Narendra Mukherjee

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Employment

July 2019- **Machine Learning Scientist**, *TripAdvisor*, Needham, USA.

•Bayesian and deep learning models of user-generated content and product recommendations for TripAdvisor's Experiences business

•Worked alongside engineering to spearhead the adoption of a modern ML platform at TripAdvisor that can deploy containerized ML models and speed-up A/B testing

Education

August 2019 **Ph.D. in Neuroscience and Quantitative Biology**, *Brandeis University*, Waltham, USA,

Dissertation title: Behaviorally relevant sensory cortical population dynamics in the rodent taste system.

•**HHMI International Predoctoral Fellow** (<15% applicants selected internationally)

May 2012 **Integrated BS-MS in Biological Sciences**, *Indian Institute of Science Education and Research*, Kolkata, India,

Dissertation title: Optimality and Courtship Behaviour in Zebrafish, *Danio Rerio*.

•**Director's Gold Medal** (Best academic performance in a class of 80)

Ongoing research projects

Bayesian inference in dynamic models of online reputation systems, *(with Amin Rahimian and Shrabastee Banerjee)*,

Using sequential neural posterior estimation (SNPE) for likelihood-free inference in simulations of user reviewing behavior on a digital platform.

Bernoulli mixture Hidden Markov Models (BM-HMM) for large scale neural ensemble recordings, *(with Jian-You Lin)*,

Variational inference in Bayesian HMMs with mixture emissions for robust modeling of massively high-dimensional time-series (like neural recordings) that are limited in size (by experimental constraints).

Bayesian nonparametric spectrum analysis, *(with Mark Goldstein)*,

Variational inference in an Indian buffet process (IBP)-based spectral model with unknown number of sinusoidal components.

Publications

2020 Lin J-Y., **Mukherjee N.,** Bernstein M.J., Katz D.B. *Perturbation of amygdala-cortical projections reduces ensemble coherence of palatability coding in gustatory cortex.* ***bioRxiv.*** **doi:** doi.org/10.1101/2020.12.02.406900

2019 **Mukherjee N.,** Wachutka J., Katz D.B. *Impact of precisely-timed inhibition of gustatory cortex on taste behavior depends on single-trial ensemble dynamics.* ***eLife.*** **doi:** doi.org/10.7554/eLife.45968.001

2019 Levitan D., Lin J-Y., Wachutka J., **Mukherjee N.,** Nelson S.B., Katz D.B. *Single and population coding of taste in the gustatory cortex of awake mice.* ***Journal of Neurophysiology.*** **doi:** doi.org/10.1152/jn.00357.2019

2018 Flores V.F, Parmet T., **Mukherjee N.,** Nelson S., Levitan D., Katz D.B. *The role of the gustatory cortex in incidental experience-evoked enhancement of later taste learning.* ***Learning and Memory.*** **25(11):** 587 - 600

2017 **Mukherjee N.,** Wachutka J., Katz D.B. *Python meets systems neuroscience: affordable, scalable and open-source electrophysiology in awake, behaving rodents.* ***Proceedings of the 16th Python in Science Conference.*** 97 - 104

2016 Sadacca B.F., **Mukherjee N.,** Vladusich T., Li J.X., Katz, D.B., Miller P. *The Behavioral Relevance of Cortical Neural Ensemble Responses Emerges Suddenly.* ***Journal of Neuroscience.*** **36(3):** 655 - 669

2013 Varma V., **Mukherjee N.,** Nisha N.K., Sharma V.K. *Strong (Type 0) phase resetting of activity/rest rhythm of fruit flies, Drosophila melanogaster, at low temperature.* ***Journal of Biological Rhythms.*** **28(6):** 380 - 389

2012 Nisha N.K., **Mukherjee N.,** Sharma V.K. *Robustness of circadian timing systems evolves in fruit flies Drosophila melanogaster as a correlated response to selection for adult emergence in a narrow window of time.* ***Chronobiology International.*** **29(10):** 1312 - 1328

