Mariah C. Boudreau

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Research Interests

Mathematical modeling for biological applications, stochastic modeling, probability generating functions, and model philosophy.

Education

Ph.D. in Mathematical Sciences | 2019 - 2024
University of Vermont, Burlington, VT

- Dissertation title: Probabilistic modeling of disease: Addressing uncertainties in within-host and population-level dynamics

- Advisors: Laurent Hébert-Dufresne and Chris Danforth

- Quantitative and Evolutionary STEM Training Program Trainee (NSF Funded Traineeship)

Bachelor of Science in Mathematics | 2015 - 2019
Saint Michael's College, Colchester, VT

- Minors in computer science and statistics

Professional Experience

Postdoctoral Fellow | September 2024 - Present
Roux Institute - Northeastern University, Portland, ME
Continuing dissertation research on probability generating functions. Specifically, formalizing a probability generating function (PGF) metapopulation modeling framework applied to airport wastewater surveillance.

Graduate Research Assistant | June 2023 - August 2024
University of Vermont, Burlington, VT
Conducting data analysis on blood work data for the Lived Experience Measured Using Rings study.

Graduate Teaching Assistant | August 2019 - May 2020 & August 2022 - May 2023
Mathematics Department, University of Vermont, Burlington, VT
Taught MATH 017: Applications of Finite Math in 2019-2020. Taught MATH 019: Fundamentals of Calculus I in 2022-2023.

Contractor | May 2022 - July 2022
Institute for Disease Modeling at the Gates Foundation, Seattle, WA
Assisted in the parameterization and development of an open-source human papillomavirus population model. Began developing a within-host model for human papillomavirus induced lesions in a cervical skin layer.

Graduate Research Assistant | August 2020 - May 2022
University of Vermont, Burlington, VT
Developed a project about the sensitivity of final outbreak predictions for probability generating functions (PGFs) when applied to epidemics. Another project expands on time-dependent PGFs to understand early epidemic uncertainty and incorporate intervention strategies.

QuEST Coding Workshop Teaching Assistant | August 2021
University of Vermont, Burlington, VT
Coordinated and taught first year Ph.D. students the fundamentals of coding in R and calculus basics.

Technical Services Intern | June 2019 - August 2019
Mylan Technologies, Saint Albans, VT
Analyzed sampling, mass balance and other essential functions at the Mylan Technologies Saint Albans manufacturing plant.

Dartmouth Summer Research Student | June 2018 – August 2018
Dartmouth College, Hanover, NH
Participated in a research experience for undergraduates to research mathematical applications in signal processing. The research project was a simplified version of a multi-measurement vector problem. The goal was to understand the fundamentals of how multiple audio signals could be used together to construct a clear signal of a single conversation. Presented this research at the end of the program at a colloquium.

BU SIBS Participant | June 2017 - July 2017
Boston University, Boston, MA
Participated in a program to learn about the field of biostatistics. Presented a research project at the end of program to BU Biostatistics Faculty. This research project utilized data from the National Health Interview Survey of the CDC. The relationship between amounts of milk consumed during one's life was compared to being diagnosed with osteoporosis. The title of the presentation given was "Got Milk?".

Publications and other writings

M.C. Boudreau, J.A. Cohen, & L. Hébert-Dufresne | August 2024
Within-host infection dynamics with master equations and the method of moments: A case study of human papillomavirus in the epithelium
ArXiv

R.M. Stuart, J.A. Cohen, C.C. Kerr, P. Mathur, R.G. Abeysuriya, M. Zimmerman, D.W. Rao,

M.C. Boudreau, S. Lee, L. Yang, & D.J. Klein | July 2024
HPVsim: An agent-based model of HPV transmission and cervical disease
PLOS Comput. Biol. 20(7) e1012181

M.C. Boudreau, A.J. Allen, N.J. Roberts, A. Allard, & L. Hébert-Dufresne | September 2023
Temporal and probabilistic comparisons of epidemic interventions
Bull. of Math. Biol. 85, 118

A.J. Allen, **M.C. Boudreau**, N.J. Roberts, A. Allard, & L. Hébert-Dufresne | February 2022
Predicting the diversity of early epidemic spread on networks
Phys. Rev. Research 4, 013123

M.C. Boudreau, W. Thompson, C.M. Danforth, J.G. Young, & L. Hébert-Dufresne | In Progress
Working title: *Sensitivity analysis of epidemic forecasting and spreading on networks with probability generating functions*
Draft available upon request

