

EE-411

**Fundamentals of inference and learning**

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Cursus	Sem.	Type
Electrical and Electronical Engineering	MA1, MA3	Obl.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	During the semester
Workload	120h
Weeks	14
<b>Hours</b>	<b>4 weekly</b>
Lecture	2 weekly
Project	2 weekly
<b>Number of positions</b>	

**Summary**

This is an introductory course in the theory of statistics, inference, and machine learning, with an emphasis on theoretical understanding & practical exercises. The course will combine, and alternate, between mathematical theoretical foundations and practical computational aspects in python.

**Content**

The topics will be chosen from the following basic outline:

- Statistical inference: Estimators, Bias-Variance, Consistency, Efficiency, Maximum likelihood, Fisher Information.
- Bayesian inference, Priors, A posteriori estimation, Expectation-Minimization.
- Supervised learning : Linear Regression, Ridge, Lasso, Sparse problems, high-dimensional Data, Kernel methods, Boosting, Bagging. K-NN, Support Vector Machines, logistic regression, Optimal Margin Classifier
- Statistical learning theory: VC Bounds and Uniform convergence, Implicit regularisation, Double-descent
- Unsupervised learning : Mixture Models, PCA & Kernel PCA, k-means
- Deep learning: multi-layer nets, convnets, auto-encoder, Gradient-descent algorithms
- Basics of Generative models & Reinforcement learning

**Keywords**

Statistics, Supervised and unsupervised learning

**Learning Prerequisites****Required courses**

- \* Basic probability theory.
- \* Basic knowlegde of python programing
- \* Basic linear algebra, and calculus

**Recommended courses**

Probability and statistics.  
Advance Python  
Basic optimization

### Important concepts to start the course

Students should be familiar with basic concepts of probability theory, calculus and linear algebra, and be familiar with python.

### Learning Outcomes

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

- Formulate statistical models and apply them to statistical learning
- Apply machine learning technics to data science problems
- Solve concrete data science problems
- Explain and understand the fundamental principle of learning theory

### Assessment methods

- \* Homeworks during the lectures
- \* Final project,

### Resources

#### Moodle Link

- <https://go.epfl.ch/EE-411>

#### Videos

- <https://tube.switch.ch/channels/P21dFjFlzG>