Michael C. Hughes

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Education

Brown University
Ph.D. and M.S., Computer Science.   *2016*

Olin College of Engineering
B.S. Electrical & Computer Engineering   *2010*

Research Experience

Postdoctoral fellow: Machine learning to improve clinical decisions in healthcare
Adviser: Prof. Finale Doshi-Velez (Harvard)   *2016 - present*
- 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 inference for Bayesian nonparametric clustering
Adviser: Prof. Erik Sudderth   *2016*
- Developed variational optimization algorithms that scale to millions of examples and hundreds of clusters.
- 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*
- Developed methods to discover common actions from many videos of humans performing household exercises.
- Improved existing inference algorithms with data-driven Metropolis-Hastings proposals.

Honors and Awards

Nominee for AMIA Clinical Informatics Research Award   *2017*
- 1 of 7 papers nominated at AMIA's 2017 Joint Summits on Translational Science, out of >50 papers.

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

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

Highlighted Publications

1. "Beyond Sparsity: Tree Regularization of Deep Models for Interpretability." Mike Wu[u], Michael C. Hughes, Sonali Parbhoo, Maurizio Zazzi, Volker Roth, and Finale Doshi-Velez. To appear in Association for Advancement of Artificial Intelligence (AAAI), 2018.
2. "Predicting Intervention Onset in the ICU with Switching State Space Models." Marzyeh Ghassemi, Mike Wu[u], Michael C. Hughes, Peter Szolovits, and Finale Doshi-Velez. AMIA Summit on Clinical Research Informatics, 2017.
3. "Right for the Right Reasons: Training Differentiable Models by Constraining their Explanations." Andrew Slavin Ross[m], Michael C. Hughes, and Finale Doshi-Velez. International Joint Conference on Artificial Intelligence (ICJAI), 2017.
4. "From Patches to Images: A Nonparametric Generative Model." Geng Ji[d], Michael C. Hughes, and Erik B. Sudderth. International Conference on Machine Learning (ICML), 2017.
5. "Scalable Adaptation of State Complexity for Nonparametric Hidden Markov Models." Michael C. Hughes, William Stephenson[u], and Erik B. Sudderth. Neural Information Processing Systems (NIPS), 2015.
6. "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.
7. "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.
8. "Memoized Online Variational Inference for Dirichlet Process Mixture Models." Michael C. Hughes and Erik B. Sudderth. Neural Information Processing Systems (NIPS), 2013.

   Superscripts indicate mentored student's role: u = undergraduate, m = masters, d = doctoral.

Highlighted Preprints

1. "Prediction-Constrained Training for Semi-Supervised Mixture and Topic Models." Michael C. Hughes, Leah Weiner[d], Gabriel Hope[d], Thomas H. McCoy, Jr., 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.

Industry Experience

Google — **Mountain View, CA**
Software Engineering Intern — *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.

Teaching and Mentorship

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

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: http://youtu.be/u7l9rBwOnwU

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).

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.

Professional Service

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

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

Invited Panelist   *2016*
- Software panel at Advances in Approximate Bayesian Inference workshop at NIPS '16.

Program Committee / Reviewer
- 2018 - ICLR, AAAI, AMIA CRI
- 2017 - NIPS, ICML, AAAI
- 2016 - NIPS
- 2015 - NIPS, ICML
- 2014 - NIPS, ICML
- 2013 - NIPS (reviewer award)

All Publications (in chronological order)

1. "Beyond Sparsity: Tree Regularization of Deep Models for Interpretability." Mike Wu[u], Michael C. Hughes, Sonali Parbhoo, Maurizio Zazzi, Volker Roth, and Finale Doshi-Velez. To appear in Association for Advancement of Artificial Intelligence (AAAI), 2018.
2. "Prediction-Constrained Topic Models for Antidepressant Prediction." Michael C. Hughes, Gabriel Hope[d], Leah Weiner[d], Thomas H. McCoy, MD, Roy H. Perlis, MD, Erik B. Sudderth, and Finale Doshi-Velez. NIPS Workshop on Machine Learning for Health (NIPS ML4H), 2017.
3. "From Patches to Images: A Nonparametric Generative Model." Geng Ji[d], 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[m], Michael C. Hughes, and Finale Doshi-Velez. International Joint Conference on Artificial Intelligence (ICJAI), 2017.
5. "Predicting Intervention Onset in the ICU with Switching State Space Models." Marzyeh Ghassemi, Mike Wu[u], Michael C. Hughes, Peter Szolovits, and Finale Doshi-Velez. AMIA Summit on Clinical Research Informatics, 2017.
6. "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.

7. "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[d], and R. Dubayah. American Geophysical Union, Fall General Assembly, 2016.

8. "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.

9. "Scalable Adaptation of State Complexity for Nonparametric Hidden Markov Models." Michael C. Hughes, William Stephenson[u], and Erik B. Sudderth. Neural Information Processing Systems (NIPS), 2015.

10. "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.

11. "BNPy: Reliable and scalable variational inference for Bayesian nonparametric models." Michael C. Hughes and Erik B. Sudderth. 3rd NIPS Workshop on Probabilistic Programming, 2013.

12. "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.

13. "Memoized Online Variational Inference for Dirichlet Process Mixture Models." Michael C. Hughes and Erik B. Sudderth. Neural Information Processing Systems (NIPS), 2013.

14. "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.

15. "The Nonparametric Metadata Dependent Relational Model." Dae Il Kim, Michael C. Hughes, and Erik B. Sudderth. International Conference on Machine Learning (ICML), 2012.

16. "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.