Artificial Intelligence: Partial Written test

04 Maggio 2016

1 Exercise 1 (Points 25)

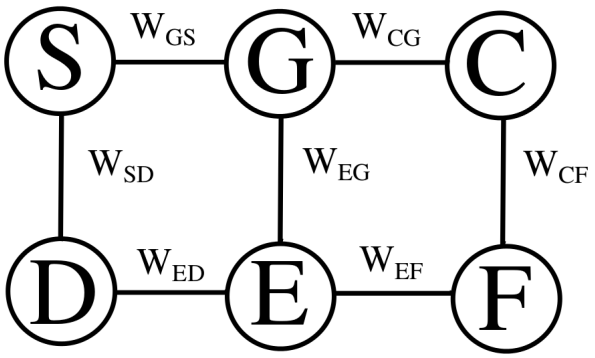

Figure 1: Mobility graph

Consider the mobility graph in Figure 1 where S and G are the start and goal positions respectively and $W_{i,j}$ represent the moving costs between the nodes i and j. Assume $W_{i,j}$ are all integer and strictly positive. Answer the following questions.

1. Give a weight allocation such that the best solution traverses at least 5 edges and has a cost of 5.
2. Given the weight allocation above, provide an admissible and consistent heuristic for the problem of finding a minimum cost path. Motivate why the heuristic is admissible and consistent.
3. Show the execution of A* using the heuristic provided above and the graph search algorithm.

2 Exercise 2 (Points 25)

Consider the following Graph coloring problem: Variables $X = \{x_1, x_2, x_3, x_4\}$, Domains $D_1 = D_3 = \{G, B\}$, $D_2 = D_4 = \{R, B\}$, Constraints $R = \{R_{12}, R_{13}, R_{14}, R_{23}, R_{24}, R_{34}\}$. 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.
4. State whether the network is consistent. Motivate your answer.

3 Exercise 3 (Points 30)

Consider the following binary cost network: variables, $X = \{x_1, x_2, x_3, x_4\}$, domains, $D_i = \{R, B\}$, hard constraints $C_h = \{R_{13}, R_{34}\}$ and soft constraints $C_s = \{F_{12}(x_1, x_2), F_{23}(x_2, x_3), F_{24}(x_2, x_4)\}$. Where each F_{ij} has the following form

$$F_{ij}(x_i, x_j) = \begin{cases} 0 & \text{if values are different} \\ 2 & \text{if values are equal to R} \\ 1 & \text{if values are equal to B} \end{cases}$$

Answer the following questions:

1. Apply the Bucket Elimination algorithm to find a solution for this network. Use a Max Cardinality order starting from x_1 and breaking ties by selecting the lowest id.
2. State what is the size of the largest bucket (number of variable) and the size of the biggest table (number of entries)
3. Is it possible to find an order that results in a bucket larger than the one obtained above ? Motivate your answer.

4 Exercise 4 (Points 20)

Consider the following constraint network: variables, $X = \{x_1, x_2, x_3, x_4\}$, domains, $D_i = \{0, 1\}$, constraints $C = \{R_{123} = \{(1,0,0), (0,1,0), (0,0,1)\}, R_{234} = \{(1,1,0), (0,1,1), (1,0,1)\}\}$. Answer the following questions:

1. State whether the network is acyclic using the primal based recognition method.
2. Find all solutions to this problem by using the approach you consider most efficient, motivate your choice.