DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

1.9 PROBLEM SOLVING APPROACH TO TYPICAL AI

PROBLEMS Problem-solving agents

In Artificial Intelligence, Search techniques are universal problem-solving methods. **Rational agents** or **Problem-solving agents** in AI mostly used these search strategies or algorithms to solve a specific problem and provide the best result. Problem- solving agents are the goal-based agents and use atomic representation. In this topic, wewill learn various problem-solving search algorithms.

· Some of the most popularly used problem solving with the help of artificial intelligence are:

1. Chess.
2. Travelling Salesman Problem.
3. Tower of Hanoi Problem.
4. Water-Jug Problem.
5. N-Queen Problem.

Problem Searching

· In general, searching refers to as finding information one needs.

· Searching is the most commonly used technique of problem solving in artificial intelligence.

· The searching algorithm helps us to search for solution of particular problem.

Problem: Problems are the issues which comes across any system. A solution is needed to solve that particular problem.

Steps : Solve Problem Using Artificial Intelligence

· The process of solving a problem consists of five steps. These are:

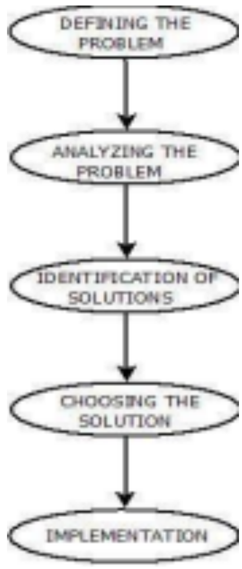

Figure 1.11 Problem Solving in Artificial Intelligence

Defining The Problem: The definition of the problem must be included precisely. It should contain the possible initial as well as final situations which should result in acceptable solution.

1. **Analyzing The Problem**: Analyzing the problem and its requirement must be done as few features can have immense impact on the resulting solution.
2. **Identification Of Solutions**: This phase generates reasonable amount of solutions to the given problem in a particular range.
3. **Choosing a Solution**: From all the identified solutions, the best solution is chosen basis on the results produced by respective solutions.
4. **Implementation**: After choosing the best solution, its implementation

is done. **Measuring problem-solving performance**

We can evaluate an algorithm's performance in four ways:

Completeness: Is the algorithm guaranteed to find a solution when there is one? **Optimality:** Does the strategy find the optimal solution?

Time complexity: How long does it take to find a solution?

Space complexity: How much memory is needed to perform the search? **Search Algorithm Terminologies**

· Search: Searching is a step by step procedure to solve a search-problem in a given search space. A search problem can have three main factors:

1. Search Space: Search space represents a set of possible solutions, which a system may have.
2. Start State: It is a state from where agent begins the search.
3. Goal test: It is a function which observe the current state and returns whether the goal state is achieved or not.

· Search tree: A tree representation of search problem is called Search tree. The root of the search tree is the root node which is corresponding to the initial state.

· Actions: It gives the description of all the available actions to the agent.

· Transition model: A description of what each action do, can be represented as a transition model.

· Path Cost: It is a function which assigns a numeric cost to each path.

· Solution: It is an action sequence which leads from the start node to the goal node. Optimal Solution: If a solution has the lowest cost among all solutions.

Example Problems

A **Toy Problem** is intended to illustrate or exercise various problem-solving methods. A**real- world problem** is one whose solutions people actually care about.

Toy Problems

Vacuum World

States: The state is determined by both the agent location and the dirt locations. The agent is in one of the 2 locations, each of which might or might not contain dirt. Thus there are 2*2^2=8 possible world states.

Initial state: Any state can be designated as the initial state.

Actions: In this simple environment, each state has just three actions: *Left*, *Right*, and *Suck*. Larger environments might also include *Up* and *Down*.

Transition model: The actions have their expected effects, except that moving *Left* in the leftmost squ are, moving *Right* in the rightmost square, and *Suck*ing in a clean square have no effect. The complete state space is shown in Figure.

Goal test: This checks whether all the squares are clean.

Path cost: Each step costs 1, so the path cost is the number of steps in the path.

