Intro to AI, Assignment-3

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1 Question 1.

Consider the sensorless version of the erratic vacuum world. Draw the belief-state space reachable from the initial belief state 1, 3, 5, 7, and explain why the problem is unsolvable.

Answer

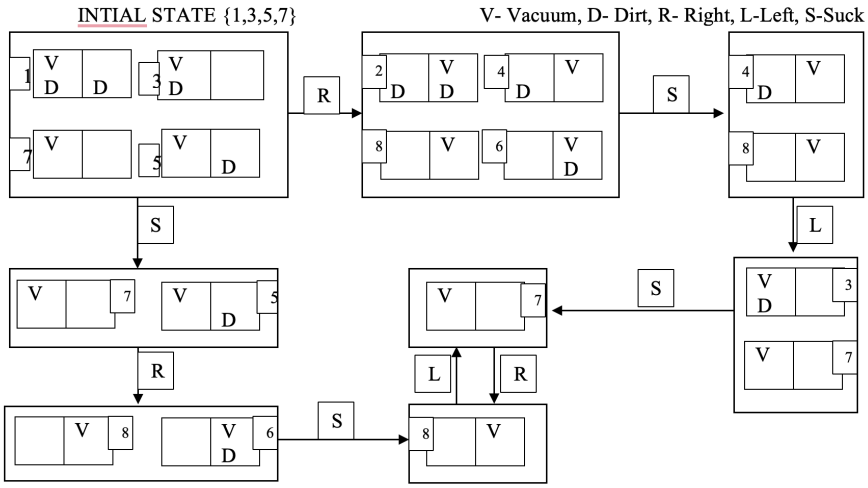


Figure 1: Belief State Space from {1,3,5,7} state.

2 Question 2.

This exercise explores subset–superset relations between belief states in sensorless or partially observable environments. Prove that if an action sequence is a solution for a belief state b, it is also a solution for any subset of b. Can anything be said about supersets of b?

Answer

The attainable belief-state space for the deterministic, sensorless vacuum environment is depicted in Figure 4.14. Out of 256 possible belief states, there are only 12 that can be reached.
The newly arrived states in a regular graph search are checked to see if they have already been reached. It also applies to belief states. For instance, in Figure 4.14, the action sequence [Suck,Left,Suck] starting from the initial state reaches the same belief state as [Right,Left,Suck], namely, {5,7}. Now think about the belief state attained by [Left], specifically, {1,3,5,7}.Obviously, this is a superset of {5,7} rather than being an exact match. Any such superset belief state can be eliminated (pruned).
We don't need to try to solve {1,3,5,7} instead, we can focus on trying to solve the strictly simpler belief state {5, 7}. This is because a solution from {1,3,5,7} must be a solution for each of the individual states 1, 3, 5, and 7, and as a result, it is a solution for any combination of these individual states, such as {5,7}.Therefore, if an action sequence is a solution for a belief state b, then it is also a solution for any subset of b.

On the other hand, any subset, such as {5, 7} is assured to be solvable if {1,3,5,7} has already been created and found to be solvable. The effectiveness of sensorless problem-solving could be significantly increased by this additional level of trimming.

3 Question 3.

The caption of Fig.4.14 says "The reachable portion of the belief-state space...". This sentence implies there exist belief state that is not reachable. Provide one example of a belief state that is not reachable in this sensorless vacuum world.

Answer
Given below are some examples of the belief states that are not reachable

1. No vacuum, no dirt in any block.

2. Dirt in one block, no vacuum in any.

D	

3. Dirt in both blocks, no vacuum in any.

D	D

4. Vacuum in both the blocks.

V	V

5. Vacuum in both, dirt in left block.

D V	V

6. Vacuum in both, dirt in right block.

V	D V

Figure 2: Belief States not Reachable

4 Question 4.

Continue drawing the AND-OR search tree in Fig.4.16 to show its second level and third level.

