Rush Hour Report

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1 Choice of Heuristic

My choice of heuristic was the number of cars in the same row as the goal car. I initially implemented this by iterating through all of the other cars. For each car I would then get each of the positions and if the position was on the same row as the goal car, then I could add 1 to the cost. This approach had some issues however which had to be refined. The optimisations I made were to ignore horizontal cars as these could never be in the way, only look at cars to the right of the goal car as the goal car is trying to move right, and infer the position of the car as iterating through all of its positions is inefficient.

My chosen heuristic consistently resulted with fewer expanded nodes over every puzzle provided, thus demonstrating that it is more efficient than a breadth first search of all of the solutions. This consistent increase in efficiency was due to the fact that the most important outcome of a move was to clear space for the goal car to find its way to the finish. Therefore calculating roughly the number of moves required to clear the path was the most obvious solution as minimising this heuristic minimised the overall number of nodes expanded.

2 Heuristic Admissibility

The heuristic is admissible as the cost is calculated by the number of cars that are in the way:

$$1 + \sum_{i=1}^{n} C_i$$

Where C_i is the cost of moving the i^{th} of n cars that are between the goal car and the goal. The lowest possible cost of a solution would be to move each of the cars out of the way and then to move the goal car to the right side of the board. Although uncommon, the lowest possible value of C_i would be 1, assuming that there are no cars in the way of the car trying to move out of the way of the goal car. As the lowest possible number of moves per car is 1, and the lowest possible number of moves of the goal car is 1, the true cost can not be less than this heuristic. Therefore the heuristic is admissible.

3 Heuristic Improvements

An improvement to the heuristic function could be to see how many moves it would take to allow each of the cars in the way of the goal car to move out of the way. A possible way of doing this cold be to recursively call the A* solver to find the cost of moving each car in the way of the goal car out of the way. The greatest drawback with this method is the time taken and computational power required to execute the heuristic function. Currently, the heuristic function has an efficiency of $O(n)$ where n is the number of cars. Using the improved heuristic function, the efficiency would be reduced greatly. Although the number of nodes expanded in the top level A* call would likely be reduced, there would be a huge number of nodes expanded for the subsequent A* searches for each of the cars in the way. The method could be called recursively on each car in the way. The deeper the level of recursion, the more the cost would tend towards the true cost.