Study program: Artificial intelligence

Name of the subject: Graphical Models and Probabilistic Inference

Teacher(s): Miloš Savić, Miloš Radovanović

Status of the subject: elective

Number of ECTS credits: 5

Conditions: none

Subject goal

- 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

Outcome of the subject

- 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

Subject content

Theory

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 learning

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.
Expert from the industry will be included into the project assignment realization as an external tutor.

Literature

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

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

Method of carrying out the teaching

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

Evaluation of knowledge (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
Colloquia	30	Written exam	30
Course project	40		