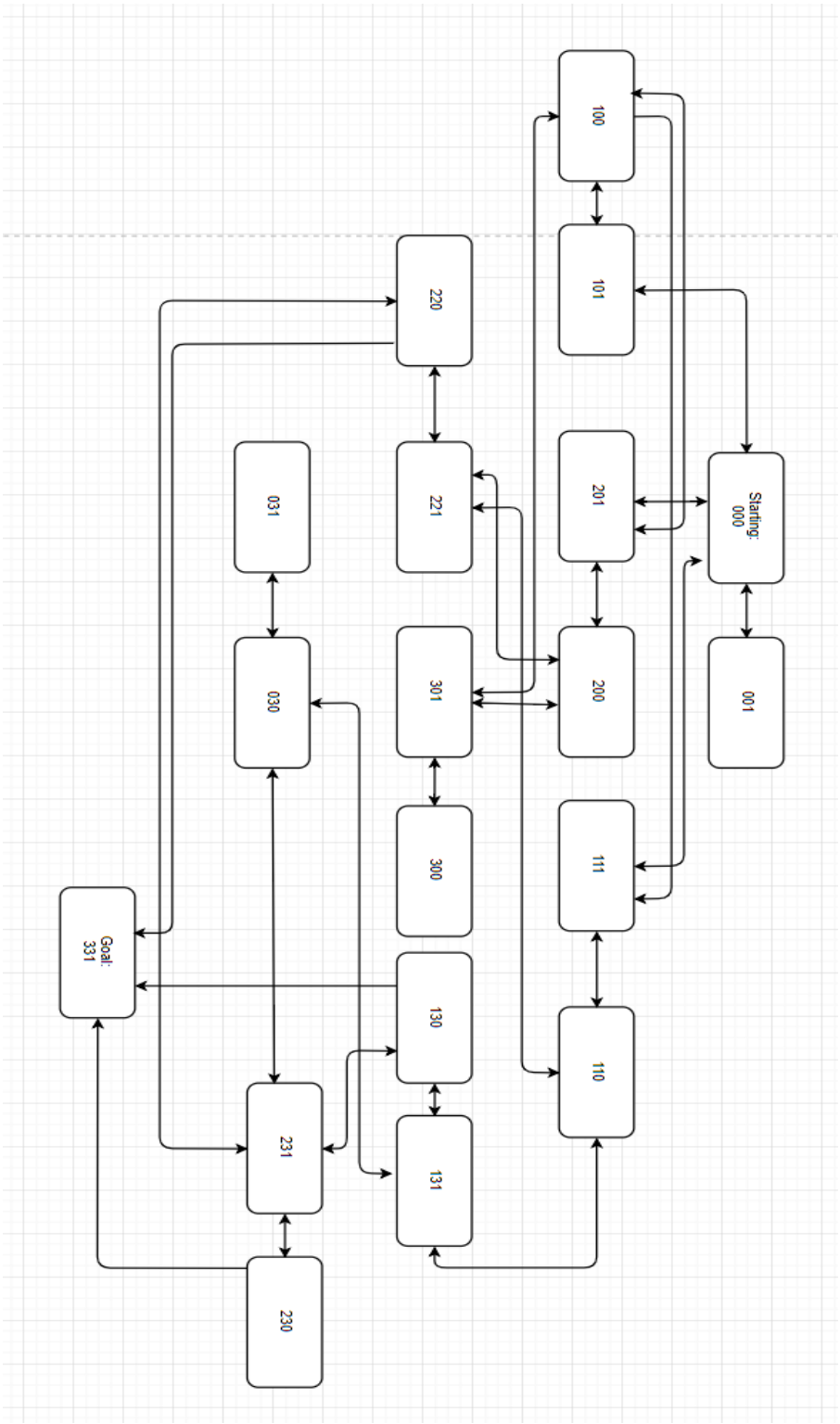
1. Give a complete problem formulation for each of the following. Choose a formulation that is precise enough to be implemented.
    a. **Initial state**: Planar map with no regions colored.
    Possible Actions: Color a region that isn't colored with a different color from its adjacent regions.
    Transition Model: A region is colored.
    Goal Test: Planar map has all regions colored with no two adjacent regions having the same color.
    Path Cost: The number of regions that need to be colored.
    b. **Initial state**: 2-ft tall giraffe is on the floor.
    Possible Actions: Stack, unstack, climb, step down, and move crates.
    Transition Model: Giraffe is somewhere in the room, stacks/unstacks crate, moves crate(s), climbs on/off crate, gets peaches.
    Goal Test: Giraffe gets peaches.
    Path Cost: Number of steps it takes for the giraffe to reach the peaches.
    c. **Initial state**: Any record may output illegal input record.
    Possible Actions: Split file in half, run half of file, run other half of file
    Transition Model: Figure out which half of file contains illegal record, repeat
    Goal Test: Run a single record, which outputs the message illegal input record.
    Path Cost: Number of times file is split and run
    d. **Initial state**: All buckets have no water
    Possible Actions: Fill bucket from faucet, empty out bucket, pour as much water to fill another bucket
    Transition Model: One bucket is always filled or emptied
    Goal Test: One of the buckets have exactly 1 gallon
    Path Cost: Number of times water is poured into or out of a bucket.
2. Three dogs and three cats are on one side of a river, along with a boat that can hold one or two animals. Fine a way to get everyone to the other side without ever leaving a group of cats in one place outnumbered by the dogs in that place.
    a. **Initial state**: Three dogs and three cats on one side of river
    Possible Actions: 1 dog gets on/off boat, 1 cat gets on/off boat, boat moves one side of the river, boat moves to the other side of river
    Transition Model: Dogs and cats move from left to right, ensuring the number of dogs don't outnumber number of cats on each side.
    Goal Test: All three dogs and cats on other side of river.
    Path Cost: Number of times boat moves

Diagram:



Explanation of diagram:

I made each node of the state space diagram in 3 coordinates. The first digit indicates the number of dogs in the goal end, the second digit indicates the number of cats in the

goal end of the river, and the third digit indicates if the boat is on the goal end, 1 if on the starting end, 0. Therefore, the starting point would always be node 000, and the end would always be 331 since the boat will have to be on the goal end of the river for the goal end to have its last transport.

   b. Yes, because it seems like we would be going back to these repeating states multiple times.
   c. People have a hard time solving this puzzle because it is easy to outnumber the dogs on one side compared to the other. While it is easy to move them one by one, there are some moves which are invalid which limits the moves the person can use at the moment.

3. Answer the following questions regarding local search.
   a. Local search uses a single current state and follows the heuristic of only the current state to find the optimal path. Greedy best first search follows the heuristic value of the lowest f(n) which is the heuristic value.
   b. Local search is better when the graph is bigger, with an almost infinite state spaces.
   c. Local search is worse when the graph is smaller, with less edges and very limited state spaces. This is because it needs to calculate heuristic.
   d. When there is only one successor, local search is better than A* search. This is because A* search finds the optimal path by giving its successors heuristic values in the form of f(n) which also includes the goal. If the graph is linear, it wouldn't matter.
4. Code is in the submitted file