

MATH-524

Nonparametric estimation and inference

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

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|----------------------------|-----------------|
| 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

Nonparametric models are used to identify a wide range of relationships within data. This course gives a graduate-level overview of nonparametric statistical estimation and inference theory.

Content

- Kernel smoothing methods (Stone's theorem, kernel density estimation and regression and local polynomial kernel estimation)
- Estimation consistency, rates and minimaxity (Le Cam, Fano, basics of information theory)
- Model selection (bias-variance tradeoff, curse of dimensionality, VC dimension)
- Empirical processes (functional estimation, uniform law of large numbers)
- Regression and classification trees consistency
- K-nearest neighbours and SVM algorithmic consistency
- Universal consistency of Neural Networks

Keywords

Nonparametrics, inference, empirical process theory, machine learning, adaptive methods

Learning Prerequisites**Required courses**

Courses on basic probability and statistics (e.g., MATH-240, MATH-230) and a first course on linear regression (e.g., MATH-341, MATH-562). A basic understanding of any programming language (e.g. R, Python, Julia, Matlab)

Recommended courses

Statistical Inference (MA-562).

Important concepts to start the course

Basic statistics, probability and linear algebra

Learning Outcomes

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

- Assess / Evaluate properties of nonparametric estimation methods
- Interpret construction of complex statistical models
- Prove consistency and convergence results
- Choose appropriate estimation and inference methods

Transversal skills

- Demonstrate a capacity for creativity.
- Demonstrate the capacity for critical thinking
- Assess one's own level of skill acquisition, and plan their on-going learning goals.
- Use both general and domain specific IT resources and tools

Teaching methods

Board

Expected student activities

Attending lectures and exercise sessions; interacting in class.

Assessment methods

Final exam

Supervision

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|--------------|-----|
| Office hours | No |
| Assistants | Yes |
| Forum | Yes |

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

Hastie, Trevor, et al. *The elements of statistical learning: data mining, inference, and prediction*. Vol. 2. (2009)

Van der Vaart, Aad W. *Asymptotic statistics*. Vol. 3. Cambridge university press, 2000

Györfi, László, et al. *A distribution-free theory of nonparametric regression*. Vol. 1. (2002)

Wasserman, Larry. *All of nonparametric statistics* (2006)

Ressources en bibliothèque

- [Find the references at the Library](#)

Notes/Handbook

Will be shared on course Moodle.

Moodle Link

- <https://go.epfl.ch/MATH-524>