

# Persistent Homology and Topological Data Analysis

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Point Cloud



Constructing Simplicial Complex

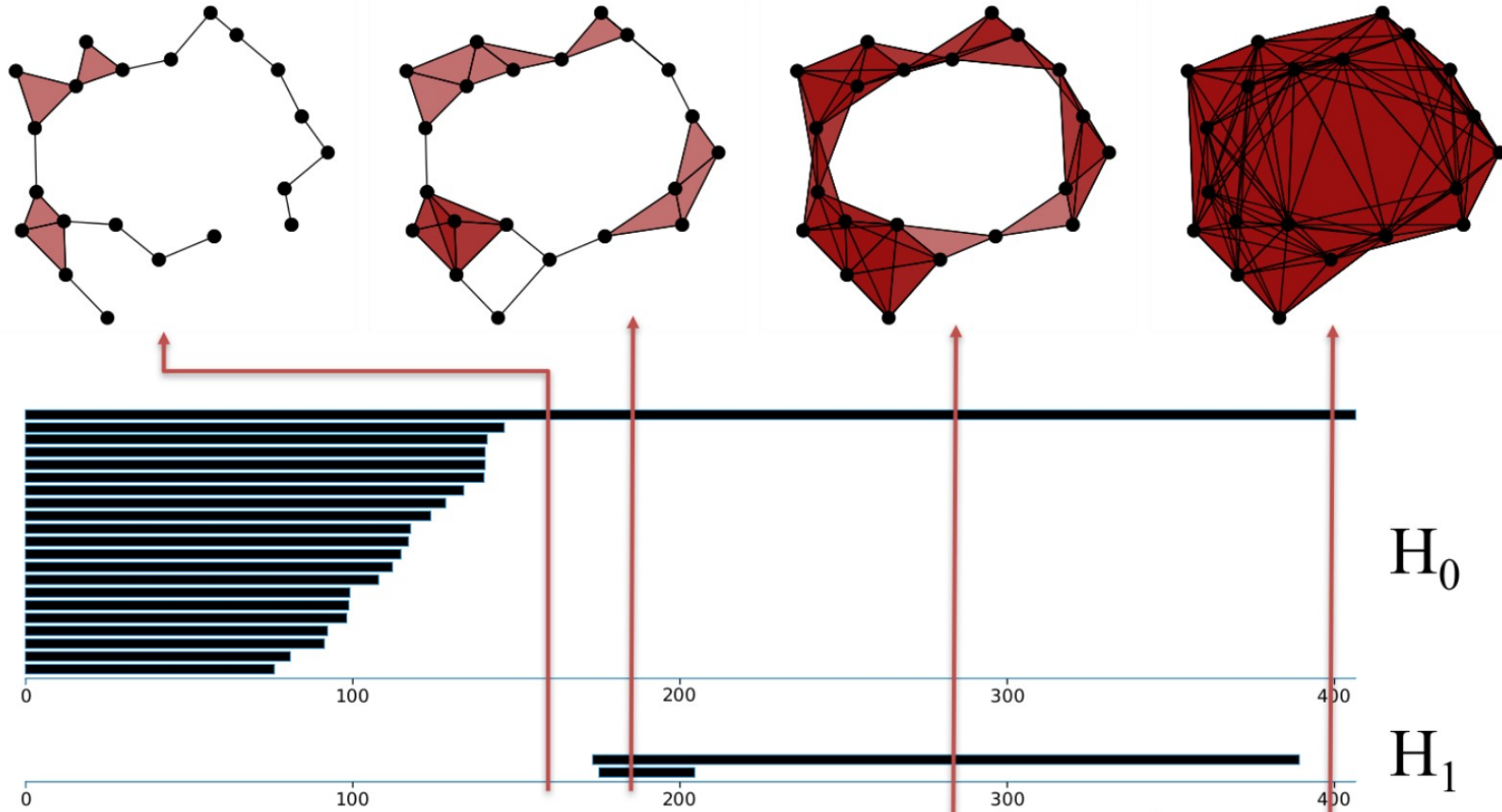


Computing **Persistent Homology** of this complex

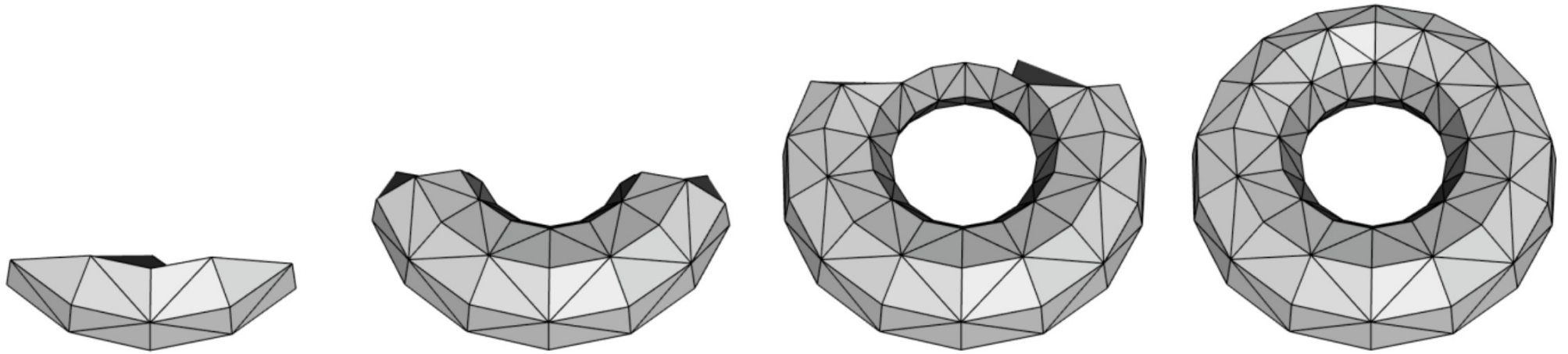


Representing Persistent Homology in terms of **Barcodes**

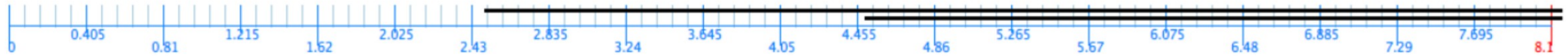
# Persistent homology



- Input: Increasing spaces. Output: barcode.
- Significant features persist.
- Cubic computation time in the number of simplices.



