In AI and problem-solving, different types of problems are characterized by the nature of the environment and the amount of information the agent has. Here's a breakdown of the problem types you’ve mentioned, along with explanations:

**1. Deterministic, Fully Observable: Single-State Problem**

* **Definition**: In this type of problem, the agent has **complete information** about the environment. The environment is **deterministic**, meaning every action has a predictable and specific outcome.
* **Agent's Knowledge**: The agent knows exactly which state it will be in after each action, with no uncertainty.
* **Solution**: The solution is a **sequence** of actions that will take the agent from the initial state to the goal state.
* **Example**:
  + **Pathfinding** on a map: Given a specific starting point and a goal, the agent knows exactly which moves to make to reach the goal.

**2. Non-Observable: Sensorless Problem (Conformant Problem)**

* **Definition**: The agent has **no information** about its environment; it doesn’t know which state it’s in, and it lacks sensory input.
* **Agent's Knowledge**: The agent is unsure of its location or the current state of the world and must act **without observation**.
* **Solution**: The solution is a **sequence** of actions that must work under any possible initial state. The agent plans without feedback from the environment.
* **Example**:
  + **Cleaning robot** in a room: The robot does not know where it is in the room or how dirty the room is. It must execute a series of actions (like covering every area) to ensure it cleans the room regardless of its initial position.

**3. Nondeterministic and/or Partially Observable: Contingency Problem**

* **Definition**: The environment is either **nondeterministic** (actions can have multiple possible outcomes) or **partially observable** (the agent only has limited information about its current state).
* **Agent's Knowledge**: The agent has partial knowledge of the environment and can use percepts to gain more information as it executes actions.
* **Solution**: The solution is a **contingent plan** or a **policy**. The agent must make decisions based on new information obtained from the environment during execution.
* **Key Feature**: The agent often needs to **interleave search and execution**, meaning it alternates between planning and acting, updating its plan based on new information.
* **Example**:
  + **Self-driving car**: The car has sensors, but they might not provide complete or accurate information about road conditions, pedestrians, or other cars. The car must adjust its actions based on real-time data, such as stopping at unexpected obstacles.

**4. Unknown State Space: Exploration Problem (Online Problem)**

* **Definition**: The agent starts in an environment where it has no prior knowledge of the state space or the rules governing the environment. The agent must **explore** to learn about the environment while acting.
* **Agent's Knowledge**: The agent doesn’t know the structure of the world, the state space, or the possible actions' effects. It must explore the environment to gather this information.
* **Solution**: The solution requires the agent to build up knowledge through **trial and error** and adapt its behavior as it learns more about the environment.
* **Example**:
  + **Maze exploration**: The agent enters an unknown maze and must explore it, learning about the walls, paths, and exits as it moves through the maze.

**Summary Table:**

| **Problem Type** | **Environment Characteristics** | **Agent Knowledge** | **Solution Type** | **Example** |
| --- | --- | --- | --- | --- |
| **Single-State Problem** | Deterministic, fully observable | Knows exact state | Sequence of actions | Pathfinding on a map |
| **Sensorless Problem (Conformant Problem)** | Non-observable, no sensors | No idea where it is | Sequence that works for all states | Cleaning robot |
| **Contingency Problem** | Nondeterministic or partially observable | Partial knowledge, uses percepts | Contingent plan or policy | Self-driving car |
| **Exploration Problem (Online Problem)** | Unknown state space, learns as it acts | No prior knowledge, learns by exploring | Exploration strategy | Maze exploration |