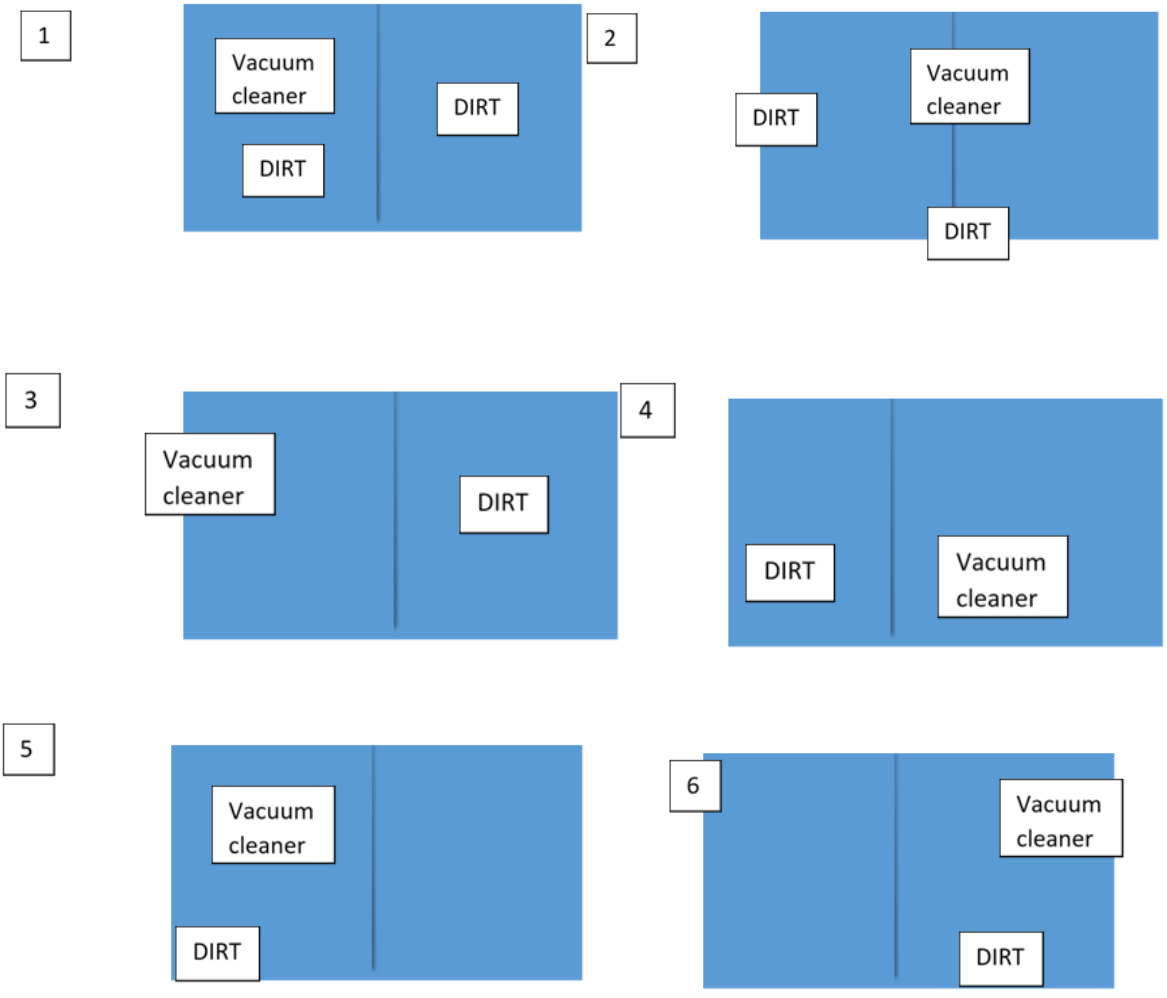
INDIAN INSTITUTE OF TECHNOLOGY, JAMMU,

Department of Computer Science and Engineering

Subject: AI

Practice problem: Consider the given classical vacuum cleaner problem where we have two rooms and one vacuum cleaner. There is dirt in both the rooms and it is to be cleaned. The vacuum cleaner is present in any one of these rooms. So, we have to reach a state in which both the rooms are clean and are dust free. Explain all possible states in vacuum cleaner problem with the help of state representation diagram.

