COURSE CONTENT

Academic Year	2022/2023	**Semester**	Summer 2023
Course Coordinator	Asst Prof Wen Bihan (Coordinator), Professor Tan Yap Beng		
Course Code	IE4483		
Course Title	Artificial Intelligence and Data Mining		
Pre-requisites	EE/IM2007/IE2107 Engineering Mathematics II + EE/IE0005 Introduction to Data Science & Artificial Intelligence, or equivalents		
No of AUs	3		
Contact Hours	Lectures: 39 hours		
Additional notes	Background on calculus and linear algebra; basics on optimization, e.g. argmin, variable, norms. Students are encouraged to learn at least one programming language, e.g. Python, C/C++ etc)		

Course Aims

This course aims at introducing you to the fundamental theory and concepts of Artificial intelligence (AI) and Data Mining methods, in particular state space representation and search strategies, association rule mining, supervised learning, classifiers, neural networks, unsupervised learning, clustering analysis, and their applications in the area of AI and Data Mining. This can be summarized as:

1. To understand the concepts of knowledge representation for state space search, strategies for the search.
2. To understand the basics of a data mining paradigm known as Association Rule Mining and its application to knowledge discovery problems.
3. To understand the fundamental theory and concepts of supervised learning, unsupervised learning, neural networks, several learning paradigms and its applications.

Intended Learning Outcomes (ILO)

Upon completion of this course, you should be able to :

1. Demonstrate and Explain the use of state representation of problems, and strategies for the search
2. Discuss and Illustrate the concepts of state space search algorithms
3. Discuss and Illustrate the concepts of heuristic search algorithms
4. Explain basic data mining concepts/algorithms for association rule mining
5. Explain the basics of machine learning models and algorithms
6. Apply the fundamental theory and concepts of data mining and AI for wide range of data analysis including association, classification, clustering, prediction.

Course Content

Structures and Strategies for State Space Representation & Search. Heuristic Search. Data Mining Concepts and Algorithms. Classification and Prediction methods. Unsupervised Learning and Clustering Analysis.

Course Outline

S/N	Topic	Lecture Hours
1	Structures and Strategies for State Space Representation & Search	4
2	Heuristic Search	4
3	Data Mining Concepts and Algorithms	5
4	Classification and Prediction methods	20
5	Unsupervised Learning and Clustering Analysis	6
	Total hours	39

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/ Individual	Assessment rubrics
1. Final Examination	ALL	EAB SLO a,b,c	60%	Individual	
2. Continuous Assessment 1 (CA1): Quiz 1	1,2,3	EAB SLO a,c	10%	Individual	
3. Continuous Assessment 2 (CA2): Assignment	2,3,4,5	EAB SLO a,b,c,e	10%	Individual	
4. Continuous Assessment 3 (CA3): Project Report	5,6	EAB SLO a,b,c,d,e	20%	Individual/team	
Total			**100%**		

Mapping of Course SLOs to EAB Graduate Attributes (new requirement to update school database)

Course Student Learning Outcomes	Cat	EAB's 12 Graduate Attributes* (indicate full/partial/weak moon/blank for the whole course for SLO a-l)											
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
IE4483 Artificial Intelligence and Data Mining	BDE	●	◐	●	◐	◐	○	○	○	○	○		○
1. Demonstrate and Explain the use of state representation of problems, and strategies for the search										EAB SLO* (a), (b), (c)			
2. Discuss and Illustrate the concepts of state space search algorithms										EAB SLO* (a), (b), (c)			
3. Discuss and Illustrate the concepts of heuristic search algorithms										EAB SLO* (a), (b), (c), (d)			

4.	Explain basics data mining concepts/algorithms for association rule mining	EAB SLO* (a), (b), (c), (d), (l)
5.	Explain the basics of machine learning models and algorithms	EAB SLO* (a), (b), (c), (d), (e), (j), (l)
6.	Apply the fundamental theory and concepts of data mining and AI for wide range of data analysis including association, classification, clustering, prediction	EAB SLO* (a), (b), (c), (d), (e), (i), (j), (l)

Legend: ● Fully consistent (contributes to more than 75% of Student Learning Outcomes)
◐ Partially consistent (contributes to about 50% of Student Learning Outcomes)
○ Weakly consistent (contributes to about 25% of Student Learning Outcomes)
Blank Not related to Student Learning Outcomes

