KAIQING ZHANG

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EDUCATION

University of Illinois at Urbana-Champaign Aug. 2017 — Present
Ph.D. Candidate in Electrical and Computer Engineering

University of Illinois at Urbana-Champaign Jan. 2016 — Dec. 2017
M.S. in Applied Mathematics

University of Illinois at Urbana-Champaign Aug. 2015 — Aug. 2017
M.S. in Electrical and Computer Engineering

Tsinghua University Sept. 2011 — Jul. 2015
B.S. in Automation (with honor) & **Dual Degree** in Economics

RESEARCH INTERESTS

My research interests lie in reinforcement learning and optimization in multi-agent and safety-critical systems, with applications in cyber-physical systems including robotics, autonomous driving systems, and the smart grid. I resort to mathematical tools from the areas of Control Theory, Game Theory, Operations Research, and Probability to develop provably convergent and efficient algorithms. Broadly speaking, my research belongs to the area of *Learning for Control*, aiming to lay theoretical foundations for the learning algorithms that address sequential-decision-making problems in control systems.

RESEARCH EXPERIENCES

Learning for robust control Sept. 2019 — Present
Department of ECE, UIUC *Advisor: Prof. Tamer Başar*

· Investigate the landscape of robust control problems, e.g., risk-sensitive control, linear quadratic games, and mixed $\mathcal{H}_2/\mathcal{H}_\infty$ control synthesis, from an optimization perspective
· Develop and analyze the global convergence property of policy gradient algorithms for these problems

Multiagent reinforcement learning with theoretical analysis Sept. 2017 — Present
Department of ECE, UIUC *Advisor: Prof. Tamer Başar*

· Develop reinforcement learning algorithms for multi-agent systems, that are networked, and/or self-interested, and/or have a large-population of agents, and/or with partial observability
· Establish convergence for these multi-agent RL algorithms, under several benchmark problem settings

On the value of communication links for distribution network operation: A game theoretic perspective Aug. 2016 — Aug. 2017
Department of ECE, UIUC *Advisor: Prof. Hao Zhu*

· Analyze and develop distributed algorithms for voltage-VAR control under limited communication links using game theoretic approaches
· Quantify the value of communication links for infrastructure deployment

On the performance of map-aware cooperative localization Oct. 2014 — May 2015
Department of EECS, MIT *Advisor: Prof. Moe Z. Win & Prof. Yuan Shen*

· Characterize the fundamental limits of localization accuracy by the information-theoretic bounds, i.e., Ziv-Zakai and Weiss-Weinstein bounds, for map-aware cooperative localization

PUBLICATIONS

Book Chapters

· **Kaiqing Zhang**, Zhuoran Yang, and Tamer Başar, "Multi-Agent Reinforcement Learning: A Selective Overview of Theories and Algorithms", *Studies in Systems, Decision and Control Handbook on Reinforcement Learning and Control, Springer, 2020.*

Journal Papers and Preprints

· **Kaiqing Zhang**, Sham M. Kakade, Tamer Başar, and Lin F. Yang, "Model-based multi-agent RL in zero-sum Markov games with near-optimal sample complexity", *Journal of Machine Learning Research (JMLR), under review, preliminary version appeared in NeurIPS 2020.*

· **Kaiqing Zhang**, Bin Hu, and Tamer Başar, "Policy optimization for $\mathcal{H}_2$ linear control with $\mathcal{H}_\infty$ robustness guarantee: Implicit regularization and global convergence", *SIAM Journal on Control and Optim. (SICON), under review.*

· **Kaiqing Zhang**, Zhuoran Yang, Han Liu, Tong Zhang, and Tamer Başar, "Finite-sample analysis for decentralized batch multi-agent reinforcement learning with networked agents", *IEEE Trans. on Automatic Control (TAC), under review.*

· Tianyi Chen, **Kaiqing Zhang**, Georgios B. Giannakis, and Tamer Başar, "Communication-efficient distributed reinforcement learning", *Automatica, under review.*

· **Kaiqing Zhang**, Alec Koppel, Hao Zhu, and Tamer Başar, "Global convergence of policy gradient methods to (almost) locally optimal policies ", *SIAM Journal on Control and Optim. (SICON), 2020, to appear.*

· **Kaiqing Zhang**†, Alec Koppel†, Hao Zhu, and Tamer Başar, "Projected stochastic primal-dual method for constrained online learning with kernels" (The authors † contributed equally), *IEEE Trans. on Signal Process. (TSP), vol. 67 , no. 10 , pp. 2528-2542, May, 2019.*

· **Kaiqing Zhang**, Yang Liu, Ji Liu, Mingyan Liu, and Tamer Başar, "Distributed learning of average belief over networks using sequential observations," *Automatica, vol. 115, May 2020.*

· **Kaiqing Zhang**, Liqun Lu, Chao Lei, Hao Zhu, and Yanfeng Ouyang, "Dynamic operations and pricing of electric unmanned aerial vehicle systems and power networks," *Journal of Transportation Research Part C: Emerging Technologies*, vol. 92, pp. 472-485, July 2018.

