Renbo Zhao

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Research Interests

Theory and computational practice of **large-scale optimization algorithms**, with applications in **machine learning**, **data science** and **game theory**. My recent research focuses on optimization algorithms for convex, nonconvex and stochastic optimization, and I am eager to explore other interesting topics, including optimization under uncertainty, online learning and reinforcement learning.

Education

PhD in Operations Research June 2023 (Expected)
Massachusetts Institute of Technology
Thesis: ???
Thesis advisor: Robert M. Freund

M.Sc. in Mathematics June 2018
National University of Singapore
Thesis: *Stochastic and Randomized Algorithms for Large-Scale Optimization in Machine Learning*
Thesis advisors: Vincent Y. F. Tan and William B. Haskell

B.Eng. in Electrical Engineering (First Class Honors) June 2015
National University of Singapore
Thesis: Online Nonnegative Matrix Factorization with Outliers
Thesis advisor: Vincent Y. F. Tan

Professional Experience

- JP Morgan Chase AI Research (NYC), Research Intern Summer 2022

  Worked with Vamsi Potluru on efficient inference of multi-dimensional Hawkes processes. Paper titled "First-Order Methods for Inference of Multidimensional Hawkes Processes" in preparation.

- Amazon.com (Seattle), Research Intern Summer 2021

  Worked with Phillip Kriett and Georgios Patsakis on two-stage stochastic resource planning problems. Developed codes of primal-dual gradient methods for solving the LP relaxation of certain two-stage stochastic mix-integer program.

- Microsoft AI Research (Redmond), Research Intern Summer 2020

  Worked with Lin Xiao and Shiqian Ma on Bregman Alternating Direction Method of Multipliers (ADMM) for large-scale optimal transport problems. Paper titled " Bregman ADMM With Applications to Optimal Transport" in preparation.

- IBM AI Research (Yorktown Heights), Research Intern — Summer 2019

  Worked with Lior Horesh, Kenneth Clarkson and Sara Magliacane on Bayesian optimal experimental design for symbolic regression problems. (Initially intended to work with Andrew Conn, who tragically passed away before the internship started.)

- École Polytechnique Fédérale de Lausanne (EPFL), Research Intern — Summer 2017

  Worked with Volkan Cevher on primal-dual algorithms for stochastic three-composite convex minimization with a linear operator. Paper titled "Stochastic Three-Composite Convex Minimization with a Linear Operator" published in the proceedings of *AISTATS*, Apr. 2018.

- National University of Singapore (NUS), Research Engineer — July 2015 – Aug. 2018

  - Worked with William B. Haskell and Vincent Y. F. Tan on stochastic and randomized algorithms for large-scale optimization in machine learning. Several papers published.
  - Worked with Vincent Y. F. Tan and Huan Xu on machine learning algorithms for online matrix factorization and ranking from pairwise comparisons. Several papers published.

Journal Papers

J1. Renbo Zhao and Robert M. Freund, "Analysis of the Frank-Wolfe Method for Convex Composite Optimization involving a Logarithmically-Homogeneous Barrier", accepted in *Mathematical Programming (Series A)*, Apr. 2022.

J2. Renbo Zhao, "Accelerated Algorithms for Stochastic Three-Composite Convex-Concave Saddle Point Problems", *Mathematics of Operations Research*, Vol. 47, No. 2, Pages 1443-1473, 2022.

J3. Renbo Zhao, William B. Haskell and Vincent Y. F. Tan, "Stochastic L-BFGS: Improved Convergence Rates and Practical Acceleration Strategies", *IEEE Transactions on Signal Processing*, Vol. 66, No. 5, Pages 1155–1169, Mar. 2018.

J4. Renbo Zhao and Vincent Y. F. Tan, "A Unified Convergence Analysis of the Multiplicative Update Algorithm for Regularized Nonnegative Matrix Factorization", in *IEEE Transactions on Signal Processing*, Vol. 66, No. 1, Pages 129–138, Jan. 2018.

J5. Changho Suh, Vincent Y. F. Tan and Renbo Zhao, "Adversarial Top-K Ranking", in *IEEE Transactions on Information Theory*, Vol. 63, No. 4, Pages 2201–2225, Apr. 2017.

J6. Renbo Zhao and Vincent Y. F. Tan, "Online Nonnegative Matrix Factorization with Outliers", in *IEEE Transactions on Signal Processing*, Vol. 65, No. 3, Pages 555-570, Feb. 2017.

Submitted and Working Papers

W1. Renbo Zhao, "Away-step Frank-Wolfe for Minimizing Logarithmically-Homogeneous Barriers over Polytopes: Global and Local Linear Convergence", in preparation.

W2. Renbo Zhao, "The Generalized Multiplicative Gradient Method and Its Convergence Rate Analysis", to be submitted.

W3. Renbo Zhao, "Non-Asymptotic Convergence Analysis of the Multiplicative Gradient Algorithm for PET-Type Problems", under second-round review at *Operations Research Letters*.

W4. Renbo Zhao and Qiuyun Zhu, "A Generalized Frank-Wolfe Method With "Dual Averaging" for Strongly Convex Composite Optimization", under second-round review at *Optimization Letters*.

