

The Hong Kong Polytechnic University

Subject Description Form

Subject Code	DSAI625
Subject Title	Advanced Topics in Brain-inspired Computing
Credit Value	3
Level	6
Pre-requisite	Knowledge in linear algebra, calculus, python programming, and artificial neural network.
Objectives	<ol style="list-style-type: none"> 1. To introduce the modern concepts in brain-inspired computing, covering advanced topics in learning algorithms, neural coding, neural architectures, and neuromorphic hardware. 2. To apply the acquired knowledge and skills to various real-world tasks, such as audio-visual perception, robotics, reasoning, and planning.
Intended Learning Outcomes	<p>Upon completion of the subject, students will be able to:</p> <ol style="list-style-type: none"> a. Acquire in-depth knowledge of the principles and theories of learning algorithms, neural coding, and neural architectures that form the foundation of neural computation. b. Critically review issues and challenges in brain-inspired computing. c. Develop new insights into cutting-edge brain-inspired computing research. d. Apply brain-inspired models and algorithms in real-world applications.
Subject Synopsis/ Indicative Syllabus	<p><u>Fundamentals</u></p> <ul style="list-style-type: none"> • Overview of brain-inspired computing concepts, including learning algorithms, neural coding, spiking neural networks, and neuromorphic hardware • Overview of neural signal analysis, including neural signal processing and analytics, brain-computer interface <p><u>Advanced Topics</u></p> <ul style="list-style-type: none"> • Learning Theory: unsupervised learning, self-supervised learning, local and online learning, continual learning, etc. • Sensory Perception: visual, auditory, olfactory, tactile, gustatory systems • Cognitive Computing: memory, emotion, attention, consciousness, etc. • Brain Simulation and Decoding • Neuromorphic hardware and systems: neuromorphic chips,

	<p>neuromorphic sensors, neuromorphic robots</p> <p>Applications</p> <ul style="list-style-type: none"> Applications of brain-inspired computing techniques in computer vision, speech processing, robotics, etc. 																																		
Teaching/Learning Methodology	39 hours of class activities including lectures on the main concepts, models, and theory, together with case studies, and class questions/answers/discussions. Additional reading of research papers will be assigned, whenever appropriate.																																		
Assessment Methods in Alignment with Intended Learning Outcomes	<p>Students' performance in this subject will be assessed using a letter-grading system in accordance with the University's convention from grade F (failure) to A+. The relative weighting of the different assessment components are as follows:</p> <table border="1"> <thead> <tr> <th rowspan="2">Specific assessment methods/ tasks</th> <th rowspan="2">% weighting</th> <th colspan="4">Intended subject learning outcomes to be assessed</th> </tr> <tr> <th>a</th> <th>b</th> <th>c</th> <th>d</th> </tr> </thead> <tbody> <tr> <td>1. Assignment</td> <td>20</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> </tr> <tr> <td>2. Project</td> <td>60</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> </tr> <tr> <td>3. Quiz</td> <td>20</td> <td>✓</td> <td></td> <td>✓</td> <td></td> </tr> <tr> <td>Total</td> <td>100</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p>Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:</p> <p>Assignment: assessment of the understanding the basic concepts and the ability for self-learning by acquiring knowledge from published works and online resources.</p> <p>Project: assessment of the ability for solving practical research problems with implementation of algorithms or systems for demonstration. The results will be presented in written reports and oral presentations.</p> <p>Quiz/Exam: assessment of the ability for comprehension of fundamental concepts, principles, algorithms, and theories by providing answers to given questions.</p>	Specific assessment methods/ tasks	% weighting	Intended subject learning outcomes to be assessed				a	b	c	d	1. Assignment	20	✓	✓	✓	✓	2. Project	60	✓	✓	✓	✓	3. Quiz	20	✓		✓		Total	100				
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1. Assignment	20	✓	✓	✓	✓																														
2. Project	60	✓	✓	✓	✓																														
3. Quiz	20	✓		✓																															
Total	100																																		
Student study effort expected	Class Contact:																																		
	Class Activities (lectures, seminars, labs, tutorials)	39 hours																																	
	Other student study effort:																																		
	Self-study, Exercises, Assignments, Quizzes, Exams	83 hours																																	
	Total student study effort	122 hours																																	
Reading list and references	1. Gerstner, Wulfram, et al. Neuronal dynamics: From single neurons to networks and models of cognition. Cambridge University Press, 2014.																																		

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| | <ol style="list-style-type: none">2. Bear, Mark, Barry Connors, and Michael A. Paradiso. Neuroscience: exploring the brain, enhanced edition: exploring the brain. Jones & Bartlett Learning, 2020.3. Research papers and articles selected from:<ul style="list-style-type: none">- Nature- Science- IEEE Transactions on Pattern Analysis and Machine- IEEE Transactions on Neural Networks and Learning Systems- AI Conference (NeurIPS, ICML, ICLR, AAI, IJCAI, etc.) |
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