

# Michael C. Hughes

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## Education

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### Brown University

*Ph.D., Computer Science.*

2016

### Brown University

*M.S., Computer Science.*

2012

### Olin College of Engineering

*B.S. Electrical & Computer Engineering*

2010

## Research Experience

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### Assistant Professor of Computer Science

*Tufts University, Medford, MA*

2018 - present

- Conduct research in statistical machine learning methods and applications to health informatics.
- Advise Ph.D., M.S., and B.S. students in machine learning research projects.
- Teach machine learning courses targeted at advanced undergraduates ([COMP 135 Intro to ML](#)) and graduate students ([COMP 150 Bayesian Deep Learning](#)).

### Postdoctoral fellow: Machine learning to improve clinical decisions in healthcare

*Adviser: [Prof. Finale Doshi-Velez](#) (Harvard)*

2016 - 2018

- Developed semi-supervised models for characterizing and treating depression (with [Dr. Perlis](#) and [Dr. McCoy](#)).
- Applied time-series models to predict ventilator interventions in the ICU for [public dataset](#) of >36,000 patients.
- Created methods for training deep models so they are more interpretable to clinicians or other users.

### Postdoc project: Estimating carbon biomass from LiDAR waveforms

*Adviser: [Prof. Erik Sudderth](#) & [Prof. Jim Kellner](#) (Brown U., Ecology & Evolutionary Biology)* 2016

- Predicted forest biomass from LiDAR waveforms to better understand land use and climate change.
- Modeled waveforms and biomass predictions jointly via nonparametric regression using our [BNPy toolbox](#).
- Intended for use in NASA's upcoming [Global Ecosystem Dynamics Investigation \(GEDI\)](#).

### Ph.D. thesis: [Reliable and scalable variational inference for Bayesian nonparametrics](#)

*Adviser: [Prof. Erik Sudderth](#)*

2016

- Thesis Title: Reliable and scalable variational inference for nonparametric mixtures, topics, and sequences
- Developed optimization algorithms for Bayesian nonparametric models that scale to millions of examples.
- Optimized lower bound on marginal likelihood, thus penalizing too simple and too complex explanations.
- Escaped local optima via data-driven proposals that add useful new clusters and remove redundant ones.
- Applied to topic models of 2 million NY Times articles and sequential models of the whole human genome.
- Implemented algorithms in [open-source package: Bayesian Nonparametrics for Python \(BNPy\)](#).

## Master's project: Sequential Models for Video and Motion Capture

Adviser: *Prof. Erik Sudderth*

2012

- o Developed methods to discover common actions from many videos of humans performing household exercises.
- o Improved existing inference algorithms with data-driven Metropolis-Hastings proposals.

## Highlighted Publications

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1. "[Prediction-Constrained POMDPs](#)." Joseph Futoma, Michael C. Hughes, and Finale Doshi-Velez. Reinforcement Learning under Partial Observability (RLPO) workshop at NeurIPS 2018, 2019.
2. "[Semi-Supervised Prediction-Constrained Topic Models](#)." Michael C. Hughes, Gabriel Hope<sup>d</sup>, Leah Weiner<sup>d</sup>, Thomas H. McCoy Jr, Roy H. Perlis, Erik B. Sudderth, and Finale Doshi-Velez. Artificial Intelligence and Statistics (AISTATS), 2018.
3. "[Beyond Sparsity: Tree Regularization of Deep Models for Interpretability](#)." Mike Wu<sup>u</sup>, Michael C. Hughes, Sonali Parbhoo, Maurizio Zazzi, Volker Roth, and Finale Doshi-Velez. Association for Advancement of Artificial Intelligence (AAAI), 2018.
4. "[From Patches to Images: A Nonparametric Generative Model](#)." Geng Ji<sup>d</sup>, Michael C. Hughes, and Erik B. Sudderth. International Conference on Machine Learning (ICML), 2017.
5. "[Predicting Intervention Onset in the ICU with Switching State Space Models](#)." Marzyeh Ghassemi, Mike Wu<sup>u</sup>, Michael C. Hughes, Peter Szolovits, and Finale Doshi-Velez. AMIA Summit on Clinical Research Informatics, 2017.

