Study programme(s): Applied Mathematics – Data Science

Level: Master studies

Course title: Graphical Models and Probabilistic Inference

Lecturer: Dušan Jakovetić

Status: elective

ECTS: 5

Requirements: Basics of theory of probability

Learning objectives

- Understanding of theory and practical implementations of graphical models and Belief-Propagation (BP) algorithms for probabilistic inference
- Understanding advantages/disadvantages of various graphical models for a given real-world application
- Ability to apply graphical models and BP algorithms in MATLAB in real-world problems

Learning outcomes

- Ability and experience in modelling, graphical representation, design and analysis of BP algorithms in real-world probabilistic inference problems
- Ability to apply the concepts of probabilistic inference on research problems from a wide variety of application areas

Syllabus

Theoretical instruction

Graphical models for probabilistic systems modeling: directed graphical models - Bayesian Networks; undirected graphical models - Markov Random Fields; Factor Graphs.
Exact Inference: Efficient marginalization via message-passing Belief-Propagation algorithms; Sum-product algorithm; Max-product (Min-Sum) algorithm.
Approximate Inference: Loopy Belief-Propagation, Monte Carlo Methods.
Learning in Graphical Models: ML estimation, Expectation-Maximization algorithm

Practical instruction

Application examples in communication systems, image processing, statistical physics, electrical grid (smart grid), computational biology etc.; Implementation methods in MATLAB; Application of selected methods on real-world examples through the course project.

Literature

21. D. Koller and N. Friedman: Probabilistic Graphical Models, MIT Press, 2009
22. M. J. Wainwright and M. I. Jordan, Graphical models, exponential families, and variational inference, Foundations and Trends in Machine Learning, 2008.
23. C. Bishop: Pattern recognition and machine learning, Springer, 2006

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

Teaching methodology

Lectures; revisions of the material; active students' participation in problem solving; knowledge tests – colloquia; application of the taught material on real-world examples within the course project.

Grading (maximum number of points 100)

Pre-exam obligations		**points**	**Final exam**	**points**
Colloquia	Course project	70 = 30 (Colloquia) + 40 (Course project)	written exam	30