Summary
We discuss a set of topics that are important for the understanding of modern data science but that are typically not taught in an introductory ML course. In particular we discuss fundamental ideas and techniques that come from probability, information theory as well as signal processing.

Content
This class presents basic concepts of Information Theory and Signal Processing and their relevance to emerging problems in Data Science and Machine Learning.
A tentative list of topics covered is:
1. Information Measures
2. Signal Representations
3. Detection and Estimation
4. Multi-arm Bandits
5. Distribution Estimation, Property Testing, and Property Estimation
6. Exponential Families
7. Compression and Dimensionality Reduction
8. Information Measures and Generalization Error

Keywords
Information Theory, Signal Processing, Statistical Signal Processing, Machine Learning, Data Science.

Learning Prerequisites
Required courses
COM-300 Modèles stochastiques pour les communications

Recommended courses
Statistics

Important concepts to start the course
Solid understanding of linear algebra and probability as well as real and complex analysis.

Learning Outcomes
By the end of the course, the student must be able to:
• Formulate the fundamental concepts of signal processing such as basis representations and sampling
• Formulate the fundamental concepts of information theory such as entropy and mutual information
• Analyze problems in statistical settings using fundamental bounds from information theory
• Formulate problems using robust and universal techniques

Teaching methods
Ex cathedra lectures, exercises, and small projects.

Expected student activities
Follow lectures; independent work on problems (homework and small projects).

Assessment methods
Written final exam during the exam session.
Homework Problem Sets during the semester.
10% homework, 30% midterm, 60% final exam; (if for some reason the course has to be given over zoom then we will skip the midterm and the course will be evaluated by 10% homework and 90% final)

Resources
Bibliography

Ressources en bibliothèque
• Elements of Information Theory / Cover
• Lecture Notes for Statistics 311/Electrical Engineering 377 / Duchi

Notes/Handbook
Lectures notes will be available on the course web page.

Moodle Link
• https://go.epfl.ch/COM-406