MATH-441

Robust and nonparametric statistics

Cursus	Sem.	Type
Data Science	MA2, MA4	Opt.
Ing.-math	MA2, MA4	Opt.
Mathématicien	MA2	Opt.

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

Remark

Cours donné en alternance tous les deux ans (pas donné en 2021-22)

Summary

In the decades from 1930 to 1950, many rank-based statistics were introduced. These methods were received with much interest, because they worked under weak conditions. Starting in the late 1950, a theory of robustness was added. The course gives an overview of these two approaches to data analysis.

Content

I. Robust Statistics

- Global and local robustness indicators: Breakdown point, influence function
- Hampel's lemma
- Huber's theory: M-estimators, L-estimators
- Robust tests
- Robust regression

II. Linear Rank Tests

- Test of Mann-Whitney-Wilcoxon and general linear rank tests: asymptotic theory, R-estimators
- Rank correlations
- U-statistics
- Comparison of tests: Pitman efficacy
- Permutation tests

III. Estimation of smooth functions

- Curve fitting: polynomial regression, splines
- Smoothing: non parametric estimation, degree of smoothness, bias vs. variance, penalization
- Kernel estimators: definition, properties
- Smoothing splines
- Local regression
- Wavelets

Learning Prerequisites

Required courses

Introduction to Probability, Introduction to Statistics

Learning Outcomes

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

- Expound the content of the course.
- Apply the statistical methods explained in the course.
- Sketch the proofs of the theoretical results given in the course.
- Choose the appropriate robust or non parametric methods for a given data analysis problem.
- Differentiate between robust and non-parametric methods.
- Generalize the tools treated in the course to other problems.
- Apply spline and kernel smoothers.
- Apply M-estimatiors in a variety of situations.

Transversal skills

- Assess one's own level of skill acquisition, and plan their on-going learning goals.
- Manage priorities.

Teaching methods

Ex cathedra lecture and exercises in the classroom

Expected student activities

Do all the exercices. Prepare each week for the course. Participate actively in the course.

Assessment methods

Oral exam.
Dans le cas de l'art. 3 al. 5 du Règlement de section, l'enseignant décide de la forme de l'examen qu'il communique aux étudiants concernés.

Resources

Bibliography

Introduction to the theory of nonparametric statistics by R.H. Randles and D.A. Wolfe, Wiley.
All of nonparametric statistics by L. Wasserman, Springer.
Robust Statistics: The approach based on influence functions by F.R. Hampel, E.M. Ronchetti, P.J. Rousseeuw, W.A. Stahel, Wiley.
Robust Statistics by P.J. Huber, Wiley (second edition).
Robust Statistics: Theory and Methods by D.R. Martin, M. Salibian-Barrera, R.A. Maronna, V.J. Yohai, Wiley.

Ressources en bibliothèque

- Introduction to the theory of nonparametric statistics / Randles & Wolfe
- Robust Statistics / Hampel & al.
- Robust Statistics / Martin & al.
- All of nonparametric statistics / Wasserman