

# Math 580a2, Applied Topology

**Instructor:** Henry Adams

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**Office:** Weber 125

**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 applied topology. 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 space's shape (which may be reflective of patterns within the data)? The main technique we cover is persistent homology; we describe its theoretical underpinnings, discuss examples of how it has been used on real-life data, and provide coding examples. We also discuss zigzag homology and applications to mobile sensor networks. Lastly, we introduce mapper and Reeb graphs.

Portions of our class will use the tutorial for computing persistent homology with the Javaplex software package: [http://www.math.colostate.edu/~adams/research/javaplex\\_tutorial.pdf](http://www.math.colostate.edu/~adams/research/javaplex_tutorial.pdf)

## 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 ([Slides](#))
2. Introduction to homotopy equivalences and homotopy groups ([Notes](#))
3. Homotopy groups, natural image data, Javaplex examples ([Notes](#))
4. Introduction to homology and persistent homology ([Slides](#), [Notes](#))
5. Persistent homology: Čech and Vietoris–Rips complexes ([Notes](#), [Slides](#))
6. Evasion paths in mobile sensor networks ([Slides](#))
7. Persistent homology in applications: The two camps you want to be in
8. The theory of Vietoris–Rips complexes ([Notes on spheres](#), [Notes on VR](#))
9. Metric reconstruction via optimal transport ([Notes](#), [Abstract](#))
10. Class cancelled for the [Calculating Your Career](#) event