

Peiyang Song

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Education

6/2026	California Institute of Technology	Pasadena, CA
(expected)	<i>B.S. in Computer Science & Minor in Robotics</i>	
	Advisors: Prof. Steven Low & Prof. Günter Niemeyer. GPA: 4.2/4.0	

Research Interests

My research focuses on **LLM reasoning**, **agentic AI**, and **neuro-symbolic AI**. I aim to advance intelligent agents capable of rigorous reasoning by combining the strengths of neural and symbolic paradigms, with one central theme and two adjacent directions:

- **Central theme:** Integrating LLM reasoning, agentic AI, and neuro-symbolic methods by combining *neural* models (LLMs) with *symbolic* systems (e.g., Lean) to advance LLM-based agents for formal reasoning in mathematics and code.
- **Broader LLM reasoning:** Extending from formal to informal reasoning, exploring how LLMs can better handle reasoning in natural language contexts, informed by *cognitive science* principles and studies of *human-like reasoning* processes.
- **Broader neuro-symbolic AI:** Applying neuro-symbolic approaches to broader AI challenges beyond formal reasoning, including the design of energy-efficient machine learning systems.

Selected Publications & Preprints

Refereed Publications

TMLR 2026	Large Language Model Reasoning Failures <u>Peiyang Song*</u> , Pengrui Han*, Noah Goodman (* Equal Contribution) <i>Transactions on Machine Learning Research, 2026, Survey Certification</i>
NeuS 2025	Lean Copilot: Large Language Models as Copilots for Theorem Proving in Lean <u>Peiyang Song</u> , Kaiyu Yang, Anima Anandkumar <i>International Conference on Neuro-symbolic Systems, 2025, 1.2k+ stars on Github, ranking 2nd after Mathlib4 among all Lean projects</i>
IEEE Micro 2025	Delay Space Arithmetic and Architecture <u>Rhys Gretsch</u> , <u>Peiyang Song</u> , Advait Madhavan, Jeremy Lau, Timothy Sherwood <i>IEEE Micro, Top Pick Award</i>
ICLR 2025	LeanAgent: Lifelong Learning for Formal Theorem Proving <u>Adarsh Kumarappan*</u> , Mo Tiwari*, <u>Peiyang Song</u> , Robert Joseph George, Chaowei Xiao, Anima Anandkumar

- TMLR 2025 **LeanProgress: Guiding Search for Neural Theorem Proving via Proof Progress Prediction**
Robert Joseph George, Suozhi Huang, Peiyang Song, Anima Anandkumar
Transactions on Machine Learning Research, 2025
- EMNLP 2024 **In-Context Learning May Not Elicit Trustworthy Reasoning: A-Not-B Errors in Pretrained Language Models**
Pengrui Han*, Peiyang Song*, Haofei Yu, Jiaxuan You (* Equal Contribution)
Findings of the Association for Computational Linguistics: EMNLP, 2024
- EMNLP 2024 **Creative and Context-Aware Translation of East Asian Idioms with GPT-4**
Kenan Tang*, Peiyang Song*, Yao Qin, Xifeng Yan (* Equal Contribution)
Findings of the Association for Computational Linguistics: EMNLP, 2024
- ASPLOS 2024 **Energy Efficient Convolution with Temporal Arithmetic**
Rhys Gretsch, Peiyang Song, Advait Madhavan, Jeremy Lau, Timothy Sherwood
ACM International Conference on Architectural Support for Programming Languages and Operating Systems, 2024
- NeurIPS 2023 **LeanDojo: Theorem Proving with Retrieval-Augmented Language Models**
Kaiyu Yang, Aidan Swope, Alex Gu, Rahul Chalamala, Peiyang Song, Shixing Yu, Saad Godil, Ryan Prenger, Anima Anandkumar
Advances in Neural Information Processing Systems, 2023, Oral Presentation

Preprints

- Preprint **AI Impact on Human Proof Formalization Workflows**
Katherine M. Collins*, Simon Frieder*, Jonas Bayer, Jacob Loader, Jeck Lim, Peiyang Song, Fabian Zasier, Lexin Zhou, Shanda Li, Sam Looi, Jose Hernandez-Orallo, Joshua B. Tenenbaum, Cameron Freer, Umang Bhatt, Adrian Weller, Valerie Chen†, Ilia Sucholutsky† (* Equal Contribution, † Equal Advising)
NeurIPS Workshop on Mathematical Reasoning and AI (MATH-AI), 2025
- Preprint **The Personality Illusion: Revealing Dissociation Between Self-Reports & Behavior in LLMs**
Pengrui Han*, Rafal D. Kocielnik*, Peiyang Song, Ramit Debnath, Dean Mobbs, Anima Anandkumar, R. Michael Alvarez (* Equal Contribution)
NeurIPS LAW Workshop: Bridging Language, Agent, and World Models, 2025, Oral Presentation + Best Paper Honorable Mention Award; NeurIPS Workshop on LLM Persona Modeling, 2025, Oral Presentation
- Preprint **Adaptation of Agentic AI**

