Topological Data Analysis

Spring 2020

Instructor(s): Wesley Hamilton, J.S. Marron
Dates: 01/29, 02/05, 02/12, 02/19, 02/26, 03/04, 03/19
Meeting time: Wednesdays, 5:00-7:15pm
Meeting room: PH 365

1 Course description

This BD2K module is an introduction to Topological Data Analysis (TDA), with a focus on practical applications. As a tool, TDA has proven to be effective at quantifying topological and geometric structure in data, and has been used as a supplement to traditional clustering techniques. Moreover, advances in both computational power and algorithms for computing topological information make TDA more applicable than ever before.

Again, the focus of this module will be on using TDA in practice and interpreting barcodes as describing intrinsic topological features of data sets. Programming experience is not necessary.

2 Topics

This module will cover the following topics:

- complexes and filtrations,

- the homology and persistent homology of filtrations,

- ways of assigning complexes to data sets,

- algorithms for computing homology and persistent homology,

- the Wasserstein metric and statistics on barcodes,

- applications and interactions of TDA to machine learning.

3 Course work

Grades will be determined by a group project. Possibilities include applying TDA methods to a dataset of choice, implementing an algorithm that computes a barcode or other topological feature of interest, etc.; a document with ideas will be made available during the first week of class. An

overview of TDA software packages will given during the first class, so students can work in a programming language of their choice. The group project will consist of 1) a short (2-3 page) write-up detailing the project, and 2) a short (10-15 minute) presentation on the project.

Optional problem sets will also be assigned. While these won't be collected and graded, they will give opportunities for students to test their knowledge and explore concepts from class sessions more deeply.