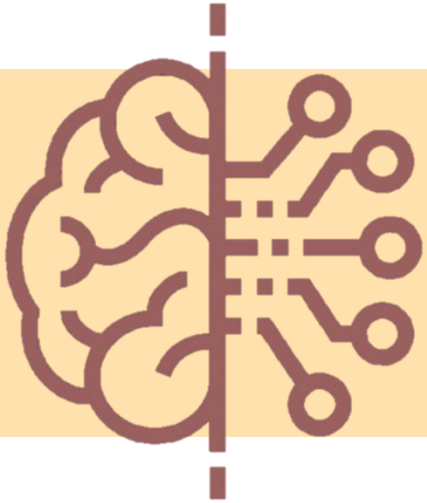
Intelligent Agents



Artificial Intelligence

School of Computing
Universiti Teknologi Malaysia

Outline

- Agents and environments
- Rationality
- Intelligent agent - PAGE and PEAS
- Agent types

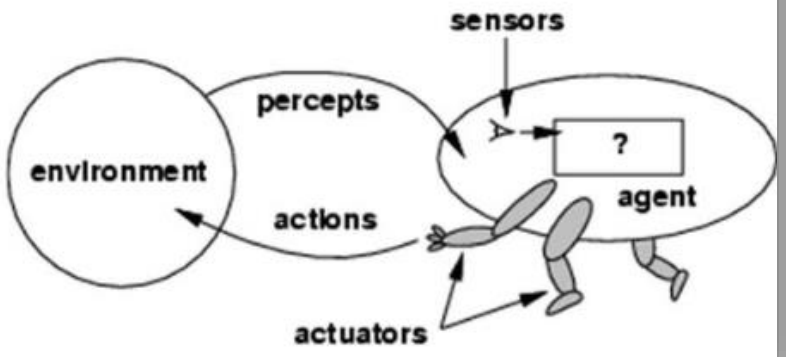
Agents in AI

An AI system can be defined as the study of the rational agent and its environment.

An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators

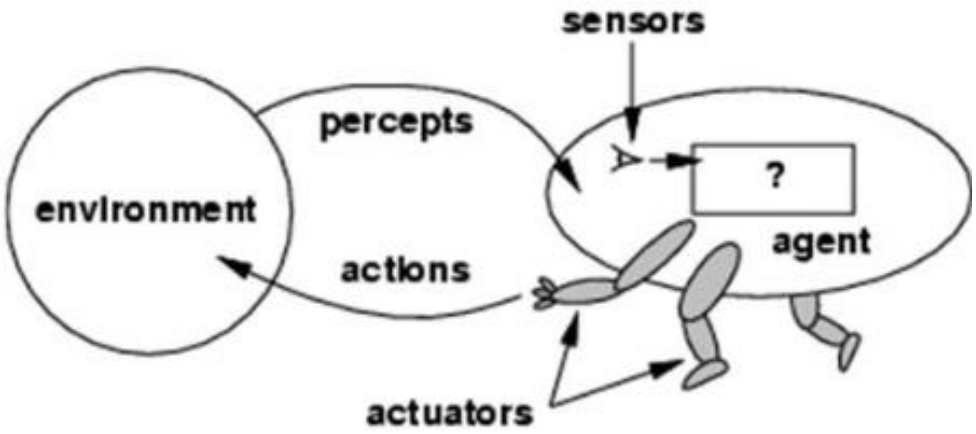
Examples:

- Human agent
- Robotic agent
- Software agent



Agents in AI

- Before moving forward, we should first know about sensors, effectors, and actuators.
- **Component of an Agent?**



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.

Effectors are the devices which affect the environment. Effectors can be legs, wheels, arms, fingers, wings, fins, and display screen.

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.

Agents in AI

- 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 (effectors).

