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Coherent Structure Detection using Persistent Homology and other Topological Tools SPENCER SMITH, Mount Holyoke College, ERIC ROBERTS, SUZANNE SINDI, KEVIN MITCHELL, University of California Merced — For non-autonomous, aperiodic fluid flows, coherent structures help organize the dynamics, much as invariant manifolds and periodic orbits do for autonomous or periodic systems. The prevalence of such flows in nature and industry has motivated many successful techniques for defining and detecting coherent structures. However, often these approaches require very fine trajectory data to reconstruct velocity fields and compute Cauchy-Green-tensor-related quantities. We use topological techniques to help detect coherent trajectory sets in relatively sparse 2D advection problems. More specifically, we have developed a homotopy-based algorithm, the ensemble-based topological entropy calculation (E-tec), which assigns to each edge in an initial triangulation of advected points a topologically forced lower bound on its future stretching rate. The triangulation and its weighted edges allow us to analyze flows using persistent homology. This topological data analysis tool detects clusters and loops in the triangulation that are robust in the presence of noise and in this case correspond to coherent trajectory sets.

Spencer Smith
Mount Holyoke College

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