Abigail Hickok

Columbia University
Department of Mathematics

Research Interests

Geometric and topological data analysis, high-dimensional data analysis, network science, spatial data, and applications to biology

Academic Appointments

Columbia University Fall 2023–Spring 2024, Fall 2025–
Department of Mathematics
NSF Postdoctoral Research Fellow

Yale University Fall 2024–Spring 2025
Wu Tsai Institute and Department of Statistics & Data Science
Wu Tsai Postdoctoral Fellow

Education

PhD in Mathematics, UCLA 2018–2023
Thesis: *Topics in Geometric and Topological Data Analysis*
Advisor: Mason Porter

BA in Mathematics, with Honors, Princeton University 2014–2018
Senior Thesis: *Khovanov Homology and Genus-2 Mutation*
Senior Thesis Advisors: Zoltán Szabó and Peter Ozsváth

Honors & Awards

AWM Dissertation Prize	2024
Ivo and Renata Babuška Thesis Prize	2024
Pacific Journal of Mathematics Dissertation Prize (UCLA)	2023
NSF Mathematical Sciences Postdoctoral Research Fellowship	2023
UCLA Dissertation Year Fellowship	2022
NSF Graduate Research Fellowship Honorable Mention	2020

UCLA Graduate Dean's Scholar Fellowship 2018
Eugene V. Cota-Robles Fellowship (UCLA) 2018

Publications & Preprints

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*Equal contribution.

13. EmbedOR: Provable Cluster-Preserving Visualizations with Curvature-Based Stochastic Neighbor Embeddings
T. Saidi, A. Hickok, B. Rieck, and A. J. Blumberg. *Proceedings of the National Academy of Sciences*, in press.

12. Persistence Diagram Bundles: A Multidimensional Generalization of Vineyards.
A. Hickok. *Foundations of Computational Mathematics*, in press.

11. Discrete Scalar Curvature as a Weighted Sum of Ollivier-Ricci Curvatures.
A. Hickok and A. J. Blumberg. arXiv:2510.04936.

10. Decomposing the Persistent Homology Transform of Star-Shaped Objects.
S. Arya, *B. Giunti, *A. Hickok, *L. Kanari, *S. McGuire, *K. Turner. *Research in Computational Topology 3, Association for Women in Mathematics Series*, in press.

9. Recovering Manifold Structure Using Ollivier-Ricci Curvature.
T. Saidi, A. Hickok, A. J. Blumberg. Spotlight paper in *Proceedings of the International Conference on Learning Representations*, 2025.

8. Persistent Homology for Resource Coverage: A Case Study of Access to Polling Sites.
A. Hickok, *B. Jarman, *M. Johnson, *J. Luo, M. A. Porter. *SIAM Review*, 2024.

7. An Intrinsic Approach to Scalar-Curvature Estimation for Point Clouds.
A. Hickok and A. J. Blumberg. arXiv:2308.02615, 2023.

6. Computing Persistence Diagram Bundles.
A. Hickok. arXiv:2210.06424.

5. A Family of Density-Scaled Filtered Complexes.
A. Hickok. arXiv:2112.03334.

4. Analysis of Spatial and Spatiotemporal Anomalies Using Persistent Homology: Case Studies with COVID-19 Data.
A. Hickok, D. Needell, M. A. Porter. *SIAM Journal on Mathematics of Data Science*, 4(3):1116-1144, 2022.

3. Topological Data Analysis of Spatial Systems.
M. Feng, A. Hickok, M. A. Porter. In F. Battiston and G. Petri (eds.) *Higher-Order Systems*, ch. 17, pp. 389–399. Springer, Cham, Switzerland, 2022.

2. A Bounded-Confidence Model of Opinion Dynamics on Hypergraphs.
A. Hickok, Y. H. Kureh, H. Z. Brooks, M. Feng, M. A. Porter. *SIAM Journal on Applied Dynamical Systems.* 21(1):1–32, 2022.

1. Adaptive Spectral Solution Method for the Landau and Lenard-Balescu Equations.
C.R. Scullard, *A. Hickok, *J. O. Sotiris, *B. M. Tzolova, *R. L. Van Heyningen, F. R. Graziani. *Journal of Computational Physics* 402, 109110, 2020.

Teaching

Columbia (Instructor)

Calculus III: Multivariable Calculus	Spring 2026

UCLA (Teaching Assistant)

Math 168: Introduction to Networks	Winter 2020, Spring 2020, Fall 2020
Math 31B: Integration and Infinite Series	Winter 2020, Spring 2020
Math 131AH: Honors Analysis	Fall 2019
Math 1: Precalculus	Fall 2019

Princeton (Undergraduate Course Assistant)