**Betti plot: Dimension 0**

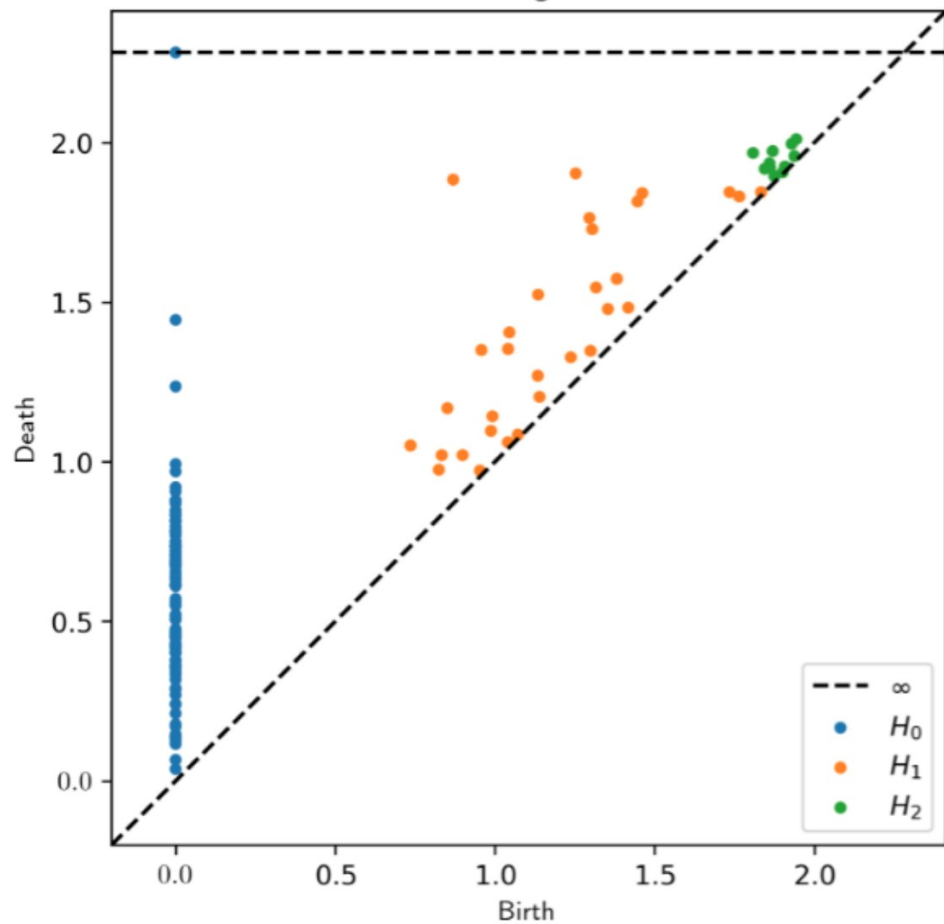


**Betti plot: Dimension 1**

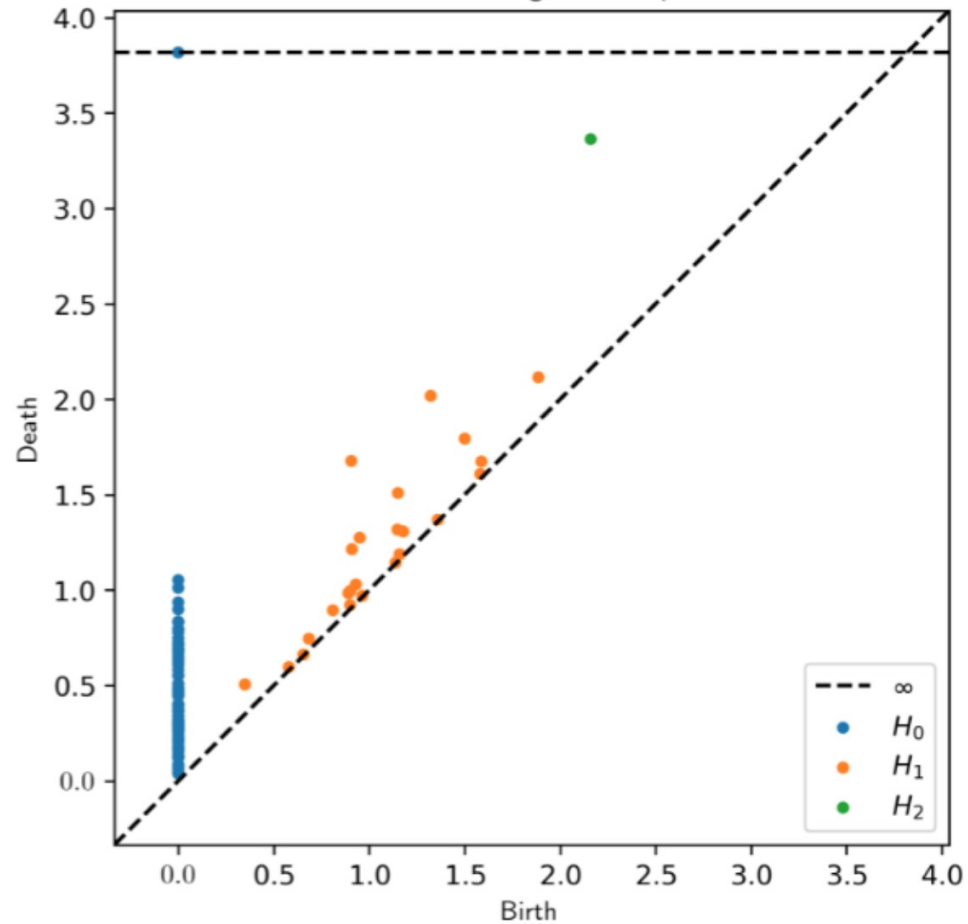


