Jikai Jin

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I'm broadly interested in optimization, applied probability and machine learning theory.

Education

School of Mathematical Sciences, Peking University **Beijing, China**
Undergraduate student *2019 – present*

B.S. in computational mathematics
Advisor: Prof. Liwei Wang.

Research Experience

Stanford University **Online**
Advisor: *Prof. Lexing Ying* *2022.6 – 2022.9*

- Theoretically investigate the problem of learning a linear operator between two Sobolev RKHSs. The motivation comes from recent advances in scientific machine learning.
- Derive a novel information theoretic lower bound on the learning rate using *Fano's method*.
- Study the shape of regularization that can lead to the optimal rate. Introduce two novel concepts: the *bias contour* and the *variance contour* that lead to optimal balance between bias and variance.
- Qualify a specific setting where multilevel training is necessary and capable of achieving a minimax optimal learning rate. The multilevel estimator is obtained via $O(\ln \ln n)$ ensemble of ridge regression models.

Princeton University **Online**
Advisor: *Prof. Simon S. Du and Prof. Jason D. Lee* *2022.1 – 2023.1*

- Consider the matrix sensing problem of recovering a low-rank matrix from partial observations.
- Prove that gradient descent (GD) on this problem follows a greedy low-rank learning (*aka.* incremental learning) procedure. This form of implicit regularization leads GD to recover the ground-truth despite over-parameterization.
- Develop novel landscape properties as a byproduct.

Massachusetts Institute of Technology **Online**
Advisor: *Prof. Suvrit Sra* *2021.3 – 2021.9*

- Revisit the powerful accelerated hybrid proximal extragradient (A-HPE) framework for accelerating optimization algorithms, and present a simple theoretical analysis via potential function.
- Generalize the framework and analysis to the Riemannian optimization setting. Provide sufficient conditions for when Riemannian acceleration can be achieved.
- Discover a number of new first-order accelerated methods as special cases.

Peking University **Beijing, China**
Advisor: *Prof. Liwei Wang* *2020.3 – present*

- Study theoretical properties of adaptive methods for non-convex non-smooth optimization. Show that adaptive step sizes are more preferable in the case with exploding gradient.
- Motivated by the analysis of adaptive methods, propose a novel first-order method for distributionally robust optimization (DRO) with strong theoretical guarantees.
- Investigate why robust generalization is hard to achieve for existing robust learning algorithms. Through theoretical evidence, connect this phenomenon to the limited expressive power of deep neural networks in terms of their sizes.

Publications

(* denotes alphabetical ordering or equal contribution)

1. Bohang Zhang*, **Jikai Jin***, Cong Fang & Liwei Wang. ***Improved Analysis of Clipping Algorithms for Non-convex Optimization***, *33th Annual Conference on Neural Information Processing Systems (NeurIPS)*, 2020.
2. **Jikai Jin**. ***On The Convergence of First Order Methods for Quasar-Convex Optimization***, *12th Annual Workshop on Optimization for Machine Learning, arXiv preprint arXiv:2010.04937*.
3. **Jikai Jin***, Bohang Zhang*, Haiyang Wang & Liwei Wang. ***Non-convex Distributionally Robust Optimization: Non-asymptotic Analysis***, *34th Annual Conference on Neural Information Processing Systems (NeurIPS)*, 2021.
4. **Jikai Jin** & Suvrit Sra. ***Understanding Riemannian Acceleration via a Proximal Extragradient Framework***, *35th Annual Conference on Learning Theory (COLT)*, 2022.
5. Binghui Li*, **Jikai Jin***, Han Zhong, John E. Hopcroft & Liwei Wang. ***Why Robust Generalization in Deep Learning is Difficult: Perspective of Expressive Power***, *35th Annual Conference on Neural Information Processing Systems (NeurIPS)*, 2022.
6. **Jikai Jin**, Yiping Lu, Jose Blanchet & Lexing Ying. ***Minimax Optimal Kernel Operator Learning via Multilevel Training***, *The Eleventh International Conference on Learning Representations (ICLR), 2023* (**spotlight**). *Preliminary version accepted by NeurIPS 2022 workshop on AI for Science.*
7. **Jikai Jin**, Zhiyuan Li, Kaifeng Lyu, Simon S. Du & Jason D. Lee. ***Understanding Incremental Learning of Gradient Descent: Fine-grained analysis of Matrix Sensing***, *Submitted. arXiv preprint arXiv:2301.11500.*

Honors and Awards

2016: Second Prize , Chinese Mathematical Olympiad (CMO)

2017: First Prize (ranked No.13) , Chinese Mathematical Olympiad (CMO)

2018: First Prize (ranked No.6) , Chinese Mathematical Olympiad (CMO)

2019: Silver Medal, 11th Romania Masters of Mathematics (RMM)

2020: Yizheng Scholarship, Peking University

2020: Qin-Jin Scholarship, Peking University

2021: Bronze Medal, S.T. Yau College Student Mathematics Contest (Probability & Statistics individual)

2021 – 2023 (expected): The elite undergraduate training program of Applied Mathematics and Statistics

2021: Peking University Exceptional Award for Academic Innovation (**top 1% of Peking University student researchers**)

2022: Qin-Jin Scholarship, Peking University

2023: Sensetime Scholarship

Language

Native: Chinese (Mandarin), Shanghainese
Fluent: English