2012 **Mukherjee N.,** Nisha N.K., Yadav P., Sharma V.K. *A model based on oscillatory threshold and build up of a developmental substance can explain gating of adult emergence in fruit flies D. melanogaster.* ***Journal of Experimental Biology.*** **215(17):** 2960 - 2968

Invited Talks

2020 **When features go missing, Bayes' comes to the rescue.**
- PyData Global - talk video

2018 **Discrete cortical population activity states underlie taste processing and consumption behavior.**
- Grossman Center for the Statistics of Mind, Columbia University, New York, USA
- Dept. of Mathematics and Statistics, Boston University, Boston, USA
- Neuroscience Statistics Research Laboratory, Massachusetts Institute of Technology (MIT), Cambridge, USA
- Jawaharlal Nehru Center for Advanced Scientific Research (JNCASR), Bangalore, India

2017 **Systems neuroscience with Python: peering into the "black box".**
- Boston Python Meetup Group, Cambridge, USA

2017 **Building affordable, scalable and open-source tools in Python to study behaviorally relevant neural population dynamics.**
- Center for Depression, Anxiety and Stress Research, McLean Hospital, Belmont, USA
- Boston Python Meetup Group, Cambridge, USA

Selected Poster Presentations at Conferences

2018 **Mukherjee N.,** Wachutka J., Katz D.B. *Dynamical structure of cortical taste responses revealed by precisely-timed optogenetic perturbation.* ***Computational and Systems Neuroscience (Cosyne) 2018, Denver, CO***

2017 **Mukherjee N.,** Wachutka J., Katz D.B. *Optogenetically perturbing behaviorally relevant stochastic cortical population dynamics.* ***Statistical Analysis of Neuronal Data (SAND8) at Pittsburgh, PA***

2016 **Mukherjee N.,** Wachutka J., Katz D.B. *Perturbing behaviorally relevant cortical population activity states.* ***Annual Meeting of the Society for Neuroscience (SfN) at San Diego, CA***

2014 **Mukherjee N.,** Li J.X., Katz D.B. *Ensemble dynamics in the rat gustatory cortex can precisely predict taste ingestion-rejection decisions.* ***Annual Meeting of the Society for Neuroscience (SfN) at Washington, DC***

2014 **Mukherjee N.,** Li J.X., Katz D.B. *Ensemble dynamics in the rat gustatory cortex can precisely predict taste ingestion-rejection decisions.* ***36th Annual Meeting of the Association for Chemoreception Sciences (AChemS) at Bonita Springs, FL***

Selected coursework

2018 MIT 6.882: Bayesian Modelling and Inference (Prof. Tamara Broderick)

2015 Harvard CS281: Advanced Machine Learning (Prof. Finale Doshi-Velez)

2014 Harvard CS181: Machine Learning (Prof. Ryan Adams)

2014 Brandeis NBIO 136: Computational Neuroscience (Prof. Paul Miller)

Teaching Experience

2016 **NPSY 18a: Introduction to Learning and Behavior**, *Brandeis University, Waltham, MA*,

- Guest lecturer for section on Machine Learning and Artificial Intelligence.

2016 **BIO 107a: Data Analysis and Statistics Workshop**, *Brandeis University, Waltham, MA*,

- Teaching Fellow with Prof. Steve Van Hooser.
- Held tutorial sessions for hands-on programming exercises.
- Graded homework assignments and exams.

Awarded Pulin Sampat Memorial Award (2014) for the Best Teaching Fellow in the Life Sciences for the following courses:

2014 **NBIO 136b: Computational Neuroscience**, *Brandeis University, Waltham, MA*,

- Teaching Fellow with Prof. Paul Miller.
- Held tutorial lectures to go over content with smaller student groups.
- Held weekly office hours.
- Graded homework assignments and exams.

