Haoyang Cao

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Web: Haoyang's Personal Website

POSITION

Department of Applied Mathematics and Statistics, Johns Hopkins University
Tenure-track Assistant Professor — *Starting from Jan 2024*
Member of
Data Science and AI Institute — *Starting from Aug 2024*
The Mathematical Institute for Data Science (MINDS) — *Starting from Aug 2024*

CMAP, École Polytechnique — *Jan 2022 - Dec 2023*
Postdoctoral Researcher
Supervisor: Prof. Mathieu Rosenbaum

The Alan Turing Institute — *Sep 2020 - Jan 2022*
Postdoc, Machine Learning in Finance
Supervisors: Prof. Samuel Cohen, Prof. Łukastz Szpruch

EDUCATION

University of California, Berkeley — *2015 - 2020*
PhD in Industrial Engineering and Operations Research
Thesis: Connecting mean-field games and generative adversarial networks
Advisor: Prof. Xin Guo

The University of Hong Kong — *2012 - 2015*
BSc in Mathematics with *First Class Honor*

RESEARCH INTERESTS

Applied Probability and Stochastic Analysis

- Stochastic control and modeling, N-player stochastic differential games and mean-field gamee, application in finance and operations research

Machine Learning

- Machine learning algorithms in dynamical system, applications in finance

RESEARCH

Journal Papers

Haoyang Cao, Zhengqi Wu, and Renyuan Xu. Inference of Utilities and Time Preference in Sequential Decision-Making. To appear in *Applied Mathematics and Optimization*, 2025.

Haoyang Cao, Xin Guo and Mathieu Laurière. Connecting GANs, MFGs and OT. *SIAM Journal on Applied Mathematics* 84(4), pp. 1255–1287, 2024.

Haoyang Cao and Xin Guo. SDE approximations of GANs training and its long-run behavior. *Journal of Applied Probability* 61(2), pp. 465–489, 2023.

Haoyang Cao, Xin Guo, and Joon Seok Lee. Approximation of N-player stochastic games with singular controls by mean field games. *Numerical Algebra, Control and Optimization* 13(3&4), pp. 604–629, 2023.

Haoyang Cao, Jodi Dianetti, and Giorgio Ferrari. Stationary discounted and ergodic mean field games with singular controls. *Mathematics of Operations Research* 48(4), pp. 1871–1893, 2022.

Haoyang Cao and Xin Guo. MFGs for partially reversible investment. *Stochastic Processes and their Applications*, Vol. 150, pp. 995–1014, August 2022.

Matteo Basei, Haoyang Cao, and Xin Guo. Nonzero-Sum Stochastic Games and Mean-Field Games with Impulse Controls. *Mathematics of Operations Research*, 47(1), February 2022.

Conference Papers

Haoyang Cao, Minshuo Chen, Yinbin Han and Renyuan Xu. Diffusion Models for Adapted Sequential Data Generation. *NeurIPS 2025 Workshop MLxOR: Mathematical Foundations and Operational Integration of Machine Learning for Uncertainty-Aware Decision-Making*, 2025.

Haoyang Cao, Samuel N. Cohen, and Lukasz Szpruch. Identifiability in inverse reinforcement learning. *Advances in Neural Information Processing Systems 34*, 2021

Book Chapters

Haoyang Cao and Xin Guo. Generative Adversarial Networks: Some Analytical Perspective. Book chapter in *Machine Learning for Financial Markets: a guide to contemporary practices*, Cambridge University Press, Editors: Agostino Capponi and Charles-Albert Lehalle, 2023.

Works Under Review

Haoyang Cao, Yuchao Dong and Zhouhao Yang. A Two-fold Randomization Framework for Impulse Control Problems. In revision for *SIAM Journal on Control and Optimization*, 2025.

Haoyang Cao, Gaotian Gu, Xin Guo and Mathieu Rosenbaum. Risk of transfer learning and its applications in finance. In revision for *Mathematical Finance*, 2025

Preprints and Working Papers

Haoyang Cao, Gokce Dayanikli, and Xiaofei Shi. Inverse reinforcement learning for mixed mean-field game-control problems. Working paper, 2026.

Haoyang Cao, Zhouhao Yang, and Vladimir Braverman. Generative model with Lévy processes. Working paper, 2026.

Haoyang Cao, Zhouhao Yang. Multi-agent system with randomized impulse control. Working paper, 2026.