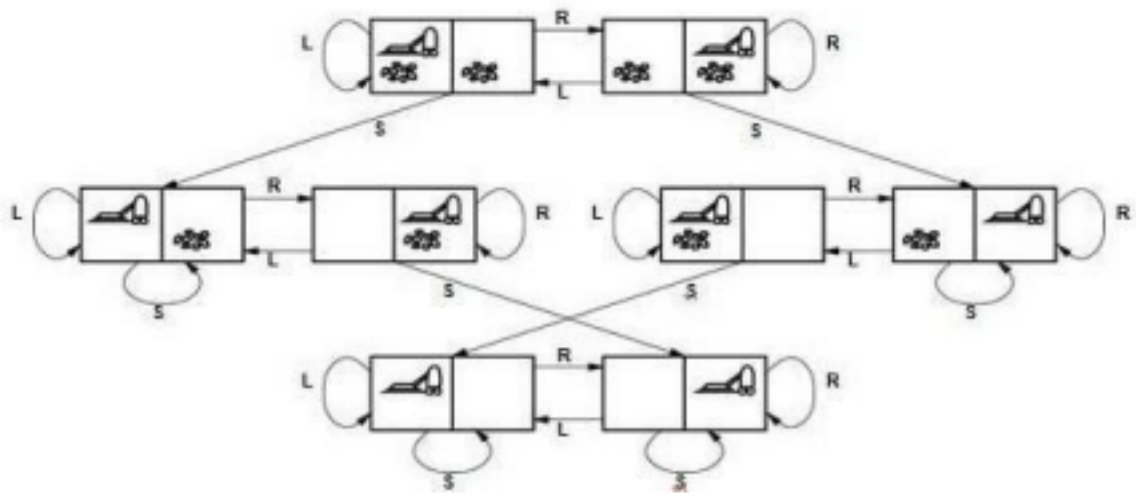

Figure 1.12 Vacuum World State Space Graph

1) 8- Puzzle Problem

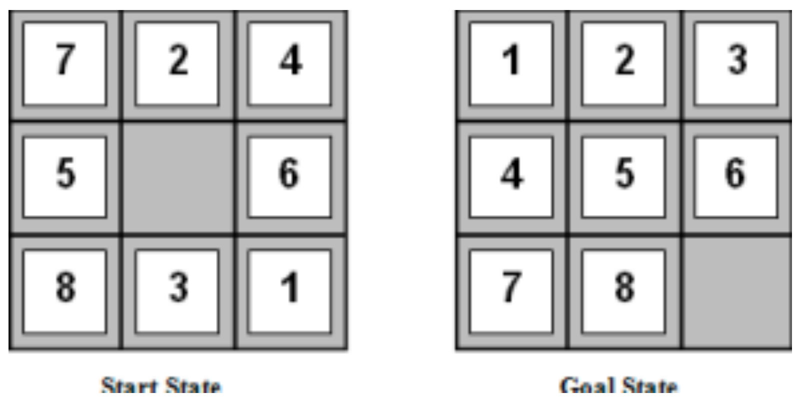

Figure 1.13 8- Puzzle Problem

States: A state description specifies the location of each of the eight tiles and the blank in one of the nine squares.

Initial state: Any state can be designated as the initial state. Note that any given goal can be reached from exactly half of the possible initial states.

The simplest formulation defines the actions as movements of the blank space *Left*, *Right*, *Up*, or *Down*. Different subsets of these are possible depending on where the blank is.

Transition model: Given a state and action, thisreturnsthe resulting state; for example, if we apply *Left* to the start state in Figure 3.4, the resulting state has the 5 and the blank switched.

Goal test: This checks whether the state matches the goal configuration shown in Figure. **Path cost:** Each step costs 1, so the path cost is the number of steps in the path.

