

Anirban Nandi

Research Scientist, Allen Institute for Brain Science

Professional Profile

Research scientist with Ph.D. in Electrical Engineering. Expertise in a diverse range of topics including high-dimensional, multimodal biological data analysis, machine/deep learning, statistical modeling, optimization and computational neuroscience with several publications in high impact peer-reviewed journals. 5+ years of experience in software development and visualization with Python, R, MATLAB. Highly proficient in data manipulation, learning frameworks, and numerical simulation using high performance computing (HPC) resources.

Work Experience

Jan 2018 - present **Research Scientist, Allen Institute for Brain Science** | Modeling, Simulation and Analyses of Neural Dynamics

- End to end model deployment: Introduced a configurable, automated optimization framework to fit single neuron models at scale and deployed it across HPC clusters, AWS. Achieved an order of magnitude improvement in compute time. [[Code](#) | [Publication](#) | [Web Product](#)]
- Derive Cell-types from multimodal datasets: Established causal links between high-dimensional genomic (RNA-sequencing), morphology and physiology data using unsupervised learning algorithms and sensitivity analysis methods. [[Code](#) | [Publication](#)]
- Prototype biological systems: Through large-scale network simulation on HPC clusters, identified biomarkers for neurodegenerative diseases and revealed functional implications for structural connectivity patterns observed in Electron Microscopy (EM) volumes of brain tissue. [[Publication](#)]
- A deep neural network approach to compare computational complexity of biophysical models.

Education

Dec. 2017 **Ph.D. Electrical Engineering**, Washington University in St. Louis , USA, GPA 3.95.

Thesis : Extrinsic and Intrinsic Control of Integrative Processes in Neural Systems. 📄

Project #1 Data driven model inference and novel control system design in biocircuits

- Designed optimal control strategies to emit desired spiking activity in biological neural networks modeled as dynamical systems.

Project #2 Derive a generative model of decision making from sensory detection task data

- Analysed experimental data from locust olfactory circuit to infer latent decision making model and the role of optimality in detection tasks.

April 2012 **Bachelor of Electrical Engineering**, Jadavpur University , India, GPA 4.0.

Software Skills

🔗 **Open-source contributions:** AllenSDK 📄, eFEL 📄

📖 **HPC experience:** Cori Supercomputer at National Energy Research Scientific Computing Center (NERSC), Berkley National Labs; BBP5 Supercomputer, Blue Brain Project, Switzerland.

</> Python, R, Matlab, C++, NEURON

aws EC2, S3, SageMaker, Lambda

SQL, Postgres, sqlalchemy, pandas, dplyr

ipyparallel, mpi4py

Matplotlib, Seaborn, ggplot2, pyQt

CentOS, Ubuntu | Apple OSX | Windows

PyTorch, Keras, TensorFlow, scikit-learn

Docker, Ansible, Flask

Hadoop ecosystem, pySpark

>_ bash, PBS, Slurm, SGE, Airflow

Jupyter, Git, Github, HTML, CSS, L^AT_EX

Machine Learning Experience

Traditional ML **Supervised:** kNN, Generalized Linear Models, SVM, Naive Bayes, Decision Trees, Random Forest, Gradient Boosted Trees, XGBoost

Unsupervised: PCA, ICA, k-Means, Mixture Models, DBSCAN, t-SNE, UMAP

Recommender Systems: Collaborative Filtering, **Topic Modeling:** Latent Dirichlet Allocation, Latent Semantic Indexing

Deep Learning **Computer Vision:** ResNet, GoogLeNet, VGGNet, **Object Detection:** Fully Convolutional Networks, YOLO, R-CNN, **Semantic Segmentation:** U-Net, DeepLabv3

NLP: LSTM, GRU, Word2Vec, GloVe Attention Networks, BERT

Representation Learning: Autoencoder, GAN


Awards

Award Student travel award for presentation at IEEE Conference on Decision and Control (CDC), Los Angeles, CA, USA, December, 2014.

Scholarship 2008-2012 Central Sector Scheme of Scholarship for College and University Students, Ministry of Human Resource Development, Government of India



Talks

Team-talk "Enlightening the Chandelier" at Allen Institute Showcase, Seattle, WA, USA, November 2019. 

Invited Langenhop Lecture and SIU Mathematics Conference, Southern Illinois University, Carbondale, USA, May 2017. 

"Neurocontrol: Manipulating neural activity via exogenous stimulation" at Conference on Decision and Control (CDC), IEEE, Los Angeles, USA, December 2014.

