Hao Wang

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Professional Experience

MIT-IBM Watson AI Lab   **Cambridge, MA**
Research Scientist   *Nov. 2022 – present*
Postdoc   *Sept. – Oct. 2022*
Project: Synderella (a platform for creating differentially private synthetic data)

Harvard University   **Cambridge, MA**
Postdoctoral Fellow   *July 2022 – Sept. 2022*

IBM Thomas J. Watson Research Center   **Yorktown Heights, NY**
Research Intern   *May 2019 – Aug. 2019*

Education

Harvard University   **Cambridge, MA**
Ph.D. in Applied Mathematics   *Sept. 2016 – May 2022*
Advisor: Flavio P. Calmon   Committee: Demba Ba, Na Li, Salil Vadhan
Thesis: Information Theory for Trustworthy Machine Learning

Harvard University   **Cambridge, MA**
M.S. in Applied Mathematics   *Sept. 2016 – May 2019*

University of Science and Technology of China (USTC)   **Hefei, China**
B.Sc. in Mathematics and Applied Mathematics   *Sept. 2012 – July 2016*

Research Interests

Areas: Information Theory, Statistical Learning Theory, Optimization
Topics: Algorithmic Fairness, Differential Privacy, Deep Learning Theory

Awards, Honors, and Scholarships

NeurIPS Outstanding Reviewer Award (top 8% of reviewers)   2021
Certificate of Distinction in Teaching   2021
Winning Outreach Video at the ISIT Student Video Exposition (Video)   2020
ICML Travel Award   2019
Certificate of Distinction in Teaching   2018
The 35th Guo Moruo Scholarship (highest honor for USTC students)   2015
China National Scholarship   2014

Sponsored Research

MIT-IBM Watson AI Lab grant: Quantifying Reliability/Uncertainty of Foundation Models (IBM PI). MIT PI: Navid Azizan, IBM Co-PI: Akash Srivastava. 2023–2024.

Publications

Journal Publications

H. Wang, R. Gao, and F. P. Calmon, "Generalization Bounds for Noisy Iterative Algorithms Using Properties of Additive Noise Channels," *Journal of Machine Learning Research*, 2023.

H. Wang, H. Hsu, M. Diaz, and F. P. Calmon, "To Split or Not to Split: The Impact of Disparate Treatment in

Classification," *IEEE Transactions on Information Theory*, 2021.

H. Wang, L. Vo, F. P. Calmon, M. Médard, K. R. Duffy, and M. Varia, "Privacy with Estimation Guarantees," *IEEE Transactions on Information Theory*, 2019.

M. Diaz*, **H. Wang***, F. P. Calmon, and L. Sankar, "On the Robustness of Information-Theoretic Privacy Measures and Mechanisms," *IEEE Transactions on Information Theory*, 2019. ***Equal contribution**.

H. Wang, "Information Theory for Trustworthy Machine Learning," *PhD Thesis*, 2022.

Peer-Reviewed Conference Proceedings

H. Wang, S. Sudalairaj, J. Henning, K. Greenewald, and A. Srivastava, "Post-processing private synthetic data for improving utility on selected measures," in *Advances in Neural Information Processing Systems (**NeurIPS**)*, 2023.

R. Feng, F. P. Calmon, and **H. Wang**, "Adapting fairness interventions to missing values," in *Advances in Neural Information Processing Systems (**NeurIPS**)*, 2023.

Y. Chen, W. Huang, **H. Wang**, C. Loh, A. Srivastava, L. M. Nguyen, and T.-W. Weng, "Analyzing generalization of neural networks through loss path kernels," in *Advances in Neural Information Processing Systems (**NeurIPS**)*, 2023.

H. Wang, L. He, R. Gao, and F. P. Calmon, "Aleatoric and epistemic discrimination: Fundamental limits of fairness interventions," in *Advances in Neural Information Processing Systems (**NeurIPS**)*, 2023. **Spotlight**.

