SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN
Established in collaboration with MIT

01.112 Machine Learning (Undergraduate) Spring 2018

Instructor	Lu Wei	luwei@sutd.edu.sg	1.302.10
Teaching Assistants	Allan Jie Thilini Cooray	zhanming_jie@mymail.sutd.edu.sg muthuthanthrige@mymail.sutd.edu.sg	
Office Hours	Lu Wei Thilini Cooray Allan Jie	Tue 12:30 - 1:30pm, or by appointment Thu 03:00 - 04:00pm, or by appointment Fri 10:00 - 11:00am, or by appointment	TT9 (1.415) TT9 (1.415) 1.417
Lessons	Every Week	Tue 10:30 - 12:30 Thu 13:00 - 15:00	
Classroom	Think Tank 9 & 10 (1.415 & 1.416)		
Prerequisites	A strong background in Linear Algebra, Probability and Python Programming. Knowledge in Algorithms.		
Assessment	Homework (30%), Project (20%), Midterm Exam (25%), Final Exam (25%)		

Description

Machine learning is the study of algorithms that improve their performance at a task with experience (Mitchell). In this course, students will learn how machine learning has led to many innovative real-world applications. The students will also gain an in-depth understanding of a broad range of machine learning algorithms from basic to state-of-the-art, such as: naïve Bayes, logistic regression, neural networks, clustering, probabilistic graphical models, reinforcement learning and SVMs.

Project - Hitherwark Modal

Learning Objectives

1. Recognize the characteristics of machine learning that make it useful to real-world problems.
2. Understand the basic underlying concepts for supervised discriminative and generative learning.
3. Understand the concepts of cross-validation and regularization, be able to use them for estimation of algorithm parameters.
4. Characterize machine learning algorithms as supervised, semi-supervised, and unsupervised.
5. Have heard of a few machine learning toolboxes.
6. Be able to use support vector machines.
7. Be able to use regularized regression algorithms.
8. Understand the concept behind neural networks for learning non-linear functions.
9. Understand and apply unsupervised algorithms for clustering.
10. Understand the foundation of generative models.
11. Understand the inference and learning algorithms for the hidden Markov model.
12. Understand the learning algorithm for hidden Markov model with latent variables.
13. Understand algorithms for learning Bayesian networks.
14. Understand reinforcement learning algorithms.

Measurable Outcomes

1. List useful real-world applications of machine learning.
2. Implement and apply machine learning algorithms.
3. Choose appropriate algorithms for a variety of problems.

Textbooks

No required textbooks as notes will be provided. For further reading, we recommend

1. C. Bishop: *Pattern Recognition and Machine Learning*. Springer, 2006.
2. G. James, D. Witten, T. Hastie, R. Tibshirani: *An Introduction to Statistical Learning*. Springer, 2009.
3. R. Duda, P. Hart, D. Stork: *Pattern Classification*, 2nd Ed. John Wiley & Sons, 2001.
4. T. Mitchell: *Machine Learning*. McGraw-Hill, 1997.
5. R. Sutton, A. Barto: *Reinforcement Learning: An Introduction*. MIT Press, 1998.

Syllabus

Weeks 01 - 07	Weeks 08 - 14
Introduction Perceptron Regression Classification with Hinge Loss Clustering Support Vector Machines Logistic Regression Naïve Bayes Expectation-Maximization	From Generative Models to Graphical Models Hidden Markov Models - Introduction Hidden Markov Models - Supervised Learning Hidden Markov Models - Inference Hidden Markov Models - Unsupervised Learning Bayesian Networks - Learning, Inference Bayesian Networks - Independence Bayesian Networks - Structured Learning Reinforcement Learning

Project
The course project consists of two components: the data collection and the final report, and may require a fair bit of programming. More details will be announced in Week 5. Until then, please form groups of 2-3 members for the project.

Homework
Assignments are to be submitted online in eDimension, with solutions combined into a single file. No deadline extensions will be granted, except in extenuating circumstances (e.g. family emergencies).

Honor Code
You are encouraged to form study groups to work on the homework together. However, please write out the solutions on your own, without referring to notes from other students, online solutions or answers from past courses. Reproducing the solution from scratch will help you to find out if you fully understand the material. Please also list your group members on the first page of your submission.

Piazza
This term we will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates, the TAs, and myself. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. If you have any problems or feedback for the developers, email team@piazza.com. More info will be released soon.

Linear Algebra, Probability Review
The teaching assistants will conduct two optional 30min reviews of linear algebra and probability, on the dates listed above. For further readings, we recommend the following textbooks.

D. Poole, *Linear Algebra: A Modern Introduction*. 3rd edition, 2010.
J. L. Devore, *Probability and Statistics for Engineering and the Science*. 8th edition, 2011.

DEEP Option
For students interested in learning advanced machine learning, there will be some additional DEEP lectures which will be taught at a faster pace. At the end of the term, we will offer an optional take-home exam, and students who perform well will received an official DEEP certificate for the course.