ZHONGYI CAI

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[Google Scholar](#)

EDUCATION

Michigan State University   Aug. 2024 - Present
Ph.D. Computer Science and Engineering
Advisor: Prof. Yu Kong

ShanghaiTech University   Sep. 2021 - July 2024
M.E. Computer Science and Technology
Advisor: Prof. Jingya Wang and Prof. Ye Shi
Core Courses: Deep Learning, Computer Vision II, Computer Graphics II, Machine Learning

ShanghaiTech University   Sep. 2017 - July 2021
B.E. Computer Science and Technology
Core Courses: Linear Algebra, Probability and Statistics, Computer Vision I, Artificial Intelligence

University of Padova   Aug. 2019 - Sep. 2019
Summer School

PUBLICATIONS

[1] **FedTP: Federated Learning by Transformer Personalization** [Paper]
*Hongxia Li#, **Zhongyi Cai#**, Jingya Wang, Jiangnan Tang, Weiping Ding, Chin-Teng Lin, Ye Shi**
- Accepted by *IEEE Transactions on Neural Networks and Learning Systems 2023*

[2] **Fed-CO$_2$: Cooperation of Online and Offline Models for Severe Data Heterogeneity in Federated Learning** [Paper]
***Zhongyi Cai**, Ye Shi*, Wei Huang, Jingya Wang*
- Accepted by *NeurIPS 2023*

[3] **Understanding Convergence and Generalization in Federated Learning through Feature Learning Theory** [Paper]
*Wei Huang, Ye Shi, **Zhongyi Cai**, Taiji Suzuki*
- Accepted by *ICLR 2024*

RESEARCH INTERESTS

- My research interests lie in the field of **Computer Vision** issues under various learning scenarios, especially those involving multiple domains, agents or tasks.

PROJECTS

- **Label Distribution Imbalance and Feature Shift Issues in Federated Learning** [2]
Supervisor: Prof. Ye Shi and Prof. Jingya Wang   October 2022 - September 2023
  - Addressed severe data heterogeneity issues in Federated Learning including both label distribution skew and feature skew.
  - Proposed a universal cooperative FL framework for mentioned data heterogeneity problems, where the predictions from the online and offline models are fused.
  - Designed an intra-client knowledge transfer mechanism that bolsters model cooperation through knowledge distillation, and an inter-client knowledge transfer mechanism that reinforces the model's domain generalization ability by introducing classifiers from the offline models of other clients for FL scenarios where feature skew appears.

- Proved that our framework Fed-CO$_2$ has better convergence behavior than prior SOTA method FedBN with the Neural Tangent Kernel theory and showed that it outperforms extensive SOTA methods in FL with label distribution skew, feature skew, and both.

- **Personalize Transformer to Adapt to Local Data Distribution in Federated Learning** [1]
  Supervisor: Prof. Ye Shi and Prof. Jingya Wang   March 2022 - May 2023

  - Explored the effects of the self-attention mechanism in personalized federated learning and revealed that the classic algorithm FedAvg may have negative impacts on self-attention when data heterogeneity is present.
  - Proposed a novel transformer-based federated learning framework to learn personalized self-attention for each client.
  - Proposed a learn-to-personalize mechanism that can better exploit clients' cooperations in the personalized layers and derived the generalization bounds.
  - Our algorithm FedTP yields SOTA performance over a wide range of personalized federated learning benchmark methods on both image and language tasks.

- **Explain Convergence and Generalization of Federated Learning with Feature Learning Theory.**[3]
  Supervisor: Dr. Wei Huang and Prof. Ye shi   July 2023 - Present

  - Demonstrated the convergence properties of the classic algorithm FedAvg based on the Feature Learning Theory.
  - Established the exact generalization gap between FedAvg and local training algorithms with signal-to-noise ratio in feature learning theory.
  - Validated our theoretical assertion by conducting extensive experiments on both synthetic and real-world datasets.

- **Cross-Domain Few-Shot Learning for Image Classification**
  Supervisor: Prof. Jingya Wang   May 2021 - December 2021

  - Developed model's ability to learn to recognize images in novel classes from novel domain with few labeled data.
  - Utilized Self-Supervised Learning technique to aid the feature extractor in capturing more comprehensive representations of input data and enhancing the domain generalization ability.

WORK EXPERIENCE

Hikvision Research Institute   December 2020 - March 2021
Algorithm Engineer Intern (Part-time)   *Shanghai, China*

- Utilized Optical Character Recognition (OCR) technique on plate number detection and recognition with YOLO.
- Engaged in ICDAR 2021 Robust Reading Challenge - Integrated Circuit Text Spotting and Aesthetic Assessment (ICDAR RRC-ICTEXT 2021) and won the first-place solution.

TEACHING EXPERIENCE

Teaching Assistant   ShanghaiTech University
Delivering tutorials; Designing projects, assignments, and quizzes; Grading homework and exams;
· CS110: Computer Architecture I   2020 Spring
· CS132: Software Engineering   2021 Spring
· CS272: Computer Vision II   2022 Spring
· CS172: Computer Vision I   2023 Spring

ADDITIONAL

- Programming: Python, C++, C, MATLAB, R, Rust

- Languages: Chinese (Native), English (Fluent)

- Framework: PyTorch

- Hobbies: Hiking, Traveling, Playing Badminton, Swimming, Playing MOBA computer games.