Thematic Course
PhD in "Scienze Economiche e Statistiche"
SEAS Department
University of Palermo

Academic Year	2021-2022
Subject	Topological Data Analysis
Instructor	Martina Vittorietti
Course description	TDA is a relatively new discipline that has provided new insight into the study of qualitative features of data. In particular, persistent homology is the branch of TDA that provides tools both for identifying qualitative features of data and to give a measure of the importance of those features. This course will give some intuitive insights on the background from algebraic topology, providing an overview of persistent homology – the main tool in TDA-, and various approaches to summarizing the information provided by persistent homology. Students will learn statistical aspects in TDA including correlation, and statistical significance tests. The tutorials will include working with established software packages (R and Python) to analyze example data.
Learning Objectives	Students completing this course should be able to: • be able to extract topological features from complex data; • analyze a real world system by identifying its geometrical structure and characterizing features; •use persistent homology to compute persistence diagrams and barcodes; •understand the structure and limitations of data used to monitor the evolution of real world systems. •apply insights from the theory of TDA to cope with real world problems.
Suggested readings	• Computational Topology An Introduction by H. Edelsbrunner, J. Harer, AMS, 2013. • Topology and Data by Gunnar Carlson, Bull. Amer. Math. Soc. **46** (2009) • Suggested papers in a dedicated shared folder
Course Activity	10h
Credits	2
Assessment Method	A written report and a presentation on a scientific on a real/simulated dataset as agreed with the instructor.
Teaching Methods	Each section utilizes a combination of lecturing, computer lab (learning by doing), and class discussion.
Calendar	May 2022
Contacts	martina.vittorietti@unipa.it

Lecture	Date	Topic	Duration
1	TBA	Introduction to TDA	2h
2	TBA	Basis concepts of Persistence Homology	2h
3	TBA	Persistence Diagram and persistence related quantities	2h
4	TBA	Hypothesis testing and permutation test	2h
5	TBA	Real data analysis	2h