INSTRUCTIONS:

Answer all questions. The marks for the paper total 90.

Most questions require only brief answers – point form answers are fine.

PLEASE NOTE

Examination candidates may only bring authorised materials into the examination room. If a supervisor finds, during the examination, that you have unauthorised material, in whatever form, in the vicinity of your desk or on your person, whether in the examination room or the toilets or en route to/from the toilets, the matter will be reported to the head of school and disciplinary action will normally be taken against you. This action may result in your being deprived of any credit for this examination or even, in some cases, for the whole unit. This will apply regardless of whether the material has been used at the time it is found.

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Q1. Search algorithms

(a) Describe the operation of breadth-first search, and its performance characteristics. 3 marks

(b) Describe the operation of depth-first search, and its performance characteristics. 3 marks

(c) Describe the operation of bidirectional search. 2 marks

(d) Argue whether breadth-first or depth-first search is more likely to be useful in bidirectional search. 2 marks

Q2. Informed search algorithms

(a) What is the fundamental difference between an informed search algorithm and an uninformed one? 3 marks

(b) Describe what it means for a heuristic to be admissible, and what it means for one heuristic to dominate another. 3 marks

(c) Given two admissible heuristics for a problem, neither of which dominates the other, how can they both be usefully deployed? 2 marks

(d) Describe with an example the pathmax modification to an informed search algorithm. 2 marks

Q3. Game-playing algorithms

(a) Describe the two principal sources of incompleteness in AI problems. 2 marks

(b) Describe two ways that incompleteness can arise in game-playing AI. 2 marks

(c) A game-playing AI usually has to make a move within a certain time limit. How does iterative deepening help with this issue? 2 marks

(d) What is meant by look-ahead in the context of game-playing AI? 2 marks

(e) Why is look-ahead less important in a dice-rolling game like backgammon? 2 marks
Q4. Learning agents

(a) What is the principal role of the problem generator in a learning AI agent? 2 marks

(b) What is the principle of Ockham’s razor, used in learning agents? 2 marks

(c) What is meant by exploitation and exploration in the context of learning agents? 2 marks

(d) What is the principal source of tension between exploitation and exploration, and how is it usually resolved? 2 marks

(e) What is meant by generalisation in the context of learning agents? 2 marks

Q5. Sequential decision problems

(a) Describe what is meant by a sequential decision problem (SDP). 2 marks

(b) What is a policy in the context of an SDP? 2 marks

(c) Describe the policy iteration algorithm for solving SDPs. 4 marks

(d) Why does policy iteration often converge faster than value iteration? 2 marks

Q6. Reinforcement learning

(a) Define and contrast reinforcement learning and supervised learning. 3 marks

(b) Define and contrast passive learning and active learning. 3 marks

(c) Describe the technique of temporal difference learning (TDL). 2 marks

(d) What is the role of the learning rate in TDL, and why is it often set to decrease over time? 2 marks
Q7. **Planning**

(a) Describe how a *partial-order planner* works.  
4 marks

(b) Operationally, what are the two principal ways in which a partial-order planner can fail, and what would be the planner’s response to each?  
3 marks

(c) Describe what is meant by *situated planning*.  
3 marks

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Q8. **Logical agents**

(a) Define the terms *sound* and *complete* in the context of an inference system.  
2 marks

(b) Explain with an example the distinction between *implication* and *causation*.  
3 marks

(c) Define with an example the *resolution rule* for performing inference.  
3 marks

(d) Argue informally that resolution is *complete* for propositional logic.  
2 marks

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Q9. **First-order logic**

(a) Describe the principal limitation of propositional logic relative to *first-order logic* (FOL).  
2 marks

(b) Give an example of an English statement that can be captured easily in FOL but that is difficult to say in propositional logic.  
2 marks

(c) Describe with an example what it means to *unify* two FOL sentences.  
4 marks

(d) Describe the *frame problem* in the context of knowledge representation.  
2 marks

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**END OF PAPER**