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1. Describe how one can calculate the advanced heuristic value for any state of the puzzle.

Let h(n) be the heuristic function for any arbitrary state n. Let coord_x, coord_y be the x and y coordinates of the goal piece of n.

$$h(n) = \begin{cases} |coord_x - 1| + |coord_y - 3|, & if\ |coord_x - 1| + |coord_y - 3| \leq 1 \\ |coord_x - 1| + |coord_y - 3| + 6, & otherwise \end{cases}$$

2. Why is your advanced heuristic admissible?

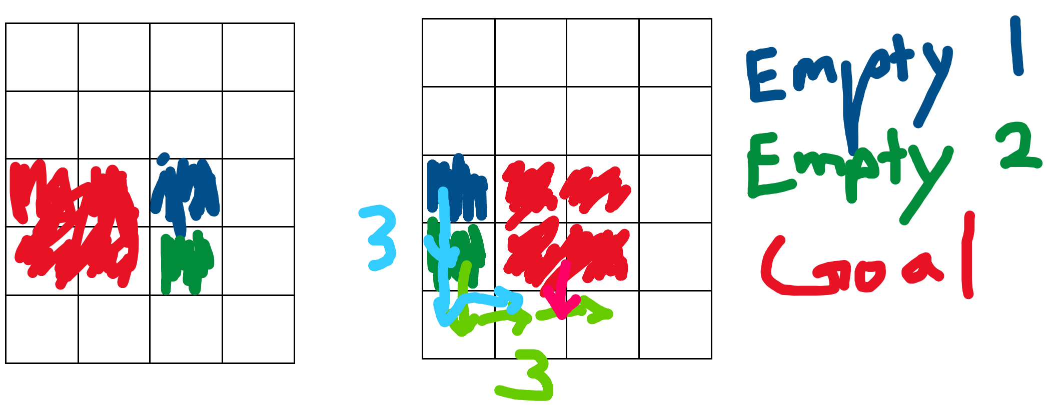
My advanced heuristic function is admissible because it never overestimates the cheapest path to get to a goal state.

The goal state is reached when coord_x = 1 and coord_y = 3 because this is the position where the goal piece is above the opening at the bottom.

Therefore, it will take at least $|coord_x - 1| + |coord_y - 3|$ moves for the goal piece to reach the goal position.

Assume the goal piece is one move away from the goal position and the empty spaces are at row 5 column 2 and row 5 column 4. Then it will take one move to get to the goal position, hence the first part of the piecewise function.

Now assume the goal piece is two or more moves away. Suppose a move is played where the goal piece moves. Then the empty spaces are now on the opposite side of the goal piece. In order to move the goal piece in any other direction, the empty spaces must both move to one of the other 3 sides. The combined Manhattan distance for both empty spaces to travel to an adjacent side is 6 (each empty space would travel 3 spaces, or one would travel 2 and the other would travel 4), and to travel to the opposite side is 10 (if both spaces travel 5). Therefore, after moving the goal piece once, to move it in any other direction it will take at least 6 moves to move the empty spaces to another side of the goal piece. The number of moves can never be less than this, therefore it is admissible.



3. Why does your advanced heuristic dominate the Manhattan distance heuristic?

My advanced heuristic dominates the Manhattan distance heuristic because the Manhattan distance heuristic is equal to $h_2(n) = |coord_x - 1| + |coord_y - 3|$, therefore $h(n) = h_2(n)$ when n is one or less moves away from the goal state, and $h(n) > h_2(n)$ otherwise, which satisfies the dominating characteristics defined in lecture.