UNIVERSITY OF MACAU
FACULTY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF COMPUTER AND INFORMATION SCIENCE
SFTW461 Artificial Intelligence II
Syllabus
1st Semester 2012/2013
Part A – Course Outline

Elective course in Computer Science

Catalog description:
(3-2) 4 credits. This course introduces key concepts of artificial intelligence and application areas. Topics include expert systems, machine learning, genetic algorithms, hybrid systems, and clustering. Upon completion of this course, students should be able to apply various artificial intelligence techniques in developing intelligent systems.

Course type:
Theoretical with substantial laboratory/practice content

Prerequisites:
- SFTW360

Textbook(s) and other required material:
- Michael Negnevitsky, *Artificial Intelligence: A Guide to Intelligent Systems*, Addison Wesley; 2nd edition, 27 Sep 2004. ISBN-10: 0321204662, ISBN-13: 978-0321204660

References:
- Stuart Russell, Peter Norvig, *Artificial Intelligence: A Modern Approach,* Prentice Hall; 2 edition, December 11, 2009. ISBN-10: 0137903952, ISBN-13: 978-0137903955
- Tom Mitchell, *Machine Learning,* McGraw Hill, 1997.
- Elaine Rich, Kevin Knight, *Artificial Intelligence,* McGraw-Hill Science/Engineering/Math; 2nd edition, December 1, 1990.
- Fakhreddine O. Karray and Clarance De Silva, *Soft computing and Intelligent systems Design, Theory and Applications,* Addison Wesley, Academic Press; 1st edition, October 15, 1999.
- Mitchell Melanie, *An Introduction to Genetic Algorithms,* Cambridge, Mass., MIT Press, 1998.
- Michael A. *Natural Language Processing for Prolog Programmers,* Covington, Prentice-Hall, 1994.

Major prerequisites by topic:
- Basic concepts in discrete structures, probability, calculus, and linear algebra.
- Intermediate programming.

Course objectives:
- Introduce to students the major topics of artificial intelligence and application areas. [a]
- Introduce students to the methods and algorithms for developing intelligent systems. [a]
- Introduce students to the design and implementation of intelligent systems. [a, c, l]

Topics covered:
- **Introduction to Knowledge-based Intelligent Systems (3 hours)**: Definition of Intelligence. Review the history of artificial intelligence (from 1943 – current).

- **Evolutionary Computation (6 hours)**: Present the overview of evolutionary computation. Introduce the main steps in developing a genetic algorithm. Introduce the schema theorem. Study evolution strategies and genetic programming.
- **Rule-based Expert Systems (3 hours)**: Discuss what is knowledge is and how experts express their knowledge in the form of production rules. Identify the main players in the expert system development team and structure of a rule-based expert system. Review forward chaining and backward chaining, conflict Resolution, advantages and disadvantages of rule-based expert system. A brief introduction to CLIPS expert system shell.
- **Reasoning under Uncertainty (3 hours)**: Review the probability theory. Present two uncertainty management techniques used in expert systems: Bayesian reasoning and certainty factors. Study Naïve Bayes Classification.
- **Fuzzy Expert Systems (3 hours)**: Introduce fuzzy logic and discuss the philosophical ideas behind it. Review fuzzy sets, linguistic variables, hedges, fuzz rules. Explore two fuzzy inference techniques: Mamdani-style inference, Sugeno-style inference. Introduce the main steps in developing a fuzzy expert system and illustrate the theory through the actual process of building and tuning a fuzzy system using MATHLAB fuzzy logic toolbox.
- **Artificial Neural Networks (6 hours)**: Discuss the basic idea behind machine learning. Present the concept of perceptron as a simple computing element and consider the perceptron learning rule. Discuss the concept of multilayer neural networks (Back-propagation algorithm), and study the accelerated learning in multilayer neural networks. Review recurrent neural networks (Hopfield network and bidirectional associated memory). Review self-organizing neural networks (Hebbian learning and Kohonen network).
- **Hybrid Intelligent Systems (6 hours)**: Consider the hybrid intelligent system as a combination of different intelligent technologies. Study neural expert systems, neuro-fuzzy systems, evolutionary neural networks, fuzzy evolutionary systems.
- **Concept Learning, Decision Tree Learning (3 hours)**: Study Find-S algorithm, list-than-eliminate algorithm, candidate-elimination algorithm. Discuss the ID3 algorithm for decision tree learning.
- **Instance-based Learning (3 hours)**: Study the advantages and disadvantages of instance-based learning. Discuss K-nearest neighbor algorithms for approximating a discrete-valued and continuous-valued function. Study distance-weighted nearest neighbor algorithms for discrete-valued and continuous-valued target functions. Review the architecture of a case-based reasoning system..
- **Clustering and Fuzzy Clustering (3 hours)**: Unsupervised learning and clustering, K-means algorithm and fuzzy c-means algorithm

