Laixi Shi

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Research Interests

My interests focus on designing robust and data-efficient algorithms for sequential decision-making, data science, and signal processing, providing the theoretical foundation and advancing real-world applications.

Academic Appointment

2023.8 – Pre **California Institute of Technology, CA, USA**,
Postdoctoral Fellow, Computing + Mathematical Sciences,
Supervisors: Adam Wierman and Eric Mazumdar.

Education

2018.8 – 2023.8 **Carnegie Mellon University, PA, USA**,
Ph.D. in Electrical and Computer Engineering,
Advisor: Yuejie Chi.

2014.9 – 2018.7 **Tsinghua University**, *Beijing, China*,
B.Eng., Electronic Engineering.

Selected Honors & Awards

2024 CMU ECE A.G. Milnes Award — the PhD thesis work judged to be of the highest quality and which has had or is likely to have significant impact in his or her field
2024 ISyE Junior Researcher Workshop Invitation by Georgia Tech
2023 Rising Stars In Machine Learning by University of Maryland
2023 Computing, Data, and Society Postdoctoral Fellow by Caltech
2023 ICASSP Rising Stars in Signal Processing
2023 UT Austin Rising Stars in Computational and Data Sciences
2022 UChicago Rising Stars in Data Science
2022 NeurIPS 2022 Top Reviewer
2022 Wei Shen and Xuehong Zhang Presidential Fellowship
2019 Women in Machine Learning Scholarship
2018 Presidential Fellowship granted by Carnegie Mellon University
2018 Excellent Honors Graduate granted by Tsinghua University
2017 The First Prize in 35th Tsinghua University Academic Challenge Cup
2016 National Scholarship granted by the government of China
2016 Outstanding Project of Undergraduate Research Competition of Tsinghua University
2014 The Silver Medal of Chinese Physics Olympiad

Work Experience

2022.9-12 **Google Research, Brain Team**, *Mountain View, United States*,
Student Researcher, Mentor: Pablo Samuel Castro, Matthieu Geist, Robert Dadashi.

2022.6-9 **Google Research, Brain Team**, *Paris, France*,
Research Intern, Mentor: Matthieu Geist, Robert Dadashi.

2020.5-8 **Mitsubishi Electric Research Laboratories (MERL)**, *Boston, United States*,
Research Intern, Mentor: Dehong Liu.

2017.3-6 **Momenta**, *Beijing, China*,
Software Engineering Intern, Mentor: Gang Sun, Le Shan.

Selected Publications

[1] Laixi Shi, Gen Li, Yuting Wei, Yuxin Chen, Matthieu Geist, Yuejie Chi. "The Curious Price of Distributional Robustness in Reinforcement Learning with a Generative Model" submitted to *Operations Research.* A short version at *Conference on Neural Information Processing Systems (NeurIPS)*, 2023.

[2] Gen Li, Laixi Shi, Yuxin Chen, Yuejie Chi, Yuting Wei. "Settling the Sample Complexity of Model-Based Offline Reinforcement Learning" *The Annals of Statistics*, 2024.

[3] Laixi Shi, Gen Li, Yuxin Chen, Yuting Wei, Yuejie Chi. "Pessimistic Q-Learning for Offline Reinforcement Learning: Towards Optimal Sample Complexity" *International Conference on Machine Learning (ICML)*, 2022.

Publications (Journals)

[1] Laixi Shi, Gen Li, Yuting Wei, Yuxin Chen, Matthieu Geist, Yuejie Chi. "The Curious Price of Distributional Robustness in Reinforcement Learning with a Generative Model" submitted to *Operations Research.*

[2] Laixi Shi, Yuejie Chi. "Distributionally Robust Model-Based Offline Reinforcement Learning with Near-Optimal Sample Complexity" *Journal of Machine Learning Research (JMLR)*, 2024.

[3] Gen Li, Laixi Shi, Yuxin Chen, Yuejie Chi, Yuting Wei. "Settling the Sample Complexity of Model-Based Offline Reinforcement Learning" *The Annals of Statistics*, 2024.

[4] Gen Li, Laixi Shi, Yuxin Chen, Yuejie Chi. "Breaking the Sample Complexity Barrier to Regret-Optimal Model-Free Reinforcement Learning" *Information and Inference: A Journal of the IMA*, 2023.

[5] Laixi Shi and Yuejie Chi. "Manifold Gradient Descent Solves Multi-channel Sparse Blind Deconvolution Provably and Efficiently." *IEEE Transactions on Information Theory*, 2021

Publications (Conferences and Workshops)

$*$ represents equal contribution or alphabetical order.

Reinforcement Learning Theory

[1] Eric Mazumdar*, Kishan Panaganti*, Laixi Shi*. "Tractable Equilibrium Computation in Markov Games through Risk Aversion" *In submission*.

