Machine Learning (Autumn 2021)

Syllabus and Logistics

Instructor:

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Office Hour: 8:30-9:30 Wednesday @ FIT 3-109, appointment required

Venue: Classroom I-205
Date/Time: Thursday 9:50-12:15, Sept. 16 – Dec.23, 2021

TAs:

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About the Course:

This is a comprehensive course on machine learning for graduate students and senior undergraduate students. The course will cover basic concepts of machine learning and pattern recognition, basic mathematical developments of major methods, and a broad range of representative algorithms.

Working Language:

Lecture and slides: English
TA tutoring: Chinese or English
Homework: assignments in English, answers can be in English or Chinese upon students' choice
Exams: questions in English, answers can be in English or Chinese upon students' choice

Prerequisites:

English, Calculus, Linear Algebra, Probability and Statistics
basic programming skills are required (in C/C++, Python, R, or Matlab)

Reference Books:

An "official" textbook for this course is not available yet. Lecture slides will be available at the

course website of the web learning system (learn.tsinghua.edu.cn). Books that can be used as references for studying this course include:

1. 张学工、汪小我，《模式识别（第四版）：模式识别与机器学习》，清华大学出版社，2021.8 (Xuegong Zhang, Xiaowo Wang, *Pattern Recognition: Pattern Recognition and Machine Learning* (4th Edition), Tsinghua University Press, 2021, in Chinese)
2. R.O. Duda P.E. Hart, D.G. Stork, *Pattern Classification* (2nd edition), John Wiley & Sons, Inc, 2001 (Chinese translation also available)
3. S. Raschka & V. Mirjalili, *Python Machine Learning* (2nd edition), Birmingham, Packt Publishing, 2017
   (available at https://subscription.packtpub.com/book/big_data_and_business_intelligence/9781787125933)
4. Y. S. Abu-Mostafa, M. Magdon-Ismail, H-T. Lin, *Learning from Data*, AMLbook.com, 2012 (available at http://amlbook.com/)
5. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, NY: Springer, 2006 (partially available at https://www.microsoft.com/en-us/research/wp-content/uploads/2016/05/Bishop-PRML-sample.pdf and https://pdfs.semanticscholar.org/8f8f/9222d66a30f1f4026dc1035ef10f9ccd079d.pdf)
6. T. Hastie, R. Tibshirani, J. Friedman, *The Elements of Statistical Learning* (2nd edition), Springer, 2016 (available at https://web.stanford.edu/~hastie/ElemStatLearn/)
7. S. Shalev-Shwartz & S. Ben-David, *Understanding Machine Learning: From Theory to Algorithms*, Cambridge University Press, 2014
   (available at http://www.cs.huji.ac.il/~shais/UnderstandingMachineLearning)
8. I. Goodfellow, Y. Bengio, A. Courville, *Deep Learning*, MIT Press, 2017
   (available at http://www.deeplearningbook.org/ and https://github.com/janishar/mit-deep-learning-book-pdf)

Grading:

- 40% homework
- 20% course project
- 5% midterm exam
- 35% final exam

The Honor Code:

- You can discuss with others, as long as you write the homework by yourself and acknowledge from whom you received help through the discussion.
- You are also allowed/encouraged to search for references when doing homework, as long as you cite the reference and write your homework by yourself.
- Third-party computer codes can be used in homework exercises, except for tasks that require you to “hand-write” your own codes.

Syllabus:

Week	Date	Course content
1	09/16	Chapter 1. Introduction Chapter 2. Pattern Classification
2	09/23	**Part I. Deterministic Machines for Supervised Learning** Chapter 3. Classical Linear Machines
3	09/30	Chapter 4. Multi-category Classification and Nonlinear Classification
4	10/07	Chapter 5. Classical Artificial Neural Networks Course Project Introduction
5	10/14	Chapter 6. Support Vector Machines and Kernel Machines
6	10/21	Chapter 7. Essentials of Statistical Learning Theory
7	10/28	Chapter 8. Feature Selection and Extraction for Classification Chapter 9. Decision Trees, Random Forests and Ensemble Learning
8	11/04	Mid-term exam **Part II. Probabilistic Learning Machines** Chapter 10. Bayesian Decision Classifiers
9	11/11	Chapter 11. Probability Density Estimation Chapter 12. Hidden Markov Models and Introduction to Graphic Models
10	11/18	**Part III. Machines for Unsupervised Learning** Chapter 13. Clustering: Unsupervised Pattern Recognition
11	12/25	Chapter 14. Model-based Clustering and EM Algorithms Chapter 15. Manifold Learning, Dimensionality Reduction and Visualization
12	12/02	Chapter 16. Unsupervised Learning with Neural Networks: SOM and RBM
13	12/09	**Part IV. Deep Learning and Beyond** Chapter 17. Convolution Neural Networks
14	12/16	Chapter 18. Recurrent Neural Networks, LSTM and Transformers
15	12/23	Chapter 19. Deep Neural Networks and Generative Models Chapter 20. Ethics Issues in Machine Learning and AI
16		Final Exam
17		Course Project Report Due