Intelligent Agents

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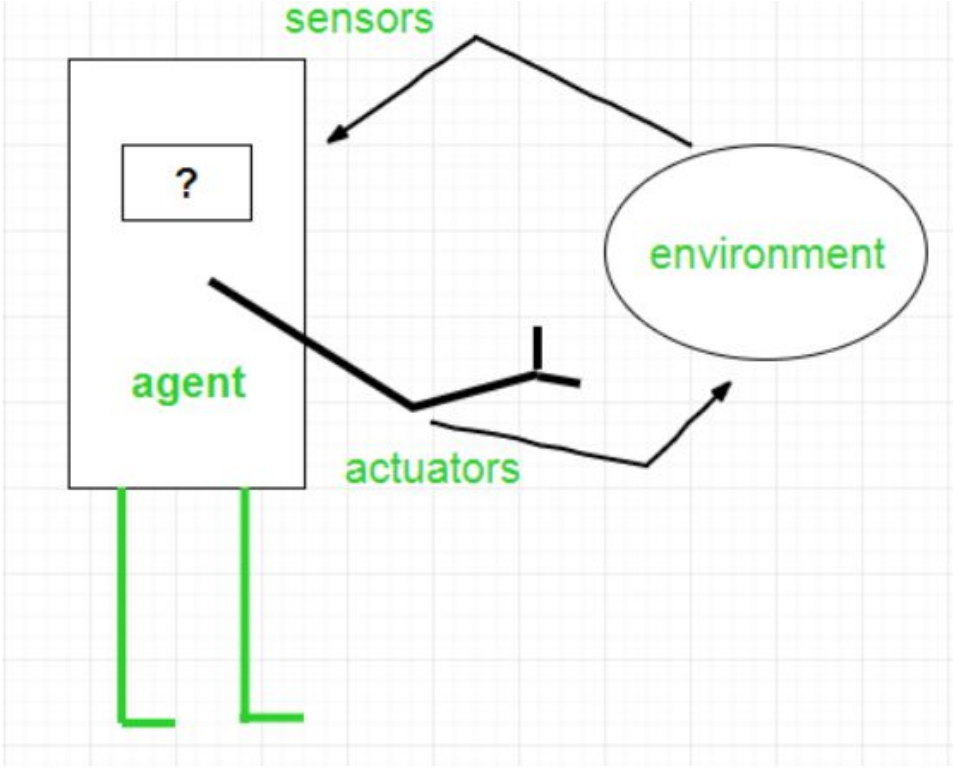
Introduction of Agents



- **An agent** is a computer program or system that is designed to perceive its environment, make decisions and take actions to achieve a specific goal or set of goals.
- It **perceives** the environment through the **sensors** and **act** upon the environment through **actuators**

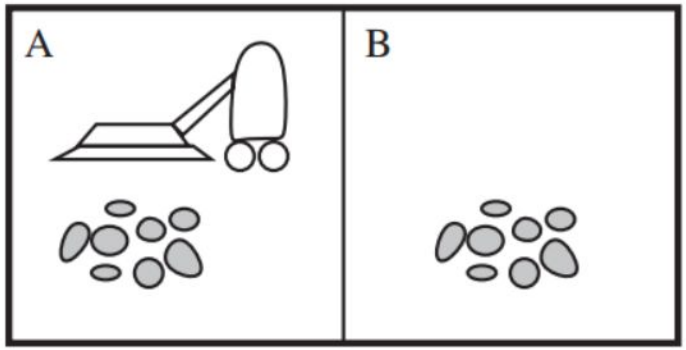
Introduction of Agents

Agent Type	Sensors	Actuators
Human	Eyes, Ears	Hands, Legs
Robot	Keystroke, sensors	Display on screen, Robotic arms and legs

Structure of Agents

- Percept: Agent's perceptual inputs at any given instant.
- Percept Sequence: Complete history of everything the agent has perceived.
- Agent Function: Maps any given percept sequence to an action.
- Agent Program: Implements agent function

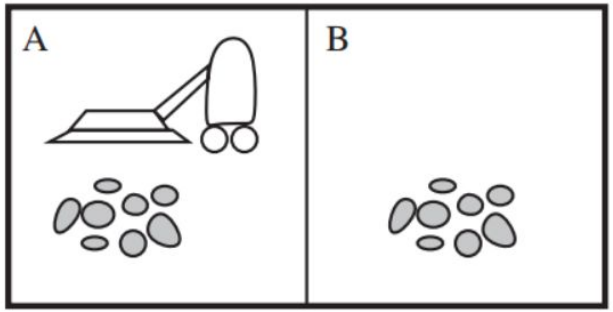
Structure of Agents



- There are 2 tiles: Tile A and Tile B.
- The pile of dust could be on any, on both or on neither of the two tiles.
- Vacuum cleaner is on one of the tiles, and it can sense and clean only one tile at a time.
- The cleaner could move left, move right, or clean the tile it rests on.

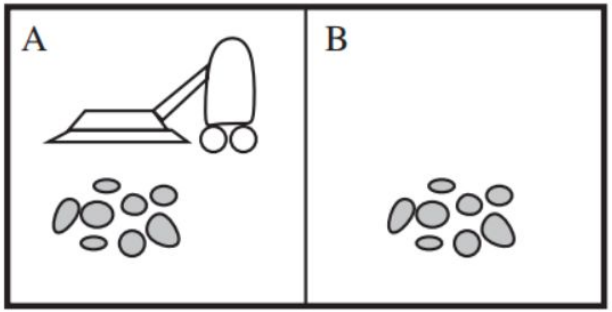
Structure of Agents

- **Simple Agent Function:** if the current square is dirty then suck the dirt otherwise move to other square.



