

Curtis McDonald

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Research Interests

I work on the design and analysis of randomized algorithms for Bayesian computation: when these algorithms succeed, via mixing times for MCMC and error control for diffusion models, and whether their output is any good, via generalization risk bounds for the estimators they produce.

Keywords: MCMC and sampling algorithms; diffusion models; Bayesian computation; PAC-Bayes and generalization; statistical learning theory; stochastic control and filtering.

Academic Appointments

Simons Institute, UC Berkeley, Berkeley, CA

September 2025–

Machine Learning Pod

Postdoctoral Researcher

Hosted by Peter Bartlett and Bin Yu

- Deriving an exact score representation theory for reward-tilted densities, enabling a single pretrained diffusion model to sample discrete distributions across a continuum of tilt strengths without retraining, with empirical solution rates matching theory.
- Establishing a split-budget theory for score estimation, distributing a fixed query budget across multiple locations and pooling via ridge regression to recover non-trivial terminal W_2 and KL control even when the base score estimator degrades substantially.
- Contributing statistical and probabilistic analysis to AI safety research, including published work on capability emergence in grokking and ongoing work on diffusion models for adversarial prompting in large language models.

Education

Yale University, New Haven, CT

May 2025

Ph.D. in Statistics and Data Science

Advisor: Andrew Barron

Francis J. Anscombe award for outstanding academic performance

Thesis: “Computation and Estimation for Neural Networks via
Log-Concave Coupling”

Queen’s University, Kingston, ON

November 2019

M.A.Sc. in Applied Mathematics and Engineering

Advisor: Serdar Yüksel

Thesis: “Filter Stability, Observability and Robustness for
Partially Observed Stochastic Dynamical Systems”

Queen’s University, Kingston, ON

June 2017

B.A.Sc. in Applied Mathematics and Engineering

Specialisation in Computing and Communications

Thesis: “Decentralized Learning for Power Grid Control”

Publications

Pre-Prints

- **C. McDonald**, *Technical note on relating scores of tilted distributions*. Preprint (2026), [arXiv]

Journal Articles

- **McDonald, C.**, Barron, A. “*Rapid Bayesian Computation and Estimation for Neural Networks via Log-Concave Coupling*”. Math. Stat. Learn. (2026). published online first. DOI 10.4171/MSL/59[Link]
- **McDonald, C.**, Yüksel, S. “*Stochastic Observability and Filter Stability under Several Criteria*”. IEEE Trans. Automatic Control. vol. 69, no. 5, pp. 2931-2946, May 2024. [Link]
- **McDonald, C.**, Yüksel, S. “*Robustness to incorrect priors and controlled filter stability in partially observed stochastic control*”. SIAM Journal on Control and Optimization. vol 60, issue 2 . April 2022. [Link] [arXiv]
- **McDonald, C.**, Yüksel, S. “*Exponential filter stability via Dobrushin’s coefficient*”. Electronic Communications in Probability. vol 25, pp. 1-13. August 2020. [Link]
- **McDonald, C.**, Alajaji, F., Yüksel, S. “*Two-Way Gaussian Networks with a Jammer and Decentralized Control*”. IEEE Transactions on Control of Network Systems. vol. 7, no. 1, pp. 446-457, March 2020. [Link]

Conference Papers

- **McDonald, C.**, Barron, A. (2024) “*Log-Concave Coupling for Sampling Neural Net Posteriors*”. 2024 IEEE International Symposium on Information Theory (ISIT). pp 2251-2256. [Link]
- **McDonald, C.**, Yüksel, S. (2019) “*Observability and Filter Stability for Partially Observed Markov Processes*”. 2019 IEEE 58th Conference on Decision and Control (CDC). pp. 1623-1628. [Link]
- **McDonald, C.**, Yüksel, S. (2018) “*Stability of Non-Linear Filters, Observability and Relative Entropy*”. 2018 56th Annual Allerton Conference on Communication, Control, and Computing (Allerton). pp 110 - 114. [Link]
- **McDonald, C.**, Alajaji, F., Yüksel, S. (2018) “*Two-Way Gaussian Channels with an Intelligent Jammer*”. 2018 Annual American Control Conference (ACC). pp. 1784- 1789. [Link]

Workshop Papers

- Dern, N., Mazioud, S., Heiss, J., Ghosh, A., **McDonald, C.**, Clara, G., Yu, B. (2026) “*Tracking Training Phases in Compositional Learning with Task-Agnostic Measures*”. CompLearn 2026 Workshop at the International Conference on Machine Learning (ICML). [Link]
- **McDonald, C.**, Barron, A. (2022) “*Proposal of a Score Based Approach to Sampling Using Monte Carlo Estimation of Score and Oracle Access to Target Density*”. NeurIPS 2022 Conference Workshop on Score Based Methods. [Link]

