澳門理工大學
Universidade Politécnica de Macau
Macao Polytechnic University

FACULTY OF APPLIED SCIENCES

BACHELOR OF SCIENCE IN ARTIFICIAL INTELLIGENCE

LEARNING MODULE OUTLINE

Academic Year	2025/2026	Semester	2
Module Code	CSAI3123		
Learning Module	Neural Networks and Deep Learning		
Pre-requisite(s)	MATH1111 Linear Algebra MATH1112 Calculus		
Medium of Instruction	English		
Credits	3	Contact Hours	45 hrs
Instructor	Shangsong Liang	Email	sliang@mpu.edu.mo
Office	--	Office Phone	--

MODULE DESCRIPTION

This module is an advanced Machine Learning module concentrates on modern deep neural network (DNN) based machine learning topics. It starts with the key concepts in Deep Learning including deep neural networks, activation and loss function, back propagation. Popular Deep Learning methods will be discussed in details, including training tips for DNN, CNN, anomaly detection, attacking and defence of DNN, RNN, LSTM, word embedding, GAN, GNNs, VAE, Diffusion model, and their applications such as in anomaly detection, and bioinformatics etc.

Some DNNs for applications will also be introduced, including Sequence-to-sequence Model, Attention-based Model, Transformers etc. Students will learn these concepts with practices using Python language and Machine Learning frameworks such as PyTorch or Keras.

MODULE INTENDED LEARNING OUTCOMES (ILOS)

On completion of this learning module, students will be able to:

M1.	Apply theoretical machine learning concepts and algorithms solve practical problems; (C2;)
M2.	Design deep learning network architectures and apply proper training procedures; (C2, C3, C5)
M3.	Examine multiple criteria for analyzing different deep learning algorithms, and evaluate algorithms on these metrics: e.g., empirical performance, convergence, etc. (C3, C4)
M4.	Identify appropriate state-of-the-art deep learning algorithms to tackle a real-world machine learning application task, analyze the experimental results, and draw the conclusion; (C5, C6, C7, C16, C17)

These ILOs aims to enable students to attain the following Programme Intended Learning Outcomes (PILOs):

PILOs	M1	M2	M3	M4
P1. Select and apply proven methods, tools and techniques to the effective and efficient implementation of information systems on common platforms, including the Internet platform;	✓		✓	✓
P2. Acquire essential knowledge in specific fields of artificial intelligence, including machine learning, computer vision and natural language processing;	✓	✓		✓
P3. Apply necessary mathematical techniques to model, analyse and devise solutions to complex problems;	✓	✓		✓
P4. Work independently to develop an understanding of, and the knowledge and skills associated with the general support and mitigation of security risks of computer systems and networks;				✓
P5. Design and implement both relational and non-relational data stores, with an emphasis on how to organise, maintain, retrieve and analyse information;				
P6. Distinguish the fundamental and operational issues of computer systems and artificial intelligence applications, with considerations of user, business, ethical, societal and environmental needs;				✓
P7. Evaluate, prepare and communicate effectively on technical information to both technical and non-technical audience;				✓
P8. Work as an effective member of a team in the analysis, design and development of software systems, with recognition of requirement to support equality, diversity and inclusion;				✓
P9. Use project planning, risk management and quality management techniques in solutions to complex problems;				
P10. Build the capacity and desire for lifelong learning and to learn advanced and emerging technologies on one's own.				

MODULE SCHEDULE, COVERAGE AND STUDY LOAD

Week	Content Coverage	Contact Hours
1	1. Introduction	3
	1.1 What are neural networks?	
	1.2 Activation functions and error functions	
	1.3 Back propagation networks	
	1.4 Applications of neural networks	
2-5	2. Deep learning	12
	2.1 Back propagation	
	2.2 Convolutional neural networks	
	2.3 Training deep models	

