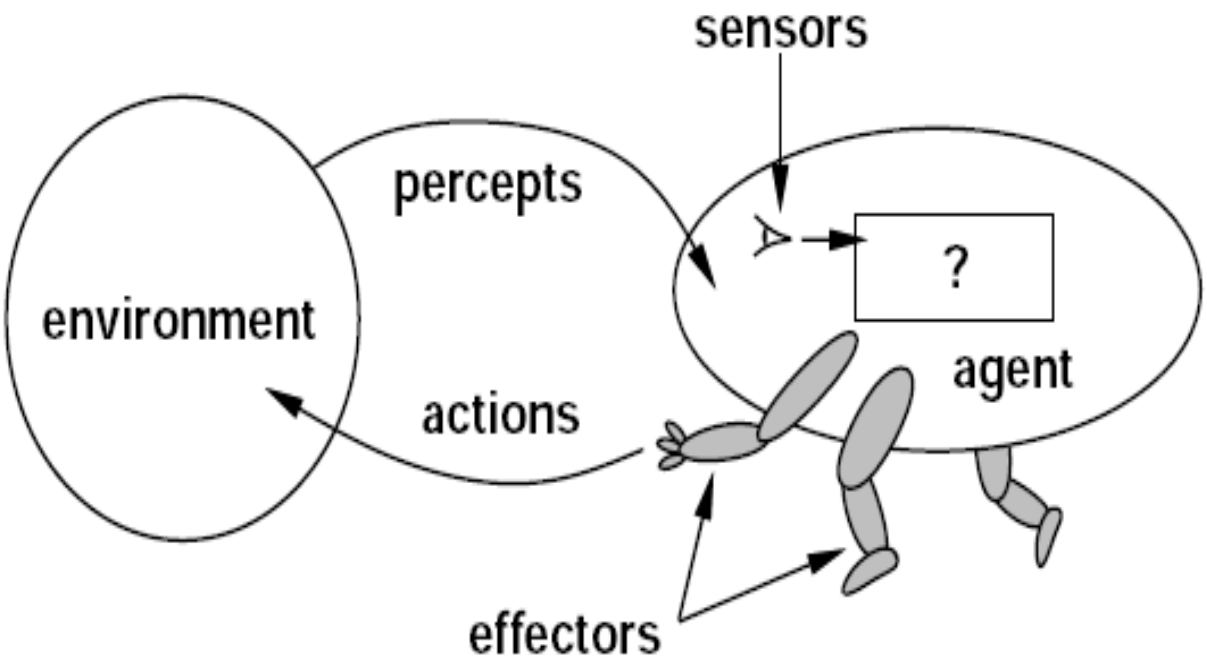
Agent

- An agent is anything that perceives its environment through sensors and acts upon that environment through sensors.
- Its action can change environment through different states.
- The sensors act as input device and actuators act as output device.
- The percept is complete set of inputs at a given time.
- It has agent program that decides the best action to be taken based upon current percept.
- The mapping between percept and its action is done by function.
- The agent function is a mathematical function that maps a sequence of perceptions into action.
- The function is implemented as the agent program.
- Agent function can be in terms of table or rule.

  $f : P^* \rightarrow A$

For eg: a human agent has eyes, ear and other organs as sensors and legs, hands etc as an actuators.
A robotic agent might have camera as sensor and motors as actuators.


sensors
percepts
environment
?
agent
actions
effectors

Sensors, Percepts, Effectors and Actions

For humans,

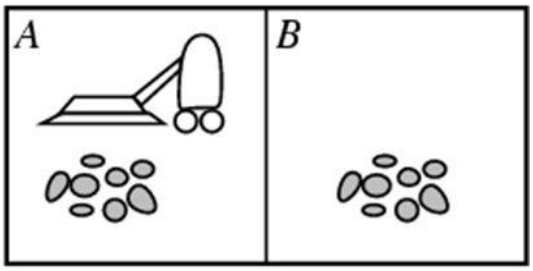
- Sensors: eyes(vision), skin(touch), tongue(gestation), nose(smell), ears(hearing)
- Percepts:
  - At the lowest level: Signals from the sensors
  - After preprocessing: Visual (location, texture, color, direction), Auditory (pitch, loudness)
- Effectors: legs, hands, eyes, head
- Actions: lift finger, walk, talk, run, carry an object