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

Agents

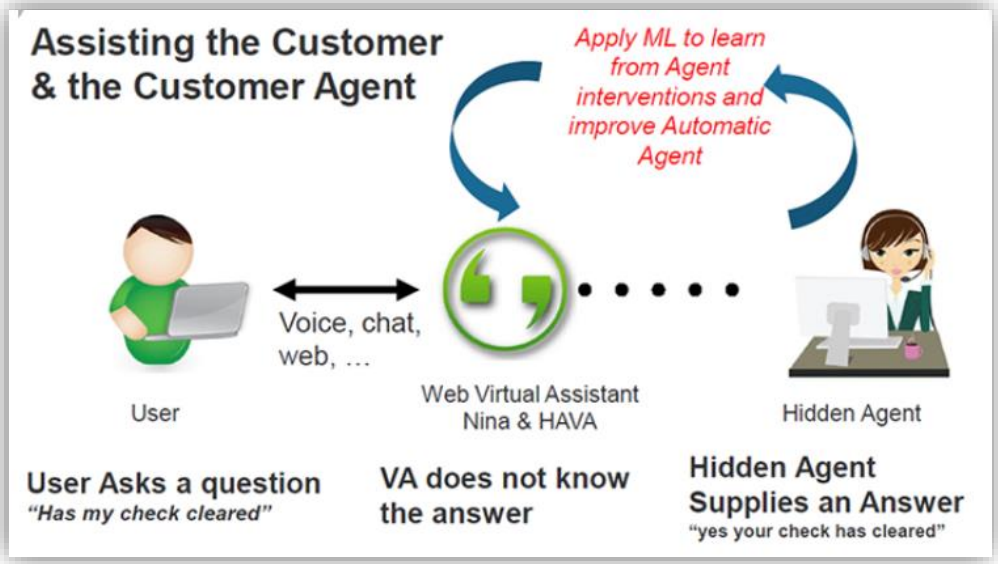
An agent is an entity that perceives (observes) and acts

An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators

- Percept refers to the agent's perceptual input at a given instant
- Percept Sequence is a complete history of percepts.

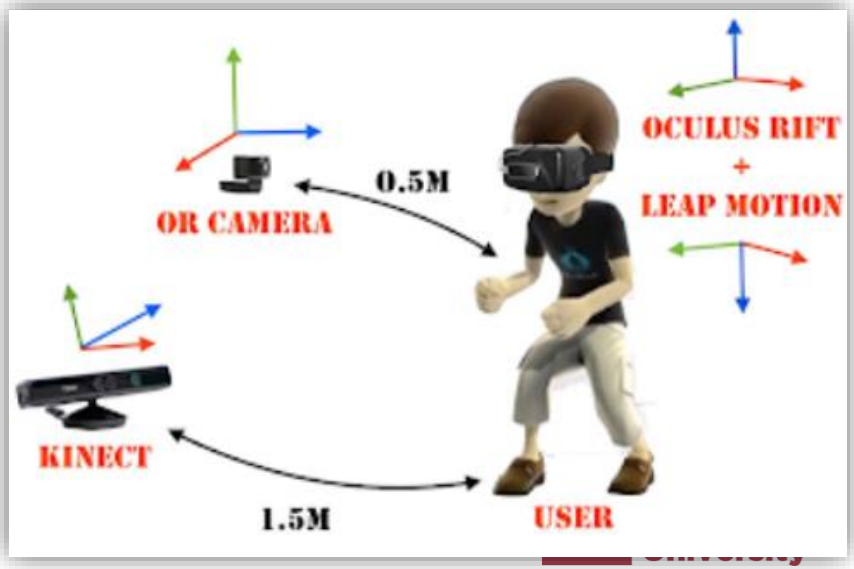
Example of human-agent

Virtual assistant



Sensor - ?
Effector - ?
Actuator - ?

Virtual reality game



Sensor - ?
Effector - ?
Actuator - ?

Example of robotic-agent

Intelligent Drone

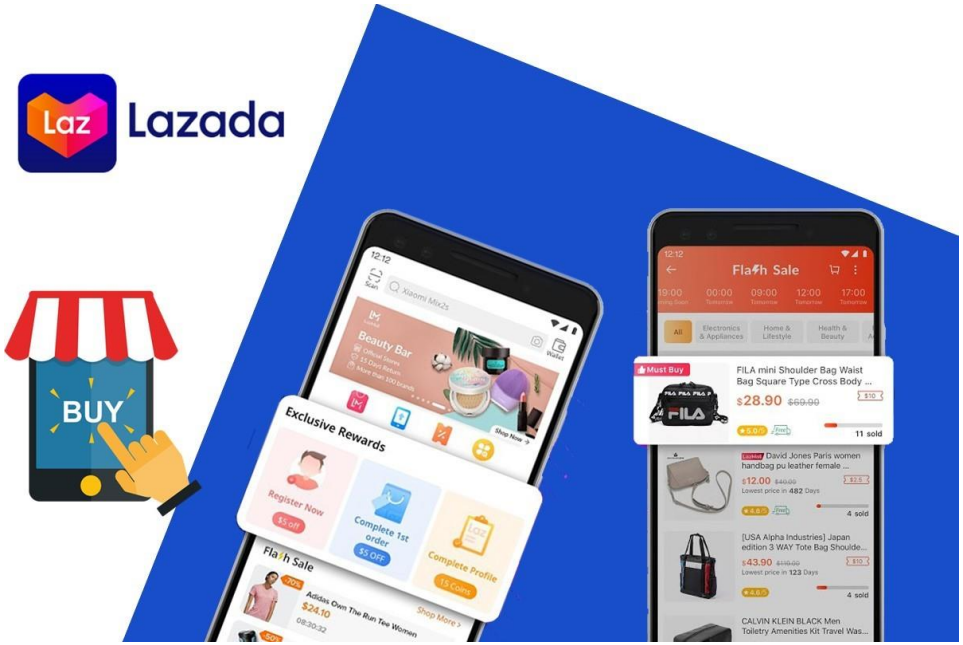
Sensor - ?
Effector - ?
Actuator - ?

