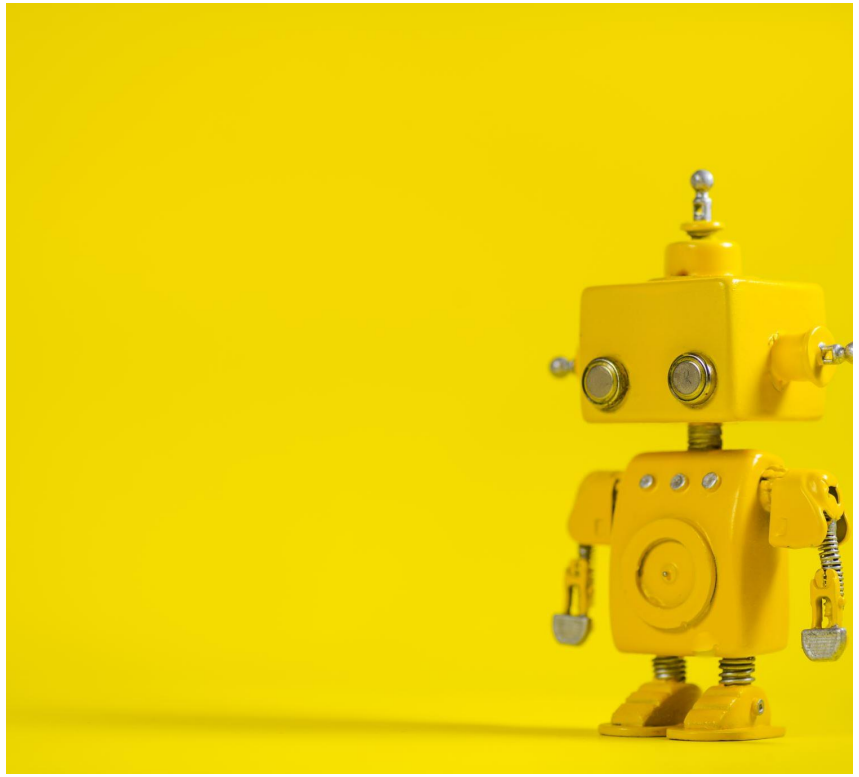

INTELLIGENT AGENT

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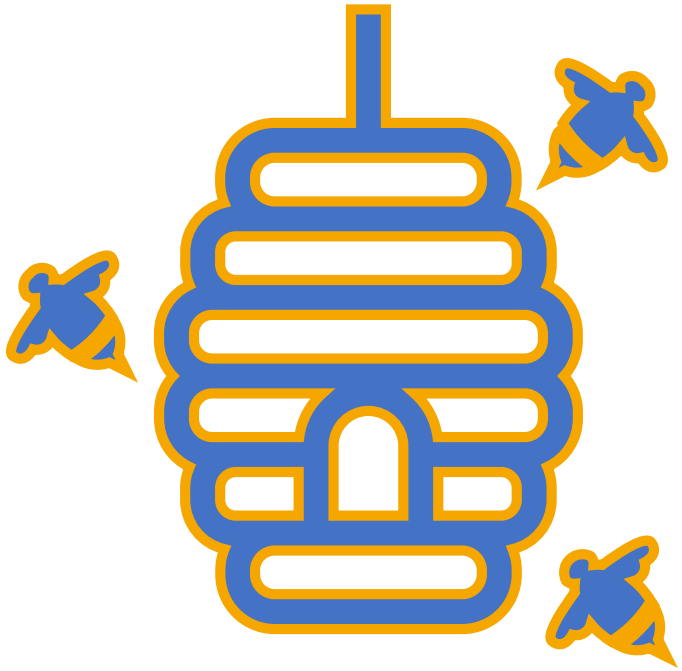


Intelligent agent

- Introduction, structure and properties of intelligent agent
- Configuration of agent (PEAS Description)
- Types of Agent
- Environment Types

Intelligent agent

- **According to Wikipedia:**

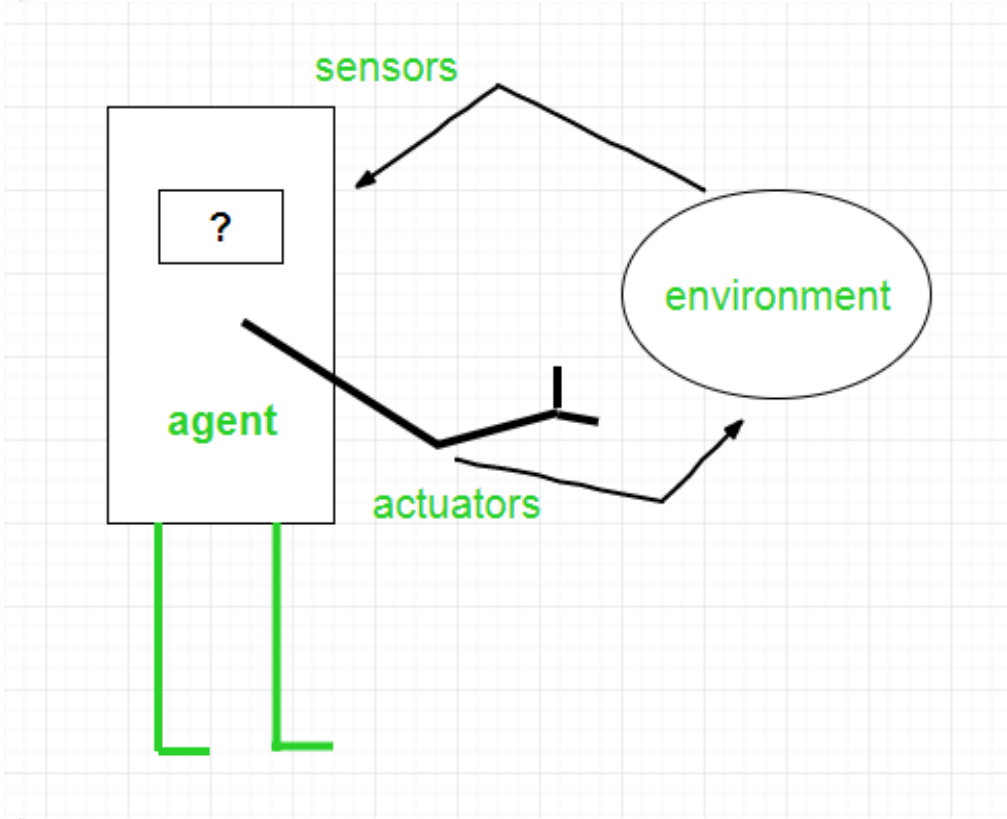
" In artificial intelligence, an **intelligent agent** (**IA**) refers to an **autonomous** (*independent or self-governing*)entity which acts, directing its activity towards achieving goals (i.e. it is an agent), upon an environment using observation through sensors and consequent actuators (i.e. it is intelligent). "

Intelligent agent

- An Intelligent Agent perceives its environment via sensors and acts rationally upon that environment with its effectors (actuators). Hence, an agent gets percepts one at a time, and maps this percept sequence to actions.
- The agents sense the environment through sensors and act on their environment through actuators. An AI agent can have mental properties such as knowledge, belief, intention, etc.