Percepts and actions need to be defined carefully at different levels of abstraction

Example of agent:

Vacuum-cleaner world

- **Percepts:**
  Location and status,
  e.g., [A,Dirty]
- **Actions:**
  Left, Right, Suck, NoOp



Example vacuum agent program:

function Vacuum-Agent([location,status]) returns an action

- *if* status = Dirty *then* return Suck
- *else if* location = A *then* return Right
- *else if* location = B *then* return Left

Properties of Agents

- Autonomous
- Interacts with other agents and the environment
- Reactive to the environment
- Pro active/ goal directed

Types of agents

a. Intelligent agent:
This type of agent must sense, act, be autonomous and be rational. For e.g. The little paperclip guy in ms-word is intelligent agent.

b. Rational agent:
Rational agent always does right thing based upon its prior knowledge, percept history, its ability and its constraints like time and space limitation. A rational agent must be able to learn and be autonomous. It always act to maximize its expected value.

What is rational at a given time depends on four things:
- performance measure
- prior environment knowledge
- actions
- percepts

c. Omniscient Agent:
This type of agent knows the actual outcome of its action and can act accordingly. But omniscience is impossible in reality.

Agent Structure

1. **Table based agent**

- In this agent, the mapping between percepts and its action is stored in the form of table
- it looks on table and takes the appropriate actions
- It is good for simple task or environment where agent's action depends upon only current percept.
- It has no autonomous and no learning.

  Eg: vacuum cleaner

Percept	Action
[A, Dirt]	Suck
[A, Clean]	Move right

2. **Simple Reflex Agent**

- It responds immediately to the percept by matching the percept into action.
- Such matching is done by using some rules or policy.
- Such type of agent is very simple and good for fully observable environment.
- It lacks learning.
- For e.g. Whenever I touch the heater, I immediately remove my hand from it. It means it can't show deliberate action as it does not think about situation it has perceived.

