Michael C. Burkhart

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Research Interests

sequential Bayesian inference • neurodegenerative disease • semi-supervised learning • causal inference

Education

Brown University Providence RI	Ph.D. Applied Mathematics	2013–2019
Rutgers University New Brunswick NJ	M.Sc. Mathematics	2011–2013
Purdue University West Lafayette IN	B.Sc.'s Mathematics, Statistics, & Economics	2007–2011

Experience

University of Cambridge
Cambridge UK

Research Associate 2021–

- developed a mixture of trajectory models to better understand the progression of neurodegenerative disease

Adobe, Inc.
San Jose CA

Machine Learning Scientist 2018–2021

- built and validated predictive models for user segmentation (PySpark/LightGBM)
- supervised intern projects in semi-supervised learning and causal inference (Keras/Tensorflow)

BrainGate Clinical Trial
Providence RI

Doctoral Researcher 2014–2018

- developed and implemented a novel nonlinear filter for online neural decoding (Matlab/Python)
- framework enabled participants with quadriplegia to communicate and interact with their environments in real time using mental imagery alone
- experimented with Bayesian solutions to provide robustness against commonly encountered non-stationarities for online neural decoding

Spotify USA, Inc.
New York NY

Data Research Intern 2017

- implemented online stochastic variational inference for topic models (Latent Dirichlet Allocation & Hierarchical Dirichlet Processes) on playlist data

Argonne National Laboratory
Lemont IL

Graduate Research Aide 2012

- developed and implemented a novel nonlinear filter for online neural decoding (Matlab/Python)
- propagated variance in a multi-step prediction model to better estimate prediction error (Matlab/R)

Journal Articles

M. Burkhart. **Conjugacy conditions for supersoluble complements of an abelian base and a fixed point result for non-coprime actions.** Proceedings of the Edinburgh Mathematical Society (2022)

M. Burkhart. **Discriminative Bayesian filtering lends momentum to the stochastic Newton method for minimizing log-convex functions.** Optimization Letters (2022)

M. Burkhart, D. Brandman, B. Franco, L. Hochberg, & M. Harrison. **The Discriminative Kalman Filter for Bayesian Filtering with Nonlinear and Nongaussian Observation Models.** Neural Computation 32 (2020)

D. Brandman, M. Burkhart, J. Kelemen, B. Franco, M. Harrison, & L. Hochberg. **Robust Closed-Loop Control of a Cursor in a Person with Tetraplegia using Gaussian Process Regression.** Neural Computation 30 (2018)

D. Brandman, T. Hosman, J. Saab, M. Burkhart, B. Shanahan, J. Ciancibello, et al. **Rapid calibration of an intracortical brain computer interface for people with tetraplegia.** Journal of Neural Engineering 15 (2018)

M. Burkhart, Y. Heo, & V. Zavala. **Measurement and verification of building systems under uncertain data: A Gaussian process modeling approach.** Energy and Buildings 75 (2014)

Conference Proceedings

M. Burkhart & G. Ruiz. **Neuroevolutionary Feature Representations for Causal Inference.** Computational Science – ICCS 2022

M. Burkhart. **Discriminative Bayesian Filtering for the Semi-supervised Augmentation of Sequential Observation Data.** Computational Science – ICCS 2021

M. Burkhart & K. Shan. **Deep Low-Density Separation for Semi-supervised Classification.** Computational Science – ICCS 2020

M. Burkhart & K. Modarresi. **Adaptive Objective Functions and Distance Metrics for Recommendation Systems.** Computational Science – ICCS 2019

Dissertation

M. Burkhart. "A Discriminative Approach to Bayesian Filtering with Applications to Human Neural Decoding." Ph.D. Dissertation, Brown University, Division of Applied Mathematics (2019)

Patents Pending

M. Burkhart & G. Ruiz. **Causal Inference via Neuroevolutionary Selection.** Filed 2022

M. Burkhart & K. Shan. **User Classification from Data via Deep Segmentation for Semi-supervised Learning.** U.S. Patent Application #16/681,239. Filed 2019. Published as US 2021/0142152 A1. Granted 2022 as US 11,455,518 B2

M. Burkhart & K. Modarresi. **Digital Experience Enhancement using an Ensemble Deep Learning Model.** U.S. Patent Application #16/375,627. Filed 2019. Published as US 2020/0320382 A1

