Topics Covered: This assignment covers: Heuristic Search (also known as Informed Search).

Must be done independently.

Complete the following problems/answer the following questions.

Problem 1: 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* search 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.
f. 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 distance travelled.

Problem 2: Show all operations taken by A* search applied to the problem of getting from Timisoara to Bucharest using the straight line distance heuristic. That is, show how the priority queue changes, the states removed from the priority queue, the backpointers, etc, during a run of A* search. Also specify the path found by A* and its cost. You will need to refer to Figure 3.1 on page 64 for the graph that corresponds to the map of Romania, which shows the actual costs of transitions, etc. You will also need to refer to Figure 3.16 on page 85, which lists the straight line distances from each city to Bucharest that you will need for the heuristic (i.e., that table is the heuristic).

Problem 3: We have examined various search algorithms, some uninformed, and some informed. We saw a few that use a Priority Queue, with the primary difference in the priorities given to states as they are added to the priority queue. Consider an algorithm for which the priority of a state n is given by:

$$f(n) = (2 - w) \cdot g(n) + w \cdot h(n)$$

Assume that h(n) is an admissible heuristic. Also, just like the algorithms seen in class, g(n) is the actual cost of getting to state n from the start, assuming the path implied by the backpointers. The w is a constant, real-valued parameter (i.e., don't just assume it is an integer). Answer the following questions:

a. If w = 0, then what search algorithm is this equivalent to in terms of order that states will be expanded?
b. If w = 1, then what search algorithm is this equivalent to?

c. If w = 2, then what search algorithm is this equivalent to in terms of order that states will be expanded?
d. For what range of values of w is this algorithm guaranteed to be optimal? Hint: if your answers to the previous parts are correct, then knowledge of those algorithms may be helpful in answering this question.