3.6

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 in such a way that no two adjacent regions have the same color.

Initial state: the map with no regions colored
Actions: color a region
Transition model: returns the map with one more colored region
Goal test: all regions are colored and no two adjacent regions have the same color
Path cost: number of times coloring a region

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.

Initial state: the monkey, the suspended bananas, and two crates in the room
Actions: move around the room, move the crates, climb up or down the crate, stack the crate onto the other, grab bananas
Transition model: crates are moved or stacked, monkey climbs up or down the crate, grab bananas
Goal test: the monkey has the bananas
Path cost: number of movements the monkey has to make to get the bananas

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.

Initial state: all input records
Actions: feed an input record to the program
Transition model: the program outputs a message to tell if the record is illegal
Goal test: find out which input record is illegal (i.e. the program outputs “illegal input record”)
Path cost: number of runs it takes

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.

Initial state: three empty jugs ([0,0,0] where the first entry is the volume of water in the 12-gallon jug, the second is the 8-gallon jug, the third is the 3-gallon jug)
Actions: fill a jug with water, pour water out of the jug to another jug or onto the ground
Transition model: change the corresponding coordinate to the capacity of the jug when filling it, set the corresponding coordinate to 0 when emptying the jug, add min(capacity of A - x, y) to x and subtract min(capacity of A - x, y) from y when transferring water from jug B (whose water level is y) to jug A (whose water level is x).
Goal test: one gallon of water in one of the jugs
Path cost: number of steps it takes

3.9a

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. This problem is famous in AI because it was the subject of the first paper that approached problem formulation from an analytical viewpoint (Amarel, 1968).

A. Formulate the problem precisely, making only those distinctions necessary to ensure a valid solution. Draw a diagram of the complete state space.

State: [number of missionaries on the first side, number of cannibals on the first side, is the boat on the first side, number of missionaries on the second side, number of cannibals on the second side, is the boat on the second side]

Initial state: three missionaries, three cannibals, and the boat on one side of a river

Actions: assign one or two people to the boat

Transition model: update the state after moving people in the boat from one side to another

Goal test: all three missionaries and three cannibals are on the other side of the river

Path cost: each action costs one point