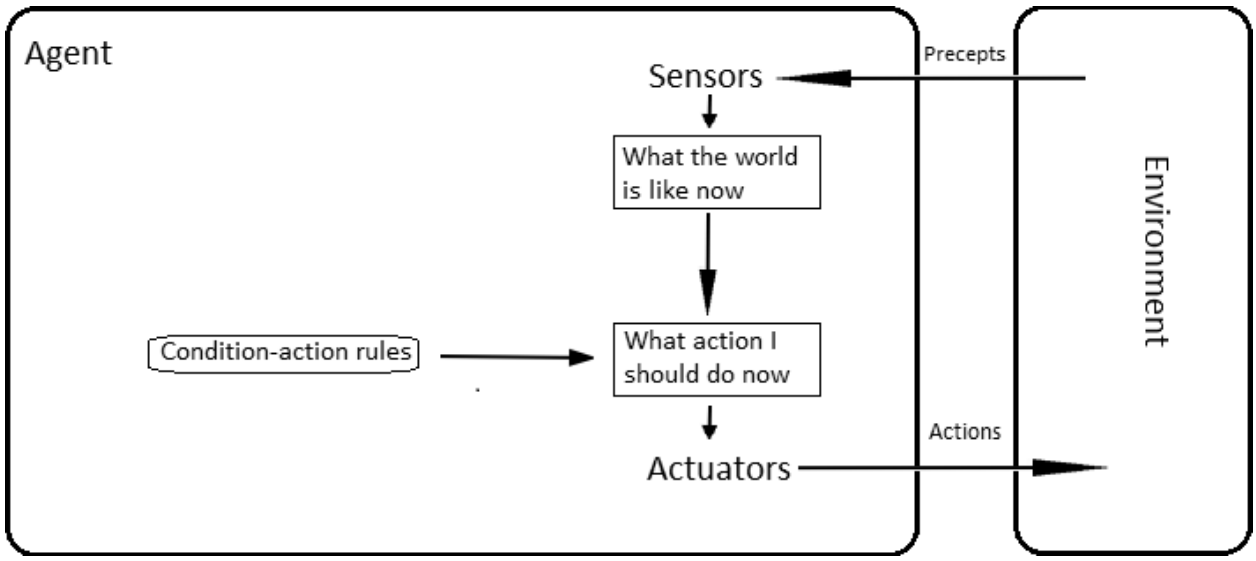
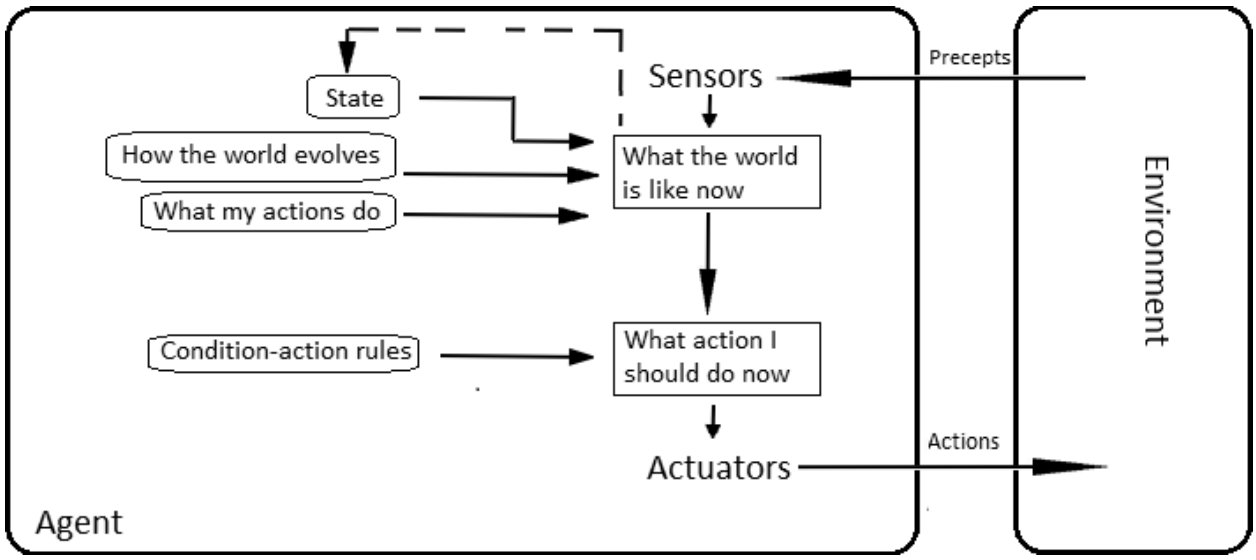