Pengcheng Jiang*, Jiacheng Lin*, Zhiyi Shi*, Zifeng Wang, Luxi He, Yichen Wu, Ming Zhong, Peiyang Song, Qizheng Zhang, Heng Wang, Xueqiang Xu, Hanwen Xu, Pengrui Han, Dylan Zhang, Jiashuo Sun, Chaoqi Yang, Kun Qian, Tian Wang, Changran Hu, Manling Li, Quanzheng Li, Hao Peng, Sheng Wang, Jingbo Shang, Chao Zhang, Jiaxuan You, Liyuan Liu, Pan Lu, Yu Zhang, Heng Ji, Yejin Choi, Dawn Song, Jimeng Sun, Jiawei Han (* Equal Contribution)

Preprint, 2025

- Preprint **How and Why LLMs Generalize: A Fine-Grained Analysis of LLM Reasoning from Cognitive Behaviors to Low-Level Patterns**

Haoyue Bai*, Yiyou Sun*, Wenjie Hu, Shi Qiu, Maggie Ziyu Huan, Peiyang Song, Robert Nowak, Dawn Song (* Equal Contribution)

Preprint, 2025

Selected Academic Awards

- 1/2026 **Survey Certification @ TMLR**
For paper “Large Language Model Reasoning Failures”
- 12/2025 **Best Paper Honorable Mention Award @ NeurIPS LAW Workshop**
For paper “The Personality Illusion: Revealing Dissociation Between Self-Reports & Behavior in LLMs”
- 5/2025 **ICLR Notable Reviewer Award**
In recognition of outstanding review service at ICLR 2025
- 4/2025 **George W. Housner Student Discovery Fund**
For paper “Lean Copilot: Large Language Models as Copilots for Theorem Proving in Lean”
- 2/2025 **IEEE Micro Top Pick Award**
For paper “Energy Efficient Convolutions with Temporal Arithmetic”
- 4/2023 **Caltech SURF Fellowship**
For research work on machine learning for theorem proving in Lean

Selected Media

- 2026 **Scientists Found AI’s Fatal Flaw—The Most Advanced Models Are Failing Basic Logic Tests**
Popular Mechanics
- 2025 **New Framework Simplifies the Complex Landscape of Agentic AI**
VentureBeat
- 2025 **This AI Paper Explains Why Most “Agentic AI” Systems Feel Impressive in Demos and then Completely Fall Apart in Real Use**
MarkTechPost
- 2025 **Researchers Discover “Personality Illusion” to Reveal a Profound Disconnect Between Language and Behavior in LLMs**

- MIT Technology Review China*
- 2024 **Mathematicians' Newest Assistants Are Artificially Intelligent**
Scientific American
- 2024 **LeanAgent: The First Life-Long Learning Agent for Formal Theorem Proving in Lean**
MarkTechPost
- 2024 **Lean Copilot: An AI Tool That Allows Large Language Models (LLMs) to Be Used in Lean for Proof Automation**
MarkTechPost
- 2023 **Can LLMs Generate Mathematical Proofs That Can Be Rigorously Checked?**
MarkTechPost

Invited Talks & Tutorials

LLM Reasoning for Math and Code

10/2025 Carnegie Mellon University L3 Lab

Tutorial: Neuro-Symbolic Theorem Proving with Lean

9/2024 3rd Neuro-Symbolic AI Summer School (NSSS)

Towards An AI Mathematician

12/2023 UC Santa Barbara NLP Lab

11/2023 CCS Research & Creative Activities Conference (RACA-CON)

8/2023 Caltech SURF Seminar Day

Teaching Experience

Spring 2026 **CS 38: Algorithms**

Teaching Assistant @ *California Institute of Technology*

Winter 2026 **ME/CS/EE 133B: Robotics – Planning**

Teaching Assistant @ *California Institute of Technology*

Fall 2025 **ME/CS/EE 133A: Robotics – Kinematics**

Teaching Assistant @ *California Institute of Technology*

Academic Services

- Reviewer** Conference on Neural Information Processing Systems (NeurIPS)
International Conference on Learning Representations (ICLR)
Conference on Language Modeling (COLM)
Association for Computational Linguistics Rolling Review (ARR)
Annual Meeting of the Association for Computational Linguistics (ACL)
Conference on Empirical Methods in Natural Language Processing (EMNLP)
International Joint Conference on Natural Language Processing (IJCNLP)

Asia-Pacific Chapter of the Association for Computational Linguistics (AACL)

NeurIPS Mathematical Reasoning and AI (MATH-AI) Workshop

NeurIPS Workshop on Deep Learning for Code (DL4C)

NeurIPS Workshop on Behavioral Machine Learning

ICLR VerifAI: AI Verification in the Wild Workshop

ICLR Workshop on Representational Alignment (Re-Align)

ICML AI for Math (AI4MATH) Workshop

ICML Workshop on LLMs and Cognition (LLM-Cognition)

ICML Workshop on Assessing World Models

ICML Workshop on Models of Human Feedback for AI Alignment (MoFA)

Organizing Staff Agentic AI Summit 2025 @ UC Berkeley

On-Campus Services & Appointments

Caltech Admissions Ambassador @ Caltech Undergraduate Admissions Office

First-Year Caltech Connector (FCC) @ Student & Family Engagement Office