HAORAN ZHANG

Phone: (+1) 412-514-7332 ⋄ Email: haoranz5@andrew.cmu.edu

Homepage: users.ece.cmu.edu/~haoranz5

Google Scholar ⋄ Github ⋄ LinkedIn

EDUCATION

Carnegie Mellon University (CMU)   May 2025 (expected)
M.S. in Electrical and Computer Engineering (Advanced Study)
GPA: 4.0/4.0

Huazhong University of Science and Technology (HUST)   June 2023
B.E. in Automation (Advanced Class), School of Artificial Intelligence and Automation
GPA: 3.9/4.0   GRE: 327+3.5

The Technical University of Munich (TUM)   April 2023 - August 2023
Exchange student in Electrical Engineering Department

RESEARCH INTERESTS

My research focuses on optimizing federated learning (a type of distributed ML) systems through theoretical insights. I am also interested in system-level optimization for large-scale ML deployments, mathematical analysis of ML algorithms, and exploring new fields.

RESEARCH EXPERIENCE

Variance-Reduced Sampling in Multi-Model Federated Learning [1]   Jan 2024 - Jul 2024
Supervisors: Dr. Marie Siew, Prof. Carlee Joe-Wong, and Prof. Rachid El-Azouzi   CMU

· Proposed a client sampling approach to minimize the update variance for MMFL, boosting average accuracy across models by over 30% compared to random sampling.
· Presented preliminary findings at ICDCS 2024, receiving the **Best Poster Award**.

Towards Optimal Sampling in Multi-Model Federated Learning [2], [3] Jan 2024 - Present
Supervisors: Dr. Marie Siew, Prof. Carlee Joe-Wong, and Prof. Rachid El-Azouzi   CMU

· Extended sampling process to a "multi-processor" level to incorporate device heterogeneity in MMFL.
· Proposed a cost-efficient sampling method to approximate the computation-intensive method presented in [1], making the approach more feasible for large-scale deployment.
· Improved training efficiency by integrating stale updates in the aggregation process, achieving a mere 4% accuracy gap with only 10% client participation versus full participation (100% clients).
· Conducted convergence analysis to explain the impact of different sampling methods on training.
· Developed an MMFL algorithm that organizes client sampling in a group-based manner, improving convergence speed by up to 15% through increased intra-group homogeneity.

Task Fairness in Multi-Model Federated Learning [4]   Jan 2024 - Mar 2024
Supervisors: Dr. Marie Siew and Prof. Carlee Joe-Wong   CMU

· Evaluated the FedFairMMFL algorithm across diverse multi-model settings, demonstrating improved fairness with 10 models and implemented q-FEL as a baseline.
· Optimized the codebase for clarity and GPU efficiency, streamlining experimental workflows.
· Explored a Bayesian-based sampling probability model to accelerate convergence under extreme client heterogeneity settings.

Efficient Medical Segmentation and Domain-adversarial Learning [5] Feb - Nov 2022
Supervisor: Prof. Hao Chen The Hong Kong University of Science & Technology (HKUST)

· Proposed a pyramidally downsampled 3D Transformer, improving the model's accuracy by 1.72% and efficiency by 12% on brain stroke lesion and prostate segmentation tasks.
· Introduced a cluster-based domain-adversarial learning method to exploit domains at a fine-grained level, improving generalization ability by 2.61% on multi-domains segmentation tasks.
· Finished the code and manuscript (publised at ISBI 2023) independently.

4D Artery Reconstruction and Motion Magnification Apr - Aug 2023
Supervisor: Dr. Zhongliang Jiang TUM

· Implemented motion magnification algorithm to enhance the motion of the artery, facilitating the detection of potential diseases of arteries (demo: tinyurl.com/m-Magnification).
· Implemented a method based on the Transformer and Siamese-like network for tracking 2D arteries from ultrasound videos (demo: tinyurl.com/arterytrack).

DNA Computing and Molecular Circuits Design (Undergrad Thesis) Sep 2022 - Jun 2023
Supervisor: Prof. Linqiang Pan HUST

· Designed DNA switching circuits to simulate the computational devices made of DNA.
· Simulated and synthesized multiple 3D nanostructures using DNA origami.

PUBLICATIONS

[1] **H. Zhang**, Z. Li, Z. Gong, M. Siew, C. Joe-Wong, and R. El-Azouzi, "Poster: Optimal variance-reduced client sampling for multiple models federated learning," in *2024 IEEE 44th International Conference on Distributed Computing Systems (ICDCS)*, Best Poster Award, IEEE, 2024.

[2] **H. Zhang**, Z. Gong, Z. Li, M. Siew, C. Joe-Wong, and R. El-Azouzi, "Federated learning paper," Under Review at INFOCOM 2025.

[3] Z. Gong*, **H. Zhang***, M. Siew, C. Joe-Wong, and R. El-Azouzi, "Group-based client sampling in multi-model federated learning," Under Review at ICASSP 2025 (* for equal contribution).

[4] M. Siew, **H. Zhang**, J.-I. Park, *et al.*, "Fair concurrent training of multiple models in federated learning," *arXiv preprint arXiv:2404.13841*, 2024.

[5] **H. Zhang** and H. Chen, "Efficient 3d transformer with cluster-based domain-adversarial learning for 3d medical image segmentation," in *2023 IEEE 20th International Symposium on Biomedical Imaging (ISBI)*, IEEE, 2023, pp. 1–5.

ACHIEVEMENTS

Best Poster Award, ICDCS 2024	Summer 2024
Outstanding Graduate, HUST	Summer 2023
Scholarship for Scientific and Technological Innovation, HUST	Fall 2022
Honorable Mention in Mathematical Contest In Modeling 2022, COMAP	Summer 2022
Team leader (1st place among 300+ teams) in new student recruitment event, HUST	Fall 2020
Scholarship for Community Engagement, HUST	Fall 2020
Scholarship for Extracurricular Activities and Sports, HUST	Fall 2019

SKILLS/HOBBIES

Programming Languages	Python, C, C++, MATLAB
Machine Learning Tools	Pytorch, Tensorflow, Sklearn, Pandas, Numpy, MONAI
Hobbies	birding and hiking