

# Andrew J. Holbrook, Ph.D.

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## Research Interests

Bayesian statistics and machine learning; dimension reduction; imaging statistics; viral epidemiology  
Dissertation title: *Geometric Bayes*; Advisor: Babak Shahbaba, Ph.D.; Co-Advisor: Daniel L. Gillen, Ph.D.

## Education

2015-2018, Ph.D., Statistics, University of California, Irvine, CA  
2013-2015, M.S., Statistics, University of California, Irvine, CA  
2005-2009, B.A., German and Classical Languages, *with Honors*, University of California, Berkeley, CA

## Positions

2023-present, Member, Center for Quantum Science and Engineering, University of California, Los Angeles  
2022-present, Member, California NanoSystems Institute, University of California, Los Angeles  
2020-present, Assistant Professor, Department of Biostatistics, University of California, Los Angeles

## Awards and Academic Honors

- NSF CAREER Award (2023)
- Toffler Scholar Award, The Karen Toffler Charitable Trust (2023)
- Mitchell Prize (Honorable Mention), International Society for Bayesian Analysis (2022)
- NIH K Award (2020)
- Leonard J. Savage Award, International Society for Bayesian Analysis (2018)  
*Honorable Mention for a Dissertation in Theory and Methods*
- Carl W. Cotman Young Investigator Award, UCI MIND (2018)
- UC Irvine Graduate Dean's Dissertation Fellowship Award (2017-2018)
- UCI MIND Aging Fellowship (2015-2017)
- Robert L. Newcomb 1st Year Graduate Student Award, UC Irvine Department of Statistics (2014)

## Support

- NSF DMS 2236854 (Sole-PI) 07/01/2023 - 06/30/2028, \$549,227.  
*CAREER: Data-Centric Evolutionary Contagion Models with Parallel and Quantum Parallel Computing*
- Toffler Scholar Award, The Karen Toffler Charitable Trust, 2023, \$20,000.
- NSF DMS 2152774 (Sole-PI) 07/01/2022 - 06/30/2025, \$300,000.  
*Accelerating Bayesian Dimension Reduction for Dynamic Network Data with Many Observations*
- NIH K25 AI153816 (Sole-PI) 06/01/2020 - 05/31/2025, \$532,335.  
*Big Data Predictive Phylogenetics with Bayesian Learning*

## Book Chapters

2. Sheth A, Glatt-Holtz N, Krometis J, Mondaini C, **Holbrook A**. "Sacred and profane: the involutive theory of MCMC explains helpful Hamiltonian hacks." To appear in Brooks, S., Gelman, A., Jones, G.L., and Meng, X.L. (Eds.). *Handbook of Markov Chain Monte Carlo*, Second Edition (2024): Chapman & Hall/CRC.

1. **Holbrook A**, Nishimura A, Ji X, Suchard M. "Computational statistics and data science in the twenty-first century." In Piegorsch, W.W., Levine, R.A., Zhang, H.H., and Lee, T.C.M. (Eds.). *Computational Statistics in Data Science*, (2022): John Wiley & Sons.

