Computational topology - group project

Robustness of persistence diagrams

The goal of this project is to demonstrate the robustness of persistence diagrams of the Vietoris-Rips complex on a specific example.

- You are given a set of points S. Compute the largest distance R between any two points in the data set S and divide the interval $[0, R]$ into 10 equal parts with partition points $0 = r_0 < r_1 < r_2 < \cdots < r_{10} = R$.
- Construct the Vietoris-Rips complexes $V_i = V_{r_i}(S)$, $i = 0, \ldots, 10$. This gives you a filtration
$$V_0 \leq V_1 \leq \ldots \leq V_{10}.$$
Can you describe V_0 and V_{10}?
- Construct the persistence diagrams of the filtration in dimensions 0, 1 and 2.
- Now shake the points in S a little, that is, define 100 data sets S_i obtained by adding a random error term $\varepsilon < R/100$ to the coordinates of each point in S. Construct Vietoris-Rips filtrations
$$V_0 \leq V_1 \leq \ldots \leq V_{10}$$
on the new data sets and the corresponding persistence diagrams.
- Compare the new persistence diagrams obtained in this way with the original one. For each one compute its bottleneck distance from the original persistence diagram. Compute some basic statistics and tests on the obtained sample of distances: what is the average value and standard deviation, are they distributed nornally? Compare the results between the dimensions and provide a statiustically sound interpretation.