CH.0: Syllabus

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Class hrs. : Thur. 9:10 – 10:30; 10:50 – 12:00

遲到: 9:31 - 10:30; 缺席: 10:31 - 12:00.

請假務必當天以e-mail告知老師

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Goal of Course

This course will cover a wide range of research problems and provides detailed algorithmic and theoretical treatments for each.

Theory oriented: boring;

Techniques oriented: too many techniques lead to hard to choose;

Foundation oriented: balance between theory and technique oriented approaches.

Textbook

Introduction to Machine Learning

Fourth Edition

Ethem Alpaydin

2020

(開發圖書, 魏錦鈐, 0939852332, (02)82423988)

Contents

Ch.13: Local Models
Ch.14: Kernel Machines
Ch.15: Graphical Models
Ch.16: Hidden Markov Models
Ch.17: Bayesian Estimation
Ch.18: Combining Multiple Learners
Ch.19: Reinforcement Learning
Ch.20: Design and Analysis of Machine Learning Experiments
Appendix A : Probability
Appendix B: Linear Algebra
Appendix C: Optimization
Appendix : Scikit-Learn

Syllabus

Ch.0: Syllabus, App: Scikit Learn	(第 1 週)
Ch.1: Introduction	(第 1 週)
Ch.2: Supervised Learning	(第 2 週)
App A: Probability Theory	(第 3 週)
Ch.4: Parametric Methods	(第 4 週)
Ch.5 Multivariate Methods	(第 5 週)
Ch.6: Dimensionality Reduction	(第 5,6 週)
Ch.9: Decision Trees	(第 6,7 週)
Mid-term Exam.	(第 8 週)
Ch.11: Multilayer Perceptrons	(第 9,10週)
Ch.12: Deep Learning	(第11,12週)
Ch.19: Reinforcement Learning	(第13,14週)
Final Presentation	(第15,16週)

Final Presentations

(第 4 週) -- 繳交分組名單, 3人一組

(第 10 週) -- 繳交論文研讀心得報告, 每人交一份.
小組可選看同篇論文, 但每人需自己撰寫心得,自行繳交

(第 14 週) -- 繳交報告用PPT, 每組交一份

(第 15,16 週) -- 每組報告 __分 , Q&A __分

論文研讀心得報告含兩部份:

(1) 選讀論文之PDF檔

(2) 報告內容中需

(a) 註明論文出處(journal或conference)
以及年份

(b) 論文的Review和Comments

(c) 報告撰寫之文書格式 -- Word format

(i) Number of pages <= 3;

(ii) Word size = 14, Line interval = 1.5;

(iii) Chinese (細明體);
English (Times New Roman).

報告互評表　　姓名:_____

一、 (a)每組報告__分鐘,問題答覆__分鐘; (b)每個組員均需上台報告, 並告知姓名; (c)報告請聚焦在論文的重要性和技術細節; (d)論文的難易度,口頭報告的流暢度,**實作展示**,問題答覆各項請依五級分方式評分(最低分 1 分, 最高分 5 分); (e)組員表現請依三級分評分(最低分 1 分, 最高分 3 分)標於姓名旁; (f)同組不用互評; (g)所有報告結束後,請於總分欄標註最高(**O**)及最低(**X**)之組別.

組別	組員表現	內容的難易度	報告的流暢度	實作展示	問題答覆	總分
1						
2						
3						
4						
5						

二、每人至少提問 2 題, 至多 3 題, 少於 2 題扣分.

_____

_____

_____

本表請務必於每堂課後繳回，缺交者以缺席計。

Finding the PPTs of Chapters:

登入 Moodle

→我的課程

→機器學習(Machine Learning)

→上課用章節投影片(PPTs of Chapters)

→下載投影片

Assignment Submission

(A) Prepare the assignment file

Content:

(1) Problem statement

(2) (i) Written assignment – Answer

(ii) Project assignment –

(a) Input/Output data

(b) Source code

(c) Comments

(3) File Name: Name.hw# , e.g., 陳世旺.hw1

Example 1: Written assignment

Homework _ (Due _ /_)

What is the likelihood ratio $\frac{P(x \mid C_1)}{P(x \mid C_2)}$, where

$$P(x \mid C_i) = \frac{1}{\sqrt{2\pi}\sigma_i} \exp\left[-\frac{(x-\mu_i)^2}{2\sigma_i^2} \right] ?$$

