EE-613

Machine Learning for Engineers

Calinon Sylvain, Canévet Olivier, Odobez Jean-Marc, Villamizar Michael

Cursus	Sem.	Type
Civil & Environmental Engineering		Opt.
Electrical Engineering		Opt.
Microsystems and Microelectronics		Opt.
Robotics, Control and Intelligent Systems		Opt.

Language of teaching	English
Credits	4
Session	
Exam	Multiple
Workload	120h
Hours	**56**
Lecture	28
Practical work	28
Number of positions	**50**

Frequency

Every 2 years

Remark

Next time: Fall 2025

Summary

The objective of this course is to give an overview of machine learning techniques used for real-world applications, and to teach how to implement and use them in practice. Laboratories will be done in python using jupyter notebooks.

Content

Fundamentals

- Recalls in probability and information theory
- Notion of learning, cross validation and performance evaluation
- Optimization (gradient, Newton method, stochastic gradient, etc.)

Regression

- Least squares (Tikhonov regularization)
- Weighted least squares
- Iteratively reweighted least squares (IRLS)
- Tensor regression
- Gaussian mixture regression (GMR)
- Gaussian process regression (GPR)

Generative models

- Bayesian networks,
- Directed / non-directed models, conditional independence, Naive Bayes
- k-Means, Gaussian mixture model (GMM), Expectation-Maximization (EM)
- PCA and probabilistic PCA
- Hidden Markov model (HMM)

Discriminative models

- Logistic regression
- Decision trees, random forest
- Support vector machine (SVM) and Kernelization (PCA, etc.)

Deep learning
- Perceptron, Multi-Layer-Perceptron (MLP)
- Convolutional neural network (CNNs)

Meta-algorithms
- Ensemble methods
- Bagging
- Boosting

Keywords

Machine learning, pattern recognition, regression.

Learning Prerequisites

Required courses

- Undergraduate knowledge of probabilities, linear algebra, and statistics
- Python programming

Learning Outcomes

By the end of the course, the student must be able to:
- Select appropriately in practice standard learning-based inference techniques for regression, classification and density modeling.
- Understand the core principles of machine learning and of the different concepts and algorithms behind the different learning methodologies.
- Select appropriately in practice standard learning-based inference techniques for regression, classification and density modeling, including understanding the impact of different parameters

Assessment methods

Multiple.

Resources

Bibliography

Pattern Recognition and Machine Learning,
C. Bishop,
Springer, 2008

Ressources en bibliothèque

- Pattern Recognition and Machine Learning / Bishop

Moodle Link

- https://go.epfl.ch/EE-613