Mengdi (Mandy) Wang

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Department of Operations Research and Financial Engineering
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Education

- PhD in *Electrical Engineering and Computer Science*
  PhD Minor in *Mathematics*
  Massachusetts Institute of Technology, 2013
  - Advisor: Dimitri P Bertsekas
- MS in *Electrical Engineering and Computer Science*
  Massachusetts Institute of Technology, 2009
- BS in *Information Science, System and Control*
  Tsinghua University, 2007
  (4-yr early entrance through acceleration program for gifted youth)

Academic Appointments

- Assistant Professor
  Department of Operations Research and Financial Engineering
  Princeton University, July 2014 - now
- Visiting Research Scientist
  Simons Institute at Berkeley University, August - September 2017
- Senior Research Scholar
  Department of Operations Research and Financial Engineering
  Princeton University, September 2013 - June 2014
- Research Assistant
  Laboratory for Information, Decisions and Systems (LIDS)
  Massachusetts Institute of Technology, 2009-2013
- Research Assistant
  Computer Science & Artificial Intelligence Laboratory (CSAIL)
  Massachusetts Institute of Technology, 2007-2018

Research Interests

- Fundamental complexity and algorithms for stochastic optimization, with applications in dynamic decision process, stochastic control, and statistical machine learning
- Dimension reduction methods and latent-variable models for Markov decision process and reinforcement learning, with emphasis on statistical theory and computation methods
- Data-driven sequential decision-making problems in healthcare and FinTech applications

Honors and Awards

- Google Faculty Award, 2017
- NSF CAREER Award "*Stochastic Nested Composition Optimization: Theory and Algorithms*," 2017-2022 **(1st attempt)**
- Princeton SEAS Innovation Award "*Machine Learning to Aid Clinical Decision-Making*," 2017-2018 **(In collaboration with the hospital chain Hackensack Meridian Health)**
- Industrial Gift Award in FinTech "*Optimization and Machine Learning in Financial Technology*," 2017-2019
- NSF DMS Award "*Closing the Duality Gap: Decomposition of High-Dimensional Nonconvex Optimization*," 2016-2018
- *Young Researcher Prize in Continuous Optimization*, by the Mathematical Optimization Society, 2016 **(Awarded once every three years)**

Professional Services and Activities

- Conference Co-Organizer, Princeton PCTS-CSML Workshop *"Bridging Mathematical Optimization, Information Theory, and Data Science",* May 16-18, 2018
  https://csml.princeton.edu/bridgingmathematicaloptimization
  Recent years have witnessed a flurry of exciting new developments and activities in the intersection of optimization theory, information theory, and mathematical data science. For instance, optimization theory inspires algorithmic breakthroughs in machine learning and reinforcement learning; information theory offers powerful tools for understanding the fundamental limits in numerous data science applications; and the growing popularity of data science and statistical learning in turn provides new data-driven perspectives to optimization paradigms and enriches the toolbox of information theory. The goal of this workshop is to bring together participants from multiple communities including mathematical optimization, information theory, statistics, and machine learning in order to conduct in-depth discussion and foster interdisciplinary collaboration.
- Associate Editor of *Operations Research*, since Jan 2018
- SEAS Building Planning Committee, spring 2018
- Organizer of ORFE Departmental Colloquium, 2017-2018
- Session Series Organizer, ISMP, 2018
- Session Organizer for Princeton CISS Conference on "*Theoretical Reinforcement Learning*," March 23-25, 2018
- Associated Faculty Member at the Princeton CSML Undergraduate Certification Program, 2017-now
- Panel Member, Grant Reviewing Committee, *NSF*, 2016, 2017
- Organizing Chair of the Optimization Cluster, Informs International Conference, 2016
- Session Series Chair, SIAM Conference on Optimization, Vancouver, May 22-24, 2017
- Session Organizer, INFORMS Annual Meeting, 2015, 2016
- Conference Organizing Committee, *Informs Optimization Society Conference*, Mar 2015
- **Reviewer for Journals:**
  Management Science, Operations Research, Mathematical Programming, Mathematics of Operations Research, SIAM Journal on Optimization, Management Science, Journal of Machine Learning Research, Journal of the American Statistical Association, Annals of Statistics, Mathematics of Computation, INFORMS Journal on Computing, Journal of Global Optimization, Computational Optimization and Applications, Annals of Operations Research,

IEEE Transactions on Signal Processing, IEEE Transactions on Automatic Control, IEEE Transactions on Cybernetics.

