CS-526

Learning theory

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Cursus	Sem.	Type
Computer and Communication Sciences		Opt.
Computer science	MA2, MA4	Opt.
Cybersecurity	MA2, MA4	Opt.
Data Science	MA2, MA4	Opt.
SC master EPFL	MA2, MA4	Opt.
Statistics	MA2, MA4	Opt.

Language of teaching	English
Credits	6
Session	Summer
Semester	Spring
Exam	Written
Workload	180h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

Machine learning and data analysis are becoming increasingly central in many sciences and applications. This course concentrates on the theoretical underpinnings of machine learning.

Content

- Basics : statistical learning framework, Probably Approximately Correct (PAC) learning, learning with a finite number of classes, Vapnik-Chervonenkis (VC).
- Bias-variance tradeoff and modern double descent phenomena.
- Neural Nets : representation power of neural nets.
- Stochastic gradient descent, modern aspects: mean field approach, neural tangent kernel.
- Matrix factorization, Tensor decompositions and factorization, Jenrich's tehorem, Alternating least squares, Tucker decompositions.
- Applications: e.g. Learning mixture models, topic modeling.

Learning Prerequisites

Recommended courses

- Analysis I, II, III
- Linear Algebra
- Machine learning
- Probability
- Algorithms (CS-250)

Learning Outcomes

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

- Explain the framework of PAC learning
- Explain the importance basic concepts such as VC dimension, bias-variance tradeoff and double descent
- Describe basic facts about representation of functions by neural networks
- Describe recent results on specific topics e.g., matrix and tensor factorization, learning mixture models

Teaching methods

- Lectures
- Exercises

Expected student activities

- Attend lectures
- Attend exercises sessions and do the homework

Assessment methods

Final exam and graded homeworks

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes
Others	Course website