Abigail Hickok

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Department of Mathematics

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Research Interests

Topological data analysis, geometric data analysis, network science, spatial data, and applications to biology

Academic Appointments

Columbia University, Department of Mathematics 2023-Present
NSF Postdoctoral Research 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

9. 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*, in press.

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

7. Computing Persistence Diagram Bundles. A. Hickok. arXiv:2210.06424, 2022.

6. Persistence Diagram Bundles: A Multidimensional Generalization of Vineyards. A. Hickok. arXiv:2210.05124, 2022.

5. A Family of Density-Scaled Filtered Complexes. A. Hickok. arXiv:2112.03334, 2022.

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.

*Equal contribution.

Teaching

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 Talks

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

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
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 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

General Mathematical Audience Talks

Columbia Michael Zhao Memorial Student Colloquium — Nov. 2023
Columbia Undergraduate Math Society — Nov. 2023

Posters

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

Research Visits

Columbia University — Spring 2022
Visiting Scientist
Host: Andrew Blumberg

Academic Mentorship

Independent Research Project Supervision

Graduate Projects

- Tristan Luca Saidi — Spring 2024-
  Topic: *Graph neural networks for learning curvature in point-cloud and graph data*

Undergraduate Projects

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

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.*

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

ENYGMMa (Empowering NY Gender Minority Mathematicians) Fall 2023-
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