Intelligent agent

- An **agent** is anything that can perceive its environment through **sensors** and acts upon that environment through **effectors.**
  - A **human agent** has sensory organs such as eyes, ears, nose, tongue and skin parallel to the sensors, and other organs such as hands, legs, mouth, for effectors.
  - A **robotic agent** replaces cameras and infrared range finders for the sensors, and various motors and actuators for effectors.
  - A **software agent** has encoded bit strings as its programs and actions.

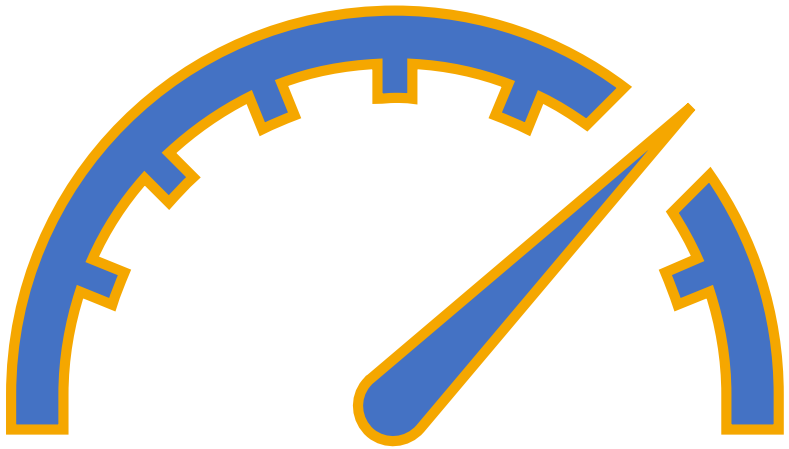


Intelligent agent

- Before moving forward, we should first know about sensors, effectors, and actuators.
- **Sensor:** Sensor is a device which detects the change in the environment and sends the information to other electronic devices. An agent observes its environment through sensors.
- **Actuators:** Actuators are the component of machines that converts energy into motion. The actuators are only responsible for moving and controlling a system. An actuator can be an electric motor, gears, rails, etc.
- **Effectors:** Effectors are the devices which affect the environment. Effectors can be legs, wheels, arms, fingers, wings, fins, and display screen.

Intelligent agent

- Following are the main four rules for an AI agent:
- **Rule 1:** An AI agent must have the ability to perceive the environment.
- **Rule 2:** The observation must be used to make decisions.
- **Rule 3:** Decision should result in an action.
- **Rule 4:** The action taken by an AI agent must be a rational action.

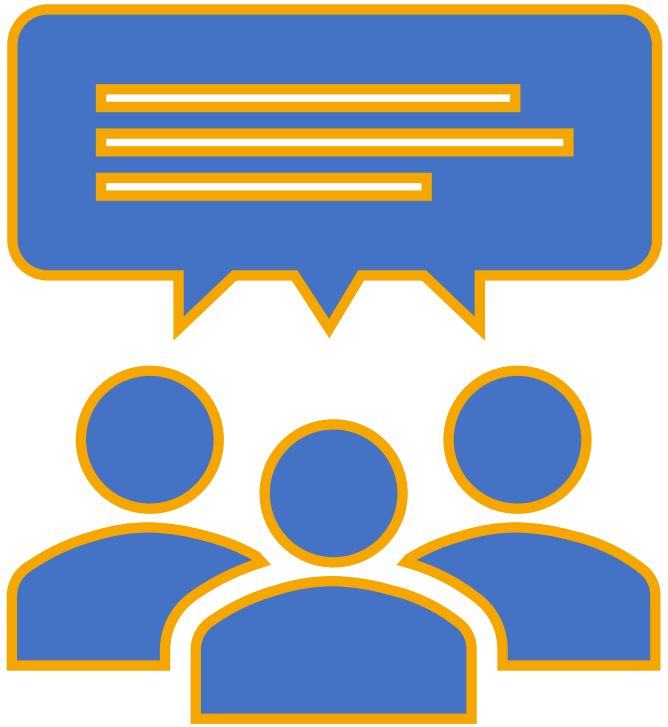


Rationality

- The rationality of an agent is measured by its performance measure. Rationality can be judged on the basis of following points:
  - Performance measure which defines the success criterion.
  - Agent prior knowledge of its environment.
  - Best possible actions that an agent can perform.
  - The sequence of percepts.

Rational Agent

- A rational agent is an agent which has clear preference, models uncertainty, and acts in a way to maximize its performance measure with all possible actions.
- A rational agent is said to perform the right things. AI is about creating rational agents to use for game theory and decision theory for various real-world scenarios.
- For an AI agent, the rational action is most important because in AI reinforcement learning algorithm, for each best possible action, agent gets the positive reward and for each wrong action, an agent gets a negative reward.



The Structure of Intelligent Agents

- Agent's structure can be viewed as –
  - **Agent** = Architecture + Agent Program
  - **Architecture** = the machinery that an agent executes on.
  - **Agent Program** = an implementation of an agent function.

