Junhong Shen

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Research Interests

Multi-Modal Reasoning, Generation, and Agent Applications

Education

Carnegie Mellon University, *Ph.D. in Machine Learning* Sep 2021 – Present

- **Advisor:** Ameet Talwalkar, **GPA:** 4.0/4.0
- **Thesis:** Navigating Through Heterogeneous Data: Building AI Systems for Diverse Data Types, Domains, and Complexities
- **Thesis Committee:** Ameet Talwalkar (CMU/Datadog), Ruslan Salakhutdinov (CMU/Meta), Aviral Kumar (CMU/DeepMind), Ludwig Schmidt (Stanford/Anthropic), Alexander Toshev (Apple)
- **Available for Full-Time:** Nov 2025

University of California, Los Angeles, *B.S. in Mathematics of Computation* Sep 2017 – June 2021

- **Daus Prize:** 5 top undergraduate students in the mathematics department, **GPA:** 4.0/4.0

Publications

Preprint

RECODE: Reasoning Through Code Generation for Visual Question Answering [paper]
Junhong Shen, Mu Cai, Bo Hu, Ameet Talwalkar, David A. Ross, Cordelia Schmid, Alireza Fathi

CodePDE: An Inference Framework for LLM-Driven PDE Solver Generation [paper] [code]
Shanda Li, Tanya Marwah, ***Junhong Shen***, Weiwei Sun, Andrej Risteski, Yiming Yang, Ameet Talwalkar

Terminal-Bench: A Benchmark for AI Agents in Terminal Environments [website] [code]
Mike Merrill, Alexander Shaw, Nicholas Carlini, Boxuan Li, Harsh Raj, Ivan Bercovich, Lin Shi, Jeong Yeon Shin, ***Junhong Shen***, ...73 authors..., Andy Konwinski, Ludwig Schmidt

Peer-Reviewed Articles

Thinking vs. Doing: Agents that Reason by Scaling Test-Time Interaction [paper] [code] [website]
NeurIPS 2025
Junhong Shen*, Hao Bai*, Lunjun Zhang, Yifei Zhou, Amrith Setlur, Shengbang Tong, Diego Caples, Nan Jiang, Tong Zhang, Ameet Talwalkar, Aviral Kumar

CAT: Content-Adaptive Image Tokenization [paper]
NeurIPS 2025
Junhong Shen, Kushal Tirumala, Michihiro Yasunaga, Ishan Misra, Luke Zettlemoyer, Lili Yu*, Chunting Zhou*

Mixture-of-Mamba: Enhancing Multi-Modal State-Space Models with Modality-Aware Sparsity [paper] [code]
ICLR 2025 Scalable Optimization for Efficient and Adaptive Foundation Models Workshop (Oral, top 8/96)
Weixin Liang*, ***Junhong Shen****, Genghan Zhang, Ning Dong, Luke Zettlemoyer, Lili Yu

ScribeAgent: Towards Specialized Web Agents Using Production-Scale Workflow Data [paper] [code] [blog]
ICLR 2025 Foundation Models in the Wild Workshop
Junhong Shen, Atishay Jain, Zedian Xiao, Ishan Amlekar, Mouad Hadji, Aaron Podolny, Ameet Talwalkar

Specialized Foundation Models Struggle to Beat Supervised Baselines [paper] [code]
ICLR 2025

Zongzhe Xu, Ritvik Gupta, Wenduo Cheng, Alexander Shen, ***Junhong Shen***, Ameet Talwalkar, Mikhail Khodak

Tag-LLM: Repurposing General-Purpose LLMs for Specialized Domains [paper] [code]
ICML 2024
Junhong Shen, Neil Tenenholtz, James Brian Hall, David Alvarez-Melis, Nicolò Fusi

UPS: Towards Foundation Models for PDE Solving via Cross-Modal Adaptation [paper] [code]
TMLR 2024 & ICML 2024 AI4Science Workshop (Spotlight)
Junhong Shen, Tanya Marwah, Ameet Talwalkar

