ICS 271
Fall 2018
Instructor : Kalev Kask
Homework Assignment 2
Due Saturday 10/20

1. (10 points) Suppose that we run a best-first search algorithm with the following evaluation functions,
   (a) f(n)=-g(n). What sort of search will this search emulate?
   (b) f(n)=g(n). What sort of search will this search emulate?

2. (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.

3. (50 points) Which of the following are true and which are false? Explain your answers.
   (a) Depth-first search always expands at least as many nodes as A* search with an admissible heuristic.
   (b) h(n) = 0 is an admissible heuristic for the 8-puzzle.
   (c) A* is of no use in robotics because percepts, states, and actions are continuous.
   (d) Breadth-first search is complete even if zero step costs are allowed.
   (e) Assume that a rook can move on a chessboard any number of squares in a straight line, vertically or horizontally, but cannot jump over other pieces. Manhattan distance is an admissible heuristic for the problem of moving the rook from square A to square B in the smallest number of moves.

4. (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.

5. (15 points) Prove each of the following statements, or give a counterexample:

   (a) Breadth-first search is a special case of uniform-cost search.

   (b) Depth-first search is a special case of best-first tree search.

   (c) Uniform-cost search is a special case of A* search.