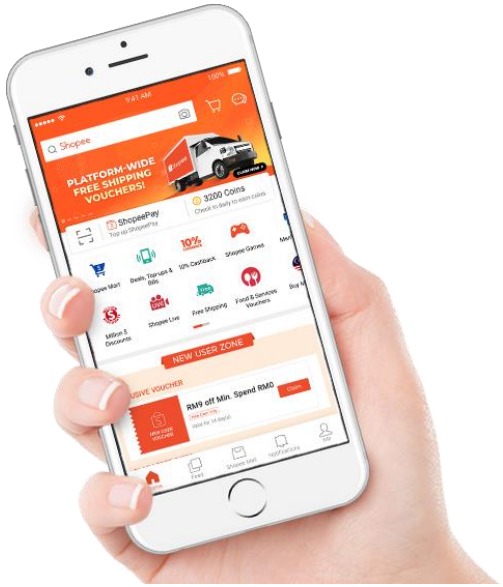
Sensor - ?
Effector - ?
Actuator - ?

Robot Player

Example of software-agent

Internet Shopping Agent

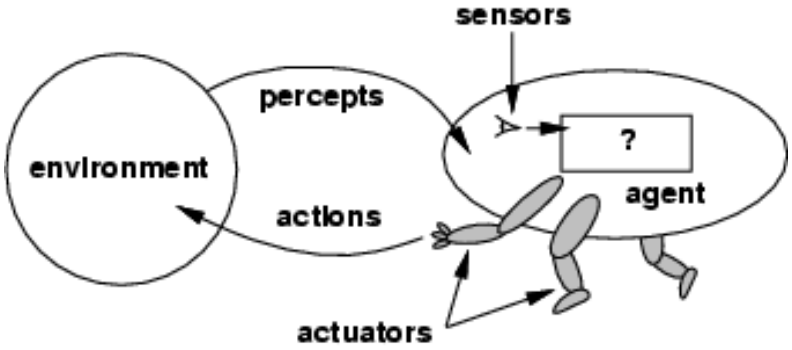




Sensor - ?

Effector - ?

Agents and environments



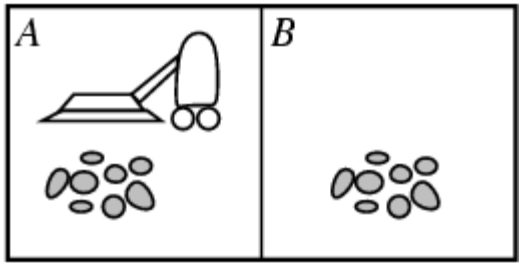
- The agent function maps from percept histories to actions:

$$[f: \mathcal{P}^{\star} \rightarrow \mathcal{A}]$$

- The agent program runs on the physical architecture to produce *f*

- agent = architecture + program

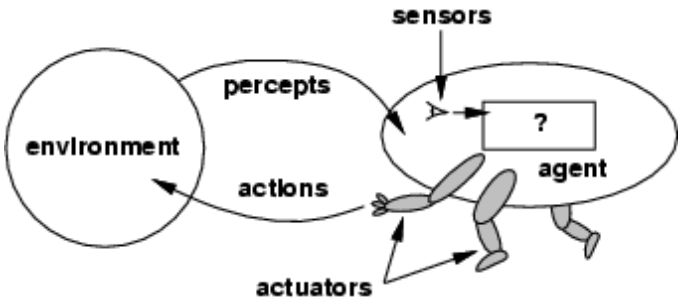
Vacuum-cleaner world

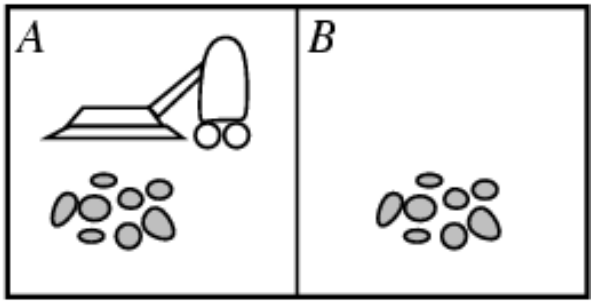


Percepts: location and contents, e.g., [A,Dirty]

