

# Fei Cao

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## Current position

*Visiting Researcher in Applied Mathematics*, Amherst College, Amherst, MA, USA.

## Research interests

- Interacting particle systems with applications to econophysics and sociophysics
- Probability theory and related fields (such as gradient-based optimization algorithms)
- Derivation of macroscopic models from microscopic interactions
- Applications of ordinary, partial, and stochastic differential equations

## Employment

2025-2026 Visiting Researcher at Amherst College  
2022-2025 Visiting Assistant Professor at the University of Massachusetts Amherst  
2017-2022 Graduate Teaching Assistant at Arizona State University

## Education

2017-2022 PH.D in Applied Mathematics, Arizona State University.  
2013-2017 BACHELOR in Applied Mathematics, Southwestern University of Finance and Economics.

## Publications

2020 F. Cao, S. Motsch, A. Reamy, R. Theisen, *Asymptotic flocking for the three-zone model*, Mathematical Biosciences and Engineering, AIMS Press, 17 (6) (2020) 7692–7707.  
2021 F. Cao, *K-averaging agent-based model: propagation of chaos and convergence to equilibrium*, Journal of Statistical Physics, Springer, 184 (2) (2021) 1–19.  
2022 F. Cao, *Explicit decay rate for the Gini index in the repeated averaging model*, Mathematical Methods in the Applied Sciences, 46 (4) (2023) 3583–3596.  
2023 F. Cao, P-E. Jabin, S. Motsch, *Entropy dissipation and propagation of chaos for the uniform reshuffling model*, Mathematical Models and Methods in Applied Sciences, 33 (4) (2023) 829–875.  
2023 F. Cao, S. Motsch, *Derivation of wealth distributions from biased exchange of money*, Kinetic &

Related Models, 16 (5) (2023) 764–794.

- 2023 F. Cao, S. Motsch, *Uncovering a two-phase dynamics from a dollar exchange model with bank and debt*, SIAM Journal on Applied Mathematics, 83 (5) (2023) 1872–1891.
- 2024 F. Cao, N. Marshall, *From the binomial reshuffling model to Poisson distribution of money*, Networks and Heterogeneous Media, 19 (1) (2024) 24–43.
- 2024 F. Cao, P-E. Jabin, *From interacting agents to Boltzmann-Gibbs distribution of money*, Nonlinearity, 37 (12) (2024) 125020.
- 2025 F. Cao, R. Cortez, *Uniform propagation of chaos for a dollar exchange econophysics model*, European Journal of Applied Mathematics, 36 (1) (2025) 27–39.
- 2025 F. Cao, R. Cortez, *Fractal opinions among interacting agents*, SIAM Journal on Applied Dynamical Systems, 24 (2) (2025) 1529–1552.
- 2025 F. Cao, S. Reed, *A biased dollar exchange model involving bank and debt with discontinuous equilibrium*, Mathematical Modelling of Natural Phenomena, 20 (2025) 5.
- 2025 F. Cao, S. Motsch, *Sticky dispersion on the complete graph: a kinetic approach*, SIAM Journal on Mathematical Analysis, 57 (4) (2025) 3953–3980.
- 2025 F. Cao, S. Reed, *The iterative persuasion-polarization opinion dynamics and its mean-field analysis*, SIAM Journal on Applied Mathematics, 85 (4) (2025) 1596–1620.
- 2025 F. Cao, J. Yang, *Quantitative convergence guarantees for the mean-field dispersion process*, to appear on Discrete and Continuous Dynamical Systems (2025).

#### SUBMITTED PAPERS

- 2025 F. Cao, X. Gong, *On the equivalence between Fourier-based and Wasserstein distances for probability measures on  $\mathbb{N}$*  (2025)
- 2025 F. Cao, *From Gini index as a Lyapunov functional to convergence in Wasserstein distance* (2025)
- 2025 F. Cao, *Mean-field analysis of a random asset exchange model with probabilistic cheaters* (2025)
- 2025 F. Cao, K. Johnston, T. Laurent, J. Li, S. Motsch, *Generative diffusion models from a PDE perspective* (2025)

#### WORKING IN PROGRESS (INCOMPLETE LIST)

- 2025 J. Brust, M. Badal, F. Cao, S. Motsch, *Natural projected flow: PDE solvers using neural networks* (tentative title).
- 2025 F. Cao, X. Gong, A. Keimer, *Analysis for the large-time behavior of the “Bando-Follow-the-Leader” car-following model* (tentative title).
- 2026 F. Cao, R. Cortez, *The fractal geometry of opinion formation* (tentative title).
- 2026 F. Cao, V. Nguyen, J. Yang, *Segregation without preference: a mean-field analysis of a Schelling-type metapopulation model* (tentative title).
- 2026 F. Cao, B. Vinatzer, *A bias-amplifying opinion dynamics and its mean-field analysis* (tentative title).
- 2026 F. Cao, S. Motsch, A. Mellet, M. Rozowski, A. Ullah, *Continuous Lloyd’s algorithm and its PDE counterpart* (tentative title).

