

# Michael C. Burkhardt

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## RESEARCH INTERESTS

sequential Bayesian inference • neural decoding • Gaussian processes • semi-supervised learning • causality

## 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



**ADOBE INC.**  
San José CA

**Sr. Machine Learning Scientist**

2021–

**Machine Learning Scientist**

2018–2021

- built and validated predictive models for user segmentation (PySpark/LightGBM)
- supervised intern projects in semi-supervised learning (Keras) and causal inference for a/b test data (R/SQL)



**BRAIN GATE 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 common non-stationarities for online decoding in Brain Computer Interfaces (BCI's)



**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
- scaled training to 500M playlists using Google's BigQuery (SQL) and cloudML



**BROWN-KOBE SUMMER SCHOOL**  
Kobe, Japan

**Team Leader, High Performance Computing**

2016

- designed and supervised a project to create a parallelized particle filter for neural decoding
- taught topics in Bayesian filtering and programming in Tensorflow/Cython to graduate students from Brown and Kobe Universities



**ARGONNE NATIONAL LAB**  
Lemont IL

**Graduate Research Aide**

2012

- propagated variance in a multi-step prediction model to better estimate prediction error (Matlab/R)
- used Monte Carlo Expectation Maximization to learn hyperparameters

## JOURNAL PUBLICATIONS

- M. Burkhardt, D. Brandman, B. Franco, L. Hochberg, & M. Harrison. **The Discriminative Kalman Filter for Bayesian Filtering with Nonlinear and Nongaussian Observation Models**. *Neural Computation* 32(5), 969–1017 (2020)
- D. Brandman, M. Burkhardt, 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(11), 2986–3008 (2018)
- D. Brandman, T. Hosman, J. Saab, M. Burkhardt, B. Shanahan, J. Ciancibello, et al. **Rapid calibration of an intracortical brain computer interface for people with tetraplegia**. *Journal of Neural Engineering* 15(2), 026007 (2018)
- M. Burkhardt, Y. Heo, & V. Zavala. **Measurement and verification of building systems under uncertain data: A Gaussian process modeling approach**. *Energy and Buildings* 75, 189–198 (2014)

## CONFERENCE PUBLICATIONS

- M. Burkhardt. **Discriminative Bayesian Filtering for the Semi-Supervised Augmentation of Sequential Observation Data**. *To appear in: International Conference on Computational Science* (2021)
- M. Burkhardt & K. Shan. **Deep Low-Density Separation for Semi-Supervised Classification**. *International Conference on Computational Science, LNCS vol. 12139*, 297–311 (2020)
- M. Burkhardt & K. Modarresi. **Adaptive Objective Functions and Distance Metrics for Recommendation Systems**. *International Conference on Computational Science, LNCS vol. 11537*, 608–621 (2019)
- M. Burkhardt & K. Modarresi. **Determining Adaptive Loss Functions and Algorithms for Predictive Models**. *International Conference on Computational Science, LNCS vol. 11537*, 595–607 (2019)

## PREPRINT

- M. Burkhardt. **Discriminative Bayesian Filtering Lends Momentum to the Stochastic Newton Method for Minimizing Log-Convex Functions**. [arXiv:2104.12949](https://arxiv.org/abs/2104.12949).

## THESIS

- M. Burkhardt. **A Discriminative Approach to Bayesian Filtering with Applications to Human Neural Decoding**. Ph.D. dissertation, advised by Professor Matthew T. Harrison. Division of Applied Mathematics, Brown University, Providence USA (2019)

## PATENTS PENDING

- M. Burkhardt & K. Shan. **User Classification from Data via Deep Segmentation for Semi-supervised Learning**. U.S. Patent Application #16/681,239. Filed Nov. 2019. Published May 2021 as 2021/0142152A1.
- M. Burkhardt & K. Modarresi. **Digital Experience Enhancement using an Ensemble Deep Learning Model**. U.S. Patent Application #16/375,627. Filed Apr. 2019. Published Oct. 2020 as 2020/0320382A1.

## 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)

## TALKS AND PRESENTATIONS

- M. Burkhart, D. Brandman, & M. Harrison. **The Discriminative Kalman Filter for nonlinear and non-Gaussian sequential Bayesian filtering.** The 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.** Society for Neuroscience (SFN), San Diego, CA, 2016.
- M. Burkhart, D. Brandman, C. Vargas-Irwin, & M. Harrison. **Nonparametric discriminative filtering for neural decoding.** 2016 ICASA 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

<b>ICCS CONFERENCE THEMATIC TRACK</b>	<b>Program Committee Member</b> • for the thematic track on Applications of Computational Methods in Artificial Intelligence and Machine Learning	<b>2019–</b>
<b>BROWN SIAM STUDENT CHAPTER</b> <small>Providence RI</small>	<b>Vice President, Chapter Records</b> • organized events within the applied math community	<b>2016–2017</b>
	<b>Interdepartmental Liaison Officer</b>	<b>2015–2016</b>
<b>PURDUE STUDENT PUBLISHING FOUNDATION</b> <small>West Lafayette IN</small>	<b>Member, Corporate Board of Directors</b> • oversaw the Exponent, Purdue's Independent Daily Student Newspaper	<b>2009–2011</b>
	<b>Chairman, Finance Committee</b> • oversaw >\$1 million annual budget, set student and faculty salaries, approved capital expenditures	<b>2010–2011</b>

## HONORS

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

## FIND ME ONLINE

<https://burkh4rt.github.io>