Zitao Shuai

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BACKGROUND

University of Michigan **Aug 2023- May 2025**

M.S. in Electrical and Computer Engineering

Zhejiang University **Sept 2019- Jun 2023**

B.E. in Computer Science (Honors) & B.A. in Finance (Dual)

Course Highlights: Programming, Data Structures & Algorithms, Computer Vision, Computer Graphics, Machine Learning, Biomedical AI, Medical Imaging, Matrix Methods & Optimization, Mathematical Modeling, Time-Series Analysis, Econometrics

Research Interests: *Multi-Modal Learning, AI for Healthcare, Generative Models, Trustworthy Machine Learning*.

PUBLICATION

First & Co-First Author

[1] Zhang F*, **Shuai Z***, Kuang K, et al. Unified fair federated learning for digital healthcare[J]. **Cell Patterns**, 2024, 5(1).

[2] **Shuai Z***, Wu C*, Tang Z*, et al. Latent Space Disentanglement in Diffusion Transformers Enables Precise Zero-shot Semantic Editing[J]. arXiv preprint arXiv:2411.08196, 2024. [Submitted to **TMLR**]

[3] **Shuai Z**, Shen L. Mitigating Heterogeneity in Federated Multimodal Learning with Biomedical Vision-Language Pre-training[J]. arXiv preprint arXiv:2404.03854, 2024. [Submitted to **TMLR**]

[4] **Shuai Z***, Wu C*, Tang Z*, et al. Dynamic Modeling of Patients, Modalities and Tasks via Multi-modal Multi-task Mixture of Experts. [Submitted to **ICLR2025**]

[5] **Shuai Z**, Yuan J, Zhang F, Zhang K, Kuang K. Incremental Domain Generalization with Contrastive Fusion Training. [UG Thesis]

Non-First-Author

[6] Wang B, **Shuai Z**, Huang C, et al. Multi-Sources Fusion Learning for Multi-Points NLOS Localization in OFDM System[J]. **IEEE Journal of Selected Topics in Signal Processing**, 2024.

[7] Wu C, Restrepo D, **Shuai Z**, et al. Efficient In-Context Medical Segmentation with Meta-driven Visual Prompt Selection[C]//**MICCAI**. Cham: Springer Nature Switzerland, 2024: 255-265.

[8] mBRSET: A Portable Retina Fundus Photos Benchmark Dataset for Clinical and Demographic Prediction. medRxiv, 2024-07. [Submitted to **Nature Scientific Data**]

[9] Multi-OphthaLingua: A Multilingual Benchmark for Assessing and Debiasing LLM Ophthalmological QA in LMICs [Submitted to **AAAI2025**]

Presentation

[10] **Shuai Z***, Wu C*, Tang Z*, et al. Exploring Disentangled Latent Space of Text-to-Image Diffusion Transformer for Fine-grained Semantic Editing. **Multimodal AI TTIC 2024**

RESEARCH EXPERIENCE

Biomedical AI Lab | **University of Michigan, Ann Arbor** **Advisor: Dr. Liyue Shen**

Research Roadmap: *Tackling data limitation in medical multi-modal learning* Sep 2023 - Present

- **[2,10] Uncovering Disentanglement in Diffusion Transformer for Image Editing** | Lead Researcher
  - Motivation: Uncovering disentanglement property in diffusion transformer (DiT) to precisely edit image semantic intensity.
  - Responsibility: Identified semantic disentanglement property of DiT based on experiment observation, theoretically modeled this effect and proposed a semantic-disentanglement score to quantify it, developed an Extract-Manipulate-Sample pipeline for precise image editing, conducted in-depth qualitative & quantitative experiments, co-authored and revised the manuscript.
- **[3] Federated Medical Vision-Language Pre-training under Data Heterogeneity** | Lead Researcher
  - Motivation: Modeling & tackling data heterogeneity in federated V-L pretraining with mutual information-based DRO.
  - Responsibility: Identified the data heterogeneity problem in federated multi-modal pre-training, proposed a two-stage DRO local training method and a global guidance loss, implemented pre-training methods and federated learning algorithms, conducted and scheduled over 50 pre-training trials & 500 downstream evaluations, authored and revised the manuscript.