Cross-Modal Fine-Tuning: Align then Refine [paper] [code] [talk] [website]
ICML 2023 (Oral, top 158/6538)
Junhong Shen, Liam Li, Lucio M. Dery, Corey Staten, Mikhail Khodak, Graham Neubig, Ameet Talwalkar

Efficient Architecture Search for Diverse Tasks [paper] [code] [blog]
NeurIPS 2022
Junhong Shen*, Mikhail Khodak*, Ameet Talwalkar

NAS-Bench-360: Benchmarking Neural Architecture Search on Diverse Tasks [paper] [website] [blog]
NeurIPS 2022 Datasets and Benchmarks Track
Renbo Tu*, Nicholas Roberts*, Mikhail Khodak, ***Junhong Shen***, Frederic Sala, Ameet Talwalkar

AutoML Decathlon: Diverse Tasks, Modern Methods, and Efficiency at Scale [paper] [website]
NeurIPS 2022 Competitions Track
Nicholas Roberts, ... 24 authors ..., ***Junhong Shen***, Evan Sparks

Iterative Teacher-Aware Learning [paper] [code]
NeurIPS 2021
Luyao Yuan, Dongruo Zhou, ***Junhong Shen***, Jingdong Gao, Jeffrey Chen, Quanquan Gu, Ying Nian Wu, Song-Chun Zhu

Theoretically Principled Deep RL Acceleration via Nearest Neighbor Function Approximation [paper] [code]
AAAI 2021
Junhong Shen, Lin F. Yang

Mathematical Reconstruction of Patient-Specific Vascular Networks Based on Clinical Images and Global Optimization [paper] [code] [talk]
IEEE Access
Junhong Shen, Abdul Hannan Faruqi, Yifan Jiang, Nima Maftoon

Emergence of Pragmatics from Referential Game between Theory of Mind Agents [paper] [code]
NeurIPS 2019 Emergent Communication Workshop
Luyao Yuan, Zipeng Fu, Jingyue Shen, Lu Xu, ***Junhong Shen***, Song-Chun Zhu

* Equal Contribution

Experience

Student Researcher, Google DeepMind, Mountain View, CA — May 2025 – Sep 2025

- Mentors: Alireza Fathi, Cordelia Schmid, David A. Ross
- Improving visual reasoning agents via code generation and image derendering.

Research Intern, FAIR at Meta, Seattle, WA — May 2024 – Dec 2024

- Mentors: Chunting Zhou, Lili Yu, Luke Zettlemoyer
- Worked on caption-based adaptive image tokenization. Paper accepted by NeurIPS 2025.

Senior Machine Learning Researcher, Scribe AI/ML, Pittsburgh, PA Feb 2024 – May 2024

- Post-training LLMs for web navigation. Developed ScribeAgent, the SOTA open-source web agent.

Research Intern, Microsoft Research, Cambridge, MA May 2023 – Aug 2023

- Mentors: David Alvarez-Melis, Nicolò Fusi
- Aligning LLMs to specialized domains (e.g., low-resource languages, protein sequences, chemical formulas) via special tokens. Paper accepted by ICML 2024.

Research Intern, Determined AI, Hewlett Packard Enterprise, Pittsburgh, PA Jun 2022 – Dec 2022

- Mentor: Liam Li
- Fine-tuning LLMs and ViTs for diverse modalities via tokenizer training and distribution alignment. Paper accepted by ICML 2023 as an oral presentation.

Product Manager Intern, SenseTime Face ID Research, Beijing, China Jun 2018 – Sep 2018

- Worked on 3D-structured-light Face ID; participated in 5 software version releases and testing.