[2] Laixi Shi, Eric Mazumdar, Yuejie Chi, Adam Wierman. "Sample-Efficient Robust Multi-Agent Reinforcement Learning in the Face of Environmental Uncertainty" *International Conference on Machine Learning (ICML)*, 2024.

[3] Jiin Woo, Laixi Shi, Gauri Joshi, Yuejie Chi. "Federated Offline Reinforcement Learning: Collaborative Single-Policy Coverage Suffices" *International Conference on Machine Learning (ICML)*, 2024.

[4] He Wang, Laixi Shi, Yuejie Chi. "Sample Complexity of Offline Distributionally Robust Linear Markov Decision Processes" *Reinforcement Learning Conference (RLC)*, 2024.

[5] Zhengfei Zhang, Kishan Panaganti, Laixi Shi, Yanan Sui, Adam Wierman, Yisong Yue. "Distributionally Robust Constrained Reinforcement Learning under Strong Duality" *Reinforcement Learning Conference (RLC)*, 2024.

[6] Laixi Shi, Gen Li, Yuting Wei, Yuxin Chen, Matthieu Geist, Yuejie Chi. "The Curious Price of Distributional Robustness in Reinforcement Learning with a Generative Model" *Conference on Neural Information Processing Systems (NeurIPS)*, 2023.

[7] Laixi Shi, Gen Li, Yuxin Chen, Yuting Wei, Yuejie Chi. "Pessimistic Q-Learning for Offline Reinforcement Learning: Towards Optimal Sample Complexity" *International Conference on Machine Learning (ICML)*, 2022.

[8] Gen Li, Laixi Shi, Yuxin Chen, Yuejie Chi. "Breaking the Sample Complexity Barrier to Regret-Optimal Model-Free Reinforcement Learning" *Information and Inference: A Journal of the IMA*. A short version has been accepted by *Conference on Neural Information Processing Systems (NeurIPS)*, 2021 (**NeurIPS Spotlight**).

Reinforcement Learning Practice

[9] Haohong Lin, Wenhao Ding, Jian Chen, Laixi Shi, Jiacheng Zhu, Bo Li, Ding Zhao. "BECAUSE: Bilinear Causal Representation for Generalizable Offline Model-based Reinforcement Learning" *Preprint.*

[10] Shangding Gu*, Laixi Shi*, Yuhao Ding, Alois Knoll, Costas Spanos, Adam Wierman, Ming Jin. "Enhancing Efficiency of Safe Reinforcement Learning via Sample Manipulation" *Preprint.*

[11] Wenhao Ding*, Laixi Shi*, Yuejie Chi, Ding Zhao. "Seeing is not Believing: Robust Reinforcement Learning against Spurious Correlation" *Conference on Neural Information Processing Systems (NeurIPS)*, 2023.

[12] Laixi Shi, Robert Dadashi, Yuejie Chi, Pablo Samuel Castro, Matthieu Geist. "Offline Reinforcement Learning with On-Policy Q-Function Regularization" *European Conference on Machine Learning (ECML)*, 2023.

[13] Yiqi Wang, Mengdi Xu, Laixi Shi, Yuejie Chi. "A Trajectory is Worth Three Sentences: Multimodal Transformer for Offline Reinforcement Learning" Accepted by *The Conference on Uncertainty in Artificial Intelligence (UAI)*, 2023.

[14] Peide Huang, Mengdi Xu, Jiacheng Zhu, Laixi Shi, Fei Fang, Ding Zhao. "Curriculum Reinforcement Learning using Optimal Transport via Gradual Domain Adaptation" *Conference on Neural Information Processing Systems (NeurIPS)*, 2022.

Data Science, Signal Processing and Real-World Applications

[15] Laixi Shi and Yuejie Chi. "Manifold Gradient Descent Solves Multi-channel Sparse Blind Deconvolution Provably and Efficiently." *IEEE Transactions on Information Theory, vol. 67, no. 7, pp. 4784-4811,* 2021. Short version at *International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, 2020.

[16] Laixi Shi, Dehong Liu, Jay Thornton. "Robust Camera Pose Estimation For Image Stitching" *IEEE International Conference on Image Processing (ICIP)*, 2021. Another version at *U.S. Patent Application 17/214,813*, 2022.

[17] Sang Yu, Laixi Shi, and Yimin Liu. "Micro hand gesture recognition system using ultrasonic active sensing." *IEEE Access, vol. 6, pp. 49339-49347*, 2018.

[18] T. Low, Y. Chi, J. Hoe, S. Kumar, A. Prabhakara, L. Shi, U. Sridhar, N. Tukanov, C. Wang, and Y. Wu. "Zoom Out: Abstractions for Efficient Radar Algorithms on COTS Architectures." *IEEE International Symposium on Phased Array Systems and Technology (PAST)*, 2022.

