

Artificial Intelligence

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Assignment 2

Que 1)

Please define each of the following terms:

- a) **Adversarial Agent:** An Adversarial Search Agent is an agent that works towards a goal in multi-agent competitive environments. Its job is to identify the actions, or series of actions that lead to the goal taking in account the activities of the other agents.
- b) **Zero Sum Game:** A zero-sum game is a situation where, if one party loses, the other party wins, and the net change in wealth is zero. Zero-sum games can include just two players or millions of participants.
- c) **Alpha-Beta Pruning:** Alpha Beta Pruning is a method that optimizes the Minimax algorithm. The number of states to be visited by the minimax algorithm are exponential, which shoots up the time complexity. Alpha Beta Pruning cuts off these useless branches and, in best-case, cuts back the exponent to half.
- d) **Arc Consistency:** The pair (X, Y) of constraint variables is arc consistent if for each value there exists a value such that the assignments $X = x$ and $Y = y$ satisfy all binary constraints between X and Y. A CSP is arc consistent if all variable pairs are arc consistent.
- e) **Forward Checking:** Forward checking detects the inconsistency earlier than simple backtracking and thus it allows branches of the search tree that will lead to failure to be pruned earlier than with simple backtracking. This reduces the search tree and (hopefully) the overall amount of work done.
- f) **Ordering:** Order constraints determine the order in which the variables run. You can configure an order constraint to determine the order in which variables start and stop. Ordering can sometimes provide best case situation and hence will decrease the time. There are many types of Ordering for CSP. Some of the

examples are Minimum Remaining Values : Choose the variable with fewest legal left values in its domain and Least constraining values : Given a choice of values, choose the least constraining values.

- g) **Backtracking**: Backtracking algorithm repeatedly chooses an unassigned variable, and then tries all values in the domain of that variable in turn, trying to find a solution. It will check the previous values again after each iteration and update the values of the variables.

Que 2)

Please use the Alpha Bet pruning and identify which nodes will be pruned. Please explain the process and how you are doing this.

→ First, we will prune 12 as no other node has been pruned before. Now we have to check both 4 and 15 nodes as both of the nodes can be bigger or smaller than the first checked 12 node. Now the node b that is $\min(12, 4, 15)$ will be 4.

We will now check the middle route that is child of node c that is $\min(3, 4, 1)$. We will first check node with 3 value. We need not to check the next two nodes of node 3, i.e., node with value 4 and 1 because the final node will be the maximum of node b, c, d and node with value 3 is lower than node b with value 4 so either way if we get the next two nodes greater than or equal to 3 then the min value will be 3 which will not be the final answer or if the next two nodes have value less than 3 then that number will be minimum but will not be selected in the final answer.

Now let's check child of node d. We will first check node with value 14. We can not determine anything by checking node with value 14 so we will check next child which is node with value 2. Now we need not to check next child of node d because if the next node will have value greater or equal to 2 then it will not be selected but if it has value less than 2 then the new node will be considered minimum but will not be final answer because it is not greater than 4.

Therefore, we will only check nodes with values 12, 4, 15, 3, 14, and 2.

Que 3)

Similar to the example in the lecture, assume that we are trying to colour the map of Australia with three different colours (red, blue, green). Assume that we coloured NT (Northern Territory) as blue and NSW (New South Wales) as red.

- a) Please explain and present the process in which forward checking check the map and when it identifies that it cannot colour the map.

| | West Australia | Northern Territory | Queensland | New South Wales | Victoria | South Australia |
|---------------------|-------------------|-----------------------|------------|-----------------------|----------|--------------------|
| T = 0 | R, G, B | R, G, B | R, G, B | R, G, B | R, G, B | R, G, B |
| After NT = Blue | R, G | Blue | R, G | R, G, B | R, G, B | R, G |
| After NSW = Red | R, G | Blue | G | Red | G, B | G |
| After SA = Green | R | Blue | | Red | B | <u>Green</u> |

We will first assign Northern Territory as blue, then we will eliminate all the neighbours of NT i.e., WA, Q, and SA. Now, we will assign New South Wales as red, then we will eliminate Blue color from all its neighbours i.e., WA, Q, and SA. We will then assign South Australia as Green.

After South Australia is considered Green, Queensland has no legal colour. At this point, a conflict occurs as Queensland has no legal colour. Hence, we can say that Forward checking identifies that it can not colour the map and therefore it will backtrack.

b) Please explain and present the process in which arc consistency check the map and when it identifies that it cannot colour the map.

| | West Australia | Northern Territory | Queensland | New South Wales | Victoria | South Australia |
|--------------------|-------------------|-----------------------|------------|-----------------------|----------|--------------------|
| T = 0 | R, G, B | R, G, B | R, G, B | R, G, B | R, G, B | R, G, B |
| After NT = Blue | R, G | Blue | R, G | R, G, B | R, G, B | R, G |
| After NSW = Red | R, G | Blue | <u>G</u> | Red | G, B | <u>G</u> |

We will first assign Northern Territory as blue, then we will eliminate all the neighbours of NT i.e., WA, Q, and SA. Now, we will assign New South Wales as red, then we will eliminate Blue color from all its neighbours i.e., WA, Q, and SA.

In Arc consistency, we will get to know the conflict when both the adjacent territories i.e., Queensland and South Australia have same colour remaining.