MICRO-570 **Advanced machine learning**

Cursus	Sem.	Type
Financial engineering	MA2, MA4	Opt.
Mechanical engineering	MA2, MA4	Opt.
Microtechnics	MA2, MA4	Opt.
Quantum Science and Engineering	MA2, MA4	Opt.
Robotics, Control and Intelligent Systems		Opt.
Robotics	MA2, MA4	Opt.
Systems Engineering minor	E	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Oral
Workload	120h
Weeks	14
Hours	**5 weekly**
Lecture	3 weekly
Exercises	.5 weekly
Project	.5 weekly
Number of positions	

Remark

Pas donné en 2023-24. Cours donné tous les deux ans.

Summary

This course will present some of the core advanced methods in the field for structure discovery, classification and non-linear regression. This is an advanced class in Machine Learning; hence, students are expected to have some background in the field.

Content

- Introduction to the major mathematical principles of Machine Learning
- Structure Discovery: spectral and kernel methods, kernel PCA.CCA, kernel K-means, Spectral Clustering, Manifold Learning, Support Vector Clustering
- Advanced Classification and Nonlinear Regression Methods: nu-SVM/SVR, Relevance Vector Machine, Transductive SVM, Gaussian Processes
- Stochastic Modeling: Reinforcement Learning and Gradient Methods, Hidden Markov Models

Keywords

Machine learning, statistics

Learning Prerequisites

Required courses

Probability & Statistics, Linear Algebra

Recommended courses

Machine Learning, Pattern Recognition

Important concepts to start the course

Linear Algebra: Eigenvalue and singular value decomposition
Statistics: Definitions of probability density function, marginal, likelihood, covariance, correlation
Optimization: Lagrange multipliers, gradient descent, local and global optima

Learning Outcomes

By the end of the course, the student must be able to:

- Choose an appropriate method
- Apply the method properly

Transversal skills

- Use a work methodology appropriate to the task.
- Write a scientific or technical report.
- Make an oral presentation.

Teaching methods

The format of the course is that of a Split-Class: The theory of the course is presented through a video which students must watch prior to class. One hour of the course is allocated for this. This is following by an ex-cathedra lecture that consists of a one-hour interactive lecture session. The interactive lecture takes place on campus, but students who need it can also attend through zoom. An electronic polling system is used to engage students during the lecture.
A two-hour exercise sessions is given each week after the lecture. 4 of the weeks of the course are dedicated to computer-based practical sessions, during which students learn to use the algorithms seen in class for processing real data.
Exercise sessions and computer-based practice session are done on site only. No remote connection possible.

Expected student activities

Students are expected to watch the videos prior to the interactive lecture, as the interactive lecture will not repeat the video but go in more depth in the concepts presented in the videos.
Students are expected to attend the exercise sessions and the computer-based practice sessions. They should revise the class notes prior to going to practical session to be on top of the the theoretical material prior to applying it.
Students who are no longer up to date with the pre-requisites should work on these in parralel to taking the class.

Assessment methods

40% of the grade based on personal work during semester (project or in-class critical reading of a paper) and the residual 60% based on oral exam

Supervision

Office hours	No
Assistants	Yes
Forum	Yes

Resources

Virtual desktop infrastructure (VDI)

No

Ressources en bibliothèque

- Machine Learning Technique / Billard

Notes/Handbook

Machine Learning Techniques, available at the Librairie Polytechnique. To be purchased before the class starts.

Moodle Link

- https://go.epfl.ch/MICRO-570

Videos

- https://tube.switch.ch/channels/7e86d16d

Prerequisite for

Students must be knowledgeable about machine learning and have taken a course in the area either at EPFL or elsewhere. Relevant courses at EPFL are:
Applied Machine Learning - MICRO-455
Pattern Classification and Machine Learning: CS-433
Data Analysis and Model Classification - EE-516