## Teaching experience

2018	<b>Teaching Assistant</b> , <i>Applied Probability and Stochastic Processes</i> , Arizona State University
2019	<b>Recitation Instructor</b> , <i>Precalculus</i> (Math 171), Arizona State University
2020	<b>Teaching Assistant</b> , <i>Introduction into Deep Neural Networks</i> , Arizona State University
2021	<b>Teaching Assistant</b> , <i>Ordinary Differential Equations</i> , Arizona State University
2022	<b>Instructor</b> , <i>Calculus II</i> , University of Massachusetts Amherst
2023	<b>Instructor</b> , <i>Ordinary Differential Equations</i> , University of Massachusetts Amherst
2024	<b>Instructor</b> , <i>Calculus I</i> , University of Massachusetts Amherst
2025	<b>Instructor</b> , <i>Ordinary Differential Equations</i> , University of Massachusetts Amherst

## Miscellaneous

2025	<b>2025 AMS-Simons Travel Grant</b> awarded by the American Mathematical Society during Summer 2025.
2025	<b>Visiting Scholar</b> in the Department of Mathematics at The Pennsylvania State University (02/13/2025 - 02/24/2025), hosted by Professor Pierre-Emmanuel Jabin.
2024	<b>FY25 MSP Research Support Fund A</b> intramural grant (\$1,000) allocated by University of Massachusetts Amherst during 2024 - 2025 to support research-related expenses.
2023	<b>FY24 MSP Research Support Fund A</b> intramural grant (\$1,000) allocated by University of Massachusetts Amherst during 2023 - 2024 to support research-related expenses.
2023	<b>Visiting Scholar</b> in the School of Mathematical and Statistical Sciences at Arizona State University (11/06/2023 - 11/10/2023), hosted by Associate Professor Sebastien Motsch.
2022	<b>Visiting Scholar</b> in the Department of Mathematics at The Pennsylvania State University (02/02/2022 - 02/18/2022), hosted by Professor Pierre-Emmanuel Jabin.
2023	<b>REU mentor</b> during summer 2023, the undergraduate mentee Minh Le is guided to work on gradient descent and related optimization algorithms.
2022	<b>Graduate Student Research Award</b> awarded by School of Mathematical and Statistical Sciences at Arizona State University.

## Skills

- **Programming:**  $\text{\LaTeX}$ , Julia, Matlab, Python
- **Language:** English (fluent), Chinese (native language), Japanese (basic), Germany (basic)

## Referee Service for

- Mathematical Modelling of Natural Phenomena
- Methods and Applications of Analysis
- Networks and Heterogeneous Media
- SIAM Journal on Applied Mathematics

## Invited Talks

**SIAM Conference on Applications of Dynamical Systems (DS25)** *Summer 2025*

Invited talk at a mini-symposium as part of the SIAM Dynamical Systems conference held from May 11 to May 15, 2025 in Denver, Colorado, USA.

**Financial Mathematics Seminar at Worcester Polytechnic Institute** *Spring 2025*

Invited talk at on March 31, 2025 at Worcester Polytechnic Institute, Worcester, Massachusetts, USA.

**Dynamical Systems Seminar at Boston University** *Spring 2025*

Invited talk on March 24, 2025 at Boston University, Boston, Massachusetts, USA.

**Tufts Ergodic and Dynamical Systems Seminar** *Fall 2023*

Invited talk on November 28, 2023 at Tufts University, Boston, Massachusetts, USA.

## Conferences and Summer Schools

**2025 Seminar on Stochastic Processes** *Spring 2025*

Three days conference on stochastic processes at Indiana University Bloomington, Bloomington, USA.

**ICERM Topical Workshop “Patterns, Dynamics, and Data in Complex Systems”** *Winter 2025*

Four days workshop on patterns, dynamics, and data in complex systems at the Institute for Computational and Experimental Research in Mathematics, Rhode Island, USA.

**New England Dynamics Seminar 2024** *Fall 2024*

A joint one-day seminar on dynamical systems and PDEs at the University of Massachusetts Amherst, Amherst, USA.

**ICERM Topical Workshop “Robust Optimization and Simulation of Complex Stochastic Systems”** *Fall 2024*

Three days workshop on optimization and simulation of stochastic systems at the Institute for Computational and Experimental Research in Mathematics, Rhode Island, USA.

**Graduate Student Probability Conference 2024** *Fall 2024*

Two days conference on probability theory at University of Wisconsin–Madison, Madison, USA.

**13th Cornell Probability Summer School** *Summer 2024*

Two weeks workshop on probability theory and related fields at Cornell University, Ithaca, USA.

**Recent Progress in Stochastic Analysis and its Applications** *Summer 2024*

One week workshop on stochastic analysis at Loyola University Chicago, Chicago, USA.

**Mathematical Problems in Industry (MPI) Workshop** *Summer 2024*

One week workshop on problems of interest to science and industry at the University of Vermont, Burlington, USA.