Queens Problem

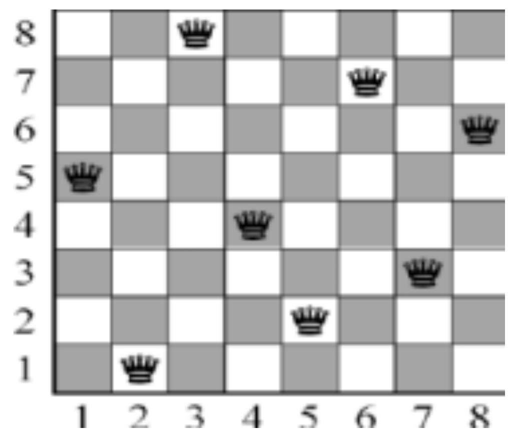

Figure 1.14 Queens Problem

· **States**: Any arrangement of 0 to 8 queens on the board is

a state. · **Initial state**: No queens on the board.

· **Actions**: Add a queen to any empty square.

· **Transition model**: Returns the board with a queen added to the specified

square. · **Goal test**: 8 queens are on the board, none attacked.

Consider the given problem. Describe the operator involved in it. Consider the water jug problem: You are given two jugs, a 4-gallon one and 3-gallon one. Neither has any measuring marker on it. There is a pump that can be used to fill the jugs with water. How can you get exactly 2 gallon of water from the 4-gallon jug ?

Explicit Assumptions: A jug can be filled from the pump, water can be poured out of a jug on to the ground, water can be poured from one jug to another and that there are no other measuring devices available.

Here the initial state is (0, 0). The goal state is (2, n) for any value of n.

State Space Representation: we will represent a state of the problem as a tuple (x, y) where x represents the amount of water in the 4-gallon jug and y represents the amount of water in the 3-gallon jug. Note that $0 \leq x \leq 4$, and $0 \leq y \leq 3$.

To solve this we have to make some assumptions not mentioned in the problem. They are:

· We can fill a jug from the pump.

· We can pour water out of a jug to the ground.

· We can pour water from one jug to another.

· There is no measuring device available.

Operators - we must define a set of operators that will take us from one state to another. **Table 1.1**

Sr.	**Current State**	**Next State**	**Descriptions**
1	(x,y) if $x < 4$	(4,y)	Fill the 4 gallon jug
2	(x,y) if $x < 3$	(x,3)	Fill the 3 gallon jug
3	(x,y) if $x > 0$	(x – d, y)	Pour some water out of the 4 gallon jug
4	(x,y) if $y > 0$	(x, y – d)	Pour some water out of the 3 gallon jug
5	(x,y) if $y > 0$	(0, y)	Empty the 4 gallon jug
6	(x,y) if $y > 0$	(x 0)	Empty the 3 gallon jug on the ground
7	(x,y) if $x + y >= 4$ and $y > 0$	(4, y – (4 – x))	Pour water from the 3 gallon jug into the 4 gallon jug until the 4 gallon jug is full
8	(x,y) if $x + y >= 3$ and $x > 0$	(x – (3 – x), 3)	Pour water from the 4 gallon jug into the 3 gallon jug until the 3 gallon jug is full

9	(x,y) if x + y < = 4 and y > 0	(x + y, 0)	Pour all the water from the 3 gallon jug into the 4 gallon jug
10	(x,y) if x + y < = 3 and x > 0	(0, x + y)	Pour all the water from the 4 gallon jug into the 3 gallon jug
11	(0, 2)	(2, 0)	Pour the 2 gallons from 3 gallon jug into the 4 gallon jug
12	(2, y)	(0, y)	Empty the 2 gallons in the 4 gallon jug on the ground

Figure 1.15 Solution

Table 1.2

Solution

S.No.	Gallons in 4-gel jug(x)	Gallons in 3-gel jug (y)	Rule Applied
1.	0	0	Initial state
2..	4	0	1. Fill 4
3	1	3	6. Poor 4 into 3 to fill
4.	1	0	4. Empty 3
5.	0	1	8. Poor all of 4 into 3

6.	4	1	1. Fill 4
7.	2	3	6. Poor 4 into 3

- 4-gallon one and a 3-gallon Jug

- No measuring mark on the jug.
- There is a pump to fill the jugs with water.
- How can you get exactly 2 gallon of water into the 4-gallon jug?