UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Green Computing

2526-1-F1802Q108

Aims

(DdD 1) Knowledge and understanding
By the end of the course, the student will be able to:

- Describe the fundamental principles of green computing, including the ethical, environmental, and economic motivations behind sustainability in the field of computer science.
- Demonstrate knowledge of key data science and artificial intelligence techniques aimed at energy efficiency and sustainability.

(DdD 2) Applying knowledge and understanding
By the end of the course, the student will be able to:

- Conduct life cycle assessments (LCA) of computing resources, identifying environmental impacts and possible optimizations.

(DdD 3) Making judgements
Throughout the course, the student will develop the ability to:

- Critically evaluate existing computing solutions in terms of environmental impact and propose data-driven strategies for improvement.
- Write reports or short technical essays expressing well-founded judgements on the trade-offs between performance and sustainability.

(DdD 4) Communication skills
Through course activities, the student will be able to:

- Present sustainability-focused projects or analyses within the ICT domain.

(DdD 5) Learning skills

By the end of the course, the student will have developed the ability to:

- Continue studying independently, deepening their understanding of advanced and interdisciplinary topics related to the environmental impact of computing.

Contents

The course consists of the following modules:

Module 1 - Overview of Sustainability and Impact of Computing
Module 2 - Energy efficient architectures, computing, and software engineering
Module 3 - Data Science, AI and sustainability

Detailed program

Module 1 - Overview of Sustainability and Impact of Computing

Introduction to Green Computing
• Definition and significance of green computing.
• Historical context and evolution.
• Key drivers and stakeholders in green computing.

Environmental Impact of Computing
• The greenhouse effect
• Energy consumption in computing
• What is AI and why it needs so much energy
• Basics of Blockchains
• Estimating carbon emissions
• Carbon footprint of data centers

Module 2 - Energy efficient oriented architectures, computing, and software engineering

Energy-Efficient Systems
• Principles of energy-efficient computing.
• Energy efficient hardware
• Energy efficient architectures
• Networks, 5G, 6G
• Flow analysis and predictive analytics for energy consumption
• Programming language energy consumption
• Energy-efficient algorithms
• Sustainable software development practices.
• Lifecycle Assessment of Computing Resources

Green Computing Metrics and Standards
• Metrics for measuring energy efficiency and sustainability.
• Tools for monitoring and reporting sustainability metrics.

Module 3 - Data Science, AI and Sustainability

Data Science and Sustainability
• Environmental impact of Big Data and AI.
• Traditional vs ML pipelines
• Algorithmic improvement
• Transfer Learning
• Knowledge Distillation
• Pruning
• Research trends in ML and green computing
• Neuromorphic Computing
• Reservoir Computing

Elements of AI for Green
Case Studies

Prerequisites

- Basic knowledge of computer science and data science.
- Understanding of basic concepts in statistics and machine learning.

Teaching form

The course comprises

- classroom lectures (DE 30 hours)
- interactive exercises in the classroom (DI 16 hours)

The course will be delivered in English

Textbook and teaching resource

Lecture notes, slide decks and articles provided by the lecturer.

Semester

Second year, Second semester

Assessment method

The exam consists of a written test (worth 20/30) and the completion of a project (worth 10/30).
The project typically involves data analysis and is carried out on a topic agreed upon with the instructors. It must be

completed individually.

The written test consists of open-ended questions and problems.
During the exam, books and notes can be consulted, and the use of a calculator is allowed.
There are no midterm exams.

Evaluation criteria:

Open Questions

- Understanding of Concepts: The ability to clearly explain the key concepts and theories related to the course material.
- Clarity and Coherence: The clarity, coherence, and organization of the responses.
- Relevance: The relevance and accuracy of the information presented in relation to the questions asked.

Analytical Solutions of Problems

- Accuracy: Correctness of the mathematical computations and solutions.
- Methodology: The appropriateness and correctness of the methods and approaches used to solve the problems.
- Clarity of Work: Clear presentation of the solutions, including all steps and justifications.

Project

- Originality
- Appropriateness of analysis techniques
- Interpretation of results and communication

Office hours

Appointment to be agreed by email.

Sustainable Development Goals

INDUSTRY, INNOVATION AND INFRASTRUCTURE | SUSTAINABLE CITIES AND COMMUNITIES | RESPONSIBLE CONSUMPTION AND PRODUCTION | CLIMATE ACTION