# Dongsheng Ding


CONTACT INFORMATION

Department of Electrical and Systems Engineering
University of Pennsylvania
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TEACHING INTERESTS

I view teaching as a responsibiity toward future generations and society. Technology rapidly advances, yet engineering course materials stay relatively static in traditional fields, limiting alignment with today's interdisciplinary applications and innovations. My teaching aims to develop forward-thinking curricula that bridge interdisciplinary gaps and expand career possibilities.

RESEARCH INTERESTS

Application of principles and tools in optimization and control to the *study of requirement-driven machine decision-making*.

Topics of interest span: constrained reinforcement learning; multi-agent reinforcement learning; constrained generative models; constrained alignment of diffusion and large language models; robustness and resilience analysis of optimization algorithms; nonlinear control of fractional-order dynamical systems.

Applications of interest include: autonomous robots/vehicles; generative artificial intelligence in applied science and engineering, such as natural language processing, image processing, and molecular design; decision-making systems for power grid, transportation, communication, and healthcare management.

APPOINTMENT

**Postdoctoral Researcher** — September 2022 – Now
University of Pennsylvania
Host: Alejandro Ribeiro

**Graduate Research Assistant** — August 2017 – August 2022
University of Southern California

**Graduate Research Assistant & Teaching Assistant** — August 2015 – August 2017
University of Minnesota, Twin Cities

EDUCATION

**PhD in Electrical Engineering**, GPA: 4.0/4.0 — August 2022
University of Southern California
Thesis: Provable reinforcement learning for constrained and multi-agent control systems
Advisor: Mihailo R. Jovanović

**MS in Electrical Engineering**, GPA: 3.9/4.0 — August 2017
University of Minnesota, Twin Cities

**ME in Control Theory & Engineering**, GPA: 3.7/4.0 — March 2015
**BE in Automation**, GPA: 3.8/4.0 — June 2011
Zhejiang University, Hangzhou, China

PARTICIPATION IN GRANT APPLICATIONS

1. NSF-Swiss NSF Lead Agency Opportunity: Generative Graph Models at Scale: Discrete Diffusion, Transferability and Requirements, PIs: Pascal Frossard and Alejandro Ribeiro, 10/2024 – 09/2027. (amount $450,000, approved)
2. NSF Mathematical Foundations of Artificial Intelligence (MFAI): Mathematical Foundations of Alignment of Generative Artificial Intelligence, PIs: Alejandro Ribeiro, Edgar Dobriban, and Hamed Hassani, 07/2025 – 06/2028. (amount $1,271,517, pending)

SUBMITTED PAPERS

1. S. Rozada, D. Ding, A. Marques, A. Ribeiro. "Deterministic policy gradient primal-dual methods for continuous-space constrained MDPs." arXiv:2408.10015, 2024. (under review)

REFEREED PUBLICATIONS

**Journals**

1. D. Ding, K. Zhang, J. Duan, T. Başar, and M. R. Jovanović. "Convergence and sample complexity of natural policy gradient primal-dual methods for constrained MDPs," *J. Mach. Learn. Res.*; also arXiv: 2206.02346, 2022. (under review)
2. D. Ding, X. Wei, Z. Yang, Z. Wang, and M. R. Jovanović. "Fast multi-agent temporal-difference learning via homotopy stochastic primal-dual optimization," *IEEE Trans. Control. Netw. Syst.*; also arXiv:1908.02805, 2020. (under revision)
3. Q. Wang, J. Zhang, D. Ding, and D. Qi, "Adaptive Mittag-Leffler stabilization of a class of fractional order uncertain nonlinear systems," *Asian J. Control*, 18(6) 2343–2351, 2016.
4. D. Ding, D. Qi, and Q. Wang, "Asymptotic pseudo-state stabilization of uncertain fractional-order nonlinear systems with additive disturbance," *Nonlinear Dyn.*, 81(1) 667–677, 2015.
5. Q. Wang, D. Ding, and D. Qi, "Mittag-Leffler synchronization of uncertain fractional order chaotic systems," *Chinese Physics B*, 24(6), 2015.
6. D. Ding, D. Qi, and Q. Wang, "Nonlinear Mittag-Leffler stabilization of commensurate fractional-order nonlinear systems," *IET Control Theory Appl.*, 9(5) 681–690, 2014.
7. D. Ding, D. Qi, X. Luo, J. Chen, X. Wang, and P. Du, "Convergence analysis and performance of an extended central force optimization algorithm," *Appl. Math. Comput.*, 219(4), 2246–2259, 2012.
8. D. Ding, X. Luo, J. Chen, X. Wang, P. Du, and Y. Guo, "A convergence proof and parameter analysis of central force optimization algorithm," *J. Convergence Inf. Technol.*, 6(10), 16–23, 2011.

