Fin Amin

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Last Updated: October 20, 2024
US Citizen (Security Clearance in Progress)

RESEARCH INSTITUTIONS

Massachusetts Institute of Technology Lincoln Laboratory — Lincoln, MA
Graduate 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.
- Giving clinics to neuroscientists at Massachusetts General Hospital on using AI for axon centerline detection.
- Investigating how to reduce energy consumption in mobile AI systems.

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 for 3D Floorplanning in Elec. Design Automation
- Additional Research Interests: Neural Network {Model Calibration, Pruning, Knowledge Distillation}, Unsupervised Domain Adaptation, LLM Fine-Tuning and Graph Neural Networks.[1]
- GPA: 3.85/4.00
- Junior advisor 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
- Received Computational Science and Engineering Certificate
- 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.

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[1]In spring 2024, I was initially nominated for the NCSU Graduate Researcher of the Year Award. Due to moving to MIT-LL, I was considered ineligible. As for the research funding: I have worked on other successful grants but did not list them unless I had significant technical contribution.

Publications

During my time at NC State, I wanted to enrich my knowledge beyond what I was learning in class and within Prof. Franzon's lab. To do this, I joined 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, junior advisor, teaching assistant, and research/grant proposal writer. I have manuscripts being prepared; contact me for details.

- **Real-Time Vessel Segmentation for Ultra-Sound Guided Surgery**   Feb 2024 - November 2024
  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**   Aug 2023 - Ongoing
  Under review, 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**   Sept 2022 – Ongoing
  Under review, 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?**   March 2024 - May 2024
  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**   May 2022 – Aug 2023
  Published as first author in BioInspired Processing (BIP '23), supervised by Sozzani Lab and USDA
  - Won Best Paper award.
  - Introduced a SOTA technique for feature-importance determination.
  - 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**   Oct 2022 – July 2023
  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.
  - Showed 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**   May 2022 – Nov 2022
  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 Dirchlet Equivalent Uniform to inference underlying latent relationships between variables.

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

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)

Technical Skills

- Extremely experienced with PyTorch and TensorFlow machine learning frameworks.

- Expert in Python. Skilled with Java[2] and LaTeX.

- Highly familiar with libraries such as OpenCV, PIL, sci-kit-image, and Gym.

- Skilled at digital {tomography, image, video, voxel} processing. Also skilled with pattern recognition, detection and estimation theory. Strong background in reinforcement learning and Bayesian optimization.

Professional Service

- Reviewer for Neurips 2024 Workshop FM4Science 2024.

- 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.

- 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.

- 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)

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.

[2]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.