Experiment: 03

Aim : Identify any AI Problem (eg. River Crossing, water Jug, Brain Vita marbles etc) find its state space and find the solution for the same.

Theory:

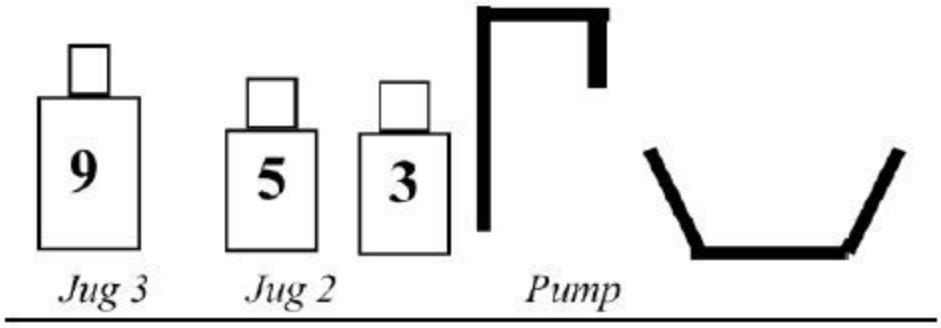
A state space represents a problem in terms of states and operators that change states. State space representation is defined as a set of all possible states for a given problem is known as the state space of the problem or a state space represents a problem in terms of states and operators that change states. A state space consists of:

- A representation of the states the system can be in. In a board game, for example, the board represents the current state of the game.
- A set of operators that can change one state into another state. In a board game, the operators are the legal moves from any given state. Often the operators are represented as programs that change a state representation to represent the new state.
- An initial state.
- A set of final states; some of these may be desirable, others undesirable. This set is often represented implicitly by a program that detects terminal states.

Find:

- A sequence of operators that leads from the initial state to a goal state
- The search space is the implicit tree (or graph) defined by the initial state and the operators
- The search tree (or graph) is the explicit tree generated during the search by the control strategy

Water jug problem-



Example-1

- You are given two jugs, a 4-litre one and a 3-litre one. Neither has any measuring markers on it. There is a pump that can be used to fill the jugs with water. How can you get exactly 2 litres of water into 4-litre jug.
- **State:** (x y) for liters in jugs 1, 2 integers 0 to 4 assigned to all possible permutations of 1 2
- **Operations:** empty jug, fill jug.
- **Initial state:** (0,0)
- **Goal state:** (2,4)
- **State Space representation**
  current state = (0, 0)
  Loop until reaching the goal state (2, 0)

Apply a rule whose left side matches the current state get the new current state to be the resulting state
(0, 0)
(0, 3)
(3, 0)
(3, 3)
(4, 2)
(0, 2)
(2, 0).

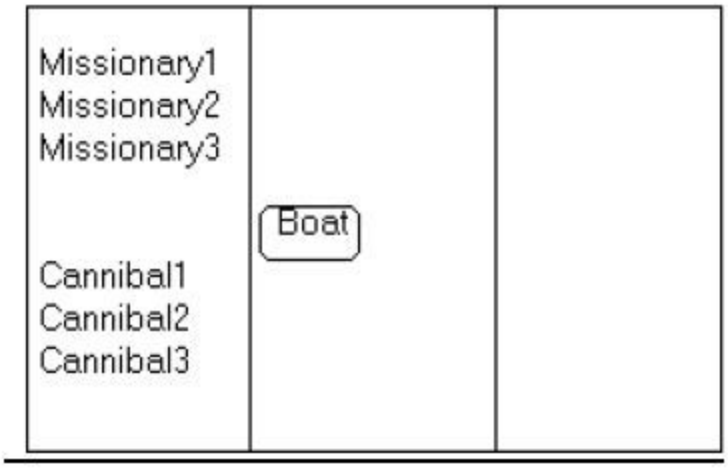
Thus 2 gallons of water are successfully obtained in the gallon jug without having measuring marks.

Example-2

- Given 3 jugs (9, 5 and 3 liters), a water pump, and a sink, how do you get exactly 7 liters into the 9 liter jug.
- **State:** (x y z) for liters in jugs 1, 2, and 3 integers 0 to 9 assigned to all possible permutations of 1 2 3
- **Operations:** empty jug, fill jug.
- **Initial state:** (0,0,0)
- **Goal state:** (7,0,0)
- **State Space representation**
  current state = (0, 0,0)
  Loop until reaching the goal state (7, 0,0)
  Apply a rule whose left side matches the current state get the new current state to be the resulting state
  (9,0,0),
  (4,5,0),
  (0,5,2),
  (5,0,2),
  (7,0,0)

Thus 7 gallons of water are successfully obtained in the gallon jug without having measuring marks.

Missionaries and Cannibals:



3 missionaries, 3 cannibals wish to cross the river. They have a boat that will carry two people. Everyone can navigate the boat. If at any time the cannibals outnumber the missionaries on either
bank of the river , they will eat the missionaries. Find the smallest number crossing that will allow
everyone to cross the river safely. The problem can be solved in 11 moves. But people rarely get the optimal solution because the MC problem contains a tricky state of the end where two people move back across the river.

Goal: Move all the missionaries and cannibals across the river.
Constraint: Missionaries can never be outnumbered by cannibals on either side of river, or else the missionaries are killed.
State: configuration of missionaries and cannibals and boat on each side of river.
Operators: Move boat containing some set of occupants across the river (in either direction) to the other side.

Missionaries and Cannibals Solution :

	Near Side		Far Side
0 Initial Setup:	MMMCCC B		-
1 Two Canibals Cross Over	MMMC	B	CC
2 One returns	MMMCC B		C
3 two cannibals go over again	MMM	B	CCC
4 one comes back	MMMC B		CC
5 two missionaries cross	MC	B	MMCC
6 a missionary and cannibal return	MMCC B		MC
7 two missionaries cross again	CC	B	MMMC
8 a cannibal returns	CCC B		MMM
9 two cannibals cross	C	B	MMMCC
10 one returns	CC B		MMMC
11 ands brings over the third	-	B	MMMCCC

Conclusion:
Thus the state space representation for water jug problem and missions and cannibals has been studied and implemented.