**Machine Learning and Artificial Intelligence Conferences**

1. X. Huang, S. Li, E. Dobriban, O. Bastani, H. Hassani, and D. Ding. "One-shot safety alignment for large language models via optimal dualization." in *Proceedings*

*of the Advances in Neural Information Processing Systems*, Vancouver, Canada, 2024; to appear and arXiv: 2405.19544. (**acceptance rate** 25.8%**, spotlight**)

2. S. Khalafi, D. Ding, and A. Ribeiro. "Constrained diffusion models via dual training." in *Proceedings of the Advances in Neural Information Processing Systems*, Vancouver, Canada, 2024; to appear and arXiv:2408.15094. (**acceptance rate** 25.8%)
3. D. Ding, Z. Huan, and A. Ribeiro. "Resilient constrained reinforcement learning." in *Proceedings of the 27th International Conference on Artificial Intelligence and Statistics*, Valencia, Spain, 2024. (**acceptance rate** 27.6%)
4. D. Ding, C.-Y. Wei, K. Zhang, and A. Ribeiro. "Last-iterate convergent policy gradient primal-dual methods for constrained MDPs," in *Proceedings of the Advances in Neural Information Processing Systems*, New Orleans, Louisiana, 2023. (**acceptance rate** 26.1%)
5. D. Ding, X. Wei, Z. Yang, Z. Wang, and M. R. Jovanović. "Sample efficient genearalized Lagrangian policy optimization for safe multi-agent reinforcement learning," in *Proceedings of the Learning for Dynamics and Control Conference*, Philadelphia, Pennsylvania, 2023.
6. D. Ding, C.-Y. Wei, K. Zhang, and M. R. Jovanović. "Independent policy gradient for large-scale Markov potential games: sharper rates, function approximation, and game-agnostic convergence," in *Proceedings of the 39th International Conference on Machine Learning*, Baltimore, Maryland, 2022. (**acceptance rate** 21.5%**, 118/1117 long presentations**)
7. D. Ding, X. Wei, Z. Yang, Z. Wang, and M. R. Jovanović. "Provably efficient safe exploration via primal-dual policy optimization," in *Proceedings of the 24th International Conference on Artificial Intelligence and Statistics*, Virtual, 2021. (**acceptance rate** 30%**, 48/455 orals**)
8. D. Ding, K. Zhang, T. Başar, and M. R. Jovanović. "Natural policy gradient primal-dual method for constrained Markov decision processes," in *Proceedings of the Advances in Neural Information Processing Systems*, Virtual, 2020. (**acceptance rate** 20%)
9. D. Ding, X. Wei, Z. Yang, Z. Wang, and M. R. Jovanović. "Fast multi-agent temporal-difference learning via homotopy stochastic primal-dual method," in *the Optimization Foundations for Reinforcement Learning Workshop at NeurIPS*, Vancouver, Canada, 2019.

## Control Conferences

1. D. Ding and M. R. Jovanović. "Policy gradient primal-dual mirror descent for constrained MDPs with large state spaces," in *Proceedings of the 61st IEEE Conference on Decision and Control*, Cancún, Mexico, 2022.
2. D. Ding, K. Zhang, T. Basar and M. R. Jovanović, "Convergence and optimality of policy gradient primal-dual method for constrained Markov decision processes,"

in *Proceedings of the 2022 American Control Conference*, Atlanta, Georgia, 2022.