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

Vacuum-cleaner function



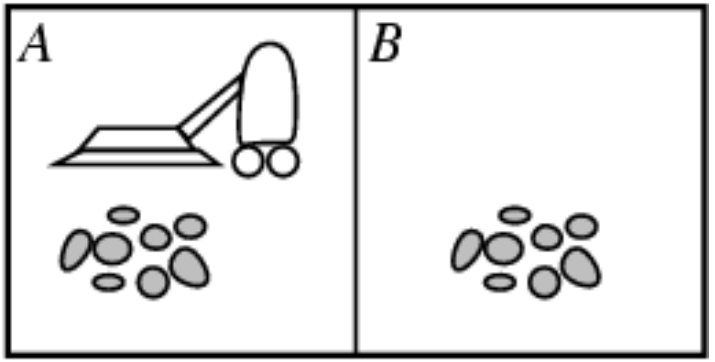


[*location, status*])

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

The Vacuum-cleaner world

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



function REFLEX-VACUUM-AGENT ([*location, status*]) return an action

if *status == Dirty* then return *Suck*

else if *location == A* then return *Right*

else if *location == B* then return *Left*

Rational agents

- A ***rational agent*** is one that acts in a manner that causes it to be as successful as it can.
- What counts as successful obviously depends on what we require the agent to do.
- We need to determine an appropriate ***performance measure*** in each case. One has to be careful in choosing that measure, as there are often many conflicting criteria that need to be taken into account.

Ideal Rational agents

- An ***ideal rational agent*** is one that takes whatever action is expected to maximise its performance measure on the basis of the evidence provided by its perceptual history and whatever built-in knowledge it has
- If an agent's actions are based only on its built-in knowledge, and not on its own experience with its environment, then we say that the agent lacks autonomy.
- An ***autonomous agent*** will supplement its built-in knowledge with its own acquired (or learned) knowledge in order to act appropriately.
- It is often a good AI strategy to build systems/agents that have enough knowledge to get them started, and then leave them to learn the rest.

Intelligent Agents - PAGE

- **Agents** are comprised of an ***architecture*** (e.g. a computer) plus a ***program*** that runs on that architecture.
- In designing intelligent systems there are four main factors to consider:

  P **Percepts** – the inputs to our system

  A **Actions** – the outputs of our system

  G **Goals** – what the agent is expected to achieve

  E **Environment** – what the agent is interacting with

Intelligent Agents - PEAS

- *PAGE Descriptors* are not the unique way of describing intelligent systems.
- One popular alternative involves *PEAS Descriptors*:

  P **Performance** – how we measure the system's achievement's

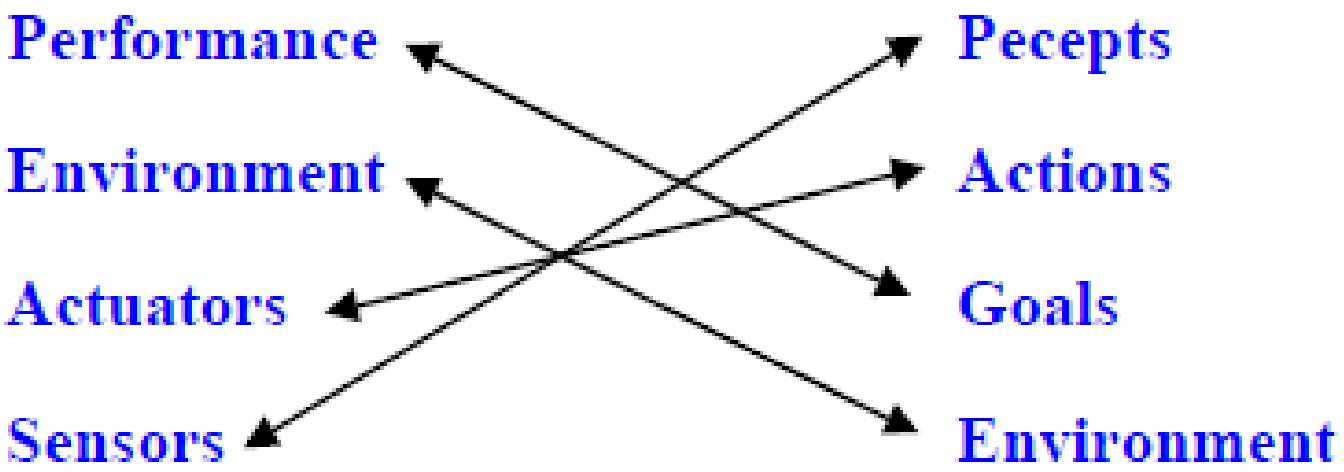
  E **Environment** – what the agent is interacting with

