Title (Units): **COMP4015 Artificial Intelligence and Machine Learning (3,2,1)**

Course Aims: To introduce the foundations, state-of-the-art models and techniques and applications of artificial intelligence, and in particular, machine learning. To give students practical insights into the current development of the field.

Prerequisite: i) COMP2015 Data Structures and Algorithms
Any two of MATH1205 Discrete Mathematics,
MATH2005 Calculus, Probability and Statistics for Computer Science
MATH2006 Calculus, Probability, and Statistics for Science
MATH2206 Probability and Statistics
COMP2027 Applied Linear Algebra for Computing
Or
ii) COMP2865 Fundamental of Data Analysis and Management

Course Intended Learning Outcomes (CILOs):
Upon successful completion of this course, students should be able to:

No.	Course Intended Learning Outcomes (CILOs)
	Knowledge
1	Explain the capabilities, strengths and limitations of various artificial intelligence and machine learning techniques
2	Explain various AI and machine learning algorithms and their applications
3	Describe learning models and algorithms
	Professional Skill
4	Apply selected AI and machine learning algorithms to solve real world problems
5	Understand complex ideas and relate them to specific situations, the ability to evaluate available learning methods and select those appropriate to solve a given task

Calendar Description: This course aims to introduce the principles and fundamental techniques of artificial intelligence, and in particular, machine learning. Students will learn the fundamentals and state-of-the-art techniques and acquire practical insights into the current development of this field.

Teaching and Learning Activities (TLAs):

CILOs	Type of TLA
1-5	Students will learn the foundations, models and techniques in lectures. Examples of how to solve problems will be demonstrated in tutorials or labs to help students to have a deep understanding of the teaching materials.
3-5	Students will work on assignments and labs to enhance the understanding of learning principles, and acquire hands-on experience on a mini project.

Assessment:

No.	Assessment Methods	Weighting	CILOs to be addressed	Description of Assessment Tasks
1	Continuous Assessment	40%	1-5	Assignments, lab exercises and mini-project will be used to evaluate students' understanding of the concepts and to assess their ability to apply learning techniques, applications and tools to solve real world problems
2	Examination	60%	1-5	Examination will be used to assess students' overall understanding of various artificial intelligence and

				machine learning algorithms, their applications, as well as their capabilities, strengths and limitations.

Assessment Rubrics:

Excellent (A)	• Achieve all CILOs, demonstrating a good mastery of both the theoretical and practical aspects of the knowledge and skills associated with artificial intelligence and machine learning • Able to develop correct solutions to problems • Demonstrate a thorough understanding and solid knowledge of artificial intelligence and machine learning • Able to apply a variety of techniques and relevant knowledge for solving problems in artificial intelligence and machine learning
Good (B)	• Achieve most of the CILOs, demonstrating a good understanding of the knowledge and skills associated with artificial intelligence and machine learning • Able to develop correct solutions to problems • Demonstrate a competent level of knowledge of artificial intelligence and machine learning • Ability to make use of appropriate techniques and knowledge and apply them to familiar problems
Satisfactory (C)	• Achieve some of the CILOs, demonstrating a basic level of understanding of the knowledge and skills associated with artificial intelligence and machine learning • Able to provide acceptable solutions to problems • Demonstrate an adequate level of knowledge of artificial intelligence and machine learning • Ability to make use of some techniques and knowledge and apply them to familiar situations
Marginal Pass (D)	• Achieve few of the CILOs, with minimal understanding of the associated concepts and underlying methodologies • Able to provide solutions to simple problems • Demonstrate a basic level of knowledge of artificial intelligence and machine learning • Ability to apply some techniques and knowledge to a limited number of typical situations
Fail (F)	• Achieve none of the CILOs, with little understanding of the associated concepts and underlying methodologies • Unable to provide solutions to simple problems • Knowledge of artificial intelligence and machine learning falling below the basic minimum level • Unable to apply techniques and knowledge to situations or problems

Course Content and CILOs Mapping:

Content		**CILO No.**
I	Foundations of AI	1, 2, 3
II	Foundations of Machine Learning	1, 2, 3
III	Bayesian Learning	2, 4
IV	Foundations of Deep Learning	3, 5
V	Reinforcement and Imitation Learning	2, 3, 5
VI	Advanced Methods such as Trustworthy Learning	2, 3, 4

References:

- Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar, Foundations of Machine Learning (Adaptive Computation and Machine Learning series) 2nd Edition, The MIT Press, December 2018.

- Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning (Adaptive Computation and Machine Learning series), The MIT Press, November 2016.
- Francois Chollet, Deep Learning with Pytorch, Manning Publication, 2017.
- Tom M. Mitchell, Machine Learning, McGraw-Hill International Editions, 1997
- Stuart Russell and Peter Norvig, Artificial Intelligence, A Modern Approach, Prentice Hall, 3rd Edition, 2009.

Course Content:

Topic

I. Foundations of AI
   A. Knowledge Representations
   B. Logic, Reasoning, and Search
   C. Concept Learning
   D. Decision Tree

II. Foundations of Machine Learning
   A. Machine Learning Basics
   B. PAC Learning, Rademacher Complexity and Model Selection
   C. Classification, Regression and Ranking
   D. Traditional Models (SVM, Kernel, Maximum Entropy etc.)

III. Bayesian Learning
   A. Maximum Likelihood, Least-Squared Error Hypotheses and Minimum Description Length Principle
   B. Bayes Optimal Classifier and Gibbs Algorithm
   C. Bayesian Belief Networks

IV. Foundations of Deep Learning
   A. Deep Forward Networks
   B. Regularization Methodology for Deep Learning
   C. Optimization Methodology for Training Deep Models
   D. Convolutional Networks and Recurrent Networks

V. Reinforcement and Imitation Learning
   A. Q-learning
   B. Temporal Difference Learning
   C. Relationship to Dynamic Programming

VI. Advanced Methods such as Trustworthy Learning