3. D. Ding, X. Wei, H. Yu, and M. R. Jovanović. "Byzantine-resilient distributed learning under constraints," in *Proceedings of the 2021 American Control Conference*, Virtual, 2021.
4. D. Ding, J. Yuan, and M. R. Jovanović. "Discounted online Newton method for time-varying time series prediction," in *Proceedings of the 2021 American Control Conference*, Virtual, 2021.
5. D. Ding and M. R. Jovanović. "Global exponential stability of primal-dual gradient flow dynamics based on the proximal augmented Lagrangian: A Lyapunov-based approach," in *Proceedings of the 59th IEEE Conference on Decision and Control*, Virtual, 2020.
6. D. Ding, X. Wei, and M. R. Jovanović. "Distributed robust statistical learning: Byzantine mirror descent," in *Proceedings of the 58th IEEE Conference on Decision and Control*, Nice, France, 2019.
7. D. Ding and M. R. Jovanović. "Global exponential stability of primal-dual gradient flow dynamics based on the proximal augmented Lagrangian," in *Proceedings of the 2019 American Control Conference*, Philadelphia, Pennsylvania, 2019.
8. D. Ding, B. Hu, N. K. Dhingra, and M. R. Jovanović. "An exponentially convergent primal-dual algorithm for nonsmooth composite minimization," in *Proceedings of the 57th IEEE Conference on Decision and Control*, Miami Beach, Florida, 2018.
9. D. Ding and M. R. Jovanović. "A primal-dual Laplacian gradient flow dynamics for distributed resource allocation problems," in *Proceedings of the 2018 American Control Conference*, Milwaukee, Wisconsin, 2018.
10. D. Ding, D. Qi, and Q. Wang, "Adaptive Mittag-Leffler stabilization of commensurate fractional-order nonlinear systems," in *Proceedings of the 53rd IEEE Conference on Decision and Control*, Los Angeles, California, 2014.
11. D. Ding, G. Zhang, D. Qi, and H. Zhang, "Strategy analysis of an evolutionary spectrum sensing game," in *Proceedings of the Intelligent Computing and Applications (LSMS & ICSEE)*, Shanghai, China, 2014. (**nominate paper award**)
12. D. Ding, D. Qi, and Q. Wang, "Alternative LMI characterizations for fractional-order linear systems," in *Proceedings of the 33rd Chinese Control Conference*, Nanjing, China, 2014.
13. D. Ding, D. Qi, and Q. Wang, "Fractional-order integral state space modeling and quasi state analysis via block operational matrix scheme," in *Proceedings of the 26th Chinese Control and Decision Conference*, Changsha, China, 2014.

## RESEARCH PRESENTATIONS

### Invited Talks & Posters

1. Invited talk of "Multi-agent reinforcement learning for large-scale Markov potential games," in *the Workshop on Multi-Agent Learning in Dynamic Environments*, Texas A&M Institute of Data Science, TAMU, 2024.

2. Invited talk of "Multi-agent reinforcement learning for large-scale Markov potential games," in *the ESE PhD Colloquium*, UPenn, 2024.
3. Invited talk of "Constrained policy optimization: A tale of regularization and optimism," in *the INFORMS Optimization Society Conference*, Houston, Texas, 2024.
4. Invited talk of "Constrained policy optimization: A tale of regularization and optimism," in *the ESE PhD Colloquium*, UPenn, 2023.
5. Invited talk of "Provable constrained policy optimization in reinforcement learning," in *the Safe Reinforcement Learning Online Seminar*, Virtual, 2023.
6. Invited talk of "Finite-time performance of policy optimization methods for constrained reinforcement learning," in *the INFORMS 2022 Annual Meeting*, Indianapolis, Indiana, 2022.
7. Invited poster of "Independent policy gradient for large-scale Markov potential games" in *the REAL@USC-Meta center workshop*, ECE, USC, 2022.
8. Invited poster of "Provably efficient safe exploration via primal-dual policy optimization" in *the 11th Annual Research Festival*, ECE, USC, 2021.
9. Invited talk of "Provable constrained policy optimization for reinforcement learning" in *the 38th Southern California Control Workshop*, University of California, Irvine, California, Virtual, 2021.
10. Invited poster of "Distributed robust statistical learning: Byzantine mirror descent" in *the 10th Annual Research Festival*, ECE, USC, 2019.
11. Invited poster of "An exponentially stable primal-dual algorithm for nonsmooth optimization" in *the 9th Annual Research Festival*, ECE, USC, 2018.
12. Invited talk of "A primal-dual algorithm for distributed resource allocation" in *the 34th Southern California Control Workshop*, University of California, Riverside, California, 2018.

## Conference Talks & Posters

1. Contributed poster of "One-shot safety alignment for large language models via optimal dualization." in *the Next Generation of AI Safety Workshop at ICML* and *the Workshop on Theoretical Foundations of Foundation Models at ICML*, Vienna, Austria, 2024.
2. Contributed talk & poster of "Last-iterate convergent policy gradient primal-dual methods for constrained MDPs" in *the 37th Conference on Neural Information Processing Systems*, New Orleans, Louisiana, 2023.
3. Contributed poster of "Sample efficient genearalized Lagrangian policy optimization for safe MARL" in *the 5th Annual Learning for Dynamics and Control Conference*, Philadelphia, Pennsylvania, 2023.

