Artificial Intelligence: Written Exam

13 June 2017

1 Exercise 1 (Points 30)

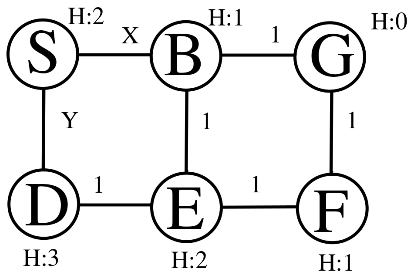

Figure 1: Road Network, S is the starting positions, G is the goal position, X represents moving cost from node S to node B, Y represents moving cost from node S to node D, and the H values for nodes represent the value of the heuristic in that node

Consider the road network in Figure 1 where S and G are the starting and goal nodes respectively. Consider the problem of finding a minimum cost path from S to G. The H values for nodes specify an heuristic that considers the minimum number of edges to reach the goal G. Assume $X \geq 1$ and $Y \geq 1$ Answer the following questions:

1. give an allocation for X and Y such that an A* search procedure would expand strictly more states that a greedy best first approach. Avoid repeated states on the same branch for both strategies. Motivate your answer.

2. State whether the heuristic reported in the picture is admissible considering the allocation you provided for X and Y.

3. State whether the heuristic reported in the picture is consistent considering the allocation you provided for X and Y.

2 Exercise 2 (Points 20)

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

Answer the following questions:

1. State whether the network is arc consistent. Motivate your answer.
2. Find all solutions by using backtracking plus forward checking with the following fixed ordering for variable expansion $o = \{x_1, x_2, x_3, x_4\}$ always expand R before B and G before B.
3. Find all solutions by using backtracking plus arc consistency with the same order defined above. Quantify the gain with respect to forward checking as number of nodes that are not expanded.

3 Exercise 3 (Points 20)

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 $R = \{R_{13}, R_{23}, R_{24}, R_{34}\}$ (same as exercise 2). Answer the following questions:

1. Is this network acyclic ? Motivate your answer.
2. Provide a solution using either Tree solver or JTC, motivate your choice.

4 Exercise 3 (Points 30)

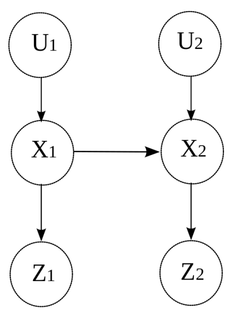

Figure 2: Bayesian Network.

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

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