## Refereed Publications

23. Didier G, Glatt-Holtz N, **Holbrook A**, Magee A, Suchard M. *On the surprising effectiveness of a simple matrix exponential derivative approximation, with application to global SARS-CoV-2*. Revised and resubmitted to PNAS, 2023.
22. Magee A, **Holbrook A**, Pekar J, Caviedes-Solis I, Matsen F IV, Baele G, Wertheim J, Ji X, Lemey P, Suchard M. *Random-effects substitution models for phylogenetics via scalable gradient approximations*. Revised and resubmitted to Systematic Biology, 2023.
21. Su E, Weiss R, Nouri-Mahdavi K, **Holbrook A**. A spatially varying hierarchical random effects model for longitudinal macular structural data in glaucoma patients. Under revision at the Annals of Applied Statistics, 2023.
20. **Holbrook A**. *A quantum parallel Markov chain Monte Carlo*. Journal of Computational and Graphical Statistics, vol. 32, no. 4, pp. 1402-1415, 2023.
19. Zhang Z, Nishimura A, Tróvão S, Cherry J, **Holbrook A**, Ji X, Lemey P, Suchard M. *Accelerating Bayesian inference of dependency between mixed-type biological traits*. PLOS Computational Biology, vol. 19, no. 8, e1011419, 2023.
18. **Holbrook A**. *Generating MCMC proposals by randomly rotating the regular simplex*. Journal of Multivariate Analysis, vol. 194, 105106, 2023.
17. Hassler G, Gallone B, Aristide L, Allen W, Tolkoﬀ M, **Holbrook A**, Baele G, Lemey P, Suchard M. *Principled, practical, flexible, fast: a new approach to phylogenetic factor analysis*. Methods in Ecology and Evolution, vol. 13, pp. 2181-2197, 2022.
16. **Holbrook A**, Ji X, Suchard M. *From viral evolution to spatial contagion: a biologically modulated Hawkes model*. Bioinformatics, vol. 38, no. 7, pp. 1846-1856, 2022.
15. **Holbrook A**, Ji X, Suchard M. *Bayesian mitigation of spatial coarsening for a Hawkes model applied to gunfire, wildfire and viral contagion*. Annals of Applied Statistics, vol. 16, no. 1, pp. 573-595, 2022.
14. Tustison N, Cook P, **Holbrook A**, Johnson H, Muschelli J, Devanyi G, Duda J, Das S, Cullen N, Gillen D, Yassa M, Stone J, Gee J, Avants B. *ANTsX: A dynamic ecosystem for quantitative biological and medical imaging*. Scientific Reports, vol. 11, no. 9068, 2021.
13. **Holbrook A**, Loeffler C, Flaxman S, Suchard M. *Scalable Bayesian inference for self-excitory stochastic processes applied to big American gunfire data*. Statistics and Computing, vol. 31, no. 4, 2021.
12. **Holbrook A**, Lemey P, Baele G, Dellicour S, Brockmann D, Rambaut A, Suchard M. *Massive parallelization boosts big Bayesian multidimensional scaling*. Journal of Computational and Graphical Statistics, vol. 30, no. 1, pp. 11-24, 2021.
11. Shahbaba B, Lan S, Streets J, **Holbrook A**. *Nonparametric Fisher geometry with application to density estimation*. Proceedings of the 36th Conference on Uncertainty in Artificial Intelligence (UAI), PMLR vol. 124, pp. 101-110, 2020.
10. **Holbrook A**, Tustison N, Marquez F, Roberts J, Yassa M, Gillen D. *Anterolateral entorhinal cortex thickness as a biomarker for early detection of Alzheimer's disease*. Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring, vol. 12, no. 1, 2020.
9. Ji X, Zhang Z, **Holbrook A**, Nishimura A, Baele G, Rambaut A, Lemey P, Suchard M. *Gradients do grow on trees: a linear-time  $O(N)$ -dimensional gradient for statistical phylogenetics*. Molecular Biology and Evolution, vol. 37, no. 10, pp. 3047-3060, 2020.
8. Lan S, **Holbrook A**, Elias G, Fortin N, Ombao H, Shahbaba B. *Flexible Bayesian Dynamic Modeling of Correlation and Covariance Matrices*. Bayesian Analysis, vol. 15, no. 4, pp. 1199-1228, 2020.
7. **Holbrook A**, Lumley T, Gillen D. *Estimating prediction error for complex samples*. Canadian Journal of Statistics, vol. 48, no. 2, pp. 204-221, 2020.
6. Tustison N, **Holbrook A**, Avants B, Roberts J, Cook P, Reagh Z, Stone J, Gillen D, Yassa M. *Longitudinal mapping of cortical thickness measurements: an Alzheimer's Disease Neuroimaging Initiative-based evaluation study*. Journal of Alzheimer's Disease, vol. 71, no. 1, pp. 165-183, 2019.
5. Li L, **Holbrook A**, Shahbaba B, Baldi P. *Neural network gradient Hamiltonian Monte Carlo*. Computational Statistics, vol. 34, no. 1, pp. 281-299, 2019.
4. **Holbrook A**. *Differentiating the pseudo determinant*. Linear Algebra and its Applications, vol. 548, pp. 293-304, 2018.

