Artificial Intelligence: Written Exam

27 June 2018

1 Exercise 1 (Points 25)

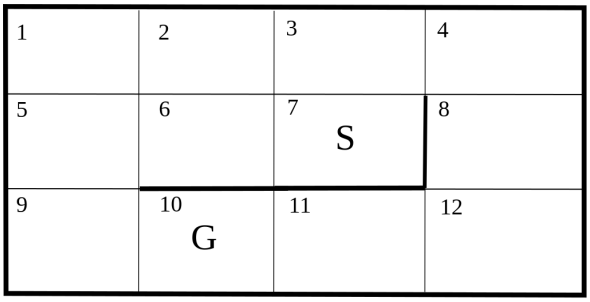

Figure 1: S is the starting position, thick lines are obstacles and G is the goal position

Consider Figure 1 where S and G are the starting and goal positions respectively. Consider the problem of finding a minimum cost path from S to G assuming the agent can move in the four directions (if there is no obstacle) and that each movement has a unitary cost. Answer the following questions:

1. State whether the manhattan distance to the goal would be a consistent heuristic for this problem. motivate your answer.
2. Show an execution trace for A* stating whether it is best to use a graph search or tree search strategy. Motivate your answer. For both search strategies, avoid repeated states on the same branch.
3. Consider an Iterative Deepening Search approach using the graph search strategy, is this approach guaranteed to return the minimum cost path ? Motivate your answer.
4. Can you find a configuration for the start ang goal position where an Iterative Deepening Search approach using the tree search strategy would not return the minimum cost path ? Motivate your answer.

2 Exercise 2 (Points 25)

Consider the following Graph coloring problem: Variables $X = \{x_1, x_2, x_3, x_4\}$, Domains $D_2 = \{G, B\}$, $D_1 = D_3 = D_4 = \{R, B\}$, Constraints $R = \{R_{13}, R_{23}, R_{24}, R_{34}\}$. Answer the following questions:

1. State whether the network is acyclic. Motivate your answer.
2. Solve the constraint network by using either Join Tree Clustering or Tree Solver, motivate your choice.
3. Find all solutions by using backtracking plus arc consistency $o = \{x_1, x_3, x_2, x_4\}$ always expand R before B and G before B.

3 Exercise 3 (Points 25)

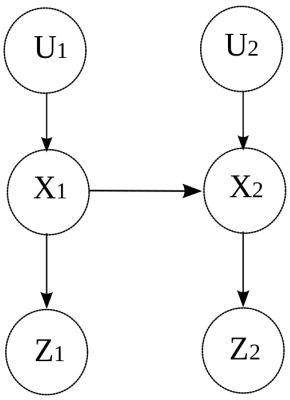

Figure 2: Bayesian Network.

Consider the Bayesian Network in Figure 2. Answer the following questions:

1. State whether U_2 is conditionally independent from Z_2 given X_1. Motivate your answer.
2. Assume variables $\{X_1, X_2\}$ can take three different values while $\{U_1, U_2, Z_1, Z_2\}$ are binary. State how many parameters must be provided to compute the joint probability table for this Bayesian Network.

4 Exercise 4 (Points 25)

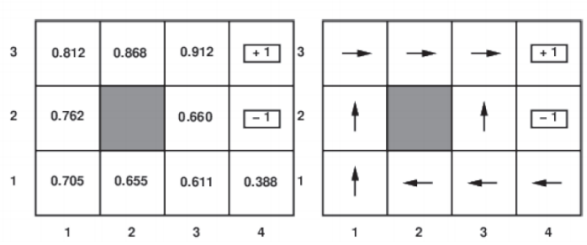

Figure 3: MDP environment: value function (left) and policy (left).

Consider the environment displayed in Figure 3, where states $(4, 3)$ and $(4, 2)$ are terminal states with reward $+1$ and -1 respectively[1]. The agent can move in the four directions. The transition model states that for every state and action the agent has 0.8 chances of moving in the chosen direction and 0.1 chances to move in the othogonal directions. The reward model states that for every state, action and successor state the agent pays -0.04. Assume that the left diagram reports the value function for the underlying MDP and that the MDP is undiscounted. Answer the following questions:

1. Consider the right diagram and focus on states $(3, 2)$ and $(3, 1)$. Say whether the actions reported in the diagram represent the optimal actions for those states. Motivate your answer.
2. Compute the probability of ending in state $(4, 2)$ if we execute the sequence of actons $< Up, Up >$ from state $(3, 1)$. Motivate your answer.

[1] State are represented as (x, y) where $x \in \{1, 2, 3, 4\}$ (i.e., columns) and $y \in \{1, 2, 3\}$ (i.e., rows)