NAMIBIA UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATICS
DEPARTMENT OF SOFTWARE ENGINEERING

QUALIFICATION: BACHELOR OF COMPUTER SCIENCE (SOFTWARE DEVELOPMENT)	
QUALIFICATION CODE: 07BACS	LEVEL: 7
COURSE: ARTIFICIAL INTELLIGENCE	COURSE CODE: ARI711S
DATE: JUNE 2024	SESSION: THEORY
DURATION: 3 HOURS	MARKS: 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
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THIS QUESTION PAPER CONSISTS OF 6 PAGES
(Including this front page)

INSTRUCTIONS TO STUDENTS:

1. Read all the questions, passages, scenarios, etc., carefully before answering.
2. All questions must be answered in the Answer Booklet. Clearly indicate the question number for each answer.
3. Please, ensure that your writing is legible, neat and presentable.
4. There are no books, notes or any other additional aids allowed in the examination.
5. Use the allocated marks as a guideline when answering questions.
6. Looking at other students' work is strictly prohibited.

PERMISSIBLE MATERIALS

1. Calculator
2. Ruler

Question 1 **(10 marks)**

Select whether the following statements are either **TRUE** or **FALSE**.

1.1 Greedy search can take longer to terminate than uniform-cost search. **(2 marks)**

1.2 Backtracking algorithms are guaranteed to find a solution for any CSP with a solution. **(2 marks)**

1.3 Doubling your computer's speed allows you to double the depth of a tree search given the same amount of time. **(2 marks)**

1.4 The Bellman equation is a key formula used in solving MDPs to determine the optimal value function and policy. **(2 marks)**

1.5. Arc consistency is a stronger form of consistency checking compared to forward checking. **(2 marks)**

Question 2 **(6 marks)**

Explain the difference between planning problems and identification problems?

Question 3 **(6 marks)**

Backtracking algorithms explore a search space by making choices and potentially backtracking from them. How can **filtering** be used to improve the efficiency of backtracking in general?

Question 4 **(10 marks)**

Explain the key concepts related to solving Markov Decision Processes (MDPs)?

Question 5 - Machine Learning **(15 marks)**

Machine learning algorithms can be categorised based on the type of data they use and the learning approach they employ. Explain the fundamental differences between supervised

learning, unsupervised learning, and reinforcement learning and provide examples of common algorithms or applications associated with this learning paradigm.

Supervision: **(3 marks)**

Learning Goal: **(3 marks)**

Data Interaction: **(3 marks)**

Examples (Provide 2 example for each in the table below)

Supervised Learning	Unsupervised Learning	Reinforcement Learning

Question 6 - Model-based learning **(5 marks)**

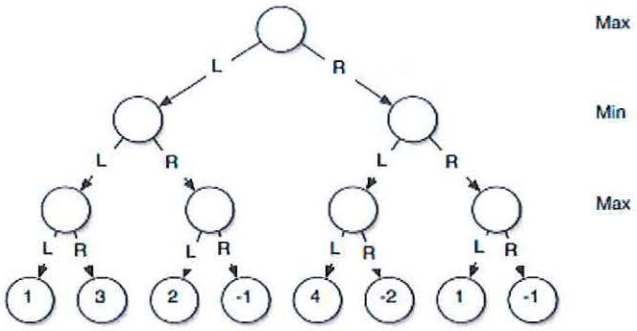
Model-based learning offers a powerful approach for decision-making in complex environments. However, achieving optimal performance often requires balancing exploration and exploitation.

Explain the following concepts in the context of model-based learning?

Exploration vs. Exploitation Dilemma:

Question 7 - Game Search **(10 marks)**

Consider the game tree shown below. Assume the top node is a max node. The labels on the arcs are the moves. The numbers in the bottom layer are the values of the different outcomes of the game to the max player.