Solution: There are eight possible states possible in given vacuum cleaner problem. These can be well illustrated with the help of the following diagrams:



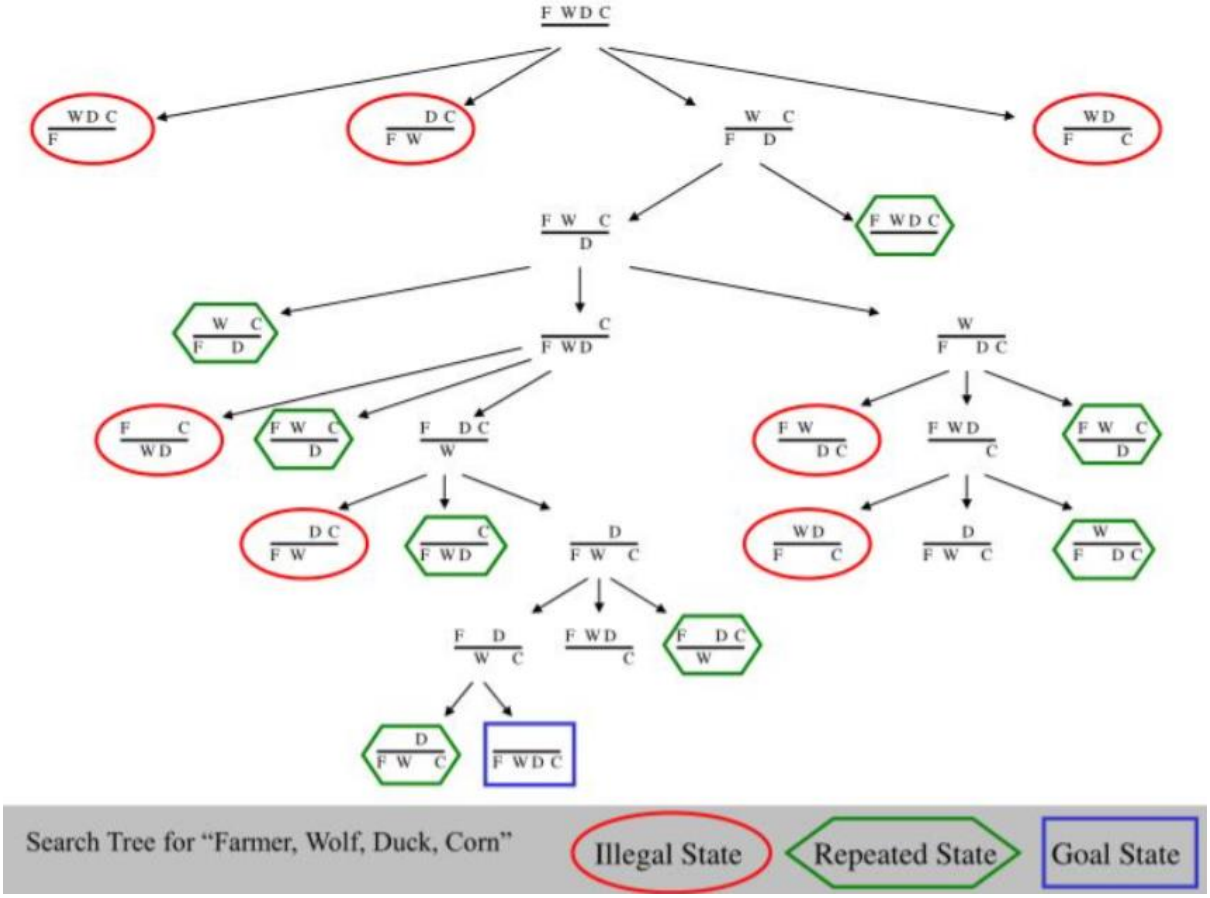
Here, states 1 and 2 (any one) are initial states and state 7 and state 8 are final states (goal states). This means that, initially, both the rooms are full of dirt and the vacuum cleaner can reside in any room. And to reach the final goal state, both the rooms should be clean and the vacuum cleaner again can reside in any of the two rooms.

Problem 2:

Practice problem: Give the complete state space representation of the farmer, wolf, goat and cabbage problem:

A farmer with his wolf, goat, and cabbage come to the edge of a river they wish to cross. There is a boat at the river's edge, but, of course, only the farmer can row. The boat also can carry only two things (including the rower) at a time. If the wolf is ever left alone with the goat, the wolf will eat the goat; similarly, if the goat is left alone with the cabbage, the goat will eat the cabbage. Devise a sequence of crossings of the river so that all four characters arrive safely on the other side of the river. Explain all possible states with the help of state representation diagram.

Solution:



In this river crossing puzzle, the total number of states can be calculated based on the possible configurations of the farmer, wolf, goat, and cabbage on either bank.