Interdisciplinary Collaborations

- Sieberer J. M., Park N., Manafzadeh A. R., Desroches S. T., Brennan K., **McDonald C.**, Tommasini S. M., Wiznia D. H., Fulkerson J. P. “*Visualization of Trochlear Dysplasia Using 3-Dimensional Curvature Analysis in Patients With Patellar Instability Facilitates Understanding and Improves the Reliability of the Entry Point to Trochlea Groove Angle*”. Arthroscopy, Sports Medicine, and Rehabilitation. September, 2024. [Link]
- Sieberer J. M., Park N., Rancu A. L., Desroches S. T., **McDonald C.**, Manafzadeh A. R., Tommasini S. M., Wiznia D. H., Fulkerson J. P. “*Analyzing Alignment Error in Tibial Tuberosity–Trochlear Groove Distance in Clinical Scans Using 2D and 3D Methods*”. The American Journal of Sports Medicine. September, 2024. [Link]
- Beitler B. G., Sieberer J., Islam W., **McDonald C.**, Yu K., Tommasini S. M., Fulkerson J. P. “*The Morphologic Patella Entry Point Into The Proximal Trochlea Is More Lateral in Recurrent Dislocators Than Controls as Measured by Entry Point-Trochlear Groove Angle*”. Arthroscopy: The Journal of Arthroscopic and Related Surgery. May, 2024. [Link]
- Kim, J., **McDonald, C.**, Meosky, P., Katsaros, M., Tyler, T. “*Promoting Online Civility Through Platform Architecture*”. Journal of Online Trust and Safety. vol 1, issue 4. September 2022. [Link]
- Kumar N., Corpus I., Hans M., Harle N., Yang N., **McDonald C.**, Nakamura Sakai S., Janmohamed K., Chen K., Altice F. L., Tang W., Schwartz J. L., Jones-Jang S. M., Saha K., Memon S. A., Bauch C. T., Choudhury M. D., Papakyriakopoulos O., Tucker J. D., Goyal A., Tyagi A., Khoshnood K., Omer S. “*COVID-19 vaccine perceptions in the initial phases of US vaccine roll-out: an observational study on reddit*”. BMC Public Health. vol 22, issue 1, March 2022. [Link]

Dissertations

- McDonald, Curtis James. “*Computation and Estimation for Neural Networks via Log-Concave Coupling*”. Diss. Yale University (USA), 2025.[Link]
- Mcdonald, Curtis James. “*Filter Stability, Observability and Robustness for Partially Observed Stochastic Dynamical Systems*”. Diss. Queen’s University (Canada), 2019. [Link]

Presentations

Conference Talks

ISIT , Athens, Greece <i>Log-Concave Coupling for Sampling Neural Net Posteriors</i>	July 2024
CDC , Nice, France <i>Observability and Filter Stability for Partially Observed Markov Processes</i>	December 2019
Allerton , Monticello, IL <i>Stability of Non-Linear Filters, Observability and Relative Entropy</i>	October 2018
ACC , Milwaukee, WI <i>Two-Way Gaussian Channels with an Intelligent Jammer</i>	June 2018

Department Seminars

Machine Learning Theory Seminar , UC Berkeley <i>Tilted Diffusion for Discrete Densities: Exploiting Symmetries of the Hypercube</i>	August 2026
Machine Learning Group Research Talk , UC Berkeley <i>SGD and Auxiliary Random Variable MCMC: Similarities and Differences</i>	November 2025
Statistics Student Seminar , UC Berkeley <i>Log-Concave Coupling: A Method for Bayesian Estimation and Computation in Single Hidden Layer Neural Networks</i>	September 2025
Meet the Fellows , Simons Institute, UC Berkeley <i>Sampling Algorithms for Machine Learning with Auxiliary Random Variables and Diffusion Models</i>	September 2025
Yu Group Meeting , UC Berkeley <i>Diffusion Models for Inference</i>	September 2025
Stochastic Control (and Related Fields) Seminar , Queen's University <i>Log-Concave Coupling for Rapid Bayesian Neural Network Sampling</i>	September 2024
Theory Students Lunch , Yale University <i>Computing Score Based Diffusion Via Log-Concave Sampling</i>	February 2024
Optimization, Sampling, and Games Reading Group , Yale University <i>Optimal Transport Gradient Descent Problem</i>	October 2023
Stochastic Control (and Related Fields) Seminar , Queen's University <i>Score Based Diffusion as a Density Evolution Method</i>	March 2023
Statistics Student Research Seminar , Yale University <i>Markov Chain Monte Carlo and Modern Problems</i>	February 2022
Stochastic Control (and Related Fields) Seminar , Queen's University <i>Utilizing the Bakry-Emery Condition in Markov Chain Monte Carlo</i>	July 2021
Statistics Students Research Seminar , Yale University	July 2020

