BISWADEEP CHAKRABORTY

biswadeep@gatech.edu || +1(404)932-2269 || Google Scholar || Linkedin

EDUCATION

Georgia Institute of Technology *January 2020 - Present*
Ph.D. in Electrical and Computer Engineering *Advisor:* Prof. Saibal Mukhopadhyay
Minor in Mathematics
Masters in Electrical and Computer Engineering

Jadavpur University *July 2015 - June 2019*
B. Tech. in Electronics and Telecommunication Engineering *Advisor:* Prof. Amit Konar
First Class with Honors & Distinction

EXPERIENCE

Georgia Institute of Technology Atlanta, USA
GREEN Lab *January 2020- Present*

Graduate Research Assistant under the supervision of Prof. Saibal Mukhopadhyay.

· My current research endeavors are centered around non-convex optimization, zeroth order optimization, stochastic optimal control, meta-learning, online convex optimization, and online learning. This work focuses on developing advanced computational methods and algorithms for efficient problem-solving in complex, dynamic environments. Specifically, I am investigating the application of these techniques in the context of machine learning and neuromorphic computing, aiming to enhance the capabilities and efficiency of neural network models. My efforts include exploring innovative strategies in online learning and optimization and applying meta-learning principles to adapt and evolve models in real time. The ultimate goal of this research is to push the frontiers of brain-inspired learning methods enabling more sophisticated and energy-efficient data processing and decision-making systems.

PanAgora Asset Management Boston, USA
Stock Selector & Equity Strategies Team *May 2023-August 2023*

· Worked as *Equity Research Intern* 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 Singapore
NUS-Singtel Cyber-Security Research and Development Laboratory *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 Quebec, Canada
INTERLAB Research Laboratory *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 West Bengal, India
Artificial Intelligence Lab *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   New Delhi, India
National Physical Laboratory   *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   West Bengal, India
Advanced Embedded and Digital Systems Laboratory   *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

Relevant Publications

[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, B. Kang, H. Kumar, and S. Mukhopadhyay. "Sparse Spiking Neural Network: Exploiting Heterogeneity in Timescales for Pruning Recurrent SNN." Submitted to *International Conference in Learning Representations* **(ICLR, 2024)**.*(under review)*

[P1*] B. Chakraborty and S. Mukhopadhyay. "Methodology to Compare Representations of Recurrent Spiking Neural Network using Representation Topology Divergence." 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

[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. Kang, **B. Chakraborty**, and S. Mukhopadhyay. "Unmasking the Limitations of Threshold-Based Evaluation: An ROC-AUC Solution for Stochastic Complex Systems." Submitted to *Nature Machine Intelligence*.

[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

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.

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 Ferrolectronics 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 Variations
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 School of Electrical and Computer Engineering