**Betti plot: Dimension 2**

Persistence Diagram of Torus

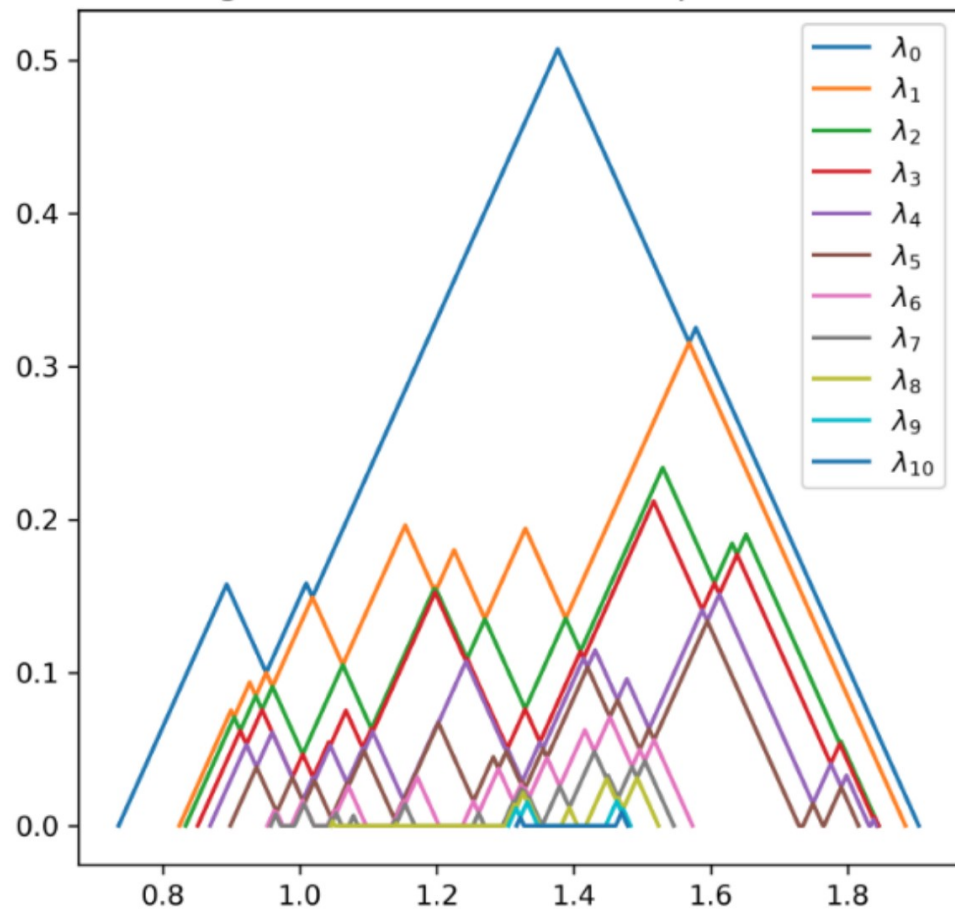


Persistence Diagram of Sphere

