

BISWADEEP CHAKRABORTY

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EDUCATION

Georgia Institute of Technology

Ph.D. in Electrical and Computer Engineering
Minor in Mathematics
Masters in Electrical and Computer Engineering

January 2020 - Present
Advisor: Prof. Saibal Mukhopadhyay

Jadavpur University

B. Tech. in Electronics and Telecommunication Engineering
First Class with Honors & Distinction

July 2015 - June 2019
Advisor: Prof. Amit Konar

EXPERIENCE

GREEN Lab, Georgia Institute of Technology

Graduate Research Assistant

Atlanta, USA
January 2020- Present

My research focuses on leveraging Spiking Neural Networks (SNNs) to advance Artificial Intelligence. By harnessing SNNs' temporal processing capabilities, I aim to develop next-generation AI technologies with improved performance, robustness, and cost-efficiency. Key areas of focus include:

- **Exploiting SNNs' temporal processing** for innovative applications, capitalizing on the inherent heterogeneity in time scales.
- Integrating **parallel computational** nature of spiking networks with Neural Architecture Search for energy-efficient, distributed learning at the edge.
- Applying SNNs to solve **combinatorial optimization** problems on large-scale dynamic graphs and develop event-based vision models for low-power edge devices.

PanAgora Asset Management

Stock Selector & Equity Strategies Team

Boston, USA
May 2023-August 2023

- Worked as *Quantitative Research Intern - Equities* with Mr. Lei Liu and Mr. Richard Tan at the Stock Selector and Equity Strategies team, building event-driven volatility trading strategies using large language models.

National University of Singapore

NUS-Singtel Cyber-Security Research and Development Laboratory

Singapore
July 2019-December 2019

- Worked as *Research Assistant* at the Singtel-NUS Lab with Prof. Mohan Gurusamy, Dr. Dinil Divakaran, Dr. Ido Nevat, and Prof. Gareth Peters on developing and implementing a risk-aware feature selection algorithm for IoT Device Classification.

University of Sherbrooke

INTERLAB Research Laboratory

Quebec, Canada
May 2018-August 2018

- Worked on research projects involving developing algorithms and a simulator using VPython to perform stochastic simulations of the nano-wire formation in a nano-communication network.

Jadavpur University

Artificial Intelligence Lab

West Bengal, India
December 2017 - June 2019

- Worked under Prof. Amit Konar on several research projects based on deep learning and signal processing-based modeling and characterization of EEG and fMRI signals and their applications in novel brain-computer interface algorithms.

Indian Academy of Sciences

National Physical Laboratory

New Delhi, India

May 2017– July 2017

- Worked under Dr. Amitava Sen Gupta, ex-Director, National Physical Laboratory, India, on modeling an algorithm for shooter localization from gunshot acoustics using wireless sensor networks.

Jadavpur University

Advanced Embedded and Digital Systems Laboratory

West Bengal, India

May 2016 – December 2017

- Worked as an undergraduate research assistant under Dr. Amitava Mukherjee, IBM India, and Prof. Mrinal Kanti Naskar on future 5G Communication Networks, Information Centric Networks, and Network Security.

PUBLICATIONS

Selected Publications

[C8] **B. Chakraborty**, B. Kang, H. Kumar, and S. Mukhopadhyay. "Sparse Spiking Neural Network: Exploiting Heterogeneity in Timescales for Pruning Recurrent SNN." In *International Conference in Learning Representations (ICLR, 2024)* (top 8% score).

[C7] **B. Chakraborty** and S. Mukhopadhyay. "Heterogeneous Neuronal and Synaptic Dynamics for Spike-Efficient Unsupervised Learning: Theory and Design Principles." In *International Conference on Learning Representations (ICLR, 2023)*.

[J6] **B. Chakraborty** and S. Mukhopadhyay. "Heterogeneous Recurrent Spiking Neural Network for Spatio-Temporal Classification." In *Frontiers in Neuroscience, 2022*. (IF: 4.3)

[C5] **B. Chakraborty** and S. Mukhopadhyay. "Self-Organizing Spiking Neural Network for Continual Time Series Prediction." In *International Joint Conference on Neural Networks (IEEE IJCNN, 2023)* IEEE.