Superscripts indicate mentored student's role: u = undergraduate, m = masters, d = doctoral. Complete publication list at end of this document.

## Highlighted Preprints

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1. "[Prediction-Constrained Training for Semi-Supervised Mixture and Topic Models](#)." Michael C. Hughes, Leah Weiner<sup>d</sup>, Gabriel Hope<sup>d</sup>, Thomas H. McCoy, Roy H. Perlis, Erik B. Sudderth, and Finale Doshi-Velez. arXiv e-print, 2017.
2. "[Fast Learning of Clusters and Topics via Sparse Posteriors](#)." Michael C. Hughes and Erik B. Sudderth. arXiv e-print, 2016.
3. "[BNPy: Reliable and scalable variational inference for Bayesian nonparametric models](#)." Michael C. Hughes and Erik B. Sudderth. 3rd NIPS Workshop on Probabilistic Programming, 2014.

## Honors and Awards

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*Top 200 Reviewer Award, [NeurIPS 2018](#)*

2018

- o Recognized as one of top 200 of more than 3500 expert reviewers at the top international machine learning conference.

*Best Paper Award, [SoCal NLP Symposium 2018](#)*

2018

- o Awarded for [2 page summary](#) of our [AISTATS 2018 paper](#).

*Nominee for AMIA Clinical Informatics Research Award*

2017

- o 1 of 7 papers nominated at [AMIA's 2017 Joint Summits on Translational Science](#), out of >50 papers.

*NSF Graduate Research Fellowship Award* 2011  
o Three year award to fund Ph.D. studies. Covers tuition and provides research stipend.

*NDSEG Graduate Research Fellowship Award* 2011  
o Three year funding award. Declined to accept NSF fellowship.

## Professional Service

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*Invited Tutorial* 2018  
o [Machine Learning for Clinicians: Advances for Multi-Modal Health Data](#) at MLHC '18  
o Designed to help clinicians understand enough modern machine learning to collaborate successfully with ML researchers.

*Workshop Organizer* 2018  
o [Machine Learning for Health workshop](#) at NeurIPS '18 (NeurIPS ML4H 2018)  
o Full-day workshop with invited keynotes and accepted papers involving clinicians, statisticians, and computer scientists.  
o Helped with website, PR, and continuity in peer-review process from previous years.

*Workshop Organizer* 2017  
o [Machine Learning for Health workshop](#) at NIPS '17 (NIPS ML4H 2017)  
o Full-day workshop with invited keynotes and panels involving clinicians, statisticians, and computer scientists.  
o Organized peer-review process for 118 submitted papers.

*Workshop Organizer* 2016  
o [Practical Bayesian Nonparametrics workshop](#) at NIPS '16.  
o Full-day workshop with invited speakers, contributed talks, two panel discussions, and lively poster session.  
o Led decisions on >25 submitted papers based on peer review.

*Invited Panelist* 2016  
o Software panel at [Advances in Approximate Bayesian Inference workshop](#) at NIPS '16.

*Program Committee / Reviewer*  
o 2019 - NIPS, AISTATS, ICLR  
o 2018 - NIPS ([reviewer award](#)), AAAI, AISTATS, ICLR, AMIA CRI  
o 2017 - NIPS, ICML, AAAI  
o 2016 - NIPS  
o 2015 - NIPS, ICML  
o 2014 - NIPS, ICML  
o 2013 - NIPS ([reviewer award](#))

## Teaching and Mentorship

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**Tufts CS Dept.**  
*Course:* [COMP 135 Introduction to Machine Learning](#) Spring 2019  
o Taught core principles of machine learning to about 50 students  
o Course format: 3 open-ended projects, weekly homeworks, and 2 exams

## **Tufts CS Dept.**

Course: *COMP 150 Bayesian Deep Learning*

Fall 2018

- Taught advanced topics seminar to about 18 students
- Course format: weekly homeworks for first month, then 2-month open-ended team project

## **Harvard University SEAS**

Research Mentor

2016-2017

- Mentored undergraduate senior thesis projects on Bayesian nonparametric inference.
- Frederick Widjaja. 2017 honors thesis: Streaming Variational Inference for the Indian Buffet Process.
- Madhu Vijay. 2017 honors thesis: Characterizing Posterior Uncertainty for the Indian Buffet Process.