W5. Renbo Zhao, "A Primal-Dual Smoothing Framework for Max-Structured Nonconvex Optimization", under second-round review at *Mathematics of Operations Research*.

W6. Le Thi Khanh Hien, Renbo Zhao and William B. Haskell, "An Inexact Primal Dual Smoothing Framework for Large-Scale Non-Bilinear Saddle Point Problems", submitted to *Journal of Optimization Theory and Applications*.

Conference Proceedings

C1. Renbo Zhao, William B. Haskell and Vincent Y. F. Tan, "An Optimal Algorithm for Stochastic Three-Composite Optimization", in *Proc. 22nd Int. Conf. Artif. Intell. Stat. (AISTATS)*, Okinawa, Japan, 2019.

C2. Renbo Zhao and Volkan Cevher, "Stochastic Three-Composite Convex Minimization with a Linear Operator", in *Proc. 21st Int. Conf. Artif. Intell. Stat. (AISTATS)*, Lanzarote, Canary Islands, Spain, 2018.

C3. Renbo Zhao, William B. Haskell and Vincent Y. F. Tan, "Stochastic L-BFGS Revisited: Improved Convergence Rates and Practical Acceleration Strategies", in *Proc. 33rd Conf. Uncertain. Artif. Intell. (UAI)*, Sydney, Australia, 2017.

C4. Renbo Zhao, Vincent Y. F. Tan and Huan Xu, "Online Nonnegative Matrix Factorization with General Divergences", in *Proc. 20th Int. Conf. Artif. Intell. Stat. (AISTATS)*, Fort Lauderdale, FL, USA, 2017.

C5. Renbo Zhao and Vincent Y. F. Tan, "A Unified Convergence Analysis of the Multiplicative Update Algorithm for Nonnegative Matrix Factorization", in *Proc. 42nd IEEE Int. Conf. Acoust. Speech Signal Process. (ICASSP)*, New Orleans, LA, USA, 2017.

C6. Renbo Zhao and Vincent Y. F. Tan, "Online Nonnegative Matrix Factorization with Outliers", in *Proc. 41st IEEE Int. Conf. Acoust. Speech Signal Process. (ICASSP)*, Shanghai, China, 2016.

C7. Renbo Zhao, Siu Wa Lee, Dong-Yan Huang and Minghui Dong, "Soft Constrained Leading Voice Separation with Music Score Guidance", in *Proc. 9th ISCA/IEEE Int. Symp. Chin. Spok. Lang. Process. (ISCSLP)*, Singapore, 2014.

Teaching Experience

Teaching Assistant at MIT for:

- 15.075: Statistical Thinking and Data Analysis (Undergraduate level) — Spring 2022
- 6.252/15.084: Nonlinear Optimization (PhD level) — Spring 2021
- 6.251/15.081: Introduction to Mathematical Programming (PhD level) — Fall 2020

Mentor for the capstone project of MBAn students with TripAdvisor — Spring 2019

Talks

Individual Invited Talks at Universities:

- UWaterloo, Workshop on Large Scale Optimization and Applications — Oct. 2022
- Clemson University, Operations Research Seminar — Sept. 2022

Talks at Conferences:

- INFORMS Annual Meeting, Indianapolis, IN — Oct. 2022
- International Conference on Continuous Optimization (ICCOPT), Lehigh U., PA — July 2022
- IINFORMS Optimization Society Conference, Clemson U., SC — Mar. 2022
- SIAM Conference on Optimization, Virtual — July 2021
- Microsoft Research, Machine Learning & Optimization Group Meeting — Sept. 2020
- INFORMS Annual Meeting, Virtual — Nov. 2020
- INFORMS Annual Meeting, Seattle, WA — Oct. 2019
- National University of Singapore, ISEM Seminar — May 2019
- Rensselaer Polytechnic Institute, Applied Math Day — Apr. 2019
- MIT, LIDS Student Conference — Jan. 2019
- INFORMS Annual Meeting, Phoenix, AZ — Nov. 2018
- International Symposium on Mathematical Programming (ISMP), Bordeaux, France — July 2018

Professional Activities

Memberships: INFORMS, SIAM, MOS, IEEE

Session (Co-)Chairs: INFORMS Annual Meeting 2022, International Conference on Continuous Optimization 2022, SIAM Conference on Optimization 2021, INFORMS Annual Meeting 2019

Reviewer for:

- Journals: *Mathematical Programming (Series A)*, *SIAM Journal on Optimization*, *Journal of Optimization Theory and Applications*, *Journal of Machine Learning Research*, *Computational Optimization and Applications*, *IEEE Transactions on Signal Processing*
- Conferences: *Advances in Nueral Information Processing Systems (NeurIPS)*, *IEEE Int. Symp. Inf. Theory (ISIT)*, *IEEE Int. Conf. Acoust. Speech Signal Process. (ICASSP)*

Miscellaneous

Computer Skills: Python, MATLAB, R, Julia
Hobbies: Cooking (Chinese and American cuisines), Sports (basketball, kayaking, cycling, table tennis, etc.), Travel, Hiking