



THE UNIVERSITY
of LIVERPOOL

SUMMER 2002 EXAMINATIONS

Bachelor of Arts : Year 2
Bachelor of Science : Year 1
Bachelor of Science : Year 2
Bachelor of Science : Year 3
Bachelor of Science : Year 4

INTRODUCTION TO ARTIFICIAL INTELLIGENCE

TIME ALLOWED : Two Hours

INSTRUCTIONS TO CANDIDATES

SECTION A: Answer all 10 questions
SECTION B: credit will be given for the best 3 answers.

If you attempt to answer more than the required number of questions (in any section), the marks awarded for the excess questions will be discarded (starting with your lowest mark).



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Section A

Each question is worth 4 marks:

1. What is meant by the *state space* for a problem?
2. Give a resolution based proof to show the following set of clauses

$$\{p \vee q \vee r, p \vee \neg q, \neg p \vee q, \neg p \vee \neg q, \neg r\}$$

is unsatisfiable.

3. Explain how forward chaining works in a rule-based system.
4. Using an example, explain the difference between *facts* and *rules* in a Prolog program.
5. Describe the four parts needed for representing actions in the STRIPS planner.
6. What is meant by the Turing Test?
7. In propositional logic what is a *proposition*? Give an example of a statement that is a proposition and one that is not a proposition.
8. Using a short example to illustrate your answer, in Prolog, what is meant by the *closed world assumption*?
9. Write the following statements in first-order logic.
 - (a) All dogs eat bones.
 - (b) Some dogs eat bones.
 - (c) Rex is a dog.
10. In the context of knowledge representation, describe and explain the use of *scripts*.



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Section B

Answer 3 of the questions below.

Each question is worth 20 marks.

1. (a) What is meant by a frame based system? 4 marks
- (b) Draw a frame-based system that represents the following statements.
- People (persons) have two legs.
Clare is a lecturer.
Clare is 163cm tall.
Lecturers are a kind of person.
Lecturers are employed in the education sector. 8 marks
Richard is a software engineer.
Richard is 185cm tall.
Software engineers are a kind of person.
Software engineers are employed in the industry sector.
- (c) With reference to your answer in (b), and the question "How many legs does Clare have?", explain how inference is performed in a frame-based system. 4 marks
- (d) Outline two drawbacks of frame-based systems. 4 marks
2. (a) Using the following propositions
- t Jane is a temporary employee
 p Jane has worked for a year or more
 h Jane is eligible for a holiday
 r Jane receives holiday pay
- express the following formulae in words.
- i. $p \wedge \neg t$
ii. $p \Rightarrow h$
iii. $\neg r \Rightarrow (\neg p \vee t)$
iv. $h \wedge r$
- 4 marks
- (b) Construct a truth table for the expression $\neg r \Rightarrow (\neg p \vee t)$. Using your truth table state whether $\neg r \Rightarrow (\neg p \vee t)$ is valid, satisfiable, or unsatisfiable, and why. 7 marks
- (c) Give one drawback of using truth tables to check the validity of *large* propositional formulae. Explain why truth tables cannot be used for checking the validity of formulae of first-order logic. 4 marks
- (d) Using the proof rules

$$[\text{modus ponens}] \frac{A \Rightarrow B, A}{B} \quad \text{and} \quad [\wedge - \text{elimination}] \frac{A \wedge B}{A}$$

show $p \wedge \neg t, p \Rightarrow h \vdash h$.

5 marks



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3. (a) What is an expert system? **2 marks**
(b) Give two advantages and two disadvantages of expert systems. **8 marks**
(c) Describe the architecture of the expert system MYCIN. **6 marks**
(d) Describe how MYCIN explains how it arrives at its conclusions. **4 marks**
4. Consider the 8-puzzle (described in lectures) with the initial state,

1	2	
8	6	3
7	5	4

goal state,

1	2	3
8		4
7	6	5

and operations

- o_1 : move any tile to the left of an empty square to the right;
 - o_2 : move any tile to the right of an empty square to the left;
 - o_3 : move any tile above an empty square down;
 - o_4 : move any tile below an empty square up.
- (a) Suggest appropriate path cost functions and admissible heuristics for the 8-puzzle. **4 marks**
- (b) Explain what is meant by an A* search. Why is A* search useful? **4 marks**
- (c) Draw the search tree from performing an A* search on the 8-puzzle with initial and goal states described above, showing all relevant calculations. **8 marks**
- (d) What is meant by *abstraction* and why is the level of abstraction chosen when formulating a search problem important? **4 marks**