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Topological data analysis using discrete homology

Persistent homology is a tool of Topological Data Analysis commonly used to detect the shape of data. When the data of interest comes from a metric space, for example a finite subset of $\mathbb{R}^n$, the method is generally noise resistant. We show that this is not the case when the data fails the triangle inequality.

To solve this issue, we propose a new method: persistence discrete homology. This method uses discrete cubical homology, which is a homology theory for simple undirected graphs. This allows us to take homology over a filtration of graphs rather than the filtration of simplicial complexes normally used.

In this talk, we will introduce the classical method of persistent homology, discuss discrete cubical homology and how it can be used for persistence, and compare the two methods. We show that persistent discrete homology is better suited to analyze data not coming from metric spaces.

This talk is based on joint work with Chris Kapulkin, and the corresponding paper can be found here: arxiv.org/html/2506.15020.