ICS 271
Fall 2016
Instructor : Kalev Kask
Homework Assignment 2
Due Tuesday 10/18

1. (10 points) Trace the operation of graph-search A^* applied to the problem of getting to Bucharest from Zerind using the straight-line distance heuristic. That is, show the frontier at each step, nodes that the algorithm will expand and the f, g and h value for each node.

2. (50 points) A heuristic function is consistent if for every node n and its child node $n\prime$, $h(n) \leq c(n, n\prime) + h(n\prime)$. Prove the following properties of algorithm A^*.

   (a) (10) The f-values of the nodes expanded by Best-First-Search form a non-decreasing sequence.

   (b) (10) Prove that if h_1 and h_2 are both consistent, so also is $h = max(h_1, h_2)$.

   (c) (10) Prove that if h is consistent then it is also admissible (hint, you can prove this by induction moving from the goal node backwards).

   (d) (10) Prove that if the heuristic function is consistent then A^* graph search will never re-open any nodes.

   (e) (10) Prove or give a counter example: if for every node n, $h_1(n) \geq h_2(n)$, and for some nodes $h_1(n) > h_2(n)$ then A^* with h_1 always expands less nodes than A^* with h_2.

3. (20) This question is about weighted heuristic evaluation functions. The **heuristic path algorithm** (Pohl, 1977) is a best-first search in which the evaluation function is $f(n) = (2-w)g(n)+wh(n)$. For what values of w is this complete? For what values is it optimal, assuming that h is admissible? What kind of search does this perform for $w = 0, w = 1$ and $w = 2$?

4. (10 points) Lets assume that you are using A* graph search with a consistent heuristic. Further, lets suppose you are given a solution (a

path from start to goal) U, with its cost f_U. Note that you don't know if this solution is optimal. Can you use this fact (solution U and its cost) to improve the efficiency of your A*? If yes, how?

5. (10 points) Algorithm A^* does not terminate until a goal node is selected for expansion. However, a path to a goal node might be reached (generated) long before that node is selected for expansion. Why not terminate as soon as a goal node has been found? Illustrate your answer with an example.