

Citizenship: Canada, Netherlands

CONTACT
INFORMATION

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EDUCATION AND
ACADEMIC POSITIONS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY 2016-present
Postdoctoral Associate, Computer Science and Artificial Intelligence Laboratory (CSAIL)
Supervisor: Professor Tamara Broderick
Research Focus: Bayesian nonparametrics; exchangeability; streaming, distributed inference

MASSACHUSETTS INSTITUTE OF TECHNOLOGY 2013-2016
Doctor of Philosophy (Ph.D.), Machine Learning and Statistics
Laboratory for Information and Decision Systems (LIDS)
Supervisor: Professor Jonathan P. How
Thesis Title: Truncated Bayesian Nonparametrics
Cumulative GPA: 5.0/5.0

MASSACHUSETTS INSTITUTE OF TECHNOLOGY 2011-2013
Master of Science (S.M.), Aeronautics and Astronautics
Laboratory for Information and Decision Systems (LIDS)
Supervisor: Professor Jonathan P. How
Thesis Title: Multiagent Planning with Bayesian Nonparametric Asymptotics
Cumulative GPA: 5.0/5.0

UNIVERSITY OF TORONTO 2007-2011
Bachelor of Applied Science (B.A.Sc.), Engineering Science, Honours with High Distinction
Major in Aerospace Engineering
Cumulative GPA: 3.93/4.0

RESEARCH
INTERESTS

BAYESIAN NONPARAMETRICS

Bayesian nonparametric models—those with infinitely many latent parameters—uniquely possess the flexibility to capture the unknown latent complexity underlying many data sets. They are particularly well-suited to streaming data, where the complexity grows with the amount of observed data. However, having infinitely many latent parameters presents numerous challenges in the development, study, and application of Bayesian nonparametrics. I seek to make Bayesian nonparametrics more widely applicable and practical by developing new models and approximations with quality guarantees, understanding the properties of those that exist at a deeper level, and providing tractable approximate inference procedures. My past work in this area has provided approximate representations of nonparametric priors and corresponding error analyses, new exchangeable combinatorial structures and characterizations thereof, and sparse nonparametric network models.

STREAMING, DISTRIBUTED BAYESIAN INFERENCE

Persistent, distributed data streams—to which Bayesian nonparametrics are naturally suited—are ubiquitous. I seek to tractably learn abstract, high-level representations of such data streams in a Bayesian framework. A key challenge is that the complexity of inference algorithms for persistent data streams can not depend on the amount of observed data; this implies data summarization is necessary. My past work in this area has occurred on two fronts: I have developed data summarization techniques for Bayesian inference with both complexity and approximation quality guarantees, and addressed the combinatorial issues associated with summarization of streaming, distributed data in the context of Bayesian nonparametrics.

OPTIMIZATION

Underpinning much of my research, especially my work on Bayesian inference, are optimization methods. Although generally a secondary research focus, my work often involves theory and algorithms from many different subfields of optimization—including convex, combinatorial, and variational optimization—and has in the past provided some novel developments in global and robust optimization.

PUBLICATIONS

REFEREED PUBLICATIONS

- **T. Campbell***, J. Straub*, J. P. How, J. W. Fisher III. “Efficient global point cloud alignment using Bayesian nonparametric mixtures”. IEEE Conference on Computer Vision and Pattern Recognition, 2017. (**spotlight, 10% acceptance**)
- J. Huggins, **T. Campbell**, T. Broderick. “Coresets for scalable Bayesian logistic regression”. Advances in Neural Information Processing Systems, 2016 (**22% acceptance**).

