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

Core Courses Syllabi

ML704 - Machine Learning Paradigms

Title	Machine Learning Paradigms
Code	ML704
Loading	4 Credit-hours
Prerequisites	• Basics of Linear Algebra, Calculus, Probability and Statistics • Proficiency in Python • ML 701 Machine Learning or equivalent
Catalog Description	This course focuses on machine learning and on developing skills for performing research to the state of the art in machine learning. This course builds upon concepts from Mathematical Fundamentals for AI (course code: MTH701) and assumes familiarity with fundamental concepts in optimization, and statistics. Students will learn about methods in supervised, unsupervised learning, and semi-supervised learning. The course will discuss variants of learning algorithms in each of the three types of learning algorithms.
Goal	This graduate course aims to inculcate a deeper understanding of machine learning methods, so the students are capable of researching, developing, and implementing these methods for solving real-world problems. This course aims to train students to the level of expertise in learning algorithms in supervised, unsupervised, and semi-supervised domains. 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)** Supervised Learning, **(II)** Unsupervised Learning, **(III)** Semi-Supervised Learning
Recommended Textbooks	1. Tom M. Mitchell, Machine Learning, McGraw-Hill Science/Engineering/ Math publishing, ISBN: 0070428077 2. C. Bishop, *Pattern Recognition and Machine Learning*, Berlin: Springer-Verlag, 2006. ISBN: 0387310738
Recommended References & Supplemental Material	Relevant research papers, tech reports, and surveys for each topic, where needed, are identified in the teaching plan ahead. In addition, the following textbooks may be useful: 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
	Overview of Machine learning: Course Information, Motivation
1	**Supervised Learning** **Lectures** • Introduction to Supervised Learning • Discussion of papers: - Panik, M. J. 2009. “Regression Modeling: Methods, Theory, and Computation with SAS”. Boca Raton, FL: CRC Press. - C. Cortes, V. N. Vapnik, "Support-vector networks,” Machine Learning, 20 (3): 273–297, 1995. - Breiman, L. 2001. “Random Forests.” Machine Learning 45:5–32 **Lab** • Discussion on choosing a relevant paper to implement for the project • Start project-1 work
2	**Supervised Learning** **Lecture** • Regression modelling • Group discussion on the relevant papers - Panik, M. J. 2009. Regression Modeling: Methods, Theory, and Computation with SAS. Boca Raton, FL: CRC Press. **Lab** • Continue project-1 work
3	**Supervised Learning** **Lecture** • Support-Vector Machines • Group discussion on the relevant papers - C. Cortes, V. N. Vapnik, "Support-vector networks,” *Machine Learning*, 20 (3): 273–297, 1995. **Lab** • Continue project-1 work
4	**Supervised Learning** **Lecture** • Decision Tree • Group discussion on the relevant papers - Breiman, L. 2001. “Random Forests.” Machine Learning 45:5–32 **Lab** • Preparation of presentation on project-1 work • Continue project-1 work

Teaching Week	Topics
5	**Supervised Learning** **Lecture** • Exam will be held instead of 1 scheduled lecture • Student presentations **Lab** • Complete project-1 work and presentation
6	**Unsupervised Learning** **Lecture** • Introduction to Unsupervised Learning • Discussion of papers: - Hartigan, J. A. and Wong, M. A. 1979. "Algorithm AS 136: A k-Means Clustering Algorithm." Journal of the Royal Statistical Society, Series C 28:100–108. - Cheng, Y. 1995. "Mean Shift, Mode Seeking, and Clustering." IEEE Transactions on Pattern Analysis and Machine Intelligence 17:790–799. - Schölkopf, B., Smola, A., and Müller, K.-R. 1997. "Kernel Principal Component Analysis." In Artificial Neural Networks—ICANN'97, 583–588. Berlin: Springer. **Lab** • Discussion on choosing a relevant paper to implement for the project • Start project-2 work
7	**Unsupervised Learning** **Lecture** • Introduction to Clustering • Reading group activity on relevant papers: - Hartigan, J. A. and Wong, M. A. 1979. "Algorithm AS 136: A k-Means Clustering Algorithm." Journal of the Royal Statistical Society, Series C 28:100–108. **Lab** • Continue project-2 work
8	**Unsupervised Learning** **Lecture** • Introduction to Clustering • Discussion of relevant papers: - Cheng, Y. 1995. "Mean Shift, Mode Seeking, and Clustering." IEEE Transactions on Pattern Analysis and Machine Intelligence 17:790–799. **Lab** • Continue project-2 work

Teaching Week	Topics
9	**Unsupervised Learning** **Lecture** • Introduction to PCA • Discussion of relevant papers: - Schölkopf, B., Smola, A., and Müller, K.-R. 1997. “Kernel Principal Component Analysis.” In Artificial Neural Networks—ICANN'97, 583–588. Berlin: Springer. **Lab** • Preparation of presentation on project-2 work • Continue project-2 work
10	**Unsupervised Learning** **Lecture** • Exam will be held instead of 1 scheduled lecture • Student presentations **Lab** • Complete project-2 work and presentation
11	**Semi-Supervised Learning** **Lecture** • Introduction to Semi-Supervised Learning • Discussion of relevant papers: - Nigam, K., McCallum, A.K., Thrun, S. and Mitchell, T. 2000. "Text Classification from Labeled and Unlabeled Documents using EM." Machine Learning 39:103-134. - Belkin, M., Niyogi, P., and Sindhwani, V. 2006. “Manifold Regularization: A Geometric Framework for Learning from Labeled and Unlabeled Examples.” The Journal of Machine Learning Research 7:2399-2434. - Vincent, P., Larochelle, H., Bengio, Y., and Manzagol, P.A. 2008. “Extracting and Composing Robust Features with Denoising Autoencoders.” Proceedings of the 25th International Conference on Machine Learning. New York: ACM. **Lab** • Discussion on choosing a relevant paper to implement for the project • Start project-3 work
12	**Semi-Supervised Learning** **Lecture** • Expectation maximization • Discussion of relevant papers: - Nigam, K., McCallum, A.K., Thrun, S. and Mitchell, T. 2000. "Text Classification from Labeled and Unlabeled Documents using EM." Machine Learning 39:103-134. **Lab** • Continue project-3 work

Teaching Week	Topics
13	**Semi-Supervised Learning** **Lecture** • Manifold regularization • Discussion of relevant papers: - Belkin, M., Niyogi, P., and Sindhwani, V. 2006. "Manifold Regularization: A Geometric Framework for Learning from Labeled and Unlabeled Examples." The Journal of Machine Learning Research 7:2399-2434. **Lab** • Continue project-3 work
14	**Semi-Supervised Learning** **Lecture** • Denoising autoencoders • Discussion of relevant papers: - Vincent, P., Larochelle, H., Bengio, Y., and Manzagol, P.A. 2008. "Extracting and Composing Robust Features with Denoising Autoencoders." Proceedings of the 25th International Conference on Machine Learning. New York: ACM. **Lab** • Preparation of presentation on project-3 work • Continue project-3 work
15	**Semi-Supervised Learning** **Lecture** • Exam will be held instead of 1 scheduled lecture • Student presentations **Lab** • Complete project-3 work and presentation