AWM Honors 2024 Dissertation Prize Winners

Abigail Hickok and Parvathi M. Kooloth

Abigail Hickok received her PhD in 2023 at UCLA under the supervision of Mason Porter. She is currently an NSF Postdoctoral Fellow at Columbia University.

Hickok's dissertation consists of work from six papers and a book chapter in the area of topological and geometric data analysis. In topological data analysis one uses ideas from algebraic topology to analyze the global structure and “shape” of data not captured by traditional methods in data science, often using persistent homology. In geometric data analysis, one tries to extract the geometry of the data, like curvature, in addition to the topological information. Although her work can be viewed as applied mathematics, she uses many ideas from pure mathematics — from subjects such as algebraic topology, geometry, and probability. Hickok defines the notion of a persistent-diagram (PD) bundle and develops an algorithm to compute piecewise linear PD bundles. She uses this to study the theory and algorithms for dynamic datasets (evolving over time) and study how its persistent homology (PH) changes over time. In another paper, Hickok considers the analysis of spatial and spatiotemporal anomalies, with detailed case studies to COVID-19 infection cases in Los Angeles and vaccination rates in New York City. One letter writer wrote "the method that Abby has developed is the current state-of-the-art approach for using persistent homology to study geospatial and geospatiotemporal data."

Parvathi M. Kooloth received her PhD in Mathematics in 2022 at the University of Wisconsin-Madison under the direction of Professor Leslie M. Smith. She is currently a Postdoctoral Research Associate at the Pacific Northwest National Laboratory.

Kooloth is interested in Geophysical Fluid Dynamics, Climate Feedbacks, Data Science, and Dynamical Systems. Her groundbreaking thesis titled "Moist potential vorticity and coherent structures in the atmosphere." In it, she was able to solve a long-standing puzzle in the fluid dynamics of the atmosphere and the ocean. She introduced a moist potential vorticity and dealt with clouds in the atmosphere and with phase changes using a new Hamiltonian/Lagrangian formulation. In a series of elegant theoretical analyses, Kooloth derived fundamental conservation laws for compressible and incompressible moist dynamics with phase changes. She also uses idealized numerical simulations to demonstrate and track the existence of the special potential-vorticity-conserving volumes. As one of her letter writers said "Her dissertation work is without question the most important work in recent years in the mathematics of climate. Her theories will reshape how we think about geophysical flows with phase changes and will drive new approaches to climate modeling."

The AWM Dissertation Prize was established in 2016, an annual award recognizing exceptional work in a dissertation defended in the last 24 months. The award is intended to be based entirely on the dissertation itself, not on other work of the individual. Learn more at www.awm-math.org. The prizes will be presented on January 03, 2024 during the Joint Prize Ceremony at the Joint Mathematics Meetings in San Francisco, CA. Full Citations and responses from the prize winners are posted at AWM Dissertation Prizes 2024.