UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# COURSE SYLLABUS

# Big Data in Geographic Information Systems

**2526-2-FDS01Q024-FDS01Q025M**

## Learning objectives

The aim of the module is to enable students to have a basic competence to manage and analyze georeferenced data. The teaching module is part of the offer in the statistics and informatics disciplinary area.

1. Knowledge and Understanding
   Students will acquire foundational knowledge in the field of geospatial data, including key concepts related to cartography, Geographic Information Systems (GIS), and types of georeferenced data. The course emphasizes the relationship between data and the systems that generate them, and introduces theoretical tools for managing and interpreting such data. Applications are drawn particularly from climate science, with examples ranging from physical observations to climate model simulations.

2. Applied Knowledge and Understanding
   Through practical sessions, students will gain hands-on experience in handling, visualizing, and analyzing geospatial data using Python. These sessions include exercises and assignments that support the application of statistical and computational techniques to real-world climate datasets. Students will apply tools for space-time data analysis, hypothesis testing, and pattern recognition in guided and autonomous activities.

3. Autonomy of Judgment
   Students are expected to demonstrate independent critical thinking through the development of a final individual project. This project requires selecting appropriate methods for analyzing geospatial data, integrating course concepts with techniques learned elsewhere in the master's program. The final presentation will evaluate students' ability to make informed decisions when designing and interpreting geospatial analyses.

4. Communication Skills
   Students will practice communicating technical content effectively through the presentation and discussion of their final projects. This oral examination emphasizes the ability to explain methodological choices, interpret results, and engage in discussion about data analysis problems.

5. Ability to Learn
   The course encourages self-directed learning through coding assignments and project work. By engaging with open-source tools and real data, students develop the capacity to extend their skills beyond the classroom.

## Contents

Module 1: Introduction to geospatial data

Module 2: Observational data in climate sciences

Module 3: Climate models

Module 4: Analysis of climate data

Module 5: The challenges of climate change

## Detailed program

The frontal lessons (2 hours per module) will present some background on the field of application, with specific attention to the relation between the data and the system that generated them, providing the theoretical tools for their management.

The practical sessions (3 hours per module) will provide the software tools for geospatial data handling, visualization and analysis. Python will be used for examples shown by the teacher and for students individual or group exercises. Small assignments are foreseen, due by the last week of classes (a malus of 2/30 will be applied for every assignmnet not delivered on time).

Module 1 will introduce the topic of geospatial data, including data types, and basic concepts related to cartography and Geographic Information Systems.

In Modules 2-4 examples and applications will be drawn from the domain of climate science. Different geospatial data types will be presented, including from observations of the physical world (M2) and from computer model simulations (M3), each characterized by different features and challenges. Integrated data analysis applications, ranging from simple hypothesis testing to space-time pattern recognition, will be introduced (M4, M5). Correction of the assignments will be carried out in Module 5.

## Prerequisites

Basic knowledge of Python.

## Teaching methods

5 two-hour lectures (delivered didactics, in person)
5 three-hours laboratory sessions (interactive teaching, in person)

## Assessment methods

Oral exam: 50% presentation and discussion of a final individual project, 50% topics and assignments from the course.

The discussion of practical examples and assigments (by then reviewed during the last lesson) aims at verifying the understanding that students have of specific passages for the solution of data analysis and visualization problems.

The presentation and discussion of a final individual project aims at testing the students' ability to autonomously develop a data analysis application appropriate for the topics of the course, by applying both methods presented in class and techniques acquired elsewhere with the master program in data science.

There are no mid-term tests, but failing to deliver assignments in time (last class of this module) will cause a malus to the final score (see details in section "Detailed program").

## Textbooks and Reading Materials

Teacher slides; links to scientific papers and webpages. Distributed via elearning.

## Semester

Second semester

## Teaching language

English.

## Sustainable Development Goals

CLIMATE ACTION