

KAIQING ZHANG

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ACADEMIC EXPERIENCES

- University of Maryland, College Park** Oct. 2022 — Present
Assistant Professor
Department of Electrical and Computer Engineering (ECE)
Institute for Systems Research (ISR)
Maryland Robotics Center (MRC)
- Massachusetts Institute of Technology** May 2021 — Oct. 2022
Postdoctoral Scholar
Laboratory for Information and Decision Systems (LIDS)
Computer Science & Artificial Intelligence Laboratory (CSAIL)
Hosts: Asu Ozdaglar; Russ Tedrake; Costis Daskalakis
- University of California, Berkeley & Simons Institute** Jan. 2022 — May 2022
Research Fellow
Program: Learning and Games
Mentor: Michael I. Jordan
- University of Illinois at Urbana-Champaign** Aug. 2017 — May 2021
Ph.D. in Electrical and Computer Engineering (ECE) & Coordinated Science Lab (CSL)
Advisor: Tamer Başar
- University of Illinois at Urbana-Champaign** Aug. 2015 — Aug. 2017
M.S. in Applied Mathematics & **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 the intersection of *machine/reinforcement learning*, *control theory*, and *game theory*, especially in *multi-agent* and *safety-critical* systems; with applications in intelligent and distributed cyber-physical systems, e.g., robotics, smart grid, and transportation systems. I resort to mathematical tools from the areas of Control Theory, Game Theory, Operations Research, and Probability Theory to develop *provably convergent* and *efficient* algorithms. Broadly speaking, the primary goal of my research is to lay theoretical foundations for the learning algorithms and systems that address (*data-driven*) *sequential-decision-making* problems in game theory and control theory, particularly in the presence of multiple decision-makers, towards *large-scale* and *reliable* autonomy.

PUBLICATIONS

[†] denotes equal contribution/alphabetical order

Monographs

- **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*, pp. 321-384, Springer, 2021 (Invited Chapter).
- Asuman Ozdaglar[†], Muhammed O. Sayin[†], **Kaiqing Zhang**[†], “Independent Learning in Stochastic Games”, *International Congress of Mathematicians 2022 (ICM 2022)* (Invited).

- Bin Hu, **Kaiqing Zhang**, Na Li, Mehran Mesbahi, Maryam Fazel, Tamer Başar, “Towards a Theoretical Foundation of Policy Optimization for Learning Control Policies”, *Annual Review of Control, Robotics, and Autonomous Systems*, 2022 (Invited Article).

Journal Papers and Preprints

- Constantinos Daskalakis[†], Noah Golowich[†], **Kaiqing Zhang**[†], “The complexity of Markov equilibrium in stochastic games”, *under review*.
- Weichao Mao, **Kaiqing Zhang**, Ruihao Zhu, David Simchi-Levi, and Tamer Başar, “Model-free non-stationary RL: Near-optimal regret and applications in multi-agent RL and inventory control”, *Management Science (MS)*, *under review*.
- **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)*, *conditionally accepted, preliminary version appeared in NeurIPS 2020 (Spotlight)*.
- **Kaiqing Zhang**, Bin Hu, and Tamer Başar, “Policy optimization for \mathcal{H}_2 linear control with \mathcal{H}_∞ robustness guarantee: Implicit regularization and global convergence”, *SIAM Journal on Control and Optim. (SICON)*, 2021.
- **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)*, 2021.
- Tianyi Chen, **Kaiqing Zhang**, Georgios B. Giannakis, and Tamer Başar, “Communication-efficient distributed reinforcement learning”, *IEEE Trans. on Control of Network Systems (TCNS)*, 2021.
- **Kaiqing Zhang**, Zhuoran Yang, and Tamer Başar, “Decentralized multi-agent reinforcement learning with networked agents: Recent advances”, *Frontiers of Information Technology & Electronic Engineering*, 22(6):802-814, 2021.
- **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.
- Alec Koppel[†], **Kaiqing Zhang**[†], Hao Zhu, and Tamer Başar, “Projected stochastic primal-dual method for constrained online learning with kernels”, *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**, 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.
- **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.

Conference Papers

- Asuman Ozdaglar[†], Sarath Pattathil[†], Jiawei Zhang[†], and **Kaiqing Zhang**[†], “What is a good metric to study generalization of minimax learners?”, *Neural Info. Process. Systems (NeurIPS)*, 2022 & (**Oral, 4 out of all submissions**) at *New Frontiers in Adversarial Machine Learning Workshop, ICML, 2022*).
- Jack Umenberger, Max Simchowitz, Juan C Perdomo, **Kaiqing Zhang**, and Russ Tedrake, “Globally convergent policy search over dynamic filters for output estimation”, *Neural Info. Process. Systems (NeurIPS)*, 2022.
- H. J. Terry Suh, Max Simchowitz, **Kaiqing Zhang**, and Russ Tedrake, “Do differentiable simulators give better policy gradients?”, *Intl. Conf. on Machine Learning (ICML)*, 2022 (**Long-oral & Outstanding Paper Award**).