4. Contributed talk of "Policy gradient primal-dual mirror descent for constrained MDPs with large state spaces," in *the 61st IEEE Conference on Decision and Control*, Cancún, Mexico, 2022.
5. Contributed talk of "Policy gradient primal-dual method for constrained MDPs," in *the 2022 American Control Conference*, Atlanta, Georgia, 2022.
6. Contributed talk & poster of "Independent policy gradient for large-scale Markov potential games: sharper rates, function approximation, and game-agnostic convergence" in *the 39th International Conference on Machine Learning*, Baltimore, Maryland, 2022. (118/1117 long presentations)
7. Contributed talk & poster of "Provably efficient safe exploration via primal-dual policy optimization" in *the 24th International Conference on Artificial Intelligence and Statistics*, Virtual, 2021. (48/455 orals)
8. Contributed talk & poster of "Natural Policy Gradient Primal-Dual Method for Constrained Markov Decision Processes" in *the 34th Conference on Neural Information Processing Systems*, Virtual, 2020.
9. Contributed talk of "Global exponential stability of primal-dual gradient flow dynamics based on the proximal augmented Lagrangian" in *the 59th IEEE Conference on Decision and Control*, Virtual, 2020.
10. Contributed poster of "Fast multi-agent temporal-difference learning via homotopy stochastic primal-dual method," in *the Optimization Foundations for Reinforcement Learning Workshop at NeurIPS*, Vancouver, Canada, 2019; *the Southern California Machine Learning Symposium*, UCSD, 2020.
11. Contributed talk of "Exponential stability of primal-dual gradient flow dynamics based on proximal augmented Lagrangian," in *the 2019 American Control Conference*, Philadelphia, Pennsylvania, 2019.
12. Contributed talk of "Nonsmooth composite minimization: an exponentially convergent primal-dual algorithm," in *the 57th IEEE Conference on Decision and Control*, Miami Beach, Florida, 2018.
13. Contributed talk of "A primal-dual Laplacian gradient flow dynamics for distributed resource allocation problems," in *the 2018 American Control Conference*, Milwaukee, Wisconsin, 2018.
14. Contributed talk of "Adaptive Mittag-Leffler stabilization of commensurate fractional-order nonlinear systems" in *the 53rd IEEE Conference on Decision and Control*, Los Angeles, California, 2014.
15. Contributed talk of "Alternative LMI characterizations for fractional-order linear systems" in *the 33rd Chinese Control Conference*, Nanjing, China, 2014.
16. Contributed talk of "Fractional-order integral state space modeling" in *the 26th Chinese Control and Decision Conference*, Changsha, China, 2014.

HONORS & AWARDS

**Scholar Award**, Conference on Neural Information Processing Systems 2023
**Expert Reviewers**, International Conference on Machine Learning 2021
**Travel Award**, Conference on Neural Information Processing Systems 2020
**Top Reviewers**, International Conference on Machine Learning 2020
**Travel Award**, IEEE Conference on Decision and Control 2020
**Travel Award**, American Control Conference 2018, 2019, 2022
**MHI PhD Scholar Finalist**, ECE, University of Southern California 2018, 2021
**ECE Department Fellowship**, University of Minnesota 2015
**Honor for Outstanding Graduate Student**, Zhejiang University 2015
**Nominate Paper Award**, LSMS & ICSEE, 2014, Shanghai 2014
**Bosch Scholarship**, Bosch in China 2013
**The First-Class of Graduate Scholarship**, Zhejiang University 2012–2015
**National Scholarship**, Ministry of Education of P.R. China 2011
**Wei Shaoxiang Engineering Talent**, Wei Shaoxiang Foundation, HongKong 2010
**The Second-Class of Physics and Technology Innovation Contest**, Zhejiang Physical Society, Zhejiang, China 2009
**The First-Class of Advanced Mathematics Contest**, Zhejiang Mathematical Society, Zhejiang, China 2008

ACADEMIC SERVICE

**Journal Referee**

IEEE Transactions on Control of Network Systems
IEEE Transactions on Automatic Control
IEEE Robotics and Automation Letters
IEEE Transactions on Intelligent Vehicles
IEEE Control Systems Letters
Systems & Control Letters
Optimization Letters
Machine Learning
Neural Networks
Automatica
IEEE Transactions on Pattern Analysis and Machine Intelligence
APSIPA Transactions on Signal and Information Processing
Engineering Applications of Artificial Intelligence
SIAM Journal on Mathematics of Data Science
Transactions on Machine Learning Research
Journal of Machine Learning Research
IET Control Theory & Applications
International Journal of Robust and Nonlinear Control
Frontiers of Information Technology & Electronic Engineering
International Journal of Systems Science
The Journal of the Franklin Institute
Journal of Applied Mathematics and Computing
Nonlinear Dynamics

