Study programme(s): Applied Mathematics – Data Science

Level: master studies

Course title: Statistics theory for learning and signal processing

Lecturer: Danijela Rajter-Ćirić

Status: elective

ECTS: 6

Requirements: Basics of linear algebra and probability

Learning objectives

- Understanding of a wide range of statistical metrics, methods, and analytical techniques for machine learning and signal processing

Learning outcomes

- Ability to select a suitable statistical method for a given research problem
- Ability to apply the taught statistical methods on a given research problem
- Ability to validate/assess, and give guarantees, for various machine learning/signal processing approaches based on the taught statistical metrics

Syllabus

Theoretical instruction

Estimation: Minimum variance unbiased estimation, Cramer-Rao lower bound, Maximum likelihood estimation, Bayesian estimation, Unbiasedness, Asymptotic efficiency, Asymptotic normality; Detection: Binary hypothesis testing, M-ary hypothesis testing, Neyman-Pearson optimal detection, Average error probability-optimal detection; Concentration inequalities: Markov, Chebyshev, Chernoff, Hoeffding, Efron-Stein; Large deviations: Cramer theorem, Gartner-Ellis theorem, Stein's lemma, Chernoff's lemma; Minimax theory: Le Cam's method, Fano's method; Risk minimization: Tsybakov's noise conditions, Surogate loss functions.

Practical instruction

Application examples in telecom, electric grid (smart grid), machine learning, sensor networks, etc.

Literature

Selected parts of the following books:

14. Larry Wasserman: All of Statistics: A Concise Course in Statistical Inference, Springer, 2014
15. Harry L. Van Trees: Detection, Estimation, and Modulation Theory, John Wiley, 2001.
16. Louis L. Scharf: Statistical Signal Processing: Detection, Estimation, and Time Series Analysis, Addison-Wesley, 1991
17. Amir Dembo, Ofer Zeitouni: Large Deviations Techniques and Applications, Springer, 2009

Weekly teaching load				Other: 0
Lectures: 2	Exercises: 3	Other forms of teaching: 0	Student research: 0	

Teaching methodology

Lectures; revisions of the material; active students' participation in problem solving; knowledge tests – colloquia; homeworks.

Grading (maximum number of points 100)

Pre-exam obligations	**points**	**Final exam**	**points**
Colloquia + Homeworks	30 (Colloquia) + 30 (Homeworks)	written exam	40