  A **Actuators** – what produces the outputs of the system

  S **Sensors** – what provides the inputs to the system

PAGE Descriptors vs. PEAS Descriptors

- A simple mapping between *PAGE* and *PEAS*:



Agents in AI

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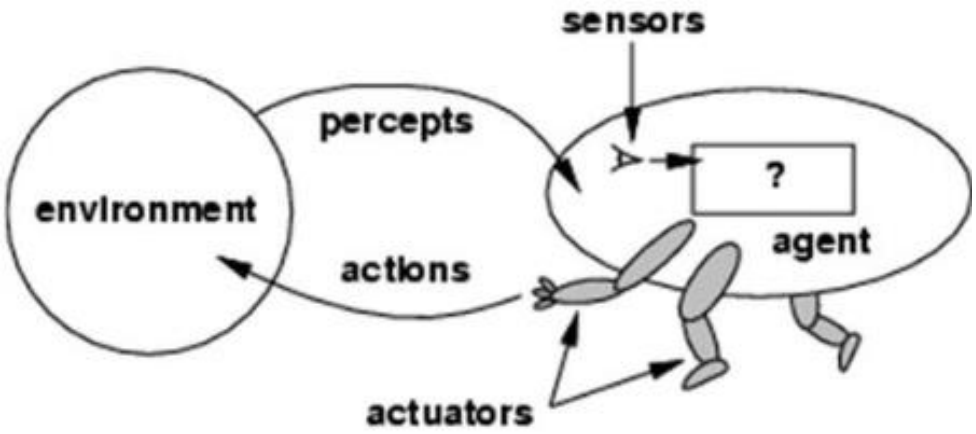

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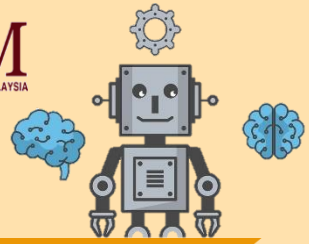
Examples of Intelligent Agents

Agent Type	Percepts	Actions	Goals	Environment
Medical diagnostic system	Symptoms, test results, patient's answers	Questions, test requests, treatments, referrals	Healthy patients, minimise costs	Patient, hospital, staff
Satellite image analysis system	Pixels of varying intensity and colour	Display a categorisation of the scene	Correct image categorisation	Images from orbiting satellite
Part-picking robot	Pixels of varying intensity and colour	Pick up parts and sort them into bins	Place parts into correct bins	Conveyor belt with parts, bins
Refinery controller	Temperature, pressure and chemical readings	Open and close valves, adjust temperature	Maximise purity, yield, safety	Refinery, staff

Part-picking robot

Sensor - ?
Goals - ?
Actuator - ?
Environment - ?



PEAS Representation

- PEAS is a type of model on which an AI agent works upon. When we define an AI agent or rational agent, then we can group its properties under PEAS representation model. It is made up of four words:
  - ✓**P:** Performance measure
  - ✓**E :** Environment
  - ✓**A:** Actuators/Effectors
  - ✓**S:** Sensors

PEAS Representation: Example

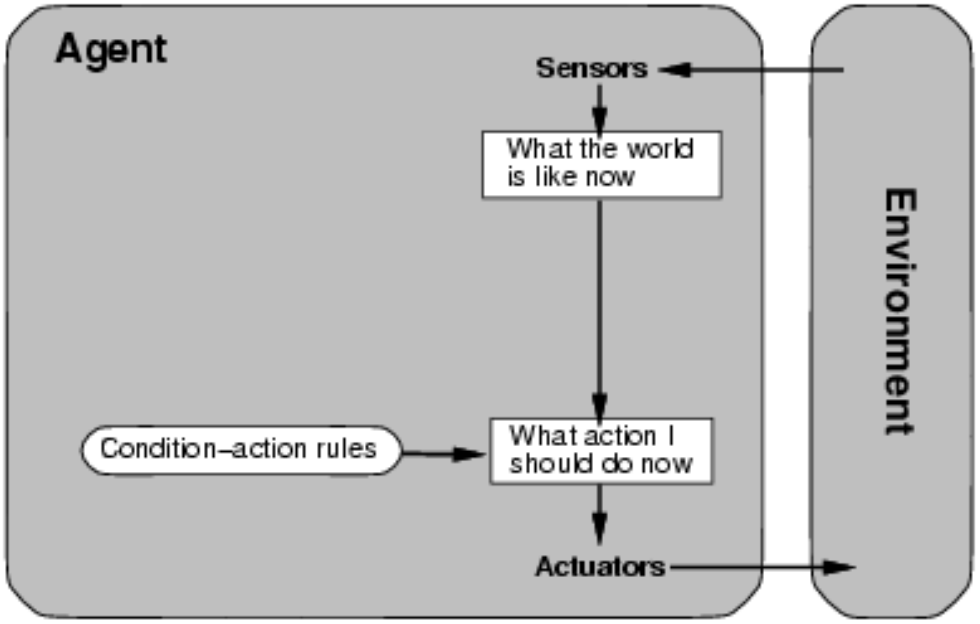
Self Driving Car

- **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.

