ARTIFICIAL INTELLIGENCE (A.I.)

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What is an Agent?

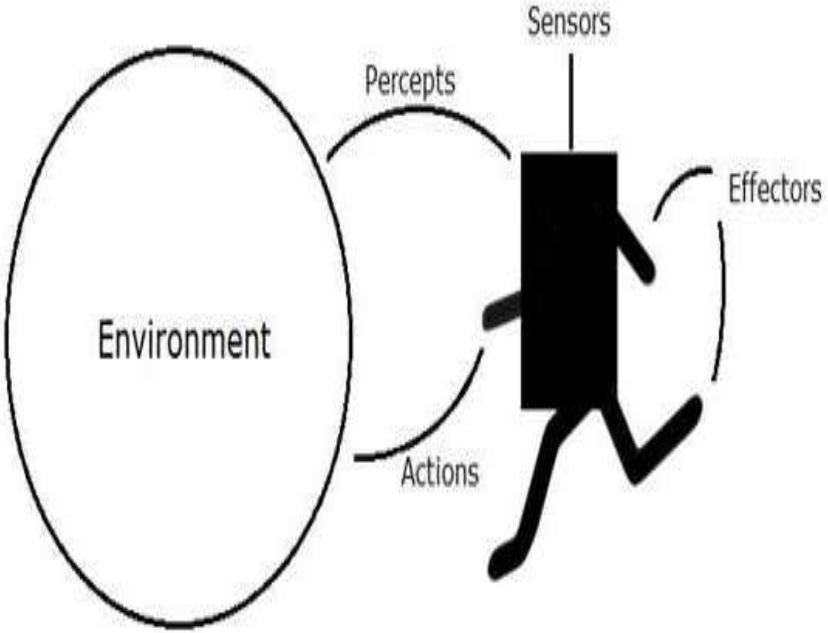
An agent can be anything that perceive its environment through sensors and act upon that environment through actuators. An Agent runs in the cycle of **perceiving**, **thinking**, and **acting**.

An agent can be:

- **Human-Agent:** A human agent has eyes, ears, and other organs which work for sensors and hand, legs, vocal tract work for actuators.
- **Robotic Agent:** A robotic agent can have cameras, infrared range finder, NLP for sensors and various motors for actuators.
- **Software Agent:** Software agent can have keystrokes, file contents as sensory input and act on those inputs and display output on the screen.

Hence the world around us is full of agents such as thermostat, cellphone, camera, and even we are also agents.

Agent Terminology



Percept − It is agent's perceptual inputs at a given instance.

Percept Sequence − It is the history of all that an agent has perceived till date.

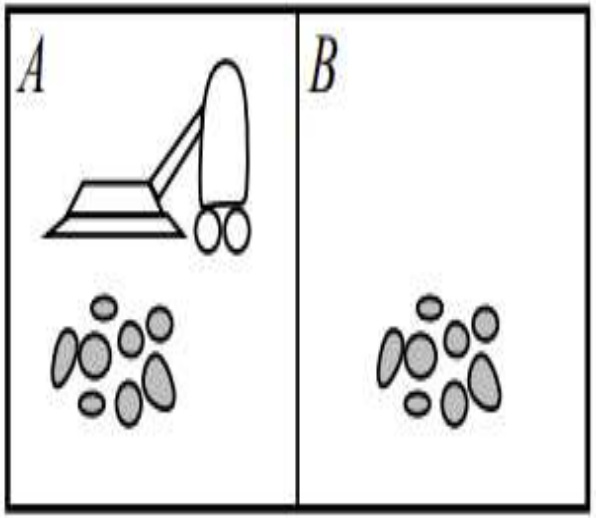
Behavior of Agent − It is the action that agent performs after any given sequence of percepts.

Agent Function − It is a map from the precept sequence to an action.

$$f:P^* \rightarrow A$$

Performance Measure of Agent − It is the criteria, which determines how successful an agent is.

Example: Vacuum Cleaner world



Percepts: location and contents, e.g., $[A, Dirty]$

Actions: *Left*, *Right*, *Suck*, *NoOp*

Percept Sequence	Action
[A, Clean]	Right
[A, Dirty]	Suck
[B, Clean]	Left
[B, Dirty]	Suck
.....	