W. Alghamdi, H. Hsu, H. Jeong, **H. Wang**, P. W. Michalak, S. Asoodeh, and F. P. Calmon, "Beyond Adult and COMPAS: Fair Multi-Class Prediction via Information Projection," in *Advances in Neural Information Processing Systems (**NeurIPS**)*, 2022. **Oral presentation**.

H. Jeong, **H. Wang**, and F. P. Calmon, "Fairness without Imputation: A Decision Tree Approach for Fair Prediction with Missing Values," in *AAAI Conference on Artificial Intelligence (**AAAI**)*, 2022. **Oral presentation**.

H. Wang, Y. Huang, R. Gao, and F. P. Calmon, "Analyzing the Generalization Capability of SGLD Using Properties of Gaussian Channels," in *Advances in Neural Information Processing Systems (**NeurIPS**)*, 2021.

H. Wang, H. Hsu, M. Diaz, and F. P. Calmon, "The Impact of Split Classifiers on Group Fairness," in *IEEE International Symposium on Information Theory (**ISIT**)*, 2021.

W. Alghamdi, S. Asoodeh, **H. Wang**, F. P. Calmon, D. Wei, and K. N. Ramamurthy, "Model Projection: Theory and Applications to Fair Machine Learning," in *IEEE International Symposium on Information Theory (**ISIT**)*, 2020.

H. Wang, B. Ustun, and F. P. Calmon, "Repairing without Retraining: Avoiding Disparate Impact with Counterfactual Distributions," in *International Conference on Machine Learning (**ICML**)*, 2019.

H. Wang, M. Diaz, J. C. S. Santos Filho, and F. P. Calmon, "An Information-Theoretic View of Generalization via Wasserstein Distance," in *IEEE International Symposium on Information Theory (**ISIT**)*, 2019.

H. Wang, M. Diaz, F. P. Calmon, and L. Sankar, "The Utility Cost of Robust Privacy Guarantees," in *IEEE International Symposium on Information Theory (**ISIT**)*, 2018.

H. Wang, B. Ustun, and F. P. Calmon, "On the Direction of Discrimination: An Information-Theoretic Analysis of Disparate Impact in Machine Learning," in *IEEE International Symposium on Information Theory (**ISIT**)*, 2018.

H. Wang and F. P. Calmon, "An Estimation-Theoretic View of Privacy," in *Annual Allerton Conference on Communication, Control, and Computing*, 2017.

Workshop Papers

Y.-J. Park, **H. Wang**, S. Ardeshir, and N. Azizan, "Representation reliability for foundation models," in *Robotics Systems and Science (RSS) Safe Autonomy Workshop*, 2023. **Spotlight presentation**.

H. Jeong, **H. Wang**, and F. P. Calmon, "Fairness without Imputation: A Decision Tree Approach for Fair Prediction with Missing Values," in *Symposium on Foundations of Responsible Computing (FORC)*, 2022.

W. Alghamdi, H. Hsu, H. Jeong, **H. Wang**, P. W. Michalak, S. Asoodeh, and F. P. Calmon, "Beyond Adult and COMPAS: Fairness in Multi-Class Prediction," in *ICML Workshop on Responsible Decision Making in Dynamic Environments*, 2022.

H. Wang, H. Hsu, M. Diaz, and F. P. Calmon, "To Split or Not to Split: The Impact of Disparate Treatment in Classification," in *Symposium on Foundations of Responsible Computing (FORC)*, 2020.

H. Wang, B. Ustun, and F. P. Calmon, "Avoiding Disparate Impact with Counterfactual Distributions," in *NeurIPS Workshop on Ethical, Social and Governance Issues in AI*, 2018.

Pre-Prints and Working Papers

Y.-J. Park, **H. Wang**, S. Ardeshir, and N. Azizan, "Representation reliability and its impact on downstream tasks," *arXiv preprint arXiv:2306.00206*, 2023.

H. Sun, N. Azizan, A. Srivastava, and **H. Wang**, "Private synthetic data meets ensemble learning," *arXiv preprint arXiv:2310.09729*, 2023.