* Please refer to Appendix 2 on the EAB accreditation SLO

Formative feedback

You would be able to receive the feedback through

- Continuous Assessment 1 (CA1): Quiz 1;
- Continuous Assessment 2 (CA2): Homework Assignments 1-5 ;
- Continuous Assessment 3 (CA3): Project Report;
- Examination results; and
- Markets' report on overall examination performance.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
LECTURE	The faculty will present the course contents to you via lecture notes, face-to-face teaching and videos, which provide the basic background and essential theory for achieving the Intended Learning Outcomes (ILO) 1-6.
TUTORIAL	N/A
LABORATORY(if any)	N/A

Reading and References

Textbooks

1. Luger George F, Artificial Intelligence : Structures and Strategies for Complex Problem Solving, 6th Edition, Addison-Wesley, 2009. (Q335.L951)
2. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining: Pearson 2nd Edition, 2019.
3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016. ISBN: 978-

0262035613 (Q325.5.G651)

References

1. Jiawei Han, Micheline Kamber and Jian Pei, Data Mining: Concepts and Techniques, 3rd Edition, Morgan Kaufmann, 2011, ISBN: 978-0-12-381479-1.
2. S. Russell and P. Norvig, Artificial Intelligence A Modern Approach, 4th Edition, Prentice Hall, 2020.
3. Kevin P. Murphy, Probabilistic Machine Learning - An Introduction, The MIT Press, 2022.
4. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006

Course Policies and Student Responsibilities

General: Students are expected to attend all lectures/tutorials and take and submit all scheduled continuous assessments. During the course period, announcements will be broadcast online. Students are required to check course website regularly and follow up with these announcements closely.

Absenteeism: Continuous assignments make up a significant portion of the total mark. Absence from continuous assignments without official approved leave will result in zero marks and affect the overall course grade.

Academic Integrity

Honesty and good ethical behaviour are pillars of good academic work. Both students and course instructors must adhere to the principles of academic integrity and to the NTU Honor Code.

It is important that students recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you carry out at NTU. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating.

Course Instructors

Instructor	Office Location	Phone	Email
Tan Yap Peng			eyptan@ntu.edu.sg
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Planned Schedule

Lesson	Topic	Course LO	Readings/ Activities
1	Introduction to AI & Brief history State Space Representation Search Strategies: data /goal driven	ILO1	Lecture1-3 **Homework 1**

2	Search Algorithms: Backtracking/BreadthFirst/DepthFirst	ILO2	Lecture4-6 **Homework 2**
3	Heuristic Search: Hill-climbing/ Best-First / MiniMax/ Alpha-Beta	ILO3	Lecture7-9
4	Introduction to DataMining Association Rule Mining: Apriori/FPGrowth	ILO4/ILO6	Lecture10-12
5	Introduction to Machine Learning	ILO5/ILO6	**Quiz1** Lecture14-15
6	Classification and Decision Trees	ILO5/ ILO6	Lecture16-18 **Homework 3**
7	Nearest Neighbor Classifiers and Support Vector Machines	ILO5/ ILO6	Lecture19-21 **Project**
8	Neural Networks: Perceptrons, The Backpropagation Algorithm	ILO5/ ILO6	Lecture 22-24 **Homework 4**
9	Neural Networks: Convolutional Neural Networks, Other Popular Deep Learning Networks	ILO5/ ILO6	Lecture 25-27
10	Unsupervised Learning Clustering & Regression	ILO5/ ILO6	Lecture 28-30 **Homework 5**
11	Regularization and Optimization for Deep Models	ILO5	Lecture 31-33
12	Dimentionality Reduction + Bayesian Reasoning	ILO5/ ILO6	Lecture 34-36
13	Bayesian Reasoning	ILO5/ ILO6	Lecture 37-39

Appendix 2: The EAB (Engineering Accreditation Board) Accreditation SLOs (Student Learning Outcomes)

a) **Engineering knowledge:** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems
b) **Problem Analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c) **Design/development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
d) **Investigation:** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e) **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
f) **The engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g) **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.
h) **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i) **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
j) **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k) **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l) **Life-long Learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.