MA 59800 - Fall 2021- Syllabus
Topological Data Analysis

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Class times: MWF 10:20-11:30 pm REC 112

Homepage for the course: http://www.math.purdue.edu/~rkaufman/MA598f21/

Office hours: TBA. By appointment.

Texts: Some references are:
"Computational Topology" by Herbert Edelsbrunner and John L. Harer
"Topological pattern recognition for point cloud data" Acta Numerica. 23. by Gunnar Carlsson.
more TBA, check webpage

Course description:
Topological data analysis, as the name says, is right the junction of pure mathematics and data applications. It is a recent tool designed to capture structural features of data sets and has found wide applications in diverse fields.
This course will be an introduction to the subject with the intent to provide both a working knowledge and a deeper understanding of the theory that provide the flexibility needed to solve real world problems as well as to further the theoretical toolkit.
The course is aimed at non-experts and is intended to be accessible to a wide audience. All mathematical notions will be developed from scratch, running the gamut from theory to application.
In the first part, we will introduce the main notions of persistent homology and bar codes. For this we will review the essential features of the homology that is used and the computational aspects. We will give precise definitions of the workings of persistence and introduce persistence diagrams. These concepts are put into a broader context compared with notions from other areas. As concrete examples we will consider various discrete and graphical setups relating to nerve constructions, such as Cech, Vietoris-Rips, Voronoi, Delaunay, and Alpha complexes. We will then discuss various metrics and measures of stability, such as the bottleneck distance.
In the second part of the course, we will discuss further topics which may include Reeb graphs, visualization using the Mapper algorithm, principal component analysis, and various clustering algorithms. This will also depend on the interests of the audience.
As a third component, it is planned to briefly touch upon programming using the jupyter interface.
The plan is to have an end project, which could either be a presentation of a paper in the subject or a small programming project.

Required Work: Besides the expected participation in class there may be short homework assignments. Oral presentation or projects by students are envisioned.

All Standard Syllabus Components Apply. Check Brightspace.