

Ruizhe Shi

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Education

University of Washington, Seattle, USA

Feb. 2024 – Present

Research Visitor at Paul G. Allen School of Computer Science

Tsinghua University, Beijing, China

Sept. 2021 – Present

Undergraduate at Special Pilot Class in Computer Science (Yao class)

- Major: *Computer Science and Technology*
- Minor: *Chinese Language and Literature*

GPA 3.93/4.00

GPA 4.00/4.00

Publications

(* indicates equal contribution.)

[4] Ruizhe Shi, Yifang Chen, Yushi Hu, Alisa Liu, Hannaneh Hajishirzi, Noah A. Smith, Simon S. Du.
Decoding-Time Language Model Alignment with Multiple Objectives.

ICML Workshop on Theoretical Foundations of Foundation Models, 2024.

[3] Chenhao Lu, Ruizhe Shi*, Yuyao Liu*, Kaizhe Hu, Simon S. Du, Huazhe Xu.
Rethinking Transformers in Solving POMDPs.

International Conference on Machine Learning, 2024.

[2] Ruizhe Shi*, Yuyao Liu*, Yanjie Ze, Simon S. Du, Huazhe Xu.

Unleashing the Power of Pre-trained Language Models for Offline Reinforcement Learning.

International Conference on Learning Representations, 2024.

[1] Yanjie Ze, Yuyao Liu*, Ruizhe Shi*, Jiaxin Qin, Zhecheng Yuan, Jiashun Wang, Huazhe Xu.

H-InDex: Visual Reinforcement Learning with Hand-Informed Representations for Dexterous Manipulation.

Annual Conference on Neural Information Processing Systems, 2023.

Research Experience

DPO Theory

May 2024 – Present

Supervised by Prof. Simon S. Du

CSE, University of Washington

Multi-Objective Language Model Alignment

Dec. 2023 – May 2024

Supervised by Prof. Simon S. Du

CSE, University of Washington

- We propose a training-free, simple yet effective decoding-time algorithm for multi-objective alignment of language models, with optimality guarantees. Under review.
- We exploit a common form among a family of f -divergence regularized alignment approaches (such as PPO, DPO, and their variants) to identify a closed-form solution by Legendre transform, and derive an efficient decoding strategy. Theoretically, we show why existing approaches can be sub-optimal even in natural settings and obtain optimality guarantees for our method.

Representation Theory of Transformer for Reinforcement Learning

Nov. 2023 – Jan. 2024

Supervised by Prof. Huazhe Xu

IIIS, Tsinghua University

- We challenge the common wisdom and prove theoretically and empirically that Transformers are not suitable for Partially Observable RL, while advocating Linear RNN as a promising alternative. Second-authored work accepted by **ICML 2024**.
- We establish that regular languages, which Transformers struggle to model, are reducible to POMDPs. This poses a significant challenge for Transformers in learning POMDP-specific inductive biases, due to their lack of inherent recurrence found in other models like RNNs, with empirical results highlighting the sub-optimal performance of the Transformer and considerable strength of LRU.

Tuning Language Model for Offline Reinforcement Learning

June 2023 – Sept. 2023

Supervised by Prof. Huazhe Xu

IIIS, Tsinghua University

- We leverage the power of pre-trained Language Models for low-level motion control in offline reinforcement learning. First-authored work accepted by **ICLR 2024**.
- We demonstrate the superiority of LaMo over DT-based and value-based offline RL algorithms. Specifically, we find that LaMo could successfully handle the challenging low-data regime while DT could not. This highlights the great potential of our cross-domain pre-training for sequential modeling.

Visual Representation for Reinforcement Learning

Mar. 2023 – May 2023

Supervised by Prof. Huazhe Xu

IIIS, Tsinghua University

- We propose H-InDex, a hand-informed visual representation for dexterous manipulation with reinforcement learning. Second-authored work accepted by **NeurIPS 2023**.
- We show the effectiveness of our framework on 12 challenging visual dexterous manipulation tasks, comparing with recent strong foundation models such as VC-1. Our study has offered valuable insights into the application of pre-trained models for dexterous manipulation, by exploring the direct application of a 3D human hand pose estimation model

Awards & Honors

Jiang Nanxiang Scholarship <i>Tsinghua University</i>	Nov. 2023 <i>top scholarship; 1 student per major</i>
China National Endeavor Scholarship <i>Beijing Education Bureau</i>	Oct. 2022 <i>1 student per major</i>
Xue Tang Scholarship of Tsinghua University <i>Tsinghua University</i>	Oct. 2021 – Present
First Prize in College Student Mathematics Competition <i>Chinese Mathematical Society</i>	Oct. 2022
First Prize in National High School's Mathematics Competition of China <i>Chinese Mathematical Society</i>	Oct. 2020 <i>top 20</i>

Service

Conference Reviewer <i>NeurIPS 2024</i>	<i>Online</i>
Workshop Program Committee <i>FMDM 2023 at NeurIPS</i> [link]	Oct. 2023 <i>Online</i>
Drop-in Tutoring for STEM Courses <i>Tsinghua University</i> <i>I have 157 hours of officially recorded volunteering work.</i>	Oct. 2022 – Present <i>Beijing, China</i>

Selected Courses

Mathematics and Theory: Calculus (**A**⁺), Linear Algebra (**A**), Abstract Algebra (**A**), Introduction to Complex Analysis (**A**), Probability and Statistics (**A**), Basic Topology (**93**), Introduction to Optimization (**A**), Theory of Computation (**A**), Physics of Information (**A**);

Programming and AI: Introduction to Programming in C/C++ (**A**⁺), Intelligent Unmanned System (**A**⁺), Type-safe Modern System Practice (**A**), Machine Learning (**A**), Artificial Intelligence: Principles and Techniques (**A**), Natural Language Processing (**A**).

Technical Skills

Programming Skills: Python, C/C++, L^AT_EX, Bash, Scala, Matlab.

Language Skills: Chinese Mandarin (native), English (CET-6, TOEFL 104 [R30/L26/S23/W25]).