香港城市大學
City University of Hong Kong

City University of Hong Kong
Course Syllabus

offered by School of Data Science
with effect from Semester A 2024/25

Part I Course Overview

Course Title:	Reinforcement Learning
Course Code:	SDSC8006
Course Duration:	One semester
Credit Units:	3
Level:	R8
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
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

The goal of this course is to provide a clear account of the key concepts and solution algorithms of reinforcement learning. Topics include optimal control, dynamic programming (including policy iteration and value iteration), Markov decision processes, temporal-difference learning, value approximation, policy approximation, Q-learning and various reinforcement learning algorithms. Emphasis will be placed on trade-off between exploitation and exploration, and the trade-off between the sub-optimality and tractability. We will learn how to formulate, analyze and solve various reinforcement learning problems. Applications in various fields will be also discussed.

2. Course Intended Learning Outcomes (CILOs)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes		
			A1	*A2*	*A3*
1.	Explain the basic ideas, concepts and principles of dynamic programming and reinforcement learning	10%	✓	✓	
2.	Explain the theories and solution methodologies for optimal control, dynamic programming and reinforcement learning	60%	✓	✓	✓
3.	Formulate various problems to be reinforcement learning problems and implement the correct solvers to solve them	15%		✓	
4.	Model the applications of reinforcement learning in real world	15%	✓	✓	✓
		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. Learning and Teaching Activities (LTAs)

LTA	Brief Description	CILO No.					Hours/week (if applicable)
		1	2	3	4	5	
Lectures	Students will engage in lectures that introduce key knowledge points of dynamic programming and reinforcement learning methods covered in this course	✓	✓	✓	✓		29 hours/sem
Tutorial Sessions	Students will participate in tutorial sessions that have more explanation and exercises to familiarize themselves with the methods learnt during the lectures. Students will develop the ability of implementing dynamic programming and reinforcement learning algorithms.	✓	✓	✓	✓		10 hours/sem

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.					Weighting	Remarks
	1	2	3	4			
Continuous Assessment: 70 %							
Assignments Students are required to explain knowledge and apply methodologies learned from the course in solving some problems.	✓	✓	✓	✓		20%	
Midterm Students will be assessed via the examination in their ability to explain the concepts and apply methodologies and technologies in solving dynamic optimization problems and reinforcement learning problems learned in class.	✓	✓	✓	✓		20%	
Course project(s) Students will be assessed via course projects in demonstrating their ability in solving reinforcement learning problems. Students will present their projects to their peers, and they will write feedbacks for others' presentations. Students will also write a report on their project. Possible topics include state-of-the-art reinforcement learning algorithms and theories, as well as advanced topics in reinforcement learning that are not covered in lectures.	✓	✓	✓	✓		30%	
Examination: 30% (duration: 2 hours)						30%	
						100%	

5. Assessment Rubrics

Applicable to students admitted from Semester A 2022/23 to Summer Term 2024

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Assignments	Based on submitted written work to evaluate the ability to explain the knowledge of reinforcement learning learned in class.	High	Moderate	Basic	Not even reaching marginal levels
2. Midterm	Based on submitted written work and programming code to evaluate their ability to explain core concepts of reinforcement learning, as well as the ability of applying different reinforcement learning algorithms.	High	Moderate	Basic	Not even reaching marginal levels
3. Course project(s)	Based on submitted written work and oral presentation to evaluate students' synthesis ability and clarity, their knowledge of reinforcement learning, and their ability to extend their knowledge in reinforcement learning.	High	Moderate	Basic	Not even reaching marginal levels
4. Examination	Ability to solve problems of reinforcement learning and Markov decision process with fundamental methods.	High	Moderate	Basic	Not even reaching marginal levels

Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Assignments	Based on submitted written work to evaluate of the ability to explain the knowledge of reinforcement learning learned in class.	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Midterm	Based on submitted written work and programming code to evaluate their ability to explain core concepts of reinforcement learning, as well as the ability of applying different reinforcement learning algorithms.	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Course project(s)	Based on submitted written work and oral presentation to evaluate students' synthesis ability and clarity, their knowledge of reinforcement learning, and their ability to extend their knowledge in reinforcement learning.	High	Significant	Moderate	Basic	Not even reaching marginal levels
4. Examination	Ability to solve problems of reinforcement learning and Markov decision process with fundamental methods.	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

Dynamic programming, Markov decision processes, temporal-difference learning, value approximation, policy approximation, Q learning, bandit problems

2. Reading List

2.1 Compulsory Readings

1.	Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction
2.	Lecture Notes and Slides

2.2 Additional Readings

NIL

1.	Dimitris Bertsimas. Dynamic Programming and Optimal Control
2.	Csaba Czepesvári, Algorithms for Reinforcement Learning
3.	Dimitris Bertsimas. Reinforcement Learning and Optimal Control