

Darin Tsui

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Education

Georgia Institute of Technology

Atlanta, GA

PH.D. IN ELECTRICAL AND COMPUTER ENGINEERING

Aug. 2023 - Jun. 2028 (Expected)

- Advisor: Amirali Aghazadeh

University of California San Diego

San Diego, CA

BACHELOR OF SCIENCE IN BIOENGINEERING, GPA 3.919

Sep. 2019 - Jun. 2023

- Advisors: Gert Cauwenberghs and Frank E. Talke

Research Experience

AI ML and Information Research Group at the Georgia Institute of Technology

Atlanta, GA

ADVISOR: AMIRALI AGHAZADEH

Jun. 2023 - Present

- Designed fast Fourier transform algorithms optimized for models with vocabulary sizes, achieving an exponential sample complexity reduction compared to conventional Fourier algorithms.
- Achieved up to a 1000-fold reduction in the amortized computation of Shapley interactions compared to state-of-the-art algorithms.
- Applied fast Walsh-Hadamard transforms on the evidence lower bound (ELBO) in variational autoencoders to extract explainable features.

Integrated Systems Neuroengineering Lab at UC San Diego

San Diego, CA

ADVISOR: GERT CAUWENBERGHS

Jun. 2022 - Jun. 2023

- Worked on the design and development of a COVID-19 diagnostic test using a graphene field-effect-transistor (GFET).
- Developed feature extraction and machine learning pipeline of current-voltage signals using scikit-learn.
- Achieved accuracies of 98.5% when detecting COVID-19 proteins, improving classification by 30.1%.

Talke Biomedical Device Lab at UC San Diego

San Diego, CA

ADVISOR: FRANK E. TALKE

Dec. 2021 - Aug. 2023

- Designed low-cost vision system for minimally invasive surgery using OpenCV with fiducial markers.
- Used ArUco markers to enable tracking of instruments in real-time in Python. Position tracking coordinates were exported and post-processed in MATLAB. Applied 3D homography to positional coordinates.
- Developed live platform for filtering and thresholding images for use in stereoscopic vision.
- Implemented Kalman filtering to achieve sub-millimeter error in design-validation testing.

Swartz Center for Computational Neuroscience at UC San Diego

San Diego, CA

ADVISOR: TZYU-PING JUNG

Mar. 2021 - Mar. 2023

- Worked with Ph.D. candidate Chiyuan Chang in electroencephalography-based (EEG) classification experiments. Conducted machine learning analysis in Python of subjects' respective stress levels in resting and stressful classroom settings.
- Performed support vector machine (SVM) and linear discriminant analysis (LDA) and Mann Whitney U statistical analysis using MATLAB and Python.
- Improved classification of stress vs. non-stress groups by 42.1% in correlation with physiological features.

Teaching Experience

Teaching Assistant

Atlanta, GA

ADVISOR: JEFFERY HURLEY

Aug. 2023 - Dec. 2023

- Graduate teaching assistant for ECE 4122/6122—Advanced Programming Techniques for Engineering Applications—with an enrollment of 300 graduate and undergraduate students. The course teaches undergraduate and graduate students techniques for distributed and parallel computing to run computational heavy tasks.
- Taught and assisted students in developing C++ code for lab assignments. Held office hours for 10 hours a week.

Instructional Assistant

San Diego, CA

ADVISOR: ROBERT SAH

Dec. 2020 - Mar. 2021

- Oversaw two lab sections of 30 students each for BENG 1, an introductory Bioengineering lab course.
- Trained students in the fundamentals of Bioengineering. Topics taught included biomechanics, noninvasive cardiovascular sensing, and spine segmentation. Held office hours and lab sections for 10 hours a week.

Professional Experience

Surgalign

San Diego, CA

DATA ENGINEERING INTERN

Jan. 2023 - Aug. 2023

- Interned at Surgalign, a small medical device company focused on developing AI solutions in spinal surgery (now acquired by Xtant Medical and Augmetics).
- Designed an internal MRI image processing application using Python that reduced preprocessing time per sample.
- Assisted in developing ground truth dataset of imaging data to assess the effectiveness of deep learning models.
- Validated deep learning models against surgeon-generated data using Sørensen-Dice coefficient statistical testing.

