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)

Member of Chu Kochen Honors College

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] Wu C*, **Shuai Z*,** Tang Z*, et al. Dynamic Modeling of Patients, Modalities and Tasks via Multi-modal Multi-task Mixture of Experts. https://openreview.net/forum?id=NJxCpMt0sf [**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] Wu, C., Restrepo, D., Nakayama, L. F., Ribeiro, L. Z., **Shuai, Z.**, ... & Andrade, R. E. (2024). mBRSET: A Portable Retina Fundus Photos Benchmark Dataset for Clinical and Demographic Prediction. [Submitted to **Nature Scientific Data, Minor Revision**]

[9] Restrepo, D., Wu, C., Tang, **Z., Shuai**, ... & Nakayama, L. F. (2024). Multi-OphthaLingua: A Multilingual Benchmark for Assessing and Debiasing LLM Ophthalmological QA in LMICs. arXiv preprint arXiv:2412.14304. [**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. Leo A Celi**

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

- **Synthetic Counterfactual Pairs for Learning Generalizable Retinal Classifier** | Lead Researcher
  - Motivation: Leveraging synthetic data to improve the robustness of retinal models to image qualities.
  - Responsibility: Identified performance decrease of retinal classifiers on under-represented subgroups and unseen domains, trained multiple retinal latent diffusion models and diagnosis model, derived a group-balancing training loss to train a less biased model, and adapted the direct preference optimization to align diffusion model.
  - Contribution: An in-preparation paper for The Lancet Digital Health, 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
"Meritorious Winner" in the Mathematical Contest In Modeling and Interdisciplinary Contest In Modeling (10%) Feb 2021
2nd Prize in National High School Mathematical Olympiad (5%) Oct 2018
2nd Prize in National High School Biology Olympiad (5%) May 2018

ACADEMIA SERVICES

Reviewer for Machine Learning Healthcare Jun 2024
Reviewer for International Conference of Machine Learning Mar 2024
Reviewer for IEEE Transaction of Medical Imaging Mar 2024
Reviewer for IEEE Transaction of Neural Network Learning System Mar 2024
Reviewer for ACM Knowledge Discovery and Data Mining Mar 2023

SKILLS

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

OUTREACH

Teaching Assistant **| Magic AI Summer School, University of Michigan** **Aug 2024**

- Prepared course materials and demos, delivered lectures on fundamental AI concepts, provided support for student inquiries.

Varsity Member **| Men's Tennis Varsity, Zhejiang University** **Sept 2019 - Mar 2022**

- Achieved top 8 placements in campus competitions, organized tennis promotion events.