A more specific example: Automated taxi driving system

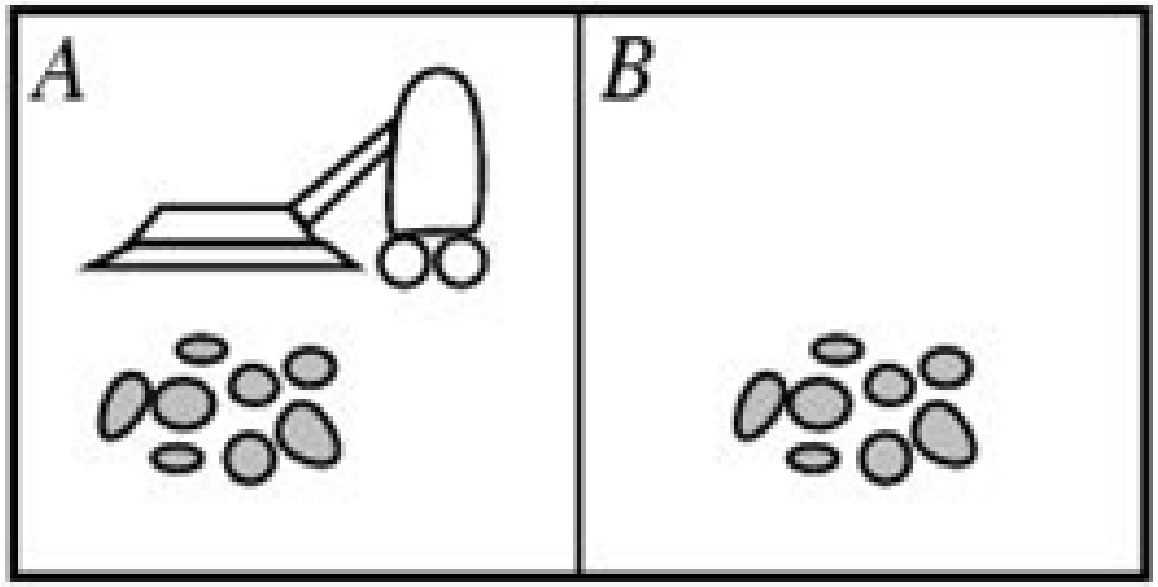
- **Percepts**: Video, sonar, speedometer, odometer, engine sensors, keyboard input, microphone, GPS, …
- **Actions**: Steer, accelerate, brake, horn, speak/display, …
- **Goals**: Maintain safety, reach destination, maximize profits (fuel, tire wear), obey laws, provide passenger comfort, …
- **Environment**: Urban streets, freeways, traffic, pedestrians, weather, customers, …

Then how does Agent Process the information ??

- Agent works how it perceives the things from environment
- **Percept:** The Agents perceptual inputs at any given instant.
- **Percept Sequence:** The complete history of everything the agent has ever perceived.
- The ***agent function*** is mathematical concept that maps percept sequence to actions. $f : P^* \rightarrow A$
-
- The ***agent function*** will internally be represented by the ***agent program.***
- The agent program is concrete implementation of agent function it runs on the physical *architecture* to produce *f*.

The vacuum-cleaner world: Example of Agent

- **Environment:** square A and B
- **Percepts:** [location and content] *E.g. [A, Dirty]*
- **Actions:** left, right, suck, and no-op



[A,CLEAN]	RIGHT
[A, Dirty]	Suck
[B, Clean]	Left
[B, Dirty]	Suck
…….	……

PEAS description of Agent

- We know that there are different types of agents in AI. PEAS System is used to categorize similar agents together. The PEAS system delivers the performance measure with respect to the environment, actuators and sensors of the respective agent.
- **PEAS** stands for *Performance measure, Environment, Actuator, Sensor*.
- **Performance:** The output which we get from the agent. All the necessary results that an agent gives after processing comes under its performance.
- **Environment:** All the surrounding things and conditions of an agent fall in this section. It basically consists of all the things under which the agents work.
- **Actuators:** The devices, hardware or software through which the agent performs any actions or processes any information to produce a result are the actuators of the agent.
- **Sensors:** The devices through which the agent observes and perceives its environment are the sensors of the agent.

PEAS description of Agent (self-driving cars)

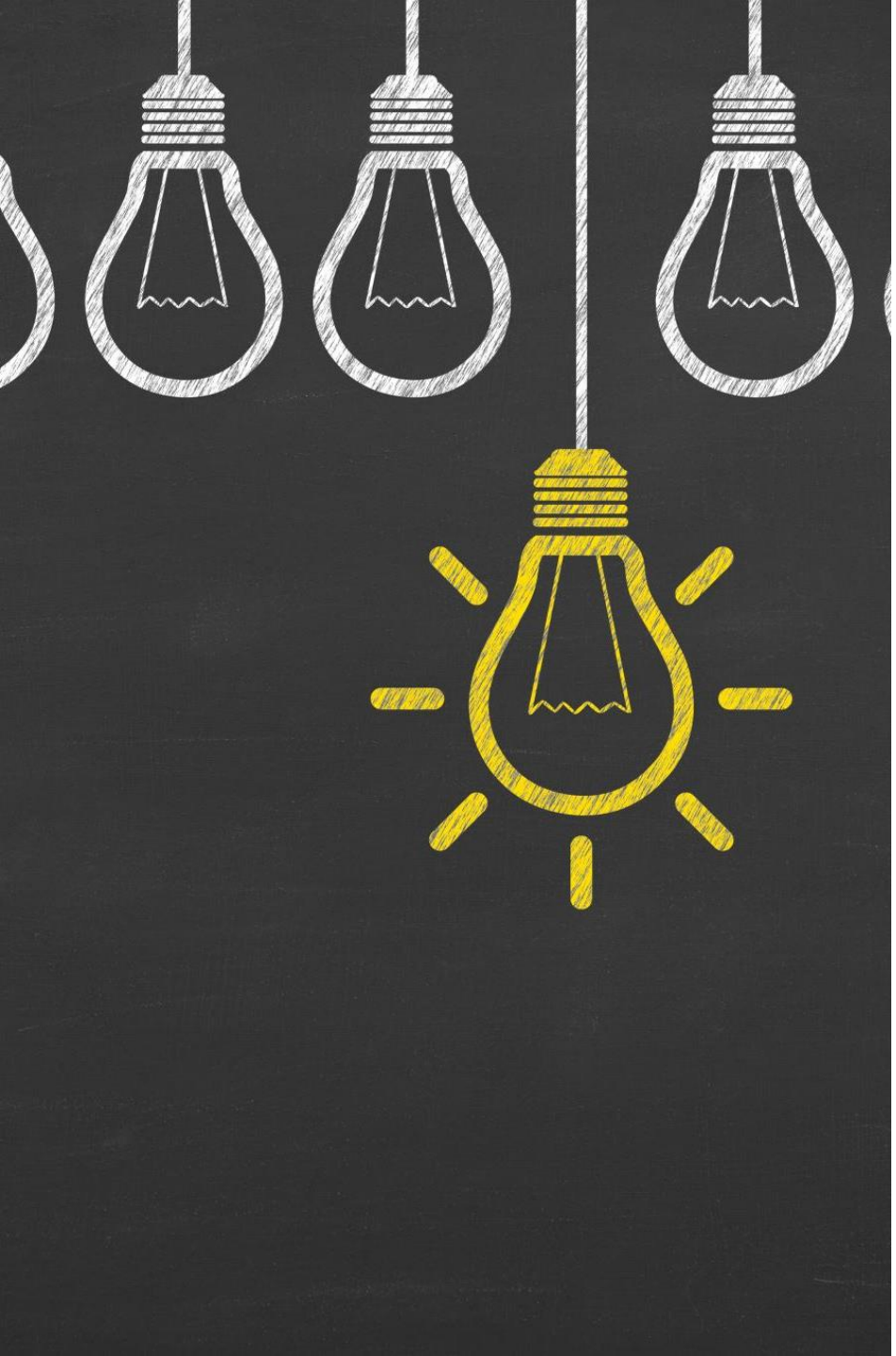
- **Performance:** Safety, time, legal drive, comfort
- **Environment:** Roads, other vehicles, road signs, pedestrian
- **Actuators:** Steering, accelerator, brake, signal, horn
- **Sensors:** Camera, GPS, speedometer, odometer, accelerometer, sonar.