[C4] **B. Chakraborty**, U. Kamal, X. She, S. Dash, and S. Mukhopadhyay. "Brain-Inspired Spatiotemporal Processing Algorithms for Efficient Event-Based Perception." In *Design, Automation and Test in Europe Conference (DATE, 2023)*.

[J3] **B. Chakraborty** and S. Mukhopadhyay. "Characterization of Generalizability of Spike Time Dependent Plasticity trained Spiking Neural Networks." In *Frontiers in Neuroscience, 2021*. (IF: 4.3)

[J2] **B. Chakraborty**, X. She, and S. Mukhopadhyay. "A Fully Spiking Hybrid Neural Network for Energy-Efficient Object Detection." In *IEEE Transactions on Image Processing, 2021*. (IF: 4.83)

[J1] D. Kim, **B. Chakraborty**, X. She, E. Lee, B. Kang, and S. Mukhopadhyay. "MONETA: A Processing-In-Memory-based Hardware Platform for the Hybrid Convolutional Spiking Neural Network with On-line Learning." In *Frontiers in Neuroscience, 2021*. (IF: 4.3)

[P2*] **B. Chakraborty**, H. Kumar, and S. Mukhopadhyay. "Tackling Oversmoothing in Large Dense Graphs Using Hebbian-based Attention." *40th Conference on Uncertainty in Artificial Intelligence (UAI), 2024*. (submitted)

[P1*] **B. Chakraborty** and S. Mukhopadhyay. "Topological Representations of Heterogeneous Learning Dynamics of Recurrent Spiking Neural Networks" Submitted to *International Joint Conference on Neural Networks (IEEE IJCNN, 2024)* IEEE. (submitted)

Other Publications

1. Journal Papers

[J6] H. Kumar, **B. Chakraborty**, S. Sharma, and S. Mukhopadhyay. "XMD: An Expansive Hardware-telemetry-based Mobile Malware Detector to Enhance Endpoint Detection." In *IEEE Transactions on Information Forensics & Security*, 2023. (IF: 6.8)

[J5] **B. Chakraborty** and S. Mukhopadhyay. " μ DARTS: Model Uncertainty-Aware Differentiable Architecture Search." In *IEEE Access*, 2022. (IF: 3.9)

[J4] A. Ghosh, **B. Chakraborty**, A. Raha, and A. Mukherjee. "Improving Network Throughput by Hardware Realization of a Dynamic Content Caching Scheme for Information-Centric Networking (ICN)." In *Wireless Personal Communications*, 2021, Vol. 116, No. 4, pp.2873-2898. (IF: 2.2)

[J3] **B. Chakraborty**, D.M. Divakaran, I. Nevat, G.W. Peters, and M. Gurusamy. "Cost-aware Feature Selection for IoT Device Classification." In *IEEE Internet of Things Journal*, 2021. (IF: 10.238)

[J2] **B. Chakraborty**, L. Ghosh, and A. Konar. "Optimal selection of EEG electrodes using interval type-2 fuzzy-logic-based semi-separating signaling game." In *IEEE Transactions on Cybernetics*, 2020. (IF: 11.8)

[J1] **B. Chakraborty**, L. Ghosh, and A. Konar. "Designing phase-sensitive common spatial pattern filter to improve brain-computer interfacing." In *IEEE Transactions on Biomedical Engineering*, 2019, Vol. 67, No. 7, pp. 2064-2072. (IF: 4.8)

2. Conference Papers

[C9] N. Miller, **B. Chakraborty**, and S. Mukhopadhyay. "A Reconfigurable Quantum State Tomography Solver in FPGA." In *IEEE International Conference on Quantum Computing & Engineering (QCE)*, 2023.

[C8] B. Kang, **B. Chakraborty**, and S. Mukhopadhyay. "Unsupervised 3D object learning through neuron activity aware plasticity." In *International Conference on Learning Representations (ICLR)*, 2023.

[C7] M. Lee, X. She, **B. Chakraborty**, S. Dash, B. Mudassar, and S. Mukhopadhyay. "Reliable Edge Intelligence in Unreliable Environment." In *2021 Design, Automation & Test in Europe Conference & Exhibition (DATE)*, 2021, pp. 896-901, IEEE.