[19] Laixi Shi*, Peide Huang*, Rui Chen*. "Latent Goal Allocation for Multi-Agent Goal-Conditioned Self-Supervised Learning." *NeurIPS Bayesian Deep Learning Workshop*, 2021. (* = equal contribution)

[20] Laixi Shi, Dehong Liu, Masaki Umeda, and Norihiko Hana. "Fusion-Based Digital Image Correlation Framework for Strain Measurement." *International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, 2021. Another version at *U.S. Patent Application 17/148,609*, 2022.

[21] Laixi Shi, Yue Zhang, Shijia Pan, and Yuejie Chi. "Data Quality-Informed Multiple Occupant Localization using Floor Vibration Sensing." *The 21st International Workshop on Mobile Computing Systems and Applications*, 2020.

[22] Laixi Shi, Mostafa Mirshekari, Jonathon Fagert, Yuejie Chi, Hae Young Noh, Pei Zhang, and Shijia Pan. "Device-free Multiple People Localization through Floor Vibration." *First ACM Workshop on Device-Free Human Sensing*, 2019.

Patents

[1] Dehong Liu, Laixi Shi. "System and Method of Image Stitching using Robust Camera Pose Estimation." *US Patent App. 17/214,813*, 2022.

[2] Dehong Liu, Laixi Shi, Masaki Umeda, and Norihiko Hana. "Fusion-Based Digital Image Correlation Framework for Strain Measurement" *US Patent App. 17/148,609*, 2022.

Mentorship

CMU ECE
Yuchen Wu (master student → Ph.D. student at University of Washington), 2021-2022
Gore Kao (master student → Tiktok), 2022-2023
Yiqi Wang (master student → master in Robotics Institute at CMU), 2022-Present

Caltech CMS
Chenbei Lu (visiting Ph.D. student), 2023-Present
Zhengfei Zhang (visiting undergraduate student), 2023-Present
Chengrui Qu (visiting undergraduate student), 2024-Present

Selected Professional Services

Area Chair: Conference on Parsimony and Learning (CPAL).

Organization:
- Breakout session leader at *3rd Women in Machine Learning Un-Workshop, ICML 2022.*
- Session Chair for the strategic and distributionally robust sequential decision making session at the 2022 INFORMS annual meeting, APS cluster.

Journal Review: The Journal of Machine Learning Research, the IEEE Transactions on Information Theory, the IEEE Transactions on Signal Processing, Foundations of Computational Mathematics, Operations Research, Mathematics of Operations Research, the IEEE Transactions on Pattern Analysis and Machine Intelligence.

Conference Review: ICLR (2022-2023), ICASSP (2022-2023), ICML (2020-2024), CHIL (2022), NeurIPS (2021-2022,2024), ISIT (2022), ECML(2023), ICRA(2023).

Workshops Review: IEEE Statistical Signal Processing Workshop (SSP 2021), Women in Machine Learning (2019), Women in Data Science and Mathematics (WiSDM 2023).

Teaching Experience

2020 Spring 18202 Mathematical Foundations of Electrical Engineering, Grad TA, CMU ECE Department.

2021 Spring 18202 Mathematical Foundations of Electrical Engineering, Grad TA, CMU ECE Department.

2024 Summer Reinforcement Learning Bootcamp, Instructor, Caltech.

Presentations

Invited Talks

- The Power of Distributional Robustness. *Georgia Tech ISyE Junior Researcher Workshop* 2024.4
- The Cost of Distributional Robustness in Reinforcement Learning: Minimax-Optimal Sample Efficiency.

  Information Theory and Applications Workshop (ITA) 2024.2

  Rising Stars In Machine Learning, University of Maryland 2023.11

  WORDS 2023: Workshop in Operations Research and Data Science, Duke University 2023.11

  Safe Reinforcement Learning Online Seminar 2023.10

  2023 INFORMS Annual Meeting 2023.10

  RSRG/FALCON Tea Talk at Caltech 2023.9
- Sample-Efficient Artificial Intelligence. *IST ADVISORY COUNCIL MEETING at Caltech* 2023.10
- Provable Algorithms for Reinforcement Learning: Efficiency and Robustness

  UT Austin Rising Stars in Computational and Data Sciences 2023.4

  Information Theory and Applications Workshop (ITA) 2023.2

  UChicago Rising Stars in Data Science (2022) 2022.11
- Offline Reinforcement Learning: Towards Optimal Sample Complexity and Distributional Robustness.

  Computer Science & Engineering at University of Connecticut 2023.2

  Air Force Center of Excellence Meeting 2023.1
- Reinforcement learning based on game theory, stochastic composition optimization and regularization. *Intern presentation at Google Brain* 2022.9
- Manifold Gradient Descent Solves Multi-Channel Sparse Blind Deconvolution Provably and Efficiently.

