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	1
Module Code	COMP2112		
Learning Module	Data Structures and Algorithms		
Pre-requisite(s)	MATH1113 Discrete Mathematics		
Medium of Instruction	English		
Credits	3	Contact Hours	45 hrs
Instructor	Dennis Wong Hong Lin	Email	cwong@mpu.edu.mo linhong@mpu.edu.mo
Office	N46B, Wui Chi, Main Campus A323, Chi Un, Main Campus	Office Phone	8599-6875 8599-6294

MODULE DESCRIPTION

This learning module provides an introduction to data structures and algorithms using the Python programming language. The module begins with a brief introduction to Python, followed by the concrete and abstract linear structures: linked lists, stacks and queues. Next, the fundamentals of algorithm analysis are covered. Recursive algorithms are introduced with mathematical induction to show the elementary reasoning about algorithms. Trees are discussed with the applications in heaps and search trees. Hashing and various sorting algorithms are explained and analyzed. Finally, the module concludes with some advanced algorithms on graphs.

MODULE INTENDED LEARNING OUTCOMES (ILOS)

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

M1.	Apply the fundamental techniques in algorithm analysis (C1, C3)
M2.	Define data structures for elementary algorithms (C1, C2)
M3.	Write elementary recursive algorithms (C1, C2)
M4.	Reason about elementary recursive functions and loops (C1)
M5.	Implement linked data structures (C1)
M6.	Classify and implement the fundamental sorting algorithms (C1)
M7.	Explain and show some advanced data structures, such as Trees and Graphs, and the related algorithms (C1)

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

PILOs		M1	M2	M3	M4	M5	M6	M7
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 – 2	1. Background	6
	1.1 Python Programming Fundamentals	
	1.2 Python Objects	
	1.3 Iterators and Generators	
	1.4 Representations of Data Relations	

3	2. Linear Data Structures	3
	2.1 Array-Based Sequences	
	2.2 Abstract Data Types	
	2.3 Stacks, Queues and Deques	
4	3. Fundamentals of Algorithm Analysis	3
	3.1 Asymptotic Complexity	
	3.2 The Big-O Notation	
	3.3 The Best, Average and Worst Cases	
	3.4 Amortized Complexity	
5 – 6	4. Recursion	6
	4.1 Recursive Problems and Solutions	
	4.2 Recursive Method Calls	
	4.3 Tail Recursions	
	4.4 Mathematical Induction	
7	5. Linked Lists	3
	5.1 Singly Linked Lists	
	5.2 Circular Doubly Linked Lists	
8 – 9	6. Trees and Heaps	6
	6.1 Trees and Binary Trees	
	6.2 Priority Queues and Heaps	
	6.3 Complete Binary Trees	
10	7. Binary Search Trees	3
	7.1 Properties of Binary Search Trees	
	7.2 Tree Traversals	
	7.3 Tree Rotations	
11	8. Hash Tables	3
	8.1 Hashing and hash functions	
	8.2 Hash tables and collision resolution	
12 – 13	9. Sorting Algorithms	6

	9.1 Insertion Sort	
	9.2 Selection Sort and Heapsort	
	9.3 Divide-and-Conquer, Mergesort and Quicksort	
	9.4 A Lower Bound on Comparison-Based Sorting	
14 – 15	10. Graphs	6
	10.1 Graphs and Their Representations	
	10.2 Topological Order	
	10.3 Depth-First and Breadth-First Search	
	10.4 Spanning Trees	
	10.5 Dijkstra's Shortest Path Algorithm	

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**	**M5**	**M6**	**M7**
T1. Lectures	✓	✓	✓	✓	✓	✓	✓

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/Classwork	25	C1, C2, C3	M1, M2, M3, M4, M5, M6, M7
A2. Test	25	C1, C2, C3	M1, M2, M3, M4, M5, M6, M7
A3. Examination	50	C1, C2, C3	M1, M2, M3, M4, M5, M6, M7

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. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser. (2013): *Data Structures and Algorithms in Python* (1st Edition). Wiley. ISBN-13: 978-1118290279

REFERENCES

1. Thomas H. Cormen., Charles E. Leiserson, Ronald L. Rivest, Clifford Stein. (2009): *Introduction to Algorithms* (3rd Edition, International Edition). MIT Press. ISBN-13: 978-0262033848
2. Bradley N. Miller, David L. Ranum. (2011): *Problem Solving with Algorithms and Data Structures Using Python* (2nd Edition). Franklin, Beedle & Associates. ISBN-13: 978-1590282571

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/.