

# 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

- Upcoming **Bayesian imputation of missing feature values in product sort and recommendation at Tripadvisor.**
- 14th ACM International Conference on Web Search and Data Mining (WSDM 2021)
- 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** **Donald B Katz**  
Professor of Psychology, Brandeis University  
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**Co-author** **Paul Miller**  
Associate Professor of Biology and Computational Neuroscience, Brandeis University  
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**PhD thesis committee member** **Shantanu Jadhav**  
Assistant Professor of Psychology, Brandeis University  
[shantanu@brandeis.edu](mailto:shantanu@brandeis.edu)

**Former** **Dr. Clementine Plati**  
**Tripadvisor colleague** Machine Learning Engineer II, Cortex Applied Research, Twitter

**Former** **Dr. Jennifer X Li**  
**Tripadvisor colleague** Senior Data Scientist, Uber