- D. Cai, **T. Campbell**, T. Broderick. “Edge-exchangeable graphs and sparsity.” Advances in Neural Information Processing Systems, 2016 (**22% acceptance**).
- **T. Campbell**, J. Straub, J. W. Fisher III, and J. P. How. “Streaming, massively parallel variational inference for Bayesian nonparametrics”. Advances in Neural Information Processing Systems, 2015 (**22% acceptance**).
- J. Straub, **T. Campbell**, J. P. How and J. W. Fisher III. “Small-variance nonparametric clustering on the hypersphere”. IEEE Conference on Computer Vision and Pattern Recognition, 2015. (**oral, 3% acceptance**)
- **T. Campbell** and J. P. How. “Bayesian nonparametric set construction for robust optimization”. American Control Conference, 2015.
- **T. Campbell** and J. P. How. “Approximate decentralized Bayesian inference”. Uncertainty in Artificial Intelligence, 2014. (**32% acceptance**)
- **T. Campbell**, M. Liu, B. Kulis, L. Carin and J. P. How. “Dynamic clustering via asymptotics of the dependent Dirichlet process mixture”. Advances in Neural Information Processing Systems, 2013. (**25% acceptance**)
- **T. Campbell**, L. Johnson and J. P. How. “Multiagent allocation of Markov decision process tasks”. American Control Conference, 2013.
- **T. Campbell**, R. H. Klein, A. Geramifard and J. P. How. “Simultaneous clustering on representation expansion for learning multimodel MDPs”. Reinforcement Learning and Decision Making, 2013.

SUBMITTED FOR REVIEW

- **T. Campbell**, D. Cai, T. Broderick. “Exchangeable trait allocations”. Available at arXiv:1609.09147.
- **T. Campbell***, J. Huggins*, J. How, T. Broderick. “Truncated Random Measures”. Available at arXiv:1603.00861.
- **T. Campbell**, B. Kulis and J. P. How. “Dynamic Clustering Algorithms via Small-Variance Analysis of the Markov Dependent Dirichlet Process”. 2016 (submitted).

BOOK REVIEWS

- **T. Campbell**, T. Broderick. Review of “Handbook of mixed membership models and their applications”. Book Reviews, Journal of the American Statistical Association, 111:516, 1840–1851, 2016.

IN THE NEWS

- Research featured on the MIT front page in July 2014. “Collaborative Learning – for Robots”. Online: <http://newsoffice.mit.edu/2014/collaborative-learning-for-robots-0625>
- Research covered by Popular Science in July 2014: “Collaborative Algorithm Lets Autonomous Robots Team Up and Learn From Each Other”. Online: <http://www.popsci.com/blog-network/zero-moment/collaborative-algorithm-lets-autonomous-robots-team-and-learn-each-other>

HONORS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

- 2016 SBSS Student Paper Award
- 2012 GNC Best Presentation in Session
- 2011 Natural Science and Engineering Research Council of Canada PGS-M Research Fellowship

UNIVERSITY OF TORONTO

- 2011 James D. Todd Memorial Scholarship
- 2010 Kenneth Sullivan / Pratt Whitney Canada Scholarship
- 2009 Natural Science and Engineering Research Council of Canada Undergraduate Summer Research Award
- 2008 Engineering Science Research Opportunity Program Scholarship
- 2007 Faculty of Applied Science and Engineering Admissions Scholarship

PROFESSIONAL SERVICE

REVIEWER

- Neural Information Processing Systems (NIPS)
- Artificial Intelligence and Statistics (AISTATS)
- International Conference on Machine Learning (ICML)
- Journal of Neurocomputing
- Journal of Aerospace Information Systems (JAIS)
- American Controls Conference (ACC)
- AIAA Conference on Guidance, Navigation and Control (GNC)
- International Conference on Intelligent Robots and Systems (IROS)

PROGRAM & ORGANIZING COMMITTEES

- NIPS 2016 Workshop on Advances in Approximate Bayesian Inference
- NIPS 2016 Workshop on Practical Bayesian Nonparametrics
- NIPS 2015 Workshop on Advances in Approximate Bayesian Inference
- NIPS 2015 Workshop on Bayesian Nonparametrics: The Next Generation

AWARD COMMITTEES

- 2017 SBSS Student Paper Award Committee

PREVIOUS RESEARCH EXPERIENCE

MASSACHUSETTS INSTITUTE OF TECHNOLOGY 2011-2016

Doctoral Research

Supervisor: Professor Jonathan P. How

Research focused on statistical inference and approximations for Bayesian nonparametric models with streaming, distributed data. Major research contributions include truncated approximations for normalized and unnormalized completely random measures, approximate variational techniques for both parametric and nonparametric streaming, distributed inference, fast low-variance asymptotic Bayesian nonparametric clustering algorithms, and statistically-designed uncertainty sets for robust linear optimization.

