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

- 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

Professional Experience

Postdoctoral Fellow | September 2024 - Present
Roux Institute - Northeastern University, Portland, ME
Continuing dissertation research on probability generating functions.

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 Bill and Melinda Gates Foundation, Seattle, WA
Assisted in the parameterization and development of an open-source human papillomavius population model. Began developing a with-in host model for human papillomavirus induced lesions in a cervical skin layer.

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

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 stochastic polynomials, and its application to epidemic forecasting and random graphs*
Draft available upon request

Conferences attended

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

Presentations

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.

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

Joint Peer Review | July 2023
Physical Review Research

Volunteer Ski Patrol | March 2021 - April 2023
Assist with mountain operations and first-aid at Bolton Valley Ski Resort.

Other interests

Hiking, skiing, Crossfit and learning more about Vermont.