ECE805 – Machine Learning

MSc in Intelligent Critical Infrastructure Systems

Spring Semester 2020-2021

Instructor: Professor Marios Polycarpou, mpolycar@ucy.ac.cy

Teaching Assistants: Rafaella Elia (elia.rafaella@ucy.ac.cy); Dr. Kleanthis Malialis (malialis.kleanthis@ucy.ac.cy); Dr. Christos Kyrkou (kyrkou.christos@ucy.ac.cy)

Lectures: Tuesday and Thursday: 15:00-16:30, except in the case of 25Th March and 1st April, when the lectures will be moved to Wednesday (see schedule on the course webpage)

Tutorials: Friday: 16:00-18:00 (see schedule on the course webpage)

Course Objective

This course aims to introduce the theory, methods and applications of the field of Machine Learning. The objectives of the course are the presentation of the core principles and algorithms of supervised, unsupervised and reinforcement learning, the explanation of the application of these algorithms for the solution of regression, classification, clustering and decision-making problems and the demonstration of practical machine learning tools suitable for the analysis of data sets and the solution of machine learning problems. Special emphasis will be placed on real-world critical infrastructure systems applications.

By the end of the course, students should be able to understand the principles of supervised, unsupervised and reinforcement learning, to design and implement a wide variety of machine learning algorithms, to analyze raw data to create representations that are more suitable for machine learning algorithms and to solve and evaluate the performance of classification, regression, dimensionality reduction and clustering problems that arise in critical infrastructure systems using state-of-the-art machine learning tools.

Course Outline

1. *Introduction to Machine Learning*
2. *Neural Networks*
3. *Supervised Learning*
4. *Online Learning*
5. *Unsupervised Learning*
6. *Reinforcement Learning*
7. *Application to Monitoring and Control*

References

There are several good books that cover Machine Learning from different angles. The following are good suggested references:

- S. Haykin, "Neural Networks and Learning Machines," 3rd Edition, Pearson, 2009.
- I. Goodfellow, Y. Bengio, and A. Courville, "Deep Learning," MIT Press, 2016.
- S. Theodoridis, "Machine Learning: a Bayesian and Optimization Perspective," 2nd edition, 2020.
- A. Burkov, "The Hundred-Page Machine Learning Book," 2019.
- R.O. Duda, P.E. Hart, and D.G. Stork, "Pattern Classification," Wiley, 2001.
- C.M. Bishop, "Pattern Recognition and Machine Learning, Springer, 2006.
- D. Bertsekas, "Reinforcement Learning and Optimal Control, 2019.
- J.A. Farrell and M.M. Polycarpou, "*Adaptive Approximation Based Control*", J. Wiley, 2006.

Pre-requisites

Linear algebra; calculus; probability theory; differential equations.

Evaluation Methods – Grade Distribution

- Coursework (40%), assigned and carried out during the course
- Final Exam (60%), take home exam, May 2021

Academic Honesty: it is acceptable to work together in small groups for study and discussing the coursework assignments. However, work that you turn in under your name must be your own. Cheating will not be tolerated; neither during coursework nor during exams. Note that all the rules set by the University of Cyprus and the Department of Electrical and Computer Engineering apply.