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US Citizen (Security Clearance in Progress)

Mission Statement

I am passionate about making education more accessible and inclusive. To achieve this, I aim to be an academic after finishing my doctoral studies.

During my time at NC State, I wanted to enrich my knowledge beyond what I was learning in class and within my advisor's lab. I collaborated with two additional labs: the low-resource computing lab under Prof. Jung-Eun Kim in the CS department and Sozzani lab under Prof. Ross Sozzani in the Microbial Biology department. I concurrently produced research for all three labs while balancing my responsibilities as a student, mentor, teaching assistant, and research/grant proposal writer.

Similarly, I wanted to make the most of my time in MA. In addition to working full time at MIT LL, I collaborated with two labs: MIT CSAIL's CLEAR Lab under Prof. Andreea Bobu and Harvard's Edge Computing Lab under Prof. Vijay Reddi.

Research Institutions

- **Massachusetts Institute of Technology Lincoln Laboratory** — Lexington, MA
  Research Scientist (CO-OP) in Human Health and Performance Systems — *Feb 2024 - Ongoing*
  - Developing computer-vision algorithms for brain mapping based on 3D confocal microscopy data.
  - Working on the next generation of AI Guide, an AI-guided emergency surgical tool.
  - Introducing meta-learning for self-supervised pre-training for tomography.
  - Investigating how to reduce energy consumption in mobile AI systems.
  - Estimating the intents and behaviors of health-care professionals via control theoretic and inverse reinforcement learning frameworks.
- **North Carolina State University** — Raleigh, NC
  Ph.D Student in Electrical Engineering advised by Prof. Paul D. Franzon — *Aug 2021 - Ongoing*
  - Dissertation Topic: Reinforcement Learning and Language Models for 3D Floorplanning in Elec. Design Automation
  - Research Interests: Neural Network {Model Calibration, Pruning, Knowledge Distillation, Unsupervised Domain Adaptation}, Language Model {Multimodality, Self-Supervision, Fine-tuning}, Generative Diffusion Models and Graph Neural Networks.
  - GPA: 3.85/4.00
  - Mentor to four Ph.D students.
  - Funded the research of three other Ph.D students.
- **The University of Texas at Austin** — Austin, TX
  Bachelor of Science in Electrical Engineering — *Aug 2016-May 2021*
  - Primary Interest: Data Science, Digital Image/Video Processing, Digital Signal Processing
  - Computational Science and Engineering Program
  - Terry Foundation Scholar (full tuition and housing)

Earned Research Funding: $313,900

- **CISCO Research** — 08/16/2024
  $75,000 *Rapid 3DIC Thermal Modeling*
  - Proposed a novel machine learning approach for thermal modeling in 3DICs, focusing on addressing the challenges of heat dissipation across multiple stacked layers.
  - Introduced the concept of using a diffusion model to transform power maps into high-resolution heat maps, aiming to improve accuracy and efficiency over traditional methods.
  - Second author, written with Prof. Franzon and a labmate.
- **LAD Student Travel Grant** — 06/28/2024
  $900 *to present research at LLM-Aided Design*
  - Presented research on a novel LLM adaptation technique to over 200 researchers, industry members and tech startups.
  - Released a benchmark for LLM adaptation on microelectronic reasoning.
- **CAEML Research Award** — 04/28/2024
  $70,000 *for the development of Natural Language Optimization Models for PCBs and Analog ICs*
  - Motivated the development of LLMs for a query-based optimizer focused on packaging and on-chip interconnect problems.
  - Proposed support for multimodal inputs and outputs, including eye diagrams, waveform figures, and actual layouts.

- Demonstrated proof of concept via retrieval augmented generation demo.
- Co-first author with Prof. Franzon.

- **Qualcomm Innovation Fellowship** 05/03/2023
  $100,000 *for the development of Reinforcement Learning Agents for 3D Floorplanning in EDA*
  - Proposed and developed proof of concepts of novel RL algorithms for floorplanning.
  - Motivated research by identifying critical drawbacks in the SOTA.
  - Presented and defended research over 3 rounds of interviews.
  - Co-first author with a lab mate. Supervised by Prof. Franzon and Prof. Xiaorui Liu.
- **CAEML Research Award** 04/11/2023
  $68,000 *for the development of Siamese-Graph Neural Networks for Circuit Graph Isomorphism Detection*
  - Proposed and developed a novel SGNN architecture to address the circuit graph isomorphism detection problem.
  - Demonstrated proof of feasibility and scalability for large graphs.
  - First author, supervised by Prof. Franzon.