	2.4 Special training technologies	
	2.5 Application domains	
	2.6 Recurrent neural networks	
	2.7 LSTM	
	2.8 Application domains	
	2.9 Why deep	
6	3. Sequence to sequence	3
	3.1 Sequence as in input	
	3.2 Self attention	
	3.3 Batch normalization	
	3.4 Encoder and decoder	
7-9	4. Generation	9
	4.1 GANs	
	4.2 Theory behind GANs	
	4.3 VAE	
	4.4 Diffusion models	
	4.5 Flow based models	
10	5. Recent advance in self-supervised learning	3
	5.1 Word embedding models	
	5.2 BERT	
	5.3 GPT	
	5.4 Multi-modal self-supervised learning	
11	6. Attack and Defense	3
	6.1 Attacking Deep Neural Networks	
	6.2 Defense methods	
	6.3 Explainable AI	
12-14	7. Other Deep Learning methods	9
	7.1 Network compression	
	7.2 Life-long learning	

	7.3 Meta learning	
	7.4 Graph neural networks	
	7.5 Re-enforcement learning	
15	8. Applications of Deep Learning	3
	8.1 Anomaly detection	
	8.2 Information retrieval	
	8.3 Generative augmented retrieval	
	8.4 NLP	
	8.5 Bioinformatics	

TEACHING AND LEARNING ACTIVITIES

In this learning module, students will work towards attaining the ILOs through the following teaching and learning activities:

Teaching and Learning Activities	**M1**	**M2**	**M3**	**M4**
T1. Lectures	✓	✓	✓	✓
T2. In-class tutorials and question-answering		✓	✓	✓

ATTENDANCE

Attendance requirements are governed by the Academic Regulations Governing Bachelor's Degree Programmes of the Macao Polytechnic University. Students who do not meet the attendance requirements for the learning module shall be awarded an 'F' grade.

ASSESSMENT

In this learning module, students are required to complete the following assessment activities:

Assessment Activities	**Weighting (%)**	**AHEP4 LOs**	**ILOs to be Assessed**
A1. Assignments (x2)	20	C4, C5, C6, C7, C16, C17	M3, M4
A2. Group project	15	C4, C5, C6, C7, C16, C17	M3, M4
A3. Test	15	C2, C3	M1, M2, M3
A4. Examination	50	C2, C3	M1, M2, M3

The assessment will be conducted following the University's Assessment Strategy (see www.mpu.edu.mo/teaching_learning/en/assessment_strategy.php). Passing this learning module indicates that students will have attained the ILOs of this learning module and thus acquired its credits.

Students with an overall score of less than 35 in the coursework must take the re-sit examination even if the overall score for the module is 50 or above.

Students with a score of less than 35 in the final examination must take the re-sit examination even if the overall score for the module is 50 or above.

Students with an overall final grade of less than 35 are NOT allowed to take the re-sit examination.

REQUIRED READINGS

There is no official textbook for this module. Module notes are distributed in the class.

REFERENCE BOOK(S)

1. Stuart Russel and Peter Norvig, Artificial Intelligence: A Modern Approach (4th Edition), Pearson, (2020)

2. Shai Shalev-Shwartz and Shai Ben-David (2014). *Understanding Machine Learning: From Theory to Algorithms.* Cambridge University Press.

3. Ian Goodfellow, Yoshua Bengio and Aaron Courville (2016). *Deep Learning.* An MIT Press book, http://www.deeplearningbook.org.

STUDENT FEEDBACK

At the end of every semester, students are invited to provide feedback on the learning module and the teaching arrangement through questionnaires. Your feedback is valuable for instructors to enhance the module and its delivery for future students. The instructor and programme coordinators will consider all feedback and respond with actions formally in the annual programme review.

ACADEMIC INTEGRITY

The Macao Polytechnic University requires students to have full commitment to academic integrity when engaging in research and academic activities. Violations of academic integrity, which include but are not limited to plagiarism, collusion, fabrication or falsification, repeated use of assignments and cheating in examinations, are considered as serious academic offenses and may lead to disciplinary actions. Students should read the relevant regulations and guidelines in the Student Handbook which is distributed upon the admission into the University, a copy of which can also be found at www.mpu.edu.mo/student_handbook/.