Practice Assignment
(Not to be graded or submitted)

Wednesday, September 14, 2016

1. In state space searching, *completeness* is defined as a property of a search algorithm such that if a solutions exists it is guaranteed to find it. *Optimality* is defined as the guarantee to find the least cost path. Discuss whether these two properties hold in the case of DFS and BFS. Justify your answer.

2. Explain what is the Uniform Cost Search (UCS) and best first (or greedy) search. We get A* if we combine both. Given Figure 1, run A* to find the shortest path from Oradea to Bucharest showing the search in the tree. Give the details of which part are you using as UCS and which part for best first (greedy). Using this heuristic, are you always guaranteed to find the optimal solution? Justify.

3. Suppose you are given to apply A* to the problem given in Figure 2. Start state and goal states are given to you. Provide any three admissible heuristics (prove). Show the cost of reaching the goal state from the start state under the admissible heuristic that you are using.

4. Consider n queens problem. Recall the formulation of it in which Variables were given as $X_{ij} \in \{0, 1\}$. To be precise, i represents the row number and j represents the column. Write the set of constraints. Solve the following independent instances of 4 queens problem.

   (a) Consider the start state given to you is $\{X_{31}$, X_{22}, X_{33},$X_{42}\} = 1$. Apply hill climbing using min-conflicts heuristic to reach to the final state. Draw all the steps and reason for transition to next state at each step.

   (b) Consider empty state as the start state. Make use of the three heuristics, namely, (a). Minimum Remaining Values, (b) Degree Heuristic and (c) Least Constraining Value to start assigning values to the variables X_{ij} such that you reach a goal state of the 4 queens problem.

5. Define X_n as the number of rows, columns, or diagonals with exactly n X's and no O's. Similarly, O_n is the number of rows, columns or diagonals with just n O's. Assuming $n = 3$, the utility function assigns $+1$ to any position with $X_3 = 1$ and -1 to any posiition with $O_3 = 1$. All other terminal positions have utility 0. For nonterminal positions, we use a linear evaluation function defined as $Eval(s) = 3X_2(s)+X_1(s)-3(O_2(s)+O_1(s))$.

   (a) Approximately how many possible games of tic-tac-toe are there?

   (b) Show the whole game tree starting from an empty board down to depth 2 (i.e., one X and one O on the board), taking symmetry into account.

   (c) Mark on your tree the evaluations of all the positions at depth 2.

   (d) Using the minimax algorithm, mark on your tree the backed-up values for the positions at depths 1 and 0, and use those values to choose the best starting move.

   (e) Circle the nodes at depth 2 that would not be evaluated if alpha-beta pruning were applied, assuming the nodes are generated in the optimal order for alpha-beta pruning.

6. Prove that with a positive linear transformation of leaf values (i.e., transforming a value x to $ax + b$ where $a > 0$), the choice of move remains unchanged in a deterministic min-max game tree.

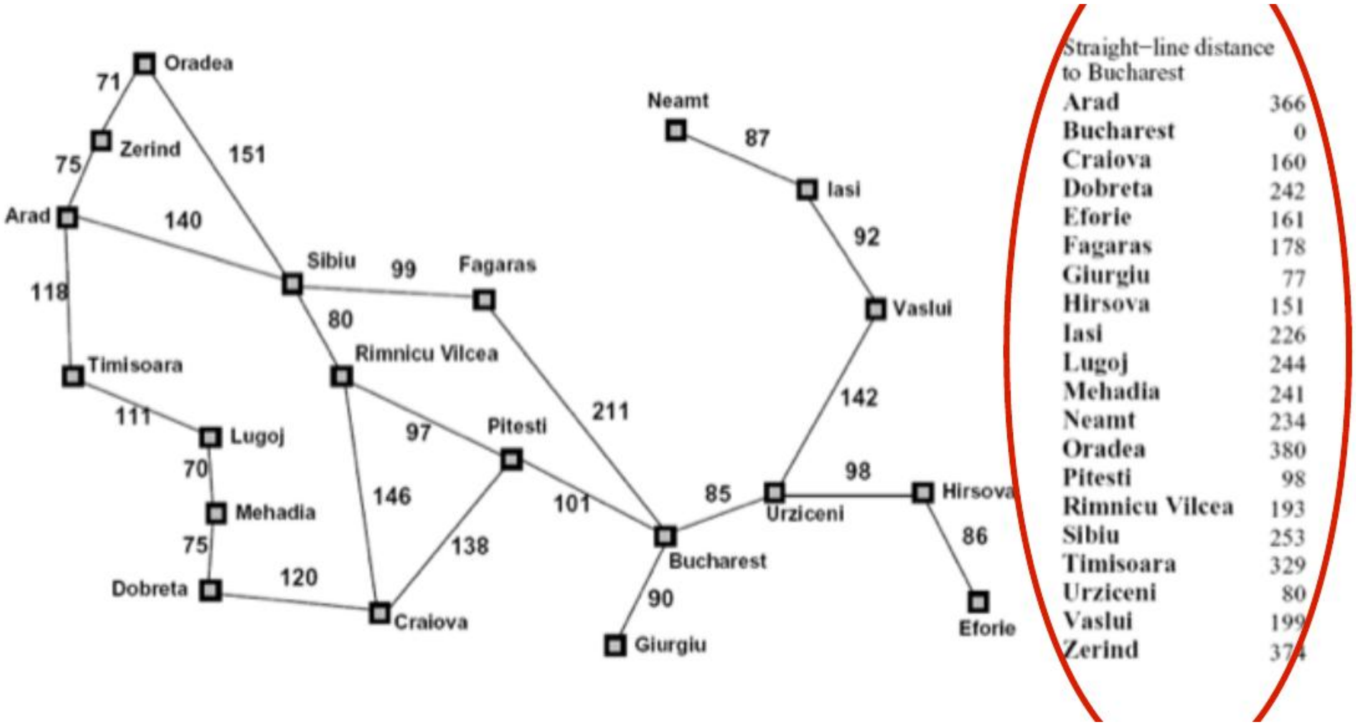

Figure 1: Map of Romania.

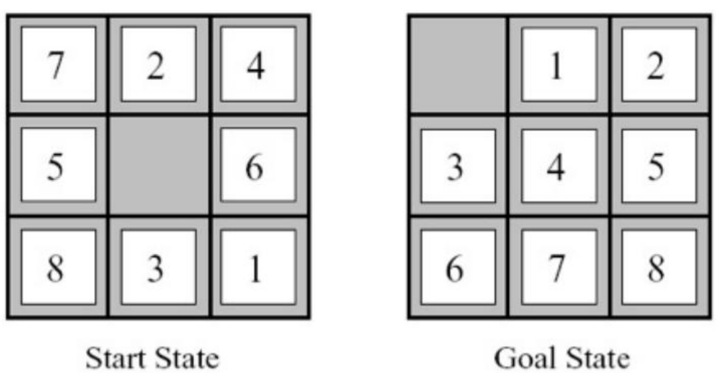

Figure 2: Tiles Problem.