Zhanzhan Zhao

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Education

Jan 2024 — Postdoctoral Fellow in **Boston Children's Hospital & Harvard Medical School**
Computational Health Informatics Program
Advisors: Prof. Maia Majumder, Prof. William La Cava

Aug 2023 - Dec 2023 — Postdoctoral Fellow in **Mathematical Sciences Research Institute**, Berkeley
Algorithms, Fairness, and Equity Program, UC Berkeley
Mentors: Prof. Paul Milgrom, Prof. Daryl DeFord

2018 - 2023 — Doctor of Philosophy, **Georgia Institute of Technology**, Atlanta
Machine Learning Program in Computer Science | Advisor: Prof. Dana Randall
Thesis: Understanding and Mitigating Bias in Algorithms, Data, and Society | Video

2018 - 2020 — Master in Computer Science, **Georgia Institute of Technology**, Atlanta
Machine Learning | Advisor: Prof. Dana Randall

2016 - 2018 — Master in Aerospace Engineering, **University of Michigan**, Ann Arbor
Autonomous Systems & Control | Advisor: Prof. Dennis S. Bernstein

2012 - 2016 — Bachelor of Engineering, *Honors School*, **Harbin Institute of Technology**, China
Flight Vehicle Design and Engineering | Advisor: Prof. Naigang Cui

2014 - 2015 — Exchange Student in **Seoul National University**, the South Korea
Mechanical Engineering | Advisor: Prof. Frank Chongwoo Park

Research Experience

Sep 2023-Present — Mitigating Social Dilemmas through Game-theoretic Approaches
Mentor: Prof. Paul Milgrom
- Formulated a game theory framework to address social dilemmas.

Sep 2023-Present — Mitigating Racial and Wealth Segregation Through Fair School Zone Designs
Mentors: Prof. Irene Lo, Prof. Daryl DeFord
- Working on an efficient algorithm for equitable school zoning.
- Demonstrated initial results with data of Atlanta.

Sep 2022-Present — Mitigating Ideological Polarization Through Novel Recommendation Designs
Advisor: Prof. Dana Randall
- Proposed a stochastic model considering persistent influencers and individuals' social pressure.
- Showed highly personalized recommendations can contribute to escalating extreme polarization.
- Proposed tolerance-aware and adaptively diversifying recommendations to reverse polarization.
- Conducted participation observation and member interviews to study an online community r/antiwork.
- Collaborating with behavioral economist Yunhao Zhang, trying to conduct experiments.

Sep 2020-Sep 2023

Mitigating Residential Segregation Through Allocating Public Amenities

Advisors: Prof. Catherine Ross, Prof. Dana Randall

- Proposed a stochastic model considering individuals' homophily and socioeconomic incentives.
- Proved segregation can be worsened or mitigated with centralized or distributed amenity allocations.
- Clustered 220 U.S. cities into five types according to their amenity distributions and segregation levels.
- Showed nationwide correlations between clustering levels of amenities and segregation severity.
- Investigated deep reinforcement learning framework of finding the optimal distributions of amenities.
- Investigated correlations between people's city impressions and segregation severity with text mining.

July 2021-Sep 2023

Quantifying Gerrymandering and Non-responsiveness in Redistricting via Sampling

Advisors: Profs. Gregory Herschlag, Swati Gupta, Jonathan Mattingly, Dana Randall

- Helped to propose, implement and prove the "batched parallel tempering" for sampling efficiency.
- Quantified the non-responsiveness and polarization in competitive districts of the GA redistricting map.
- Analyzed the spatial mechanisms of forming the gerrymandering pattern in the GA congressional map.
- Quantified the dilution of minority voting power in the 2021 Georgia Congressional plan.

Feb 2019-Sep 2020

Learning to Control on the Fly

Advisors: Prof. Jacob Abernethy, Prof. Arkadi Nemirovski

- Proposed a novel online control algorithm with no system dynamics knowledge by adding constraints when the feasibility of the decision variable is violated.
- Proved the upper bound of the number of feasibility violations before the convergence of the state.

