University of Macau
Faculty of Science and Technology
Department of Computer and Information Science
SFTW360 Artificial Intelligence I
Syllabus
2nd Semester 2011/2012
Part A – Course Outline

Compulsory course in Computer Science

Catalog description:
(3-2) 4 hours credit. Introduction to AI, definition of AI, disciplines of AI; the concept of agent in AI; problem solving agent, building search tree, local search; logical agent, knowledge base representation, reasoning using propositional and first-order logic. Prolog is the language widely used in AI field. This programming language will also be covered in the course. Two hours of practice or computer lab for prolog programming per week.

Course type:
Theoretical with substantial laboratory/practice content

Prerequisites:
- SFTW241

Textbook(s) and other required material:
- Stuart Russell and Peter Norvig, *Artificial Intelligence: A modern approach*, 3rd edition, Prentice Hall International 2010 (Required)

References:
- Dennis Merritt, *Adventure in Prolog*, available on http://www.amzi.com/AdventureInProlog

Major prerequisites by topic:
None

Course objectives:
- Learn the fundamental concept of AI. [a]
- Learn building search tree to solve simple AI problem. [a, e]
- Learn advance searching techniques, local search, and constraint satisfaction problems. [a, e]
- Learn the concept of knowledge-based systems with propositional logic, and first-order logic. [a, e]
- Learn PROLOG programming [l]

Topics covered:
- **Basic Concepts (3 hours)**: Study the different definitions of AI, including thinking humanly, acting humanly, thinking rationally, and acting rationally. Define AI as a rational agent. Review the foundation of AI, the history of AI, and the state-of-the-art of AI.
- **Intelligent Agents (3 hours)**: Study the concept and definition of an agent, and a rational agent. A general concept of agent interacting with environment is presented. Define rationality and the necessary items for rationality. Different task environments and their properties are discussed. Introduce what are agent program and the different types of agent programs.
- **Prolog programming (12 hours):** Prolog syntax. Mechanism of inference engine. Facts, queries, rules, unification, data structure, lists, cut operators, control structures, etc. are discussed.
- **Problem Solving and Uninformed Search (4.5 hours)**: Study goal-based agent. Show how to construct goal formulation and problem formulation. Show the necessary items for a well-defined problem and solution. Discuss the concept of generating a search tree automatically by computer. Discuss different search strategies and their pros and cons using performance measure. Show the family of breadth-first search and depth -first search.

- **Informed or Heuristic Search (4.5 hours)**: Study best-first search, A* search, and memory bounded search. Study heuristic function and branching factor. Discuss invention of admissible heuristic function. Study different local search including hill-climbing search, simulated annealing, and genetic algorithms.
- **Constraint Satisfaction Problem (6 hours)**: Study constraint satisfaction problem (CSP) along with incremental and complete-state formulation. Different types of constraints are discussed. General heuristic methods for CSP are shown. Local search for CSP is also introduced.
- **Propositional Logic and Inference (4.5 hours)**: The concept of logical agent is discussed and how logical agent can work in partially observable environment. The reasoning procedure using propositional logic and inference is shown to solve an example problem. Knowledge representation in propositional logic like conjunctive normal form (CNF) is presented. Logical inference including forwarding chaining, backward chaining, and resolution are discussed.
- **First-order Logic and Inference (4.5 hours)**: Review the inability of propositional logic. Introduce new concepts and mechanism provided in first-order logic: objects and quantifiers. Show how to use first-order logic. Inference rules of first-order logic are presented and analyzed their connection to the implementation of PROLOG. Logical inference for first-order logic including forwarding chaining, backward chaining, and resolution are discussed.

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	Nil	2	14	70	4	1 / 3 hours

Student study effort required:

Class contact:	
Lecture	42 hours
Practice	28 hours
Other study effort	
Self-study	35 hours
Projects	20 hours
Total student study effort	125 hours

Student assessment:
Final assessment will be determined on the basis of:
Projects 30% Midterm 25% Final exam 45%

Course assessment:
The assessment of course objectives will be determined on the basis of:
- Projects and final exams
- Course evaluation

Course outline:

Weeks	Topic	Course work
1	**Basic Concepts** Different definitions of AI. What is a rational agent. Foundation of AI. History of AI. State-of-the-art of AI.	
2	**Intelligent Agents** Rational agent. Task environments. Different types of agents and agent programs.	
3-6	**Prolog Programming** Prolog syntax. Inference engine. Facts, rules, queries. Different constructs and data strucutures.	Project 1
7-8	**Problem solving and uniformed search** Goal-based agent. Goal and problem formulation, well-define problem and solution. Search strategies. Concept of performance measure. Family of breadth-first search and depth-first search.	

Weeks	Topic	Course work
8-9	**Informed or Heuristic search** Best-first search, A* search, and heuristic function. Local search: hill-climbing, simulated annealing, and genetic algorithms.	
10-11	**Constraint Satisfaction Problem (CSP)** What is CSP? Incremental and complete-state formulation of CSP. Different types of constraints. General heuristic methods for CSP. Local search for CSP.	Project 2
12-13	**Propositional Logic and Inference** Logical agent. Reasoning procedure. Syntax and knowledge representation using propositional logic. Inference: forwarding chaining, backward chaining, resolution.	
13-14	**First-order Logic and Inference** First-order logic. Objects and quantifiers in first-order logic. Syntax and knowledge representation using first-order logic. Inference rules: Modus Ponens, and a list of other inference rules in first-order logic. Conjunctive normal form. Horn clauses. Forwarding chaining and backward chaining in first-order logic. Resolution and strategies.	

Contribution of course to meet the professional component:
This course prepares students with fundamental concepts and techniques about fundamental concept of AI and rational agent. The concept of problem-solving agent using different basic and advance search techniques; and logical agent using propositional logic and first-order logic are introduced. In addition, an important AI programming language PROLOG is also covered in this course.

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 mathematics, science, and engineering.
(e) an ability to identify, formulate, and solve engineering problems
(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**
0%	50%	50%	100%

Coordinator:
Prof. Zhiguo Gong

Persons who prepared this description:
Dr. Chi Man Vong

Part B – General Course Information and Policies

2nd Semester 2011/2012

Instructor:	Dr. Chi Man Vong	Office:	N307
Office hour:	by appointment	Phone:	8397 4357
Email:	cmvong@umac.mo		

Time/Venue: Mon 5:30 pm – 7:30 pm, NG02 (practice)
Thu 9:30 am – 11:30 am, NG02 (practice)
Fri 4:00 pm – 7:00 pm, WLG305 (lectures)

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 and the slides are to explain and to supplement the text material. Students are responsible for studying the text material for fully understanding. Students are encouraged to look at other sources (other texts, etc.) to complement the lectures and the text.

Project policy:
Computer group project is an important learning experience and also an effective training to improve interpersonal skill and collaboration, because students in Computer Science will collaborate with others for analysis, design, and computer programming in their future careers; therefore:

- There are 2 computer group projects.
- Submission deadlines are fixed and controlled in Moodle (http://ummoodle.umac.mo). No late submission is accepted.

Note:

- Laboratory and project recitation session is an important part of this course and attendance is strongly recommended.
- Check Moodle (ummoodle.umac.mo) for announcement, project presentation schedule, 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.
Rubric for (e)	**5 (Excellent)**	**3 (Average)**	**1 (Poor)**
Modeling, problem formulation and problem solving	Students choose and properly apply the correct techniques.	Students model correctly but cannot select proper technique or model incorrectly but solve correctly accordingly.	Students at loss as to how to solve a problem.
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.