EE-452 **Network machine learning**

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| Cursus | Sem. | Type |
|---|---|---|
| Electrical and Electronical Engineering | MA2, MA4 | Opt. |

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| Language of teaching | English |
| Credits | 4 |
| Session | Summer |
| Semester | Spring |
| Exam | During the semester |
| Workload | 120h |
| Weeks | 14 |
| **Hours** | **4 weekly** |
| Courses | 2 weekly |
| Project | 2 weekly |
| **Number of positions** | |

## Summary

Fundamentals, methods, algorithms and applications of network machine learning

## Content

**Context**
In the last decade, our information society has mutated into a data society, where the volume of worldwide data doubles every 1.5 years. Out of this, an increasing amount of information is structured on networks of different forms. How to make sense of such tremendous volume of data? Developing effective techniques to extract meaningful information from large-scale and high-dimensional network datasets has become essential for the success of business, government and science.
**Objective**
The goal of this course is to provide a broad introduction to effective methods algorithms in data science, network analysis and network machine learning. A major effort will be given to show that existing data analysis techniques can be defined and enhanced on graphs. Graphs can encode complex structures like cerebral connection, stock exchange, and social network. Strong mathematical tools have been developed based on statistics, or linear and non-linear graph spectral harmonic analysis to advance the standard data analysis algorithms. At the same time, modern machine learning tools such as neural networks have been adapted to process data defined on network structures. The objective of the class is to develop fundamentals and review algorithms that permit to develop modern network data analysis methods. The main topics of the course are networks, network science, network epidemics, unsupervised and supervised learning on graphs and networks, visualization, sparse representation, multi-resolution analysis, neural networks.
**Structure**
The course is organized into two parts: lectures (2 hours) and lab assignements and projects (1 hour). The essential objective of the exercises and lab assignements is to apply the theory on real-world cases. The objective of the projects is to study practical network machine learning cases, and develop effective solutions based on tools studied in the class.
Evaluation
Evaluation will be conducted on a continuous basis: homeworks and coding assignments.

## Keywords

graph representation learning, machine learning, network science

## Learning Prerequisites

### Required courses

Fundamentals of Machine Learning, or equivalent
Signal Processing, or equivalent
Introduction to Statistics, or equivalent

Python programming

## Learning Outcomes

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

- Apply modern machine learning techniques to network data
- Analyze network properties, network data distributions, and properties of the most common network machine learning algorithms
- Propose solutions for network data analysis problems

## Transversal skills

- Use a work methodology appropriate to the task.
- Give feedback (critique) in an appropriate fashion.
- Communicate effectively, being understood, including across different languages and cultures.

## Resources

### Bibliography

Network Science, Albert-László Barabási, Cambridge University Press
Graph Representation Learning, William L. Hamilton, Morgan & Claypool

### Ressources en bibliothèque

- Graph Representation Learning / Hamilton
- Network Science / Barabási

### Moodle Link

- https://go.epfl.ch/EE-452