SYLLABUS DEL CORSO

Matematica Numerica per il 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
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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;

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

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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.

Semester

2nd 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. ⎯⎯⎯⎯⎯

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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