PEAS description of Agent

Agent	Performance measure	Environment	Actuators	Sensors
1. Medical Diagnose	•Healthy patient •Minimized cost	•Patient •Hospital •Staff	•Tests •Treatments	Keyboard (Entry of symptoms)
2. Vacuum Cleaner	•Cleanness •Efficiency •Battery life •Security	•Room •Table •Wood floor •Carpet •Various obstacles	•Wheels •Brushes •Vacuum Extractor	•Camera •Dirt detection sensor •Cliff sensor •Bump Sensor •Infrared Wall Sensor
3. Part -picking Robot	•Percentage of parts in correct bins.	•Conveyor belt with parts, •Bins	•Jointed Arms •Hand	•Camera •Joint angle sensors.

PEAS description of Agent

Agent	Performance measure	Environment	Actuators	Sensors
Hospital Management System	•Patient's health, Admission process, Payment	•Hospital, •Doctors •Patients	•Prescription •Diagnosis •Scan report	Symptoms Patient's response
Subject Tutoring	•Maximize scores, • Improvement is students	•Classroom •Desk ,Chair, Board, • Staff • Students	•Smart displays, • Corrections	•Camera •Infrared Wall Sensor •Notebooks
satellite image analysis system	Correct image categorization	• downlink from orbiting satellite	• display categorization of scene	• color pixel arrays
refinery controller	maximize purity, yield, safety	• refinery, operators	• valves, pumps, heaters, displays	• temperature, pressure, chemical sensors



Types of Agents

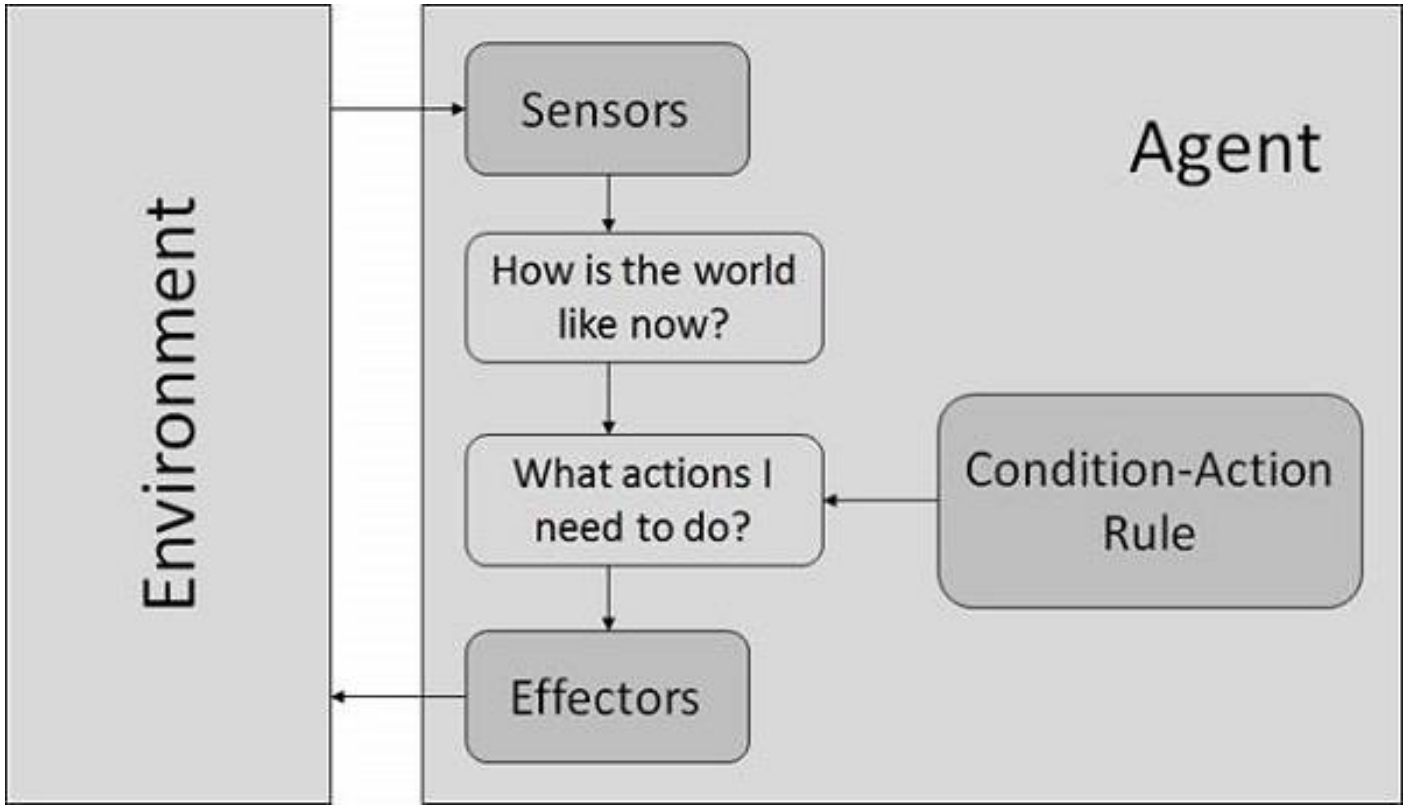
- Agents can be grouped into four classes based on their degree of perceived intelligence and capability :
  - **Simple Reflex Agents**
  - **Model-Based Reflex Agents**
  - **Goal-Based Agents**
  - **Utility-Based Agents**
  - **Learning Agent**

