UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Intelligent Monitoring and Control Systems

2627-2-F9103Q044

Aims

The course presents artificial intelligence techniques for designing, training and effectively deploying intelligent systems for a wide range of industrial applications. After the description of standards and certifications of the legislation in industrial monitoring, design techniques for intelligent systems are presented, ranging from the collection of training data to the main learning methods. The course primarily focuses on image analysis, with occasional reference to time series data. The course also presents a number of use cases, tools and environments for their implementation.

Contents

The course includes both theoretical and practical sessions. The theoretical part presents the current trends for deploying intelligent monitoring systems, the relevant tasks for industrial scenarios and the main techniques used to optimize AI-based systems. The practical part equips students with the skills to analyze, design, and solve real-world problems.

Detailed program

- Legislation in the field of industrial monitoring: standards and certifications;
- Description of intelligent systems for industrial automation, robotics, power distribution grids, automotive, and transport systems;
- Artificial intelligence: current trends, applications, and major challenges;
- Artificial Intelligence for industrial processes;
- Data augmentation and transfer learning techniques;
- Explainable methods for industrial applications;

- Detection and segmentation;
- Defect analysis of products and production lines and anomaly detection;
- Predictive maintenance for industrial components;
- Self-supervised Learning (SSL) for intelligent systems;
- Attention networks and memory for anomaly detection;
- Continual learning for control and optimization;
- Federated learning and graph-based methods for control systems;
- Unimodal and multimodal learning, and information fusion;
- Optimization and memory efficiency for edge computing;
- Generative modeling for control systems and industrial scenarios;
- Image quality assessment (IQA) techniques.

A detailed list of topics of each lesson is presented and regularly updated on the course site.

Prerequisites

The student should have basic knowledge of computer programming and algorithms, as well as mathematics, notions of probability theory and statistics, and linear algebra. It is also advisable to be familiar with basic concepts in artificial intelligence, machine learning, image and signal processing, and pattern recognition.

Teaching form

The course consists of 8 four-hour lectures conducted in-person and 12 two-hour lab activities conducted interactively in-person. The exercises will allow students to experiment with the techniques introduced in class in various operational scenarios and to develop critical judgment.

Textbook and teaching resource

- Simon J. D. Prince, "Understanding Deep Learning", MIT Press, 2023;
- Kevin P. Murphy, “Probabilistic Machine Learning: Advanced Topics”, MIT Press, 2023;
- Jeremy Howard, Sylvain Gugger, “Deep Learning for Coders with fastai and PyTorch”, O'Reilly Media, Inc., 2020;
- Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.

Online resources and handouts are available throughout the lectures on the official course website.

Semester

First semester.

Assessment method

The exam consists of developing a small project focusing on one or more topics presented in the course. Students are asked to present and discuss their project, and answer a few questions about the topics addressed in class. The presentation should focus on the selected task, the methodology used to solve it, and the achieved results. Students are also expected to address, in a critical fashion, all the issues dealt with during its development. The mark is expressed in thirtieths.

Office hours

Via appointment by email.

Sustainable Development Goals

QUALITY EDUCATION