City University of Hong Kong
Course Syllabus

offered by School of Data Science
with effect from Semester A 2019/20

Part I Course Overview

Course Title:	**Deep Learning**
Course Code:	**SDSC4008**
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 course provides students with an extensive exposure to deep learning. Topics include shallow and deep neural networks, activation functions and rectified linear unit, construction of deep neural networks and matrix representations including deep convolutional neural networks and deep recursive neural networks, computational issues including backpropagation, automatic differentiation, and stochastic gradient descent, complexity analysis, approximation analysis including universality of approximation, design of deep neural network architectures and programming according to various applications.

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 the basic ingredients of deep learning and constructing deep neural networks by matrix representations	20%	√		
2.	State clearly application domains and the properties of deep neural networks with various architecture	20%	√	√	
3.	Conduct complexity analysis and approximation analysis of deep learning methods	30%	√	√	√
4.	Apply deep learning algorithms to typical datasets, design new algorithms from theoretical understanding of complexity and approximation, and solve some practical problems in data science by deep learning algorithms	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: 40%						
Test	√	√	√	√	20--40%	Questions are designed for the first part of constructing deep neural networks and computing with backpropagation to see how well the students have learned the basic ingredients of deep learning and applications of deep learning algorithms to some typical datasets.
Hand-in assignments			√	√	0--20%	These are skills based assessment to enable students to demonstrate the basic concepts, methods and algorithms of deep learning, and applications of deep learning algorithms in some applications.
Formative take-home assignments		√	√	√	0%	The assignments provide students chances to demonstrate their achievements on deep learning methods learned in this course.
Examination: 60% (duration: 2 hours)	√	√	√	√	60%	Examination questions are designed to see how far students have achieved their intended learning outcomes.
**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. Test	Ability to understand the basic ingredients of deep learning and apply deep learning algorithms.	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Hand-in assignments	Ability to learn the basic concepts, apply methods and algorithms of deep learning, and develop applications of deep learning algorithms.	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Formative take-home assignments	Ability to grasp basic principles of deep learning, understand deep neural network structures, and apply deep learning algorithms to some practical data sets.	High	Significant	Moderate	Basic	Not even reaching marginal levels
4. Examination	Ability to solve learning tasks using deep learning algorithms.	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.)

- Review of neural networks: activation functions, sigmoidal functions and rectified linear unit.
- Construction of deep neural networks and matrix representations: fully connected networks represented by full matrices, deep convolutional neural networks represented by convolutional matrices, deep recursive neural networks represented by structured matrices, and pooling.
- Computational issues: backpropagation and automatic differentiation, and the role of rectified linear unit in deep learning, non-convex optimization and saddle problems in training deep neural networks.
- Complexity analysis: regularization for deep learning, learning ability in terms of the number of hidden neurons and depth of the deep neural networks.
- Approximation analysis: universality of approximation of functions, better approximation by deeper layers.
- Design of deep neural network architectures and programming according to various applications of deep learning.

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.	Neural Networks and Deep Learning: a Textbook by Charu C. Aggarwal. Springer. 2018

2.2. Additional Readings

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

1.	Deep Learning Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016 http://www.deeplearningbook.org