CS303A Homework 1

Q1 . Consider a state space where the start state is number 1 and each state k has two successors: numbers 2k and 2k + 1.

a. Draw the portion of the state space for states 1 to 15.

b. Suppose the goal state is 11. List the order in which nodes will be visited for breadth-first search, depth-limited search with limit 3, and iterative deepening search.

c. How well would bidirectional search work on this problem? What is the branching factor in each direction of the bidirectional search?

d. Does the answer to (c) suggest a reformulation of the problem that would allow you to solve the problem of getting from state 1 to a given goal state with almost no search?

e. Call the action going from k to 2k Left, and the action going to 2k + 1 Right. Can you find an algorithm that outputs the solution to this problem without any search at all?

Q2. The traveling salesperson problem (TSP) can be solved with the minimum-spanning- tree (MST) heuristic, which estimates the cost of completing a tour, given that a partial tour has already been constructed. The MST cost of a set of cities is the smallest sum of the link costs of any tree that connects all the cities.

a. Show how this heuristic can be derived from a relaxed version of the TSP.

b. Show that the MST heuristic dominates straight-line distance from the current city back to the start city.

c. Design a hill-climbing algorithm and write the procedure to solve the TSP.

d. Repeat part (a) using a genetic algorithm instead of hill climbing.

Q3. Consider the two-player game described in Figure 1:

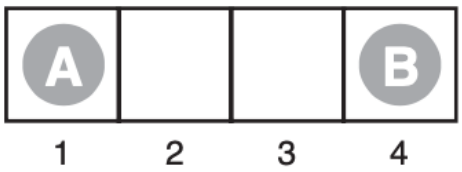

Figure 1 The starting position of a simple game. Player A moves first. The two players take turns moving, and each player must move his token to an open adjacent space in either direction. If the opponent occupies an adjacent space, then a player may jump over the opponent to the next open space if any. (For example, if A is on 3 and B is on 2, then A may move back to 1.) The game ends when one player reaches the opposite end of the board. If player A reaches space 4 first, then the value of the game to A is +1; if player B reaches space 1 first, then the value of the game to A is −1.

a. Draw the complete game tree, using the following conventions: • Write each state as (s_A, s_B), where s_A and s_B denote the token locations. • Put each terminal state in a square box and write its game value in a circle. • Put *loop states* (states that already appear on the path to the root) in double square boxes. Since their value is unclear, annotate each with a "?" in a circle.

b. Now mark each node with its backed-up minimax value (also in a circle). Explain how you handled the "?" values and why.

Q4. Consider the graph with 8 nodes A_1, A_2, A_3, A_4, H, T, F_1, F_2. A_i is connected to A_{i+1} for all i, each A_i is connected to H, H is connected to T, and T is connected to each F_i. Find a 3-coloring of this graph by hand using the following strategy: backtracking with conflict-directed backjumping, the variable order A_1, H, A_4, F_1, A_2, F_2, A_3, T, and the value order R, G, B.