UNIVERSITY OF TORONTO INSTITUTE FOR AEROSPACE STUDIES

Spring 2011

Undergraduate Thesis Research

Supervisor: Professor Phillippe Lavoie

Research focused on dielectric barrier discharge plasma actuators for flow control over airfoils. Created computational engine for simulating the creation, absorption and transport processes of the plasma that occurs around the actuators. Developed a new initial condition for plasma actuator simulations based on solutions of the Laplace equation on a rectangular domain, with a focus on optimizing the relaxation time of such simulations.

UNIVERSITY OF TORONTO INSTITUTE FOR AEROSPACE STUDIES

Summer 2009

Summer Research Project

Supervisor: Professor Timothy Barfoot

Research focused on the use of LiDAR intensity images for lighting-invariant vision-based localization in mobile robotics. Created a 3D odometry package for the research group using data from wheel odometry sensors and an inertial measurement unit. Ran experiments in decentralized state estimation of groups of robots, laser ranger point cloud stitching, and optimization of next viewpoint for environment mapping.

UNIVERSITY OF TORONTO DEPARTMENT OF PHYSICS

Summer 2008

Summer Research Project

Supervisor: Professor Henry van Driel

Research focused on surface plasmon polaritons on gold and silver surface gratings. Programmed a finite difference time domain computational simulation engine for Maxwell's equations in 2D environments.

TEACHING EXPERIENCE

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

- Spring 2017 – 6.882 Bayesian Modeling and Inference

OTHER RELEVANT EXPERIENCE

PDT PARTNERS, LLC

Summer 2015

Summer Research Associate

Conducted quantitative market research.

HILL & SCHUMACHER PATENT & TRADEMARK AGENTS

Summers 2010-2011

Assistant Patent Agent

Supervisors: Lynn Schumacher, Ph.D. and Nancy Hill, LL.B.

Performed all aspects of patent prosecution. Under the supervision of two patent agents, met with clients to discuss their inventions, drafted full patent applications, provisionals, divisionals, continuations-in-part, and Patent Cooperation Treaty (PCT) applications for those inventions, and responded to office actions from the government. Performed these duties for Canadian, American, European, and Japanese jurisdictions.

UNIVERSITY OF TORONTO BLUE SKY SOLAR CAR RACING TEAM

2009-2010

Mechanical Systems Co-Director

Designed the suspension system and supervised the design of the braking system, roll cage, wheel rims, and steering system for the solar car.

AER201: ENGINEERING DESIGN

2009

Electrical Systems Designer

Designed and built the electrical system of a candy vending machine robot. The system contained a microprocessor, display, dispenser motors, infrared sensor circuits, and fail-safe battery backup. The system dispensed 4 types of candy and sensed when the correct number had been dispensed.

UNIVERSITY OF TORONTO

2009-2010

Facilitated Learning Group Leader

Ran tutorial sessions in Circuit Analysis (ECE150) and Advanced Computer Programming (CSC192) for students in Engineering Science.

COURSEWORK

Inference and Learning: Fundamentals of Probability Theory, Algorithms for Inference, Theoretical Statistics, Probability and Statistics, Stochastic Estimation

Optimization: Nonlinear Programming, Combinatorial Optimization, Robust Optimization, Scientific Computing

Control and Decision Making: Classical Control Systems, State-Space Control Systems, Principles of Optimal Control, Stochastic Control, Principles of Autonomy and Decision Making

Mathematics: Calculus, Vector Calculus, Ordinary Differential Equations, Partial Differential Equations, Complex Analysis, Real Analysis, Functional Analysis, Linear Algebra, Abstract Algebra

ADDITIONAL
SKILLS

Programming: C/C++ (12 years), Python (5 years), Java (7 years), MATLAB (7 years), L^AT_EX(6 years), SVN/Git (5 years)

Robotics: Electrical design, mechanical design, microcontroller programming, soldering (10 years). Platforms: Pioneer 3-AT, Robosoft RobuROC 6, iRobot Create

Intellectual Property: Drafting patent applications and all other aspects of prosecution, including responding to office actions, for Canada, the United States, Europe, and Japan (2 summers)

REFERENCES

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Director of the Aerospace Controls Laboratory
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BOSTON UNIVERSITY