Simple Reflex Agent

- Simple reflex agents ignore the rest of the percept history and act only on the basis of the **current percept**.
- Percept history is the history of all that an agent has perceived till date. The agent function is based on the **condition-action rule**. A condition-action rule is a rule that maps a state i.e, condition to an action. If the condition is true, then the action is taken, else not.
- This agent function only succeeds when the environment is fully observable.

Simple reflex agent

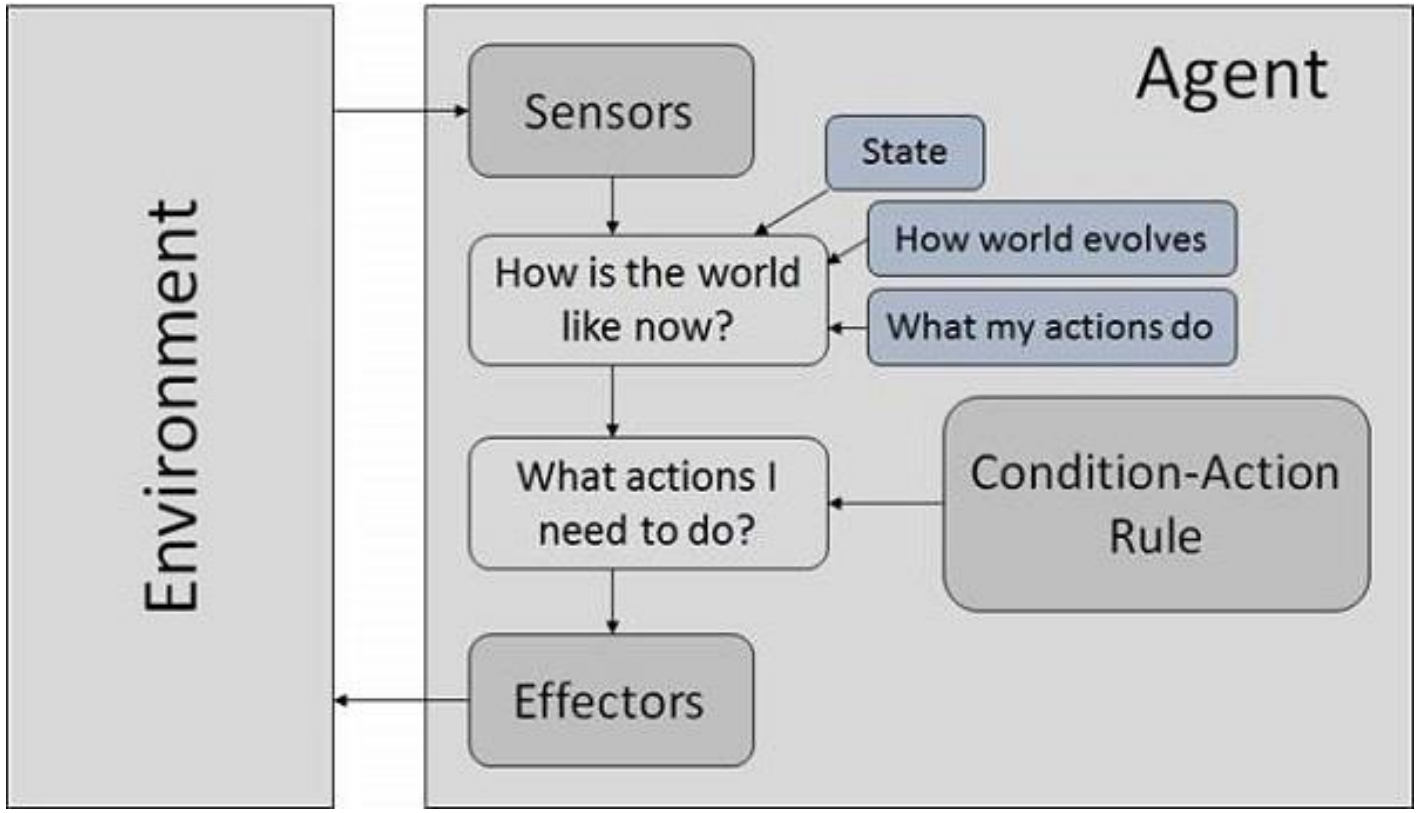
- They choose actions only based on the current percept.
- They are rational only if a correct decision is made only on the basis of current precept.
- If there occurs any change in the environment, then the collection of rules need to be updated.



Model-based reflex agent

- It works by finding a rule whose condition matches the current situation. A model-based agent can handle **partially observable environments** by use of model about the world. The agent has to keep track of **internal state** which is adjusted by each percept and that depends on the percept history. The current state is stored inside the agent which maintains some kind of structure describing the part of the world which cannot be seen.