## **Brown University**

Research Mentor

2014-2016

- Mentored students on projects related to Bayesian nonparametric clustering and the BNPy Python package.
- William Stephenson. 2015 undergraduate honors thesis: *Variational Inference for Hierarchical Dirichlet Process based Nonparametric Models*.
- Sonia Phene. 2015 undergraduate honors thesis: *Multiprocessor Parallelization of Variational Inference for Bayesian Nonparametric Topic Models*.
- Mengrui Ni. 2015 masters project: *Variational Inference for Beta-Bernoulli Dirichlet Process Mixture Models*.
- Mert Terzihan. 2015 masters project.

Lead Graduate TA for *CS 142: Intro to Machine Learning*

Fall 2013

- Led weekly 1 hour recitation session to review key concepts for 50+ students.
- Designed homework assignments and exam questions.

## **Outreach Experience**

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### **TEALS and Boston Latin Academy**

Roxbury, MA

Volunteer AP Computer Science Instructor

2014-2016

- Taught 1-2 classes / week for 2 years via *TEALS "CS in every high school"* initiative sponsored by Microsoft.
- Developed hands-on lessons to excite students from diverse backgrounds about computational thinking.
- Mentored full-time teacher Ingrid Roche as she transitioned from media arts to AP computer science (Java).

### **Harvard Humanitarian Initiative**

Cambridge, MA

*Signal Program Fellow*

2014

- Developed prototype detector for common housing structures in sub-Saharan Africa from satellite images.
- Intended for humanitarian oversight of conflict areas where burning structures is common attack pattern.
- Featured in TEDx talk: <https://youtu.be/u719rBw0nwU>

### **Olin College Engineering Discovery**

Needham, MA

Co-Founder and Curriculum Director

2007-2010

- Managed 15 undergrads in developing hands-on lessons for 4th-8th graders.
- Hosted workshops for 30 children to design, build, and launch bottle rockets.
- Pioneered green energy workshop which earned over \$750 in outside funding.

## Industry Experience

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### Google

Software Engineering Intern

Mountain View, CA

Summer 2013

- Improved walking/biking/running classifier using smartphone accelerometer data.
- Led collection of dataset from dozens of individuals for classifier evaluation via custom Android app.

