UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Supervised Learning

2526-1-F9103Q045-F9103Q04501

Aims

The aim of the course is to develop the skills for solving supervised learning problems.

Knowledge and Understanding
The student will acquire fundamental knowledge of theoretical and methodological principles related to supervised learning models. Both traditional paradigms and newer techniques based on deep learning and machine learning will be explored.

Applying knowledge and understanding
The student will be able to design and implement supervised learning models, using established software tools and libraries. He/she will also be able to apply these solutions to practical cases in different application domains.

Making judgments
The student will develop the ability to critically analyze methodological and design choices (e.g., algorithms, architectures, preprocessing and understanding techniques) and to evaluate the performance of the adopted solutions in terms of correctness, efficiency and effectiveness with respect to the objectives of the problem.

Communication skills
The student will be able to present in a clear, rigorous and structured manner the techniques and models used, the results obtained and the implications of design choices, including through visualizations and technical reports, using language appropriate to the academic and professional context.

Learning skills
The course will provide the necessary notions to enable the student to independently explore advanced supervised learning techniques, including the latest developments in deep learning, while fostering continuous updating of their skills in a rapidly evolving field.

Contents

In this course we will introduce and develop different machine learning algorithms for different types of data (images, videos, signals, texts, etc.) in different domains.
Course contents:

- Classification and regression frameworks: experiment definition, dataset split, metrics, augmentation, etc.
- Machine learning algorithms design and evaluation for classification and recognition tasks in the image domain such as consumer photos, fashion, medical images, etc.: image classification, image captioning, object detection, face recognition, image segmentation, quality control, etc.
- Machine learning algorithms design and evaluation for classification and recognition tasks in the signal domain such as audio, ecg: identity recognition, activity recognition, etc.
- Machine learning algorithms design and evaluation for regression tasks in different domains and applications such as: quality assessment, forecast, etc.

Detailed program

In detail the topics addressed are:

- Formulation of the learning process, popular learning algorithms (LDA, Decision Trees, NN, k-NN, SVM), evaluation and comparison
- Classification and regression frameworks: experiment definition, dataset split, metrics, augmentation, etc.
- Ensemble methods: Boosting, Bagging, Random Tree ensembles, Stacking
- Object detection with local descriptors: SIFT and BoW
- Viola-Jones Object detection Framework
- Convolutional Neural Networks (CNNs): convolution, training, famous architectures, transfer learning
- Recurrent and Recursive Neural Networks (RNNs): computational graph, training, gated RNNs (LSTM and GRU)
- Neural object detection: two-stage detection (R-CNN, fast R-CNN, faster R-CNN) and one-stage detection (YOLO)
- Transformers
- Self-supervised Learning

Prerequisites

Basic programming skills.
Basic knowledge in statistics and mathematics.

Teaching form

The course will be composed of frontal/theoretical classes concerning the methods and interactive practical classes concerning the case studies and applications using Matlab and/or Python.
The two parts will be based both on delivery mode and interactive mode.

Textbook and teaching resource

Slides, articles, and notes given by the professor in addition to the textbooxs:

- Hastie T., Tibshirani R., Friedman J. (2021). The Elements of Statistical Learning (2nd edition). Springer Verlag.
- Simon J.D. Prince (2023). Understanding Deep Learning. MIT Press.

Semester

Second.

Assessment method

The exam consists of a project, where students divided into small groups must design, implement and write a report about the chosen supervised learning task, and its oral presentation during which theoretical contents of the course can also be verified.

Office hours

After the class or agreed by email.

Sustainable Development Goals

QUALITY EDUCATION