

CHENBEI LU

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RESEARCH INTERESTS

Motivated by critical challenges in sustainable energy systems, my research interests lie at the intersection of reinforcement learning, stochastic optimization, and online optimization. I focus on developing sample-efficient and robust decision-making frameworks with provable guarantees by formalizing and encoding task-dependent structures and information. Specifically, I aim to address the challenges in energy system operations within time-varying and safety-critical environments, contributing to scalable and adaptive solutions for real-world applications.

EDUCATION

Tsinghua University Institute of Interdisciplinary Information Sciences

Beijing, CN

Ph.D. in Computer Science

Sept. 2020 - Expected 2025

Advisor: Prof. Chenye Wu

California Institute of Technology Computing & Mathematical Sciences Department

Pasadena, US

Visiting Ph.D. Student

Aug. 2023 - Feb. 2024

Advisor: Prof. Adam Wierman

Huazhong University of Science & Technology School of Software Engineering

Wuhan, CN

B.E. in Computer Software Engineering

Sept. 2016 - Jun. 2020

GPA 3.97, Rank 1/180

PUBLICATIONS

Working Papers (* indicates equal contribution)

1. **Chenbei Lu**, Laixi Shi, Zaiwei Chen, Chenye Wu, Adam Wierman. “Overcoming the Curse of Dimensionality of Reinforcement Learning via Approximate Factorization.” In submission to *ACM SIGMETRICS 2025*.
2. **Chenbei Lu**, Zaiwei Chen, Tongxin Li, Chenye Wu, Adam Wierman. “A Sample Efficient Model-Based Reinforcement Learning leveraging Transition Predictions.” In preparation for submission.
3. Hongyu Yi*, **Chenbei Lu***, Chenye Wu. “On the Sample Complexity of Joint Chance-Constrained Markov Decision Processes.” In preparation for submission.
4. **Chenbei Lu**, Chenye Wu, Wei Qi. “Strategic Virtual Bidding in a Two-Settlement Multi-Node Electricity Market.” In preparation for submission to *Operations Research*, 2024.

Journal Articles

1. **Chenbei Lu**, Hongyu Yi, Jiahao Zhang, and Chenye Wu. “Self-Improving Online Storage Control for Stable Wind Power Commitment.” in *IEEE Transactions on Smart Grid*, (2024).
2. **Chenbei Lu**, Gu Nan, Wenqian Jiang, and Chenye Wu. “Sample-Adaptive Robust Economic Dispatch With Statistically Feasible Guarantees.” in *IEEE Transactions on Power Systems*, (2023).
3. Jinhao Liang, Wenqian Jiang, **Chenbei Lu**, and Chenye Wu. “Joint Chance-constrained Unit Commitment: Statistically Feasible Robust Optimization with Learning-to-Optimize Acceleration.” in *IEEE Transactions on Power Systems* (2024).
4. **Chenbei Lu**, Jingshi Cui, Haoxiang Wang, Hongyu Yi, and Chenye Wu. “Privacy Preserving User Energy Consumption Profiling: From Theory to Application.” in *IEEE Transactions on Smart Grid*, (2023).
5. **Chenbei Lu**, Jinhao Liang, Nan Gu, Haoxiang Wang, and Chenye Wu. “Manipulation-Proof Virtual Bidding Mechanism Design.” in *IEEE Transactions on Energy Market, Policy and Regulation*, (2023).
6. **Chenbei Lu**, Jiaman Wu, Jingshi Cui, Yanyan Xu, Chenye Wu, and Marta C. Gonzalez. “Deadline Differentiated Dynamic EV Charging Price Menu Design.” in *IEEE Transactions on Smart Grid*, (2022).