- **Reviewer for Conferences:**
  Neural Information Processing Systems (NIPS), International Conference on Machine Learning (ICML), Artificial Intelligence and Statistics (AISTATS), International Conference on Learning Representations (ICLR), IEEE Conference of Decision and Control (CDC), Winter Simulation Conference (WSC)

Invited Departmental Seminars

- Carnegie Mellon University, Department of Mathematics, Nov 15, 2018
- University of Michigan, Department of Electrical Engineering, Sept 20, 2018
- IBM Research, Mathematics of Artificial Intelligence, Sept 17 2018
- Duke University, Department of Mathematics, Sept 5, 2018
- Microsoft Research, Deep Learning and Natural Language Processing Group, May 2018
- Purdue University, Department of Statistics, Mar 30, 2018
- Alibaba Research, Mountain View, Feb 2018
- Stanford University, OR Seminar, Feb 2018
- DIDI AI Research, Beijing, Jan 2017
- University of Chicago, Booth OM Seminar, Business School, November 28, 2017
- Microsoft Research, Machine Learning and Optimization Group, fall 2017
- Duke University, Business School, Department of Decision Science, September 27, 2017
- Cornell University, Department of Industrial Engineering and Operations Research, September 19, Fall 2017
- Berkeley University, Department of Statistics, Neyman Seminar, September 6, 2017
- UCLA, Department of Applied Math, September 1, 2017
- MIT EECS, LIDS Seminar, June 27, 2017
- Hong Kong Polytechnic University, Department of Mathematics, June 2017
- Microsoft Research Talk Series, Redmond, Seattle, May 19, 2017
- Stanford University, ICME, May 15, 2017
- Columbia University, EOR, April 11, 2017
- MIT, Operations Research Center, April 7, 2017
- Rutgers University, Business School, March 10
- Stanford University, MSE November 30, 2016
- University of Wisconsin, SILO, November 2, 2016
- Georgia Institute of Technology, ISyE, September 28, 2016
- Princeton Neuroscience Institute, PNI-Intel Meeting, September 9, 2016
- Lehigh University, Dept. Industrial and System Engineering, September 6, 2016
- Princeton University, CS, ML Reading Group, July 11
- Peking University, Department of Mechanics, June 27, 2016
- Tsinghua University, Department Industrial Engineering, Beijing, China, Jan 7, 2016
- Chinese Academy of Science, Institute of Mathematical System Control, Beijing. Jan 5, 2016
- Peking University, Department of Mathematics, Jan. 7, 2015.

- University of South California, Department of Industrial and System Engineering, Beach-Front Optimization Workshop, July 2014.
- Tsinghua University, Department of Electrical Engineering, Global Scholars Fellowship Program, June, 2014.
- University of South California, Dept. Industrial Engineering, Epstein Institute Seminars, May 7, 2014.
- UIUC, Department of Industrial System and Engineering, Nov 20, 2013.
- Tsinghua University, Department of Electrical Engineering, Aug 21, 2013