Class/laboratory schedule:

Timetabled work in hours per week			No of teaching weeks	Total hours	Total credits	No/Duration of exam papers
Lecture	Tutorial	Practice				
3	2	Nil	14	70	4	1 / 3 hours

Student study effort required:

Class contact:	
Lecture	42 hours
Tutorial	28 hours
Other study effort	
Self-study	28 hours
Homework assignment	7 hours
Programming assignments	20 hours
Total student study effort	125 hours

Student assessment:

Final assessment will be determined on the basis of:

Homework	15%	Course project	25%
Mid-term	30%	Final exam	30%

Course assessment:

The assessment of course objectives will be determined on the basis of:

- Assignments (written, programming) and exams
- Course evaluation

Course outline:

Weeks	Topic	Course work
1	**Introduction to Knowledge-based Intelligent Systems** Definition of intelligence, Turing imitation game, the birth of artificial intelligence (1943-56), the rise of artificial intelligence (1956-late 1960), the impact of reality (late 1960 – early 1970), the technology of expert systems (early 1970 – mid 1980), how to make the machine learn (mid 1980 – onwards), evolutionary computation (1970 – onwards), the new era of knowledge engineering (late 1980 – onwards).	Assignment#1
2-3	**Evolutionary Computation** Genetic algorithms, Schema Theorem, evolution strategies, genetic programming	Course project
4	**Rule-based Expert Systems** Knowledge representation technique, the main players in the expert system development team, structure of a rule-based expert system, forward chaining and backward chaining, conflict Resolution, advantages and disadvantages of rule-based expert system, CLIPS expert system shell.	Assignment#2, Programming Assignment#1
5	**Reasoning Under Uncertainty** Bayesian reasoning, Certainty factors theory and evidential reasoning, comparison of Bayesian reasoning and certainty factors, Naïve Bayes Classification	
6	**Fuzzy Expert Systems** Fuzzy sets, linguistic variables, hedges, fuzz rules, Mamdani-style inference, Sugeno-style inference, MATHLAB fuzzy logic toolbox	Assignment#3
7-8	**Artificial Neural Networks** How the brain works, the neuron, the perceptron, multilayer neural networks (Back-propagation algorithm), accelerated learning in multilayer neural networks, the Hopfield network, bidirectional associated memory, Self-organizing neural network (Hebbian learning and Kohonen network)	Assignment#4 Midterm exam
9-10	**Hybrid Intelligent Systems** Neural expert systems, neuro-fuzzy systems, evolutionary neural networks, fuzzy evolutionary systems	
11	**Concept Learning, Decision Tree Learning** Find-S algorithm, list-than-eliminate algorithm, candidate-elimination algorithm, ID3 algorithm	Assignment#5
12	**Instance-based Learning** K-nearest neighbor algorithm for approximating a discrete-valued and continuous-valued function, distance-weighted nearest neighbor	

Weeks	Topic	Course work
	algorithm for discrete-valued and continuous-valued target functions, case-based reasoning	
13	**Clustering and Fuzzy Clustering** Unsupervised learning and clustering, K-means and fuzzy c-means algorithm.	Programming Assignment#2
14	**Review**	

Contribution of course to meet the professional component:
This course prepares students to work professionally in the area of Artificial Intelligence.