Each character (farmer, wolf, goat, cabbage) can either be on the left bank (L) or the right bank (R). Since there are four entities and each can be in one of two places, the total number of states is:

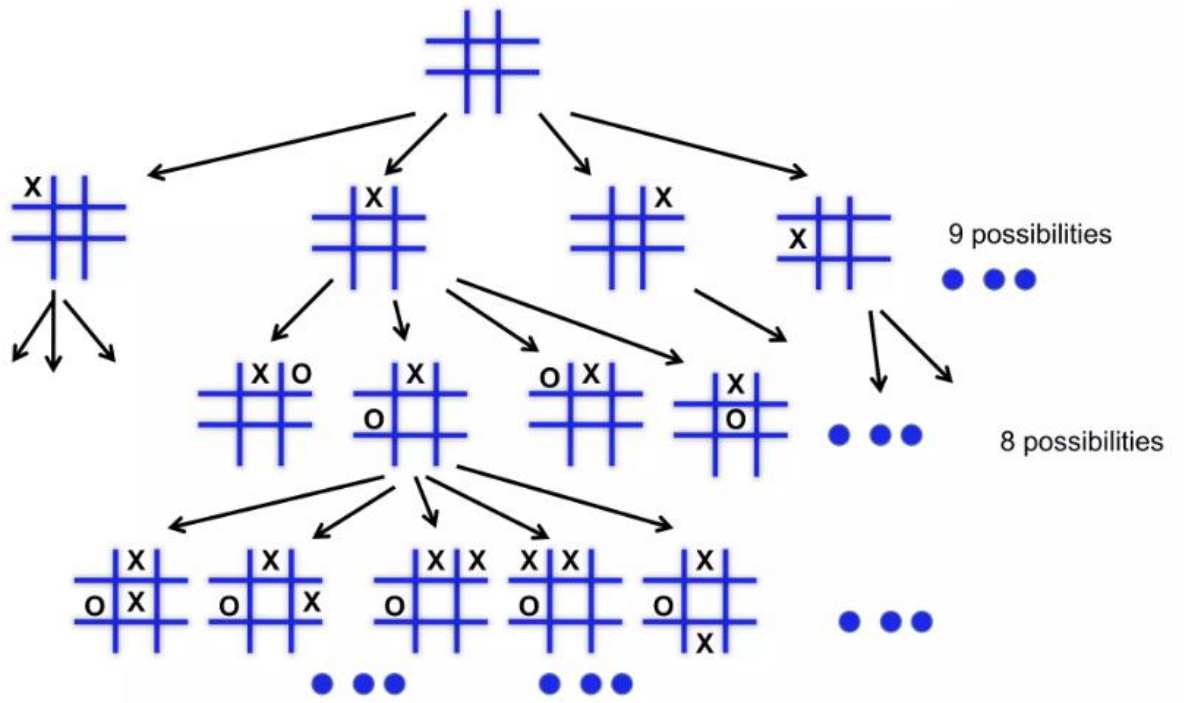
$2^4=16$

However, not all of these states are valid due to the constraints

Practice problem:

Tic Tac Toe is a classic game played on a 3x3 grid. Two players take turns, one using Xs and the other Os. The objective is to get three of your symbols in a row—horizontally, vertically, or diagonally—before your opponent does. Players alternate placing their marks in empty squares, aiming to block their opponent while creating their own winning line. The game can end in three possible outcomes: one player wins by achieving three in a row, the other player wins, or the game results in a draw if all squares are filled without a winner.
Explain all possible states with the help of state representation diagram.

Solution:

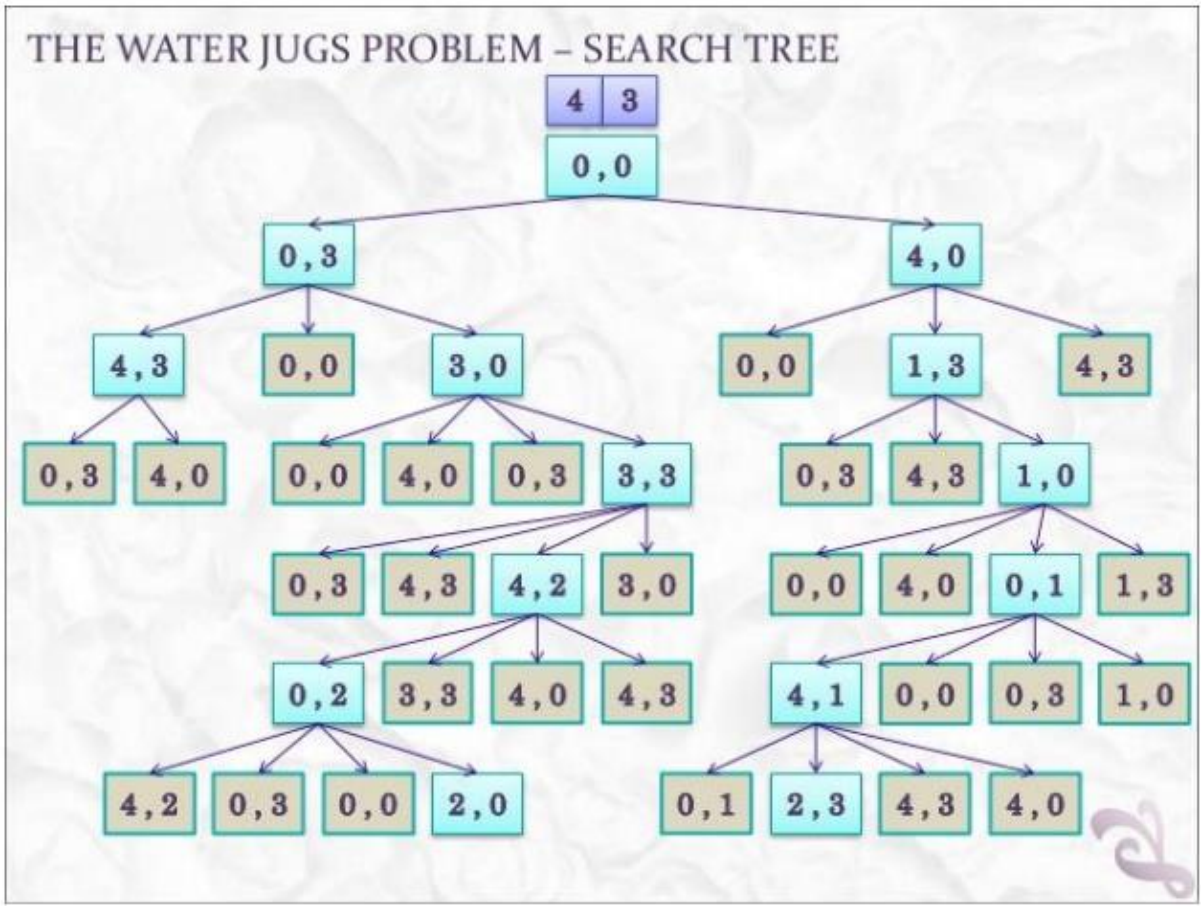


The total number of possible game states can be quite large due to the combinations of moves. However, the total number of unique board configurations, including those that may not lead to a valid game, is 5,478.

Here's a breakdown:

1. Empty board: 1 state
2. One move: 9 states (any of the 9 squares)
3. Two moves: 9 choices for X and then 8 for O = 72 states
4. And so on...

Problem: There are two jugs, a 4-gallon one and a 3-gallon one. Neither jug 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 gallons of water into 4-gallon jug?
Explain all possible states with the help of state representation diagram.



In the water jug problem with a 4-gallon jug and a 3-gallon jug, the total number of possible states can be calculated based on the combinations of water levels in both jugs. Each jug can hold a specific amount of water, and here's how to define the states:

1. 4-gallon jug: Can hold 0, 1, 2, 3, or 4 gallons (5 possible states).
2. 3-gallon jug: Can hold 0, 1, 2, or 3 gallons (4 possible states).

Total States Calculation:

The total number of states is the product of the possible states of both jugs:

Total States=(States of 4-gallon jug)×(States of 3-gallon jug)=5×4=20

However, not all combinations are valid based on the constraints of pouring and filling. For example, some states may not be reachable due to the pouring and filling actions allowed.

Despite this, the theoretical maximum number of combinations (or states) is 20, but only certain configurations will be valid during gameplay.

Other AI problem you can explore:

Explain all the possible states with the help of state representation diagram for given AI problems.

8-Puzzle:

- A sliding puzzle consisting of a 3x3 grid with 8 numbered tiles and one empty space.

Tower of Hanoi:

- A mathematical puzzle involving three rods and a number of disks of different sizes, requiring moving all disks from one rod to another under specific rules.

8 Queen :

- The challenge is to place eight queens on an 8x8 chessboard such that no two queens threaten each other. This means that no two queens can share the same row, column, or diagonal.

Ludo

- Ludo is a classic board game derived from the Indian game "Pachisi.". The goal is to be the first to move all four of your pieces from the starting area to the center of the board.

Snakes and Ladders.

- Snakes and Ladders is a classic board game played on a numbered grid, typically 1 to 100. The aim is to reach the last square (usually square 100) before any other player.