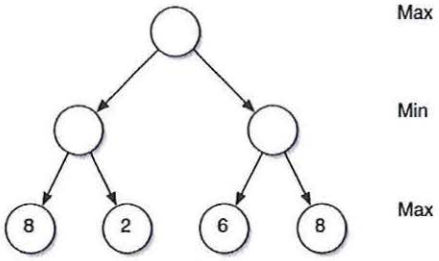


7.1. What is the value of the game to the max player? (2 marks)

7.2. What first move should the max player make? (2 marks)

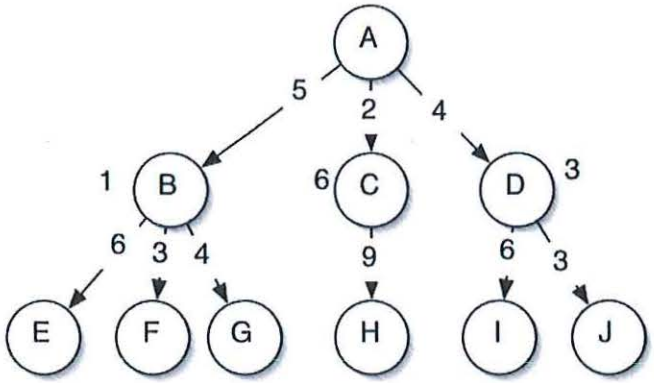
7.3. Assuming the max player makes that move, what is the best next move for the min player, assuming that this is the entire game tree? (2 mark)

7.4. Using alpha-beta pruning, consider the nodes from right to left, which nodes are cut off? Circle the nodes that are not examined on the game tree below (4 marks)



Question 8 - Tree Search **(15 marks)**

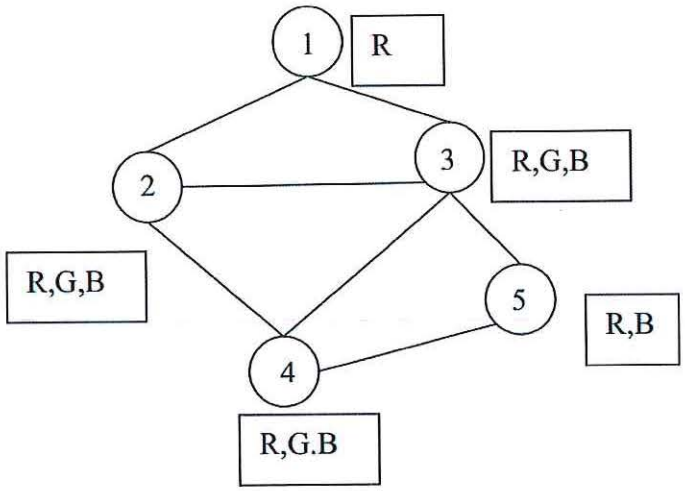
Consider the tree shown below. The numbers on the arcs are the arc lengths; the numbers near states B, C, and D are the heuristic estimates; all other states have a heuristic estimate of 0.



Assume that the children of a node are expanded in alphabetical order when no other order is specified by the search, and that the goal is state **J**. No visited or expanded lists are used. What order would the states be expanded by each type of search. Write only the sequence of states expanded by each search.

Search Type	**List of States**
Breadth First	
Depth First	
Uniform Cost Search	
Greedy Best-First Search	
A* Search	

Question 9 - Constraint Satisfaction Problem (CPS) **(15 marks)**



Show the sequence of variable assignments during backtracking with **forward checking (BT + FC),** assume that the variables are **examined in numerical order** and the values are assigned in the order shown next to each node. Show assignments by writing the variable number and the value, **e.g. 1R. Show each step to the solution.**

Question 10 - Perceptron **(8 marks)**

The following table shows a data set and the number of times each point is misclassified during a run of the perceptron algorithm, starting with zero weights. What is the equation of the separating line found by the algorithm, as a function of x1, x2, and x3? Assume that the learning rate is 1 and the initial weights are all zero.

x_1	x_2	x_3	y	times misclassified
2	3	1	+1	12
2	4	0	+1	0
3	1	1	-1	3
1	1	0	-1	6
1	2	1	-1	11

Use the equation below

$$\bar{w} = \eta \sum_{i=1}^{m} \alpha_i y^i \bar{x}^i$$

— END OF QUESTION PAPER —