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
⋮	⋮
[A, Clean], [A, Clean], [A, Clean]	Right
[A, Clean], [A, Clean], [A, Dirty]	Suck
⋮	⋮

Structure of Agents



Agent Program:

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 Agent

- Rational agent is one that does the right thing
- In case of vacuum cleaner world, every entry in the table for the agent function is filled out correctly.

  But what does it mean to do the right thing?????

  Answer: Performance Measure

- Rationality depends on
  - Performance measure
  - Prior Knowledge
  - Actions
  - Percept Sequence

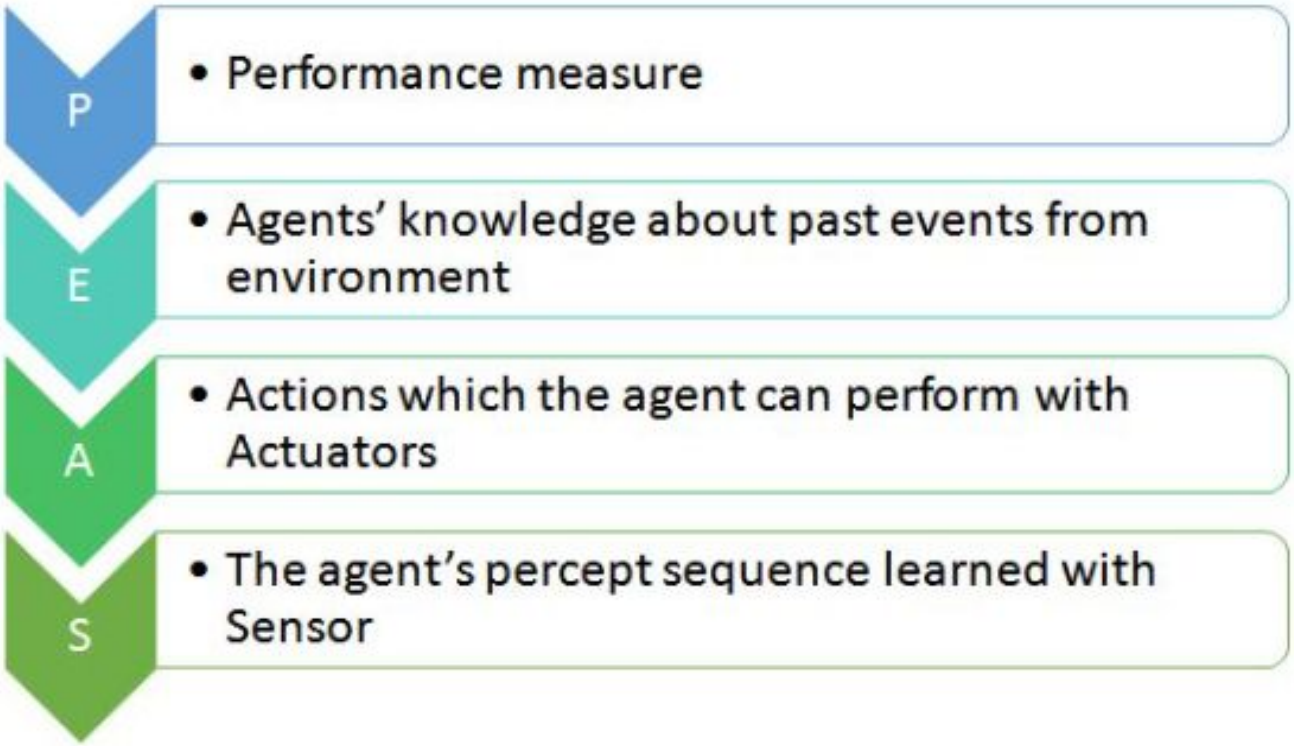
Rational Agent

Definition

"For each possible percept sequence, a rational agent should select an action that is expected to maximize its performance measure, given the evidence provided by the percept sequence and whatever built in knowledge the agent has".

Consider vacuum cleaner agent, is it a rational agent?

Task Environment



Task Environment

PEAS for 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.

Task Environment

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.

Task Environment

Agent	Performance Measure	Environment	Actuators	Sensors
Playing Soccer	Score, Injuries, Team work.	Players, Referees, Field, Crowd, Goals, Ball.	Strength, Stamina, Coordination.	Eyes, Ears, Mouth, Ears, Touch.
Exploring Titan	Underwater mobility, Safety, Data, Navigation.	Shuttle, Rover, Atmosphere, Surface, Ocean.	Communication, Sustainability, Reliability.	Camera, GPS, Temperature, Pressure.
AI Book Shopping	Prices, Ease of site, Shipping time.	Websites, Internet, PC.	Correct Information, User.	Pictures, Information, Eyes.
Playing Tennis	Scoring, Stamina, Team work, Strategy.	Players, Referees, Crowd, Net, Court, Ball.	Strength, Stamina, Coordination.	Eyes, Skill, Footwork.
Practicing Tennis	Stamina, Lowering missed balls.	Player, Wall, Racket, Ball.	Stance, Racket Placement, Speed.	Eyes, Skill, Footwork.
High Jump	Form, Height, Landing.	Height bar, Padded Mat, Judge, Field.	Speed, Form, Leg Strength, Flexibility.	Eyes, Touch.
Knitting a Sweater	Correct Dimension, Reducing mistakes.	Yarn, Needles, Instructions, Room.	Speed, Yarn type, Sweater size, