

Applied Topology in Albany (ATiA) Seminar

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TDA FOR NONUNIFORM DATA: A FAMILY OF DENSITY-SCALED FILTERED COMPLEXES

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11:30 a.m. on Zoom

ABSTRACT. In this talk, I will discuss a new approach for using persistent homology to infer the homology of an unknown Riemannian manifold (M, g) from a point cloud sampled from an arbitrary smooth probability density function. Standard distance-based filtered complexes, such as the Čech complex, often have trouble distinguishing noise from features that are simply small. Moreover, the standard Čech complex may only be homotopy-equivalent to M for a very small range of filtration values. I address this problem by defining a family of “density-scaled filtered complexes” that includes a density-scaled Čech and Vietoris-Rips complexes. The density-scaled Čech complex is homotopy-equivalent to M for filtration values in an interval whose starting point converges to 0 in probability as the number of points $N \rightarrow \infty$ and whose ending point approaches infinity as $N \rightarrow \infty$. The density-scaled filtered complexes also have the property that they are invariant under conformal transformations, such as scaling.

I will also talk about my implementation of a filtered complex that approximates the density-scaled Vietoris–Rips complex. This implementation is stable (under conditions that are almost surely satisfied) and designed to handle outliers in the point cloud that do not lie on M . For applications, I

will use this implementation to identify clusters in a point cloud whose clusters have different densities, and apply it to a time-delay embedding of the Lorenz dynamical system.