Invited Single-Track Conference/Plenary Talks

- Reunion workshop for the program on “Bridging Continuous and Discrete Optimization," Simons Institute, Berkeley, Dec 10-13, 2018.
- Workshop “From Theory to Practice: Data-driven Supply Chain Management,” Institute for Mathematics and its Applications (IMA), University of Minnesota, MN, December 3 - 7, 2018
- Mostly OM Workshop, School of Management Science, Tsinghua University, June 1-2, 2018
- Princeton CSML Faculty Research, Jan 8, 2018
- SoCal Machine Learning Symposium, University of South California, Oct 6, 2017
- Workshop on Iterative Methods, Simons Institute, Berkeley, Wednesday, Oct 3 – 6, 2017
- Conference on Nonconvex Statistical Learning (CNSL), USC May 26-27, 2017
- Ant Financials-Princeton Workshop, Hangzhou, Mar 20-21, 2017
- Workshop on FinTech and Machine Learning, Tsinghua IIS, Beijing, December 16-17, 2016
- Plenary Paper Competition Talk, International Conference on Continuous Optimization (ICCOPT), Tokyo, Japan, August 8-11, 2016
- International Conference on Numerical Analysis, Approximation and Optimization. Chinese Academy of Science, Beijing, August 5-7, 2016
- Workshop on Optimization and Eigenvalues Computation, Peking University BICMR, June 24-26, 2016
- SPOC, December 15, 2015
- Institute for Mathematics and its Applications (IMA), workshop Analysis and Control of Network Dynamics, Oct.19-23, 2015
- USC Workshop on Stochastic Optimization, October 16, 2015.
- Workshop on Simulation and Optimization (ISIM), Purdue University, July 24-27, 2015.
- International Workshop on Signal Processing, Optimization, and Control, Chinese Academy of Science, December, 2014.
- 3rd Rutgers Applied Probability Conference, Rutgers Business School, Jun. 7th, 2014.
- 2nd Rutgers Applied Probability Conference, Rutgers Business School, Dec. 5th, 2013.
- Princeton-Humboldt Conference, Princeton University, Nov. 1nd, 2013.

Invited/Peer-Reviewed Conference Presentations

- Conference on Neural Information Processing Systems (NIPS), 2018 (Lin Yang to present)
- Informs Annual Conference, Applied Probability Track, 2018
- International Conference on Machine Learning, 2018
- International Symposium on Mathematical Programming, 2018 (Xudong Li, Lin Yang to present)
- Informs International Conference, Taiwan, June 2018

- American Mathematics Society Conference, Boston, April 21-22 2018.
- Informs Conference on Optimization, 2018 (Yichen Chen presented)
- AAAI, 2018 (Jason Ge presented)
- International Conference on Data Science organized by Fudan University, Dec 17-18, 2017
- Conference on Neural Information Processing Systems (NIPS), 2017 (Lin Yang, Junchi Li presented)
- INFORMS Applied Probability Society Conference, July 10-12, 2017
- SIAM Conference on Optimization, Vancouver, May 22-24, 2017
- Conference on Decisions and Control, December 12-14, 2016
- Winter Simulation Conference, Washington DC, December 11-14, 2016
- Informs International Conference, Hawaii, June 15, 2016 (Yichen Chen presented)
- Princeton Informs Optimization Conference, Princeton, March, 2016
- INFORMS Annual Meeting, Philadelphia, 2015.
- International Conference on Industrial and Applied Mathematics, Beijing, August 10-14, 2015.
- International Symposium on Mathematical Programming (ISMP), July, 2015.
- SIAM Conference on Computational Science and Engineering, Featured Minisymposium on Distributed Methods for Convex Optimization, March, 2015.
- INFORMS Computing Society Conference, Jan. 11th, 2015.
- INFORMS Annual Conference, November 2014.
- SIAM Conference on Optimization, May 2014.

Teaching

- **ORF570: Special Topics in Statistical Optimization and Reinforcement Learning**
  - A brand new PhD-level seminar course; co-offered with Prof. Yuxin Chen
- **ORF522: Linear and Nonlinear Optimization, Princeton**
  - A core PhD-level course on the theoretical and algorithmic foundations for optimization, focusing on linear programs, nonlinear optimization, first-order optimization algorithms and special topics
- **ORF360: Decision Modeling in Business Analytics**
  - A new junior-level course focusing on analytics and machine learning in business applications, which was proposed and developed by M Wang since 2014
  - Included in the program of Engineering & Management Systems (EMS) Certificate
- Applied Math Summer School: **Dynamic Programming and Reinforcement Learning**, Peking University, 2016
- Global Scholar Summer Course: **Optimization in Big Data**, Tsinghua University, July 2014

