

# KAIQING ZHANG

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## EDUCATION

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<b>University of Illinois at Urbana-Champaign</b> <b>Ph.D. Candidate</b> in Electrical and Computer Engineering	Aug. 2017 — Present
<b>University of Illinois at Urbana-Champaign</b> <b>M.S.</b> in Applied Mathematics	Jan. 2016 — Dec. 2017
<b>University of Illinois at Urbana-Champaign</b> <b>M.S.</b> in Electrical and Computer Engineering	Aug. 2015 — Aug. 2017
<b>Tsinghua University</b> <b>B.S.</b> in Automation (with honor) & <b>Dual Degree</b> in Economics	Sept. 2011 — Jul. 2015

## RESEARCH INTERESTS

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My research interests lie in reinforcement learning and optimization in multi-agent/networked systems, game theory, and robust control; with applications in cyber-physical systems including smart grid and electricity markets, transportation networks, and robotics.

## RESEARCH EXPERIENCES

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<b>Learning for robust control</b> <i>Department of ECE, UIUC</i>	Sept. 2018 — Present <i>Advisor: Prof. Tamer Başar</i>
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- Investigate the landscape of robust control problems, e.g., risk-sensitive control and linear quadratic games, from an optimization perspective
- Develop and analyze reinforcement learning algorithms for robust control

<b>Multiagent reinforcement learning with theoretical analysis</b> <i>Department of ECE, UIUC</i>	Sept. 2017 — Present <i>Advisor: Prof. Tamer Başar</i>
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- Develop and analyze distributed reinforcement learning algorithms for networked systems

<b>Global convergence of policy gradient methods</b> <i>Department of ECE, UIUC</i>	June 2018 — Sept. 2018 <i>Advisor: Prof. Tamer Başar</i>
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- Investigate the global convergence property of policy gradient algorithms
- Identify a condition for reward-reshaping that benefits the global convergence

<b>On the value of communication links for distribution network operation: A game theoretic perspective</b> <i>Department of ECE, UIUC</i>	Aug. 2016 — Aug. 2017 <i>Advisor: Prof. Hao Zhu</i>
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- Analyze and develop distributed algorithms for voltage-VAR control under limited communication links using game theoretic approaches
- Aim to quantify the fundamental value of communication links for infrastructure deployment

<b>Dynamic electric vehicles travel management in coupled power and transportation networks</b> <i>Department of ECE &amp; CEE, UIUC</i>	April 2016 — April 2017 <i>Advisor: Prof. Hao Zhu</i>
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- Electricity pricing for electric vehicles that benefits both power and transportation networks operation
- Improve the modeling of the coupled networks by incorporating time-varying/dynamic travel demand

### 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

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### 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.

### Journals and Preprints

- **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”, *arXiv:1910.09496*, 2019.
- **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)*, 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”, *IEEE Trans. on Automatic Control (TAC)*, under review.
- **Kaiqing Zhang**<sup>†</sup>, Alec Koppel<sup>†</sup>, Hao Zhu, and Tamer Başar, “Projected stochastic primal-dual method for constrained online learning with kernels” (The authors <sup>†</sup> contribute 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*, 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.
- Yingchen Zhang, Rui Yang, **Kaiqing Zhang**, Huaiguang Jiang, and Jun Jason Zhang, “Consumption behavior analytics-aided energy forecasting and dispatch,” *IEEE Intelligent Systems*, vol. 32, no. 4, pp. 59-63, Aug. 2017.
- **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.