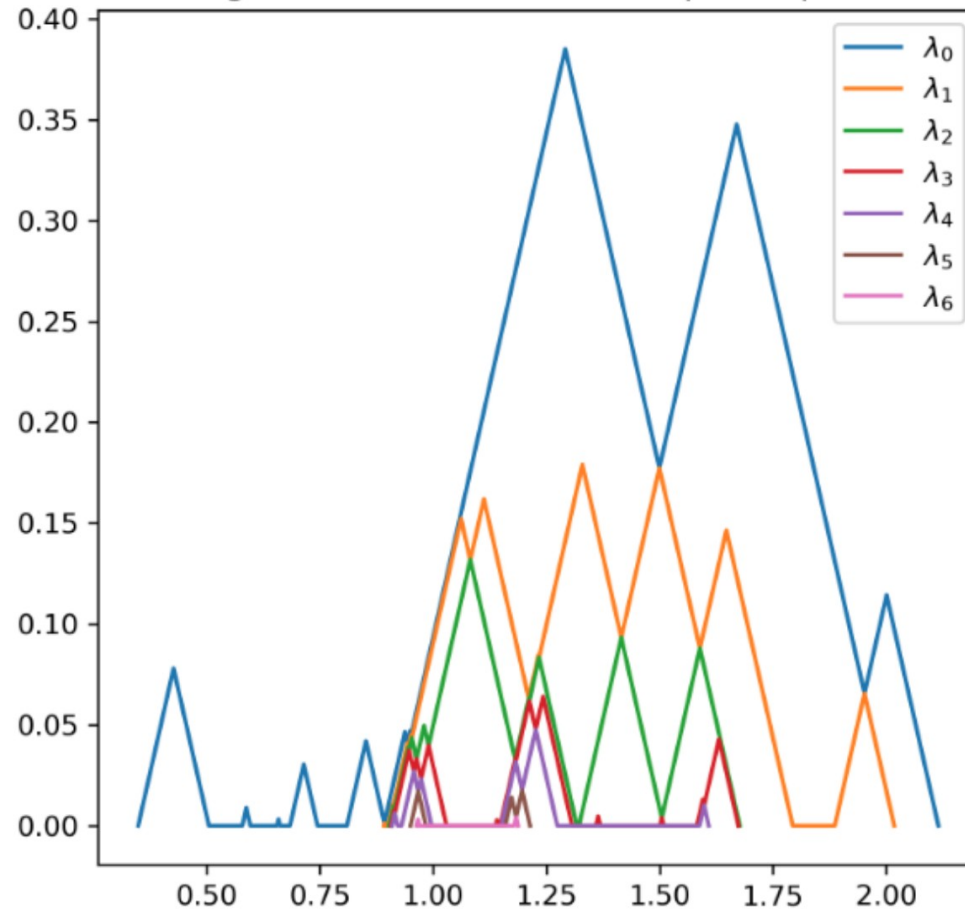


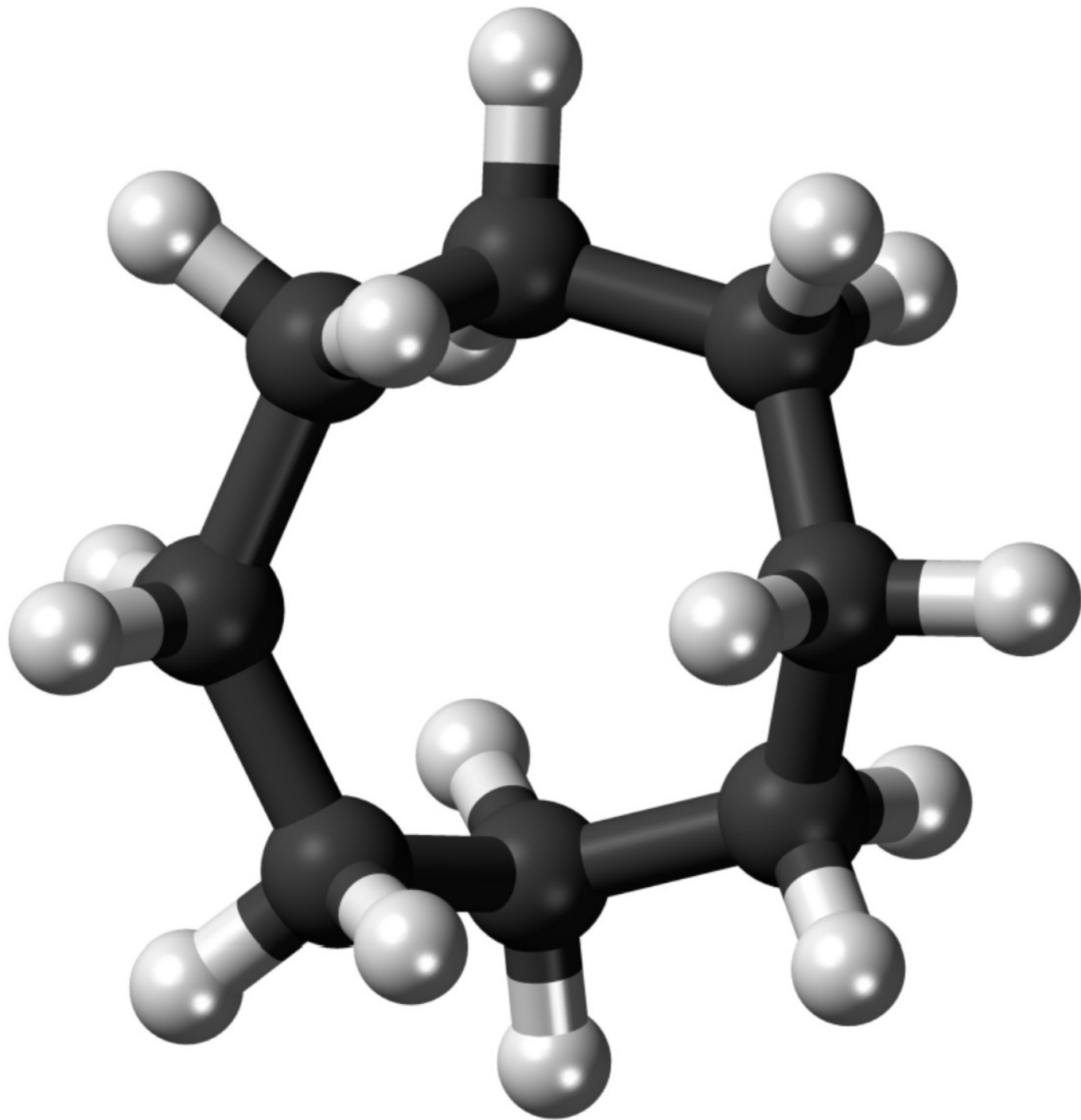


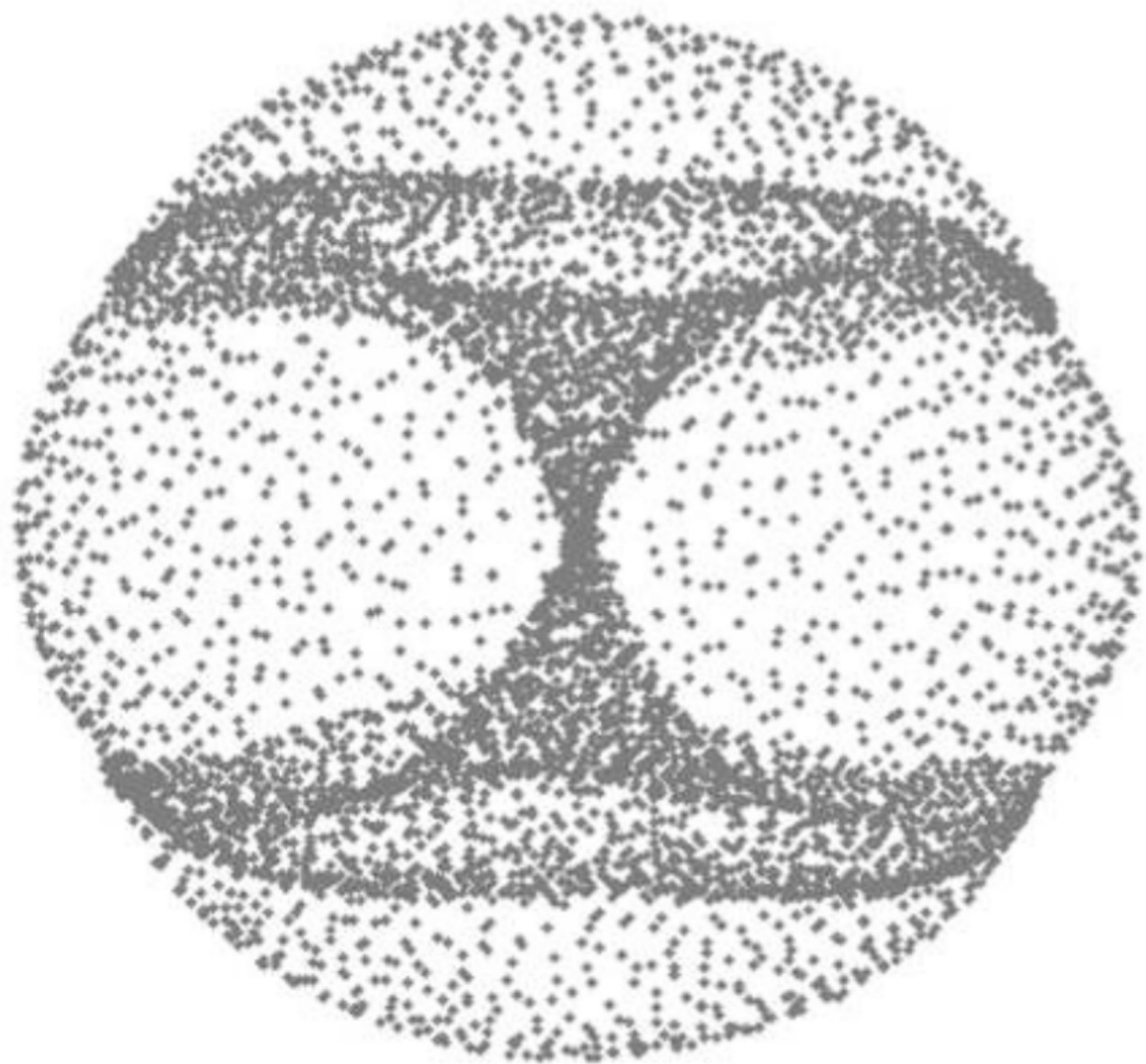