A Geometric Approach to Single Layer Neural Nets

Yüksel Research Group Meeting, Queen's University

April 2019

Hilbert Metric, Dobrushin Coefficient, and Kernel Operators as Contraction Mappings

Yüksel Research Group Meeting, Queen's University

September 2018

Stability of Non-Linear Filters, Observability and Relative Entropy

Posters

NeurIPS Workshop on Score Based Methods

December 2022

Proposal of a Score Based Approach to Sampling Using Monte Carlo Estimation of Score and Oracle Access to Target Density

Teaching Experience

University of California, Berkeley

Lecturer, Department of Statistics

Summer 2026

STAT 20: Introduction to Probability and Statistics — Instructor of Record, 50 students

- Delivered 9 hours per week of in-person content over an 8-week session, covering probability, hypothesis testing, linear regression, and data summary and visualization in R.
- Taught in the department's flipped-classroom format, with live coding demonstrations, group problem solving, and in-class work sessions with active instructor feedback.
- Rewrote the three-lecture series on introduction to probability theory, restructuring axioms and set theory, uniform densities and combinatorics, and PMFs and density functions into a single coherent arc.
- Wrote all in-class examinations; managed the course website, assignment schedule, and grade administration; supervised and coordinated a staff of 6 tutors and graders.
- Taught a cohort spanning first-year, transfer, visiting international, and concurrently enrolled high school students, supporting widely varying quantitative preparation through office hours and individual follow-up after low quiz and lab performance.

Yale University

Teaching Fellow, Department of Statistics and Data Science

2020–2025

S&DS 364	Information Theory	Spring 2024, Spring 2025
S&DS 238	Probability and Bayesian Statistics	Fall 2024
S&DS 312	Linear Models	Fall 2021, Fall 2022
S&DS 351	Stochastic Processes	Spring 2022
S&DS 365	Applied Data Mining and Machine Learning	Spring 2021
S&DS 242	Theory of Statistics	Spring 2020

- Led weekly discussion sections and office hours across 8 course offerings spanning introductory theory, applied machine learning, and graduate probability.
- Graded problem sets and contributed to problem set design and course materials.

- Supported the department’s transition to online and hybrid instruction (2020–2021).

Queen’s University

Teaching Assistant, Faculty of Engineering and Applied Science 2015–2019

- Led tutorials and graded for undergraduate courses in calculus, linear algebra, functional analysis, and complex analysis.
- Delivered all lectures and coordinated instruction for a 300-student calculus course during a two-week instructor leave of absence.

Teaching Interests

Prepared to Teach: Probability, statistics, stochastic processes, optimization, machine learning.

Prepared to Develop: Graduate topics courses in Markov chain Monte Carlo, sampling algorithms, and the mathematical foundations of diffusion models.

Fellowships and Awards

Francis J. Anscombe Award	Yale University	Academic Award	2025
NSERC Postgraduate Scholarship – Doctoral	Yale University	\$63,000	2019–2021
Nominee, Teaching Assistant Excellence Award	Queen’s University	Teaching Award	2018
Alexander G. Bell Canada Graduate Scholarship	Queen’s University	\$17,500	2018
Queen Elizabeth II Scholarship in Science and Technology	Queen’s University	\$15,000	2017
NSERC Undergraduate Summer Research Award	Queen’s University	\$4,500	2016–2017

Professional Service

Review Duties

Grant Review

German Research Foundation (DFG) 2026

Journal Refereeing

IEEE Transactions on Automatic Control	2024–2026
IEEE Transactions on Control of Network Systems	2023, 2024
Mathematics of Operations Research	2024, 2026
Foundations of Data Science	2021

Conference Refereeing

IEEE Conference on Decision and Control (CDC) 2025, 2026

American Control Conference (ACC)	2024, 2026
IEEE International Symposium on Information Theory (ISIT)	2024, 2025

Service

Organizer , Machine Learning Theory Reading Group <i>Simons Institute, UC Berkeley</i>	Spring, Fall 2026
Organizing Committee , Workshop Honoring Andrew Barron: Forty Years at the Interplay of Information Theory, Probability and Statistical Learning <i>Yale Institute for Foundations of Data Science</i>	April 2024
Poster Selection Committee , Recent Advances and Future Directions for Sampling <i>Yale Institute for Foundations of Data Science</i>	October 2024
Graduate Recruitment Host , Admitted Students Visit Days <i>Department of Statistics and Data Science, Yale University</i>	2021–2024
Student Social Organizer <i>Department of Statistics and Data Science, Yale University</i>	2020–2025