Fig. block diagram of simple reflex agent

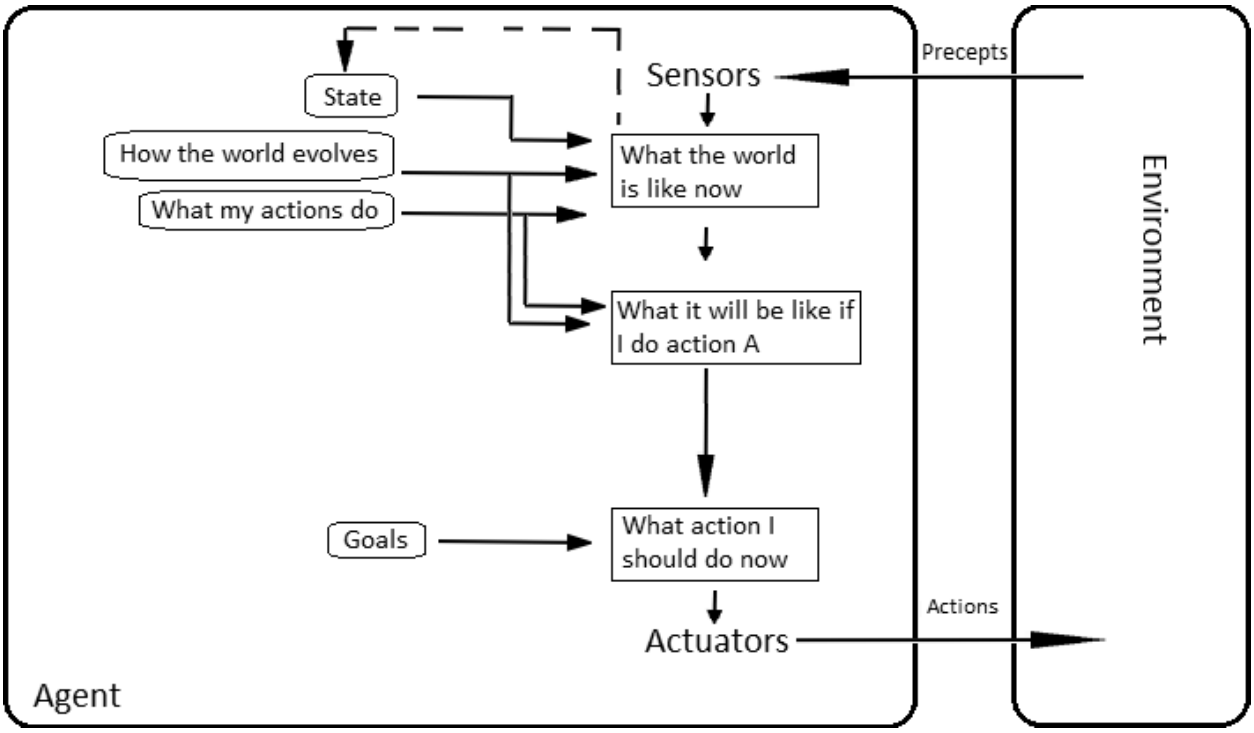
3. Model Based agent

- This type of agent has some internal memory
- It keeps world model in some memory to remember what was perceived before and keep track the different aspects of the world.
- This allows the agent to compute the next state of the world based upon the current state and world model.
- This type of agent is good for partially observable environment. It is good for games like puzzle, chess etc.