Publications/Under Review/Under Revision

- **Topology-Aware Deep Supervision for Axon Centerline Detection**
  To appear at ISBI '25. Submitted as co-first author. Supervised by MIT-LL, MBF Bioscience and Univ. of Florida
  - Addressed the issue of limited annotations for axon centerline detection data in brain mapping.
  - Improved performance over baseline despite using only 66% of the annotations.
  - Maintained performance for fully-annotated setting.
- **Mobile-Optimized Real-Time Vessel Segmentation for Ultra-Sound Guided Surgery**
  Published as second author in High Performance Extreme Computing (HPEC '24). Supervised by MIT-LL
  - Investigated various pruning/quantization techniques for real-time image segmentation of human vessels.
  - Contributed to writing a custom application for evaluating performance on a mobile AI system.
  - Motivated the processing of tomographic segmentation algorithms from a discrete computer to a mobile AI system in the next generation of AI Guide.
- **Large Reasoning Models for 3D Floorplanning in EDA**
  Under revision, submitted as first author. Supervised by Qualcomm Fellowship and Prof. Franzon
  - Developed an auto-regressive decision-making model to optimize 3D IC floorplanning.
  - Implemented an architecture that integrates sequence-to-sequence reinforcement learning algorithms, enhancing the model's ability to reason over large discrete action spaces.
  - Achieved notable improvements in sample efficiency by incorporating non-expert trajectories.
  - Evaluated the model against the SOTA ML approach, demonstrating superior performance in reducing wirelength and reasoning over multiple objectives.
- **The Over-Certainty Phenomenon**
  Under review at AAAI '25, submitted as first author, supervised by Prof. Jung-Eun Kim
  - Introduced a novel memory-efficient unsupervised domain adaptation algorithm (UDA) which improves calibration.
  - Identified key issues in state-of-the-art UDA algorithms which harm model calibration.
  - Retained comparable accuracy to SOTA.
- **Can Low-Rank Knowledge Distillation be Useful for Microelectronic Reasoning?**
  Published as co-first author, LLM-Aided Design (LAD '24)
  - Presented empirical results on the feasibility of using offline LLMs in EDA.
  - Evaluated Llama-2-7B's performance as a microelectronics Q&A expert, focusing on its reasoning and problem-solving abilities.
  - Introduced a novel LLM adaptation technique, low-rank knowledge distillation (LoRA-KD).
  - Released an evaluation benchmark to support future research.
- **Optimal Brain Dissection**
  Published as first author in BioInspired Processing (BIP '23), supervised by Sozzani Lab and USDA
  - Won Best Paper award.
  - Introduced a technique for feature-importance determination that exploits pruning algorithms.
  - Developed the dense autoencoder, a new autoencoder architecture for reducing reconstruction error in -omics data.
  - Outperformed the *de facto* gene regulatory network with respect to explaining gene expressions.
- **DepthGraphNet**
  Published as first author in Machine Learning for Computer Aided Design (MLCAD '23)
  - Investigated the use of siamese-graph neural networks for circuit graph isomorphism (CGI) detection.
  - Empirically demonstrated logarithmic run-time complexity with respect to graph size.

- Outperformed all other classical and neural methods in CGI detection accuracy.
- Introduced theorems for the optimal architecture of GNNs for CGI detection.

- **Network Inference Approach for Phosphoproteomics**
  Published as second author in Methods in Molecular Biology (MIMB vol. 2690), supervised by Sozzani Lab
  - Described methods to statistically analyze label-free phosphoproteomic data and infer post-transcriptional regulatory networks over time.
  - Used the Bayesian Dirichlet Equivalent Uniform to inference underlying latent relationships between variables.

In Preparation (First-Author-Level Effort)

- **Gaslighting Robots to Generalize Human** `[REDACTED]`
  Supervised by Prof. Bobu of MIT CLEAR Lab
  - Work involving language and human robot interaction.
- **Just Go With The (Optical) Flow!**
  Supervised by MIT LL
  - Work involving improving tomography algorithms via optical flow.
- `[REDACTED]`
  Supervised by MIT LL
  - Work involving meta learning and tomography.

In Preparation (Coauthor-Level Effort or Supervision)

- **Is This Worth Asking?**
  Supervised by Prof. Bobu of MIT CLEAR Lab
  - Work involving understanding human effort answering questions.
- **A Domain-Specific Q&A Dataset for Computer Architecture**
  Preprint. Supervised by Harvard Edge Computing Lab
  - Developed a Q&A dataset for benchmarking LLMs in computer architecture.
  - Assessed LLMs, identifying gaps in systems topics like memory and interconnects.
  - Proposed a roadmap to enhance LM reasoning and design capabilities.
- **Faster Subgraph Matching to Detect IP Theft in Designs**
  Supervised by Prof. Franzon
  - Work involving the design of custom subgraph representations for hashing.
- **Large Language Optimization Model for Electronic Design**
  Supervised by Prof. Franzon
  - Work involving the design of a multi-modal agent which interfaces with optimization algorithms.
- **Diffusion Models for Rapid 3DIC Thermal Modeling**
  Supervised by Prof. Franzon
  - Work involving the design of a conditional diffusion model which estimates the thermal properties of 3DICs.