7. **Chenbei Lu**, Wenqian Jiang, and Chenye Wu. “Effective End-to-end Learning Framework for Economic Dispatch.” in *IEEE Transactions on Network Science and Engineering* 9, no. 4 (2022): 2673-2683.
8. Gaoyuan Xu, Jian Shi, Jiaman Wu, **Chenbei Lu**, Chenye Wu, Dan Wang, Zhu Han, “An optimal solutions-guided deep reinforcement learning approach for online energy storage control.” in *Applied Energy* 361, 122915
9. Haoxiang Wang, Jiasheng Zhang, **Chenbei Lu**, and Chenye Wu. “Privacy Preserving in Non-intrusive Load Monitoring: A Differential Privacy Perspective.” in *IEEE Transactions on Smart Grid* (2020).

Selected Conference Proceedings

1. **Chenbei Lu**, Jiaman Wu, and Chenye Wu. “Privacy-preserving Decentralized Price Coordination for EV Charging Stations.” in *the 22nd Power Systems Computation Conference (PSCC 2022)*.
2. **Chenbei Lu**, Zhiqi Wang, and Chenye Wu. “Storage-aided Service Surcharge Design for EV Charging Stations.” In *the 60th IEEE Conference on Decision and Control (CDC)*, pp. 5653-5658. IEEE, 2021.
3. Hongyu Yi, **Chenbei Lu**, Chenye Wu, “Online Storage Control for Stable Wind Power Commitment via Lyapunov Optimization”, in *IEEE Sustainable Power and Energy Conference 2023 (iSPEC 2023)*.
4. Wenqian Jiang, Jinhao Liang, **Chenbei Lu**, Chenye Wu. “Robust Online EV Charging Scheduling with Statistical Feasibility.” in *the 62nd IEEE Conference on Decision and Control (CDC)*, 2023.

SELECTED PROJECTS

Overcoming the Curse of Dimensionality of Reinforcement Learning via Approximate Factorization (with Laixi Shi, Zaiwei Chen, Chenye Wu and Adam Wierman)

In the realm of RL, the curse of dimensionality presents significant challenges. We develop a universal framework that approximately factorizes RL problems to effectively mitigate these challenges. Our contributions include:

- A synchronous sampling method along with model-based and accelerated model-free algorithms tailored for factored structures.
- Enhanced variance control and tighter concentration bounds for estimation errors within both model-based estimation and model-free variance-reduced empirical Bellman iterations.
- [The first near-minimax optimal sample complexity](#) results for both model-based and model-free factored MDPs.

A Sample-Efficient Model-Based Reinforcement Learning leveraging Transition Predictions

(with Zaiwei Chen, Tongxin Li, Chenye Wu and Adam Wierman)

This paper introduces a novel formulation of predictable MDPs (PMDPs) utilizing a prediction oracle for future transitions. Our key contributions include:

- A rigorous characterization of the value of multi-stage, incomplete, and inaccurate predictions in MDPs, enhancing our understanding of prediction utility in RL.
- A novel telescoping decomposition approach combined with multi-stage variance control, enabling tighter statistical analysis.
- [The first sample complexity result](#) showing that PMDPs are easier to learn than traditional MDPs, characterized by $\tilde{O}(\frac{|S||A|}{(1-\gamma)^2(1-\gamma^K)})$, paving the way for more efficient learning algorithms.

On the Sample Complexity of Joint Chance-constrained Markov Decision Processes

(with Hongyu Yi and Chenye Wu)

We are the first to rigorously formulate the nonconvex joint chance-constrained MDPs (JCCMDPs) that incorporate chance constraints directly on policies, addressing critical safety concerns in decision-making processes. Our contributions include:

- A novel cumulative distribution function (CDF) concentration technique that provides tighter bounds on the violation rates within empirical trajectories, enhancing the efficiency of policy evaluation.
- [The first sample complexity result](#) for learning the optimal deterministic policy in general-form JCCMDPs, characterized by $\tilde{O}(\frac{|S|^2|A|M}{(1-\gamma)\Delta^2} + \frac{|S||A|}{(1-\gamma)^3\epsilon^2})$, which offers valuable insights for practitioners in risk-sensitive environments.

