Course Title	Advanced Topics in Machine Learning				
Course Code	AI620				
Course Type	Elective				
Level	Master (2nd Cycle)				
Year / Semester	1st Year/2nd Semester or 2nd Year/1st Semester				
Teacher's Name	TBA				
ECTS	7	Lectures / week	Up to 6 Teleconferences	Laboratories / week	None
Course Purpose and Objectives	This course focuses on advanced topics of machine learning, including clustering, reinforcement learning, ensembles methods, cost-sensitive learning and class imbalance.				
Learning Outcomes	Upon successful completion of this course students should be able to: • Discover structure in unlabeled data in the form of clusters. • Design and implement sequential decision making agents interacting with their environment and learning the optimal policy of acting. • Deal with issues that arise when working with real world data in practical applications, such as class imbalance and the need to optimize the particular (business) cost/benefit in a task, instead of the typical cost function or evaluation measure.				
Prerequisites	AI600	Co-requisites	None		

Course Content	1-4) *Unsupervised Learning:* k-means, hierarchical clustering, density-based clustering, Principal Components Analysis (Kernel PCA, SPARSE PCA), Self-organizing Maps, Independent Components Analysis 5-6) Ensemble methods: bagging, (gradient) boosting, output flipping and smearing, random subspaces and patches, rotation forest, stacking 7) Cost-sensitive learning: cost-based evaluation, minimizing the expected cost, probability calibration, sampling methods, example weighting Class imbalance: types of class imbalance, in(appropriate) evaluation measures, sampling methods, generating synthetic examples 8) Active learning: active learning scenaria, uncertainty sampling, query-by-committee, error-based methods, density-weighted methods, similarities/differences with semi-supervised learning 9-13) Reinforcement learning: multi-armed bandits, Markov decision processes, dynamic programming, Monte Carlo methods, temporal difference learning, on-policy prediction with approximation.
Teaching Methodology	E-Learning
Bibliography	Hastie T., Tibshirani R., Friedman J. (Latest Edition). The elements of statistical learning, Latest Edition, Springer Introduction to Data Mining (Latest Edition). Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar, Pearson Education, Limited Sutton, R. S., & Barto, A. G. (Latest Edition). Reinforcement learning: an introduction, Latest Edition, MIT Press Settles, B. (Latest Edition). Active learning. Morgan & Claypool. Zhou, Z.-H. (Latest Edition). Ensemble methods: Foundations and algorithms. Chapman and Hall/CRC. He, H., Garcia, E. (Latest Edition) Learning from Imbalanced Data, IEEE Transactions on Knowledge and Data Engineering, 21(9), pp. 1263-1284 Branco, P., Torgo, L., & Ribeiro, R. P. (Latest Edition). A Survey of Predictive Modeling on Imbalanced Domains. ACM Computing Surveys. Elkan, C. (Latest Edition). The foundations of cost-sensitive learning. In IJCAI International Joint Conference on Artificial Intelligence (pp. 973–978)

Assessment	Final Examination	50%
	Assignments/On-going evaluation	50%
		100%
Language	English	