Subject Description Form

Subject Code	COMP5554
Subject Title	Advanced Artificial Intelligence
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	The objectives of this subject are to: 1. introduce the fundamental and advanced concepts and techniques of artificial intelligence (AI). 2. solve important problems using comprehensive AI techniques
Intended Learning Outcomes *(Note 1)*	Upon completion of the subject, students will be able to: a) build an extensive understanding of various advanced AI topics b) develop AI solutions, e.g., reasoning systems and deep learning methods, for real data-driven problems c) get an in-depth understanding of reinforcement learning, active learning and contrastive learning d) apply advanced AI methods, e.g, transfer learning, ensemble learning, and meta-learning, to develop sophisticated deep learning models. e) Master the rationales and techniques for adversarial learning and federated learning f) Design explainable AI techniques for real-life problems
Subject Synopsis/ Indicative Syllabus *(Note 2)*	1. *Neural Networks and Deep Learning:* Neurons, Multi-Layer Perceptron, gradient descent, important concepts of deep learning, Recurrent Neural Networks, LSTM, GRU, Convolutional Neural Networks, Graph Neural Networks, Transformers 2. *Reinforcement Learning:* Important concepts of reinforcement learning, model-based learning, model-free learning, temporal difference learning, exploration vs. exploitation, regret, and policy search 3. *Knowledge representation and reasoning:*

	Rule-based production systems, case-based reasoning systems, model-based reasoning systems, reasoning under uncertain situations: stochastic methods and fuzzy expert systems 4. *Active Learning and Contrastive Learning:* Definitions of active learning, active learning strategies and algorithms, contrastive learning objectives, algorithms for contrastive learning 5. *Adversarial Learning:* Attack strategies and types, adversarial learning techniques, adversarial learning in deep neural networks, graph adversarial networks 6. *Transfer Learning:* Concepts and applications of transfer learning, classic transfer learning approaches, transfer learning in various domains 7. *Ensemble Learning and Meta Learning:* Definitions of ensemble and meta learning, bagging and boosting in ensemble learning, multi-task learning, optimization-based meta-learning, Bayesian meta-learning 8. *Federated Learning:* Concepts of federated learning, distributed machine learning, privacy-preserving federated learning, and horizontal and vertical federated learning. 9. *Explainable AI:* Definitions and goals of Explainable AI, classic explainable methods (e.g., decision trees, Bayesian networks, sparse linear models), explainable deep learning techniques, and data visualization.
Teaching/Learning Methodology *(Note 3)*	This course explores advanced AI techniques. It provides a comprehensive view of the problems and techniques of artificial intelligence. The course involves both theory and practice of AI topics. The course covers both classic AI algorithms and recent advances in the field. Lectures will contain sufficient analysis, examples, demos, and exercises. There will be tutorials or lab sessions to let students get hands-on experience on AI techniques. A fair portion of guided reading will also be provided. 39 hours of class activities, including lectures, tutorials, labs, etc where applicable.

Assessment Methods in Alignment with Intended Learning Outcomes

(Note 4)

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)					
		a	b	c	d	e	f
1. Assignments, Tests, & Projects	55	✓	✓	✓	✓	✓	✓
2. Final Examination	45	✓	✓	✓	✓	✓	✓
Total	100 %						

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Continuous assessment consists of assignments, tests, and projects to facilitate students to achieve the intended learning outcomes. The project is designed to enhance students' ability to acquire the understanding and using different knowledge, principles, techniques, tools to solve a real problem.

The examination will assess and evaluate the student's overall understanding of the subject.

Student Study Effort Expected

Class contact:	
▪ Class activities (lectures, tutorials, labs, etc)	39 Hrs.
▪	Hrs.
Other student study effort:	
▪ Assignments, tests, projects and exam	66 Hrs.
▪	Hrs.
Total student study effort	105 Hrs.

Reading List and References

1. Deep Learning, by Aaron Courville, Ian Goodfellow, and Yoshua Bengio, The MIT Press, 2015.
2. Xindong Wu et al., Top 10 Algorithms in Data Mining, Knowledge and Information Systems, 14(2008), 1: 1-37.
3. Ronald J. Brachman, Hector J. Levesque, Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.
4. Richard S. Sutton, Andrew G. Barto, Reinforcement Learning : An Introduction, MIT Press Ltd, 2018.

	5. Anthony D. Joseph, Blaine Nelson, Benjamin I. P. Rubinstein , J. D. Tygar, Adversarial Machine Learning, Cambridge University Press, 2019. 6. Qiang Yang, Yu Zhang, Wenyuan Dai, Sinno Jialin Pan, Transfer Learning, Cambridge University Press, 2020 7. Zhou Zhihua, Ensemble Methods: Foundations and Algorithms. Chapman and Hall/CRC, 2012 8. Jonathan Gordon, John Bronskill, Matthias Bauer, Sebastian Nowozin, Richard E. Turner, Meta-Learning Probabilistic Inference For Prediction, ICLR, 2019 9. Qiang Yang, Yang Liu, Yong Cheng, Yan Kang, Tianjian Chen, Han Yu, Federated Learning, Morgan & Claypool Publishers, 2019 10. "Explainable Artificial Intelligence (XAI): Concepts, Taxonomies, Opportunities and Challenges toward Responsible AI" by DeepAI. 2019-10-22 11. Amina Adadi and Mohammed Berrada, Peeking Inside the Black-Box: A Survey on Explainable Artificial Intelligence (XAI). IEEE Access. 6: 52138–52160, 2018