City University of Hong Kong
Course Syllabus

offered by Department of Electrical Engineering
with effect from Semester B in 2022/2023

Part I Course Overview

Course Title:	Machine Learning for Signal Processing Applications
Course Code:	EE5434
Course Duration:	One Semester (13 weeks)
Credit Units:	3
Level:	P5
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	Programming training equivalent to EE2331
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

This course aims to provide students with a fundamental understanding of basic and emerging machine learning models and their applications in processing signals in various fields such as smart health, bioinformatics, adaptive control theory, medical image analysis, etc.

The course is designed so that the students can obtain the basic ideas and intuition behind modern machine learning methods as well as some formal understanding of how and why they work. Correspondingly, one set of topics will focus on the general theme of statistical inference, which will allow the students to apply the basic techniques to different types of data, such as sensor data, discrete samples from wearables, and medical images. Another set of topics will focus more on existing machine learning models/algorithms such as supervised learning (neural networks, support vector machines); unsupervised learning (clustering, dimensionality reduction); adaptive control; transfer learning. The course will also discuss recent applications of machine learning such as medical image analysis, multi-sensor data analysis, spatial and temporal signal processing. This course requires students to have prior knowledge on basic programming skills, at a level sufficient to write a reasonable computer program, basic probability theory and linear algebra.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Recognize the latest needs and issues in applying machine learning to infer patterns and knowledge from data obtained from modern technologies in signal processing;		✓		
2.	Identify key applications and research problems in signal processing that can benefit from machine learning algorithms and models		✓	✓	
3.	Understand and be able to implement key machine learning analysis techniques				✓
4.	Demonstrate the ability of critical thinking of choosing and using appropriate machine learning models and methods		✓	✓	
		100%			

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.

A3: *Accomplishments*
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4			
Lecture	Lectures on statistical inference, machine learning models, algorithms, and implementation-related issues for applications in signal processing.	✓	✓	✓	✓			3 hrs/wk (wk 1 – wk 8, wk 11 – wk 13)
Presentations by students	After the students obtained a good understanding of basic machine learning methods and models, they will need to identify some key applications or needs for using machine learning models/methods in signal processing by conducting critical reading of academic and industrial publications for delivering presentation(s).	✓	✓	✓	✓			3 hrs/wk (wk 9 and 10)

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting	Remarks
	1	2	3	4				
Continuous Assessment: 60%								
Tests (min.: 2)	✓	✓	✓	✓			40%	
#Assignments (min.: 3)	✓	✓	✓	✓			20%	
Examination: 40% (duration: 2hrs , if applicable)								
Examination	✓	✓	✓	✓			40%	
							100%	

Remark:
To pass the course, students are required to achieve at least 30% in course work and 30% in the examination.
may include homework, tutorial exercise, project/mini-project, presentation

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Applicable to students admitted in Semester A 2022/23 and thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B,)	Marginal (B-, C+, C)	Failure (F)
1. Examination	Achievements in CILOs	High	Medium	Low	Not even reaching marginal level
2. Coursework	Achievements in CILOs	High	Medium	Low	Not even reaching marginal level

Applicable to students admitted before Semester A 2022/23

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Examination	Achievements in CILOs	High	Significant	Moderate	Basic	Not even reaching marginal level
2. Coursework	Achievements in CILOs	High	Significant	Moderate	Basic	Not even reaching marginal level

6. Constructive Alignment with Programme Outcomes

PILO	How the course contribute to the specific PILO(s)
1, 2	Students will be able to describe current and anticipated trends in the selected areas, and be able to evaluate and analyze new technologies in the selected areas through literature survey.
6	Students will be able to apply effective communication skills in their professions through report writing and presentation.

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

The course will give an overview of many concepts and techniques in machine learning, including both basic machine learning methods such as decision tree and also more powerful techniques such as deep learning. The course will also emphasize the applications of machine learning methods/models on different types of data. Some example topics can be found below:

1. Fundamental concepts in machine learning
    - The problem formulation of learning
    - Components of learning
    - Different types of learning problems
2. Feasibility of learning
    - Generalization error
    - Effective hypothesis space
    - Growth function of hypothesis
    - VC (Vapnik-Cheronenkis) dimension and VC inequality
3. Fundamental learning models
    - Linear learning models
    - Generative models for discrete data
    - Gaussian models
    - Bayesian statistics
    - Linear regression
    - Logistic regression
    - Perceptron model
    - Neural network
    - Expectation-Maximization algorithm
    - Support Vector machines
    - Non-linear transformation
    - CNN (Convolutional Neural Network)
4. Application of machine learning in different fields such as bioinformatics, smart health, medical image analysis

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

1.	Nil

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	Learning from data: Yaser S. Abu-Mostafa, Malik Magdon-Ismail, Hsuan-Tien Lin.
2.	Pattern Recognition and Machine Learning, Christopher M. Bishop, 2006
3	Machine Learning: a Probabilistic Perspective by Kevin Patrick Murphy