Dec 2016-June 2019

Adaptive Spacecraft Attitude Control with Unmodeled Dynamics

Advisor: Prof. Dennis S. Bernstein

- Derived and simulated the spacecraft attitude dynamics with gimbal angular-rate-commanded CMG's.
- Adapted the adaptive control algorithms to use no knowledge of the system dynamics.
- Tested the algorithms under input singularity, spacecraft inertia variations and various maneuvers.
- Derived the dynamics of the dual-rigid-body spacecraft on a Lie Group, analyzed the nonminimum-phase zeros, and adapted the control algorithm to the nonlinear system with verification of robustness.

July 2017-Dec 2017

Deep Reinforcement Learning Based Stochastic Control for Multi-Task Coordination

Advisor: Prof. Dongkun Han

- Constructed a Lyapunov-like barrier function to encode multiple control objectives and designed distributed gradient-based controllers.
- Applied Kalman filter to estimate state under stochastic disturbance and sensor noise; rebuilt Lyapunov-like barrier function based on the estimation to encode the objectives within confidence intervals.
- Proposed the fusion of Deep Deterministic Policy Gradient and gradient-based control and found time-varying gains to achieve shortest settling time with the minimum control input.

Teaching Experience and Employment

2019-2023	Research Assistant, Georgia Tech
2022	Teaching Assistant for CS3510: Design and Analysis of Algorithms, Georgia Tech
2021	Teaching Assistant for CS2050: Introduction to Discrete Math, Georgia Tech
2019	Teaching Assistant for AE3610: Experiments in Fluid and Solid Mechanics, Georgia Tech
2018	Teaching assistant for AE4803: Robotics and Autonomy, Georgia Tech
2017	C++ programmer for 3DSSP software at IOE Department, University of Michigan
2016	Internship at GE Power, China Innovation Center, Harbin
2015	Internship at Innovative Design and Integrated Manufacturing Lab, Seoul National University

Selected Awards

- Travel Grant from the ACM Conference EAAMO, 2022
- Certificate on Technology Entrepreneurship, Scheller College of Business, Georgia Tech, 2022
- Georgia Tech ARC-TRIAD Fellowship, 2021
- Z. Zhao, "A Vortex Lattice C++ Implementation for NACA Tapered Sweep Wing Investigations", Second Place in Masters' Category, 2017 AIAA Region III Student Conference, 2017
- Champion at the 16TH National Robotics Competition, China (1/60), 2014
- Honorable Mention in the 2014 International Mathematical Contest in Modeling, 2014
- Outstanding Undergraduate International Exchange Fellowship, 2014
- "Excellent Student" (1 out of 10 in Harbin Institute of Technology), 2013

Publications

[1] **Z. Zhao** and D. Randall. "A Heterogeneous Schelling Model for Wealth Disparity and its Effect on Segregation." *ACM Conference on Equity and Access in Algorithms, Mechanisms, and Optimization*, 2022.

[2] **Z. Zhao**, C. Hettle, S. Gupta, J. Mattingly, D. Randall and G. Herschlag. "Mathematically Quantifying Non-responsiveness of the 2021 Georgia Congressional Districting Plan." *ACM Conference on Equity and Access in Algorithms, Mechanisms, and Optimization (EAAMO)*, 2022.

[3] **Z. Zhao**, G. Cruz and D. S. Bernstein. "Adaptive Spacecraft Attitude Control Using Control Moment Gyros without Singularity Avoidance." *Journal of Guidance, Control, and Dynamics*, 2019. (impact factor 2.024, the best journal in the control area in Aerospace Engineering)

[4] **Z. Zhao**, G. Cruz, T. Lee, and D. S. Bernstein. "Adaptive Attitude Control of a Dual-Rigid-Body Spacecraft with Unmodeled Nonminimum-Phase Dynamics." *American Control Conference (ACC)*, 2018. (one of the top two control conferences)

[5] **Z. Zhao** and D. Han. "Multi-Task Formation of Multi-Spacecraft via Distributed Hierarchical Control." *IEEE Aerospace Conference*, 2018.

[6] **Z. Zhao**. "A Novel Viscous-Inviscid Interactive Method for Arbitrary Wings." *AIAA SciTech Forum*, 2018.