Agent types

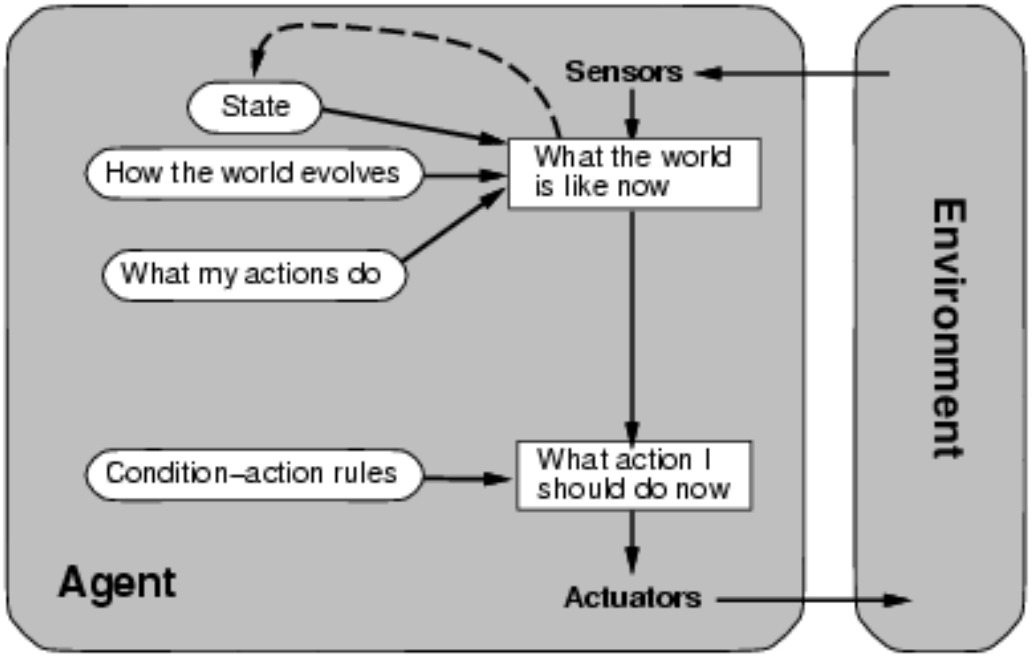
- We shall consider four types of agent system of increasing sophistication:
    1. Simple Reflex Agents
    2. Reflex Agents with an Internal State
    3. Goal based agents
    4. Utility based agents

Simple reflex agents



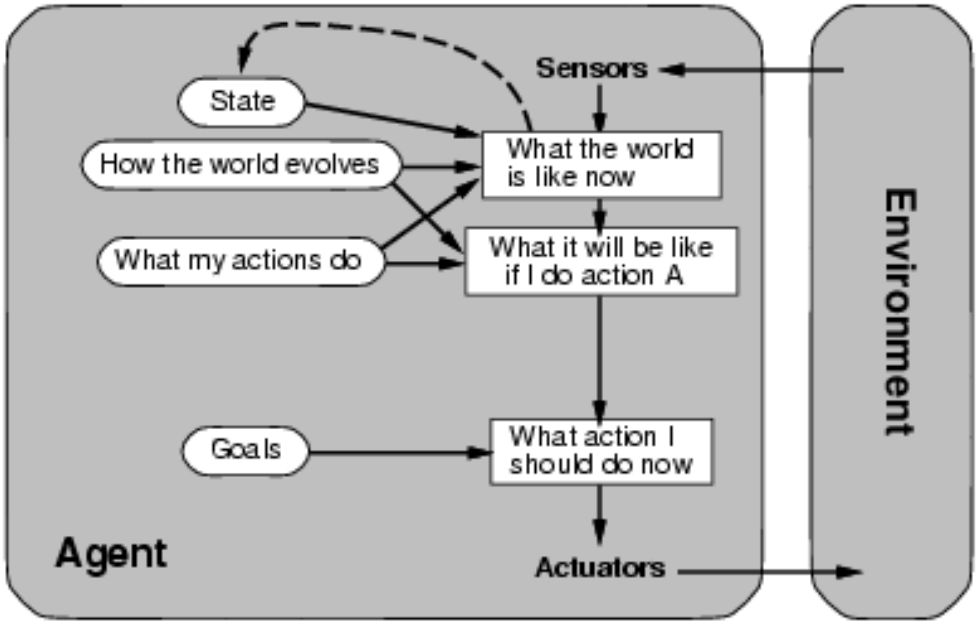
- Select action on the basis of *only the current* percept, e.g. the vacuum-agent
- Implemented through *condition-action rule, e.g.* If dirty then suck