  SIAM Conference on Imaging Science (IS22) 2022.3

  IEEE East Asian School of Information Theory (2021) 2021.8

  Optimization interest seminar in Mitsubishi Electric Research Laboratories (MERL) 2020.7
- Fusion-Based Digital Image Correlation Framework for Strain Measurement. *Intern presentation at Mitsubishi Electric Research Laboratories (MERL)* 2020.8

Poster presentations at conferences/workshops

2023.10 Provable Algorithms for Reinforcement Learning: Efficiency and Robustness. *2023 INFORMS Annual Meeting QSR Poster Competition Session*, 2023

2023.6 Provable Algorithms for Reinforcement Learning: Efficiency and Robustness. *ICASSP Rising Stars in Signal Processing*, 2023

2022.12 Curriculum Reinforcement Learning using Optimal Transport via Gradual Domain Adaptation. *Conference on Neural Information Processing Systems (NeurIPS)*, 2022

2022.7 Pessimistic Q-Learning for Offline Reinforcement Learning: Towards Optimal Sample Complexity. *International Conference on Machine Learning (ICML)*, 2022

2021.12 Breaking the Sample Complexity Barrier to Regret-Optimal Model-Free Reinforcement Learning. *Conference on Neural Information Processing Systems (NeurIPS)*, 2021

2021.9 Robust camera pose estimation for image stitching. *IEEE International Conference on Image Processing (ICIP)*, 2021

2021.6 Fusion-Based Digital Image Correlation Framework for Strain Measurement. *International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, 2021

2019.12 Nonconvex Optimization for Multi-channel Sparse Blind Deconvolution. *Women in Machine Learning at NeurIPS*, 2019

2019.11 Device-free Multiple People Localization through Floor Vibration. *First ACM Workshop on Device-Free Human Sensing*, 2019

Full list of Honors & Awards

Honors/Fellowships:

2024 CMU ECE A.G. Milnes Award — the PhD thesis work judged to be of the highest quality and which has had or is likely to have significant impact in his or her field

2024 ISyE Junior Researcher Workshop Invitation by Georgia Tech

2023 Rising Stars In Machine Learning by University of Maryland

2023 Computing, Data, and Society Postdoctoral Fellow by Caltech

2023 ICASSP Rising Stars in Signal Processing

2023 UT Austin Rising Stars in Computational and Data Sciences

2022 UChicago Rising Stars in Data Science

2022 NeurIPS 2022 Top Reviewer

2022 Leo Finzi Memorial Fellowship

2022 Wei Shen and Xuehong Zhang Presidential Fellowship

2021 Liang Ji-Dian Graduate Fellowship

2019 Women in Machine Learning Scholarship

2018 Presidential Fellowship granted by Carnegie Mellon University

2018 Carnegie Institute of Technology Dean's Fellowship

2018 Excellent Honors Graduate granted by Tsinghua University

2017 The First Prize in 35th Tsinghua University Academic Challenge Cup

2015-2017 Technology Innovation Excellence Award granted by Tsinghua University

2017 Enterprise Sponsored Scholarship granted by Tsinghua University

2016 National Scholarship granted by the government of China

2016 Qualcomm Scholarship granted by Tsinghua University

2016 Outstanding Project of Undergraduate Research Competition of Tsinghua University

2015 The First Prize in National Physics Contest for College Student

2014 The Silver Medal of Chinese Physics Olympiad

Travel Awards:

2022 IAS WAM Mathematics in Machine Learning Travel Support

2020 National Science Foundation (NSF) Student Travel Grants for ICASSP

2020 Computing Research Association Grad Cohort for Women Travel Support

2019 The ACM International Workshop on Device-Free Human Sensing Travel Grant

2019 Women in Data Science and Mathematics Travel Support

References

Adam Wierman **adamw@caltech.edu**
Carl F Braun Professor of Computing Mathematical Sciences, California Institute of Technology
Director of the Information Science and Technology (IST) of Computing Mathematical Sciences

Yuejie Chi **yuejiec@andrew.cmu.edu**
Sense of Wonder Group Endowed Professor of Electrical and Computer Engineering, Carnegie Mellon University

Eric Mazumdar **mazumdar@cms.caltech.edu**
Assistant Professor of Computing Mathematical Sciences and Economics, California Institute of Technology

Yuxin Chen **yuxinc@wharton.upenn.edu**
Associate professor of Statistics and Data Science and of Electrical and Systems Engineering, University of Pennsylvania

Matthieu Geist **matthieu.geist@gmail.com**
Cohere AI (ex Google Research, Brain Team)
On leave of Professor, Université de Lorraine