CS360 – Homework #5

Search

1) Solve Problem 3 from Homework 4 for A* with a) the (consistent) Manhattan distance heuristic and b) the straight-line distance heuristic. The Manhattan distance heuristic between two grid cells (x_1, y_1) and (x_2, y_2) is $|x_1 - x_2| + |y_1 - y_2|$ (the length of a shortest path between the two cells, assuming that there are no obstacles on the grid). For instance, the Manhattan distance between A1 and E3 is $|1 - 5| + |1 - 3| = 6$. Remember to expand every state at most once. Explain which of the two heuristics one should prefer and why.

2) We are given a sequence of integers and want to sort them in ascending order. The only operation available to us is to reverse the order of the elements in some prefix of the sequence. For instance, by reversing the first three elements of (1 2 3 4), we get (3 2 1 4). This problem is also known as the "pancake flipping" problem. We model this problem as a search problem, where each state corresponds to a different ordering of the elements in the sequence. Given an initial sequence (2 4 1 3), in which order does A* expand the states, using the breakpoint heuristic described below? Assume that ties are broken toward states with larger g-values, and, if there are still ties, they are broken in lexicographic order. That is, (2 1 4 3) is preferred to (2 4 1 3).

Breakpoint heuristic: A breakpoint exists between two consecutive integers if their difference is more than one. Additionally, a breakpoint exists after the last integer in the sequence if it is not the largest integer in the sequence. For instance, in (2 1 4 3), there are two breakpoints: one between 1 and 4 (since their difference is more than 1) and the other one after 3 (since it is at the end and of the sequence and is not the largest integer in the sequence). The breakpoint heuristic is the number of breakpoints in a given sequence. (Bonus question: Is this heuristic a) admissible and b) consistent? Why?)

3) Does A* always terminate if a finite-cost path exists? Why?

4) Given two consistent heuristics h_1 and h_2, we compute a new heuristic h_3 by taking the maximum of h_1 and h_2. That is, $h_3(s) = max(h_1(s), h_2(s))$. Is h_3 consistent? Why?

5) In the arrow puzzle, we have a series of arrows pointing up or down, and we are trying to make all the arrows point up with a minimum number of action executions. The only action available to us is to choose a pair of adjacent arrows and flip both of their directions. Using problem relaxation, come up with a good heuristic for this problem.

6) Explain why heuristics obtained via problem relaxation are not only admissible but also consistent.

7) What are the advantages and disadvantages of a) uniform-cost search and b) greedy best-first search over A* search?