CHENYU ZHANG

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EDUCATION

Massachusetts Institute of Technology, Cambridge, MA　　*2024 - present*
Ph.D. Social and Engineering Systems and Statistics

Columbia University, New York, NY　　*2022 - 2024*
M.S. Data Science
GPA: 4.00/4.00

Fudan University, Shanghai, CN　　*2018 - 2022*
B.S. Mathematics and Applied Mathematics
Honors Student of Su Buqing Top Talent Program

PUBLICATIONS

- **Chenyu Zhang**, Xu Chen, and Xuan Di. Stochastic semi-gradient descent for learning mean field games with population-aware function approximation. *Advances in Neural Information Processing Systems*, 2024. [Accepted]
- Fuzhong Zhou, **Chenyu Zhang**, Xu Chen, and Xuan Di. Graphon mean field games with a representative player: analysis and learning algorithms. *International Conference on Machine Learning*, 2024. [Accepted] [OpenReview]
- **Chenyu Zhang**, Han Wang, Aritra Mitra, and James Anderson. Finite-time analysis of on-policy heterogeneous federated reinforcement learning. *International Conference on Learning Representations*, 2024. [Accepted] [OpenReview]
- **Chenyu Zhang**, Xu Chen, and Xuan Di. A single online agent can efficiently learn mean field games. *European Conference on Artificial Intelligence*, 2024. [Accepted] [Preprint]
- **Chenyu Zhang** and Rujun Jiang. Riemannian adaptive regularized Newton methods with Hölder continuous Hessians. *Computational Optimization and Applications*, 2023. [Under review] [Preprint]
- **Chenyu Zhang**, Rufeng Xiao, Wen Huang, and Rujun Jiang. Riemannian trust region methods for SC^1 minimization. *Journal of Scientific Computing*, 2023. [Under revision] [Preprint]

RESEARCH EXPERIENCE

Neural Networks　　*May 2023 - Present*
Research assistant, advised by Prof. John Wright　　*Dept. EE&APAM, Columbia University, NY*

- Identified constraints within neural tangent kernels and designing data-aware kernels for analyzing fully-connected neural networks.
- Analyzed limitations of Transformers and designing tailored attention mechanisms with tensor kernels and invariant similarity weights.
- Conducted a comprehensive empirical study on intrinsic dimension estimation of patch manifolds and deriving the optimal patch size for various vision tasks.

Mean Field Games　　*May 2023 - Present*
Research assistant, advised by Prof. Sharon Di　　*Dept. CEEM, Columbia University, NY*

- Pioneered the first fully online single-agent model-free methods for learning mean field games (MFGs), complete with sample complexity guarantees.
- Advanced the online methods to eliminate the reliance on forward-backward passes used in prior work, thereby obviating the need for supplementary stabilization techniques.

- Extended the scope of the online methods to encompass linear MFGs with continuous state-action spaces and graphon MFGs with large heterogeneous populations.

Federated Reinforcement Learning
September 2022 - Present

Research assistant, advised by Prof. James Anderson
Dept. EE, Columbia University, NY

Co-advised by Prof. Aritra Mitra
Dept. ECE, North Carolina State University, NC

- Developed a novel on-policy federated reinforcement learning method and established its finite-time error bounds, demonstrating its linear convergence speedups with the presence of environmental heterogeneity.
- Conducted three simulations to corroborate the theoretical results and showcase the adaptability and robustness of the proposed methods.

Nonsmooth Nonconvex Manifold Optimization
October 2021 - September 2022

Research assistant, advised by Prof. Rujun Jiang
Dept. Data Science, Fudan University, CN

Co-advised by Prof. Wen Huang
Dept. Mathematics, Xiamen University, CN

- Developed the first Riemannian trust-region method tailored for minimizing nonconvex functions on manifolds with a semismooth gradient field, complete with a comprehensive convergence analysis including global convergence and superlinear local convergence rate.
- Implemented the semismooth Riemannian trust-region method in solving augmented Lagrangian method subproblems on manifolds, demonstrating its superiority through two numerical experiments.
- Extended the methodology to formulate the Riemannian adaptive regularized Newton methods framework and established its sharp worst-case iteration and operation complexities.

Reinforcement Learning with Partial Observability
March 2021 - January 2022

Research assistant, advised by Prof. Zhaoran Wang *Dept. of IEMS&CS, Northwestern University, IL*

Co-advised by Prof. Zhuoran Yang
Dept. of Stat&Data Science, Yale University, CT

- Devised an innovative exploration mechanism to handle partial observability without reward feedback.
- Enhanced the mechanism by integrating linear function approximation, enabling its application to large and potentially infinite observation and state spaces.

TEACHING EXPERIENCE

COMS 4771 Machine Learning
Fall 2023

Teaching assistant, advised by Prof. Daniel Hsu
Dept. CS, Columbia University, NY

ORCS 4529 Reinforcement Learning
Fall 2023

Teaching assistant, advised by Prof. Shipra Agrawal
Dept. IEOR, Columbia University, NY

EEOR 4650 Convex Optimization
Fall 2023

Teaching assistant, advised by Prof. James Anderson
Dept. EE, Columbia University, NY

CSOR 4231 Analysis of Algorithms
Spring 2023

Teaching assistant, advised by Prof. Eleni Drinea
Dept. CS, Columbia University, NY

RELEVANT COURSEWORK

Graduate Courses

Machine Learning	A	Reinforcement Learning*	A+
High-Dimensional Probability*	A	Probability and Statistics for Data Science	A+
Modern Control Theory*	A+	Algorithms for Data Science	A+
Exploratory Data Analysis	A+	Computer Systems	A

Selected Undergraduate Courses

Numerical Linear Algebra and Optimization[†]	A	Deep Learning	A
Numerical Solution to Differential Equations	A	Methods of Optimization	A
Functions of Complex Variable	A	Probability Theory	A
An Introduction to Differential Manifolds[†]	A-	Advanced Algebra	A
Computational Thinking	A	Fundamentals of Mechanics	A

Selected Seminars

Matrix Analysis	Convex Optimization
Heuristic Optimization Algorithms	Complex Analysis
Advanced Mathematical Analysis	Principles of Mathematical Analysis
Global Differential Geometry	Differential Manifolds and Differential Topology
Differential Geometry of Curves and Surfaces	Non-Euclidean Geometry and Point Set Topology

SCHOLARSHIP & AWARD

- Lorber Presidential Fellowship, Massachusetts Institute of Technology *2024*
- Honors Student of Top Talent Program, Fudan University *2022*
- Undergraduate Merit Scholarship, Fudan University *2018-2019, 2019-2020, 2020-2021, 2021-2022*
- Undergraduate Major Scholarship, Fudan University *2019-2020, 2020-2021, 2021-2022*
- The Chinese Mathematics Competitions - Second Class Award *2019*
- The Chinese Physics Competitions - Second Class Award *2019*
- Freshman Scholarship, Fudan University *2018*

INVITED TALKS

- "A Semismooth Trust-Region Augmented Lagrangian Method for Nonsmooth Nonconvex Optimization on Riemannian Manifolds," Undergraduate Research Talks, Fudan University, 2022.
- "How to Segment Images? On Intrinsic Dimension Estimation for Patch Manifolds," Data Science Institute Lightning Talks, Columbia University, 2023.

SERVICE

Conference Reviewing

- Learning for Dynamics & Control Conference (L4DC) *2024*
- Conference on Neural Information Processing Systems (NeurIPS) *2024*

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[*]Ph.D. level courses
[†]Honors courses