

Joseph R. Mathews

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Seeking postdoctoral or teaching positions in probability and statistics

Research Interests

- My research focuses on the theoretical analysis and development of Monte Carlo algorithms for high-dimensional statistical inference, with an emphasis on provable finite-sample guarantees. I am primarily interested in their application to problems in computational biology, especially site-dependent models of molecular sequence evolution.

Education

- Aug. 2019 - Sept. 2025 ■ **Ph.D., Duke University** in Statistical Science,
Advisor: *Scott C. Schmidler*
Dissertation Title: *Advances in Sequential Monte Carlo Methods and Site-Dependent DNA Evolution Models*
- Aug. 2014 – May 2019 ■ **B.S., Austin Peay State University** in Mathematics



Research Publications

Published / In Press

- 1 Y. Li, **J. Mathews**, and S. C. Schmidler, “On Gibbs sampling for endpoint-conditioned neighbor-dependent sequence evolution models,” *Journal of Computational and Graphical Statistics*, 2025, (In press).
- 2 **J. Mathews**, E. Van Itallie, Y. Li, K. Wiehe, and S. C. Schmidler, “Computing the inducibility of broadly neutralizing antibodies under a context-dependent model of affinity maturation: Applications to sequential vaccine design,” *Journal of Immunology*, 2025, (In press).
- 3 **J. Mathews** and S. C. Schmidler, “Finite sample complexity of sequential Monte Carlo estimators on multimodal target distributions,” *Annals of Applied Probability*, vol. 34, no. 1B, pp. 1199–1223, 2024. 🔗 DOI: 10.1214/23-AAP1989.
- 4 J. Marion, **J. Mathews**, and S. C. Schmidler, “Finite sample complexity of sequential Monte Carlo estimators,” *Annals of Statistics*, vol. 51, no. 3, pp. 1357–1375, 2023. 🔗 DOI: 10.1214/23-AOS2295.
- 5 **J. Mathews**, S. Bhattacharya, S. Sen, and I. Das, “Multiple inflated negative binomial regression for correlated multivariate count data,” *Dependence Modeling*, vol. 10, pp. 290–307, 1 2022. 🔗 URL: <https://doi.org/10.1515/demo-2022-0149>.
- 6 **J. Mathews**, S. Sen, and I. Das, “Doubly-inflated negative binomial model using Gaussian copula,” in *2018 Springer Proceedings: Modern Statistical Methods for Spatial and Multivariate Data*, N. Diawara, Ed., Springer Nature Switzerland AG, 2019, pp. 147–161.

In Review


- 1 J. Marion, **J. Mathews**, and S. C. Schmidler, “Finite sample bounds for sequential Monte Carlo and adaptive path selection using the L_2 norm,” 2025. arXiv: 1807.01346. 🔗 URL: <https://arxiv.org/abs/1807.01346>.
- 2 **J. Mathews** and S. C. Schmidler, “Approximating marginal likelihoods in evolutionary processes with context-dependence,” 2025.


- 3 **J. Mathews** and S. C. Schmidler, “Importance sampling approximation of sequence evolution models with site-dependence,” 2025. arXiv: 2508.11461.  URL: <https://arxiv.org/abs/2508.11461>.
- 4 **J. Mathews** and S. C. Schmidler, “Posterior bounds on divergence time of two sequences under dependent-site evolutionary models,” 2025. arXiv: 2507.19659.  URL: <https://arxiv.org/abs/2507.19659>.

In Preparation

- 1 **J. Mathews** and S. C. Schmidler, “Lower bounds on the complexity of sequential Monte Carlo samplers,” 2025.






Research Experience

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| May 2022 – Sept. 2025 |  Modeling HIV Broadly Neutralizing Antibody Mutations,
Duke Human Vaccine Institute, Duke University




Developed a stochastic model of B-cell clonal maturation and somatic hypermutation to quantify the probability of acquiring key mutations required to elicit HIV broadly neutralizing antibodies. Our analysis revealed how mutation orderings shape the probability of key mutations occurring, informing challenges in eliciting broadly neutralizing antibodies through immunization. |
| May 2023 – August 2023 |  Sampling from Cut-Bayes Posterior Distributions,
Los Alamos National Laboratory, New Mexico

Contributed to the development of a sequential Monte Carlo algorithm for sampling from “cut-Bayesian” posterior distributions—modified versions of traditional Bayesian posterior distributions that minimize the impact of known model inaccuracies. Established theoretical performance guarantees and introduced practical strategies to speed up computation. |



Employment History

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| Jan. 2023 – Sept. 2025 |  Research Assistant,
Department of Statistical Science, Duke University. |
| Jan. 2020 – May 2025 |  Teaching Assistant,
Department of Statistical Science, Duke University. |
| Jan. 2015 – May 2019 |  Peer Tutor,
Academic Support Center, Austin Peay State University. |
| Aug. 2018 – May 2019 |  Peer Tutor Subject Area Supervisor,
Academic Support Center, Austin Peay State University. |
| Jan. 2015 – May 2016 |  Structured Learning Assistant Leader,
Academic Support Center, Austin Peay State University. |


Teaching Experience

- Jan. 2025 – May 2025  **Teaching Assistant, Categorical Data Analysis (STA 841)**,
Department of Statistical Science, Duke University.
- Supported instruction in mixed effects, generative, graphical, and latent variable models.
 - Held weekly office hours and graded assignments.
- Jan. 2022 – Dec. 2022  **Teaching Assistant, Bayesian Methods and Modern Statistics (STA 360 & STA 601)**,
Department of Statistical Science, Duke University.
- Led multiple weekly labs on Bayesian modeling using R and Stan.
 - Graded lab reports and reviewed homework exercises during office hours.
- Jan. 2019 – Dec. 2021  **Teaching Assistant, Data Analysis and Statistical Inference (STA 101)**,
Department of Statistical Science, Duke University.
- Led weekly labs introducing R programming and data analysis.
 - Reviewed homework exercises and exam study guides during office hours.
 - Mentored student groups on capstone data-analysis projects, providing guidance on modeling choices and presentations.
 - Delivered class lectures when instructor was unavailable.

Presentations

- March 2022  **J. Mathews** and S. Schmidler. "Computational Complexity of Sequential Monte Carlo Samplers on Multimodal Target Distributions". Reading In Statistical Science Seminar, Duke University, Durham, NC.
- June 2018  **J. Mathews**, S. Sen, and I. Das. "Doubly-inflated negative binomial model using Gaussian copula". Poster Presentation at Southern Regional Council on Statistics (SRCOS) Conference, Virginia Beach, VA.

Skills

Coding  Proficient: Python, R, Stan, \LaTeX
Familiar: Matlab, C++

References

Available upon request