Extended persistence for 3D shapes

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Abstract

The purpose of this project is to implement an extension of persistent homology called *extended persistent homology*. This other version of persistence works by computing both sublevel and superlevel sets of a given function, and allows to gather more information than usual persistence with nice theoretical properties. The implementation will then be tested on real 3D shapes data.

- Download and read this article (sections 2 and 6):

  `https://drive.google.com/file/d/12ONqBuihlxIXOt-vDzOpGdJ4LHSgW2kB/view?usp=sharing`

- Using `Gudhi`'s interface, implement an algorithm that computes the extended persistence of a filtered simplicial complex (given as a simplex tree), WITHOUT using the `extended_persistence()` function of `Gudhi`.

- Test your algorithm by running it on your own triangulations of simple topological spaces, such as a sphere, torus, Möbius band, etc.

- Download and read this article (section 3):

  `https://drive.google.com/file/d/1e87mOZ3U5WTOP7agcjJdy3fMQXPW5Yh_/view?usp=sharing`

- Illustrate the symmetry theorems by running your algorithm on some 3D shapes provided there:

  `https://shape.cs.princeton.edu/benchmark/`

  For this, you will have to read .off files and store the shapes in simplex trees.

- Compute the distances (bottleneck, Wasserstein, etc.) between the persistence diagrams of all shapes (or a subset thereof).

- Use the distance matrix to run MDS and embed the 3D shapes in 2D. Use the embeddings for clustering, and compare the results with ordinary persistence.