Lab Assignment: Water Pouring Puzzle using Graphs

Objective

To model and solve the water pouring problem using graph theory and data structures.

Problem Statement

You are given three containers with capacities:

$$C_1 = 10 \text{ litres}, \quad C_2 = 7 \text{ litres}, \quad C_3 = 4 \text{ litres}$$

Initially:

$$C_1 = 0, \quad C_2 = 7, \quad C_3 = 4$$

You are allowed to pour water from one container to another, stopping either when the source container is empty or the destination container is full.

Goal: Determine if there exists a sequence of pourings such that exactly 2 litres remain in either the 7-litre or 4-litre container.

Graph Modeling Idea

- Each state of the containers can be represented as a triple (x, y, z), where:

$$x = \text{amount in 10-litre}, \quad y = \text{amount in 7-litre}, \quad z = \text{amount in 4-litre}$$

- Each valid pouring operation defines an edge from one state to another.
- Use graph traversal algorithms (BFS or DFS) to explore all reachable states from the initial state $(0, 7, 4)$.
- Stop when a state satisfies the goal condition:

$$y = 2 \text{ or } z = 2$$

Function Signatures

```
struct State {
    int c1, c2, c3;
};

int isGoal(struct State s);
void pour(struct State src, struct State* dest, int from, int to);
void BFS(struct State start);
```

Details

- Represent each state as a node in a graph.
- Create all possible transitions (edges) using the pouring operation rules.
- Use BFS or DFS to find a path from the initial state to a state where either the 7-litre or 4-litre container contains exactly 2 litres.
- Print the sequence of states (pourings) leading to the solution.

Example Walkthrough

1. Initial state: $(0, 7, 4)$
2. Pour from 7-litre to 10-litre: $(7, 0, 4)$
3. Pour from 4-litre to 10-litre: $(10, 0, 1)$
4. Pour from 10-litre to 7-litre: $(3, 7, 1)$
5. Pour from 7-litre to 4-litre: $(3, 4, 4)$
6. Pour from 4-litre to 10-litre: $(7, 4, 0)$
7. Now, the 7-litre container has exactly 2 litres? Continue until goal is reached.

Expected Output

A sequence of states representing the pourings that achieve exactly 2 litres in either the 7-litre or 4-litre container.