Relationship to CS program objectives and outcomes:
This course primarily contributes to the Computer Science program outcomes that develop student abilities to:
(a) an ability to apply knowledge of computing, mathematics, science, and engineering.
(c) an ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
(l) an ability to use the computer/IT tools relevant to the discipline along with an understanding of their processes and limitations.

Relationship to CS program criteria:

Criterion	DS	PF	AL	AR	OS	NC	PL	HC	GV	IS	IM	SP	SE	CN
Scale: 1 (highest) to 4 (lowest)							4			1				

Discrete Structures (DS), Programming Fundamentals (PF), Algorithms and Complexity (AL), Architecture and Organization (AR), Operating Systems (OS), Net-Centric Computing (NC), Programming Languages (PL), Human-Computer Interaction (HC), Graphics and Visual Computing (GV), Intelligent Systems (IS), Information Management (IM), Social and Professional Issues (SP), Software Engineering (SE), Computational Science (CN).

Course content distribution:

Percentage content for			
Mathematics	Science and engineering subjects	Complementary electives	**Total**
10%	40%	50%	100%

Coordinator:
Prof. Chi Man Pun

Persons who prepared this description:
Dr. Yain Whar Si
Dr. Long Chen (revised)

Part B – General Course Information and Policies

1st Semester 2012/2013

Instructor: Dr. Long Chen Office: B2-A303
Office hour: by appointment Phone: 8397 8459
Email: longchen@umac.mo

Time/Venue: WED 10:00-13:00 U103 (lecture)
FRI 17:30-19:30 T103 (tutorial)

Grading distribution:

Percentage Grade	Final Grade	Percentage Grade	Final Grade
100 - 93	A	92 - 88	A–
87 - 83	B+	82 - 78	B
77 - 73	B–	72 - 68	C+
67 - 63	C	62 - 58	C–
57 - 53	D+	52 - 50	D
below 50	F		

Comment:

The objectives of the lectures are to explain and to supplement the text material. Students are responsible for the assigned material whether or not it is covered in the lecture. Students are encouraged to look at other sources (other references, etc.) to complement the lectures and text.

Homework policy:

The completion and correction of homework is a powerful learning experience; therefore:

- There will be approximately 5 homework assignments.
- There will be approximately 2 programming assignments.
- Homework is due one week after assignment unless otherwise noted.

Quizzes:

One mid-term exam will be held during the semester.

Note:

- Check UMMoodle (UMMoodle.umac.mo) for announcement, homework and lectures. Report any mistake on your grades within one week after posting.
- No make-up exam is given except for CLEAR medical proof.
- Cheating is absolutely prohibited by the university.

Appendix:

Rubric for Program Outcomes

Rubric for (a)	5 (Excellent)	3 (Average)	1 (Poor)
Understand the theoretic background	Students understand theoretic background and the limitations of the respective applications.	Students have some confusion on some background or do not understand theoretic background completely.	Students do not understand the background or do not study at all.
Use a correct model and formulation correctly	Students choose a model correctly and properly apply correct techniques.	Students choose a wrong model sometime, use a wrong formula, or a different technique.	Students use a wrong model and wrong formula, or do not know how to model.
Compute the problem correctly	Students use correct techniques, analyze the problems, and compute them correctly.	Students sometime solve problem mistakenly using wrong techniques.	Students do not know how to solve problems or use wrong techniques completely.
Rubric for (c)	**5 (Excellent)**	**3 (Average)**	**1 (Poor)**
Design capability and design constraints	Student understands very clearly what needs to be designed and the realistic design constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	Student understands what needs to be designed and the design constraints, but may not fully understand the limitations of the design constraints.	Student does not understand what needs to be designed and the design constraints.
Process to meet desired needs	Student understands very clearly the process of the design.	Student understands what the needs of the process design, but may not fully understand the limitations of the design constraints.	Student does not understand the process.
Rubric for (l)	**5 (Excellent)**	**3 (Average)**	**1 (Poor)**
Use modern computer/IT tools relevant to the discipline	Student uses computer/IT tools relevant to the engineering discipline, and understands their limitations.	Student uses computer /IT tools relevant to the engineering discipline.	Student does not use computer/IT tools relevantly, and does not understand their limitations.