3. **Holbrook A**, Lan S, Vandenberg-Rodes A, Shahbaba B. *Geodesic Lagrangian Monte Carlo over the space of positive definite matrices: with application to Bayesian spectral density estimation*. Journal of Statistical Computation and Simulation, vol. 88, no. 5, pp. 982-1002, 2018.
2. **Holbrook A**, Vandenberg-Rodes A, Fortin N, Shahbaba B. *A Bayesian supervised dual-dimensionality reduction model for simultaneous decoding of LFP and spike train signals*. Stat Journal, vol. 6, no. 1, pp. 53-67, 2017.
1. Grill J, **Holbrook A**, Pierce A, Hoang D, Gillen D. *Attitudes toward Potential Participant Registries*. Journal of Alzheimer's Disease, vol. 56, no. 3, pp. 939-946, 2017.

### Ph.D. Students

1. Erica Su, Postdoctoral Scholar, UCLA (Completed 2023), Dissertation Title: *Bayesian Spatial Longitudinal Modeling for Local Rates of Glaucoma Progression*

### Software

- RCPPXSIMD: C++ header-only library files provide modern, portable C++ wrappers for SIMD intrinsics and parallelized, optimized math implementations (SSE, AVX, NEON, AVX512). By placing this library in our R package, we offer an efficient distribution system for Xsimd through CRAN (<https://cran.r-project.org/package=RcppXsimd>).
- MASSIVEMDS: Open-source, high-performance computing software enables Bayesian multidimensional scaling with GPU and vectorized/multi-core CPU. Available as R package, standalone C++ library or with Java API (<https://github.com/suchard-group/MassiveMDS>).
- HPHAWKES: Open-source, high-performance computing software enables Bayesian inference for the Hawkes process with GPU and vectorized/multi-core CPU. Available as R package, standalone C++ library or with Java API (<https://github.com/suchard-group/hawkes>).

### Invited Talks

22. NASA Jet Propulsion Laboratory, Uncertainty Quantification and Statistical Analysis Group, "MCMC with Multiple Proposals" (Pasadena, CA; Nov 2023)
21. University of Minnesota, Institute for Research in Statistics and its Applications conference *The Fast and the Curious: Modern Markov Chain Monte Carlo*, "MCMC with Multiple Proposals" (Minneapolis, MN; May 2023)
20. phyloseminar.org, "From viral evolution to spatial contagion: a biologically modulated Hawkes model" (Virtual; Aug 2022)
19. ISBA World Meeting 2022, Invited Session, *Recent Advances in Bayesian Functional Analysis, Network Regression and Parallel MCMC*, "A quantum parallel Markov chain Monte Carlo" (Montréal, CA; Jun 2022)
18. EcoSta 2022, Organized Invited Session, *Advances in High-Dimensional Sampling Methods*, "A quantum parallel Markov chain Monte Carlo" (Kyoto, JP; Jun 2022)
17. AMS Western Sectional Meeting, Special Session, *Mathematical Advances in Bayesian Statistical Inversion and Markov Chain Monte Carlo Sampling Algorithms*, "A quantum parallel Markov chain Monte Carlo" (Virtual; May 2022)
16. University of California, Irvine, Department of Statistics, "A quantum parallel Markov chain Monte Carlo" (Irvine, CA; Apr 2022)
15. Foxconn Quantum Computing Center, "A quantum parallel Markov chain Monte Carlo" (Taipei City, TW; Mar 2022)
14. Yale University, Department of Biostatistics, "Three challenges for spatiotemporal Hawkes modeling" (New Haven, CT; Sept 2021)
13. King Abdullah University of Science and Technology, Department of Biostatistics, "Three challenges for spatiotemporal Hawkes modeling" (Thuwal, KSA; Sept 2021)
12. Arizona State University, School of Mathematical and Statistical Sciences, "Three challenges for spatiotemporal Hawkes modeling" (Tempe, AZ; Sept 2021)
11. JSM 2021, Invited Paper Session, *Geometry and Bayes: Better Together*, "A simple MCMC algorithm that chooses from multiple proposals at each step" (Virtual; Aug 2021)
10. Instituto de Ciencias Matemáticas (ICMAT), "From viral evolution to spatial contagion: a biologically modulated Hawkes model" (Madrid, ES; June 2021)
9. Bayesian Inference in Stochastic Processes (BISP12), "From viral evolution to spatial contagion: a biologically modulated Hawkes model" (Virtual; May 2021)