Degree 1 Persistence Landscape of Torus



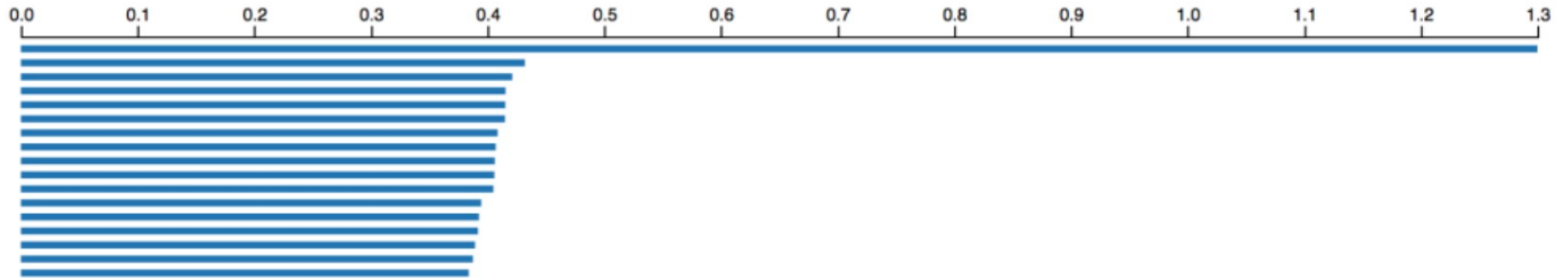
Degree 1 Persistence Landscape of Sphere



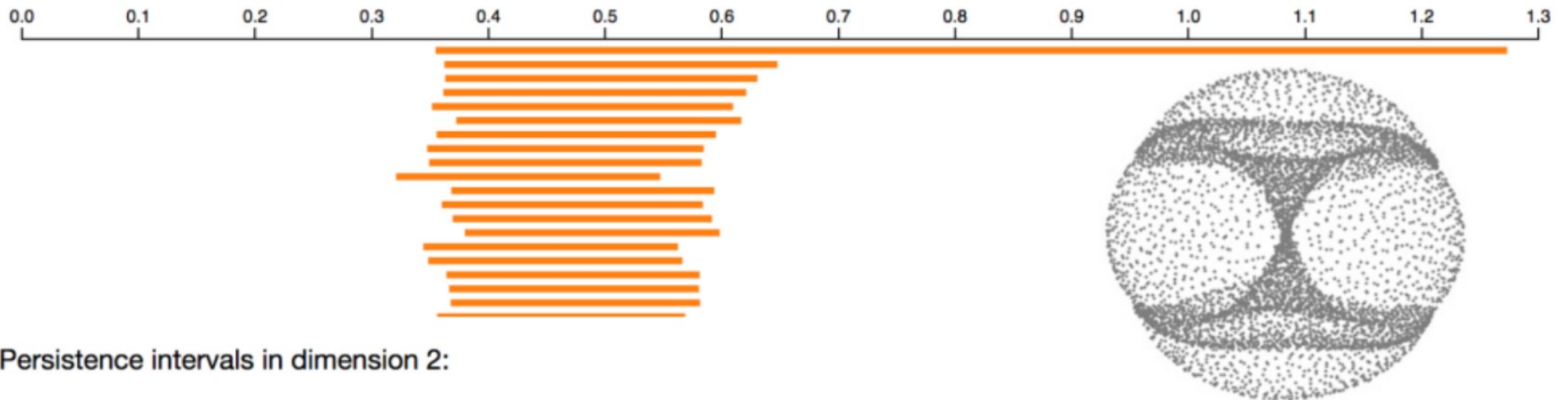




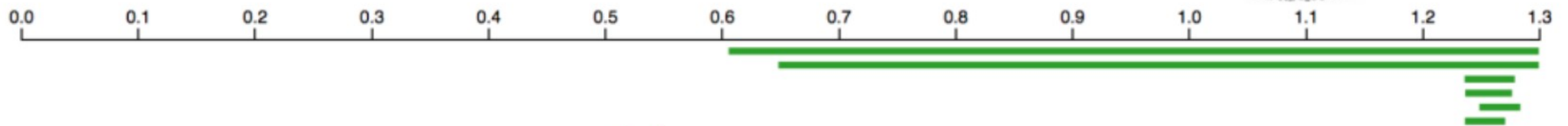
Persistence intervals in dimension 0:



Persistence intervals in dimension 1:

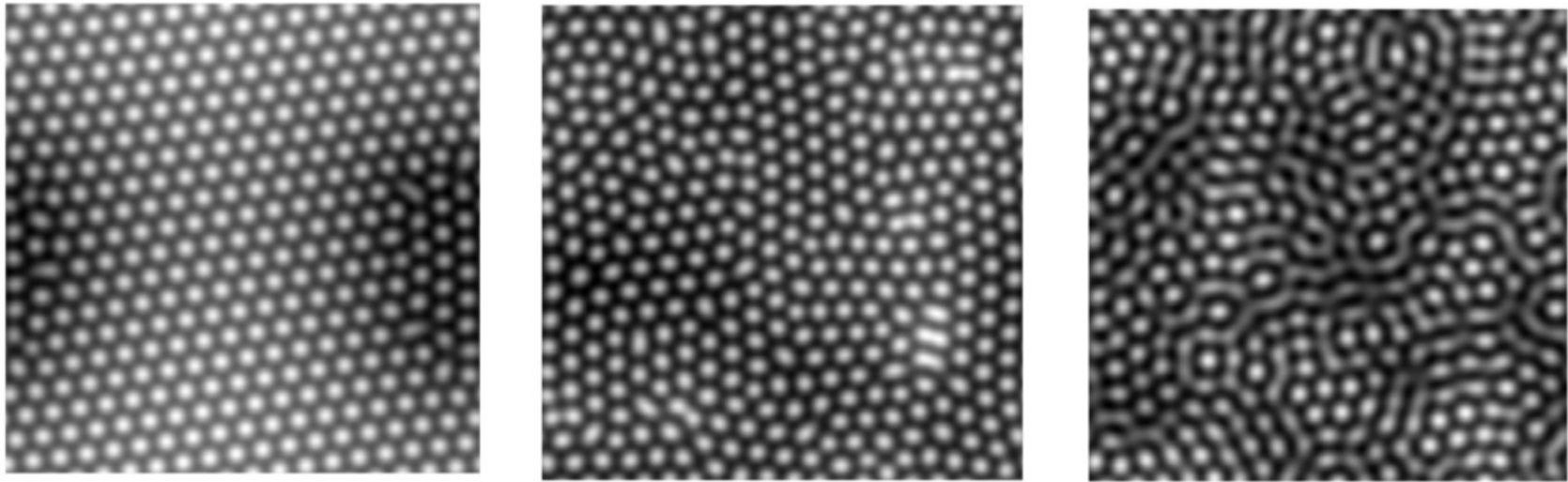


Persistence intervals in dimension 2:



*Non-Manifold Surface Reconstruction from High Dimensional Point Cloud Data*  
by Shawn Martin and Jean-Paul Watson, 2010.

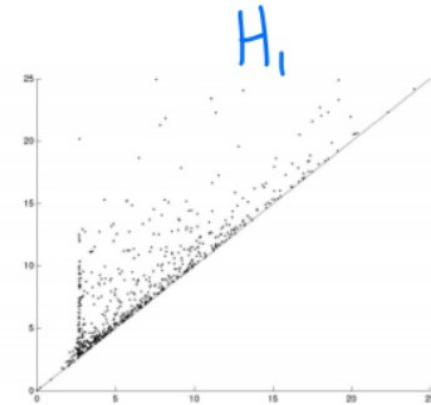
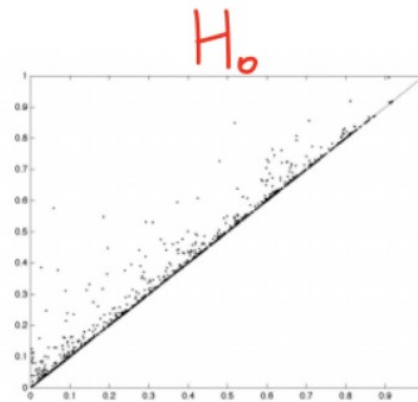
# Local geometry



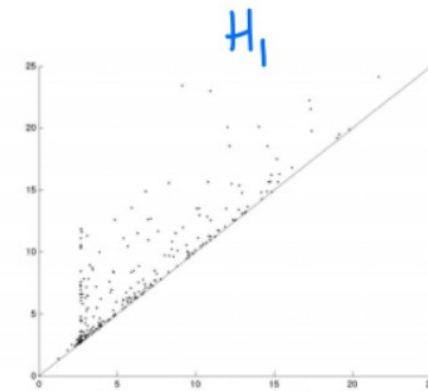
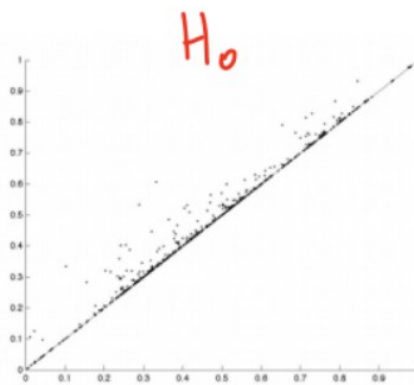
Measures of order for nearly hexagonal lattices  
Motta, Neville, Shipman, Pearson, Bradley, 2018