· **Kaiqing Zhang**, Wei Shi, Hao Zhu, Emiliano Dall'Anese, and Tamer Başar, "Dynamic power distribution system management with a locally connected communication network," *IEEE Journal of Selected Topics in Signal Process. (JSTSP)*, vol. 12, no. 4, pp. 673-687, May 2018.

· Hanchen Xu, **Kaiqing Zhang**, and Junbo Zhang, "Optimal joint bidding and pricing of profit-seeking load serving entity," *IEEE Trans. on Power Systems (TPS)*, vol. 33, no. 5, pp. 5427-5436, March 2018.

· **Kaiqing Zhang**, Siming Guo, and Hao Zhu, "Dependency analysis and improved parameter estimation for complex dynamic load modeling," *IEEE Trans. on Power Systems (TPS)*, vol. 32, no. 4, pp. 3287-3297, Nov. 2016.

· Feifei Gao and **Kaiqing Zhang**, "Enhanced multi-parameter cognitive architecture for future wireless communications," *IEEE Commun. Magazine*, vol. 53, no. 7, pp. 86-92, Jul. 2015.

Selected Conference Papers

· **Kaiqing Zhang**, Sham M. Kakade, Tamer Başar, and Lin F. Yang, "Model-based multi-agent RL in zero-sum Markov games with near-optimal sample complexity", *Neural Info. Process. Systems (NeurIPS), 2020 (**Spotlight**).*

- **Kaiqing Zhang**, Bin Hu, and Tamer Başar, "On the stability and convergence of policy-based robust adversarial reinforcement learning: A case study on linear quadratic systems," *Neural Info. Process. Systems (NeurIPS), 2020.*
- **Kaiqing Zhang**, Tianyi Chen, and Tamer Başar, "On the Convergence of Multi-Step Natural Policy Gradient Method in Zero-Sum Markov Games," *Neural Info. Process. Systems (NeurIPS), 2020.*
- Dongsheng Ding, **Kaiqing Zhang**, Mihailo R. Jovanovic, and Tamer Başar, "Global Convergence of Natural Primal-Dual Method for Constrained Markov Decision Processes," *Neural Info. Process. Systems (NeurIPS), 2020.*
- Weichao Mao, **Kaiqing Zhang**, Qiaomin Xie, and Tamer Başar, "POLY-HOOT: Monte-Carlo planning in continuous space MDPs with non-asymptotic analysis", *Neural Info. Process. Systems (NeurIPS), 2020.*
- Yanli Liu, **Kaiqing Zhang**, Tamer Başar, and Wotao Yin, "An Improved Analysis of (Variance-Reduced) Policy Gradient and Natural Policy Gradient Methods", *Neural Info. Process. Systems (NeurIPS), 2020.*
- Weichao Mao, **Kaiqing Zhang**, Erik Miehling, and Tamer Başar, "Information state embedding in partially observable cooperative multi-agent reinforcement learning," *IEEE Conf. on Decision and Control (CDC), 2020.*
- **Kaiqing Zhang**, Bin Hu, and Tamer Başar, "Policy optimization for $\mathcal{H}_2$ linear control with $\mathcal{H}_\infty$ robustness guarantee: Implicit regularization and global convergence," *Learning for Dynamics & Control (L4DC) Conference (**Oral**, 14 out of all submissions), 2020.*
- **Kaiqing Zhang**, Zhuoran Yang, and Tamer Başar, "Policy optimization provably converges to Nash equilibria in zero-sum linear quadratic games", *Neural Info. Process. Systems (NeurIPS), 2019.*
- Xiangyuan Zhang, **Kaiqing Zhang**, Erik Miehling, and Tamer Başar, "Non-Cooperative Inverse Reinforcement Learning", *Neural Info. Process. Systems (NeurIPS), pp. 9482-9493, 2019.*
- **Kaiqing Zhang**, Erik Miehling, and Tamer Başar, "Online planning for decentralized stochastic control with partial history sharing," *IEEE American Control Conf. (ACC), pp. 3544-3550, 2019.*
- **Kaiqing Zhang**, Zhuoran Yang, and Tamer Başar, "Networked multi-agent reinforcement learning in continuous spaces", *IEEE Conf. on Decision and Control (CDC), pp. 2771-2776, 2018.*
- Zhuoran Yang, **Kaiqing Zhang**, Mingyi Hong, and Tamer Başar, "A finite sample analysis of the actor-critic algorithm", *IEEE Conf. on Decision and Control (CDC), pp. 2759-2764, 2018.*
- **Kaiqing Zhang**, Zhuoran Yang, Han Liu, Tong Zhang, and Tamer Başar, "Fully decentralized multi-agent reinforcement learning with networked agents", *Intl. Conf. on Machine Learning (ICML), 2018.*
- **Kaiqing Zhang**, Zhuoran Yang, and Zhaoran Wang, "Nonlinear structured signal estimation in high dimensions via iterative hard thresholding," *Intl. Conf. on Artificial Intelligence and Statistics (AISTATS), 2018.*
- **Kaiqing Zhang**, Yuan Shen, and Moe Z. Win, "On the performance of map-aware cooperative localization," *IEEE Intl. Conf. on Commun. (ICC)*, 2016.
- **Kaiqing Zhang**, Jiachen Li, and Feifei Gao, "Machine learning techniques for spectrum sensing when primary user has multiple transmit powers," *IEEE Intl. Conf. on Commun. Systems (ICCS)*, 2014.