Model-based reflex agent

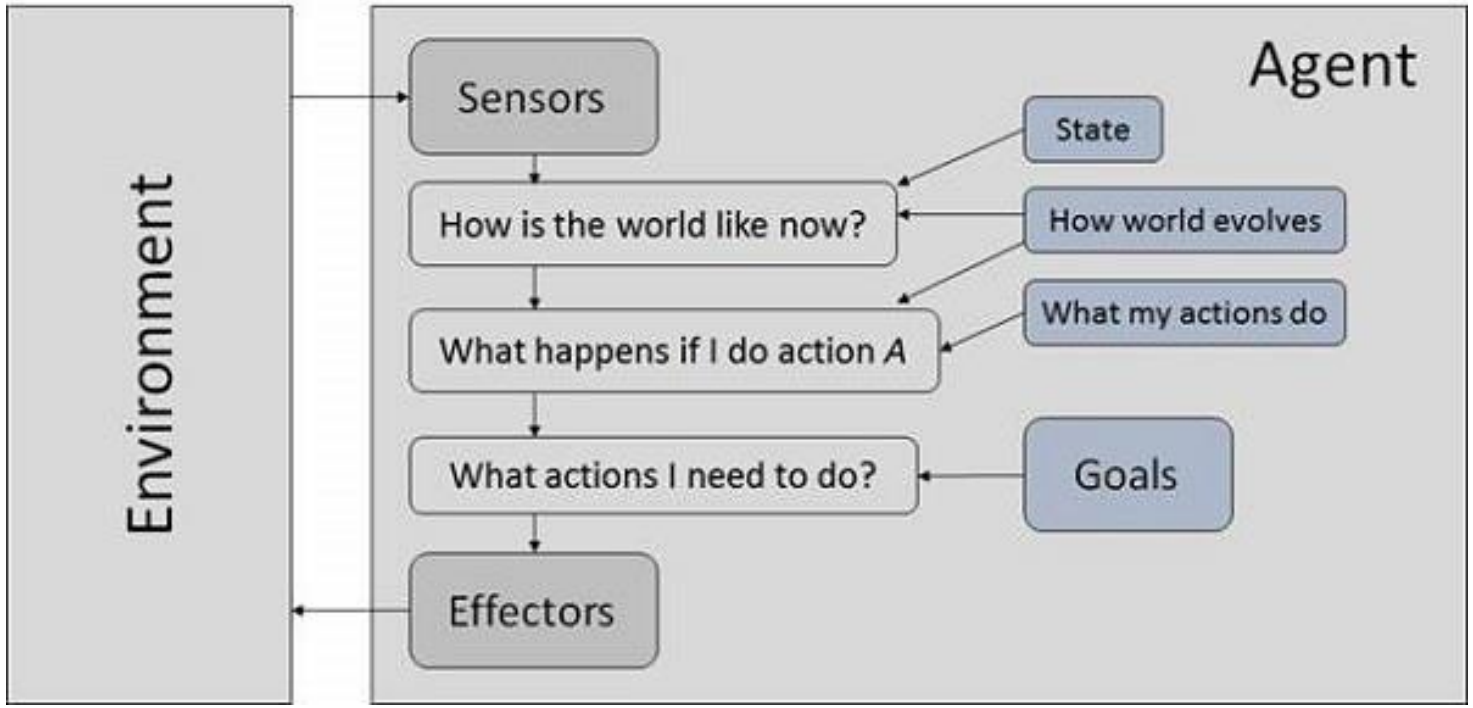


- **Model** – knowledge about "how the things happen in the world".
- **Internal State** – It is a representation of unobserved aspects of current state depending on percept history
- **Updating the state requires the information about –**
- How the world evolves.
- How the agent's actions affect the world.

Goal-based agent

- These kind of agents take decision based on how far they are currently from their **goal**(description of desirable situations). Their every action is intended to reduce its distance from the goal. This allows the agent a way to choose among multiple possibilities, selecting the one which reaches a goal state. The knowledge that supports its decisions is represented explicitly and can be modified, which makes these agents more flexible. They usually require search and planning. The goal-based agent's behavior can easily be changed

Goal-based agent



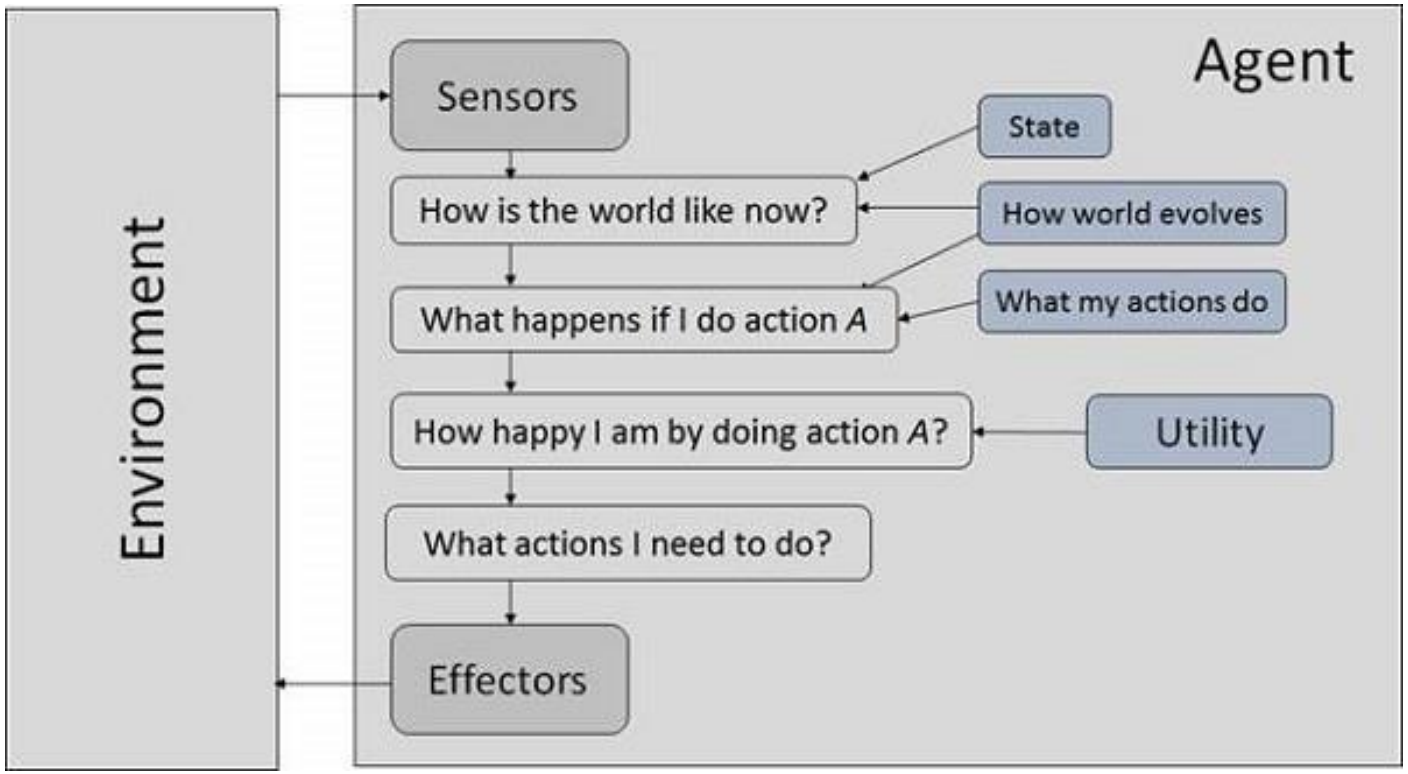
- The agent needs to know its goal which describes desirable situations.
- Goal-based agents expand the capabilities of the model-based agent by having the "goal" information.
- They choose an action, so that they can achieve the goal.