# Persistent homology measures topology and geometry

24  
years



60  
years

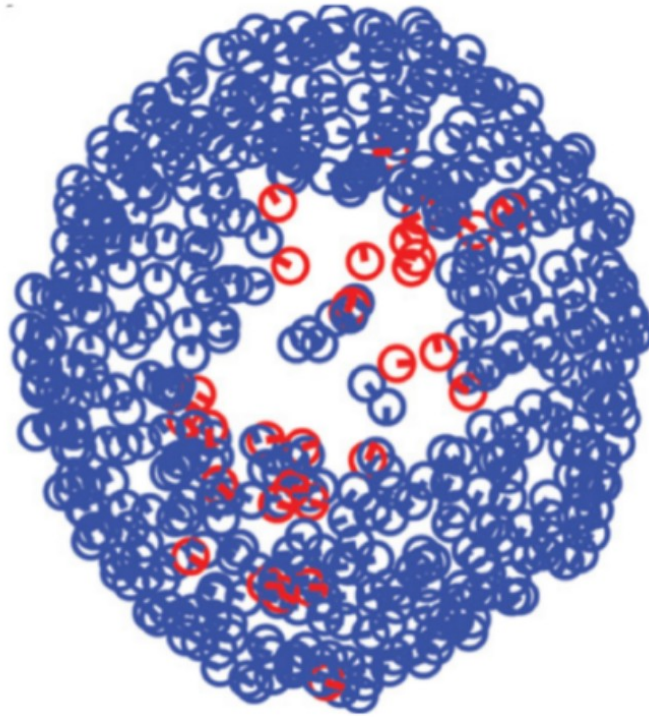


Persistent homology analysis of brain artery trees  
Bendich, Marron, Miller, Pieloch, Skwerer, 2014



Collective motion, self-organization

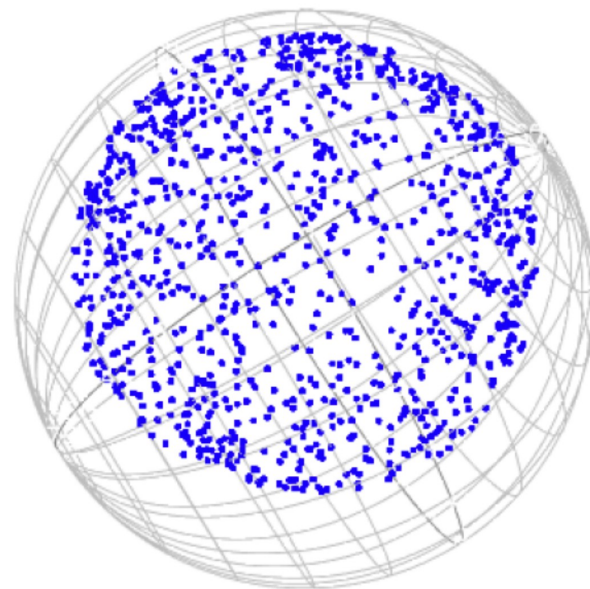
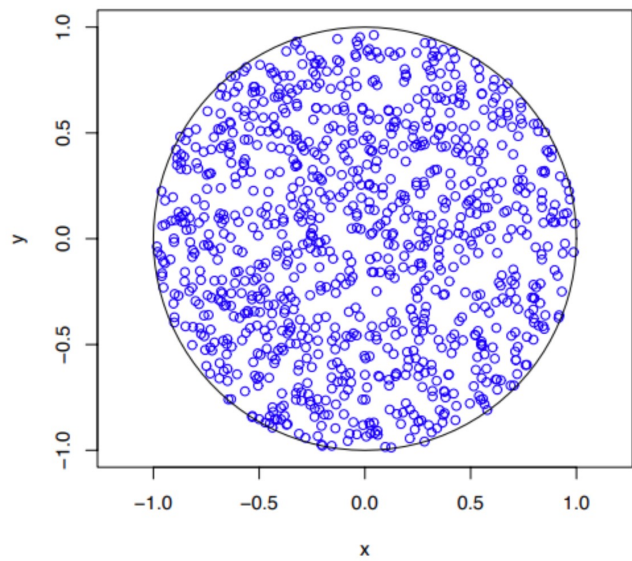
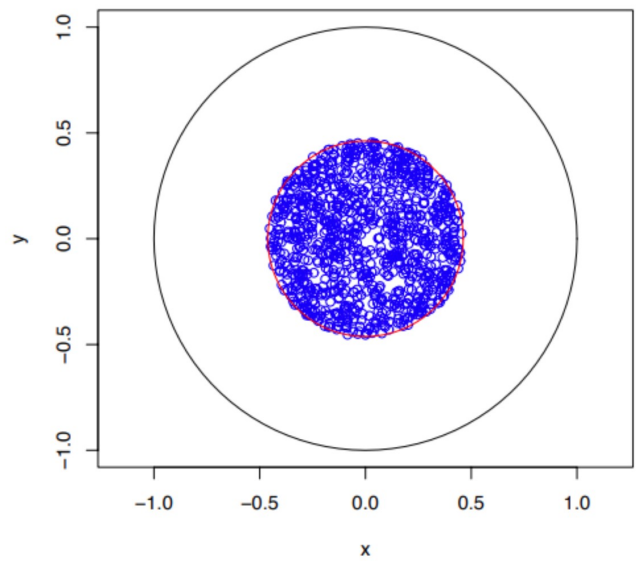
Topological data analysis of biological aggregation models  
Topaz, Ziegelmeier, Halverson, 2015



Collective motion, self-organization

Topological data analysis of biological aggregation models  
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*Thank You!*