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	CSAI0117		
Learning Module	Advacned Topics in A.I. I (Medical Image Intelligence)		
Pre-requisite(s)	Nil		
Medium of Instruction	English		
Credits	3	Contact Hours	45 hrs
Instructor	Dr. Dengqiang Jia	Email	dengqiang.jia@mpu.edu.mo
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MODULE DESCRIPTION

Intelligent healthcare has a significant impact on quality of life and accounts for billions in annual expenditures. Medical imaging techniques are essential to computer-aided diagnosis and treatment, utilizing modalities such as Magnetic Resonance Imaging (MRI), Computed Tomography (CT), Ultrasound, and X-ray. Each of these imaging modalities offers unique advantages and, as a result, requires specialized processing methods. This module examines the fundamental computing principles behind medical imaging, with a special focus on artificial intelligence algorithms. It aims to provide a thorough understanding of the needs, development, and recent advancements in the field. Key topics include the mechanisms of medical imaging, an overview of various imaging modalities, foundational image processing techniques, and major applications such as organ/pathology detection, medical image segmentation and medical image registration.

MODULE INTENDED LEARNING OUTCOMES (ILOS)

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

M1.	Apply basic knowledges of physics, statistics and computer vision principles to the solution of the problems about mechanism and modalities of medical imaging; (C1)
M2.	Identify basic challenges of the computational modelling of medical imaging computing; analyse and discuss the issues of several common tasks of medical imaging; (C1, C2)
M3.	Analyse, select and evaluate the mathematical techniques, technical literature, and other related information to address the problems of medical imaging intelligence; (C2, C4)
M4.	Select, evaluate and apply the methods to processing medical imaging with existing literature, soft-wares, tools and libraries to address the problems, recognize the limitations and apply the relevant legal matters on these evaluations. (C4, C13, C15)

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 to medical imaging: Basic concepts	3
2-3	2. Diagnostic radiology	6
	2.1. X-ray production, tubes and generators	
	2.2. Computed tomography and magnetic resonance imaging	
	2.3. Mammography, fluoroscopy and ultrasound	
4	3. Medical image data structures and visualization	3
5	4. Mathematical preliminaries	3
6	5. Image presentation and processing	3
7-8	6. Medical image segmentation	6

	6.1 Statistical shape models	
	6.2 Segmentation by deformable models	
	6.3 Graph cut-based segmentation	
9-10	7. Medical image registration	6
	7.1 Points and surface registration	
	7.2 Graph matching and registration	
	7.3 Parametric and non-parametric volumetric registration	
11	8. Machine learning in medical image analysis	3
	8.1 Deep learning fundamentals	
	8.2 Deep learning for vision and representation learning	
	8.3 Evaluation in medical image analysis	
12-13	9. Deep learning medical image segmentation	6
	9.1 CNN-based methods	
	9.2 Transformer-based methods	
	9.3 Hybrid methods	
14-15	10. Deep learning medical image registration	6
	10.1 Supervised methods	
	10.2 Unsupervised methods	

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 exercises	✓	✓	✓	✓

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. Assignment/Classwork	20%	C1, C2, C4	M1, M4
A2. Project	20%	C1, C2, C4, C13	M1, M2, M3, M4
A3. Test	20%	C1, C2, C4	M1, M2, M3
A4. Examination	40%	C1, C2, C4, C13, C15	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

1. Jerrold T. Bushberg (2011/2020). *The Essential Physics of Medical Imaging (3rd/4th ed.)*. LIPPINCOTT WILLIAMS & WILKINS.

REFERENCES

1. Alejandro F. Frangi (2023). *Medical Image Analysis (1st ed). Academic Press*

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/.