1. Give a complete problem formulation for each of the following. Choose a formulation that is precise enough to be implemented.

a. Using only four colors, you have to color a planar map so that no two adjacent regions have the same color.

b. A 3-foot tall monkey is in a room where some bananas are suspended from the 8-foot ceiling. He would like to get the bananas. The room contains two stackable, movable, climbable 3-foot-high crates.

c. You have a program that outputs the message "illegal input record" when fed a certain file of input records. You know that processing of each record is independent of the other records. You want to discover what record is illegal.

d. You have three jugs measuring 12 gallons, 8 gallons, and 3 gallons, and a water faucet. You can fill the jugs up or empty them out from one to another or onto the ground. You need to measure out exactly one gallon.

2. Consider a state space where the start state is the 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 goal state with almost no search?

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

3. Prove each of the following statements, or give a counter-example:

a. Breadth-first search is a special case of uniform-cost search.

b. Depth-first search is a special case of best-first tree search.

c. Uniform-cost search is a special case of A* search.

4. Give the name that results from each of the following special cases:

a. Local beam search with k=1.

b. Local beam search with one initial state and no limit on the number of states retained.

c. Simulated annealing with T=0 at all times (and omitting the termination test).

d. Simulated annealing with T=infinity at all times.

e. Genetic algorithm with population size N=1.