Rightsizing ML: From Sparse 3D Autonomy to Semi-Supervised Insights

Consideration for Joint Appointment in ECE

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Monday, April 14, 2025
1:30 PM • MSEE 112
https://purdue-edu.zoom.us/my/kjurss

Abstract:
My work centers on "rightsizing" machine learning (ML) algorithms for resource-limited devices or low-data regimes, balancing accuracy, latency, energy, and interpretability according to application requirements and across diverse domains. In 2D and 3D video object detection [SenSys 2020, CVPR 2022, EuroSys 2022, MobiSys 2025], I build real-time adaptive pipelines for autonomous vehicles that run on small IoST (Internet of Small Things) devices (e.g., mobile GPUs). By dynamically adjusting model configuration based on scene complexity, my Agile3D framework spans from structured 2D video to sparse, noisy LiDAR inputs, delivering efficient 3D perception under tight latency requirements. Additionally, I adapt large language models for training-free text-to-image generation [ReCON, ECCV 2024], achieving high-fidelity outputs with fewer compute steps so generative AI can run on more constrained hardware. Meanwhile, semi-supervised semantic segmentation is crucial for real-time autonomy in self-driving, where scene diversity and labeling demands are high. By implementing a Sliced-Wasserstein-based approach [SemSeg, CVPR 2025], I unify feature embeddings to deliver robust pixel-level detection even with sparse labels, all while keeping computation and memory footprints small. This preserves interpretability for tasks like pedestrian/vehicle boundary detection or road sign parsing—essential to running these pipelines efficiently on embedded systems. I will conclude by discussing how a resource-conscious ML approach can enable intelligence on smaller hardware, thus realizing real-time autonomy beyond large data centers.

Bio
Dr. Somali Chaterji (pronounced shoh-MAH-lee CHA-ter-jee) is an Associate Professor in Agricultural and Biological Engineering and in Electrical and Computer Engineering (by courtesy) at Purdue University. She is the Founder and CEO of KeyByte, a cloud computing startup, and directs ICAN (the Innovatory of Cells and Neural Machines) at Purdue. Dr. Chaterji's research focuses on developing efficient, interpretable machine learning models for cyber-physical systems (CPS) and genomics. Her vision spans two key areas: enabling Io(S)T devices to perform advanced analytics in CPS applications within latency, compute, and energy constraints, and advancing genomic analysis through high-dimensional data interpretation and RNA-based therapies. Her work bridges computing and biology, applying ML for both efficiency in ubiquitous devices and deep interpretability in genomics. Dr. Chaterji received the NSF CAREER award (CISE, 2022), co-organized the 2024 NSF CPS PI meeting, and serves as Co-PI for the NSF CISE Center CHORUS. She is also a Co-PI at the Army's Assured Autonomy Innovation Institute (A2I2) and contributed to the WHIN project for regional manufacturing and agriculture innovation, funded by the Lilly Endowment (2018-2024). She was invited to the NAE's Japan-America Frontiers of Engineering (JAFOE) symposium in 2023. More at https://schaterji.io/

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