Topological Data Analysis

Code: 104419
ECTS Credits: 6

2024/2025

Degree	Type	Year
2503740 Computational Mathematics and Data Analytics	OT	4

Contact

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Teachers

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

Students are required to have followed inear algebra, to have familiarity of the geometric notions of previous years, and to have some knowledge of Python.

Objectives and Contextualisation

The first goal is to introduce the topological features of data (namely, shapes and patterns). We shall learn the methodology do release this information, as well as some applications

Learning Outcomes

1. CM43 (Competence) Calculate the basic topological invariants relevant to data analysis.
2. CM43 (Competence) Calculate the basic topological invariants relevant to data analysis.
3. CM43 (Competence) Calculate the basic topological invariants relevant to data analysis.
4. KM35 (Knowledge) Define the concepts of topological space and continuity of applications.
5. SM42 (Skill) Distinguish, among the different mathematical tools, those that are feasible for implementation from those that are not.
6. SM42 (Skill) Distinguish, among the different mathematical tools, those that are feasible for implementation from those that are not.

Content

1 Introducció a la topologia
2 Complexos simplicials i homologia
3 Homologia persistent
4 Vectoritzacions
5 Una aplicació: periodicitat de sèries temporals
6 UMAP

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lectures	25	1	
Practices with computer	24	0.96	
Type: Supervised			
Tutoring and consultations	10	0.4	
Type: Autonomous			
Independent study and preparation	46	1.84	CM43, KM35, SM42, CM43
Use of sorftware	30	1.2	CM43, KM35, SM42, CM43

There is a theoretical part (including exercises sessions) and a practical part with computer.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Continued evaluation practices	40	10	0.4	
First partial test theory	30	2.5	0.1	CM43, KM35, SM42
Presentació final de curs	30	2.5	0.1	

Evaluations is organized as follows:

- Partial test (midterm) (30%)

- Deliveables at practical sessions(40%)
- Final presentation (30%)

- Some of the practical sessions will be evaluated at the end (previously announced). Partial tests and the practical work can be reevaluated, but the continued evaluation cannot.

- The one day assessment (avaluació unica) will take place on the same day as the final course presentations. The one day assessment will consist of the delivery of practicals (different from those carried out during the course), the final presentation and the subsequent completion of the partial test.

- Disclaimer: I have made my best to translate into English the Catalan version. In the unlikely case of differences between versions, we'll follow the Catalan one.

Bibliography

- Edelsbrunner, Herbert; Harer, John L. Computational topology. An introduction. American Mathematical Society, Providence, RI, 2010. xii+241 pp. ISBN: 978-0-8218-4925-5.
- G. Carlsson, Topology and data, Bull. Amer. Math. Soc. 46 (2009), 255-308.
- R. Kraft, Illustrations of Data Analysis Using the Mapper Algorithm and Persistent Homology, KTH Master's Thesis, 2016
- Gunnar Carlsson, Mikael Vejdemo-Johansoon, Topological data analysis with applications. 2022
- Tamal Krishna Dey, Yusu Wang, Computational topology for data analysis. 2022.
- Jean-Daniel Boissonnat, Frédéric Chazal, Mariette Yvinec, Geometric and Topological Inference, to appear in Cambridge University Press (available at https://inria.hal.science/hal-01615863/)
- https://giotto-ai.github.io/gtda-docs/0.3.0/library.html

Software

Compùter practical sessions shall be in Python. We shall use giotto-tda, built on top of scikit-learn

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	1	Catalan	first semester	morning-mixed
(TE) Theory	1	Catalan	first semester	morning-mixed