Artificial Intelligence: Partial Written test

19 April 2018

1 Exercise 1 (Points 40)

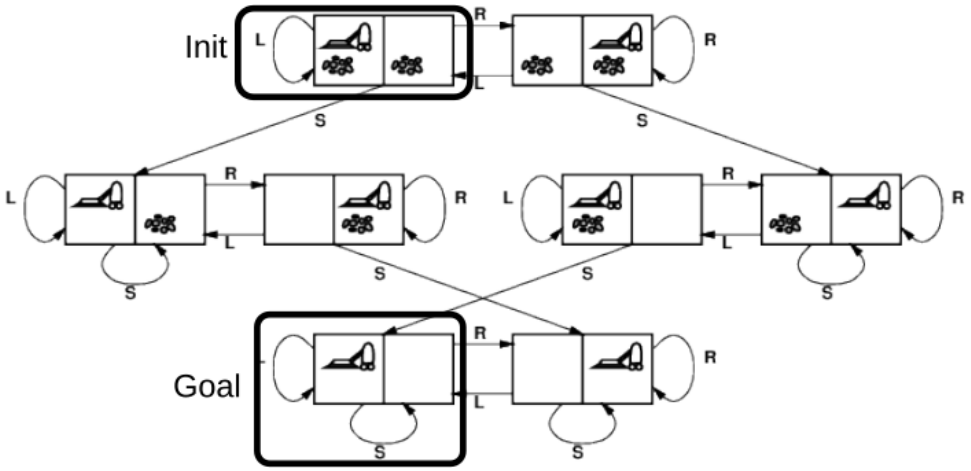

Figure 1: Vacuum cleaner state space, up left is init state, down left is goal state

Consider the vacuum cleaner environment with two rooms and three operations (Right, Left, Suck). Assume the state space is the one outlined in Figure 1, where edges report the actions, the state up left is the initial state and the one down left is the goal state. Assume all operations have a cost of cost of one unit. Represent a state with $\langle X, Y, Z\rangle$ where $X \in \{l, r\}$, $Y, Z \in \{d, c\}$. l stands for the left location, r stands for the right location, d indicates that a square contains dirt and c indicates that a square is clean. For example the init state is $\langle l, d, d\rangle$ and the goal state is $\langle l, c, c\rangle$. Answer the following questions (Always avoid repeated states on the same branch when performing search).

1. Consider Iterative Depening Search (IDS) with tree search strategy. Will this strategy return the optimal solution for the init and goal states considered here ? Motivate your answer.

2. Consider now BFS with graph search strategy, will this strategy return the optimal solution for the init and goal states considered here ? Motivate your answer.

3. Consider as a heuristic the number of squares that contain dirt plus the distance from the goal location (i.e., l) counted as number of movements required to reach such location. For example the state $\langle r, c, d\rangle$ will have a heuristic value of 2 because the number of dirty squares is one and the distance to goal location is 1. Is this heuristic consistent ?

4. Considering the heuristic defined above, show an execution of A*. Choose either graph search or tree search. Motivate your choice.

2 Exercise 2 (Points 30)

Consider the following binary cost network: variables, $X = \{x_1, x_2, x_3, x_4\}$, domains, $D_2 = D_3 = D_4 = \{R, B\}$ $D_1 = \{G, B\}$, hard constraints $C_h = \{R_{12}, R_{13}, R_{14}, R_{34}\}$ and soft constraints $C_s = \{\forall i | F_i(x_i)\}$. Where each R_{ij} is an inequality constraint and each F_i has the following form

$$F_i(x_i) = \begin{cases} 1 & \text{if } x_i = B \\ 0 & \text{otherwise} \end{cases}$$

Answer the following questions:

1. Apply the Bucket Elimination algorithm to find a solution for this network. Use the order $\{x_4, x_3, x_1, x_2\}$.
2. State what is the optimal value obtained by the best configuration. State whether there is only one configuration that achieves such optimal value or not. Motivate your answer.
3. State whether it is possible to find an order for the buckets that requires a higher computational effort (i.e., a "worse" order).

3 Exercise 3 (Points 30)

Consider the following constraint network: variables, $X = \{x_1, x_2, x_3, x_4\}$, domains, $D_3 = \{G, B\}$, $D_1 = D_2 = D_4 = \{R, B\}$, constraints $C = \{R_{12}, R_{13}, R_{23}, R_{24}\}$. Where each R_{ij} is an inequality constraint. Answer the following questions:

1. State whether this network is Arc Consistent. Motivate your answer.
2. State whether the network is acyclic using the primal based recognition method. When building the max-cardinality order start from x_1 and break ties by selecting the variable with lowest id.
3. Solve this problem by using either the tree solver approach or the join tree clustering method (motivate your choice). Is the network consistent ?