Peter Bubenik
Department of Mathematics

MAT 4930, Special Topics – Topological Data Analysis and Machine Learning

Time and Location

M W F Period 4 (10:40-11:30am) (online)

Content of the course

This course will introduce topology and see how it can be combined with machine learning to be used in applications.

What is topology?

Topology is geometry without lengths and angles. Topology is good for combining local quantitative information to obtain global qualitative descriptions that are coordinate-free and not sensitive to small errors.

Our main mathematical object will be the simplicial complex, a generalization of a graph. Instead of just having vertices and edges, we are allowed to add triangles, tetrahedra etc. From a simplicial complex we will use matrices to calculate something called simplicial homology and its modern variant, persistent homology. Persistent homology allows us to combine simplicial homology with geometric information.

What is machine learning?

Machine learning consists of algorithms and ideas from statistics and computer science for the automated study of data. It is based on linear algebra.

We will introduce some important ideas in machine learning: unsupervised learning, supervised learning, clustering, classification, regression, support vector machines. We will learn how to use the statistical programming language R.

What is it good for?

In addition to learning some interesting mathematics, we will also introduce some of the most important tools in modern data science. Finally we will see how topology can be used in applications. For example, the following two figures are in fact simplicial complexes. We will use topological data analysis to distinguish such figures.

Prerequisites

MAS 4105 Linear Algebra 1, or permission from the instructor.

Please contact me if you have any questions and/or requests!

Textbook

A Short Course in Computational Geometry and Topology, by Herbert Edelsbrunner. Available from the UF library as an eBook download.

Syllabus

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