Utility-based agent

- When there are multiple possible alternatives, then to decide which one is best, utility-based agents are used.They choose actions based on a **preference (utility)** for each state. Sometimes achieving the desired goal is not enough. We may look for a quicker, safer, cheaper trip to reach a destination. Agent happiness should be taken into consideration. Utility describes how **"happy"** the agent is. Because of the uncertainty in the world, a utility agent chooses the action that maximizes the expected utility. A utility function maps a state onto a real number which describes the associated degree of happiness.

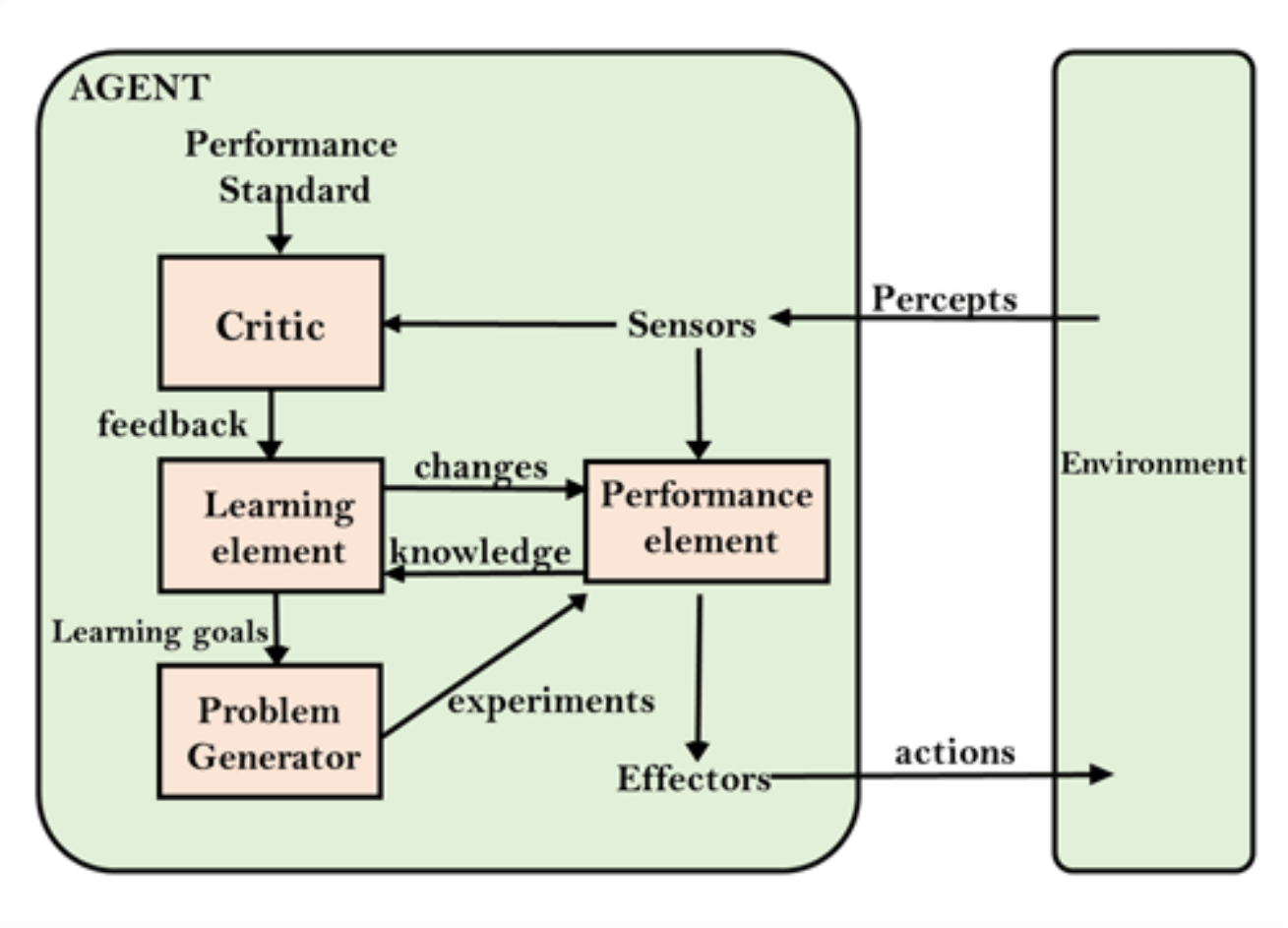
Utility- based agent

- Utility-based agent act based not only goals but also the best way to achieve the goal.
- The Utility-based agent is useful when there are multiple possible alternatives, and an agent has to choose in order to perform the best action.
- The utility function maps each state to a real number to check how efficiently each action achieves the goals.



Learning Agent

- A learning agent in AI is the type of agent which can learn from its past experiences or it has learning capabilities.
  It starts to act with basic knowledge and then able to act and adapt automatically through learning.
  A learning agent has mainly four conceptual components, which are:
  - **Learning element :**It is responsible for making improvements by learning from the environment
  - **Critic:** Learning element takes feedback from critic which describes how well the agent is doing with respect to a fixed performance standard.
  - **Performance element:** It is responsile for selecting external action
  - **Problem Generator:** This component is responsible for suggesting actions that will lead to new and informative experiences.



Learning Agent

- A learning agent in AI is the type of agent which can learn from its past experiences, or it has learning capabilities.
- It starts to act with basic knowledge and then able to act and adapt automatically through learning.
- learning agents are able to learn, analyze performance, and look for new ways to improve the performance.