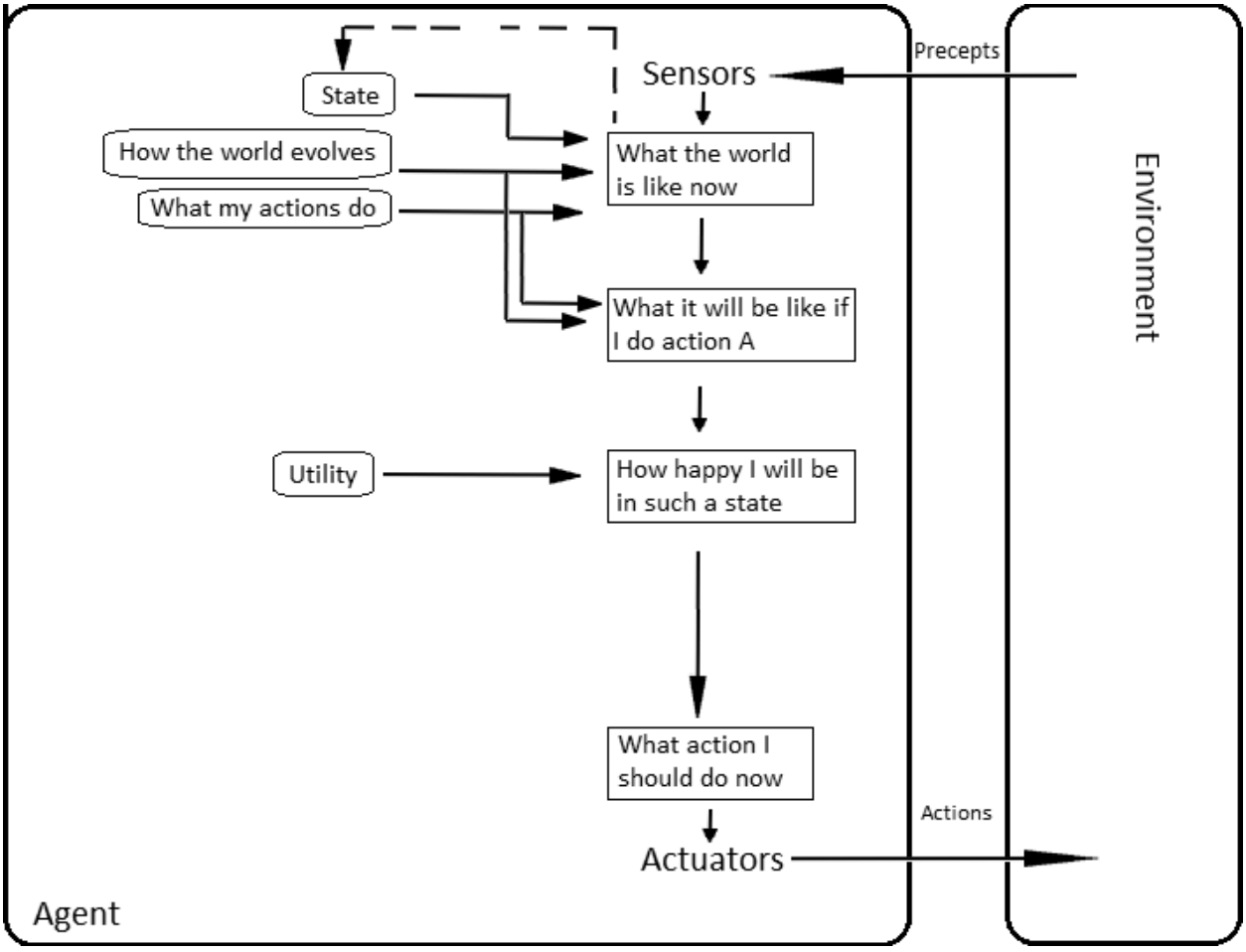
4. Goal Based Agent

- This type of agent has some goal to achieve with its world model, perception history and list of actions it can perform.
- It tries sequence of actions that can lead to goal internally.
- If it does, it takes that action. i.e. It check whether this action takes me to the goal or not.
- It can analyze and think over current situation.