Math 215: Honors Analysis	Spring 2018
Math 335: Complex Analysis	Fall 2017

Talks and Poster Presentations

Invited Conference Talks

Workshop on TDA at the Symposium of Computational Geometry	June 2026
ICERM Foundations of Computational Geometry and Topology	May 2026
JMM Special Session on Mathematics of Elections and Redistricting	Jan. 2026
AMS Eastern Sectional Meeting	Apr. 2025
AMS Eastern Sectional Meeting	Oct. 2024
UQAM Summer Research School on TDA and Geometric Invariant Theory	June 2024
AMS Spring Southeastern Sectional Meeting	Mar. 2024
JMM Special Session on Bridging Applied and Quantitative Topology	Jan. 2024
JMM Special Session on Complex Social Systems	Jan. 2024
SIAM Central States Sectional Meeting	Oct. 2023
ICIAM, minisymposium on Higher-Order Networks for Complex Systems	Aug. 2023
SIAM Conference on Applied Algebraic Geometry	July 2023
AMS Spring Southeastern Sectional Meeting	Mar. 2023
University of Florida, Topological Data Analysis conference	Feb. 2023
SIAM Conference on Applications of Dynamical Systems (virtual)	May 2021
APS March Meeting, Short Course: Introduction to TDA (virtual)	Mar. 2021

Seminar Talks

Applied Algebraic Topology Research Network (AATRN)	Aug. 2025
NYU Center for Data Science	May 2024
Columbia Algebraic Topology Seminar	Apr. 2024
CUNY Data Science & Applied Topology Seminar	Apr. 2024
EPFL Applied Topology Seminar (virtual)	Apr. 2024
Focused Research Group Meeting, K-Theory (virtual)	Mar. 2024
Montana State University, AI Seminar	Feb. 2024
Montana State University, Applied Mathematics Seminar	Feb. 2024
Columbia Michael Zhao Memorial Student Colloquium	Nov. 2023
Columbia Undergraduate Math Society	Nov. 2023
Montana State University, Mathematics Seminar	Feb. 2023
Persistence, Sheaves, and Homotopy Theory Seminar (virtual)	Jan. 2023
Santa Fe Institute	Jan. 2023
Yale, Krishnaswamy Lab group meeting (virtual)	Dec. 2022
AATRN Vietoris–Rips seminar (virtual)	Nov. 2022
SUNY Albany, Applied Topology Seminar (virtual)	Mar. 2022
EPFL Applied Topology Seminar (virtual)	Feb. 2022
Michigan State University, Topological Data Analysis Seminar (virtual)	Dec. 2021

Contributed Talks

SIAM Conference on Mathematics of Data Science	Oct. 2024
SIAM New York-New Jersey-Pennsylvania Sectional Meeting	Oct. 2023
Southern California Applied Mathematics Symposium	Apr. 2023
Joint Mathematics Meeting	Jan. 2023
SIAM Conference on Mathematics of Data Science	Sep. 2022
Young Topologist Meeting	July 2022
Joint Mathematics Meeting	Jan. 2017

Posters

SIAM Conference on Mathematics of Data Science	Oct. 2024
9th Mexican Workshop on Applied Geometry and Topology (virtual)	Nov. 2023
Algebraic Topology: Methods, Computation and Science (ATMCS)	June 2022
Applied Algebraic Topology Research Network (virtual)	Jan. 2022
Applied Algebraic Topology Research Network (virtual)	Oct. 2021
Algorithms for Threat Detection (ATD) Workshop (virtual)	Nov. 2020

Academic Mentorship

Undergraduate Independent Research Project Supervision

- Zheheng (Tony) Xiao — Spring 2024 – Present
  Topic: *Geodesic-distance estimation for high-dimensional data with noise*
- Dasha Strait — Spring 2024
  Topic: *Applications of geometric methods to single-cell RNA sequencing data*
- Laura Vinter — Spring 2024
  Topic: *Geometric methods for hierarchical community detection*
- Alena Chan — Fall 2023 – Spring 2024
  Topic: *The relationship between Ollivier-Ricci curvature and scalar curvature*

REU Mentorship

- **REU, Irving Institute for Cancer Dynamics, Columbia** — Summer 2022
  Co-mentor with Andrew Blumberg.
  Topic: *Scalar curvature estimation for biological data sets.*
- **Research in Industrial Projects for Students (RIPS), IPAM** — Summer 2021
  Mentor for a team of four undergraduates that was sponsored by Air Force Research Laboratory.
  Topic: *Deconvolution of Temporally Under-Resolved Image Sequences for Coupled Dynamical Systems.*

Undergraduate Independent Study Supervision

- **UCLA Directed Reading Program** — Fall 2018
  Mentor for an undergraduate in a reading course on Milnor's books *Topology from the Differentiable Viewpoint* and *Morse Theory.*

Service & Outreach

SIAM Conference on Mathematics of Data Science — Oct. 2024
Co-organizer of special session "Geometric and Topological Methods in Data Science and Machine Learning"

ENYGMMa (Empowering NY Gender Minority Mathematicians) — 2023-24
Co-organizer

JMM special session on applied category theory — Jan. 2023
Co-organizer

Exploring Your Universe, UCLA — Fall 2019, 2022

Volunteer

Women in Math, UCLA 2020-2022
Co-Organizer

Frontiers for Young Minds 2021
Coauthor of the outreach article "Connecting the Dots: Discovering the 'Shape' of Data," with M. Feng, Y. H. Kureh, M. A. Porter, and C.M. Topaz.

Workshop Participation

ICERM Topology and Geometry in Neuroscience	Oct. 2023
Women in Computational Topology (WinCompTop)	July 2023
Math Research Community (MRC): Applied Category Theory	June 2022