Honors & Awards

CMU MLD Google PhD Fellowship Nomination, one of 3 PhD students nominated 2025

Wilson Center, Pathways to AI Policy Program, fellow 2025

J.P. Morgan AI Ph.D. Fellowship, awardee (accepted) 2024

Bloomberg Data Science Ph.D. Fellowship, awardee (declined) 2024

CMU MLD Two Sigma PhD Fellowship Nomination, one of 2 students nominated 2023

UCLA Daus Prize, top-5 undergraduate students in mathematics 2021

UCLA Dean's Honors List, awardee 2017 – 21

Talks

Thinking vs. Doing: Agents that Reason by Scaling Test-Time Interaction Sep 2025
New York Reinforcement Learning Workshop

Production-Scale Workflow Data Empowers Specialized Web Agents Aug 2025
Ai4 Research Summit

Thinking vs. Doing: Agents that Reason by Scaling Test-Time Interaction Aug 2025
Agentic AI Summit, Berkeley

LLM Meets Web Browsing Apr 2025
AIRe Lab @ CMU

LLM Meets Web Browsing Mar 2025
EFML Reading Group, Stanford

Repurposing LLMs for Long-Tail ML Applications Aug 2024
Ai4 Research Summit

Machine Learning for Diverse Tasks Nov 2023
Guest Lecture, ML with Large Datasets, CMU 10605

Bridging LLMs and Long Tail ML Applications Nov 2023
Catalyst Reading Group, CMU

Cross-Modal Fine-Tuning Mar 2023
AI4Science Talks

DASH: How to Search Over Convolutions Dec 2022
The AutoML Podcast

Tackling Diverse Tasks with Neural Architecture Search Oct 2022
DLML Journal Club, Mayo Clinic

Professional Service

Co-organizer: CMU Agent Workshop (2024 & 2025); AutoML Decathlon, NeurIPS 2022 Competition Track

Committee Member: CMU MSML Admissions Committee (Fall 2022); CMU MLD Open House Committee (Spring 2024/2025)

Conference Reviewer: NeurIPS (2022-2025), ICLR (2024/2025), ICML (2024/2025), AAAI (2025), CVPR (2025), ICCV (2025)

Teaching Assistant: Deep Learning Systems (CMU 10714), ML in Practice (CMU 10718), Linear Algebra (UCLA Math 115A)

Skills

Programming: Python, C, C++, Bash, R (Proficient); MATLAB, Java, Arduino (Familiar)

Tools: Git, LaTeX, PyTorch, Tensorflow, Scikit-learn, OpenCV, OpenAI Gym, Google Cloud Platform, Docker, SolidWorks

Research Experience

SAGE Lab, CMU, Pittsburgh, PA June 2021 – Present
Advisor: Ameet Talwalkar
- Ph.D. research on developing effective and efficient ML/AutoML tools for solving diverse tasks in practice.

Lin Yang's Group, UCLA, Los Angeles, CA Jan 2020 – June 2021
Advisor: Lin F. Yang
- Studied sample-efficient reinforcement learning; proposed an algorithm for estimating the value functions using nearest neighbor function approximator; provided theoretical justification on the sample complexity.

Center for Vision, Cognition, Learning, and Autonomy, UCLA, Los Angeles, CA Jan 2019 – June 2021
Advisors: Song-Chun Zhu, Ying Nian Wu
- Studied how theory of mind (ToM) can be integrated into various ML settings to improve algorithm efficiency.
- **Project 1: Multi-Agent Deep Reinforcement Learning with ToM.** Proposed a ToM algorithm in a referential game setting where the teacher and the student model each other's action likelihood while learning Q-functions.
- **Project 2: Efficient Learners in Iterative Machine Teaching:** Integrated ToM into machine teaching; improved teaching efficiency by having the learners model the teacher's training sample selection strategy.
- **Project 3: Meta Machine Teaching:** Studied how meta-learning can be combined with machine teaching.

Computational Metastasis Lab, Fields Institute, Toronto, Canada Jul 2019 – Sep 2019
Advisor: Nima Maftoon (University of Waterloo)
- Developed a vascular network reconstruction framework that uses the main vessel skeletons segmented from clinical images and global constructive optimization to generate patient-specific cerebral vascular models.