INSTRUCTIONS:

Answer all questions. Each question is worth 10 marks. The total for the paper is 100.

Most questions require only brief answers: point form answers are fine where appropriate.

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. String algorithms

(a) Explain how the Rabin-Karp algorithm improves the naïve pattern-matching algorithm.  
4 marks

(b) Consider this example:

\[
\begin{align*}
T &= \text{the\_one\_phone} \\
P &= \text{one\_phone}
\end{align*}
\]

Illustrate how the bad-character and good suffix heuristic calculates the shift advance in the Boyer-Moore algorithm.  
6 marks

Q2. Optimisation algorithms

(a) Define the activity selection problem, and list four reasonable greedy rules.  
3 marks

(b) Using this example \{[6,9), [1,10), [2,4), [1,7), [5,6), [8,11), [9,11)\}, illustrate how sometimes a greedy rule can lead to the optimal solution.  
4 marks

(c) Describe how simulated annealing helps to avoid local optima.  
3 marks

Q3. Uninformed search

(a) Describe the difference between breadth-first search and depth-first search in selecting which node to expand.  
2 marks

(b) Explain why breadth-first search is complete and optimal, whereas depth-first not.  
3 marks

(c) What is the motivating principle behind depth-limited search?  
2 marks

(d) Describe three problem features that can cause problems for bidirectional search.  
3 marks
Q4. Informed search

(a) What is the difference between informed search and uninformed search?  

(b) Describe how A* uses heuristics to guide its search procedure.  

(c) Take the game tic-tac-toe as an example, explain and illustrate what an admissible heuristics for A* is.  

(d) How to come up with a heuristic to ensure A* to be optimal?  

Q5. Game-playing

(a) Describe the three usual approaches to dealing with incompleteness and non-determinism.  

(b) Briefly explain how quiescence search and horizon problem related the level of look-ahead in a game-playing AI?  

(c) Briefly explain how minimax works in a game-playing AI.  

(d) What's the role of alpha-beta pruning in minimax?  

Q6. Sequential decision problems (SDPs)

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

(b) Given a policy and a transitional model, describe the value determination and action determination process.  

(c) Describe the operation of the policy iteration algorithm for solving SDPs.  
Q7. Learning agents

(a) What are the **four** main connections between the four main components in a learning agent?  

(b) Define and contrast *Supervised Learning* and *Unsupervised Learning.*

(c) What is *inductive learning?*

Q8. Reinforcement learning

(a) What is the difference between *passive learning* and *active learning?*

(b) Describe the operational behaviour of *Adaptive Dynamic Programming.*

(c) Describe the operational behaviour of *temporal-difference learning.*

(d) What is *Q-Learning?*
Q9. Logical agents

(a) What are the three main steps in proof by resolution?  

(b) How to turn a conditional sentence ($S_1 \rightarrow S_2$) or a bi-conditional ($S_1 \leftrightarrow S_2$) into conjunctive normal form? 

(c) Describe and illustrate with an example the main way in which first-order logic is more expressive than propositional logic. 

(d) Describe and illustrate with an example what it means to unify two sentences in first-order logic. 

Q10. Planning and acting

(a) What is the main difference of factored planning as compared to traditional search algorithms? 

(b) Describe briefly how a partial-order planner works. 

(c) What is the role of topological sorting in partial-order planning? 

(d) What are the two remedies when step $S_k$ clobbers step $S_i$?