Geodesic filtrations for segmentation

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Abstract

The purpose of this project is to implement geodesic filtrations that can be used to classify points on 3D shapes, which is also called the *segmentation problem*. For this, 3D shapes will be filtered locally by using geodesic distances to basepoints in order to generate signatures that are invariant to solid transformations.

- Download and read this article (section 3.1):

  https://drive.google.com/file/d/1us20cCFAjQPyVsJ0s0mxI4Z4n_fASbNR/view?usp=sharing

- Implement an algorithm that approximates geodesic distances on a 3D shape triangulation using the shortest distances on the corresponding graph using Dijkstra's method.

- Using `Gudhi`'s interface, implement an algorithm that computes point signatures on a 3D shape by filtering the shape, for each basepoint on the shape, with the geodesic distances to that basepoint.

- Apply your algorithm on this 3D shape dataset:

  https://segeval.cs.princeton.edu/

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

- Pick two points at the same location of two different human shapes, and check that their PDs are indeed similar.

- Download and read this article (section 2):

  https://www.jmlr.org/papers/volume13/gretton12a/gretton12a.pdf

- Now that each 3D shape is characterized by a family of PDs, use Maximum Mean Discrepancy (MMD) statistics and permutation tests to distinguish between two different 3D shapes, e.g., human VS ant.

- For a single class of 3D shapes, e.g., human, classify the points on the 3D shapes using classifier models trained on persistence diagram vectorizations seen in class. If you want to use PersLay, you can either implement it yourself, or compile the `perslay` branch of `Gudhi`:

  https://github.com/MathieuCarriere/gudhi/tree/perslay