SABANCI UNIVERSITY

CS412 - Machine Learning

Spring 2022-2023

Instructor	Berrin Yanikoglu
Zoom link	**https://sabanciuniv.zoom.us/j/93366735827**
Lecture Hours	**Tuesdays 8:40-9:30 Cinema Hall (UCG030) and Thursdays: 2:40-4:30 (FASS G062)**
Recitations	**Mondays 6:40-7:30 (FASS G077)** About every 2 weeks, mainly for ML programming in Python
Textbook(s)	Textbooks: None, some references will be provided. Optional Readings: Advanced or alternative explanations will be provided as supplement to lecture slides and course textbook. There are also many ML or Pattern Recognition books in IC, some as online resources. • Elements of Statistical Learning - Hastie • Neural Networks and Learning Machines - Haykin • Ethem Alpaydin book (Online book available through IC) – Alpaydın: General introductory ML book
Course Description	This is an introductory machine learning course that will aim a solid understanding of the fundamental issues in machine learning (overfitting, bias/variance), together with several state-of-art approaches such as decision trees, k-nearest neighbor, Bayesian classifiers, regression (linear, logistic, polynomial), neural networks and deep learning, and classifier combination.
Grading	• **Midterm (20%) & Final (35%)** – in person (only exceptions will be earthquake related exceptions) • **Homeworks: 25%** – 4-5 total: 2 or 3 written, 2 or 3 programming (Python) • **Project: 10%** – Can be done in groups of 2-4, but with individual grading. • **Quizzes: 10%** – At least 10 quizzes, each of them about 10 points worth **Passing Grade:** • To pass the course you grade as calculated above must be at least 35 (strict) and "final exam grade" should be above 29/100 (you shd. be able to answer “near” one third of the question to claim to have learned the material). • If you take the final but get a failing grade (<30), you need to take the makeup as well, in which case the average of the final and the makeup will be considered as your final exam grade. You will fail the course if that weighted average is below 30. • Attendance & class participation will be taken into account in border-line grades. So make sure to attend lectures if you have to pass the course.
Quizzes	○ **Quiz dates are the end 10 minutes of every Thursday lecture.** ○ If the max total is 200 points, your quiz score will be computed as: min(100,100*sum(all your quiz scores)/(200*0.9)) to allow for missing quizzes due to any reasons. I.e. you can lose 10% of quiz points and still have 100 as your quiz score. ○ People who add the course during the Add/Drop period will have those quizzes not counted.

Learning Objectives	1. Understand the basic concepts, issues, assumptions and limitations in machine learning (e.g. overfitting, error measures, curse of dimensionality...). 2. Have a working knowledge of the basic mathematics (probability, expectation, entropy, basic linear algebra, ...) and algorithms behind common machine learning techniques; together with their suitability in given situations. 3. Given a machine learning problem, be able to implement and evaluate one of the standard machine learning algorithms (e.g. decision trees, neural networks, SVMs) using a tool such as Weka/Matlab or a programming language Python/R.
Learning Outcomes	1. Have a solid understanding of the basic concepts, issues, assumptions and limitations in machine learning and how they apply to various machine learning techniques. 2. Have a working knowledge of the basic mathematics (probability, expectation, entropy, basic linear algebra, ...) and algorithms behind common machine learning techniques; together with their suitability in given situations. 3. Given a machine learning problem, select, implement and evaluate one of the appropriate machine learning algorithms (e.g. decision trees, neural networks, SVMs) using a programming environment such as Python (Colab) or Matlab.
Tentative Outline	1. **Introduction to ML concepts**: supervised learning, regression, classification, features, train-validation, overfitting, error measures,… (~2 weeks) 2. **Simple ML approaches**: Linear regression; Logistic regression; Nearest Neighbor Classifier; Decision tree learning (~2 weeks) **3. Bayesian Approaches:** Bayes theorem, Naïve Bayes, Multivariate Gaussian distribution, Parameter estimation (~2 weeks) 4. **Neural Networks** – Multi-Layer Perceptron, Activation functions, Capabilities, Backpropagation (~2 weeks) 5. **Deep learning**: Convolutional neural Networks, Transfer Learning (~2 weeks) **6. Support Vector Machines: SVMs and Kernels** (2 hrs) 7. **Bias-Variance and Ensemble Methods** (1.5-2 weeks) 8. **Practical Issues in ML:** Missing values, Imbalanced Classes,… (~1 week)

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Textbook(s) Textbooks: None, some references will be provided. Optional Readings: Advanced or alternative explanations will be provided as supplement to lecture slides and course textbook. There are also many ML or Pattern Recognition books in IC, some as online resources. E.g. E. Alpaydin, Machine Learning.

Course Description: This is an introductory machine learning course that will aim a solid understanding of the fundamental issues in machine learning (overfitting, bias/variance), together with several state-of-art approaches such as decision trees, linear regression, k-nearest neighbor, Bayesian classifiers, neural networks, logistic regression, and classifier combination.

Grading

- **Midterm** (25%) & **Final** (30%) – in person (allowing for earthquake related exceptions)
- **Homeworks**: 25% - 4-5 total: 2 or 3 written, 2 or 3 programming (Python)
- **Project**: 10%
  - Project will be chosen among few given alternatives – most likely a Kaggle competition
  - Can be done in groups of 2-4, but with individual grading.
- **Quizzes** (at least 10 quizzes, each of them about 5-15 points worth): 10%

Quizzes

- Quiz dates are the end 10 minutes of every 2-hr lecture.
- If the max total is 200 points, your quiz score will be computed as:

  min(100,100*sum(all your quiz scores)/(200*0.9))

  to allow for missing quizzes due to any reasons. I.e. you can lose 10% of quiz points and still have 100 as your quiz score.

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Learning Objectives

1. Understand the basic concepts, issues, assumptions and limitations in machine learning (e.g. overfitting, error measures, curse of dimensionality...).
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Learning Outcomes

1. Have a solid understanding of the basic concepts, issues, assumptions and limitations in machine learning and how they apply to various machine learning techniques.
2. Have a working knowledge of the basic mathematics (probability, expectation, entropy, basic linear algebra, ...) and algorithms behind common machine learning techniques; together with their suitability in given situations.
3. Given a machine learning problem, select, implement and evaluate one of the appropriate machine learning algorithms (e.g. decision trees, neural networks, SVMs) using a programming environment such as Python (Colab) or Matlab.

Tentative outline:

1. Introduction to ML concepts
2. Simple ML approaches: Nearest Neighbor Classifier; Linear regression; Decision tree learning;
3. Bayesian Approaches
4. Multivariate Distr.-Gaussian Bayes - Parameter Estimation
5. Neural Networks – Basic (Multi-Layer Perceptron)
6. Deep learning: Convolutional neural Networks
7. Practical Issues (Missing values, imbalanced classes,…)
8. Bias-Variance and Ensemble Methods
9. Support Vector Machines