Intelligent Agents

An intelligent agent is an autonomous entity which act upon an environment using sensors and actuators for achieving goals. An intelligent agent may learn from the environment to achieve their goals.

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.

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.

Rationality

Rationality is nothing but status of being reasonable, sensible, and having good sense of judgment.

Rationality is concerned with expected actions and results depending upon what the agent has perceived. Performing actions with the aim of obtaining useful information is an important part of 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.

What is Ideal Rational Agent?

An ideal rational agent is the one, which is capable of doing expected actions to maximize its performance measure, on the basis of −

- Its percept sequence
- Its built-in knowledge base

A rational agent always performs right action, where the right action means the action that causes the agent to be most successful in the given percept sequence. The problem the agent solves is characterized by **Performance Measure, Environment, Actuators, and Sensors (PEAS).**

Omniscient Agents

An **omniscient agent** is an **agent** which knows the actual outcome of its action in advance. A chess **AI** can be a good example of a rational **agent** because, with the current action, it is not possible to foresee every possible outcome whereas a tic-tac-toe **AI** is **omniscient** as it always knows the outcome in advance.

Rationality differs from Omniscience because an Omniscient agent knows the actual outcome of its action and act accordingly, which is not possible in reality.

Task Environment

The “problems” for which rational agents are the “solutions” -- **PEAS (Performance measure, Environment, Actuator, Sensor)**

Performance Measure: Performance measure is the unit to define the success of an agent. Performance varies with agents based on their different percept.

Environment: Environment is the surrounding of an agent at every instant. It keeps changing with time if the agent is set in motion. There are 5 major types of environments:

- Fully Observable & Partially Observable
- Episodic & Non-Episodic
- Static & Dynamic
- Discrete & Continuous
- Deterministic & Stochastic

Actuator: Actuator is a part of the agent that delivers the output of an action to the environment.

Sensor: Sensors are the receptive parts of an agent which takes in the input for the agent.

Properties of Task Environment

The environment has multifold properties −

1. **Discrete / Continuous** − If there are a limited number of distinct, clearly defined, states of the environment, the environment is discrete (For example, chess); otherwise it is continuous (For example, driving).

2. **Observable / Partially Observable** − If it is possible to determine the complete state of the environment at each time point from the percepts it is observable; otherwise it is only partially observable.

3. **Static / Dynamic** − If the environment does not change while an agent is acting, then it is static; otherwise it is dynamic.

4. **Single agent / Multiple agents** − The environment may contain other agents which may be of the same or different kind as that of the agent.

5. **Accessible / Inaccessible** − If the agent's can have access to the complete state of the environment, then the environment is accessible to that agent.

6. **Deterministic / Non-deterministic** − If the next state of the environment is completely determined by the current state and the actions of the agent, then the environment is deterministic; otherwise it is non-deterministic.

7. **Episodic / Non-episodic** − In an episodic environment, each episode consists of the agent perceiving and then acting. The quality of its action depends just on the episode itself. Subsequent episodes do not depend on the actions in the previous episodes. Episodic environments are much simpler because the agent does not need to think ahead.

Example of Environment and their Characteristics

Environment	Accessible	Deterministic	Episodic	Static	Discrete
Chess with a clock	Yes	Yes	No	Semi	Yes
Chess without a clock	Yes	Yes	No	Yes	Yes
Poker	No	No	No	Yes	Yes
Backgammon	Yes	No	No	Yes	Yes
Taxi driving	No	No	No	No	No
Medical diagnosis system	No	No	No	No	No
Image-analysis system	Yes	Yes	Yes	Semi	No
Part-picking robot	No	No	Yes	No	No
Refinery controller	No	No	No	No	No
Interactive English tutor	No	No	No	No	Yes

Example of PEAS

Agent: self-driving cars

Performance measure: 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.

Agent: Medical diagnosis system

Performance measure: Healthy patient, minimize costs, lawsuits

Environment: patient, hospital, staff

Actuators: Screen display (question, tests, diagnoses, treatment, referrals)

Sensors: Keywords (entry of symptoms, finding, patient's, answer)

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.