8. University of California, Los Angeles, Department of Mathematics, Applied Math Colloquium, "From viral evolution to spatial contagion: a biologically modulated Hawkes model" (Los Angeles, CA; Mar 2021)
7. University of California, Los Angeles, Department of Statistics, "Bayesian modeling of global viral diffusions at scale" (Los Angeles, CA; Dec 2020)
6. Tulane University, Department of Mathematics, "Bayes in the time of Big Data" (New Orleans, LA; Nov 2020)
5. University of California, San Francisco, Department of Epidemiology and Biostatistics, "Bayesian modeling of global viral diffusions at scale" (San Francisco, CA; Nov 2020)
4. University of Auckland, Department of Statistics, Bayesian Research Group, "Bayes in the time of Big Data" (Auckland, NZ; Nov 2020)
3. Johns Hopkins University, Department of Biostatistics, Bayesian Learning and Spatial Temporal modeling (BLAST) working group, "Bayes in the time of Big Data" (Baltimore, MD; Oct 2020)
2. JSM 2019, Savage Award Session, "Excerpts from *Geometric Bayes*" (Denver, CO; Aug 2019)
1. Statistical Methods in Imaging, "Evaluating the ANTs longitudinal cortical thickness pipeline" (Irvine, CA; Jun 2019)

## Teaching

- *Bayes Theory* (Biostats 202C); Fall 2022; Department of Biostatistics, UCLA
- *Stochastic Processes* (Biostats 270); Spring 2022, Spring 2023; Department of Biostatistics, UCLA
- *Advanced Bayesian Computing* (Biostats 285); Spring 2021, Spring 2022; Department of Biostatistics, UCLA
- *Introduction to Probability and Statistics* (Stat 7); Fall 2014, Summer 2015; Department of Statistics, UC Irvine
- *Biostatistics* (Stat 8); Winter 2015; Department of Statistics, UC Irvine
- *Mathematics*; 2010-2011; Dalian American International School
- *English as a Second Language*; 2010-2011; Dalian American International School

## Professional Experience

- Postdoctoral scholar with Prof. Marc A. Suchard, M.D., Ph.D. at the Department of Human Genetics, University of California, Los Angeles; Los Angeles, California (2018-2020)
- Statistical consultant, the Alzheimer's Disease Research Center at the University of California, Irvine; Irvine, California (2015-2017)
- Statistical consultant, the Center for Statistical Consulting at the University of California, Irvine; Irvine, California (Winter and Spring 2014)
- Trainee, the Summer Institute for Training in Biostatistics at North Carolina State University and the Duke Clinical Research Institute; Raleigh, North Carolina (Summer 2013)
- Teacher, the Dalian American International School; Dalian, People's Republic of China (2010-2011)

## Service and Community Involvement

- UC-HBCU Initiative Faculty Mentor (2022)
- Member, Faculty Search Committee, UCLA Department of Biostatistics (2023-2024)
- Member, Master of Data Science in Health Executive Committee, UCLA Fielding School of Public Health (2023-present)
- Member, Education Policy and Curriculum Committee, UCLA Fielding School of Public Health (2023-2025)
- Chair, ISBA World Meeting 2022, session *Sampling state-of-the-arts in Bayesian computation for large-scale applications*
- NSF panelist, Division of Mathematical Sciences (2022-2023) ( $\times 3$ )
- Lead organizer, *Conference on philosophy of machine learning: knowledge and causality*. March 17-18, 2018 at the University of California, Irvine
- Member, American Statistical Association (2018-present)
- Member, International Society for Bayesian Analysis (2020-present)

**Journal Reviewer**

AISTATS

Alzheimer's & Dementia: The Journal of the Alzheimer's Association ( $\times 2$ )

Annals of Applied Statistics ( $\times 2$ )

Applied Mathematics and Computation

Bayesian Analysis ( $\times 3$ )

IEEE Transactions on Artificial Intelligence

IEEE Transactions on Industrial Electronics

Journal of Computational and Graphical Statistics ( $\times 2$ )

Journal of Machine Learning Research

Journal of the American Statistical Association

PLOS Computational Biology

Scandinavian Journal of Statistics

SIAM Journal on Matrix Analysis and Applications

Statistics and Computing ( $\times 4$ )

Technometrics

WIREs Computational Statistics