IEEE Access

**Conference Referee**

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| IEEE Conference on Decision and Control | 2018–2024 |
| Conference on Neural Information Processing Systems | 2020–2024 |
| International Conference on Learning Representations | 2021–2025 |
| International Conference on Artificial Intelligence and Statistics | 2021, 2025 |
| International Conference on Machine Learning | 2020–2024 |
| ICML Workshop on Next Generation of AI Safety | 2024 |
| ICML Workshop on Theoretical Foundations of Foundation Models | 2024 |
| NeurIPS Safe Generative AI Workshop | 2025 |
| Learning for Dynamics and Control Conference | 2024 |
| AAAI Conference on Artificial Intelligence | 2023, 2024 |
| American Control Conference | 2018–2024 |
| IFAC World Congress | 2020 |
| Chinese Control Conference | 2014 |
| Chinese Control and Decision Conference | 2014 |

**Conference Volunteer**

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| 38th International Conference on Machine Learning, Virtual | 2021, 2022 |
| 24th International Conference on Artificial Intelligence and Statistics, Virtual | 2021 |
| 35th Conference on Neural Information Processing Systems, Virtual | 2021 |

**Co-chair of Nonlinear System and Control Section**

26th Chinese Control and Decision Conference, Changsha, China 2014

**Admissions Committee**, University of Pennsylvania

PhD Admission in the Department of Electrical and Systems Engineering Fall 2023

## TEACHING EXPERIENCE

**Lab Assistant**, University of Pennsylvania

ESE 2000 Artificial Intelligence Lab: Data, Systems, and Decisions Summer 2024

**Guest Lecturer**, University of Pennsylvania

ESE 5140 Graph Neural Networks Fall 2023

**Teaching Assistant**, University of Southern California

EE 587 Nonlinear Systems Spring 2018

**Guest Lecturer**, University of Minnesota Twin Cities

EE 3015 Statistical Methods in Electrical and Computer Engineering Spring 2017

**Teaching Assistant**, University of Minnesota Twin Cities

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| EE 4231 Automatic Control Systems | Fall 2016 |
| EE 3015 Statistical Methods in Electrical and Computer Engineering | Spring 2017 |
| EE 8231 Optimization Theory | Spring 2017 |

## MENTORING EXPERIENCE

**Research Mentor for PhD Students**, University of Pennsylvania

Shervin Khalafi (2nd year) September 2023 – Now

Topic: Constrained learning for diffusion models

Xinmeng Huang (5th year) February 2024 – Now
Topic: Safe generation of large language models
Berkay Uslu (2nd year) September 2023 – Now
Topic: Diffusion policy optimization in reinforcement learning

**Research Mentor for PhD Students**, King Juan Carlos University, Madrid, Spain
Sergio Rozada (5th year) February 2024 – Now
Topic: Constrained reinforcement learning in continuous state-action space

**Research Mentor for Master Students**, University of Pennsylvania
Zhengyan Huan September 2023 – February 2024
Topic: Resilient constrained reinforcement learning

**Research Mentor for Undergraduate Students**, University of Southern California
Directed Research 490 January 2022 – June 2022

**Academic Mentor for Master Students**, University of Southern California
Viterbi Graduate Mentorship Program August 2018 – June 2021

SKILLS

Python, LaTeX, C/C++, Matlab, SQL

MEMBERSHIPS

The Institute of Electrical and Electronics Engineers (IEEE)
IEEE Control Systems Society Membership
The Institute for Operations Research and the Management Sciences (INFORMS)
Stanford Encyclopedia of Philosophy

GRADUATE COURSE HIGHLIGHTS

**Control Systems:** EE 5231 Linear System and Optimal Control, EE 8215 Nonlinear Systems, AEM 8421 Robust Multi-Variable Control Systems, AEM 8423 Convex Optimization Methods in Control; **Optimization and Computation:** EE 5239 Introduction to Nonlinear Optimization, EE 8231 Optimization Theory, ISE 633 Large-Scale Optimization for Machine Learning, CSCI 5304 Computational Aspects of Matrix Theory, CSCI 8314 Sparse Matrix Computations; **Probability and Machine Learning:** MATH 507A/B Theory of Probability, EE 556 Stochastic Systems & Reinforcement Learning, CSCI 5525 Machine Learning, EE 546 Mathematics of High-Dimensional Data, DSO 699 Statistical Learning Theory, CSCI 699 Theoretical Machine Learning, EE 5581 Information Theory and Coding.