Water Pitcher Problem

Informed Search Algorithm (A*)

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Problem Definition

- Implement a program that reads this input file and calculates the shortest path (number of steps) from initial state (all pitchers are empty) to the final state (where the “infinite” capacity pitcher has the target quantity).
- Any kind of water movement (from any pitcher to any other pitcher) represents one step.
- Implement an informed search (A*) for this problem.
- Write test cases (JUnit or equivalent) to ensure to make sure your program works. Unit test code is also included in the grading.

State Definition

Each state is an object of a class. (Programming language : Python)

The class contains the following attributes

- Pitchers = [] (List that stores the current state of water in the pitchers)
- Distance (Stores the steps from the start state)
- Path (Stores the path from the start state)
- Parent (Stores which action from the parent caused the creation of the current state)

Global Variables

- CAPACITY = [] (Stores the maximum capacities of all the jugs)
- Visited = [] (Stores all the states that were visited)
- Priority = [] (Fringe that stores the unvisited states and prioritizes lower heuristic values)

Dynamic Creation of States

The successor function is responsible for the creation of the child states from the current state.

The function calls 3 other functions

- transfer(curr, dest) - transfers water between the indexed jugs
- fill(index) - fills water into the indexed jug
- empty(index) - empties water from the indexed jug

The transfer(), fill() and empty() functions follow all the rules defined for the environment.

The heuristic function is called by the constructor of the class.

Heuristic Function

h(n) = | Target - (Current amount of water in inf pitcher + Max(Remaining water in finite pitchers)) |

- The heuristic function gives a sense of direction for the algorithm to reach the goal state from the current state efficiently.
- The lower bound is estimated as the difference between the target amount of water in the infinite pitcher and the sum of the current amount of water in the infinite pitcher and the maximum remaining water in the finite pitcher.

The heuristic also considers these 2 factors:

- If at any state, any of the finite pitchers have the exact amount of water remaining to reach the target in the infinite pitcher, its heuristic value becomes -1.

- If the heuristic value is the same for all the states in a level, it orders them with the following priority.
  - Child obtained from transfer of water b/w jugs (Highest Priority)
  - Child obtained from filling a jug (Medium Priority)
  - Child obtained from emptying a jug (Lowest Priority)

Example Outputs

Pitcher = 3,5 Target = 1

```
[0, 0, 0]
[3, 0, 0]
[0, 3, 0]
[3, 3, 0]
[1, 5, 0]
[0, 5, 1]

Goal Node can be reached in 5 steps.
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Pitcher = 2 Target = 143

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No Solution Found

-1
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