Johnson & Johnson

Redwood City, CA

INSTRUMENTS R&D INTERN

Jun. 2022 - Aug. 2022

- Interned at Auris Health, Johnson & Johnson's flexible robotics division for minimally invasive surgery of urology. Supported design validation clinical trials through preparation and sterilization of instruments.
- Performed root cause analysis on the failure of instrument devices. Designed near-infrared camera system for calibration in endoscopes.
- Supported systems investigations towards optical calibration stations and instrumentation platforms.

Publications

Darin Tsui, Aryan Musharaf, and Amirali Aghazadeh. SHAP zero explains all-order feature interactions in black-box genomic models with near-zero query cost. *arXiv preprint arXiv:2410.19236*, 2024.

Darin Tsui and Amirali Aghazadeh. On recovering higher-order interactions from protein language models. In *International Conference on Learning Representations (ICLR) 2024 Generative and Experimental Perspectives for Biomolecular Design (GEM) workshop*, 2024.

Darin Tsui, Kirsten Ramos, Capalina Melentyev, Ananya Rajan, Matthew Tam, Mitsuhiro Jo, Farshad Ahadian, and Frank E. Talke. A low-cost, open-source-based optical surgical navigation system using stereoscopic vision. *Microsystem Technologies*, 1–9, 2024.

Darin Tsui, Capalina Melentyev, Ananya Rajan, Rohan Kumar, and Frank E. Talke. An optical tracking approach to computer-assisted surgical navigation via stereoscopic vision. In *ASME 2023 32nd Conference on Information Storage and Processing Systems (ISPS)*. ASME, 2023.

Darin Tsui, Francisco Downey, Shreenithi Navaneethan, Akshay Paul, Tyler Bodily, Min Lee, Yuchen Xu, Ratnesh Lal, and Gert Cauwenberghs. A machine learning approach to COVID-19 detection via graphene field-effect transistor (GFET). In *2023 45th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*. IEEE, 2023.

Darin Tsui, Mitsuhiro Jo, Bryan Nguyen, Farshad Ahadian, and Frank E. Talke. Optical surgical navigation: A promising low-cost alternative. In *2023 45th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*. IEEE, 2023.

Presentations

Darin Tsui. Generative and Geometric Deep Learning in Computational Biology, *presented as a guest lecturer for ECE 8803—Generative and Geometric Deep Learning—at Georgia Tech*, Atlanta, GA, 2023.

Darin Tsui. Surgical site localization with non-invasive skin markers for pain management, *presented at the Center for Memory and Recording Research (CMRR) Research Review*, San Diego, CA, 2023.

Darin Tsui. Bioelectronic COVID-19 detection via graphene-field-effect-transistor (GFET), *presented at Bioengineering Day at UC San Diego*, San Diego, CA, 2023.

Darin Tsui. Design of a surgical navigation system via positional tracking of fiducial markers, *presented at the 2022 Conference on Micromechatronics for Information and Precision Equipment*, San Diego, CA, 2022.

Awards, Fellowships, and Grants

NSF Graduate Research Fellowship

2024 - 2027

- Research proposal title: *Discovery of Protein Variants Using Data and Information Fusion in Deep Generative Modelling.*

Course Enhancements & Improvement Award at Georgia Tech

2023

- Award received for developing course materials for ECE 8803—Generative and Geometric Deep Learning.

Graduate Student Conference Scholarship Award at ISPS 2023

2023

- Award received at ISPS 2023 for outstanding research and paper submission.

President's Fellowship at Georgia Tech

2023

- Award received for exemplary levels of scholarship and research innovation.

Bioengineering Travel Award

2023

- Award received from the UC San Diego Bioengineering Department for presentation of research at ISPS 2023.

Anushka Michailova Memorial Best Undergraduate Poster Award at Bioengineering

2023

Day at UC San Diego

- Award received for best capstone project out of 100 teams. Submissions were evaluated on technical depth, innovation, and research dissemination.

Galvanizing Engineering in Medicine (GEM) Grant at UC San Diego

2022 - 2023

- Grant to perform research for the 2022-2023 school year in the Talke Biomedical Device Lab. Wrote the introduction, methods, and specific aims sections. Funded my research towards designing a low-cost stereoscopic vision system.

Academic Senate Grant at UC San Diego

2021 - 2022

- Grant to perform research for the 2021-2022 school year in the Talke Biomedical Device Lab. Wrote the methods section. Funded research towards the real-time tracking of fiducial markers using a smartphone.

Projects

Speculative Decoding via. Mixture of Experts (MoE), Georgia Tech

Sept. 2024 - Present

- Improving speculative decoding for fast autoregressive generation by incorporating mixture of experts for domain-specific tasks.

