Advanced Machine Learning

Course Workload		Assessment form (examination/ graded test/ ungraded test)
ECTS	Hours	
3	108	Exam

The course is aimed at studying the principles of operation of machine learning algorithms. As part of the course, you will get acquainted with the mathematical foundations of supervised learning algorithms, unsupervised learning algorithms, and deep learning algorithms.

Course structure:

1. Introduction to Machine Learning. Non-parametric Models. Linear Models.

1.1. Concept of machine learning. Examples of ML problems
1.2. Optimization problem. Supervised learning. CRISP-DM methodology
1.3. Validation techniques. Similarity-based classification and regression
1.4. One nearest neighbor. kNN and hyperparameter tuning. Generalized distance-based classifiers
1.5. Nonparametric regression. Prototype selection. Performance measures
1.6. Linear classification. Gradient descent.
1.7. Linear regression and matrix decomposition. Regularization

2. Support Vector Machine. Probabilistic Classifiers. Trees and Ensembles.

2.1. Linearly separable case. Linearly inseparable case
2.2. Kernel trick. Kernel selection and synthesis. Regularization for SVM
2.3. Bayesian classification. Non-parametric density recovery
2.4. Parametric density recovery. Logistic regression
2.5. Logical rules. Comprehension. Rules induction. Decision trees
2.6. Composition of algorithms. Boosting. AdaBoost and its theoretical properties
2.7. Random Algorithm synthesis. Random Forest. Stacking

3. Neural Networks

3.1. History of neural networks. Completeness problem of neural networks. Multilayer neural networks
3.2. Backpropagation. Modularity. Computational graph. DNN best practices
3.3. Advanced optimization
3.4. Convolutional neural networks
3.5. Recurrent neural networks

4. Clustering. Dimensionality reduction

4.1. EM algorithm. Clustering problem. EM-like clustering
4.2. Graph-based clustering. Density-based clustering. Hierarchical clustering
4.3. Dimensionality reduction. FE: PCA, Autoencoders, t-SNE
4.4. FS: Embedded methods, Wrappers, Filters