Model-based reflex agents



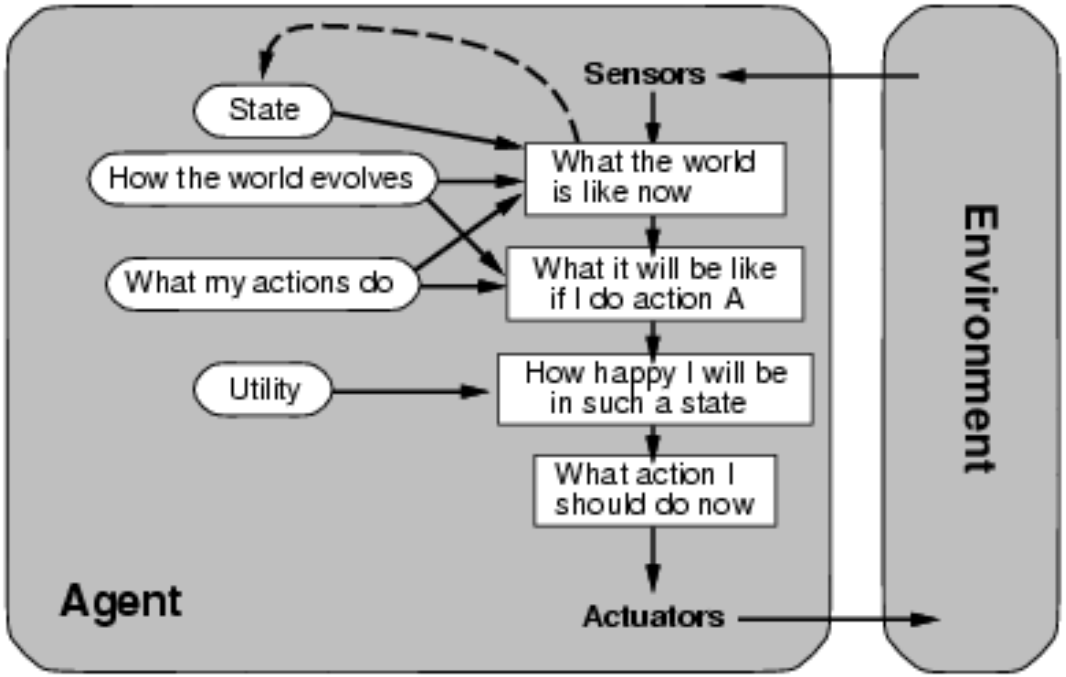
- Able to keep track of its previous states (i.e. maintain a description or "model" of its previous history in the world),
- Able to make better informed decisions about its actions.

Goal-based agents



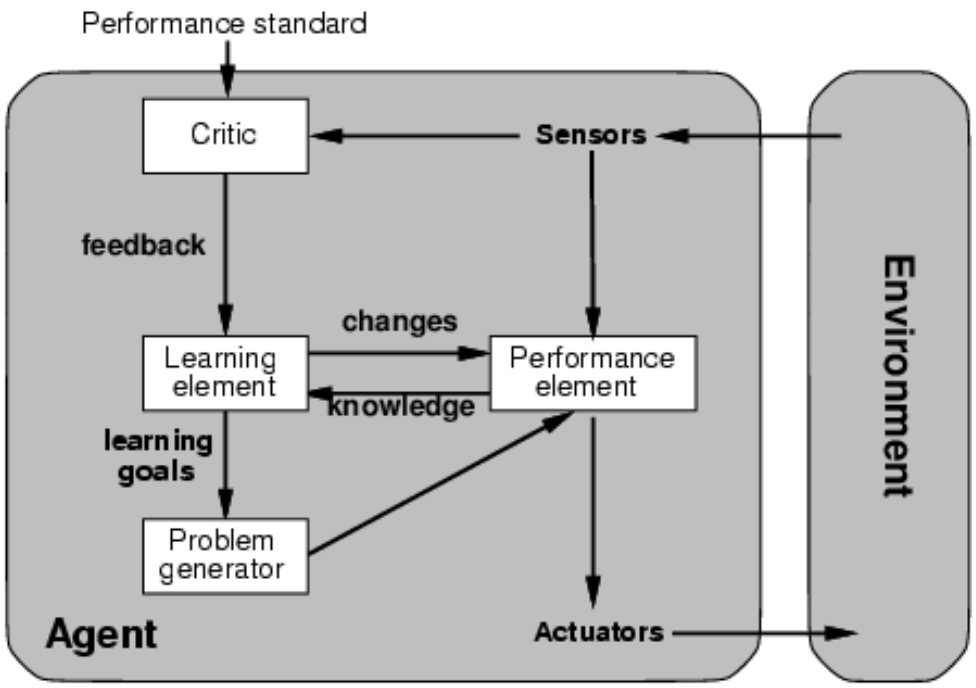
- The appropriate action for the agent will often depend on what its goals are, and so it must be provided with some ***goal information.***
- If a long sequence of actions is required to reach the goal, then ***Search*** and ***Planning*** are the sub-fields of AI that must be called into action.