Refereed Journal Articles

- [1] **Anirban Nandi**, Werner Van Geit, Tom Chartrand, Anatoly Buchin, Christof Koch, and Costas A. Anastassiou. "Cellular models linking electrophysiology, morphology and transcriptomics across cortical cell types". In: *(Under Review)* (2020).
- [2] Casey Schneider Mizell, **Anirban Nandi**, Costas A. Anastassiou, Forrest Collman, and Nuno da Costa. "A fine structural analysis of the Chandelier Cell input in a densely segmented volume of layer 2/3 of mouse primary visual cortex". In: *(Under Review)* (2020).
- [3] Clayton P. Mosher, Yina Wei, Jan Kaminski, **Anirban Nandi**, Adam N. Mamelak, Costas A. Anastassiou, and Ueli Rutishauser. "Cellular classes in the human brain revealed in vivo by heartbeat-related modulation of the extracellular action potential waveform". In: *Cell Reports* (2020). : <https://doi.org/10.1016/j.celrep.2020.02.027>.
- [4] Sruti Mallik, Srinath Nizampatnam, **Anirban Nandi**, Debajit Saha, Baranidharan Raman, and ShiNung Ching. "Neural Circuit Dynamics for Sensory Detection". In: *Journal of Neuroscience* (2020). : <https://doi.org/10.1523/JNEUROSCI.2185-19.2020>.

- [5] Anatoly Buchin, Rebecca de Frates, **Anirban Nandi**, Peter Chong, Rusty Mann, Lindsay Ng, Jeremy Miller, Christof Koch, Jonathan Ting, and Costas A. Anastassiou. “Multi-modal characterization and simulation of human epileptic circuitry”. In: (*Under Review*) (2019).
- [6] **Anirban Nandi**, Heinz Schättler, and ShiNung Ching. “Optimal Control for Fast, Accurate Threshold-Hitting”. In: *SIAM Journal on Control and Optimization* 57.4 (2019), pp. 2269–2291. doi: 10.1137/17M1161580.
- [7] Brian E Kalmbach, Anatoly Buchin, Brian Long, Jennie Close, **Anirban Nandi**, Jeremy A Miller, Trygve E Bakken, Rebecca D Hodge, Peter Chong, Rebecca de Frates, et al. “h-Channels Contribute to Divergent Intrinsic Membrane Properties of Supragranular Pyramidal Neurons in Human versus Mouse Cerebral Cortex”. In: *Neuron* 100.5 (2018), pp. 1194–1208. doi: 10.1016/j.neuron.2018.10.012.
- [8] **Anirban Nandi**, Heinz Schättler, Jason T Ritt, and ShiNung Ching. “Fundamental limits of forced asynchronous spiking with integrate and fire dynamics”. In: *The Journal of Mathematical Neuroscience* 7.1 (2017), p. 11. doi: 10.1186/s13408-017-0053-5.
- [9] **Anirban Nandi**, MohammadMehdi Kafashan, and ShiNung Ching. “Control Analysis and Design for Statistical Models of Spiking Networks”. In: *IEEE Transactions on Control of Network Systems* (2017). doi: 10.1109/TCNS.2017.2687824.
- [10] MohammadMehdi Kafashan, **Anirban Nandi**, and ShiNung Ching. “Relating observability and compressed sensing of time-varying signals in recurrent linear networks”. In: *Neural Networks* 83 (2016), pp. 11–20. doi: 10.1016/j.neunet.2016.07.007.

Refereed Conference Articles

- [1] **Anirban Nandi**, Heinz Schättler, and ShiNung Ching. “Selective spiking in neuronal populations”. In: *American Control Conference (ACC), 2017*. IEEE. 2017, pp. 2811–2816. doi: 10.23919/ACC.2017.7963377.
- [2] **Anirban Nandi**, MohammadMehdi Kafashan, and ShiNung Ching. “Controlling point process generalized linear models of neural spiking”. In: *American Control Conference (ACC), 2016*. IEEE. 2016, pp. 5779–5784. doi: 10.1109/ACC.2016.7526575.
- [3] Jason Ritt, **Anirban Nandi**, Joseph Schroeder, and ShiNung Ching. “Neurocontrol in sensory cortex”. In: *APS Meeting Abstracts*. 2016.
- [4] **Anirban Nandi**, Jason T Ritt, and ShiNung Ching. “Non-negative inputs for underactuated control of spiking in coupled integrate-and-fire neurons”. In: *53rd Annual Conference on Decision and Control (CDC), 2014*. IEEE. 2014, pp. 3041–3046. doi: 10.1109/CDC.2014.7039857.

Posters and Abstracts

- “Generating All-Active Biophysical Models for Human and Mouse Neurons” at Society for Neuroscience (SFN), San Diego, CA, USA, November 2018.
- “Development of realistic single-neuron models of mouse V1 capturing in-vitro and in-vivo properties” at Organization of Computational Neurosciences (OCNS) Meeting, Seattle, WA, USA, July, 2018.
- “Phasic response motifs are optimal for persistent detections” at International Conference on Mathematical Neuroscience (ICMNS), Boulder, CO, USA, June, 2017.

Teaching Experience

- Teaching Served as Teaching Assistant for different graduate level courses within the Electrical Engineering Department : Nonlinear Dynamical Systems, Linear Dynamical Systems, Optimization and Optimal Control.
- Mentoring Mentored Jianmo He, MS thesis for Electrical Engineering, 2016, Washington University in St. Louis.

Professional Memberships and Academic Services

- Membership Institute for Electrical and Electronics Engineers (IEEE), IEEE Control Systems Society (CSS), Society for Neuroscience (SFN).
- Reviewer American Control Conference (2016-17), Automatica (2015-16), Non-Linear Analysis and Hybrid Systems (2017), Journal of Biological Physics (2017).