UNIVERSITY OF MINNESOTA
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

5511 **ARTIFICIAL INTELLIGENCE I** **FALL 2018**

ASSIGNMENT 2 (100 points)
Assigned: 10/02/18 Due: 10/16/18

Problem 1 (25 points)
Consider a state space where the start state is number 1, and the successor function for state n returns two states $2n$ and $2n + 1$.

(i) (5 points) Draw the portion of the state space for states 1 through 15.

(ii) (10 points) Suppose that the goal state is 11. Write down the order in which nodes will be visited for breadth-first search, depth-limited search with depth limit 3, and iterative deepening search.

(iii) (10 points) Can you apply best-first search to this problem? What would be a good heuristic? Write down the order in which nodes will be visited during the search for the goal of 11 using your previously selected heuristic.

Problem 2 (15 points)
In the A* search that you have seen in the AI class and AI books, the objective function at each node n is $f(n) = g(n) + h(n)$, where $g(n)$ is the cost from start to this node, and $h(n)$ is an admissible heuristic estimating the cost from n to a goal. Let us examine now a new $f(n)$: $f(n) = w * g(n) + (300 - w) * h(n)$ where w is larger than or equal to 0 and smaller than or equal to 300.

(a) (5 points) What search algorithm do you get when $w = 0$?

(b) (5 points) What does it happen when $w = 150$?

(c) (5 points) For what values of w is this algorithm guaranteed to be optimal? Give a brief explanation.

Problem 3 (15 points)
In the "Four-Queens Puzzle," you are given a 4x4 chessboard and the goal is to place four queens on the board so that no queen can capture any other. That is, only one queen can be on any row, column, or diagonal of the array. Placing one queen anywhere on the array is the only operator, and has cost 1. Answer "Yes" or "No" whether the $h(n) = 7depth(n)$, where $depth(n)$ is the depth of the node n in the search tree, is an admissible heuristic. Please explain.

Problem 4 (15 points)
We want to employ the A* search algorithm to solve 2D maze problems. Mention your state representation, your function that will generate the various children of a node, and an admissible heuristic function. Explain qualitatively how this heuristic may help you. You may use a 2d array (with white and black squares) to represent a maze. You may also find useful to have a function that queries each square for its color (black or white).

Problem 5 (15 points)
Assume that we have two admissible heuristics h_1 and h_2, for a given problem. Also assume that h_1 and h_2 are non-negative. Which of the following combinations will also be admissible? Justify your answers (Each subquestion is worth 5 points).

(i) $3.5(h_1 + h_2)$

(ii) $min(h_1, h_2)$

(iii) $max(h_1, h_2/11)$

Problem 6 (15 points)
Explain why the following statements hold:

(i) (5 points) Breadth-first search is a special case of uniform-cost search.

(ii) (5 points) Breadth-first search, depth-first search, and uniform-cost search are special cases of best-first search.

(iii) (5 points) Uniform-cost search is a special case of A*.