Homework 1

CS 3793/5233 – Fall 2016 — assigned August 23, 2016
Tom Bylander, Instructor — due September 2, 2016

In the Moving Problem, m items are placed in a $n \times n$ grid, no more than one item per square. The goal of the agent is to move all the items to its home square (the lower left corner), which is also where it starts. The agent can go left, right, up, or down one square at a time (not diagonally). When the agent enters a square with an item, it picks it up, except that when the agent enters its home square, it puts down all the items it is carrying. There are no more moves once the agent has moved all its items to the start square.

1. (20 pts.) Display the whole state space graph for the 2×2 Moving Problem displayed below. The agent starts in the lower left square.

1	1
0	0

   Hint: I think there are 18 states. Two states can be different if the agent is in a different location and/or if a square contains a different number of items.

2. (20 pts.) For the Moving Problem, estimate the number of states in the state space for an $n \times n$ grid. Assume that the initial state has one item in each square. Provide a lower bound and an upper bound. Hint: It's much much bigger than n^2.

3. (20 pts.) For the 2×2 Moving Problem below:

1	1
0	0

   show the sequence of states that are visited for breadth-first search (BFS) and iterative deepening (ID). A state is considered visited when it is tested for being a goal state.

   Assume that BFS uses multiple path pruning, that is, no state is expanded more than once (see Section 3.7.2).

   Assume that ID uses cycle checking, that is, no state appears twice in a path (see Section 3.7.1).

4. Consider the same Moving problem. As usual, the agent starts in the lower left square.

1	1
0	0

   Define a heuristic for the Moving problem as follows. Let m be the number of items.

   For a given state, let k be the number of items that the agent has not picked up yet. If $k > 0$, the heuristic is $k + 1$. If $k = 0$, then the agent is either away from home (heuristic is 1), or the agent is home (heuristic is 0).

   For example, the initial state has a heuristic of 3 because there are 2 items that have not been picked up.

(a) (20 pts.) Prove that the heuristic is admissible. That is, it never overestimates the number of moves to the goal state. In other words, why are k moves not enough to pick up k items and return home?

(b) (20 pts.) Show the order in which A* search would visit the states.