

University of Macau
Department of Computer and Information Science
CISB358 – Fundamentals of Artificial Intelligence
Syllabus
2nd Semester 2014/2015
Part A – Course Outline

Elective course in Computer Science

Catalog description:

(2-2) 3 credits. 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.

Prerequisites:

- CISB210 Algorithms and Data Structures II

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>

Course objectives:

1. Learn the fundamental concept of AI. [a]
2. Learn building search tree to solve simple AI problem. [a]
3. Learn advance searching techniques including local search and constraint satisfaction problems. [a]
4. Learn the concept of knowledge-based systems with propositional logic, and first-order logic. [a]
5. Learn PROLOG programming [a, c]

Topics covered:

1. **Basic Concepts (2 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.
2. **Intelligent Agents (2 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.
3. **Prolog programming (8 hours):** Prolog syntax. Mechanism of inference engine. Facts, queries, rules, unification, data structure, lists, cut operators, control structures, etc. are discussed.
4. **Problem Solving and Uninformed Search (3 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.
5. **Informed or Heuristic Search (3 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.
6. **Constraint Satisfaction Problem (4 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.
7. **Propositional Logic and Inference (2 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.

- 8. First-order Logic and Inference (4 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 | | | | |
| 2 | Nil | 2 | 14 | 56 | 3 | 1 / 3 hours |

Student study effort required:

| Class contact: | |
|-----------------------------------|-----------------|
| Lecture | 28 hours |
| Practice | 28 hours |
| Other study effort | |
| Self-study | 20 hours |
| Projects | 20 hours |
| Total student study effort | 96 hours |

Student assessment:

Final assessment will be determined on the basis of:

- Attendance 5%
- Projects 30%
- Mid-term Exam 30%
- Final Exam 35%

Course assessment:

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

- Projects and exams
- Course evaluation

Topic 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. | |
| 3,4,5,6 | Prolog Programming Prolog syntax. Inference engine. Facts, rules, queries. Different constructs and data structures. | 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. | |
| 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 | 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 CIS program objectives and outcomes:

This course primarily contributes to CIS program outcomes that develop student abilities to:

- (a) an ability to apply knowledge of mathematics, science, and engineering.
- (c) an ability to analyze a problem, and identify and define the computing requirements appropriate to its solution.

Relationship to CIS program criteria:

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

Persons who prepared this description:

Prof. Chi-Man Vong

Part B General Course Information and Policies

2nd Semester 2014/2015

Instructor: Prof. Chi-Man Vong
Office Hour: by appointment
Email: cmvong@umac.mo

Office: E11-4013
Phone: 88224357

Time/Venue: Refer to <http://isw.umac.mo>

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.

Computer Group Project Policy:

Computer group project is a powerful learning experience and also an effective training to improve interpersonal skill and collaboration, because students in CIS 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

(a) An ability to apply knowledge of computing and mathematics to solve complex computing problems in computer science discipline.

| Measurement Dimension | Excellent (80-100%) | Average (60-79%) | Poor (<60%) |
|---|---|--|---|
| 1. An ability to apply knowledge of computing to the solution of complex computing problems | Students understand the computing principles, and their limitations in the respective applications. Use the computing principles to formulate and solve complex computing problems. | Students understand the computing principles, and their limitations in the respective applications. But they have trouble in applying the computing principles to formulate and solve complex computing problems. | Students do not understand the computing principles, and their limitations in the respective applications. Do not know how to apply the appropriate computing principles to formulate and solve complex computing problems. |
| 2. An ability to apply knowledge of mathematics to the solution of complex computing problems. | Students understand the mathematical principles, e.g., calculus, linear algebra, probability and statistics, relevant to computer science, their limitations in the respective applications. Use the mathematical principles to formulate and solve complex computing problems. | Students understand the theoretical background and know how to choose mathematical principles relevant to computer science. But they have trouble in applying these mathematical principles to formulate and solve complex computing problems. | Students do not understand the mathematical principles, and do not know how to formulate and solve complex computing problems. |

(c) An ability to analyse a problem, and identify and define the computing requirements appropriate to its solution

| Measurement Dimension | Excellent (80-100%) | Average (60-79%) | Poor (<60%) |
|---|--|---|--|
| 1. An ability to understand problem and identify the fundamental formulation | Students understand problem correctly and can identify the fundamental formulation | Students understand problem correctly, but have trouble in identifying the fundamental formulation | Students cannot understand problem correctly, and they do not know how to identify the fundamental formulation |
| 2. An ability to choose and properly apply the correct techniques | Students know how to choose and properly apply the correct techniques to solve problem | Students can choose correct techniques but have trouble in applying these techniques to solve problem | Students have trouble in choosing the correct techniques to solve problem |

Student Disabilities Support Service:

The University of Macau is committed to providing an equal opportunity in education to persons with disabilities. If you are a student with a physical, visual, hearing, speech, learning or psychological impairment(s) which substantially limit your learning and/or activities of daily living, you are encouraged to communicate with your instructors about your impairment(s) and the accommodations you need in your studies. You are also encouraged to contact the Student Disability Support Service of the Student Counselling and Development Section (SCD), which provides appropriate resources and accommodations to allow each student with a disability to have an equal opportunity in education, university life activities and services at the University of Macau. To learn more about the service, please contact SCD at scd.disability@umac.mo, or 8397 4901 or visit the following website:

http://www.umac.mo/sao/scd/sds/aboutus/en/scd_mission.php