AI Assignment

Q 1. Show that the 8-puzzle states are divided into two disjoint sets, such that any state is reachable from any other state in the same set, while no state is reachable from any state in the other set. Devise a procedure to decide which set a given state is in, and explain why this is useful for generating random states.

Q 2. Prove each of the following statements, or give a counterexample:

1. Breadth-first search is a special case of uniform-cost search.
2. Depth-first search is a special case of best-first tree search.
3. Uniform-cost search is a special case of A∗ search.

Q 3. n vehicles occupy squares $(1, 1)$ through $(n, 1)$ (i.e., the bottom row) of an $n \times n$ grid. The vehicles must be moved to the top row but in reverse order; so the vehicle i that starts in $(i, 1)$ must end up in $(n - i + 1, n)$. On each time step, every one of the n vehicles can move one square up, down, left, or right, or stay put; but if a vehicle stays put, one other adjacent vehicle (but not more than one) can hop over it. Two vehicles cannot occupy the same square.

a. Calculate the size of the state space as a function of n.
b. Calculate the branching factor as a function of n.
c. Suppose that vehicle i is at (x_i, y_i); write a nontrivial admissible heuristic h_i for the number of moves it will require to get to its goal location $(n - i + 1, n)$, assuming no other vehicles are on the grid.
d. Which of the following heuristics are admissible for the problem of moving all n vehicles to their destinations? Explain.
    (i) $\sum_{i=1}^{n} h_i$
    (ii) $\max(h_1, \ldots\ldots, h_n)$
    (iii) $\min(h_1, \ldots\ldots, h_n)$

Q 4. The **missionaries and cannibals** problem is usually stated as follows. Three missionaries and three cannibals are on one side of a river, along with a boat that can hold one or two people. Find a way to get everyone to the other side without ever leaving a group of missionaries in one place outnumbered by the cannibals in that place.

a. Formulate the problem precisely, making only those distinctions necessary to ensure a valid solution. Draw a diagram of the complete state space.
b. Implement and solve the problem optimally using an appropriate search algorithm. Is it a good idea to check for repeated states?
c. Why do you think people have a hard time solving this puzzle, given that the state space is so simple?