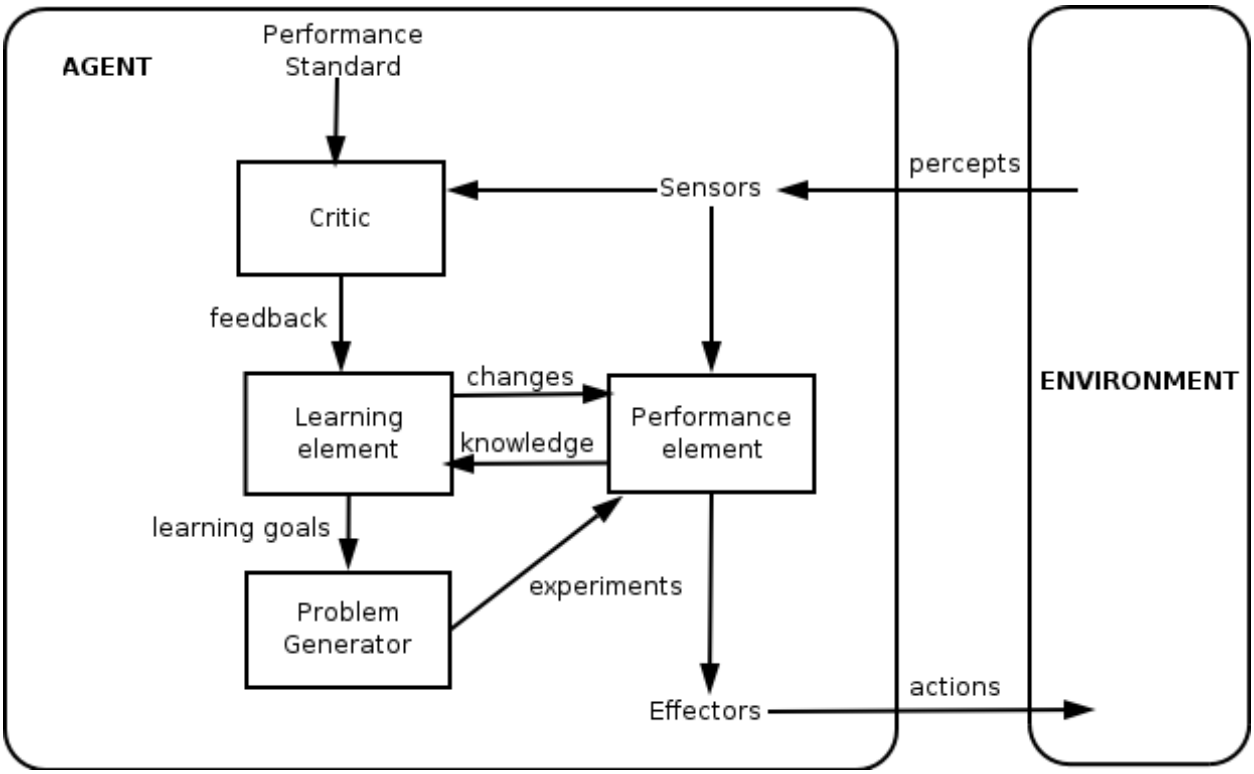
5. Utility Based Agent

- It is a goal based agent that tries to maximize its utility.
- it tries to achieve optimal goal.
- Some goals can be achieved different ways and every way has some preferences or utility.
- chooses the action that maximizes the expected utility of the action outcomes
- has to model and keep track of its environment, tasks, perception, representation, reasoning, and learning.



6. Learning agents

- A learning agent learns about environment model
- learns about its action consequences and its utility.
- It learns with the feedback from environment.
- Learning enables an agent to adapt new situations without being reprogrammed by humans.



Performance Evaluation of agents

Performance measure tells how successful an agent is. Agent changes the environment into different sequence of states. If the states are desirable then, agent has performed well. The performance measure can be stated in terms of various factors like quality of solution, desirable states, quickness of solution etc.

PEAS Description

To design an agent we must specify its task environment. Task environment includes:

- Performance
- Environment
- Actuators and
- Sensors

Example: PEAS description of Fully automated taxi:

- Performance: Safety, destination, profits, legality, comfort

- Environment: Streets/freeways, other traffic, pedestrians, weather, …
- Actuators: Steering, accelerating, brake, horn, speaker/display,…
- Sensors: Video, sonar, speedometer, engine sensors, keyboard, GPS,

Characteristics of Task environment

Fully observable Vs partially observable:
In fully observable environment, all aspects relevant to the task being considered is observable. It means agent's sensor can access to the complete state of environment at each point. For eg chess The relevant features may be partially observable in some cases. For eg Poker

Deterministic Vs Stochastic:
In deterministic environment, given a action and a state, the change in environment is known. For eg. Chess. In stochastic, the change in environment is uncertain. For eg. Ludo.

Episodic Vs sequential:
Certain task can be divided into different episodes. The action of one episode does not affect subsequent episodes. Such a environment is called episodic. In such environment agent does not plan beyond a episode. For eg. determining defective parts. If current action may affect other episodes then, it is called sequential. For eg. Playing chess, taxi driving.

Discrete Vs Continuous:
If number of actions, percepts and states are limited or discrete, then is it discrete environment otherwise continuous or infinite. Chess playing is discrete environment while taxi driving is continuous.

Single Agent Vs Multi agent:
Environment having single agent that operates itself is called single agent environment. For eg crossword puzzle solving agent. If it is two or more agent, then it is multiage. For eg chess playing.