2013 **NBIO 45a: The Cognitive and Neurobiological Basis of Memory**, *Brandeis University, Waltham, MA*,

- Teaching Fellow with Prof. John Lisman.
- Held tutorial lectures to go over content with smaller student groups.
- Held weekly office hours.
- Graded homework assignments and exams.

Grants and Awards

2017-2019 $29,513 (estimated) towards cloud computing resources on the Jetstream supercomputer of the Extreme Science and Engineering Discovery Environment (XSEDE) of the National Science Foundation (NSF) (as administrator).

2014-2017 $70,000 per year towards tuition and fellowship from the Howard Hughes Medical Institute (HHMI) as part of the International Predoctoral Fellowship.

2008-2012 Innovation in Science Pursuit for Inspired Research (INSPIRE) Scholarship for Higher Education (SHE), DST, Govt. of India.

2010, 2011 Summer Research Fellowship, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bangalore, India.

2010 Rajiv Gandhi Science Talent Research Scholarship, Rajiv Gandhi Foundation, New Delhi and JNCASR (Best project under Summer Research Fellowship, 2010).

2008, 2009 CSIR Program for Youth on Leadership in Science (CPYLS) associateship at Centre for Cellular and Molecular Biology (CCMB), Hyderabad, CSIR, Govt. of India.

Technical Expertise

Software

Expert: Python, Unix/Linux, SQL(Hive, BigQuery, Postgres), LaTeX, HPC environments, Docker.

Intermediate: R, MATLAB, PySpark.

Working knowledge: C++, HTML, Kubernetes.

Modelling

Machine Learning: Standard models for regression/classification, neural networks (deep networks, CNNs, RNNs, autoencoders), probabilistic graphical models (clustering, time-series models like HMMs, LDA, probabilistic PCA), Bayesian inference (including nonparametric priors with MCMC and variational-EM), NLP (TF-IDF, Doc2Vec, Word2Vec, ULMFiT, Transformers/BERT), Learning-to-rank (LambdaRank, LambdaMART).

Statistics: Frequentist techniques (parametric/non-parametric), Bayesian statistics (Hierarchical models, MCMC), computational neuroscience models (e.g, point-process models, drift-diffusion model of decision-making).

Frameworks: numpy, scipy, scikit-learn, Tensorflow/Keras/PyTorch/FastAI, PyMC3, Datashader, Spark, XGBoost, LightGBM.

Experimental Stereotactic rodent surgeries, chronic implantation of multielectrode bundles, simultaneous electrophysiology and optogenetics in awake rodents.

Open-source projects (**Github**)

Hardware
- Co-developed a Raspberry Pi-based hardware system to perform large-scale neural recordings in rodents.
- Sampling rates of upto 40kHz from thousands of neural electrodes simultaneously.
- Costs an order of magnitude less than any comparable commercially available solution.
- Being used in 5 other neuroscience labs across the world - for details, please read our **Scipy 2017 paper**.

blech_clust
- HDF5-based data management software to store, process and analyze neural voltage recordings upto several terabytes in size.
- Tested on machines ranging from personal laptops to distributed clusters and cloud-computing environments.
- Uses parallel computing to speed up the neural *"spike sorting"* pipeline by at least 20x.

Personal

Citizenship India

Languages English (native/bilingual), Hindi (native), Bengali (native), Dutch (elementary)

Hobbies Long-distance road cycling, Travelling, Cooking

References

PhD advisor **Prof. Donald B Katz**
Professor of Psychology, Brandeis University
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Co-author **Prof. Paul Miller**
Associate Professor of Biology and Computational Neuroscience, Brandeis University
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PhD thesis committee member **Prof. Shantanu Jadhav**
Assistant Professor of Psychology, Brandeis University
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Former Tripadvisor colleague **Dr. Clementine Plati**
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Former Tripadvisor colleague **Dr. Jennifer X Li**
Senior Data Scientist, Uber
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