CSC384H1S

Assignment 1: Solving Hua Rong Dao using Search

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Due: September 29, 2022

Advanced Heuristic Function

Description. This advanced heuristic function is improved based on the Manhattan distance heuristic. The Manhattan distance heuristic is derived with the relaxation that the pieces can overlap, and only the Manhattan distance between the 2x2 piece and the bottom opening should be cared. For this advanced heuristic, a constraint is added such that the bottom half of the 2x2 piece can only overlap the empty squares when it moves downward. Then the cost of the two empty squares would also be considered, but only after the 2x2 piece has moved above the opening, and the two empty squares has moved to the next row immediately below the bottom half of the 2x2 piece (if possible). These two empty squares can be considered as one piece, and whenever it moves once, a cost estimate with a value of one is generated.

Hence there are four possible cases, where the lower right corner of the 2x2 piece is located on the second (case 1), third (case 2), fourth and fifth rows of the board respectively. Notice that the last two cases will not generate any cost estimate of change of the two empty squares, and the first two cases will generate a cost estimate with a value of two or one respectively.

Generally, this advanced heuristic function is

$$h'(n) = \begin{cases} h(n) + 2 & \text{case 1} \\ h(n) + 1 & \text{case 2} \\ h(n) & \text{otherwise} \end{cases}$$

where $h(n)$ is the Manhattan distance heuristic function.

Reason for being Admissible. In case 2, when the 2x2 piece is moved in reality, the lower right corner of it will move to the fourth row. However, the two empty squares will move to the second row instead of keeping stay in the fourth row. To make the 2x2 piece continue to move downward, more steps must be taken to create space under it, not just make a single move. Since the Manhattan distance heuristic underestimates or accurately estimates the cost of moving the 2x2 piece, and the cost of creating space under it is also underestimated, this advanced heuristic function doesn't overestimate the cost. Similarly in case 1. And for any state in other cases, the value of this advanced heuristic function is equal to the value of the Manhattan Distance Heuristic function, which is admissible. Therefore, this advanced heuristic function is also admissible by the definition.

Reason for Dominating the Manhattan Distance Heuristic. The advanced heuristic function $h'(n)$ given in Description part shows that its value is at least equal to the value of the Manhattan distance heuristic function $h(n)$ for any state n. And for any state n in case 1, $h'(n) = h(n) + 2 > h(n)$. The most classic initial configuration is an example of state in case 1. Therefore, by definition of dominate, this advanced heuristic dominates the Manhattan Distance Heuristic.