[C6] D. Dewan, L. Ghosh, **B. Chakraborty**, A. Chowdhury, A. Konar, and A.K. Nagar. "Cognitive Analysis of Mental States of People According to Ethical Decisions Using Deep Learning Approach." In *2020 International Joint Conference on Neural Networks (IJCNN)*, 2020, pp. 1-8, IEEE.

[C5] A. Chowdhury, **B. Chakraborty**, L. Ghosh, D. Dewan, and A. Konar. "A Dynamical Phase Synchronization Based Approach to Study the Effects of Long-Term Alcoholism on Functional Connectivity Dynamics." In *International Conference on Pattern Recognition and Machine Intelligence (PReMI)*, 2020, pp. 218-226, Springer, Cham.

[C4] **B. Chakraborty**, S. Ghosal, L. Ghosh, A. Konar, and A.K. Nagar. "Phase-Sensitive Common Spatial Pattern for EEG Classification." In *2019 IEEE International Conference on Systems, Man, and Cybernetics (SMC)*, 2019, pp. 3654-3659, IEEE. [Oral]

[C3] O.A. Dambri, S. Cherkaoui, and **B. Chakraborty**. "Design and Evaluation of Self-Assembled Actin-Based Nano-Communication." In *2019 15th International Wireless Communications & Mobile Computing Conference (IWCMC)*, 2019, pp. 208-213, IEEE. [Oral]

[C2] S. Ghosal, **B. Chakraborty**, M. Laha, and A. Konar. "Phase-Synchrony And Causality Analysis Of Brain Signals To Determine Signal Transduction Pathways In Color Perception." In *2019 IEEE Region 10 Symposium*, pp. 778-783, IEEE, 2019. [Oral]

[C1] **B. Chakraborty**, B. Banerjee, A. Mukherjee, and M.K. Naskar. "Optimal cache allocation in a mobility-based heterogeneous network using Bayesian games." In *2017 IEEE Calcutta Conference*, pp. 423-427, IEEE, 2017. [Oral]

3. Submitted/ Under Review

[P5] H. Kumawat, **B. Chakraborty**, and S. Mukhopadhyay. "Control conditioned Visual Representations for Dynamics Learning in Robotics" Submitted to *European Conference on Computer Vision (ECCV), 2024*.

[P4] H. Kumawat, **B. Chakraborty**, and S. Mukhopadhyay. "STEMFold: Stochastic Temporal Manifold for Multi-Agent Interactions in the Presence of Hidden Agents." Submitted to *6th Annual Learning for Dynamics & Control Conference (L4DC), 2024*.

[P3] B. Kang, H. Kumar, M. Lee, **B. Chakraborty**, and S. Mukhopadhyay. "Recurrent Neural Cellular Automata with Self-Attention for Multi-agent System." Submitted to *6th Annual Learning for Dynamics & Control Conference (L4DC), 2024*.

[P2] H. Kumar, **B. Chakraborty**, B. Kang, and S. Mukhopadhyay. "Unmasking the Limitations of Threshold-Based Evaluation: An ROC-AUC Solution for Stochastic Complex Systems." Submitted to *ACM Knowledge Discovery and Data Mining (KDD), 2024*.

[P1] H. Kumar, S. Sharma, **B. Chakraborty**, and S. Mukhopadhyay. "RT-HMD: A novel Statistical Approach for Robust Real-Time Hardware-based Malware Detection under Weak Supervision Formulation." Submitted to *ACM Design Automation Conference (DAC), 2024*.