Conferences attended

NetSci 2024 | June 2024
Complex Networks Winter Workshop | December 2023
Contagion on Complex Social Systems Workshop | August 2023
SIAM Dynamical Systems | May 2023
University of Vermont Virtual Student Research Conference | April 2021
Complex Networks Winter Workshop | January 2021
NetSci 2020 | August 2020
NetSci 2019 | June 2019

Presentations

Modeling disease spread with probability generating functions | February 2025
Women in Network Science (WiNS) seminar, Online
In this presentation, I introduced the PGF framework for disease spread and illustrated its usefulness through two examples. First, I demonstrated the use of PGFs over contact networks to determine final outbreak size results, along with their sensitivity to noise. Second, I introduced how this framework can be extended with a time-dependent PGF and track particular disease progression counts over time. Two counts of interest are cumulative infection and daily infection counts. Lastly, I discussed future work for PGF sensitivity analyses and time-dependent PGF applications.

Temporal and probabilistic comparisons of epidemic interventions | June 2024
NetSci 2024 Conference, Québec City, QC, CA
This presentation detailed work from a publication which expands a probability generating function time evolution model to incorporates intervention strategies and ways to compare them. This work was in collaboration with Andrea J. Allen, Nicholas J. Roberts, Antoine Allard and Laurent

Hébert-Dufresne.

Sensitivity analysis of stochastic polynomials, and its application to epidemic forecasting and random graphs | August 2023
Contagions on Complex Social Systems Workshop, Burlington, VT
This presentation detailed previous work of a preliminary sensitivity analysis on probability generating functions as models for epidemic forecasting.

Temporal and probabilistic forecasts of epidemic interventions | May 2023
SIAM Dynamical Systems 2023 Conference, Portland, OR
This presentation detailed work from a preprint which expands a probability generating function time evolution model to incorporates intervention strategies and ways to compare them. This work was in collaboration with Andrea J. Allen, Nicholas J. Roberts, Antoine Allard and Laurent Hébert-Dufresne.

Network analysis and its application to biology | April 2023
University of Vermont MATHCounts, Burlington, VT
This presentation gave an introduction to networks and their applications to biology, such as neural networks, forest fires and epidemics.

Modeling epidemic interventions with probability generating functions | April 2021
University of Vermont Virtual Student Research Conference, Online
The poster presentation described an expansion of a probability generating function time evolution model that incorporates intervention strategies. This work was in collaboration with Andrea J. Allen, Nicholas J. Roberts, Antoine Allard and Laurent Hébert-Dufresne.

Network analysis and its application to biology | January 2021
University of Vermont 4-H Teen Science Cafe, Online
This presentation gave an introduction to networks and their applications to biology applications such as neural networks, forest fires and epidemics.

Ski resort network analysis | January 2021
Complex Networks Winter Workshop 2020, Online
This presentation showcased network analysis techniques applied to Utah ski resorts to see if there were trend among popular ski resorts. This work was in collaboration with Alexander Caouette, Jeremy Côté and Nicholas J. Roberts.

Probabilistic epidemic forecasting using probability generating functions, and its robustness to data quality, error, biases, and noise | September 2020
University of Vermont Computer Science Research Day, Online
This presentation detailed a preliminary sensitivity analysis on probability generating functions as models for epidemic forecasting.

Probabilistic epidemic forecasting using probability generating functions, and its robustness to data quality, error, biases, and noise | September 2020
NetSci 2020 Conference, Online
This poster presentation detailed a preliminary sensitivity analysis on probability generating functions as models for epidemic forecasting.

Relevant Coursework

Mathematics:
Applied Graph Theory, Differential Equations, Advanced Ordinary Differential Equations, Partial Differential Equations, Linear Algebra, Abstract Algebra I & II, Algebraic Topology, Numerical Analysis, Numerical Partial Differential Equations, Real Analysis I

Complex Systems:
Principles of Complex Systems, Modeling of Complex Systems I & II,

Statistics:
Probability and Statistics, Applied Regression Analysis, Bayesian Statistics, Mathematical Statistics and Methods, Applied Statistical Methods, Biological Data and Statistics

Other:
One Health: Zoonoses, Philosophy of Science, Technology, and Environment, Philosophy of the Mind, Free Will, and Neuroethics

Skills

Programming:
Python, R, LaTeX, MATLAB, Java, C++

Other:
Statistical analysis, collaboration, problem solving, positive attitude, conversational French

Service

Peer Review
Applied Network Science | April 2025
Journal of Theoretical Biology | March 2025
Joint Peer Review
Physical Review Research | July 2023

Volunteer Ski Patrol | March 2021 - Present
Assist with mountain operations and first-aid at Bolton Valley Ski Resort.
Assisted with the Tuckerman Inferno race

Other interests

Hiking, skiing, Crossfit and learning more about Vermont.