KAIQING ZHANG

Personal Webpage ⋄ Google Scholar ⋄ kaiqing@umd.edu

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)
Center for Machine Learning (CML)
Department of Computer Science (CS) (Affiliated)
University of Maryland Institute for Advanced Computer Studies (UMIACS) (Affiliated)

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 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, toward *large-scale* and *reliable* autonomy.

PUBLICATIONS

† denotes equal contribution/alphabetical order

Monographs

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

· Asuman Ozdaglar†, Muhammed O. Sayin†, and **Kaiqing Zhang**†, "Independent Learning in Stochastic Games", *International Congress of Mathematicians 2022 (ICM 2022) (Invited).*

· **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).*

Journal Papers and Preprints

· 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), 2023.*

· **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), 2023, preliminary version appeared in NeurIPS 2020 (**Spotlight**).*

· **Kaiqing Zhang**, Bin Hu, and Tamer Başar, "Policy optimization for $\mathcal{H}_2$ linear control with $\mathcal{H}_\infty$ robustness guarantee: Implicit regularization and global convergence", *SIAM Journal on Control and Optim. (SICON), 59(6):4081-4110, 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), 66(12):5925-5940, 2021.*

· Tianyi Chen, **Kaiqing Zhang**, Georgios B. Giannakis, and Tamer Başar, "Communication-efficient distributed reinforcement learning", *IEEE Trans. on Control of Network Systems (TCNS), 9(2):917-929, 2022.*

· **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*, 115(108857):1-13, 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

· Lirui Wang, **Kaiqing Zhang**, Allan Zhou, Max Simchowitz, and Russ Tedrake, "Fleet policy learning via weight merging and an application to robotic tool-use", *International Conference on Learning Representations (ICLR), 2024.*

· Chanwoo Park†, **Kaiqing Zhang**†, and Asuman Ozdaglar, "Multi-player zero-sum Markov games with networked separable interactions", *Neural Info. Process. Systems (NeurIPS), 2023.*

· Dongsheng Ding†, Chen-Yu Wei†, **Kaiqing Zhang**†, and Alejandro Ribeiro "Last-iterate convergent policy gradient primal-dual methods for constrained MDPs", *Neural Info. Process. Systems (NeurIPS), 2023.*

- Zaiwei Chen, **Kaiqing Zhang**, Eric Mazumdar, Asuman Ozdaglar, and Adam Wierman, "A finite-sample analysis of payoff-based independent learning in zero-sum stochastic games", *Neural Info. Process. Systems (NeurIPS), 2023.*
- Boyuan Chen, Chuning Zhu, Pulkit Agrawal, **Kaiqing Zhang**†, Abhishek Gupta†, "Self-supervised reinforcement learning that transfers using random features", *Neural Info. Process. Systems (NeurIPS), 2023.*
- Xiangyu Liu and **Kaiqing Zhang**, "Partially observable multi-agent RL with (quasi-)efficiency: The blessing of information sharing", *Intl. Conf. on Machine Learning (ICML), 2023.*
- Asuman Ozdaglar†, Sarath Pattathil†, Jiawei Zhang†, and **Kaiqing Zhang**†, "Revisiting the linear-programming framework for offline RL with general function approximation", *Intl. Conf. on Machine Learning (ICML), 2023.*
- Constantinos Daskalakis†, Noah Golowich†, **Kaiqing Zhang**†, "The complexity of Markov equilibrium in stochastic games", *Conference on Learning Theory (COLT), 2023.*
- Max Simchowitz, Abhishek Gupta, and **Kaiqing Zhang**, "Tackling combinatorial distribution shift: A matrix completion perspective", *Conference on Learning Theory (COLT), 2023.*
- Qiwen Cui, **Kaiqing Zhang**, and Simon S. Du, "Breaking the curse of multiagents in a large state space: RL in Markov games with independent linear function approximation", *Conference on Learning Theory (COLT), 2023.*
- Yi Tian, **Kaiqing Zhang**, Russ Tedrake, and Suvrit Sra, "Can direct latent model learning solve linear quadratic Gaussian control?", *Learning for Dynamics & Control (L4DC) (**Oral**), 2023.*
- Lirui Wang, **Kaiqing Zhang**, Yunzhu Li, Yonglong Tian, and Russ Tedrake, "Does decentralized learning with non-IID unlabeled data benefit from self supervision?", *International Conference on Learning Representations (ICLR), 2023.*
- Mingyang Liu†, Asuman Ozdaglar†, Tiancheng Yu†, **Kaiqing Zhang**†, "The power of regularization in solving extensive-form games", *International Conference on Learning Representations (ICLR), 2023.*
- Aviv Netanyahu, Abhishek Gupta, Max Simchowitz, **Kaiqing Zhang**, and Pulkit Agrawal, "Learning to extrapolate: A transductive approach", *International Conference on Learning Representations (ICLR), 2023.*
- Sarath Pattathil, **Kaiqing Zhang**, and Asuman Ozdaglar, "Symmetric (optimistic) natural policy gradient for multi-agent learning with parameter convergence", *International Conference on Artificial Intelligence and Statistics (AISTATS), 2023.*
- 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 $\mathcal{H}_\infty$ 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

Lecturer	ENEE 664: Optimal Control	Spring 2024
Lecturer	ENEE 460: Control Systems	Fall 2023
Lecturer	ENEE 769L: Decision Making Under Uncertainty – RL, Control, and Games	Spring 2023
Teaching Assistant	ECE 543: Statistical Learning Theory by Prof. R. Srikant	Spring 2020

PATENTS & FUNDING

U.S. Army Research Office – Project No. 82093 (Leading PI; Share $450,000) 2023
Northrop Grumman – University of Maryland Seed Grant Program 2023
U.S. Patent No. 908486 Robust Actor/Critic Multi-Agent RL for Mobile Robotics Applications 2020

AWARDS & HONORS

· IEEE Robotics and Automation Society (RAS) TC **Best-Paper Award** 2023
· **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

· Area Chair for *ICML*, *NeurIPS*, *ICLR*, and *UAI*
· Co-organizer of *Rising Stars in Machine Learning* organized by University of Maryland, College Park
· Co-organizer of the online seminar series *Games, Decisions & Networks*

- Reviewer for *ALT*, *AAAI*, *Mathematical Programming, Mathematics of Operations Research (Math OR), Operations Research (OR), 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