

***ISCI 104 Literature Review***  
**Persistent Homology in Haze Analysis**

Timothy Tarter, Sam DiBiase

ISCI 104  
James Madison University

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- Goal: Identify new “topological features” in haze data and use it to develop an early detection system for changes in haze
- Potential bias: datamining potentially limited or skewed data instead of basing models on physical hypotheses.

**Impact**

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- ③ The study focuses particularly on PM10 (particulate matter), a major air pollutant during haze episodes in Southeast Asia.
- ④ The study employed Persistent Homology as a form of topological data analysis - studying the "shape" of data.



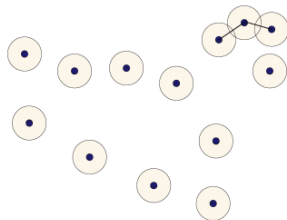
# What is Persistent Homology? (1/2)

**Want:** To attach data together based on a notion of distance.

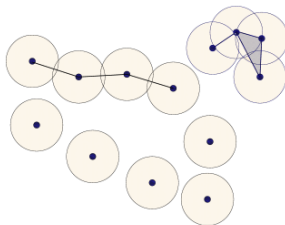
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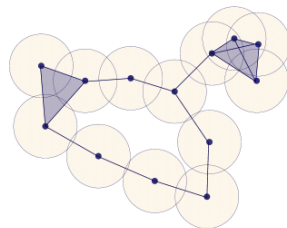
**Solution:** The Vietoris-Rips Complex.



(a) Rips complex at some scale



(b) ..at a larger scale.



(c) ...and at an even larger scale.

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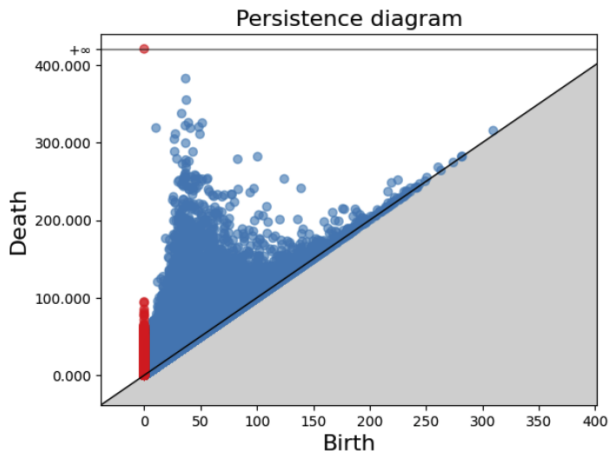
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This results in a lifespan “persistence” diagram for each of our features, which tells us how important each feature / class is.

# Persistence Diagrams



# Why Topological Data Analysis?

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- We can predict the change in the shape of the data, and,
- We can correlate features of data by persistence clustering and homotopy class as an alternative to traditional statistics.

# Primary Findings of Zulkepli

- Haze months have topological features spread farther from origin in persistence diagrams, non-haze months have more of a cluster near the origin.

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- Haze months have topological features spread farther from origin in persistence diagrams, non-haze months have more of a cluster near the origin.
- Months with severe haze show large changes in topological features compared to normal months, suggests that persistent homology could be useful for the early detection of haze episodes.

## Article Quality



# Article Quality

## Strengths:

- Clear explanations of both biology and mathematics.
- Robust modeling techniques.
- Hopeful results for the future.

## Weaknesses:

- Persistence diagrams have poor quality on the web.
- Algorithm for early detection is written informally.

## Learning Opportunities:

- Can apply TDA methods to our final project for this class.
- Make sure diagrams are clear in our paper!

# References

Primary Article: Zulkepli, Nur. <https://aaqr.org/articles/aaqr-18-08-0a-0315>

Rips complex image: Choudhary, Aruni. <https://dx.doi.org/10.22028/D291-26959>

Persistence diagram: the Carpentries Incubator. [https://carpentries-incubator.github.io/topological-data-analysis/fig/tda\\_09\\_persistence\\_example3.png](https://carpentries-incubator.github.io/topological-data-analysis/fig/tda_09_persistence_example3.png)