Teaching Experience

Graduate Teaching Assistant (Brown): Recent Applications of Probability & Statistics (Spr. '16, Spr. '18) • Statistical Inference (Spr. '17) • Computational Probability & Statistics (Fall '15) • Essential Statistics (Spr. '15) • Information Theory (Fall '14)

Team Leader, High Performance Computing (Brown–Kobe Summer School): designed and supervised a project to create a parallelized particle filter for neural decoding with graduate students from Brown and Kobe Universities (Summer '16)

Talks and Presentations

M. Burkhart, L. Lee, P. Tino, & Z. Kourtzi. **Clustering Trajectories of Neurodegenerative Disease.** Trustworthy AI for Medical & Health Research Workshop, Cavendish Laboratory, Cambridge, UK, 2022

F. Marinaro, C. Morvan, R. Au, S. Bond, M. Burkhart, N. Carlebach, et al. **The Early Detection of Neurodegenerative diseases initiative: an international and multidisciplinary effort for transforming the early detection of dementia-causing diseases.** Alzheimer's Association International Conference (AAIC), San Diego, CA, 2022

M. Burkhart & G. Ruiz. **Neuroevolutionary Feature Representations for Causal Inference.** International Conference on Computational Science (ICCS), London, UK, 2022

M. Burkhart. **Discriminative Bayesian Filtering for the Semi-supervised Augmentation of Sequential Observation Data.** ICCS, Kraków, Poland, 2021 (virtual)

M. Burkhart & K. Modarresi. **Adaptive Objective Functions and Distance Metrics for Recommendation Systems.** ICCS, Faro, Portugal, 2019

M. Burkhart, D. Brandman, & M. Harrison. **The Discriminative Kalman Filter for nonlinear and non-Gaussian sequential Bayesian filtering.** 31st New England Statistics Symposium, Storrs, CT, 2017

D. Brandman, M. Burkhart, …, M. Harrison, & L. Hochberg. **Noise-robust closed-loop neural decoding using an intracortical brain computer interface in a person with paralysis.** Society for Neuroscience (SFN), Washington, DC, 2017

D. Brandman, M. Burkhart, …, M. Harrison, & L. Hochberg. **Closed loop intracortical brain computer interface cursor control in people using a continuously updating Gaussian process decoder.** SFN, San Diego, CA, 2016

M. Burkhart, D. Brandman, C. Vargas-Irwin, & M. Harrison. **Nonparametric discriminative filtering for neural decoding.** ICSA Applied Statistics Symposium, Atlanta, GA, 2016

D. Brandman, M. Burkhart, …, M. Harrison, & L. Hochberg. **Closed loop intracortical brain computer interface control in a person with ALS using a filtered Gaussian process decoder.** American Neurological Association Annual Meeting, Baltimore, MD, 2016

—. **Intracortical brain computer interface control using Gaussian processes.** Dalhousie University Surgery Research Day, Halifax, NS, 2016

—. **Closed loop intracortical brain computer interface control using Gaussian processes in a nonlinear, discriminative version of the Kalman filter.** 9th World Congress for Neurorehabilitation, Philadelphia, PA, 2016

D. Knott, U. Walther, & M. Burkhart. **Finding the non-reconstructible locus.** SIAM Conference on Applied Algebraic Geometry, Raleigh, NC, 2011

Community Involvement

ICCS Conference Thematic Track

Program Committee Member — 2019–2021
- for the thematic track on Applications of Computational Methods in Artificial Intelligence and Machine Learning

Brown SIAM Student Chapter
Providence RI

Vice President, Chapter Records — 2015–2017
- organized events within the applied math community

Interdepartmenal Liaison Officer

Purdue Student Publishing Foundation
West Lafayette IN

Member, Corporate Board of Directors — 2009–2011
- oversaw the Exponent, Purdue's Independent Daily Student Newspaper

Chairman, Finance Committee
- oversaw >$1 million annual budget, set student and faculty salaries, approved capital expenditures

Awards and Honors

Brown Institute for Brain Science Graduate Research Award	2016
Brown International and Conference Travel Awards (Arequipa, Peru)	2016
Brown-IMPA Partnership Travel Award (Rio de Janeiro, Brazil)	2015
Brown-Kobe Exchange in High Performance Computing Travel Award (Kobe, Japan)	2014, 2016
Rutgers Graduate Assistantship in Areas of National Need	2012
National Merit Scholar Finalist	2007

Website

https://burkh4rt.github.io