Advising

- **Postdoctoral Fellows (3)**
  - Xudong Li (He is currently a tenure-track associate professor at the Institute of Data Science, Fudan University, Shanghai)
  - Saeed Ghadimi
  - Lin Yang

- **PhD Students (9)**
  - Jason Ge (Princeton ORFE, expected to graduate in 12/2018)
  - Yichen Chen (Princeton CS; expected to graduate in 06/2019)
  - Woon Sang Cho (Princeton ORFE)
  - Zachary T. Hervieux-Moore Lu (Princeton ORFE)
  - Hao Lu (Princeton ORFE)
  - Yaqi Duan (Princeton ORFE)
  - Yu Zheng (Princeton ORFE)
  - Tianyu Wang (Princeton EE; co-advised with Prof. Peter Ramadge)
  - Yifan Sun (CMU Math)
- **Junior Independent Work Advisee (1)**
  - Eliot Tan, 2016

Undergraduate Senior Theses Advised

1. Simran Mathews. Leave Me a Loan: Machine Learning Strategies for Loan Portfolio Management. 2018.
2. Jennifer Yin. Counting Stars: A Pipeline for Amazon Consumer and Product Analytics with Case Studies in Discretionary Products. 2018.
3. Julia Ni. Making Lemonade Out Of Lime: A Comparative Analysis Of Methods For Interpretable Machine Learning. 2018.
4. Snider, Bradley. An Analysis of Equilibria in Poker Tournaments with Bounties. 2017
5. Luo, Rellie. Breaking Down Healthcare: Applications of Clustering and Markov Chains for Medical Claims Data. 2017
6. Zou, Joy. The Israeli Kibbutz: A Simulation and Analysis on the Optimality of Privatization versus Degrees of Central Planning. 2017.
7. Chang, Grace. Real-Time Bidding User Response Prediction. 2017
8. Wolfson, Ben. Microfinance and Machine Learning: A Study of Loan Classification and Risk Management. 2017.
9. Govindaiah, Likith. Solving Pineapple: An Appplication of Monte-Carlo Tree Search and an Inverstigation of Selection Heuristics. 2017.
10. Jablonski, John. Creating a Competitive Multiplayer Pokerbot Using Strategy Stitching and Online Learning. 2016
11. Lu, Frances Rose. Identifying Risk Factors and Cost Anomalies in Healthcare Spending Using Medicare Claims Data. 2016.
12. Zhan, Barbara. Multi-State Markov Chain Modeling of Health Insurance Claims and Cost Prediction. 2016.
13. Wang, Angela. A Product Generation Algorithm for Revenue and Consumer Rating Optimization. 2016.
14. Simms, Kevin. Estimating the Size of Hidden Populations: A Comparison of Four Modern Methods. 2015.
15. Pal, Satyajeet. Loan Default Prediction: Classifying Clients using Risk-Sensitive Learning. 2015.
16. Casper, Michael. An Analysis of League of Legends: eSports as a Marketing Strategy, 2015

Publications

(c) Papers that I am the corresponding author and/or the primary first author

(α-β) alphabetical order/equal contribution

(p) Papers where I am a participating author

(*) This author is my student/postdoc advisee

Preprints

- (c) W. Cho*, M. Wang. **Deep Primal-Dual Reinforcement Learning.** arXiv:1712.02467
- (c) A. Zhang, M. Wang. **Spectral State Compression for Markov Processes**. In review with JASA. arXiv:1802.02920
- (p) Y. Sun*, J. Mulvey, M. Wang, J. Ye. **Learning Mean Reversion Trading Strategy With Transaction Costs Using Deep Neural Networks.** In review with Journal of Quantitative Finance. Submitted in spring 2018.
- (α-β) S. Kakade, L. Yang*, M. Wang. **Variance Reduction Methods for Sublinear Reinforcement Learning.** Preprint.
- (c) M. Wang. **Primal-Dual PI Learning: Sample Complexity and Sublinear Runtime for Ergodic Decision Process.** In preparation. arXiv:1710.06100
- (c) Y. Chen* and M. Wang. **Lower Bound On the Computational Complexity of Discounted Markov Decision Problems**. In review with Mathematics of Operations Research.

