Yuanzhe Liu | CV

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Education

Rensselaer Polytechnic Institute — **Troy, USA**
Ph.D. in Computer Science — *2023 – Expected May 2028*
Advisor: Prof. Yao Ma. Previously advised by Ziniu Hu

New York University — **New York, USA**
M.S. in Computer Science — *2021 – 2023*

Oberlin College and Conservatory — **Oberlin, USA**
B.A. in Computer Science, Piano Performance and Mathematics — *2016 – 2021*
Piano Advisor: Prof. Peter Takács

Research Interests

Large Language Model for code optimization and other coding tasks, specifically multi-agent collaboration.

In the past, I did research on (controllable and interactive) generative models (autoregressive, diffusion and others), especially for music, approximation theory and algorithmic game theory.

Selected Honors and Awards

2023: NeurIPS 2023 Co-organizer of Social Activity "AI + music". Presented a guest lecture on "Symbolic Music Generator with Rule-Guided Diffusion models" at "AI + music".

2023: SIGKDD 2023 Student Volunteer

2019: Presented my work on "harmonic measure distribution functions on cantor set" at MAA (Mathematical Association of America) Annual Meeting

2018: Perform at Several **Piano Ensemble Recitals** at Oberlin Conservatory

2018: Third Prize of Ohio Wesleyan Programming Contest

2017: Final Round for Annual Scholarship Competition in Akron, organized by Tuesday Musicale

2016-2021: Oberlin College Scholarship

Publications

1. **Lessons Learned: A Multi-Agent Framework for Code LLMs to Learn and Improve**
   - Yuanzhe Liu, Ryan Deng, Tim Kaler, Xuhao Chen, Charles Leiserson, Yao Ma, Jie Chen
   - 2025 NeurIPS Poster
2. **PIANIST: Learning Partially Observable World Models with LLMs for Multi-Agent Decision Making**
   - Jonathan Light, Sixue Xing, Yuanzhe Liu, Weiqin Chen, Min Cai, Xiusi Chen, Guanzhi Wang, Wei Cheng, Yisong Yue, Ziniu Hu
   - 2024 NeurIPS Language Gamification Workshop
3. **Symbolic Music Generation with Non-Differentiable Rule-Guided Diffusion Models**
   - Yujia Huang, Adishree Ghatare, Yuanzhe Liu, Ziniu Hu, Qinsheng Zhang, Chandramouli Sastry, Siddharth Gururani, Sageev Oore, Yisong Yue
   - 2024 ICML Oral Presentation
4. **Data Distillation for Offline Reinforcement Learning**
   - Jonathan Light*, Yuanzhe Liu*, Ziniu Hu
   - ICML 2024 Workshop on Data-Centric Machine Learning Research
5. **Algorithmic Delegation**
   - Ali Khodabakhsh, Yuanzhe Liu, Emmanouil Pountourakis, Samuel Taggart, Yichi Zhang
   - algorithmic contract theory workshops at both STOC and EC

Work and Research Experience

Graph-Based Multi-Agent Collaboration for Code Optimization   **MIT-IBM Watson AI Lab**
Research Intern   *May. 2025 – Aug. 2025*

○ *Advisor*: Jie Chen and Yao Ma
○ Designed a novel graph-based multi-agent framework with external knowledge for code optimization.
○ We studied how to enable collaboration among multiple agents with external knowledge to optimize code. I developed a graph-based collaboration framework that allows agents to select their own collaborators based on generated plans incorporating external knowledge. Our approach achieved a geometric mean speedup of 2.29 and an optimization rate of 25.6% for cases where the speedup is greater than or equal to 2, representing improvements of 86% and 265% over the single-agent baseline, respectively.

LessonL   **MIT-IBM Watson AI Lab**
Visiting Student Researcher   *May. 2024 – April 2025*

○ *Advisor*: Jie Chen and Yao Ma
○ Designed a novel lesson-based collaboration framework for a team of small LLMs to perform various coding tasks.
○ We studied how a team of agents can learn from each other's successes and failures to improve their own performance. I implemented the proposed framework LessonL, and demonstrated that a team of small LLMs with lessons learned can outperform GPT-4o by 25% in speedup.
○ **Submitted lead-author 'Lessons Learned: A Multi-Agent Framework for Code LLMs to Learn and Improve' to arxiv and for conference publication.**

FastCoder   **MIT-IBM Watson AI Lab**
Visiting Student Researcher   *May. 2024 – Aug. 2024*

○ *Advisor*: Jie Chen and Yao Ma
○ Implemented a new SPE data construction framework for training code optimizers.
○ We studied how to use supervised finetuning (SFT) and direct preference optimization (DPO) to train code optimizers using generated dataset. I constructed preference dataset by speedup and correctness and finetuned Deepseek-coder-7b-instruct-v1.5 with DPO on one single L40 GPU using lora and Llama Factory. We achieved 71% of optimization rate and 3.23 of geometric mean speedup, improving the model by 50% and 68.2%. I also fully finetuned CodeLlama 7b on Pie Dataset with SFT and DPO by huggingface TRL, enabled multi-node training and model sharding.
○ **Co-prepared a manuscript 'Fastcoder: Building AI Code Optimizer via Orchestrated Data Construction and Evaluation'**

