Jack Cai

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Education

- **Ph.D. In Computer Science** **2025 - Present**
  Princeton University *Princeton, New Jersey*

- **Master of Science in Electric and Computer Engineering** **2023 - 2025**
  University of Wisconsin-Madison *Madison, United States*
  GPA: 3.85

- **Bachelor of Science in Computer Engineering** **2019 - 2023**
  Concurrent major in Computer Science and Math *Madison, United States*
  University of Wisconsin-Madison
  GPA: 3.85, Honors in Major

Publications

- **Extrapolation by Association: Length Generalization Transfer in Transformers**

  ***Ziyang Cai**, Nayoung Lee, Avi Schwartzchild, Samet Oymak, Dimitris Papailiopoulos*

  NeurIPS Spotlight, 2025

- **Self-Improving Models Overcome Length and Hardness Generalization via Weak-to-Strong Scaling**

  Ziyang Cai, Nayoung Lee*, Avi Schwartzchild, Kangwook Lee, Dimitris Papailiopoulos*

  ICML, 2025

- **Everything Everywhere All at Once: LLMs can In-Context Learn Multiple Tasks in Superposition**

  *Zheyang Xiong, **Ziyang Cai**, John Cooper, Albert Ge, Vasilis Papageorgiou, Zack Sifakis, Angeliki Giannou, Ziqian Lin, Liu Yang, Saurabh Agarwal, Grigorios Chrysos, Samet Oymak, Kangwook Lee, Dimitris Papailiopoulos*

  ICML Spotlight, 2025

- **R&B: Domain Regrouping and Data Mixture Balancing for Efficient Foundation Model Training**

  Albert Ge, Tzu-Heng Huang, John Cooper, Avi Trost, Ziyi Chu, Satya Sai Srinath Namburi GNVV, **Ziyang Cai**, Kendall Park, Nicholas Roberts, Frederic Sala

  In Submission, 2025

- **Delving into Out-of-Distribution Detection with Vision-Language Representations**

  *Yifei Ming, **Ziyang Cai**, Jiuxiang Gu, Yiyou Sun, Wei Li, Yixuan Li*

  NeurIPS, 2022

Research Experience

- **PhD Student in Sanjeev Arora's Lab** **Sep. 2025 -Present**
  Princeton University *Princeton, NJ*

  - Researching synthetic data generation, theory of language models, and out-of-distribution generalization.

- **Research Intern** **Jun. 2025 - Aug. 2025**
  Microsoft Research *Seattle, WA*
  - Created automated synthetic data pipelines for training coding agents.
  - Synthesized hundreds of ML coding tasks and thousands of agent trajectories for training.
  - Trained 4B and 8B models to perform on-par with frontier models on the MLGym benchmark.

- **Research Assistant** **Aug. 2023 - Aug. 2025**
  Prof. Dimitris Papailiopoulos's Lab *UW-Madison*
  - Investigating in-context learning and out-of-distribution generalization in language models.
  - Demonstrated superposition phenomenon in pretrained language models, analyzing how they solve multiple superimposed ICL tasks through the lens of task vectors.
  - Demonstrated weak-to-strong generalization and length generalization in transformer models trained on synthetic problems.
  - Investigating compositional generalization in transformers on synthetic problems.

- **Research Assistant** **Jul. 2022 - Aug. 2023**
  Prof. Junjie Hu's Lab *UW-Madison*
  - Researched Scene Graph Generation using pretrained multimodal models like BLIP and OFA.
  - Fine-tuned open-source multimodal models on scene graph data, achieving comparable results with other conventional multi-staged methods.

- **Research Assistant** **Sep. 2021 - Jun. 2022**
  Prof. Sharon Li's Lab *UW-Madison*
  - Helped develop a new out-of-distribution detection method in image classification using visual-lingual representations from the CLIP model.
  - Contributed to research demonstrating the superiority of pretrained vision-language models in OOD detection compared to traditional approaches.

Work Experience

- **Teaching Assistant** **Spring 2024**
  ECE 431 Digital Signal Processing *UW-Madison*
- **Teaching Assistant** **Fall 2023**
  ECE 561 Information Theory and Machine Learning *UW-Madison*
- **Software Engineer Intern** **May 2022 - Aug. 2022**
  Cisco Systems Inc. *San Jose, CA*

Projects

- **CAFA 5 Protein Function Prediction Challenge (Kaggle)** **2023**
  - Developed a deep learning pipeline to predict hierarchical labels for protein function.
  - Leveraged diverse data sources including protein sequences, AlphaFold protein structures, and protein-protein interaction graphs.
  - Implemented a graph neural network and protein language models to generate features for prediction.

Technical Skills

- **Programming Languages:** Python, C++
- **Tools and Frameworks:** PyTorch, TensorFlow, Hugging Face, CUDA
- **Areas of Expertise:** Machine Learning, Natural Language Processing, Computer Vision, Out-of-Distribution Detection, In-Context Learning