News on My Research

My research on "An information-theoretic analysis of disparate impact in ML" has been featured in an article entitled "Just data: How algorithms go bad – and how they can be saved" at the Harvard GSAS alumni magazine.

Mentorship

- Lisa Vo (Harvard College), 2017 – 2019
  Project: Privacy with estimation guarantees (published a paper in IEEE Trans. Inf. Theory).
- Winston Michalak (Harvard College), 2019 – 2020
  Project: Using ADMM for solving model projection (published a paper in NeurIPS 2022).
- Raymond Feng (Harvard College), 2022 – 2023
  Project: Investigating algorithmic discrimination in the presence of missing values (published a <u>first-author</u> paper in NeurIPS 2023, wrote a senior thesis).
- Luxi He (Harvard College), 2022 – 2023
  Project: Analyzing fairness-accuracy trade-offs in classification (published a paper in NeurIPS 2023, wrote a senior thesis).
- Haoyuan Sun (MIT PhD, summer intern at MIT-IBM), 2023
  Project: Private synthetic data meets ensemble learning.

Teaching Experience

ES 250: Information Theory – Graduate Level Course   *Fall 2022*
Engineering and Applied Sciences | Harvard University
Guest Lecturer
Gave a guest lecture that introduced a set of useful information-theoretic tools for trustworthy machine learning.

ES 201: Decision Theory – Graduate Level Course   *Spring 2021*
Engineering and Applied Sciences | Harvard University   ***Rating: 4.9/5.0***
Section Leader
Improved section (recitation) notes to include advanced topics. Led weekly sections that extended the lectures. Held weekly office hours to address individual questions and guided 20+ students through their final projects.

ES 156: Signals and Systems – Undergraduate Level Course   *Spring 2018*
Engineering and Applied Sciences | Harvard University   ***Rating: 4.8/5.0***
Section Leader
Created new section notes that complemented the lectures. Led weekly sections and office hours. Contributed to the design and grading of the midterm and final exams. Prepared new assignments, graded, and gave feedback

to 20+ undergraduate students.

Selected Presentations

MIT-IBM Watson AI Lab	*2022*
Yale Institute for Network Science (YINS)	*2022*
MIT Institute for Data, Systems, and Society (IDSS)	*2022*
Neural Information Processing Systems (virtual)	*2021*
IEEE International Symposium on Information Theory (virtual)	*2021*
Symposium on Foundations of Responsible Computing (virtual)	*2020*
IBM AI Systems Day	*2019*
International Conference on Machine Learning	*2019*
IEEE International Symposium on Information Theory	*2019*
North American School of Information Theory (poster)	*2019*
Annual New England Machine Learning Day (poster)	*2018*
Annual Allerton Conference on Communication, Control, and Computing	*2017*

Professional Service

Conference Reviewer
- IEEE International Symposium on Information Theory (ISIT)
- Neural Information Processing Systems (NeurIPS)
- International Conference on Learning Representations (ICLR)
- International Conference on Machine Learning (ICML)
- International Conference on Artificial Intelligence and Statistics (AISTATS)
- IEEE Information Theory Workshop (ITW)
- The Web Conference (TheWebConf)
- ACM Conference on Fairness, Accountability, and Transparency (FAccT)

Journal Reviewer
- IEEE Transactions on Information Theory (T-IT)
- IEEE Transactions on Information Forensics & Security (T-IFS)
- IEEE Transactions on Automatic Control (TAC)
- IEEE Journal on Selected Areas in Information Theory (JSAIT)
- IEEE Journal of Selected Topics in Signal Processing (JSTSP)

Program Committee
- NeurIPS 2020 Workshop on Fair AI in Finance (FAIF)

Membership

IEEE Membership, IEEE Information Theory Society Membership, IEEE Young Professionals

Personal

Computer Skills: Python, C, C++, MATLAB, Mathematica
Interests: Basketball, Foosball, Traveling, Gaming, Movie, Music