

CIVIL-226

**Introduction to machine learning for engineers**

Alahi Alexandre

Cursus	Sem.	Type
Civil Engineering	BA4	Obl.
HES - GC	E	Obl.

Language of teaching	English
Credits	5
Session	Summer
Semester	Spring
Exam	During the semester
Workload	150h
Weeks	14
<b>Hours</b>	<b>5 weekly</b>
Courses	2 weekly
Exercises	3 weekly
<b>Number of positions</b>	

**Summary**

Machine learning is a sub-field of Artificial Intelligence that allows computers to learn from data, identify patterns and make predictions. As a fundamental building block of the Computational Thinking education at EPFL, Civil students will learn ML with civil case studies (summary generated by ML)

**Content**

This class will focus on the basics of Machine Learning. Students will code in Python.

**CONTENT**

The class will cover the following concepts:

**- Machine learning basics**

- Supervised vs Unsupervised
- Regression vs. Classification
- Underfitting vs Overfitting
- Bias vs. Variance
- Parametric vs Non-parametric approaches
- Discriminative vs Generative models
- Shallow vs Deep learning

**- Shallow supervised learning**

- Linear Regression
- Logistic Regression
- Naive Bayes
- Gaussian naive
- Trees
- Random forest
- Ensemble/bagging/boosting
- Support Vector Machine

**- Deep learning**

- Neural networks overview
- Type Layers
- Activation functions

- Backpropagation

#### - Unsupervised learning / dimensionality reduction

- SVD
- PCA
- Embeddings
- Autoencoders

#### - Unsupervised learning / clustering

- K-means
- Gaussian mixture
- DBSCAN

#### - Role of input

- Feature engineering
- Role of representation
- Handling different types of features
- Missing values
- Feature expansion

#### - Role of supervision

- Loss functions
- Multitask learning

#### - Role of optimization

- Stochastic/Gradient descent

#### - Recipe/tips for training

- Weight initialization
- Data augmentation
- Regularization techniques
- Transfer learning

#### - ML ethics

### Keywords

Machine learning, Computational Thinking, Artificial intelligence

### Learning Prerequisites

#### Required courses

CS-119(h)

Linear algebra

Basic programming skills (labs will use Python).

### Learning Outcomes

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

- Define the following basic machine learning problems: regression, classification, clustering, dimensionality reduction

- Explain the main differences between them
- Implement algorithms for these machine learning models
- Optimize the main trade-offs such as overfitting, and computational cost vs accuracy
- Implement machine learning methods for real-world problems, and rigorously evaluate their performance using cross-validation. Experience common pitfalls and how to overcome them.
- Finally, civil students will know the basics of Machine learning, and how they can use it in their fields of interest.

### Teaching methods

Lectures and lab exercises.

### Assessment methods

Lab homeworks: 10%

Final project: 40%

Final exam: 50%

### Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes

### Resources

#### Moodle Link

- <https://go.epfl.ch/CIVIL-226>