MATH-522

Empirical processes

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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

We learn how to control the nonasymptotic and random behavior of collections of estimators, when indexed by classes of functions/sets. Examples range from prototypical estimators used by statisticians, to nonparametric models used in machine learning.

Content

This course provides central results and methods to understand and derive generalization guarantees of modern learning algorithms. The main topics are:

- Basic probabilistic inequalities: methods and results.
- Symmetrization and chaining methods.
- How to measure the complexity of classes of functions: from combinatorial and entropic considerations to random measures.
- Concentration-of-measure phenomenon: maximal inequalities and concentration inequalities of suprema of empirical processes.
- Recent advances in empirical process theory applied to statistical learning.

The exposed methods and results will be illustrated with statistical applications related to machine learning (especially classification and regression methods) and hypothesis testing throughout the lecture and exercise sessions.

Keywords

Empirical processes, concentration of measure, probabilistic inequalities, generalization properties, learning algorthims.

Learning Prerequisites

Important concepts to start the course

Previous courseworks in analysis, mathematical statistics and probability are highly required, with interests in statistical learning theory and algorithms.

Learning Outcomes

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

- Formulate the fundamental framework related to empirical processes
- Manipulate probabilistic inequalities to empirical estimators
- Describe the concept of concentration-of-measure phenomenon for empirical processes

- Apply concentration inequalities to derive the performance of statistical learning procedures

Teaching methods

The semester will be composed of:

- Blackboard lectures.
- Exercise sessions.

Expected student activities

Student are expected to:

- Attend to all lectures.
- Participate to exercise weekly sessions.

Assessment methods

midterm and final exams

Supervision

Office hours	No
Assistant.e.s	Yes
Forum	No

Resources

Bibliography

- Stéphane Boucheron, Gábor Lugosi, and Pascal Massart, *Concentration Inequalities: A Nonasymptotic Theory of Independence*. Oxford University Press, Oxford Academic, 2013.

- Víctor H. Peña , Evarist Giné, *Decoupling. From Dependence to Independence*. Probability and Its Applications (PIA), Springer New York, 1999.

- Martin J. Wainwright. *High-Dimensional Statistics, A Non-Asymptotic Viewpoint.* Cambridge University Press, 2019.

Ressources en bibliothèque

- Find the references at the Library

Notes/Handbook

Yes

Moodle Link

- https://go.epfl.ch/MATH-522