Utility-based agents



- Described as possessing a ***utility function*** that maps a state, or sequence of states, on to a real number that represents its utility or usefulness.
- Use the utility to choose between alternative sequences of actions/states that lead to a given goal being achieved.

Learning agents



- All previous four agent-programs describe methods for selecting *actions*.
- **Learning agents :**
  - Modifies performance elements.
  - Teach them instead of instructing them.
- Advantage is the robustness of the program toward initially unknown environments.

Learning agents

- A general learning agent has four basic components:
  1) The Performance Element – which takes in percepts and decides on appropriate actions in the same way as a non-learning agent.
  2) The Critic – which uses a fixed standard of performance to tell the learning element how well the agent is doing.
  3) The Learning Element – that receives information from the critic and makes appropriate improvements to the performance element.
  4) The Problem Generator – that suggests actions that will lead to new and informative experiences (e.g. as in carrying out experiments).

Agent Environments

- An **agent** perceives and acts in an environment, has an architecture, and is implemented by an agent program.
- Often we run an **environment program** for our agents to interact with.
- Five dimensions to categorize the properties of an agent's environment : **Accessible vs. Inaccessible, Deterministic vs. Non-deterministic, Discrete vs. Continuous, Episodic vs. Non-episodic, Static vs. Dynamic**
- The most challenging environments are inaccessible, non-deterministic, continuous, non-episodic, and dynamic.

Accessible vs. Inaccessible

- An environment is ***accessible*** to an agent if the agent's sensory apparatus gives it access to the complete state of the environment.
- Thus, the agent will not then need to maintain an internal state to keep track of the world.
- An empty room whose state can be defined by its temperature is an example of an accessible environment.
- Information about an event on earth is an example of Inaccessible environment.

Deterministic vs. Non-deterministic

- The environment is ***deterministic*** if its next state is determined completely by its current state and the actions of its agents. A deterministic but inaccessible environment may *appear* non-deterministic to the agent.
- Most real environments are so complex that, in practice, they have to be treated as non-deterministic.

Discrete vs. Continuous

- A ***discrete*** environment has a limited/finite number of distinct, clearly defined percepts and actions.
- A chess game comes under discrete environment as there is a finite number of moves that can be performed.
- A self-driving car is an example of a continuous environment.

Episodic vs. Non-episodic

- In an ***episodic*** environment the agent's experience can be divided into "episodes" consisting of the agent perceiving and then producing actions that depend only on that episode.
- Non-episodic (subsequent episodes) do not depend on previous episodes, and so the agent can limit how far it needs to think ahead.
- However, in Sequential environment, an agent requires memory of past actions to determine the next best actions.

Static vs. Dynamic

- A ***static*** environment does not change while an agent is deliberating. The agent will then have no need to keep checking the world while it is deciding on an action, nor worry about the passage of time.
- However, for dynamic environment, agents need to keep looking at the world at each action.
- Taxi driving is an example of a dynamic environment whereas Crossword puzzles are an example of a static environment.

Components of an AI Agent

- We now have a good idea of the components that need to be built into an AI agent:
  1) A means to infer properties of the world from its percepts.
  2) Information about the way the world evolves.
  3) Information about what will happen as a result of its possible actions.
  4) Utility information indicating the desirability of possible world states and the actions that lead to them.
  5) Goals that describe the classes of states whose achievement maximises the agent's utility.
  6) A mapping from the above forms of knowledge to its actions.
  7) An active learning system that will improve the agents ability to perform well.

Summary: Intelligent Agents

- An **agent** perceives and acts in an environment, has an architecture, and is implemented by an agent program.
- An **ideal rational agent** always chooses the action which maximizes its expected performance, given its percept sequence.
- Task environment – **PAGE** (Percepts, Actions, Goals, Environment) and **PEAS** (Performance, Environment, Actuators, Sensors)

Summary: Intelligent Agents

- An **agent program** maps from percept history to action and updates internal state.
- Agents can improve their performance through **learning.**
- The most challenging agent environments are inaccessible, nondeterministic, dynamic, and continuous.

Activity

Determine the PEAS model for your Smart Chatbot.