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(Autonomous College Affiliated to University of Mumbai)

Computer Engineering Department &
Information Technology Engineering Department

Academic Year: 2022-2023

Class: T.Y.B.Tech **Sem.:** V **Course:** AIML

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Experiment No.	1		

AIM:	Implement an Intelligent agent. (problem formulation and implementation)

WATER JUG PROBLEM

FPRMULATION:

Problem statement

Given two water jugs with capacities **X** and **Y** litres. Initially, both the jugs are empty. Also given that there is an infinite amount of water available. The jugs do not have markings to measure smaller quantities.
One can perform the following operations on the jug:

- Fill any of the jugs completely with water.
- Pour water from one jug to the other until one of the jugs is either empty or full, (X, Y) -> (X – d, Y + d)
- Empty any of the jugs

The task is to determine whether it is possible to measure **Z** litres of water using both the jugs.

Agent Function:

Sr.No	**Description of action taken**	**Condition**	**Final state**
1.	Fill the j1-litre jug completely	If x<j1	(j1,j2)
2.	Fill the j2-litre jug completely	if y<j2	(x,j2)
3.	Empty the j1-litre jug	If x>0	(0,y)
4.	Empty the j2-litre jug	If y>0	(x,0)
5.	Pour some water from the j2-litre jug to fill the j1-litre jug	If (x+y)<j1+j2	(j1, y-[j1-x])

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6.	Pour some water from the j1-litre jug to fill the j2-litre jug	If (x+y)<j1+j2	(x-[j2-y],j2)	
7.	Pour all water from j2-litre jug to the j1-litre jug	If (x+y)<j1	(x+y,0)	
8.	Pour all water from the j1-litre jug to the j2-litre jug	if (x+y)<j2	(0, x+y)	

Agent: Water-Jug Agent
Action: fill jug, empty jug, transfer from one jug to other
Goal : x1 litres water in X jug and y1 litres water in Y jug
Environment Type: single agent, partially observable, deterministic, static, Discrete

PEAS Description:
1.Performance measure:
Correctness i.e. successfully reach goal state
2.Environment:
Two jugs and a tap with unlimited water
3.Actuators:
The Pump, to transfer the water
4.Sensors:
Sensor to detect Water level
The agent has sensors to judge when when jug is empty and full.

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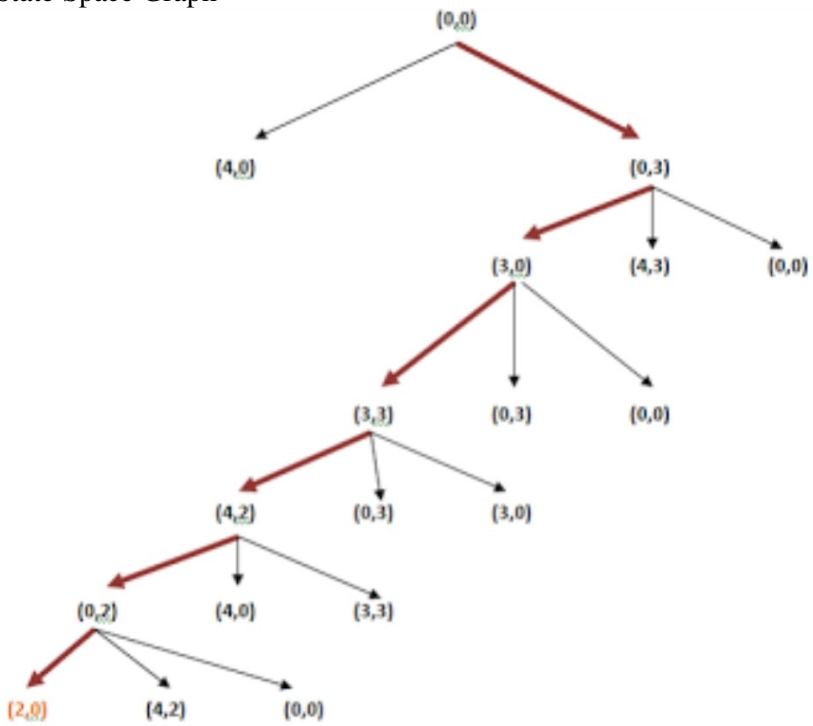
Ex: If max X = 4, max B = 3 and final x=2 final y=0

4 litres jug	3 litres jug	Rule Applied(to get 2 litres)
0	0	Initial State
4	0	1.Fill 4
1	3	6. Pour 4 into 3 to fill
1	0	4. Empty 3
0	1	8. Pour all of 4 into 3
4	1	1. Fill 4
2	3	6.Pour into 3
2	0	Empty 3

State Space Graph



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IMPLEMENTATION:

Code:

```
import java.util.ArrayList;
import java.util.LinkedList;
import java.util.Queue;
import java.util.Scanner;

class Node {
    int leftCap, rightCap;
    String path;

    public Node(int x, int y, String z) {
        this.leftCap = x;
        this.rightCap = y;
        this.path = z;
    }
}

public class WaterJugProblem {
    public static int jugA, jugB, targetA, targetB;
    public static Queue<Node> queue = new LinkedList<>();
    public static ArrayList<Node> visited = new ArrayList<>();
    public static int visitedNodes = 0;
    public static boolean flag = false;

    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        System.out.print("Enter the Capacity of Jug A: ");
        jugA = sc.nextInt();
        System.out.print("Enter the Capacity of Jug B: ");
        jugB = sc.nextInt();
        System.out.print("Enter the Target Capacity of Jug A: ");
        targetA = sc.nextInt();
        System.out.print("Enter the Target Capacity of Jug B: ");
        targetB = sc.nextInt();
        Node root = new Node(0, 0, "");
        queue.add(root);
        Node jug;

        while (!queue.isEmpty()) {
            visitedNodes++;
```

```
        jug = queue.poll();
        if (jug.leftCap == targetA && jug.rightCap == targetB) {
            System.out.println("The required capacity can be achieved after "
+ (visitedNodes + 1) + " move(s)");
            System.out.println("Number of nodes traversed: " +
visitedNodes);
            System.out.println("The path is: " + generatePath(jug));
            flag = true;
            break;
        }

        Node temp = jug;
        // Fill jug A
        if (jug.leftCap < targetA) {
            temp = new Node(jugA, jug.rightCap, generatePath(jug));
            if (!visited.contains(temp)) {
                queue.add(temp);
                visited.add(temp);
            }
        }
        // Fill Jug B
        if (jug.rightCap < targetB) {
            temp = new Node(jug.leftCap, jugB, generatePath(jug));
            if (!visited.contains(temp)) {
                queue.add(temp);
                visited.add(temp);
            }
        }
        // Empty Jug A
        if (jug.leftCap > 0) {
            temp = new Node(0, jug.rightCap, generatePath(jug));
            queue.add(temp);
            visited.add(temp);
        }

        // Empty Jug B

        if (jug.rightCap > 0) {
            temp = new Node(jug.leftCap, 0, generatePath(jug));
            queue.add(temp);
```

```
            visited.add(temp);
        }

        // Pour from Jug A to Jug B until its full
        if (jug.leftCap > 0 && (jug.leftCap + jug.rightCap) >= jugB) {
            temp = new Node(jug.leftCap - (jugB - jug.rightCap), jugB,
generatePath(jug));
            if (!visited.contains(temp)) {
                queue.add(temp);
                visited.add(temp);
            }
        }

        // Pour from Jug B to Jug A until its full
        if (jug.rightCap > 0 && (jug.leftCap + jug.rightCap) >= jugA) {
            temp = new Node(jugA, jug.rightCap - (jugA - jug.leftCap),
generatePath(jug));
            if (!visited.contains(temp)) {
                queue.add(temp);
                visited.add(temp);
            }
        }
        // Puor all water from 1st to 2nd
        if (jug.leftCap > 0 && (jug.leftCap + jug.rightCap) <= jugB) {
            temp = new Node(0, jug.leftCap + jug.rightCap,
generatePath(jug));
            if (!visited.contains(temp)) {
                queue.add(temp);
                visited.add(temp);
            }
        }

        // Puor all water from 2nd to 1st
        if (jug.rightCap > 0 && (jug.leftCap + jug.rightCap) <= jugA) {
            temp = new Node(jug.leftCap + jug.rightCap, 0,
generatePath(jug));
            if (!visited.contains(temp)) {
                queue.add(temp);
                visited.add(temp);
            }
```

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```
            }

        }
        if (!flag)
            System.out.print("\nCannot achieve the required capacity");
        sc.close();
    }

    static String generatePath(Node node) {
        String path = "[ " + node.leftCap + "," + node.rightCap + " ] ";
        return node.path + path;
    }

    static void printVisitedNodes() {
        System.out.println("Visited Nodes: ");
        for (Node node : visited) {
            System.out.print(" [ " + node.leftCap + " " + node.rightCap + " ], ");
        }
    }
}
```

```
C:\Users\HP\Desktop\SPIT_Files\AIML>cd "c:\Users\HP\Desktop\SPIT_Fi
Enter the Capacity of Jug A: 4
Enter the Capacity of Jug B: 3
Enter the Target Capacity of Jug A: 0
Enter the Target Capacity of Jug B: 2
The required capacity can be achieved after 37 move(s)
Number of nodes traversed: 36
The path is: [ 0,0 ] [ 0,3 ] [ 3,0 ] [ 3,3 ] [ 4,2 ] [ 0,2 ]
```

CONCLUSION: Solved Water jug Problem using the BFS searching technique.