UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
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Engineering, Built Environment and IT
Department of Computer Science

Artificial Intelligence
COS314

Semester Test I

Examiners

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Instructions

1. Read the question paper carefully and answer all the questions below.
2. The assessment opportunity comprises of **12** questions on **4** pages.
3. You have **1_hour (17:30 - 18:30)** to complete the paper.
4. This paper is **online** on *ClickUp* and is subject to the University of Pretoria Integrity statement provided below.
   - You are not allowed to discuss the questions with anyone.

Integrity statement:
The University of Pretoria commits itself to produce academic work of integrity. I affirm that I am aware of and have read the Rules and Policies of the University, more specifically the Disciplinary Procedure and the Tests and Examinations Rules, which prohibit any unethical, dishonest or improper conduct during tests, assignments, examinations and/or any other forms of assessment. I am aware that no student or any other person may assist or attempt to assist another student, or obtain help, or attempt to obtain help from another student or any other person during tests, assessments, assignments, examinations and/or any other forms of assessment.

Question:	1	2	3	4	5	6	7	8	9	10	11	12	Total
Marks:	1	1	1	1	1	1	8	9	10	3	4	10	50

1. Which of the following statements about Depth First Search (DFS) is true? (1)
   (a) **DFS can be used to detect cycles in a graph.**
   (b) DFS is guaranteed to find the shortest path to the goal state.
   (c) DFS always finds the shortest path between two nodes in a graph.
   (d) DFS requires a queue data structure to keep track of visited nodes.

2. Which of the following data structures is commonly used in Breadth First Search (BFS) to keep track of visited nodes and to maintain the order in which nodes are visited? (1)
   (a) Stack
   (b) **Queue**
   (c) Set
   (d) Heap.

3. What is considered as the main disadvantage of the Hill-climbing search ? (1)
   (a) Terminates after finding a near-optimum
   (b) It fails to find a solution
   (c) Its inability to find an optimum solution.
   (d) **It may terminate at a local optimum and may not find the optimum solution**

4. In many problems the path to the goal is irrelevant, this class of problems can be efficiently solved using (1)
   (a) Informed Search Techniques
   (b) Uninformed Search Techniques
   (c) **Local Search Techniques**
   (d) None of the mentioned

5. The evaluation function of which search method will select the lowest expansion node at first for evaluation? (1)
   (a) **Best-first search**
   (b) Greedy hill-climbing search
   (c) Depth-first search
   (d) None of the mentioned

6. Given logical **AND, OR** and **NOT** and inputs X_1 and X_2. Given the truth table of **XOR** with the standard bit values. Which of the following algorithms would be the most effective at finding a combination of the logical values to satisfy logical **XOR** . (1)
   (a) Tabu Search.
   (b) Simulated Annealing.
   (c) Genetic Algorithm.
   (d) **Genetic Programming.**

7. A robot has been built to navigate a maze to find a piece of cheese. The robot has two sensors: one that detects the distance to the nearest wall in front of it and another that detects if the robot is currently on the square with the cheese.

   The distance sensor returns a value between 0 and 10, with 0 indicating that the robot is right next to a wall and 10 indicating that there is no wall within the sensor's range.

   Given this scenario, state whether the environment is:
   (a) **static (1). The environment does not change while the robot is navigating the maze (1).** (2)
   (b) **Deterministic(1). The outcome of the robot's actions is predictable based on the given information(1).** (2)
   (c) **Discrete(1). The robot moves in discrete steps from one square to another.(1)** (2)
   (d) **Partially-observable(1). The robot can only observe the distance to the nearest wall in front of it and whether or not it is on the square with the cheese, but it cannot observe the entire environment.(1)** (2)

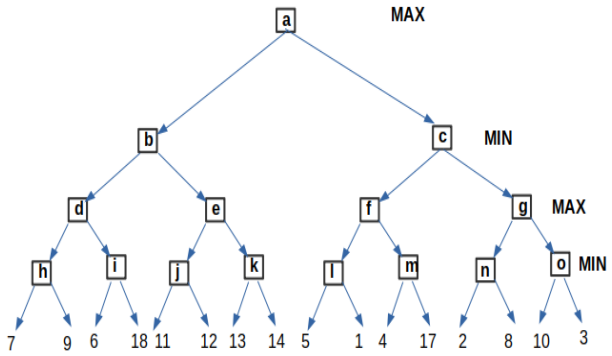

Figure 1: Game Tree

8. Consider the game tree given in Figure 2 where MAX plays MIN. The players alternate with MAX playing first.
   (a) What is the maximum score MAX can obtain (2)
   Sol: 7
   (b) What is the optimal path. (2)
   Sol: a-b-d-h
   (c) Apply the minimax algorithm with alpha-beta pruning. Clearly state between which nodes pruning will occur if at all. (5)
   Sol: (i &18)(1), (e&k)(1), (l&1)(1),(m&17)(1),(c&g)(1)

9. The examination timetabling problem is a type of scheduling problem that involves assigning exams to time slots and rooms while satisfying a set of constraints. The goal is to create a timetable that minimizes conflicts and ensures that students have enough time between exams.