ACADEMIC SERVICES

- **TPC Member:**
 - *IEEE SmartGridComm* 2024
- **Reviewer:**
 - *IEEE Transactions on Smart Grid*
 - *IEEE Transactions on Power Systems*
 - *IEEE Transactions on Industry Applications*
 - *IEEE Systems Journal*
 - *International Journal of Electrical Power & Energy Systems*
 - *Electric Power Systems Research*
 - *Scientific Reports*
 - *IEEE Conference on Decision and Control (CDC)*
 - *IEEE American Control Conference (ACC)*
 - *Power Systems Computation Conference (PSCC)*
 - *IEEE SmartGridComm*

INDUSTRIAL EXPERIENCE

Didi Chuxing Technology Co. Department of Data Science and Intelligence
Research Intern

Beijing, CN
Jan. 2021 - Nov. 2021

Topics: Improving the Efficiency of Transportation Systems through Carpooling Design

TEACHING ASSISTANCE

- 2021 Fall: **Combinatorial Mathematics** (Graduate Course), Tsinghua University
- 2022 Fall: **AI Research Practice** (Yao Class Undergrad Course), Tsinghua University

INVITED TALKS AND PRESENTATIONS

1. “**Sample-Adaptive Robust Economic Dispatch With Statistically Feasible Guarantees.**”, IEEE Power and Energy Society General Meeting 2024, Seattle, USA, July 2024.
2. “**Data-driven Power System Operation under Uncertainty: from Offline to Online Perspective.**”, National Outstanding Graduate Student Forum, The Chinese University of Hong Kong, Shenzhen, April 2024.
3. “**Sample Efficient Reinforcement Learning via Kernel Graph Decomposition.**”, Rigorous Systems Research Group Seminar, California Institute of Technology, February 2024. Hosted by Prof. Adam Wierman.
4. “**Sample Efficient Reinforcement Learning via Kernel Graph Decomposition.**”, The Chinese University of Hong Kong, Shenzhen, November 2023. Hosted by Prof. Tongxin Li.
5. “**Storage-aided Service Surcharge Design for EV Charging Stations.**”, 60th IEEE Conference on Decision and Control, Virtual, December 2021.

SELECTED HONORS

- First Prize Award, The 7th Conference on Smart Manufacturing Systems Engineering Jun. 2024
- Outstanding Presentation Award (2nd place), National Outstanding Graduate Student Forum Apr. 2024
- Ubiquant Excellence Scholarship, Tsinghua University Oct. 2023

- Yangtze River Research Institute Excellence Scholarship, Tsinghua University Oct. 2022
- Huiyan Excellence Scholarship, Tsinghua University Oct. 2021
- Outstanding Graduate, Huazhong University of Science & Technology Jul. 2020
- Excellent Dissertation Award (4%), Huazhong University of Science & Technology Jun. 2020
- Qiming Outstanding Student Award (1%), Huazhong University of Science & Technology Oct. 2018
- National Scholarship (2%), Huazhong University of Science & Technology Oct. 2017

REFERENCES

- **Chenye Wu** <wuchenye@cuhk.edu.cn>
Assistant Professor, School of Science and Engineering, The Chinese University of Hong Kong, Shenzhen
Assistant Dean, School of Science and Engineering
- **Adam Wierman** <adamw@caltech.edu>
Carl F. Braun Professor, Computing and Mathematical Sciences, California Institute of Technology
Director, Information Science and Technology (IST) Initiative
- **Zaiwei Chen** <chen5252@purdue.edu>
Assistant Professor, Department of Industrial Engineering, Purdue University
- **Wei Qi** <qiw@tsinghua.edu.cn>
Associate Professor, Department of Industrial Engineering, Tsinghua University
Adjunct Professor, Desautels Faculty of Management, McGill University