

# 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 <sup>++</sup> , NEURON	⚙️ PyTorch, Keras, TensorFlow, scikit-learn
aws EC2, S3, SageMaker, Lambda	☁️ Docker, Ansible, Flask
🗄️ SQL, Postgres, sqlalchemy, pandas, dplyr	🗄️ Hadoop ecosystem, pySpark
🔧 ipyparallel, mpi4py	📄 >_ bash, PBS, Slurm, SGE, Airflow
👁️ Matplotlib, Seaborn, ggplot2, pyQt	👤 Jupyter, Git, Github, HTML, CSS, L <sup>A</sup> T <sub>E</sub> X
💻 🐧 CentOS, Ubuntu   🍏 OSX   🪟	

## 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 Langenhof 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). doi: <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). doi: <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).

## References

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