

UNIVERSITÀ DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Numerical Mathematics For Machine Learning

2122-1-F4001Q110

Aims

In line with the educational objectives of the Master Degree in Mathematics, the course aims to provide the knowledge of the mathematical and numerical methodologies and (available) theories underlying some machine learning techniques.

Contents

- Mathematical Foundations of "General" Regression Problems
-
- ___
- •

Detailed program

Mathematical Foundations of "General" Regression Problems

- · Review of probability basics;
- Linear regression. Model assessment and selection: Empirical Minimization, Hypothesis Space, Bias-Variance Tradeoff;

Neural Networks
 Motivation and Definition. Mathematical Representation (Neurons, Artificial Neural Networks, Artificial Feedforward Neural Networks) Approximation properties, Universal Approximation, Regularity classes, theory-to-practice Generative Adversarial Network
Neural Network Learning and Training
 Neural Network Learning: Motivation, Regression/Classification; Numerical Optimization: Loss functions, back propagation; Gradient Descent methods, Stochastic gradient descent methods, accelerated gradient methods, second order methods, constrained optimization and regularization (L2, L1, sparse); Going Deep: Deep Learning. Pros and Cons. Regularization, Convolutional Neural Networks.
Prerequisites
Basic courses of the Laurea Triennale.
Teaching form
Lectures (face to face) (8 CFU)

Textbook and teaching resource

The teaching material will be made available by the instructors during the course.

• Reproducing Kernel Hilbert Spaces (RKHS), Regularization, Bayesian Interpretation.

2 nd semester
Assessment method
The evaluation of the course has two parts:
1- the development of a small project
2- an oral exam.
Mark is out of thirty.
The oral exam will evaluate the knowledge and understanding of the results and rigorous proofs developed in the course and the capacity to comprehend how the algorithms work.
There will be 5 exam sessions (in June, July, September, January, February).
Office hours
By appointment

Semester