Journal Papers In Revision

1. (c) M. Wang. **Randomized Linear Programming Solves the Discounted Markov Decision Problem In Nearly-Linear Running Time.** In revision with *Mathematics of Operations Research*, submitted in 2017.
2. (c) S. Yang, M. Wang, E. Fang. **Multi-Level Stochastic Gradient Methods for Nested Composition Optimization.** In revision with *SIAM Journal on Optimization. Submitted in December 2017.* arXiv:1801.03600

Published Journal Papers

3. (c) X. Fang, H. Liu, M. Wang. **Blessing of Massive Scale: Spatial Graphical Model Inference with a Total Cardinality Constraint.** *Mathematical Programming Series B,* accepted for publication, 2018.
4. (c) Y. Chen*, Y. Ye and M. Wang. **Strong NP-Hardness for A Class of Sparse Optimization Problems**. *Journal of Machine Learning Research*, accepted, 2018.
5. (c) M. Wang. **Vanishing Price of Anarchy in Large Nonconvex Collaborative Optimization.** *SIAM Journal on Optimization*, 27(3) 1977-2009, 2017.
6. (c) M. Wang, J. Liu (co-first author), X. Fang. **Accelerating Stochastic Composition Optimization.** A short version at NIPS, 2016. *Journal of Machine Learning Research*, 18(105): 1−23, 2017.
7. (c) J. Li*, M. Wang, H. Liu, T. Zhang. **Near-Optimal Stochastic Approximation for Online Principal Component Estimation.** *Mathematical Programming*, 167(1): 75-97, 2018.

8. (c) M. Wang, X. Fang, and H. Liu. **Stochastic Compositional Gradient Descent: Algorithms for Minimization of Nonlinear Operators of Expected-Value Functions.** *Mathematical Programming*, 161(1), 419-449, 2016.
   - **Best Paper Prize for Young Researchers in Continuous Optimization, ICCOPT 2016 (1 in 3 years)**
9. (c) M. Wang and D.P. Bertsekas. **Stochastic First-Order Methods with Random Constraint Projection**, *SIAM Journal on Optimization*, 26(1): 681–717, 2016.
10. (p) X. Wang, M. Wang, Y. Gu. **A Distributed Tracking Algorithm for Reconstruction of Graph Signals**, *IEEE Journal of Selected Topics in Signal Processing*, 9(4): 728-740, 2015.
11. (c) M. Wang and D.P. Bertsekas. **Incremental Constraint Projection Methods for Variational Inequalities**, *Mathematical Programming*, 1-43, 2014.
12. (c) M. Wang and D.P. Bertsekas. **On the Convergence of Simulation-Based Iterative Methods for Singular Linear Systems,** *Informs Journal on Stochastic Systems*, 3(1) 39-96, 2013.
13. (c) M. Wang and D.P. Bertsekas. **Stabilization of Stochastic Iterative Methods for Singular and Nearly Singular Linear Systems,** *Mathematics of Operations Research*, 39(1) 1-30, 2013.
14. (p) N. Polydorides, M. Wang, D.P. Bertsekas. **A Quasi Monte Carlo Method for Large-Scale Inverse Problems,** *Monte Carlo and Quasi-Monte Carlo Methods*, Springer Proc. in Mathematics and Statistics, 623-637, 2010.

