

Math 580A2, Topological Data Analysis

Course Syllabus

Instructor: Henry Adams

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Credits: 1

Lectures: April 4–May 4, Tuesday and Thursday 2:00–3:15pm in Weber 205

Class Webpage: <http://www.math.colostate.edu/~adams/teaching/math580A2spr2017>

Topic: This 1-credit class is an introduction to data analysis using topological techniques. We will first give an intuitive introduction to topology, including homotopy equivalent spaces, homology groups, and homotopy groups. We next move to the realm of data analysis: given only a dataset, i.e. a finite sampling from a space, what can we say about the data's shape, which may be reflective of patterns within? Clustering and dendrograms can be used to study the number of connected components. The two main techniques we cover are Mapper and persistent homology; we describe their theoretical underpinnings, provide examples of how they have been used on real-life data, and provide tips for using these techniques on new data sets.

Prerequisites:

Math 369 (linear algebra) or equivalent. Some experience with Matlab would be beneficial.

Lectures: A planned schedule for 10 lectures of 75 minutes each.

1. Course overview
2. A visual introduction to topology, homotopy equivalent spaces, homology groups, and homotopy groups
3. Clustering and dendrograms
4. Mapper: Introduction and theory (Reeb graphs)
5. Mapper: Real-life examples
6. Mapper: In practice
7. Persistent homology: Introduction and theory
8. Persistent homology: Real-life examples
9. Persistent homology: In practice
10. Further research directions