

# Yuanzhe Liu |

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## Education

Rensselaer Polytechnic Institute

*Ph.D. in Computer Science*

Advisor: Prof. Yao Ma. Previously advised by Ziniu Hu

Troy, USA

2023 – now

New York University

*M.S. in Computer Science*

New York, USA

2021 – 2023

Oberlin College and Conservatory

*B.A. in Computer Science, Piano Performance and Mathematics*

Piano Advisor: Prof. Peter Takács

Oberlin, USA

2016 – 2021

## Research Interests

Large Language Model for Code Optimization.

(Controllable and Interactive) Generative Models (autoregressive, diffusion and others), especially for creative art and **music**, with the goal of facilitating artists and composers with AI models.

In the past, I did research on 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

- 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
- Fastcoder: Building AI Code Optimizer via Orchestrated Data Construction and Evaluation**
  - Tim Kaler, Ryan Deng, [Yuanzhe Liu](#), Xuhao Chen, Yao Ma, Charles Leiserson, Jie Chen
  - Under Review
- 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
- Data Distillation for Offline Reinforcement Learning**
  - [Yuanzhe Liu](#)\*, Jonathan Light\*, Ziniu Hu
  - ICML 2024 Workshop on Data-Centric Machine Learning Research
- Automated Detection and Segmentation of Internal Carotid Artery Calcifications on CBCT Images Using Deep Neural Networks**
  - C. Qiang, A.V. Keenan, [Y. Liu](#), Y. Kou, S. Khurana

- 2024 IADR/AADOCR/CADR Abstract Presentation
6. **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

### FastCoder

Visiting Student Researcher

MIT-IBM Watson Lab

May. 2024 – Present

- *Advisor:* Jie Chen and Yao Ma
- Worked on 'Fastcoder: Building AI Code Optimizer via Orchestrated Data Construction and Evaluation'.
- Implemented a new SPE data construction framework for training code optimizers.
- We study 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.
- **Submitted a paper which is currently under review, co-authored with other collaborators.**

### PIANIST

Ph.D. Student Researcher

RPI

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

Ph.D. Student Researcher

RPI

Mar. 2024 – Present

- *Advisor:* Ziniu Hu
- Working 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 algorithm). 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

Visiting Student Researcher

Caltech

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.**

### Classification and Detection for Medical Images

Research Assistant

NYU

Feb. 2023 – Jun. 2023

- *Advisor:* Sonam Khurana
- Implemented Swin Transformer backbone to detect Internal Carotid Artery Calcification. For detection, further use Mask R-CNN and Faster R-CNN with Feature Pyramid Network to detect and segment images. Attain a recall rate of 72 percent.
- Pretrained Swin Transformer and ResNet-50 backbone on ImageNet using Self-Supervised Algorithm (MoBY, DINO). Obtained more than 40 percent of Average Precision on COCO 2017 test dataset using Mask R-CNN as the detection algorithm and mmdetection as the framework.
- Implemented Pretrained U-Net in brain MRI to classify Internal Carotid Artery Calcification. Attained an accuracy rate of 90 percent.
- **This work is accepted at 2024 IADR/AADOCR/CADR General Session for Abstract Presentation.**

### **Theoretical Algorithmic Delegation**

*TCS Research Assistant*

**Oberlin College, TCS**

*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**

*Mathematics Research Assistant*

**Oberlin College, Math**

*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 teleporation algorithm.
- **This work is presented at the MAA Ohio Spring Section Meeting in April 2018.**

## **Teaching Experience**

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- **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**

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- **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