ACADEMIC ACHIEVEMENTS

ECE STEER Fellowship 2023

J.P.Morgan Fellowship University Finalist 2022

Qualcomm Innovation Fellowship Finalist 2022

MITACS Globalink Fellow

Indian Academy of Sciences Summer Research Fellow

Best Undergraduate Thesis, Department of Electronics and Telecommunication Engineering, Jadavpur University 2019

First Class with Honors & Distinction in Bachelor of Engineering from Jadavpur University in 2019

TALKS

2024 Georgia Tech DCL Symposium Spotlight Talk

Title: Evolution Strategies in Heterogenous Recurrent Spiking Neural Network for Dynamical Control

2023 SNUFA: Invited Talk and Poster

Title: Dynamics in Diversity: Harnessing Heterogeneity in Neuronal and Synaptic Dynamics in SNNs [Link](#)

2023 ICERM Workshop on Mathematical and Scientific Machine Learning

Title: Learning to Predict Using Network of Spiking Neurons [Link](#)

2019 IEEE International Conference on Systems, Man and Cybernetics (SMC)

Title: Phase-Sensitive Common Spatial Pattern for EEG Classification.

TEACHING

Instructor of Record

Fall 2024

Will teach a section of ECE 2020 (Digital Hardware Design), for non-ECE majors in Fall 2024. As the instructor of record, I am running my section of the course – deciding course policies for the syllabus and making a schedule, and then preparing and giving lectures, making and giving homework and tests, etc.

Tech 2 Teaching Certification

2024

The Tech to Teaching program is designed to prepare Georgia Tech graduate students and postdocs for college teaching positions. Developed a pedagogical approach that leverages a thorough understanding of evidence-based teaching with reflection on mentored teaching practice.

GRANTS

Contributed to the development of key grant proposals in the fields of neuromorphic computing and spiking neural networks, for my advisor and collaborators. Notable proposals where I played a substantial role include:

A Reconfigurable Ferroelectronics Platform for Collective Computing (FALCON)

NSF FuSe

PIs: Nikhil Shukla, Zongli Lin, Saibal Mukhopadhyay, Suman Datta, Lauren Garten

Hybrid Learning for Mission-Focused Artificial Intelligence: Application to StarCraft

Office of Naval Research

PI: Saibal Mukhopadhyay

Hybrid Learning: Algorithm and Architecture for Coupling Model and Data to Learn Dynamics of Complex Systems

Army Research Office

PI: Saibal Mukhopadhyay

Enhancing Neuromorphic Design: Ferroelectric Materials in Adaptive Neural Networks

NSF CISE (under review)

PIs: Sourav Datta, Saibal Mukhopadhyay

RELEVANT PROJECTS

Hybrid Learning for Mission-Focused Artificial Intelligence

- Studied the impact of stochasticity on DNNs for modeling complex systems like forest fire, identifying and resolving failures in the training and evaluation pipeline
- Worked on sequence-to-sequence modeling using advanced Deep Learning architectures, including Convolutional, Recurrent, and Transformer-based networks, specifically for modeling spatio-temporal systems.

Robust and Trustworthy Hardware-based Malware Detector (HMD)

- Developed a real-time HMD employing a novel statistical classifier using multiple instance learning, resulting in a 6-7% decrease in false positive rates compared to existing methodologies
- Designed XMD, the next generation HMD, which boosts detection performance by 30-40% for malware lacking architectural side-channel effects
- Conducted a trustworthiness analysis of current HMDs using an ensemble-based uncertainty estimator, identifying failure points in handling out-of-distribution samples

GRADUATE COURSEWORK

Machine Learning and Optimization: Probabilistic Graphical Models in Machine Learning, Statistical Machine Learning, Mathematical Foundations of Machine Learning, Systems for Machine Learning, Stochastic Systems, Topics on Continuous Optimization, Statistical Inference on Random Graphs, Calculus of Variation

Neuroscience: Information Processing Models in Neural Systems, Neurophysics, Neuronal Dynamics and Networks

Probability and Statistics: Fourier Tech and Signal Analysis, Statistical Estimation

PROFESSIONAL ACTIVITIES

Reviewing Responsibilities

- **Journals:** IEEE Transactions on Neural Networks and Learning Systems, Neurocomputing, IEEE Transactions on Image Processing, Neural Networks
- **Conferences:** IEEE SMC, CVPR, AAAI, IEEE PReMI, NeurIPS, ECCV, ICLR, AISTATS, ICML

Mentorship Mentored six new Ph.D. students as a part of the Georgia Tech ECE Graduate Student Organization (GSO) mentorship program.

Student Government Association: Was elected as a senator for the Georgia Tech Student Government Association to represent the graduate students of the School of Electrical and Computer Engineering