   The constraints in the examination timetabling problem can include:

   No student should have two exams scheduled at the same time. There should be a minimum amount of time between exams for each student. The number of students taking an exam should not exceed the capacity of the room in which it is scheduled. Exams for certain courses may need to be scheduled in specific rooms or at specific times. The examination timetabling problem is a complex and challenging problem that is often solved using optimization algorithms. These algorithms search for a solution that satisfies the constraints and optimizes an objective function that measures the quality of the timetable.

   If you are tasked with using a Genetic Algorithm to solve this problem. With justification describe in detail how you would address the following:

   (a) Representation. (2)
   Representation(1): A solution to the examination timetabling problem can be represented as a chromosome, where each gene represents an exam (0.5) and the value (0.5) of the gene represents the time slot and room assigned to the exam
   (b) Initialization. (2)
   Sol: Initialization: The initial population of chromosomes can be generated randomly(2) OR using a heuristic algorithm that generates feasible solutions.(2)
   (c) fitness function. (2)
   The fitness function should measure the quality of a timetable by taking into account the constraints and objectives of the problem. A penalty value for each constraint violation and reward solutions that minimize conflicts and maximize the time between exams for each student.(2)
   (d) State what mutation operator you would use and how it would function (2)
   Sol: The mutation operator should introduce random changes into a chromosome to explore new regions of the search space. Mutation methods such as swap mutation or inversion mutation can be used (2)
   (e) What strategy would you use to update the population and why (2)
   Steady-state OR Generational(1) with justification(1)

10. How does the heuristic function affect the performance of the A* algorithm. (3)
    The heuristic function estimates the distance between the current node and the goal node. The heuristic function is used to guide the search towards the goal node and to prioritize the exploration of nodes that are more likely to lead to the shortest path(1). The performance of the A* algorithm depends on the accuracy and consistency of the heuristic function. An accurate heuristic function that underestimates the distance to the goal node can significantly reduce the number of

nodes visited by the algorithm, leading to faster search times(1). In contrast, an inconsistent or overestimating heuristic function can lead to suboptimal paths and slower search times (1).

11. Simulated annealing is a probabilistic optimization algorithm that is often used to find a good approximation to the global optimum of a given function. It has a temperature parameter. Explain how this temperature parameter affects the performance of the algorithm. (4)
The temperature parameter affects the performance of the algorithm by controlling the probability of accepting worse solutions(1). At high temperatures, the algorithm is more likely to accept worse solutions(1), which allows it to explore a larger portion of the search space and avoid getting stuck in local optima(1). As the temperature decreases, the algorithm becomes less likely to accept worse solutions and focuses more on improving the current solution(1)s.

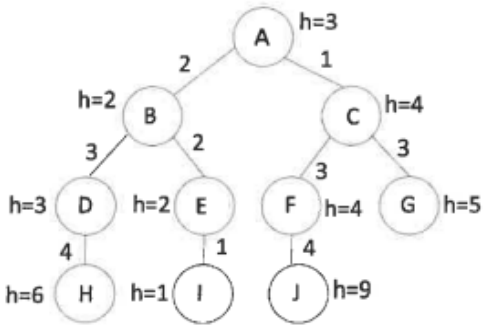

Figure 2: Game Tree

12. Consider the state space representation given below, with A being the start state and I being the goal state. Answer the questions that follow.

    (a) List the order in which the nodes will be visited if the hill climbing search is applied to the state space to find a solution. (2)
    A,B,E,I

    (b) List the order in which the nodes will be visited if the greedy-hill climbing search is applied to the state space to find a solution. (2)
    A,B

    (c) List the order in which the nodes will be visited if the best-first search is applied to the state space to find a solution. (2)
    A,B,E,I

    (d) List the order in which the nodes will be visited if the A* algorithm search is applied to the state space to find a solution. (2)
    A,B,E,I

    (e) Is the heuristic admissible ? Justify your answer (2)
    Not admissible.(1) E over-estimates the cost which is 1.(1)