Answer

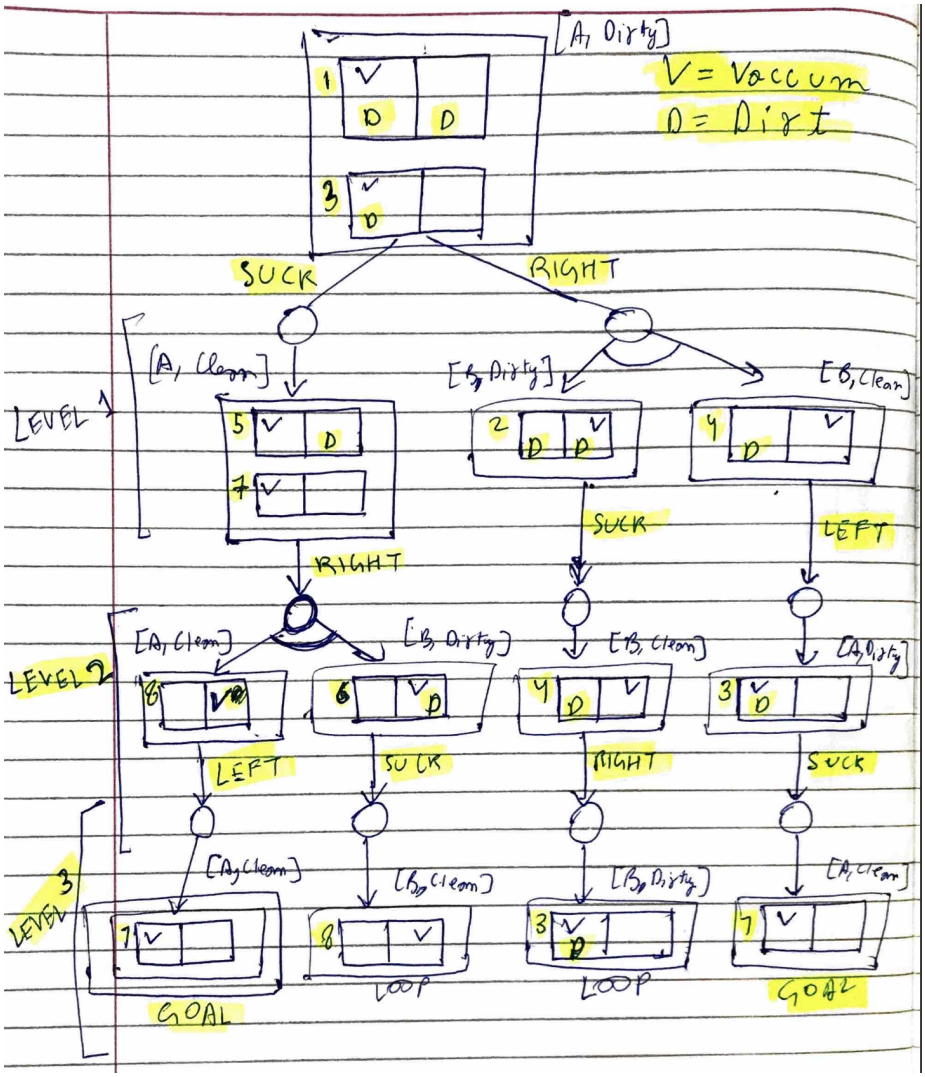


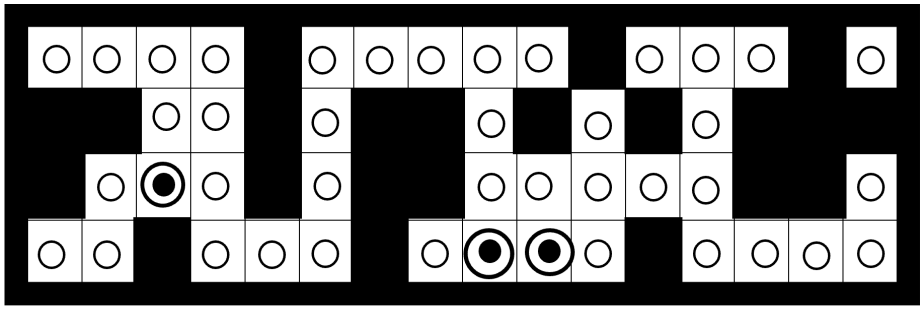
Figure 3: AND-OR Search Tree for local-Sensing Vacuum World.

5 Question 5.

In Ch.4.4.4, it discussed robot localization problem using Fig.4.18. The discussion there describes that (a) initially the robot does not know where it is, and the robot then receives the percept 1011. (b) The robot then executes a Right action, and it receives the second percept, 1011. (c) And at this point, the robot realizes its location. In the same fashion, draw a similar diagram to Fig.4.18 if the robot

1. initially does not know where it is, and the robot then receives the percept 0010. Draw a diagram similar to Fig.4.18(a) to show the robot's belief state (possible positions).

Answer

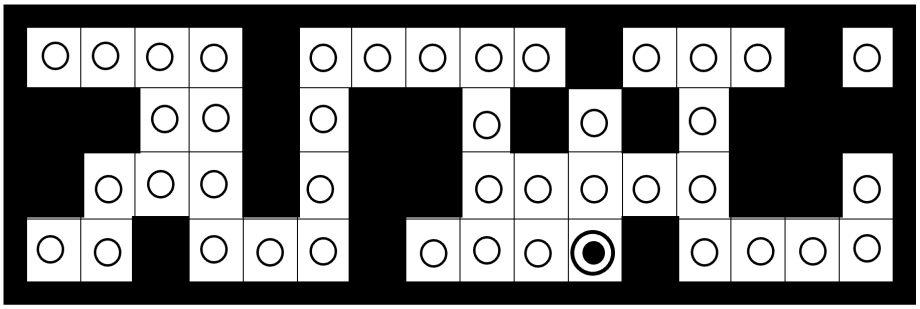


Robot's belief state (possible positions) if **PERCEPT = 0010, means only SOUTH MOVE IS BLOCKED.**

Denotes possible positions of Robot

2. The robot then executes a Down action, and it receives the second percept, 0110. Draw a diagram similar to Fig.4.18(b) to show the robot's belief state (possible positions).

Answer



Robot's belief state (possible positions) if **E1 PERCEPT = 0010, E2 = PERCEPT = 0110, means only NORTH and WEST MOVE IS ALLOWED**

Denotes possible positions of Robot

References

[RN22] Stuart J. Russell and Peter Norvig. Artificial intelligence: A modern approach. pages 144–153, 2022.