. Jarvis. Mathematical analysis of redistricting in Utah. *Statistics and Public Policy*, 9(1), 2022. doi:10.1080/2330443X.2022.2105770.
2. C. Carter, **J. W. Murri**, D. Reber, and B. Webb. A simple stability criterion for dynamical systems with stochastic switching and/or time-delays. *Nonlinearity*, 35(12):6042, 2022. doi:10.1088/1361-6544/ac9505.

Theses

1. **J. W. Murri**. Data assimilation and parameter recovery for Rayleigh–Bénard convection. Master's thesis, Brigham Young University, 2022. scholarsarchive.byu.edu/etd/9714.

Presentations

Conference Presentations

12. Recovering mixed convection flows using only temperature sensor measurements. Southern California Applied Mathematics Symposium, Los Angeles, CA, 25 April 2026.
11. Exploring continuous data assimilation algorithms for reconstructing flow from temperature measurements. APS Division of Fluid Dynamics Meeting, Houston, TX, 25 November 2025.
10. Submerged reduced-order models for incompressible flow around obstacles. APS Division of Fluid Dynamics Meeting, Salt Lake City, UT, 25 November 2024.
9. Data assimilation and parameter recovery for Rayleigh–Bénard convection. AMS Western Sectional Meeting, Salt Lake City, UT, 22 October 2022.
8. Data assimilation and parameter recovery for Rayleigh–Bénard convection. Student Research Conference, Brigham Young University, Provo, UT, 5 March 2022. *Best Presentation (session).*
7. Evaluating gerrymandering metrics in Utah. Student Research Conference, Brigham Young University, Provo, UT, 27 February 2021.
6. Stability of stochastic switched systems. Student Research Conference, Brigham Young University, Provo, UT, 27 February 2021. [slides]

5. Gerrymandering in Utah: Monte-Carlo Markov chain methods and Metropolis–Hastings sampling. Student Research Conference, Brigham Young University, Provo, UT, 29 February 2020.
4. Collinear equilibria in a simplified four-body problem. Student Research Conference, Brigham Young University, Provo, UT, 29 February 2020. [slides]
3. Exchange orbits in symmetric gravitational N-body problems. Student Research Conference, Brigham Young University, Provo, UT, 4 March 2017.

Seminars and Invited Talks

2. Recovering mixed convection flows using only temperature sensor measurements. Department of Mathematical Sciences Colloquium, Montana State University, Bozeman, MT, 30 April 2026.

Posters

1. Learning interaction kernels for nonlocal bacterial growth models. Workshop on Sampling, Inference, and Data-Driven Physical Modeling in Scientific Machine Learning, Institute for Pure and Applied Mathematics, Los Angeles, CA, 14 July 2025.