

EE-613

**Machine Learning for Engineers**

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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
<b>Hours</b>	<b>56</b>
Lecture	28
Practical work	28
<b>Number of positions</b>	<b>50</b>

**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>