



Topological Data Analysis

An attempt at a thesis defence

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What is Topological Data Analysis (TDA)?

- An approach to the analysis of datasets using techniques from topology
- General framework to analyse high-dimensional, noisy and incomplete data
- Three main tools
 - Persistent Homology
 - Mapper
 - UMAP

Persistent Homology

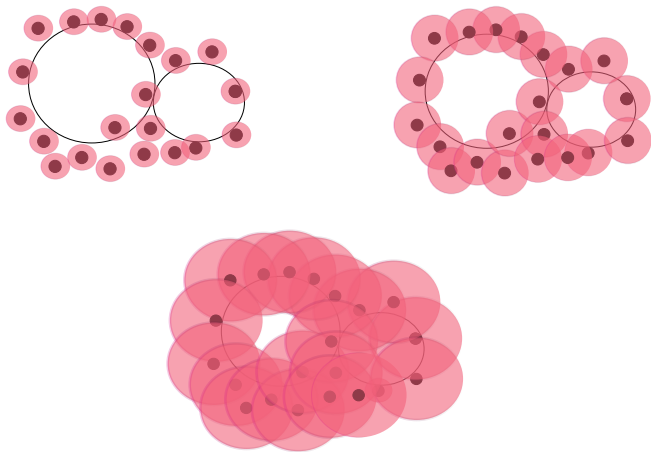


Figure: Point cloud setup

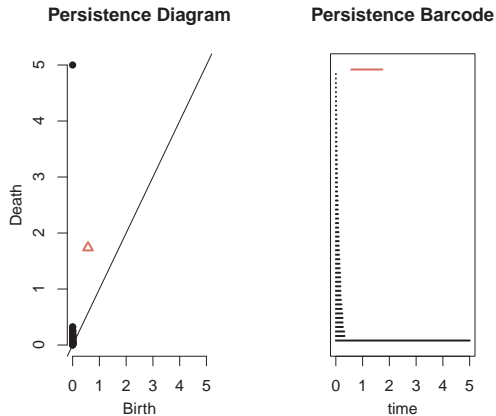


Figure: Barcodes vs Diagrams

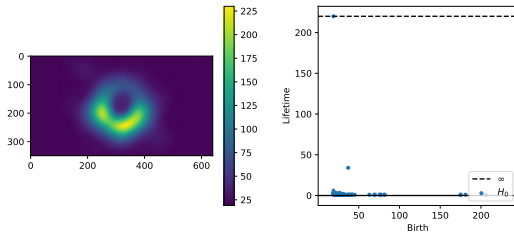


Figure: Confirming that a black hole *has* a hole

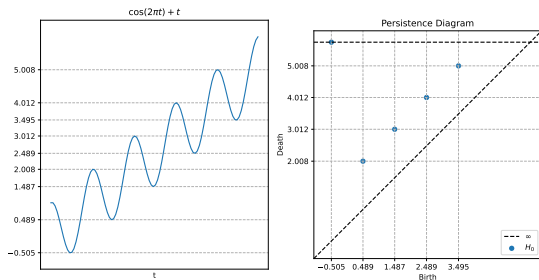


Figure: Example of sublevelset filtration

Mapper

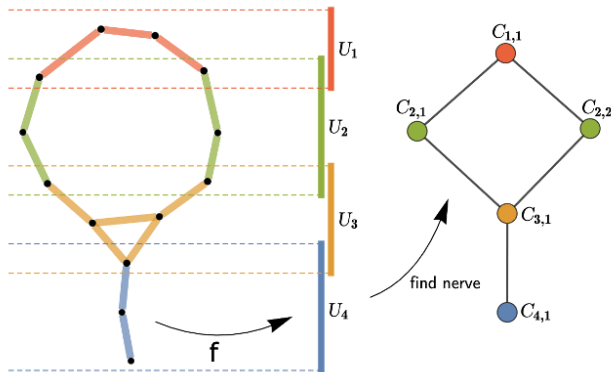


Figure: Typical Mapper example¹

¹Image taken from <https://www.quantmetry.com/blog/topological-data-analysis-with-mapper/>

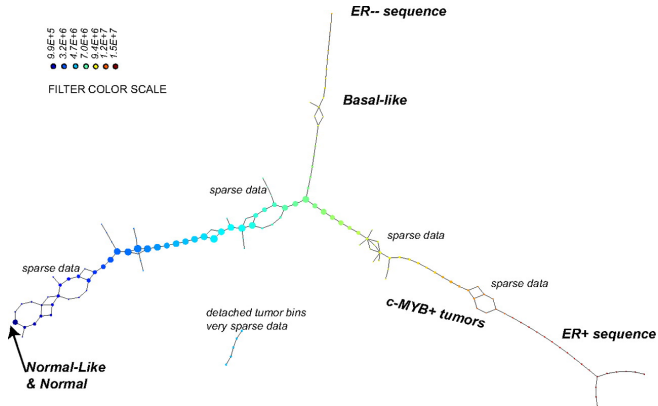


Figure: Image taken from [1]

Recent lectures

- Stefan Huber - Topological Data Analysis and Industrial Automation
- Erik Amézquita - TDA to characterize spatial distributions of mRNA at subcellular resolutions
- Fabian Roll - Bridging Persistent Homology and Discrete Morse Theory
- Paweł Dłotko - Feature Extraction and Visualization Methods in TDA
- Michael Postol - Steenrod Squares and Data Science: Is There a Connection?

Bibliography

- [1] Monica Nicolau, Arnold J. Levine, and Gunnar Carlsson.
“Topology based data analysis identifies a subgroup of breast cancers with a unique mutational profile and excellent survival”.
In: *Proceedings of the National Academy of Sciences* 108.17 (2011), pp. 7265–7270. DOI: 10.1073/pnas.1102826108. eprint: <https://www.pnas.org/doi/pdf/10.1073/pnas.1102826108>. URL: <https://www.pnas.org/doi/abs/10.1073/pnas.1102826108>.

Thank You for Your Attention!

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