Types of Environments in AI

- An environment in artificial intelligence is the surrounding of the agent. The agent takes input from the environment through sensors and delivers the output to the environment through actuators. There are several types of environments:
  - Fully Observable vs Partially Observable
  - Deterministic vs Stochastic
  - Competitive vs Collaborative
  - Single-agent vs Multi-agent
  - Static vs Dynamic
  - Discrete vs Continuous

Fully Observable vs Partially Observable

- When an agent sensor is capable to sense or access the complete state of an agent at each point of time, it is said to be a fully observable environment else it is partially observable .
- Maintaining a fully observable environment is easy as there is no need to keep track of the history of the surrounding.
- An environment is called **unobservable** when the agent has no sensors in all environments.
- **Example:**
  - **Chess –** the board is fully observable, so are the opponent's moves
  - **Driving –** the environment is partially observable because what's around the corner is not known

Deterministic vs Stochastic

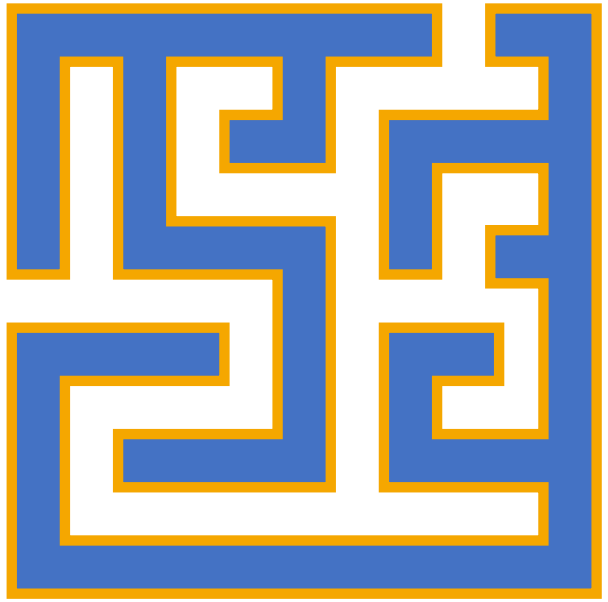
- When an uniqueness in the agent's current state completely determines the next state of the agent, the environment is said to be deterministic.
- Stochastic environment is random in nature which is not unique and cannot be completely determined by the agent.

- **Example:**

Chess – there would be only few possible moves for a coin at the current state and these moves can be determined **Self Driving Cars** – the actions of a self driving car are not unique, it varies time to time

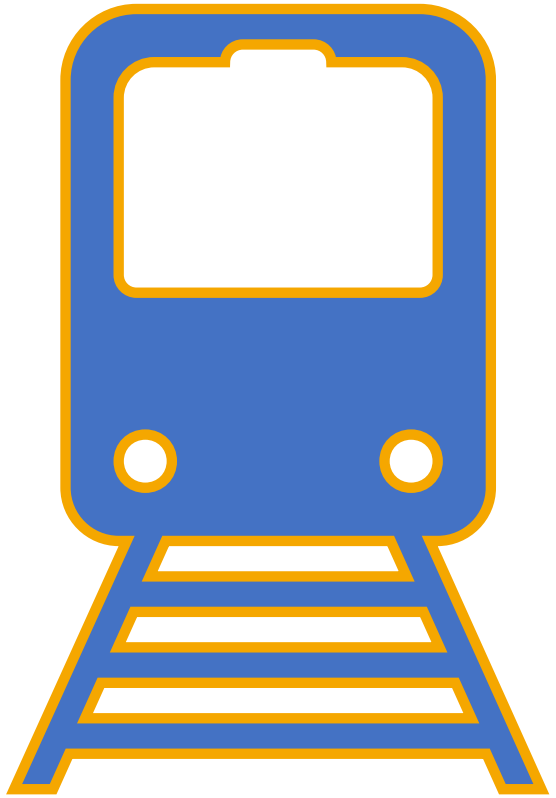
Single-agent vs Multi-agent

- An environment consisting of only one agent is said to be a single agent environment.
- A person left alone in a maze is an example of single agent system.
- An environment involving more than one agent is a multi agent environment.
- The game of football is multi agent as it involves 10 players in each team.



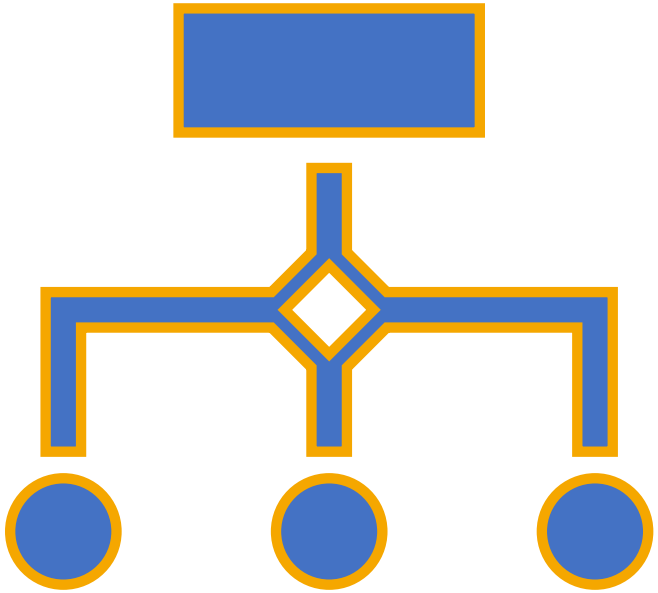
Dynamic vs Static

- An environment that keeps constantly changing itself when the agent is up with some action is said to be dynamic.
- A roller coaster ride is dynamic as it is set in motion and the environment keeps changing every instant.
- An idle environment with no change in it’s state is called a static environment.
- An empty house is static as there’s no change in the surroundings when an agent enters.



Discrete vs Continuous

- If an environment consists of a finite number of actions that can be deliberated in the environment to obtain the output, it is said to be a discrete environment.
- The game of chess is discrete as it has only a finite number of moves. The number of moves might vary with every game, but still, it's finite.
- The environment in which the actions performed cannot be numbered ie. is not discrete, is said to be continuous.
- Self-driving cars are an example of continuous environments as their actions are driving, parking, etc. which cannot be numbered.



Thank You