OTHER RESEARCH EXPERIENCES

Visiting Graduate Student	Simons Institute, UC Berkeley (virtual)	Aug. 2020 — Dec. 2020
Research Scientist Intern	Amazon AWS AI Labs, Seattle, WA	May 2019 — Aug. 2019
Visiting Fellow	Army Research Lab. (ARL), Adelphi, MD	Jun. 2018 — Aug. 2018
Research Scientist Intern	Nation. Renew. Energy Lab. (NREL), CO	Jun. 2016 — Sept. 2016

TEACHING EXPERIENCES

Teaching Assistant	ECE 543 Statistical Learning Theory by Prof. R. Srikant	Spring 2020

PATENTS

U.S. Patent No. 908486 Robust Actor/Critic Multi-Agent RL for Mobile Robotics Applications

AWARDS & HONORS

- Hong, McCully, and Allen Fellowship (**$12000**), UIUC 2018 & 2019 & 2020
- YEE Fellowship Award, College of Engineering, UIUC 2020
- NeurIPS Travel Award 2019
- CDC Student Travel Award 2019 & 2020
- Mavis Future Faculty Fellows (MF3), UIUC 2019
- ICML Travel Award 2018
- James M. Henderson Fellowship, UIUC 2016
- Beijing Outstanding Undergraduate Thesis 2015
- National Scholarship (**top 3%**), Tsinghua University 2014
- **Meritorious Winner** 2014 Mathematical Contest in Modeling 2014
- **First Prize** in 34th Challenge Cup of Tsinghua University 2014
- **Third place** in competition of Adult-Size Group in RoboCup 2013
- Comprehensive First-Class Scholarship of Tsinghua University (**top 5%**) 2012 & 2013
- **First Prize** of National Physics Olympiad, with Pre-Admission to Tsinghua 2011

PROFESSIONAL SERVICES & ACTIVITIES

- Reviewer for *ICML*, *NeurIPS*, *AAAI*, *Mathematical Programming, IEEE Trans. Automatic Control (TAC), Automatica, IEEE Journal of Selected Topics in Signal Processing (JSTSP), IEEE Trans. Smart Grid (TSG), IEEE Trans. Power Systems (TPS), IEEE Control Systems Letters (L-CSS), IEEE Communications Letters (CL), IEEE American Control Conf. (ACC), IEEE Control and Decision Conf. (CDC), IEEE Intl. Conf. on Communications (ICC).*
- Organizer of the invited sessions *Machine Learning in Complex Networks* at *IEEE Control and Decision Conf. (CDC)*, 2018, 2019
- President of Tsinghua University Alumni Association (THU-AA) in UIUC Sept. 2019 — Present
- Committee of the 8th *IEEE Power and Energy Conf. at Illinois (PECI)* April 2016 — Feb. 2017
- Vice-President of the Student Union of the Dept. of Automation Aug. 2013 — Aug. 2014