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

FACULTY OF APPLIED SCIENCES

MASTER OF SCIENCE IN BIG DATA AND INTERNET OF THINGS

LEARNING MODULE OUTLINE

Academic Year	2024/2025	Semester	1
Module Code	COMP6116		
Learning Module	Selected Topics I - Convolutional neural networks for video analysis		
Pre-requisite(s)	Nil		
Medium of Instruction	English		
Credits	3	Contact Hours	45 hrs
Instructor	Dr. Yue Sun	Email	yuesun@mpu.edu.mo
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MODULE DESCRIPTION

The exponential increase in computational power and available datasets have fueled the emergence of deep learning as a robust alternative to conventional machine learning methods. Especially in the field of computer vision, strong progress has been made in the automated recognition of image/video content using deep Convolutional Neural Networks (CNNs). This learning module introduces end-to-end machine learning approaches for automatically interpreting visual content, including image classification, object detection, object tracking, and more. The learning module addresses both the theoretical underpinnings and the practical implementation of CNNs, thereby offering an essential toolset in a wide variety of application domains, ranging from medical imaging to surveillance.

MODULE INTENDED LEARNING OUTCOMES (ILOS)

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

M1.	Outline the mechanics and objectives of the basic building blocks of a CNN (AHEP4-M4)
M2.	Discriminate the differences between conventional machine learning and deep (end-to-end) learning and critique the most important aspects of both (AHEP4-M4)
M3.	Evaluate the available image and video analysis techniques (AHEP4-M4)
M4.	Design deep learning-based solutions to real applications, starting from preparing the input data, to model training, and eventually evaluating the model performance (AHEP4-M1, AHEP4-M5)

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

PILOs		**M1**	**M2**	**M3**	**M4**
P1.	Master the principles of system engineering and relevant enabling technologies for building of IoT solutions				✓
P2.	Critically evaluate scientific methodologies and mathematical models for Big Data and its applications				✓

P3.	Master the advanced software and programming tools and techniques for IoT solutions and Big Data				✓
P4.	Explain the processes involved in IoT solutions and Big Data analytics in a typical business setting				
P5.	Explain different application domains and analyze their requirements for IoT and Big Data		✓	✓	
P6.	Apply knowledge in advanced communication and multimedia technologies for the design and implementation of IoT solutions	✓			✓
P7.	Apply knowledge in applied statistics, machine learning, leading-edge technologies and programming techniques for Big Data				✓
P8.	Design and carry out an advanced project following an ethical and professional methodology				
P9.	To demonstrate advanced knowledge and R&D techniques in Big Data and IoT			✓	
P10.	To investigate and develop new, emerging ICT technology for Big Data and IoT				
P11.	To develop a global vision on the critical development and new application of Big Data and IoT		✓	✓	
P12.	To communicate technically and effectively in both speaking and writing				
P13.	To have a positive attitude towards society and the environment.				
P14.	To adhere to high moral standards and commit to excellence in life-long learning.				

MODULE SCHEDULE, COVERAGE AND STUDY LOAD

Week	Content Coverage	Contact Hours
1-2	1. Introduction to computer vision	3
	1.1 A brief history of computer vision	
	1.2 Image/Video analysis – Computer vision subdomains	
	1.3 The deep learning revolution	
2-4	2. Data-driven image classification	8.5
	2.1 Feature engineering for machine learning	
	2.2 Linear classification	
	2.3 Model performance evaluation	
	2.4 Case study: Facial expression recognition	
4-5	3. Loss functions and optimization	3
	3.1 Loss functions	

	3.2 Optimization	
5-7	4. Introduction to CNN	6.5
	4.1 Neural networks and backpropagation	
	4.2 Multi-layer perceptrons	
	4.3 Convolution for feature extraction	
7-10	5. CNN architectures	7.5
	5.1 Convolution and pooling	
	5.2 Activation functions	
	5.3 Network case studies	
10-13	6. CNN-based object detection and tracking for image and video analysis	9.5
	6.1 YOLO: Real-time object detection algorithm	
	6.2 Tracking association	
	6.3 Case study: Multi-object detection and tracking using deep learning	
13-15	7. Motion estimation and image registration	7
	7.1 Motion detection and analysis	
	7.2 Case study: Continuous and automated video-based motion analysis	
	7.3 Learning-based image registration	

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 and tutorials	✓	✓	✓	✓
T2. Case studies	✓	✓	✓	
T3. In-class practical labs	✓			✓

ATTENDANCE

Attendance requirements are governed by the Academic Regulations Governing Master'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. Test	25%	AHEP4-M1	M1, M2, M3
A2. Assignments	35%	AHEP4-M1, AHEP4-M4, AHEP4-M5	M1, M4
A3. Project	40%	AHEP4-M1	M1, M2, M3, M4

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 will fail the module even if the overall score for the module is 50 or above.

Students with a score of less than 35 in the final examination will fail the module even if the overall score for the module is 50 or above.

REQUIRED READINGS

Complete module slides will be provided.

REFERENCES

1. Goodfellow, Bengio & Courville, "Deep Learning" (2015)
   Free online! (https://www.deeplearningbook.org/)
2. Richard Szeliski, "Computer Vision, Algorithms and Applications" (2024)

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/.