1. Problem-Solving Agents

Definition:
A **problem-solving agent** is an AI system that **decides what actions to take** in order to achieve a specific goal. It **thinks before it acts**, unlike a simple reflex agent.

How it works:

1. It **defines the goal** clearly.
2. It **describes the current state** of the environment.
3. It **figures out possible actions** (operators) it can take.
4. It **searches** for a sequence of actions (called a plan) that leads to the goal.
5. It **executes** that plan.

Example:
Imagine a robot in a maze trying to reach the exit. It will:

- See where it is now.
- Decide where it wants to go (goal).
- Look at all paths (possible actions).
- Choose the best path (search).
- Move step-by-step until it reaches the exit.

2. Well-Defined Problems & Solutions

Well-defined problem:

A problem is **well-defined** when it is clearly and completely specified.

It has 5 key components:

1. **Initial state** – Where the agent starts.
2. **Actions (operators)** – What the agent can do.
3. **Transition model** – What happens when an action is taken.
4. **Goal test** – How to check if the goal is reached.
5. **Path cost** – How much it costs to take a path (e.g., steps, time).

> ✅ If a problem has all these, it's **well-defined**. If some parts are missing or vague, it's **ill-defined**.

Well-defined solution:

- A solution is a **sequence of actions** that transforms the initial state to a goal state.
- An **optimal solution** is the one with the **lowest path cost**.

Example:

Problem: Find a route from Kolkata to Delhi.

- Initial state: You are in Kolkata.
- Actions: Drive, take a train, or fly.
- Transition model: If you fly, you reach in 2 hrs; train takes 18 hrs.
- Goal test: You're in Delhi.
- Path cost: Time, money, or distance.

3. Formulating Problems

What it means:

Formulating a problem means **converting a real-world task into a well-defined problem** that an AI agent can solve.

Steps to formulate:

1. Identify the **initial state**.
2. Clearly define the **goal**.
3. List all **possible actions**.
4. Understand the **result of each action** (transition model).
5. Decide how to **test for the goal**.
6. Assign a **cost** to each action if needed.

Example (8-puzzle):

- Initial state: Random arrangement of 8 tiles.
- Goal: Arrange tiles in order (1–8).
- Actions: Move the blank tile up/down/left/right.
- Transition model: Each move changes the state.
- Goal test: Tiles are in order.
- Path cost: Number of moves taken.