(Papers 11-14 were work done at MIT; All other works were done at Princeton)

Peer-Reviewed Conference Publications

15. (α-β) A. Sidford, M. Wang, C. Wu, L. Yang*, Y. Ye. **Near-Optimal Time and Sample Complexities for Solving Markov Decision Processes with a Generative Model**. *Neural Information Processing Systems (NIPS),* 2018.
16. (p) M. Chen, L. Yang*, M. Wang, T. Zhao. **Dimensionality Reduction for Stationary Time Series via Stochastic Nonconvex Optimization.** *Neural Information Processing Systems (NIPS),* 2018.
17. (α-β) X. Li*, M. Wang, A. Zhang. **Estimation of Markov Chain via Rank-Constrained Likelihood.** *International Conference on Machine Learning (ICML)*, 2018.
18. (c) Y. Chen*, L. Li, M. Wang. **Scalable Bilinear π Learning Using State and Action Features.** *International Conference on Machine Learning (ICML)*, 2018.
19. (α-β) A. Sidford, M. Wang, X. Wu, Y. Ye. **Variance Reduced Value Iteration and Faster Algorithms for Solving Markov Decision Processes.** *ACM-SIAM Symposium on Discrete Algorithms (SODA)*, 2018.
20. (p) J. Ge*, Z. Wang, M. Wang, H. Liu. **Minimax-Optimal Privacy-Preserving Sparse PCA in Distributed Systems.** *Artificial Intelligence and Statistics (AISTATS),* 2018.

21. (c) L. Yang*, V. Braverman, T. Zhao, M. Wang. **Online Factorization and Partition of Complex Networks from Random Walks.** *Neural Information Processing Systems (NIPS), NIPS Workshop on Optimization for Machine Learning*, 2017.
22. (c) J. Li*, M. Wang, H. Liu, T. Zhang. **Diffusion Approximations for Online Principal Component Estimation and Global Convergence.** *Neural Information Processing Systems (NIPS),* 2017
    - **NIPS Oral Presentation; top 1.23% of all papers**
23. (c) (α-β) Y. Chen*, D. Ge, M. Wang, Z. Wang, Y. Ye, H. Yin. **Strong NP-Hardness for Sparse Optimization with Concave Penalty Functions.** *International Conference on Machine Learning (ICML)*, 2017.
24. (p) X. Lian, M. Wang, J. Liu. **Finite-Sum Compositional Optimization via Variance Reduced Gradient Descent.** *International Conference on Artificial Intelligence and Statistics (AISTATS),* 2017.
25. (p) X. Li, J. Ge*, T. Zhang, M. Wang, H. Liu, and T. Zhao. **The "PICASSO" package for high dimensional nonconvex sparse learning in R.**
    - **2016 ASA Best Student Paper Award on Statistical Computing.**
26. (c) M. Wang, J. Liu (co-first author). **Accelerating Stochastic Composition Optimization.** *Conference on Neural Information Processing Systems (NIPS),* 2016.
27. (c) M. Wang and Y. Chen*. **A Stochastic Primal-Dual for Online Solution of Markov Decision Process.** *IEEE Conference of Decision and Control (CDC)*, 2016.
28. (c) M. Wang and J. Liu. **A Stochastic Compositional Subgradient Method Using Markov Samples.** *Winter Simulation Conference (WSC),* 2016.
29. (c) M. Wang, Y. Xu, Y. Gu. **Multi-Task Nonconvex Optimization with Joint Constraints: A Distributed Algorithm Using Monte Carlo Estimates**, *International Conference on Digital Signal Processing (DSP*), 2014.
30. (c) Y. Gu, M. Wang. **Learning Distributed Jointly Sparse Systems by Collaborative LMS**, *IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, 2014.

Theses and Other Publications

37. M. Wang. **Stochastic Methods for Large-Scale Linear Problems, Variational Inequalities, and Convex optimization.** PhD Thesis, MIT, 2013.
38. M. Wang. **Approximate Solution of Large-Scale Linear Least Squares Problems and Applications**. M.S. Thesis, MIT, 2010.
39. M. Wang, N. Polydorides, and D. P. Bertsekas, **Approximate Simulation-Based Solution of Large-Scale Least Squares Problems**. LIDS-P-2819, MIT, 2009.
40. Translator, **Abstract Convex Optimization**. Tsinghua University Press, 2013.