Artificial Intelligence: Partial Written test

15 May 2013

1 Exercise 1 (Points 30)

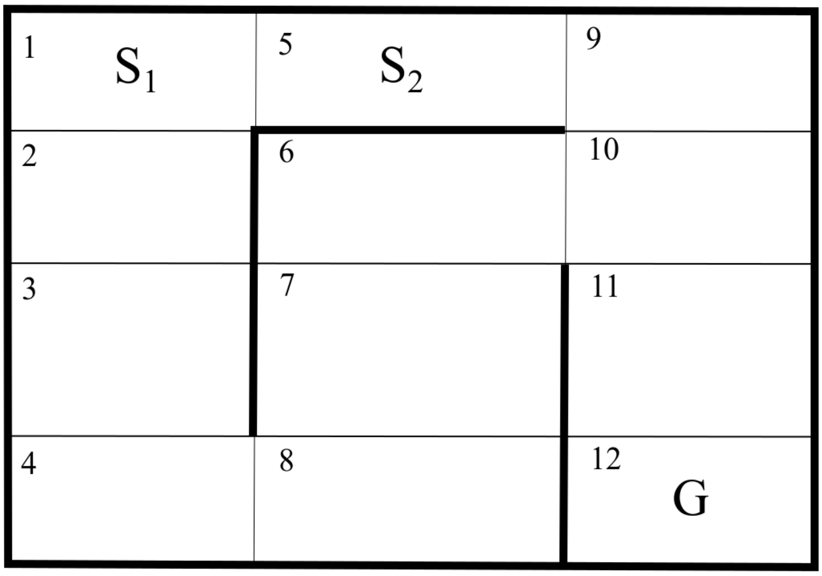

Figure 1: Mobility graph, S_1 and S_2 are the starting positions, thick lines are obstacles and G is the goal position

Consider the labyrinth in Figure 1 where S_1 and S_2 are two starting positions, G is the goal position. Consider the problem of finding a minimum cost path for two agents that move in the labyrinth, starting from S_1 and S_2 and to reach G. Agents move at the same time and they can reach the four neighbours and they must move at each time step (i.e., they do not have a "do nothing" operation). Agents can not traverse walls and each agent can not move to a cell if it is occupied by the other agent (the check is done before moving). When an agent reaches the goal cell it disappears from the environment (i.e., the goal cell is never occupied and once an agent reaches the goal cell it will not move again). Assume we want to solve this problem using search. A state is the position of the two agents, hence the start state is $< 1, 2 >$ and the goal state is $< 12, 12 >$ and movement cost is one for each move and for each agent. Define an admissible heuristic for this problem and trace the execution of a greedy local search approach (avoid repeated state in the same search branch). State whether the solution obtained is optimal.

2 Exercise 2 (Points 25)

Consider the following **binary** cost network: Variables, $X = \{x_1, x_2, x_3, x_4\}$, Domains, $D_1 = D_2 = D_3 = D_4 = \{R, B\}$, Constraints $C_h = \emptyset$ and $C_s = \{F_{12}(x_1, x_2), F_{14}(x_1, x_4), F_{24}(x_2, x_4), F_{34}(x_3, x_4)\}$. Where each F_{ij} has the following form

$$F_{ij}(x_i, x_j) = \begin{cases} RR & -1 \\ RB & 0 \\ BR & 0 \\ BB & -2 \end{cases}$$

Provide a solution for this cost network using Bucket Elimination. Use the ordering $o = \{x_4, x_3, x_2, x_1\}$.

3 Exercise 3 (Points 20)

Consider the following Graph coloring problem: Variables $X = \{x_1, x_2, x_3, x_4, x_5\}$, Domains $D_1 = D_4 = \{G, B\}$, $D_2 = D_3 = D_5 = \{R, B\}$, Constraints $R = \{R_{12}, R_{13}, R_{23}, R_{24}, R_{34}, R_{35}\}$. Solve it with backtracking plus forward checking and with backtracking forcing arc consistency at each step. Use the following fixed ordering for variable expansion $o = \{x_1, x_4, x_5, x_2, x_3\}$ and always expand R before B and G before B. Comment on whether AC is helping w.r.t. forward checking in this case (i.e., highlight the search space avoided by AC).

4 Exercise 4 (Points 25)

Consider the same Graph coloring problem defined in Exercise 3. Find one solution using the Join Tree Clustering approach. When building the max-cardinality order start from x_1 and break ties by selecting the variables with lowest ID.