Haoyang Cao, Minshuo Chen, Yinbin Han and Renyuan Xu. Diffusion Models for Adapted Sequential Data Generation (journal version). Working paper, 2025.

Haoyang Cao, Renyuan Xu, Yumin Xu, and Ruixun Zhang. Computational bi-causal optimal transport and financial applications. Working paper, 2025

Haoyang Cao, Xin Guo and Wenpin Tang. Statistical efficiency in transfer learning via transport mappings. Working paper, 2024.

Haoyang Cao, Xin Guo, and Guan Wang. Meta-learning with GANs for anomaly detection, with deployment in high-speed rail inspection system. Submitted, 2024.

Guan Wang, Yusuke Kikuchi, Haoyang Cao, Jinglin Yi, Qiong Zou, Rui Zhou, and Xin Guo. Transfer learning for retinal vascular disease detection: a pilot study with diabetic retinopathy and retinopathy of prematurity. Submitted, 2024.

Haoyang Cao, Gaotian Gu, and Xin Guo. Feasibility and risk of transfer learning: a mathematical framework. Preprint, 2024

Qinkai Chen, Mohamed El-Mennaoui, Antoine Fosset, Amine Rebei, Haoyang Cao, Philine Bouscasse, Christy Eóin O'Beirne, Sasha Shevchenko, and Mathieu Rosenbaum. Towards mapping the contemporary art world with ArtLM: an art-specific NLP model. Preprint, 2023.

INVITED TALKS

2026 SIAM Annual Meeting, Cleveland, OH (July 2026)

JHU Math Data Science Seminar, Baltimore, MD (April 2026)

UMBC Applied Math Colloquia, Baltimore, MD (April 2026)

2026 Joint Mathematics Meetings, Washington D.C. (Jan 2026)

SIAM Conference on Financial Mathematics and Engineering (FM25), Miami, FL (July 2025)

Mathematical Congress of the Americas 2025, Miami, FL (July 2025)

BIRS Workshop: Advances in Stochastic Control and Reinforcement Learning, Banff AB, Canada (May 2025)

FRE Special Seminars at NYU (Tandon), New York, NY (April 2025)

FM seminar in ORFE at Princeton University, Princeton NJ (April 2025)

2025 Spring Eastern Sectional Meeting, Hartford CT (April 2025)

Mathematical Finance Colloquium at USC, Los Angeles, CA (March 2025)

Mathematical Finance Seminar at University of Miami, Miami, FL (March 2025)

SIAM Conference on Computational Science and Engineering (CSE25), Dallas, TX (March 2025)

Mathematical Finance Seminar at Columbia University, New York, NY (February 2025)

CFMAR Seminar at UCSB, Santa Barbara, CA (November 2024)

2024 INFORMS Annual Meeting, Seattle, WA (October 2024)

8th Eastern Conference on Mathematical Finance, Toronto ON, Canada (September 2024)

12th Bachelier World Congress of the Bachelier Finance Society, Rio de Janeiro, Brazil (July 2024)

Fields-CFI Bootcamp on Machine Learning for Finance, Toronto ON, Canada (April 2024)

CIS & MINDS Seminar, Baltimore, MD (March 2024)

ICAIF'23 Workshop – Transfer Learning and its Applications in Finance, New York, NY (November 2023)

Paris Bachelier Seminar, Paris, France (November 2023)

2023 INFORMS Annual Meeting, Phoenix, AZ (October 2023)

ICAIM 2023, hybrid (August 2023)

IMSI Workshop – Machine Learning and Mean Field Games, hybrid (May 2022)

Conference in Stochastoc Control & Analysis and Applications, Hammamet, Tunisia (March 2022)

Paris Bachelier Seminar, Paris, France (February 2022)

Joint LSE Risk & Stochastics and Financial Mathematics Seminar, online (January 2022)

15th International Conference Computational and Financial Econometrics, London, UK (December 2021)

Workshop KCL-UP Mean-field Reinforcement learning, virtual (October 2021)

SIAM Minisymposium on Mathematics of Machine Learning in Finance, virtual (January 2021)

2020 INFORMS Annual Meeting, virtual (November 2020)

Oxford Data Science Seminar (November 2020)

2019 INFORMS Annual Meeting, Seattle, WA (October 2019)

Cornell ORIE Young Researchers Workshop, Cornell University, Ithaca, NY (October 2019)

