CS440: Assignment 1 Write-Up

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**Part 1:**

a) In figure 8, the agent would move east instead of north, because the cell east of the agent is closer to the goal than the cell north of the agent. If we are computing h(x) using Manhattan distances, the h(x) value for the cell east of the agent is 3. While the h(x) for the cell north of the agent is 4. If we are computing h(x) using straight-line distances the h(x) value for the cell east of the agent is 3. And the h(x) value of the cell north of the agent is sqrt(17), which is approximately 4.123. The g(x) values for the cell to the east of the agent and the cell to the north of the agent are 1 and 1 respectively. Therefore, if we are to compute h(x) using Manhattan distances the f(x) value of the cell to the east of the agent is 4 and the f(x) value of the cell to the north of the agent is 5. And if we are to compute h(x) using straight-line distances, the f(x) value of the cell to the east of the agent is 5, and the f(x) value of the cell to the north of the agent is 5.123. So no matter what you are using to compute h(x), the cell to the east of the agent is always preferable to the cell north of the agent, since the f(x) value of the cell east of the agent is always less than the f(x) value to the north of the agent.

b) If we visualize A\* search as a tree, and let all of the nodes of the tree be the cells of the environment, we would have a tree with a finite number of nodes. Cells are represented as nodes and their connections to their neighbors are represented by edges. The algorithm will be traversing the tree based on the smallest f(x) value among the nodes in the open list. In the worst case, we would have to traverse the whole tree before reaching the goal node. Since there are a finite number of nodes, traversing all of them must take a finite amount of time. Given an n x n gridworld, a move consists of moving from one unblocked cell to another unblocked cell. Let m be defined as the number of unblocked cells in the gridworld, where 2 <= m <= n. The maximum number of times the agent can visit a particular unblocked cell is 4. The agent must initially reach an unblocked cell from either the north, south, east, or west, given that the cell does not lie on an edge of the grid. Regardless of what direction the agent reaches the unblocked cell, there are now 3 possible directions for the agent to travel. Assume the worst case in which the immediate neighbors of the agent are unblocked but each path results in a dead end, which causes the agent to backtrack. There will be a total of 3 backtracks plus 1 initial visit, which results in 4 total visits to an unblocked cell. If we upperbound the number of maximum visits to an unblocked cell to 4, then we have a maximum number of 4\*m possible moves. Even if the agent were to make the maximum possible number of moves by backtracking to every cell it has visited 3 times, m2 will be an upperbound to the number of moves an agent can make for m >= 6. m must be >= 6 for backtracking in three directions to take place, 2 cells for agent and target, and 4 for the neighbors of the agent. For 2 <= m <= 5, we must consider circumstances where the agent has less than 4 neighbors. For the case where m = 2, if the target is a neighbor of the agent, then it will take one move to reach the target. Otherwise, it will take 0 moves to discover that the task is impossible. Therefore, 4 serves as a viable upperbound in this situation. For the case where m = 3, the agent can reach the target in one move if the target is a neighbor of the agent or in two moves if the agent moves to an unblocked cell and then to the target. In the case where the task is impossible, the agent will have moved a maximum of once. Therefore, 9 serves as a viable upperbound in this situation. For the case where m = 4, the agent can reach the target in either 1, 2 or 3 moves. If the target is a neighbor of the agent, then it will take the agent 1 move to reach the target. If the agent moves to an unblocked cell and then to the target, the agent moves twice. If the agent moves to an unblocked cell and then to another unblocked cell and then to the target, the agent will have moved thrice. It takes the agent a maximum of two moves to discover that the task is impossible. Therefore, 16 serves as a viable upperbound in this situation. For the case where m = 5, the agent can reach the target in either 1,2,3, or 4 moves. If the target is a neighbor of the agent, then it will take the agent 1 move to reach the target. If the agent moves to an unblocked cell and then to the target, the agent moves twice. If the agent moves to an unblocked cell and then to another unblocked cell and then to the target, the agent will have moved thrice. If the agent moves to an unblocked cell then to another unblocked cell then to another unblocked cell and then to the target, the agent will have moved four times. It takes the agent a maximum of three moves to discover that the task is impossible. Therefore, 25 serves as a viable upperbound in this situation.