Working Papers

[7] J. Carlos Martínez Mori and **Z. Zhao**. "Modeling Neighborhood Change and Gentrification." *In preparation for ACM Conference on Fairness, Accountability, and Transparency (ACM FAccT), 2024.*

[8] **Z. Zhao**, C. Yoo, N. Golshani, C. Ross, and D. Randall. "Quantifying the Biased Urban Amenity Distributions and their Associations with Segregation." *In preparation for PNAS*, 2023.

[9]**Z. Zhao**, C. Hettle, S. Gupta, J. Mattingly, D. Randall, and G. Herschlag. "Mathematically Quantifying Non-responsiveness of the 2021 Georgia Districting Plan via Parallel Tempering." *In preparation for Operations Research*, 2023.

[11] **Z. Zhao** and D. Randall. "Mitigating Extreme Political Attitudes through Novel Online Recommendation Designs." *In preparation*, 2023.

[12] V. Anand, M. Yang, and **Z. Zhao**. "Mitigating Filter Bubbles within Deep Recommender Systems." *arXiv preprint*, 2022.

[13] H. Lin, **Z. Zhao** and J. Han. "Uncovering Correlated Factors of Racial Segregation in U.S. through Large-Scale Online Opinion Mining." *In preparation*, 2022.

Professional Development

2023 Invited research talk at Harvard University
2023 Invited research talk at Mathematical Sciences Research Institute
2023 Invited research talk at Tsinghua University
2023 Invited research talk at Santa Fe Institute
2022 Analysis of online community r/antiwork through observations and interviews
2022 Investigated how to generate redistricting maps that maximally preserve communities
2021 Investigated the echo chamber effects on Twitch
2021 Investigated the effects of selfish / altruistic nodes for the emergent patterns in a Markov chain
2019 Investigated how to weaken the "rich-get-richer" effect in an initially scale-free network
2019 Research Poster Presentation at MURI Kickoff Meeting, Georgia Tech
2016 Initiated Team "MachLoop" in 2017 SpaceX HyperLoop Pod Competition (35 members)

Services

2023 Network science seminar series organizer in Mathematical Sciences Research Institute
2023 Social activity chair in Mathematical Sciences Research Institute
2023 Reviewer for the 15th Innovations in Theoretical Computer Science Conference
2021 Technology analyses for applicant Tech startups for Creative Destruction Lab—Atlanta
2020 Reviewer for the journal PLOS ONE (impact factor 2.740)
2018 Co-chaired the session "Adaptive Control IV" in 2018 American Control Conference

Doctor of Philosophy in Machine Learning

Grades for Major Courses

Course	Grade	Credit Hrs
Machine Learning Courses:		
Intro to Graduate Algorithms	A	3
Math Foundation of Machine Learning	A	3
Computational Data Analysis	A	3
Machine Learning Theory	B	3
Probabilistic Graphical Models in Machine Learning	A	3
Convex Optimization	A	3
Modern Convex Optimization	A	3
Deep Learning	A	3
Deep Reinforcement Learning for Intelligent Control	B	3
Complex Systems Courses:		
Cyber-Physical Systems and Distributed Control	A	3
Network Science	A	3
Markov Chains and Emergence	A	3
Computational Social Science	A	3
Data Science for Social Network	B	3
Online Communities	A	3
Minor on Technology Entrepreneurship:		
Innovation Analysis (Business Analysis for Innovation Projects)	A	3
Innovation and Business Model Design	A	3
Innovation Execution	A	3
Innovation Research Methods 1 (do Interviews)	A	1.5
Innovation Research Methods 2 (make observations)	A	1.5

Master of Science in Autonomous Systems and Control

Grades for Major Courses

Course	Grade	Credit Hrs
Intermediate Dynamics	A	3
Linear System Theory	A	3
Linear Feedback Control	A+	3
Nonlinear Systems and Control	A	3
Navigation and Guidance for Aerospace Vehicle	A+	3
Reinforcement Learning	B	3
Model Predictive Control	A	3
Viscous Flow	A-	3
Computational Fluid Dynamics(Audit)	VI	