**The 52nd John H. Barrett Memorial Lectures** *Summer 2024*

Three days workshop on stochastic analysis and its application at the University of Tennessee, Knoxville, USA.

**ICERM Topical Workshop “Interacting Particle Systems: Analysis, Control, Learning and Computation”** *Spring 2024*

One week workshop on interacting particle systems at the Institute for Computational and Experimental Research in Mathematics, Rhode Island, USA.

**49th Annual New York State Regional Graduate Mathematics Conference** *Spring 2024*

One day conference on mathematics focusing on graduate research at Syracuse University, Syra-

cuse, USA.

**2024 Seminar on Stochastic Processes**

*Spring 2024*

Three days conference on stochastic processes at Rice University, Houston, USA.

**Probability and Algebra: New Expressions in Mathematics**

*Summer 2023*

One week workshop in analysis and probability at Texas A&M University, Texas, USA.

**21st International Conference on Random Structures & Algorithms**

*Summer 2023*

One week conference on random structures and algorithms at Carnegie Mellon University, Pennsylvania, USA.

**Current Developments in Mathematics 2023**

*Spring 2023*

Two days conference on mathematics at Harvard University, Boston, USA.

**2023 Seminar on Stochastic Processes**

*Spring 2023*

Three days conference on stochastic processes at University of Arizona, Tucson, USA.

**2022 Fall Eastern Sectional Meeting**

*Fall 2022*

Two days AMS sectional meeting at University of Massachusetts Amherst, Amherst, USA.

**2022 PIMS-IFDS-NSF Summer School on Optimal Transport**

*Summer 2022*

Two weeks summer school on optimal transport at Seattle, Washington, USA.

**2022 MRC Conference: Data Science at the Crossroads of Analysis, Geometry, and Topology**

*Summer 2022*

One week workshop on mathematics, statistics, and related fields at Beaver Hollow Conference Center, Java Center, NY, USA.

**2022 Seminar on Stochastic Processes**

*Spring 2022*

Three days conference on stochastic processes at Lehigh University, Pennsylvania, USA.

**2021 Frontier Probability Days**

*Fall 2021*

Three days conference on probability theory and related fields at University of Nevada, Las Vegas, USA.

**2021 Blackwell Tapia Conference**

*Fall 2021*

Three days conference focusing on diversity in mathematics at UCLA, California, USA.

**2021 CRM-PIMS Summer School in Probability (Online)**

*Summer 2021*

Four weeks graduate summer school at the Mathematical Sciences Research Institute (MSRI), Canada.

**2021 Summer Program in Partial Differential Equations (Online)**

*Summer 2021*

Two weeks of concentrated study of topics in analysis at graduate level, USA.

**2021 AMS Short Course on Mathematical and Computational Methods for Complex Social Systems (Online)**

*Spring 2021*

Three days short course at the American Mathematical Society (AMS), USA.

**2020 Introduction to water waves graduate summer school (Online)**

*Summer 2020*

Two weeks graduate summer school at the Mathematical Sciences Research Institute (MSRI), Berkeley, USA.

**2020 Summer School: Ergodic Theory via Continued Fractions (Online)**

*Summer 2020*

One week graduate summer school at the University of North Carolina Greensboro, North Carolina, USA.

**2020 Hot Topics: Optimal transport and applications to machine learning and statistics (Online)**

*Summer 2020*

One week workshop at the Mathematical Sciences Research Institute (MSRI), Berkeley, USA.

**45-th Annual New York State Regional Graduate Mathematics Conference (Online)**

*Spring 2020*

One day conference on mathematics focusing on graduate research at Syracuse University, Syra-

cuse, USA.

**2020 Seminar on Stochastic Processes**

*Spring 2020*

Three days seminar on stochastic processes at the Michigan State University, Michigan, USA.

**2019 AARMS Summer School on Dynamical Systems, Differential Equations, and Special Functions**

*Summer 2019*

Four weeks summer school on dynamical systems, differential equations, and special functions at Charlottetown, Prince Edward Island, Canada.

**2019 RMMC Summer School on Inverse Problems in Imaging**

*Summer 2019*

One week summer school on inverse problems at Laramie, Wyoming, USA.

**2019 Interacting Particle Systems, Statistical Mechanics and Related Topics**

*Spring 2019*

Three days conference on interacting particle systems at UCLA, California, USA.

**2018 Advances in Asymptotic Probability**

*Winter 2018*

One week conference on theory of Asymptotic Probability at Stanford, California, USA.

**2018 Institute for Advanced Study**

*Summer 2018*

IAS/PCMI 2018: Harmonic Analysis, Park City, Utah, USA.

**2018 Boston City Limits**

*Summer 2018*

Two weeks summer School on Mathematical General Relativity and the Geometric Analysis of Waves of Fluids at MIT, Boston, USA.

**Short Course on Free Boundary Problems**

*Summer 2017*

Free boundary problems in mathematical finance, Cheng Du, China.

## References

**Professor Pierre-Emmanuel Jabin**

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