- Dongsheng Ding[†], Chen-Yu Wei[†], **Kaiqing Zhang**[†], and Mihailo R. Jovanovic, “Independent policy gradient for large-scale Markov potential games: Sharper rates, function approximation, and game-agnostic convergence”, *Intl. Conf. on Machine Learning (ICML)*, 2022 (**Long-oral**).
- Weichao Mao, Lin F. Yang, **Kaiqing Zhang**, and Tamer Başar, “On improving model-free algorithms for decentralized multi-agent reinforcement learning”, *Intl. Conf. on Machine Learning (ICML)*, 2022.
- Muhammed O. Sayin, **Kaiqing Zhang**, and Asuman Ozdaglar, “Fictitious play in Markov games with single controller”, *ACM Conference on Economics and Computation (EC)*, 2022.
- Muhammed O. Sayin[†], **Kaiqing Zhang**[†], David S. Leslie, Tamer Başar, and Asuman Ozdaglar, “Decentralized Q-Learning in zero-sum Markov games”, *Neural Info. Process. Systems (NeurIPS)*, 2021.
- **Kaiqing Zhang**[†], Xiangyuan Zhang[†], Bin Hu, and Tamer Başar, “Derivative-free policy optimization for risk-sensitive and robust control design: Implicit regularization and sample complexity”, *Neural Info. Process. Systems (NeurIPS)*, 2021.
- Weichao Mao, **Kaiqing Zhang**, Ruihao Zhu, David Simchi-Levi, and Tamer Başar, “Near-optimal model-free reinforcement learning in non-stationary episodic MDPs”, *Intl. Conf. on Machine Learning (ICML)*, 2021.
- Wesley Suttle, **Kaiqing Zhang**, Zhuoran Yang, Ji Liu, and David Kraemer, “Reinforcement learning for cost-aware Markov decision processes”, *Intl. Conf. on Machine Learning (ICML)*, 2021.
- Zengyi Qin, **Kaiqing Zhang**, Yuxiao Chen, Jingkai Chen, and Chuchu Fan, “Learning safe multi-agent control with decentralized neural barrier certificates,” *Intl. Conf. on Learning Represent. (ICLR)*, 2021.
- **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 robust adversarial reinforcement learning: A case study on linear quadratic systems,” *Neural Info. Process. Systems (NeurIPS)*, 2020.
- **Kaiqing Zhang**[†], Tao Sun[†], Yunzhe Tao, Sahika Genc, Sunil Mallya, and Tamer Başar, “Robust multi-agent reinforcement learning with model uncertainty”, *Neural Info. Process. Systems (NeurIPS)*, 2020.
- Dongsheng Ding, **Kaiqing Zhang**, Tamer Başar, and Mihailo R. Jovanovic, “Natural policy gradient 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}_∞ robustness guarantee: Implicit regularization and global convergence,” *Learning for Dynamics & Control (L4DC) Conference (Oral, top 10%, 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)*, 2019.
- **Kaiqing Zhang**, Erik Miehling, and Tamer Başar, “Online planning for decentralized stochastic control with partial history sharing,” *IEEE American Control Conf. (ACC)*, 2019.
- **Kaiqing Zhang**, Zhuoran Yang, and Tamer Başar, “Networked multi-agent reinforcement learning in continuous spaces”, *IEEE Conf. on Decision and Control (CDC)*, 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)*, 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.

OTHER ACADEMIC EXPERIENCES

Research Fellow	Simons Institute, UC Berkeley	Jan. 2022 — May 2022
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 Fellowship	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
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PATENTS

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

· CSL PhD Thesis Award, UIUC	2022
· ICML Outstanding Paper Award	2022
· Simons-Berkeley Research Fellowship , Simons Institute & UC Berkeley	2022
· Linde + CAST Postdoctoral Scholar Fellowship, Caltech CMS & CSIS (declined)	2021
· Kuck Computational Science & Engineering Scholarship, UIUC	2020
· 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 University	2011

PROFESSIONAL SERVICES & ACTIVITIES

- Co-organizer of the online seminar series *Games, Decisions & Networks*
- Area Chair for *ICML*, *NeurIPS*
- Reviewer for *ICLR*, *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)*, *System & Control Letters*, *IEEE American Control Conf. (ACC)*, *IEEE Control and Decision Conf. (CDC)*, *Learning for Dynamics & Control Conf. (L4DC)*, *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 — June 2021
- 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