- **[4] Multi-Modal Multi-Task Mixture of Experts for Medical Imaging** | Lead Researcher
  - Motivation: Modeling sample-adaptive and dynamic modality-task dependence in multi-modal multi-task learning via MoE.
  - Responsibility: Conducted analysis experiments to identify modality competition problem, proposed a task MoE block to model dynamical dependence of modalities and task in a probabilistic view, developed a M4oE framework and implemented models & baselines with team, co-authored and revised the manuscript.
- **[7] Efficient In-context Medical Image Segmentation with Natural Foundation Model** | Main Researcher
  - Motivation: Improving efficiency in leveraging natural foundation models for medical image segmentation with meta RL.
  - Responsibility: Worked with team to develop a meta-reinforcement-learning method to select visual prompts for in-context learning, run baseline models, revised writing and figures in the manuscript with collaborators.

Lab of Computational Physiology | **Massachusetts Institute of Technology** **Advisor: Dr. Luis Filipe Nakayama**

Research Roadmap: *Building Trustworthy medical AI systems* Apr 2024 - Present

- **Synthetic Counterfactual Pairs for Learning Generalizable Retinal Classifier** | Lead Researcher
  - Motivation: Improving the generalization ability of retinal models by leveraging synthetic counterfactual pairs.
  - Responsibility: Identified performance decrease of retinal classifiers on under-represented subgroups and unseen domains, trained multiple retinal latent diffusion models, generated counterfactual pairs through editing real data with the diffusion model, derived a regularization loss term to leverage counterfactual pairs to enhance generalization ability.
  - Contribution: An in-preparation paper, 1st author.
- **[8] Debiasing LLM Ophthalmological QA in Low-middle Income Countries with RAG** | Main Researcher
  - Motivation: Improving LLM's performance on ophthalmological diagnosis on LMICs data with a multi-agent RAG system.
  - Responsibility: Developed a multi-agent RAG system to reduce biases in LLMs for multilingual ophthalmological question-answering with team, implemented and evaluated the multi-agent RAG method and baselines on our provided benchmark.
- **[9] Portable Retinal CFP Benchmark Dataset for Clinical and Demographic Prediction** | Main Researcher
  - Motivation: Addressing the lack of retinal data in LMICs by providing a retinal imaging dataset taken on portable devices
  - Responsibility: Implemented 12 vision models, conducted experiments to evaluate their performance on our provided dataset.

Trustworthy AI Lab **| Zhejiang University** **Advisor: Dr. Kun Kuang**

Research Roadmap: *Improving trustworthiness of ML model in O.O.D. Scene* Jun 2022 – Dec 2023

- **[1] Unified Fair Federated Learning for Healthcare** | Lead Researcher
  - Motivation: Federally learn healthcare models with DRO to provide fair outcomes for different demographic subgroups.
  - Responsibility: Provided unified modeling of 3 fairness problems in federated learning (FL) based on the distributionally robust optimization theory, worked with team to derive the learning object and proposed a FedUFO method, implemented FL algorithms, conducted experiments and analysis studies on 4 healthcare tabular datasets.
- **[5] Incrementally Learning Domain-Generalizable Patterns** | Lead Researcher
  - Motivation: Enabling DG methods in continually learning generalizable patterns via dynamically fusing old & new knowledge.
  - Responsibility: Managed full-cycle research process, identified the challenge of continually learning generalization patterns, designed a contrastive fusion training strategy & a VMF-VAE framework, implemented 11 DG algorithms, conducted experiments and analysis studies on 5 DG benchmarks, authored and revised the manuscript.
- **[6] Multi-Points NLOS Localization with Multi-Source Fusion Training** | Main Researcher
  - Motivation: Tackling data heterogeneity of fingerprints in non-line-of-sight (NLOS) scenes with domain fusion training.
  - Responsibility: Collaborated with domain experts to identify the heterogeneity problem in NLOS localization problem, proposed an AMDNLoc framework to fuse fingerprints from multiple domains to jointly train a robust prediction model.

AWARDS &HONORS

Outstanding Graduate of Zhejiang University (10%) Jun 2023
Zhejiang University Scholarship (10%) Oct 2022
Undergraduate Research Training Project Fellowship of Zhejiang University (10%) Apr 2022
Advanced Research Training Fellowship of Chu Kochen Honors College (10%) Apr 2021

SKILLS

Programming Language: C/C++, Python, Matlab**,** Pytorch, Tensorflow, Scikit-learn, PytorchLightning