MATH-415

Probabilistic models of modern AI

Hongler Clément

Cursus	Sem.	Type
Ing.-math	MA2, MA4	Opt.
Mathématicien	MA2	Opt.
Minor in statistics	E	Opt.
Statistics	MA2, MA4	Opt.

Language of teaching	English
Credits	5
Session	Summer
Semester	Spring
Exam	Written
Workload	150h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

This is a course where we will cover various topics related to recent progress in AI. Emphasis will be on understanding conceptual and mathematical principles, and on relating those to experimental data for machine learning models used in practice.

Content

- Basics: Classification vs Regression, Information Theory
- Gaussian Models and Kernel Methods
- Neural Network Optimization and Neural Tangent Kernel
- Compression and AI
- Loss Functions and Scoring Rules
- LLMs: Basic Models and Transformers
- LLMs: Measures and Sampling, Arrows of Time
- LLMs: Fine-Tuning and Reinforcement Learning
- Causality
- Diffusion Models: Diffusion Processes and Basics
- Diffusion Models: Various Formulations
- Diffusion Models: Information-Theoretic Views
- Other Models: Normalizing Flows, GANs
- Capability Measures

Keywords

Neural Networks, LLMs, Diffusion Models

Learning Prerequisites

Required courses

Beyond the standard bachelor classes, nothing is a pre-requisite, however some familiarity with probability (in an applied sense), coding, and machine learning ideas should greatly help.

Assessment methods

Written

Resources

Moodle Link

- https://go.epfl.ch/MATH-415