City University of Hong Kong
Course Syllabus

offered by School of Data Science
with effect from Semester A 2021/22

Part I Course Overview

Course Title:	**Fundamentals of Machine Learning II**
Course Code:	**SDSC4016**
Course Duration:	**One Semester**
Credit Units:	**3**
Level:	**B4**
Proposed Area: *(for GE courses only)*	☐ Arts and Humanities ☐ Study of Societies, Social and Business Organisations ☐ Science and Technology
Medium of Instruction:	**English**
Medium of Assessment:	**English**
Prerequisites: *(Course Code and Title)*	**SDSC3006 Fundamentals of Machine Learning I**
Precursors: *(Course Code and Title)*	**Nil**
Equivalent Courses: *(Course Code and Title)*	**Nil**
Exclusive Courses: *(Course Code and Title)*	**Nil**

Part II Course Details

1. Abstract

(A 150-word description about the course)

This elective course provides students who have the basic foundations of machine learning with an intensive studies of advanced machine learning techniques for data science. Topics include linear model selection and regularization, kernel-based methods and kernel tricks, model assessment and selection, neural network models and computational learning theory.

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.	understand advanced machine learning techniques for data science	20%	√		
2.	state clearly various learning tasks and select appropriate advanced machine learning methods	20%	√	√	
3.	apply advanced machine learning algorithms and error analysis to typical datasets	30%	√	√	√
4.	solve some practical problems in data science by advanced machine learning techniques and statistical analysis	30%	√	√	√
		100%			

** If weighting is assigned to CILOs, they should add up to 100%.*

[#] Please specify the alignment of CILOs to the Gateway Education Programme Intended Learning outcomes (PILOs) in Section A of Annex.

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	Learning through **teaching** is primarily based on lectures.	√	√	√	√	39 hours in total
Take-home assignments	Learning through **take-home assignments** is primarily based on interactive problem solving and hand-on computer exercises allowing instant feedback.		√	√	√	after class

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%						
Assignments	√	√	√	√	30%	
Midterm	√	√		√	30%	
Examination: 40% (24-hour open-book taken-home programming exam)						
Examination	√	√	√	√	40%	
**The weightings should add up to 100%.*					100%	

For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

5. Assessment Rubrics

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

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Continuous assessment	Ability to understand different machine learning methods and to justify the methods using appropriate theory.	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Examination	A 24-hour open-book programming exam are designed to assess students' ability to use Python to implement appropriate machine learning methods on given datasets and make accurate predictions.	High	Significant	Moderate	Basic	Not even reaching marginal levels

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

1. Keyword Syllabus

(An indication of the key topics of the course.)

- Model Assessment and Selection:
  - Bias, variance and model complexity
  - AIC and BIC
  - Cross validation and Bootstrap methods

- Supervised and unsupervised learning:
  - Support vector machine
  - Random forest, Bagging and Boosting
  - Lasso, adaptive Lasso and other regularization methods
  - K-means, hierarchical clustering and spectral clustering
  - PCA and Kernel PCA

- Neural networks:
  - Feed-forward neural networks
  - Convolutional neural networks and recurrent neural networks
  - Autoencoder
  - Generative adversarial networks

- Basics of Learning theory:
  - Kernels; kernel-induced feature space; Reproducing Kernel Hilbert Spaces
  - Statistical estimates in expectation, exponential probability inequalities, linear support vector machines and estimates of misclassification error for separable data, nonlinear models and hypothesis spaces of functions

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.	Lecture slides and other related material

2.2. Additional Readings

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

1.	An Introduction to Statistical Learning, by James, Witten, Hastie, Tibshirani, Springer 2013
2.	The Elements of Statistical Learning, by Hastie, Tibshirani, Friedman, Springer 2001
3.	Mohri, M., Rostamizadeh, A., & Talwalkar, A. (2012). Foundations of machine learning (Adaptive computation and machine learning). Cambridge, MA: MIT Press.
4.	Tom Mitchell. “Machine Learning”. McGraw-Hill, 1997. and http://www.cs.cmu.edu/~tom/NewChapters.html
5.	Learning Theory: An Approximation Theory Viewpoint, by Cucker and Zhou, Cambridge University Press, 2007.