Notations:

* ***n\*n****: the number of grids in the parking lot, which can be seen as a board*
* ***v****: the number of vehicles in the parking lot*

1. State space: the set of all reachable and different arrangements of vehicles for the board, where at most one vehicle occupying one grid. The states are reached from the initial state/given board by taking a sequence of actions described as below.
2. Initial state: the given board

3. Actions:

*general case:* move one car with a specified car number i(e.g. i = 1, 2, 3, …) one grid from its original grid with a specified direction. The option for direction for one car is either {left, right}, or {up, down}.

*edge cases:*

* when a vehicle has no legal move because either both grids immediately before or after it are occupied, or the grid besides one end is occupied, and the other end of the vehicle is the closest grid to the border, or
* when a vehicle has only 1 legal move because one end of the vehicle is next to an unoccupied grid, while the other end is either next to the border, or next to a grid occupied by another vehicle

4. Transition Model: returns the board with the specified car (the i-th car) moved by 1 grid to the specified direction (LEFT, or RIGHT, or UP, or DOWN)

5. Goal test: whether the red car occupies the cell with the door on one of its edges

6. Lower and upper bound on the branching factor of this formulation, if computable

*Lower bound:* 0, when there is no valid action (at current board, no vehicle can be moved to any direction)

*Upper bound:* 2***v***, when all cars can be moved to both directions

7. Lower and upper bound on the solution depth of this formulation, if computable

*Lower bound:* 0, when the red car already occupies the cell with the door on one of its edges

*Upper bound:* ***v***, since A\* only explores states/boards that are not visited before, hence each state/board can be explored for at most once, and therefore the branching factor is at most ***v.***

8. Optimal solutions to the 3 initial states provided above. For each state, specify the number of moves in the

optimal solution, as well as the sequence of states in the optimal solution. Each state should be represented

textually according to your state representation. There’s no need for fancy graphics, but try to make it so that it is

easy to see where the vehicles are located.

*[Note: In the graphs below, the number in each grid is the number of each vehicle, hence]*

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14

numBoardsExplored: 2308

numBoardsVisited: 650