

# Seeing Shapes in the (Point) Clouds

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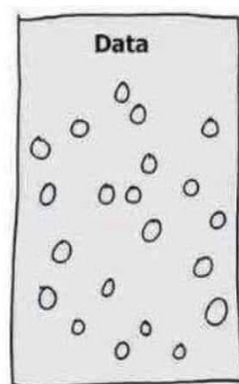
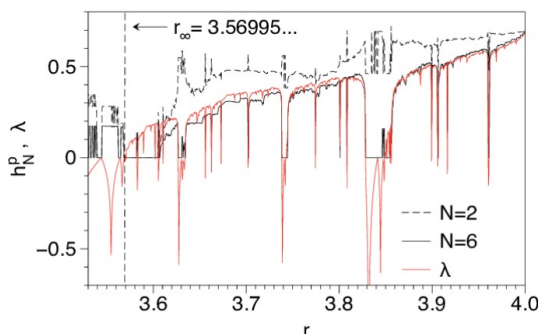
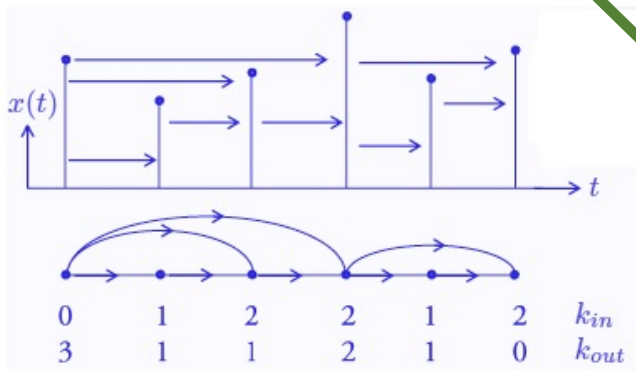


How to compare the geometry of two functions?

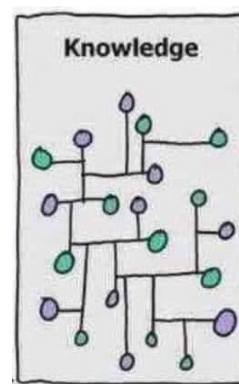
1. "HVG" Graph representation approach (physics & elsewhere)

2. TDA approach (data scientists)

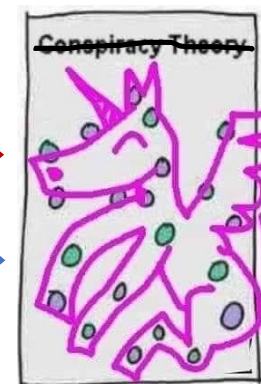
3. [NEW] "HVC" Duals to merge trees



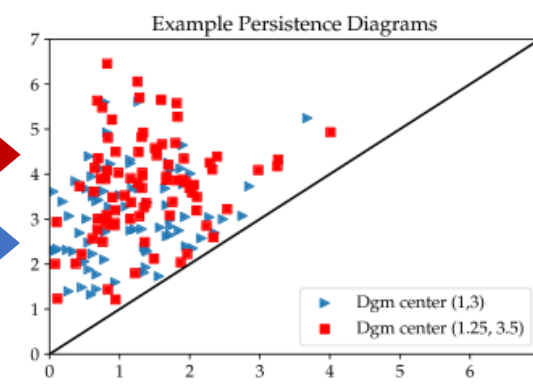
point cloud embedding



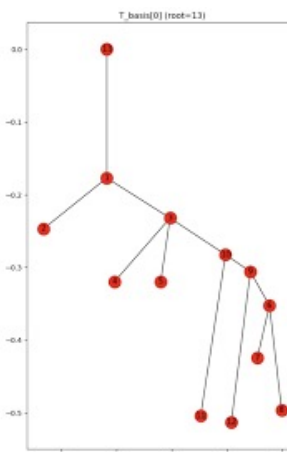
local relations



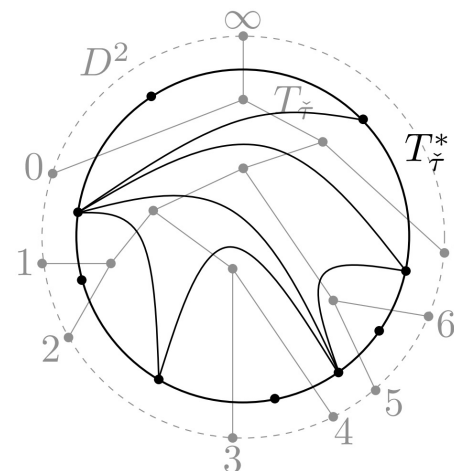
topology (global structure)



features (based on "merge tree decompositions")



sublevel merge trees



introduce their "duals" on the sphere – the "HVC"

## Theoretical Contributions:

- HVC structure extends **Approach 1**
- HVC structure underlies **Approach 2**
- $\exists$  a stable w.r.t. perturbations metric  $d$  on HVC space (none for HVGs)
- MOPs are dense in HVC space w.r.t.  $d$

## Empirical Contributions:

- First  $O(n)$  scalable HVC/HVG construction alg. (best was  $O(n^2)$  before)
- TDA on HVCs gives more discriminative features for time series classifiers than either **Approach 1** or **Approach 2**.