Professional Service

- Each year at NCSU, the incoming cohort of ECE Ph.D students watch a video named *How to Succeed Doing a Ph.D in ECE*. In this presentation, I am used as an example of a successful Ph.D student.
- Reviewer for Neurips Workshop on Foundation Models for Science (FM4Science 2024).
- Contributor to *Machine Learning Systems: Principles and Practices of Engineering Artificially Intelligent Systems*, the textbook used for Harvard's CS249R (a course on TinyML).
- Contributor to Tensorflow Probability, SciKit Learn, and Deep Robust python libraries.
- Director of NC State Community Affairs for ECE Graduate Students Association (2021-2022).
- Organized NC State ECE Research Symposium January 28, 2022.
- Organized NC State TEDx Talk with Analog Devices, March 7, 2022.
- Member of UT Austin IEEE Robotics and Automation Society.
- Director of Student Affairs for UT Austin Planet Longhorn (International Students Org) (2020-2021).

Teaching

- **ECE 220 Analytical Foundations of ECE** — Raleigh, NC
  Teaching Assistant for North Carolina State University — *Aug 2022 - May 2023*
  - Taught a sophomore-level course on circuit theory, control, differential equations and communication systems.
  - Supervised weekly labs which introduced students to MATLAB.
  - Graded homework and exams.
  - Gave career advice to aspiring engineers.
- **ECE 301 Linear Systems and Signals** — Raleigh, NC
  Teaching Assistant for North Carolina State University — *Aug 2021 - May 2022*
  - Taught a junior level course on linear systems and signals.
  - Wrote exams and lead recitation twice a week.
  - Taught students introductory machine learning in MATLAB.
  - Graded homework and exams.
  - Received outstanding feedback from my students.
- **Signal Processing and Data Science Tutor** — Austin, TX
  Varsity Tutors — *Feb 2021 - July 2021*
  - Tutored undergraduates in data science, linear systems and signals
  - Taught introductory classes in Java and Python
  - 4.9/5.0 stars (top 10% of all tutors on platform)

Research Talks and Clinics

- MLCAD talk on *Large Reasoning Models for 3D Hard Macro Placement.* 09/11/2024
- Qualcomm Innovation Fellowship invited talk on *Large Reasoning Models for 3D Floorplanning.* 07/30/2024
- LLM-Aided Design talk on *Low-Rank Knowledge Distillation for LLMs.* 06/29/2024
- MIT-LL clinic on *Axon centerline detection using 3D-UNets.* 05/18/2024
- BioInspired Processing talk on *Optimal Brain Dissection.* 11/29/2023
- MLCAD talk on *Siamese-Graph Neural Networks for Circuit Graph Isomorphism Detection.* 09/12/2023

Technical Skills

- Extremely experienced with PyTorch and TensorFlow machine learning frameworks.
- Daily usage of Python. Skilled with Java[1] and LaTeX.
- Seasoned with libraries such as OpenCV, PIL, sci-kit-image, Gym and PyBullet.
- Skilled at digital {tomography, image, video, voxel} processing. Strong background in applied reinforcement learning, pattern recognition, detection/estimation theory and Bayesian optimization.

Employment

- **Smith and Nephew** — Austin, TX
  CO-OP: Real-Time FootSwitch Demultiplexer — *May 2019 - Dec 2019*
  - Created a surgical device to demultiplex signals from a universal footswitch to numerous soft tissue ablation and coagulation systems.
  - All signals (analog, digital, RS-485) sent and received are galvanically isolated to meet medical safety requirements.

[1] I first started learning Java at age 14 while in high school. At age 16, I founded our high school's competitive CS team and our robotics team. At age 17, our robotics team made it to the national competition under my leadership.

Undergraduate Projects

- **Deep Framerate Upscaling**
  Undergraduate Computational Science and Engineering Research Certificate Project, under Prof. Al Bovik
  - Created a deep learning architecture to interpolate frames in videos to increase framerate.
  - Modified a Pix2Pix Conditional Generative Adversarial Network to predict a frame which would be present between two given frames.
  - Researched methods to reduce the smearing/ghosting artifacts traditionally associated with framerate upscaling.
  - Utilized extensive signal processing theory on the spatial and temporal attributes of videos to (unsuccessfully) create a better loss function.
- **Parallel Neural Networks in OpenMP and MPI**
  Parallel Compute Final Project
  - Worked in a team of two to create a deep neural network to train on the MNIST handwritten digits dataset from scratch in C++ for serial execution for baseline performance metric.
  - Re-implemented the same network in Open Multi-Processing and Message Passing Interface to show speed up with various network sizes.
  - Won Best Project Award.
- **EmotionNet: Autonomous Body Language Assessment**
  Project manager for Honors Senior Design supervised by Prof. Al Bovik
  - Created computer vision/image processing algorithms for dataset feature extraction such as blurry image detector, predominant face identifier, Haar Cascade Classifier, and MTCNN hyperparameter optimizer.
  - Created a deep network based on VGG16 for facial emotion classification and encoding.
  - Utilized ResNet18 to classify and encode body-posture and pose.
  - Created a recurrent neural network decoder using LSTM to establish spatio-temporal relationships between facial emotions, pose, and posture with human body language.