### Conferences

- **Kaiqing Zhang**, Zhuoran Yang, Han Liu, Tong Zhang, and Tamer Başar, “Finite-sample analyses for decentralized cooperative multi-agent reinforcement learning from batch data,” *IFAC World Congress*, 2020.
- Wesley Suttle, Zhuoran Yang, **Kaiqing Zhang**, Zhaoran Wang, Tamer Başar, Ji Liu, “Finite-sample analyses for decentralized cooperative multi-agent reinforcement learning from batch data,” *IFAC World Congress*, 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*, 2020.
- Muhammad Aneeq uz Zaman, **Kaiqing Zhang**, Erik Miehl, and Tamer Başar, “Approximate equilibrium computation for discrete-time linear-quadratic mean-field games,” *IEEE American Control Conf. (ACC)*, 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 Miehl, and Tamer Başar, “Non-Cooperative Inverse Reinforcement Learning,” *Neural Info. Process. Systems (NeurIPS)*, 2019.
- **Kaiqing Zhang**, Alec Koppel, Hao Zhu, and Tamer Başar, “Convergence and iteration complexity of policy gradient method for infinite-horizon reinforcement learning,” *IEEE Conf. on Decision and Control (CDC)*, 2019.
- Yixuan Lin, **Kaiqing Zhang**, Zhuoran Yang, Zhaoran Wang, Tamer Başar, Romeil Sandhu, and Ji Liu, “A communication-efficient multi-agent actor-critic algorithm for distributed reinforcement learning,” *IEEE Conf. on Decision and Control (CDC)*, 2019.
- **Kaiqing Zhang**, Alec Koppel, Hao Zhu, and Tamer Başar. “Policy search in infinite-horizon discounted reinforcement learning: Advances through connections to non-convex optimization,” *IEEE Annual Conf. on Info. Sci. and Syst. (CISS)*, 2019.
- **Kaiqing Zhang**, Erik Miehl, and Tamer Başar, “Online planning for decentralized stochastic control with partial history sharing,” *IEEE American Control Conf. (ACC)*, 2019.
- **Kaiqing Zhang**, Hao Zhu, Tamer Başar, and Alec Koppel, “Projected stochastic primal-dual method for constrained online learning with kernels,” *IEEE Conf. on Decision and Control (CDC)*, 2018.
- **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**, Wei Shi, Hao Zhu, and Tamer Başar, “Distributed equilibrium-learning for power network voltage control with a locally connected communication network,” *IEEE American Control Conf. (ACC)*, 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** and Hao Zhu, “A game theoretic approach for communication-free distribution system management,” *IEEE Global Conf. on Signal and Info. Process. (GlobalSIP)*, 2017.
- **Kaiqing Zhang**, Siming Guo, and Hao Zhu, “Parameter sensitivity and dependency analysis for the WECC dynamic composite load model,” *Hawaii Intl. Conf. System Sciences (HICSS)*, 2017.
- **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**, Hong Hu, Wenhan Dai, Yuan Shen, and Moe Z. Win, “An area state-aided indoor localization algorithm and its implementation,” *IEEE Intl. Conf. on Commun. (ICC)*, 2015.

- Zhao Zhang, **Kaiqing Zhang**, Feifei Gao, and Shun Zhang, “Spectrum prediction and channel selection for sensing-based spectrum sharing scheme using online learning techniques,” *IEEE Intl. Symp. on Personal, Indoor and Mobile Radio Commun. (PIMRC)*, 2015.
- **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.

## WORK EXPERIENCES

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<b>Research Scientist Intern</b>	Nation. Renew. Energy Lab. (NREL), CO	Jun. 2016 — Sept. 2016
<b>Visiting Fellow</b>	Army Research Lab. (ARL), Adelphi, MD	Jun. 2018 — Aug. 2018
<b>Research Scientist Intern</b>	Amazon AWS AI Labs, Seattle, WA	May 2019 — Aug. 2019

## TEACHING EXPERIENCES

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<b>Teaching Assistant</b>	ECE 543 Statistical Learning Theory by Prof. R. Srikant	Spring 2020
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## AWARDS & HONORS

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- NeurIPS Travel Award 2019
- CDC Student Travel Award (Declined) 2019
- Mavis Future Faculty Fellows (MF3), UIUC 2019
- Hong, McCully, and Allen Fellowship (**\$12000**), UIUC 2018 & 2019
- ICML Travel Award 2018
- James M. Henderson Fellowship, University of Illinois at Urbana-Champaign 2016
- **Best poster award** of the PSERC IAB meeting 2015
- 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

## PROFESSIONAL SERVICES & ACTIVITIES

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- Reviewer for *ICML*, *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