Equilibria in Markets, Strategic Interactions, and Complex Systems, Bielefeld University, Bielefeld, Germany (July 2019)

9^{th} General AMaMeF Conference, Paris, France (June 2019)

2018 INFORMS Annual Meeting, Phoenix, AZ (November 2018)

ORGANIZING COMMITTEE

10th Eastern Conference on Mathematical Finance, Baltimore, MD (Oct 2026)

2026 SIAM Annual Meeting, Cleveland, OH (July 2026)

SLMath Summer Graduate School on "Dynamical Systems for Machine Learning and AI", IBM Yorktown (July 2026)

JHU Math Data Science Seminar Spring 2026, Baltimore, MD

JMM2026 AWM Special Session on Recent Trends of Stochastic Methods in Modern Generative AI, Washington D.C. (Jan 2026)

2025 INFORMS Annual Meeting – Generative AI in Finance, Atlanta GA (Oct 2025)

AMS Weekly Seminars 2025–2026, Baltimore MD

SIAM Conference on Financial Mathematics and Engineering (FM25), Miami, FL (July 2025)

4th ACM International Conference on AI in Finance Workshop–Transfer Learning and its Applications in Finance, New York NY (November 2023)

Uncertainty and Risk Workshop, hosted by the Alan Turing Institute, virtual (March 2021)

INFORMS APS Cluster Session "Bridging Deep Learning with Stochastic Analysis and Mean-Field Theory, virtual (November 2020)

SERVICE

NSF Review Panelist

Scientific Committee Member, Meta-Reviewer, Reviewer of Conferences/Workshops including:
ICAIF25', NeuRIPS Workshop on GenAI in Finance

Reviewer of Peer-reviewed Journals including:
Mathematics of Operations Research, Operations Research, Annals of Applied Porbability, SIAM Journal on Financial Mathematics, SIAM Journal on Control and Optimization, Finance & Stochastics, Quantitative Finance, Management Science, IEEE Transactions on Automatic Control, etc.

TEACHING EXPERIENCE

Principal Instructor at JHU

- Graduate-level courses:
  EN.553.745 Stochastic Controls, Games and learning I, Fall 2025
  EN.553.746 Stochastic Controls, Games and learning II, Sprint 2026 EN.553.701 Real Analysis: Preparation for the Ph.D. Introductory Examination, Fall 2024
  EN.553.640 Machine Learning in Finance, Spring 2026/2025/2024
- Undergraduate-level courses:
  EN.553.101 Freshman Experience in Applied Mathematics & Statistics (Game Theory), Fall 2025

Past Graduate Student Instructor Experience at UC Berkeley

- PhD-level courses:
  IEOR 263A Applied Stochastic Processes I, Fall 2016
  IEOR 263B Applied Stochastic Processes, Spring 2018/Spring 2019
- Master-level courses:
  IEOR 241 Risk Modeling, Simulation, and Data Analysis, Fall 2017/Fall 2018
  IEOR 222 Financial Engineering Systems I, Spring 2020
- Undergraduate-level course:
  IEOR 173 Introduction to Stochastic Processes, Spring 2017

INDUSTRY EXPERIENCE

Quantitative Research Summer Associate — May 2018 - August 2018
J.P.Morgan & Chase, New York, NY

- Conducted research on LGD discount rate methodology which has been a haunting issue faced by the team, independently built, implemented and tested a CAPM-based model which will be adopted in future regulatory frameworks.
- Conducted research on Tobit models and implemented Type II Tobit model in Python to help the team convert from SAS to Python platform
- Conducted Research on Omitted Variable Biases problems, presented and documented related work to the team

HONOR & AWARD

Berkeley IEOR Summer Research Grant	2017, 2019
First Runner-up, TBSI Visiting Student Poster Contest	June 2017
Berkeley IEOR Graduate Student Group Award	May 2017
Berkeley IEOR First Year Fellowship	2015-2016
Y. M. Chen Memorial Prize in Mathematics	2014-2015
C. V. Starr Scholarships	2013-2014
Liu Ming-Chit Prize in Mathematics	2012-2013, 2013-2014
Dean's Honours List	2012-2013

TECHNICAL SKILLS

Programming: Python, Pandas, Mathematica, C++.
Optimization: CPLEX, AMPL

MISC. SKILLS & HOBBIES

Music: Piano and Clarinet Player, Singer.
Sports: Swimmer.