CSci 4511
Midterm 1

Name: _____

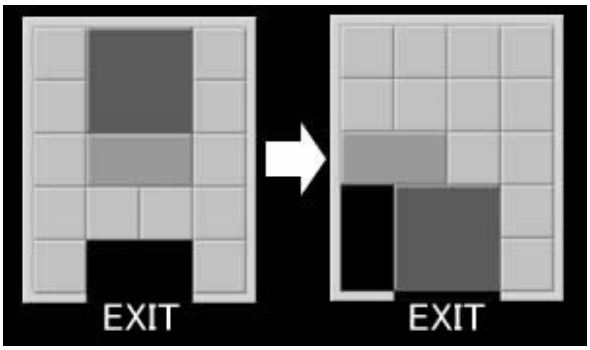
Student ID: _____

Instructions: The time limit is 75 minutes. Please write your answers in the space below. If you need more space, write on the back of the paper. The exam is open book and notes. You may use electronic devices to ONLY look at either an e-book version or electronic notes. You may not use the internet, program/run code or any other outside resources. (If you are typing on your keyboard/input device for anything other than ctrl-F to find words in the e-book or notes, this is probably not acceptable.) For all questions you must **show work**.

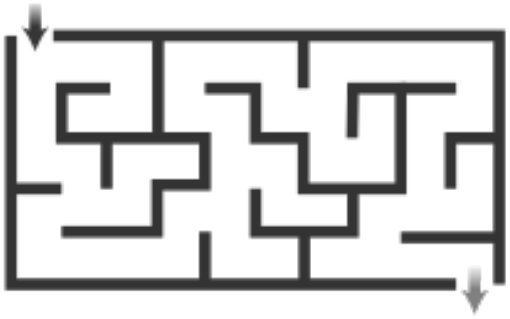
Problem (1) [20 points] Assume you have a problem with an admissible heuristic $h(n)$ for an A^* search. This problem could also be done with a bi-directional. Find a formula to estimate which search would be more efficient on this problem.

Problem (2) [20 points] For each of the following problems find a heuristic by giving (1) the relaxation and (2) a general description of how to calculate the heuristic at a given state. You can support your answer to (2) with an example, but this cannot be the only answer provided.

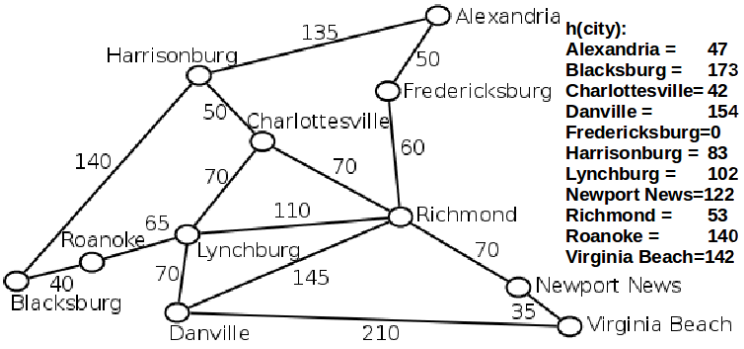
- Tic-tac-toe played on an N by N board where you need K in-a-row to win.
- A sliding puzzle (see picture below). The goal of this puzzle is to get a specific piece out of the exit in as few moves as possible (in the picture, the piece that you are trying to get out is the dark 2x2 block). Each move is sliding a block one cardinal direction into one of the open spaces (in the picture, the open spaces are the two black squares that start next to the exit). The pieces cannot rotate and cannot overlap with each other.



Problem (3) [20 points] The maze shown below starts in the top left (with an arrow pointing into the maze) and the goal is to get to the exit in the bottom right. (1) Draw a graph to represent the maze where states are nodes and actions are edges. Then (2) run depth first search (DFS) on the graph you generated in the first part to find the exit. Show your work at every step of the depth first search.



Problem (4) [20 points] The graph shown below is of a road network of cities in the state of Virginia. The goal is to reach Fredericksburg using the basic hill-climbing algorithm. (1) Run hill-climbing starting in Blacksburg and show your work. (2) Run hill-climbing starting in Virginia Beach and show your work.



Problem (5) [20 points] Answer the following questions about A^* search. For each modification shown below (done separately), state how this would effect: (1) the efficiency of the algorithm and (2) whether it is guaranteed to find an optimal solution. You may assume that the heuristic, $h(n)$, is consistent. Justify your answers with a short paragraph each for (1) and (2).

- Change $f(n) = g(n) + 2 \cdot h(n)$.
- Have some actions with negative cost.