PIANIST   **RPI**
Ph.D. Student Researcher   *Oct. 2024 – Dec. 2024*

○ Worked on 'PIANIST: Learning Partially Observable World Models with LLMs for Multi-Agent Decision Making'.
○ Implemented a framework for decomposing the world model into seven intuitive components conducive to zero-shot LLM generation.
○ We study how to use proposed framework to take actions for challenging planning tasks. I implemented GPT generated agent to play taboo games, surpassing Monte Carlo Tree Search method in win rate by 7%.
○ **The work is accepted by 2024 NeurIPS Language Gamification Workshop, co-authored with other collaborators.**

Data Distillation for Offline Reinforcement Learning   **RPI**
Ph.D. Student Researcher   *Mar. 2024 – Jun. 2024*

○ *Advisor*: Ziniu Hu
○ Worked on 'Data Distillation for Offline Reinforcement Learning'.
○ In reinforcement learning, implement a data distillation algorithm to compress the states generated by expert teacher network.
○ We study how to use teacher network to teach smaller student networks play games by using less data. I train experts on ProcGen environment, generate states by those experts, and compress those states by gradient matching (data distillation alrogithm). I also train smaller student models on such distilled dataset, achieving competitive results against Behavioral Cloning.
○ **The work is accepted by 2024 ICML DMLR workshop, co-authored as first author.**

Rule-Guided Music Generation   **Caltech**
Visiting Student Researcher   *Jun. 2023 – Jul. 2024*

- *Advisor*: Sageev Oore, Ziniu Hu and Yisong Yue
- Worked on 'Symbolic Music Generation (e.g., piano rolls) with Non-differentiable Rule-Guided Diffusion Models'.
- Implement a *Transformer-based Latent Diffusion Model* for piano-roll music generation, further extending for long-music generation using *DiffCollage*.
- We study how to use music rules (e.g., note density, chord progression) to **control diffusion process** as a plug-and-play framework. I implement those APIs for key and chord prediction using Music21, and support Yujia in investigating derivative free conditional sampling methods. I also implement classifier-guidance baselines, construct a survey for human evaluation and a Colab notebook for demonstration.
- **The work is accepted by 2024 ICML conference, and is selected as an ICML Oral.**

Theoretical Algorithmic Delegation   **Oberlin College, TCS**
TCS Research Assistant   *Jul. – Sep. 2018, Jun. – Sep. 2019*

- *Advisor*: Sam Taggart
- **Project 1 on Algorithmic Game Theory**: Analyzed the welfare and revenue of Bayes-Nash equilibrium in first-price auctions with agents. Wrote a python program to computer the equilibrium by applying dynamic programming
- **Project 2 on Algorithmic Delegation**: Extended the proof of the existence of the low bound under several constraints. Proved the APX hardness result of this particular delegation problem under certain conditions. Attempted to disprove the 2-approximation of the threshold policy by invoking examples that would break the 2-approximation.
- **These works are presented on algorithmic contract theory workshops at both STOC and EC.**

Brownian Motion and Cantor Set   **Oberlin College, Math**
Mathematics Research Assistant   *Jan. – Feb. 2018*

- *Advisor*: Kevin Gerstle
- Study of harmonic measure distribution functions (H-Functions) with focus on domains with fractal boundary shapes through MATLAB simulation. Found H-Functions on Cantor Set by simulating Brown Motion with teleportation algorithm.
- **This work is presented at the MAA Ohio Spring Section Meeting in April 2018**.

Teaching Experience

- **Teaching Assistant for RPI CSCI 4961: Network Security and Defense, 2024 Fall**.
  - Build animations for security concept, such as TCP 3-way handshake, Heartbleed, etc, review students' work, grade midterm exam, hold office hours, and address their queries regarding lab materials.
- **Teaching Assistant for RPI CSCI 2500: Computer Organization, 2023 Fall**.
  - Hold a 46-student on-campus lab (2 hours per week), review students' work, and address their queries regarding lab materials. During TA office hours, explain many details to many attended students.

Revelant Courses

- **Computer Science:** Algorithm, Deep Learning System, Natural Language Processing, Machine Learning, Operating System, Programming Language
- **Mathematics:** Linear Algebra, Group Theory, Number Theory, Analysis, Fourier Series, Probability
- **Piano Performance:** Piano Private Lesson, Degree Recitals, Keyboard Skills, Form and Analysis, Rhythmic Theory, Aural Skills, Music in the Classic Era, Intro to Electroacoustic Music