جـــامـــعـــة مـحـمـد بـــن زايـــد
للـــذكـــاء الاصـــطـــنـــاعـــي
MOHAMED BIN ZAYED UNIVERSITY
OF ARTIFICIAL INTELLIGENCE

Core Courses Syllabi

ML702 - Advanced Machine Learning

Title	Advanced Machine Learning
Code	ML702
Loading	4 Credit-hours
Prerequisites	ML701 Machine Learning or equivalent course
Catalog Description	This course focuses on recent advances in machine learning and on developing skills for performing research to advance the state of the art in machine learning. Students will learn kernel methods and graphical models, advanced learning algorithms, and reinforcement learning. This course builds upon concepts from Machine Learning (ML701) and assumes familiarity with fundamental concepts in machine learning, optimization, and statistics.
Goal	This graduate-level course aims to inculcate a deeper understanding of the advanced machine learning methods, so the students are capable of researching, developing, and implementing these methods for solving real-world problems. This course will aim to instill in students a strong grasp of the following topics: kernel methods and graphical models, advanced learning algorithms, and reinforcement learning. Additionally, a significant goal of this course is to enhance students' teamwork skills by requiring them to participate in group projects.
Content	This course covers three modules: **(I)** Kernel Methods and Graphical Models, **(II)** Advanced Learning Algorithms, **(III)** Reinforcement Learning
Recommended Textbooks	1. K. Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press, 2012. ISBN-10: 0262018020 2. C. Bishop, *Pattern Recognition and Machine Learning*, Berlin: Springer-Verlag, 2006. ISBN: 0387310738
Recommended References & Supplemental Material	1. S. Shalev-Shwartz, and S. Ben-David. *Understanding Machine Learning: From Theory to Algorithms*. Cambridge University Press, 2014. ISBN: 1107057132 2. D. Barber. *Bayesian Reasoning and Machine Learning*, Cambridge University Press, 2012. ISBN: 0521518148

Teaching Week	Topics
1	**Kernel Methods and Graphical Models** **Lecture** Overview of Machine Learning: Course information, Motivation • Kernel methods in machine learning • Duality and SVMs • Reproducible kernel Hilbert space **Lab** • Discussion on choosing a project for module-1 of the course • Start project-1 work
2	**Kernel Methods and Graphical Models** **Lecture** • Graphical models – representation • Bayesian networks • Markov models **Lab** • Continue project-1 work
3	**Kernel Methods and Graphical Models** **Lecture** • Graphical models – inference • Belief propagation • MAP algorithm • Sampling methods **Lab** • Continue project-1 work
4	**Kernel Methods and Graphical Models** **Lecture** • Graphical models – learning methods • Learning bayesian and markov networks • Learning bayesian network structure • Learning bayesian networks with incomplete data **Lab** • Preparation of presentation on project-1 work • Continue project-1 work

Teaching Week	Topics
5	**Kernel Methods and Graphical Models** **Lecture** • Exam will be held instead of 1 scheduled lecture • Student presentations **Lab** • Complete project-1 work and presentation
6	**Advanced Learning Algorithms** This module overviews the following: Manifold Learning, Transfer Learning, Multi-task Learning, Semi-supervised Learning, and Active Learning **Lecture** • Introduction to manifold learning • Local and global structure preserving methods • Dimensionality reduction • Visualization of high dimensional data **Lab** • Discussion on choosing a relevant paper to implement for the project • Start project-2 work
7	**Advanced Learning Algorithms** **Lecture** • Transferring knowledge to similar problems • Domain adaptation and sample bias correction • Multi-task learning **Lab** • Continue project-2 work
8	**Advanced Learning Algorithms** **Lecture** • Introduction to Semi-supervised Learning • Transductive settings (t-SVM, t-CNN) • Co-training paradigm • Multi-instance learning • Learning from weak and noisy labels **Lab** • Continue project-2 work

Teaching Week	Topics
9	**Advanced Learning Algorithms** **Lecture** • Active learning overview • Methods for sample selection • Expert opinion pooling • Concept drift **Lab** • Preparation of presentation on project-2 work • Continue project-2 work
10	**Advanced Learning Algorithms** **Lecture** • Exam will be held instead of 1 scheduled lecture • Student presentations **Lab** • Complete project-2 work and presentation
11	**Reinforcement Learning** **Lecture** • Model-free reinforcement learning • Q-learning • Deep Q-network (DQN) **Lab** • Discussion on choosing a relevant paper to implement for the project • Start project-3 work
12	**Reinforcement Learning** **Lecture** • Model-free reinforcement learning continued • Value and policy iteration • Policy gradients for continuous action spaces **Lab** • Continue project-3 work

Teaching Week	Topics
13	**Reinforcement Learning** **Lecture** • Duelling networks • Asynchronous actor-critic agents **Lab** • Continue project-3 work
14	**Reinforcement Learning** **Lecture** • Model-Based Reinforcement Learning • Known and learnt models **Lab** • Preparation of presentation on project-3 work • Continue project-3 work
15	**Reinforcement Learning** **Lecture** • Exam will be held instead of 1 scheduled lecture • Student presentations **Lab** • Complete project-3 work and presentation