Supervised ML Approaches for Predicting Cancer Survival Rate, UC San Diego

Apr. 2023 - Jun. 2023

- Performed binary classification on The Cancer Genome Atlas (TCGA) lung adenocarcinoma (LUAD) data to predict cancer survival.
- Performed feature selection on gene expression data using DESeq2 and XGBoost.
- Used Support Vector Machines (SVM) on feature set to achieve 69.05% accuracy.

Brain-Computer Interface (BCI) Signal Classification, UC San Diego

Jan. 2023 - Apr. 2023

- Performed multiclass classification analysis on motor imagery using a BCI competition dataset. Identified subjects' motor visualization using electroencephalography (EEG).
- Designed a novel feature extraction algorithm for electroencephalogram (EEG) data by ensembling time-based data.
- Improved state-of-the-art accuracy from 61.04% to 63.16% using PyTorch neural network architecture.

Leadership and Service

UC San Diego Bioengineering Senior Design

San Diego, CA

CAPSTONE PROJECT ADVISOR

Jul. 2023 - Jun. 2024

- Capstone project advisor for a bioengineering capstone project with Dr. Frank E. Talke.
- Mentored two undergraduates toward the design and development of a surgical navigation system with 3D tracking and augmented reality.

IEEE Engineering in Medicine and Biology Society (EMBS) at UC San Diego

San Diego, CA

FOUNDER

Apr. 2023 - Jul. 2023

- Co-founded IEEE EMBS at UC San Diego with Dr. Gert Cauwenberghs and other Ph.D. students to increase awareness of bioengineering topics and research.
- Recruited 5 graduate students to mentor undergraduate students interested in getting involved in research.

IEEE at UC San Diego

San Diego, CA

PRESIDENT

May 2022 - May 2023

- Oversaw operations for a 300+ student body. Partnered with the San Diego Supercomputing Center (SDSC) to co-found IEEE's Supercomputing Team.
- Hosted lab recruiting talks and technical seminars targeted towards first and second-years looking to get into research. Topics included research in artificial intelligence, robotics, and wearable sensors.
- Awarded the Outstanding IEEE Large Student Branch award for maintaining strong project activities and company relations during tenure.

OUTREACH CHAIR

May 2021 - May 2022

- Taught 60 elementary and middle school female-identifying students the basics of programming at Girls STEM Fair.
- Hosted a robotics workshop in collaboration with Robolink, a San Diego robotics company, where we invited 50 high school students from low-income communities to work with Robolink representatives on coding and designing their own aerial drones.

Biomedical Engineering Society (BMES) at UC San Diego

San Diego, CA

PROJECT TEAM LEAD

Oct. 2021 - Jun. 2022

- Led team of 20 undergraduates in designing a telesurgical prosthetic hand. Hand designs were formulated and constructed based on biomechanics principles.
- Held workshops in CAD, Arduino, and circuit design. Implemented robotic motion in Arduino and interfaced linear actuators.

COMMITTEE MEMBER

Sept. 2019 - Jun. 2023

- Committee member for UC San Diego's Biomedical Engineering Society's (BMES) Bioengineering Day committee, a day-long event celebrating all facets of bioengineering research and development, and Lab Expo committee, an undergraduate research symposium aiming to get students involved in research and academia.
- Recruited graduate students and professors to present research. Organized logistics and advertised events across campus.

Mentoring

2024 **Aryan Musharaf**, Computer Science Undergraduate, Georgia Institute of Technology

2024 **Kunal Talreja**, ECE Undergraduate, Georgia Institute of Technology

2023-2024 **Matthew Tam**, Bioengineering Undergraduate, University of California San Diego

2023-2024 **Eric Lee**, Bioengineering Undergraduate, University of California San Diego

2023-2024 **Kirsten Ramos**, Bioengineering Undergraduate, University of California San Diego

2022-2024 **Capalina Melentyev**, Bioengineering Undergraduate, University of California San Diego

2022-2023 **Rohan Kumar**, Nanoengineering Undergraduate, University of California San Diego

Skills

Programming Python, MATLAB, Bash (Linux Shell Scripting), C++

Libraries PyTorch, TensorFlow, Scikit-learn, OpenCV, Scipy, Matplotlib, Numpy, Pandas

Relevant Coursework Generative and Geometric Deep Learning, Statistical Learning, Bioinformatics Statistical Analysis