Study program: Artificial intelligence

Name of the subject: Statistical Theory for Learning and Signal Processing

Teacher(s): Dušan Jakovetić

Status of the subject: elective

Number of ECTS credits: 6

Conditions: none

Subject goal

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

Outcome of the subject

- 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

Subject content

Theory

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 learning

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

Literature

Selected parts of the following books:

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

Number of active teaching classes	**Theoretical teaching: 2**	**Practical teaching: 3**

Method of carrying out the teaching

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

Evaluation of knowledge (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
Colloquia	30	Written exam	40
Homeworks	30		