(1) Problem statement

What is the likelihood ratio $\frac{P(x|C_1)}{P(x|C_2)}$, where

$$P(x|C_i)=\frac{1}{\sqrt{2\pi}\sigma_i}\exp\left[-\frac{(x-\mu_i)^2}{2\sigma_i^2}\right]?$$

(2) Answer

$$\frac{P(x|C_1)}{P(x|C_2)}=\frac{\frac{1}{\sqrt{2\pi}\sigma_1}\exp\left[-\frac{(x-\mu_1)^2}{2\sigma_1^2}\right]}{\frac{1}{\sqrt{2\pi}\sigma_2}\exp\left[-\frac{(x-\mu_2)^2}{2\sigma_2^2}\right]}=\frac{\sigma_2\exp\left[-\frac{(x-\mu_1)^2}{2\sigma_1^2}\right]}{\sigma_1\exp\left[-\frac{(x-\mu_2)^2}{2\sigma_2^2}\right]}$$

$$=\frac{\sigma_2}{\sigma_1}\exp\left[-\frac{(x-\mu_1)^2}{2\sigma_1^2}+\frac{(x-\mu_2)^2}{2\sigma_2^2}\right]$$

(3) File Name: 陳世旺.hw#

Example 2: Project assignment

Homework _(Due _ /_)

1. Input a color image $C(R,G,B)$
2. Output the color image C
3. Transform the color image C into a grayscale image I by $I = (R+G+B)/3$
4. Show the grayscale image I.

(1) Problem statement

1. Input a color image $C(R,G,B)$
2. Output the color image C
3. Transform the color image C into a grayscale image I by $I = (R+G+B)/3$
4. Show the grayscale image I.

(2) (a) Input/Output Data

Input:

Color image *C*

Output:

Color image *C*

Grayscale image *I*

(b) Source Code

```
# Import libraries
import sys
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.image as
mpimg

#Convert RGB color image to grayscale
image
#I=(R+G+B)/3
def rgb2gray(rgb):
  return np.dot(rgb[..., :3],[0.2,0.5,0.3])

# Standard input image file name
img=mpimg.imread(sys.argv[1])
```

(c) Comments

There are many libraries having functions for transforming color to grayscale images. Their transformation coefficients, e.g., (0.2989, 0.5870, 0.1140), are different from the one (0.333, 0.333, 0.333) used in this homework.

(3) File Name: 陳世旺.hw#

(B) Submit the file to Moodle:

登入 Moodle

→我的課程

→機器學習(Machine Learning)

→作業繳交區

→上傳作業

作業繳交時間在下一次上課以前

References

(A) Books

1. Machine Learning by T. M. Mitchell, McGraw-Hill International Editions, 1997.
2. Learning from Data by Y. S. Abu-Mostafa, M. M. Ismail, and H. T. Lin, AMLbook.com, 2012.
3. Understanding Machine Learning: From Theory to Algorithm by S. S. Shai and B. D. Shai, 2014.
4. Fundamentals of Machine Learning for Predictive Data Analytics, Algorithm, Worked Examples, and Case Studies by J. D. Kelleher, B. M. Namee, and A. D'Arcy, 2015.
5. Foundations of Machine Learning by M. Mohri, A. Rostamizadeh, and A. Talwalkar, 2018.

6. Hands on Machin Learning with Scikit-Learn, Keras, and TensorFlow: Concept, Tools, and Techniques to Build Intelligent Systems, by A. Geron, 2019.
7. An Introduction to Machine Learning, by G. Rebala, A. Ravi, and. S. Churiwala, 2019.

1. Machine Learning by T. M. Mitchell, McGraw-Hill International Editions, 1997.

Ch.1: Introduction, Ch.2: Concept Learning and General-to-Specific Ordering, Ch.3: Decision Tree Learning, Ch.4: Artificial Neural Networks, Ch.5: Evaluating Hypotheses, Ch.6: Bayesian Learning,

Ch.7: Computational Learning Theory, Ch.8: Instance-Based Learning, Ch.9: Generic Algorithms, Ch.10: Learning Sets of Rules, Ch.11: Analytical Learning, Ch.12: Combining Inductive and Analytical Learning, Ch.13: Reinforcement Linear

2. Learning from Data by Y. S. Abu-Mostafa, M. Magdon-Ismail, and Hsuan-Tien Lin, AMLbook.com, 2012.

   Ch.1: The Learning Problems, Ch.2: Training versus Testing, Ch.3: The Linear Model, Ch.4: Overfitting, Ch.5: Three Learning Principles, Appendix: Proof of the VC Bound