## All Conference Publications (in reverse chronological order, most recent first)

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1. "[Semi-Supervised Prediction-Constrained Topic Models](#)." Michael C. Hughes, Gabriel Hope<sup>d</sup>, Leah Weiner<sup>d</sup>, Thomas H. McCoy Jr, Roy H. Perlis, Erik B. Sudderth, and Finale Doshi-Velez. Artificial Intelligence and Statistics (AISTATS), 2018.
2. "[Beyond Sparsity: Tree Regularization of Deep Models for Interpretability](#)." Mike Wu<sup>u</sup>, Michael C. Hughes, Sonali Parbhoo, Maurizio Zazzi, Volker Roth, and Finale Doshi-Velez. Association for Advancement of Artificial Intelligence (AAAI), 2018.
3. "[From Patches to Images: A Nonparametric Generative Model](#)." Geng Ji<sup>d</sup>, Michael C. Hughes, and Erik B. Sudderth. International Conference on Machine Learning (ICML), 2017.
4. "[Right for the Right Reasons: Training Differentiable Models by Constraining their Explanations](#)." Andrew Slavin Ross<sup>m</sup>, Michael C. Hughes, and Finale Doshi-Velez. International Joint Conference on Artificial Intelligence (IJCAI), 2017.
5. "[Predicting Intervention Onset in the ICU with Switching State Space Models](#)." Marzyeh Ghassemi, Mike Wu<sup>u</sup>, Michael C. Hughes, Peter Szolovits, and Finale Doshi-Velez. AMIA Summit on Clinical Research Informatics, 2017.
6. "[Scalable Adaptation of State Complexity for Nonparametric Hidden Markov Models](#)." Michael C. Hughes, William Stephenson<sup>u</sup>, and Erik B. Sudderth. Neural Information Processing Systems (NIPS), 2015.
7. "[Reliable and Scalable Variational Inference for the Hierarchical Dirichlet Process](#)." Michael C. Hughes, Dae Il Kim, and Erik B. Sudderth. Artificial Intelligence & Statistics (AISTATS), 2015.
8. "[Memoized Online Variational Inference for Dirichlet Process Mixture Models](#)." Michael C. Hughes and Erik B. Sudderth. Neural Information Processing Systems (NIPS), 2013.
9. "[Effective Split-Merge Monte Carlo Methods for Nonparametric Models of Sequential Data](#)." Michael C. Hughes, Emily Fox, and Erik B. Sudderth. Neural Information Processing Systems (NIPS), 2012.
10. "[The Nonparametric Metadata Dependent Relational Model](#)." Dae Il Kim, Michael C. Hughes, and Erik B. Sudderth. International Conference on Machine Learning (ICML), 2012.

## All Journal Publications (in reverse chronological order)

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1. "[Refinery: An Open Source Topic Modeling Web Platform](#)." Daeil Kim, Benjamin F. Swanson, Michael C. Hughes, and Erik B. Sudderth. JMLR Machine Learning Open Source Software (MLOSS), 2017.
2. "[Joint Modeling of Multiple Time Series via the Beta Process with Application to Motion Capture Segmentation](#)." Emily Fox, Michael C. Hughes, Erik B. Sudderth, and Michael I. Jordan. Annals of Applied Statistics, Vol. 8(3), 2014.

## All Workshop Papers (in reverse chronological order)

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1. "[Prediction-Constrained POMDPs](#)." Joseph Futoma, Michael C. Hughes, and Finale Doshi-Velez. Reinforcement Learning under Partial Observability (RLPO) workshop at NeurIPS 2018, 2019.
2. "[Rethinking clinical prediction: Why machine learning must consider year of care and feature aggregation](#)." Bret Nestor, Matthew B. A. McDermott, Geeticka Chauhan, Tristan Naumann, Michael C. Hughes, Anna Goldenberg, Marzyeh Ghassemi. Machine Learning for Healthcare (ML4H) workshop at NeurIPS 2018, 2019.
3. "[Prediction-Constrained Topic Models for Antidepressant Prediction](#)." Michael C. Hughes, Gabriel Hope<sup>d</sup>, Leah Weiner<sup>d</sup>, Thomas H. McCoy, Roy H. Perlis, Erik B. Sudderth, and Finale Doshi-Velez. NIPS Workshop on Machine Learning for Health (NIPS ML4H), 2017.
4. "[Associations between aboveground forest biomass and waveform LiDAR metrics: implications for modeling footprint-level biomass using Global Ecosystem Dynamics Investigation data](#)." J. Kellner, J. B. Blair, L. Duncanson, L., S. Hancock, M. A. Hofton, M. C. Hughes, S. Marselis, S., J. Armston, E. B. Sudderth, H. Tang, L. Weiner<sup>d</sup>, and R. Dubayah. American Geophysical Union, Fall General Assembly, 2016.
5. "[Supervised topic models for clinical interpretability](#)." Michael C. Hughes, Huseyin Melih Elibol, Thomas McCoy, Roy Perlis, and Finale Doshi-Velez. NIPS Workshop on Machine Learning for Health (NIPS ML4H), 2016.
6. "[Nonparametric Discovery of Activity Patterns from Video Collections](#)." Michael C. Hughes and Erik B. Sudderth. CVPR Workshop on Perceptual Organization in Computer Vision (POCV), 2012.