M096	Elective Year 3	**Machine Learning**	L	S	E	ECTS
			3	0	2	7

Course objectives. Course objectives are to familiarize students with theory and principles of machine learning and applications. Special emphasis will be given to supervised learning methods (classification and regression) and unsupervised learning methods (clustering).

Course prerequisites. Applied Mathematics for Computer Science

Syllabus.

Supervised Learning:

1. Introduction to the theory of machine learning.
2. Techniques of nonparametric learning. *K-nearest* neighbor method. Decision three.
3. Bayesian learning. Bayesian naive and optimal classifier.
4. Neural network: representation and learning.
5. Regression and classification. Linear regression. Locally weighted linear regression. Logistical regression and classification. Regularization.
6. Support Vector Machine (SVM): Hyperplane separation. Optimal marginal classification. Dual problem. Kernel method. Sequential minimal optimization.
7. Theory of statistical learning. Vapnik-Chervonenkis dimension.

Unsupervised Learning:

1. Introduction and motivation. Definitions. Different examples of applications
   Representative of the finite set from R in least squares (LS) sense and in least absolute deviations (LAD) sense. Representative of the finite set from R^2. Distance-like function in R^2. Centroid, median and geometrics median in plane. Representative of the finite set from R^n: centroid, median, geometrics median. Applications of Mahalanobis distance-like function. Representative of the data on unit circle.
2. Data clustering methods. K-means algorithm. EM (Expectation Maximization) algorithm. K-medoid method. Agglomerative clustering
3. Dimension reduction. Principal Component Analysis.
4. Appropriate number of clusters in a partition: Indexes.
5. Spectral clustering methods and theory of graphs.
6. Probabilistic and statistical aspects of data clustering

EXPECTED LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1.	To demonstrate knowledge and understanding which can serve as the foundation for developing and application of the original ideas.
2.	To apply knowledge, understanding and skills in a broad variety of problems in the field of machine learning.
3.	To integrate new knowledge to successfully solve programming problems in the IoT.
4.	To be able to present conclusions and findings to experts and laymen based on knowledge and experience.
5.	To apply the acquired skills onto further education in this field.

COUPLING OF THE EXPECTED LEARNING OUTCOMES, TEACHING PROCESS ORGANIZATION AND THE EVALUATION OF THE TEACHING OUTCOMES

TEACHING PROCESS ORGANIZATION	ECTS	LEARNING OUTCOMES **	STUDENT ACTIVITIES*	EVALUATION METHOD	SCORE	
					Min	max
Lecture attendance	1	1-5	Lecture attendance, discussion, team work and independent work on given tasks.	Attendance sheets, tracking activities	0	4
Written exam (preliminrx exam)	3	1-5	Prepairing for written exam.	Evaluation	25	48
Final exam	3	1-5	Repetition of the subject matter.	Oral exam	25	48
Total	7				50	100

Teaching methods and student assessment.

Lectures and exercises are illustrated by ready-made software packages. Exercises are partially auditory and partially laboratory, with the use of computers. Lectures, exercises and seminars are obligatory. Final exam consists of a written and oral part, and it is taken after the completion of lectures. Acceptable results achieved in mid-term exams throughout the semester replace the written part of the exam. Students may influence their final grade by doing homework or writing a seminar paper during the semester. Homework expands course contents, and students are expected to be independent and creative. Seminar papers are understood as an extension of homework.

Can the course be taught in English: Yes

Basic literature:

1. B. Schölkopf, A. J. Smola, Learning with Kernels. Support Vector Machines, Regularization, Optimization, and Beyond, MIT Press, Massachusetts, 2002
2. J. Kogan, Introduction to Clustering Large and High-Dimensional Data, Cambridge University Press, 2007.

Recommended literature:

1. V. Vapnik, *The Nature of Statistical Learning Theory*, Springer Verlag, 1995.
2. N. Cristianini, J. Shawe - Taylor, *An Introduction to Support Vector Machines*, Cambridge University Press, 2000.
3. G. Gan, C. Ma, J. Wu, Data clustering : theory, algorithms, and applications, SIAM, Philadelphia, 2007.
4. B. S. Everitt, S. Landau, M. Leese, Cluster analysis, Wiley, London, 2001.
5. L. Kaufman, P. J. Rousseeuw, Finding groups in data : an introduction to cluster analysis, Jonh Wiley & Sons, Hoboken, 2005