3. Understanding Machine Learning: From Theory to Algorithms by Shai Shalev-Shwartz and Shai Ben-David, 2014.

   Part 1

   Ch.1: Introduction, Ch.2: A Gentle Start, Ch.3: A Formal Learning Model, Ch.4: Learning via Uniform Convergence,

Ch.5: The Bias-Complexity Trade-off, Ch.6: The VC-Dimension, Ch.7: Non-uniform Learnability, Ch.8: The Runtime of Learning

Part 2

Ch.9: Linear Predictors, Ch.10: Boosting, Ch.11: Model Selection and Validation, Ch.12: Convex Learning Problems, Ch.13: Regularization and Stability, Ch.14: Stochastic Gradient Descent, Ch.15: Support Vector Machine, Ch.16: Kernel Methods, Ch.17: Multiclass, Ranking, and Complex Prediction Problems, Ch.18: Decision Trees, Ch.19: Nearest Neighbor, Ch.20: Neural Networks,

Part3

Ch.21: Online Learning, Ch.22: Clustering, Ch.23: Dimensionality Reduction, Ch.24: Generative Models, Ch.25: Feature Selection and Generation,

Part4

Ch.26: Rademacher Complexity, Ch.27: Covering Numbers, Ch.28: Proof of the Fundamental Theorem of Learning Theory, Ch.29: Multiclass Learnability, Ch.30: Compression Bounds, Ch.31: PAC-Bayes, Appendix A: Technical Lemmas, Appendix B: Measure Concentration, Appendix C: Linear Algebra

4. Fundamentals of Machine Learning for Predictive Data Analytics, Algorithm, Worked Examples, and Case Studies by J. D. Kelleher, B. M. Namee, and A. D'Arcy, 2015.

Ch.1: Machine Learning for Predictive Data Analytics, Ch.2: Data to Insights to Decisions, Ch.3: Data Exploration, Ch.4: Information-based Learning, Ch.5: Similarity-based Learning, Ch.6: Probability-based Learning, Ch.7: Error-based Learning, Ch.8: Evaluation, Ch.9: Case Study: Customer Churn, Ch.10: Case Study: Galaxy Classification, Ch.11: The Art of Machine Learning for Predictive Data Analytics

Appendix A: Descriptive Statistics and Data Visualization for Machine Learning, Appendix B: Introduction to Probability for Machine Learning, Appendix C: Differentiation Techniques for Machine Learning

5. Foundations of Machine Learning by M. Mohri, A. Rostamizadeh, and A. Talwalkar, 2018.

Ch.1: Introduction, Ch.2: The PAC Learning Framework, Ch.3: Rademacher Complexity and VC-Dimension, Ch.4: Model Selection, Ch.5: SVM, Ch.6: Kernel Machines, Ch.7: Boosting, Ch.8: On-Line Learning, Ch.9: Multi-class Classification, Ch.10: Ranking, Ch.11: Regression,

Ch.12: Maximum Entropy Models, Ch.13: Conditional Maximum Entropy Models, Ch.14: Algorithmic Stability, Ch.15: Dimensionality Reduction, Ch.16: Learning Automata and Languages, Ch.17: Reinforcement Learning

Appendix A: Linear Algebra Review, Appendix B: Convex Optimization, Appendix C: Probability Review, Appendix D: Concentration Inequalities, Appendix E: Notions of Information Theory

(B) Journals:

- IEEE Trans. on Machine Learning
- IEEE Transactions on Neural Networks
- IEEE Transactions on Pattern Analysis and Machine Intelligence
- Journal of Machine Learning Research
- Neural Computation
- Neural Networks

(C) **Proceedings:**

- International Conference on Machine Learning
- International Conference on Machine Learning and Computing
- European Conference on Machine Learning
- Neural Information Processing Systems
- Uncertainty in Artificial Intelligence
- Computational Learning Theory
- International Joint Conference on Artificial Intelligence
- International Conference on Neural Networks
- Advanced Lectures on Machine Learn
- Pattern Recognition and Machine Learning

(D) Web Packages

http://scikit-learn.org/stable/

http://scikit-learn.org/stable/user_guide.html

https://machine-learning-python.kspax.io/Introduction/intro.html

Evaluation

Homework	**30%**
Quiz	**5%**
Q&A	**10%**
Examination	**25%**
Presentation	**30%**

Late homework will not be accepted

Plagiarism is definitely not allowed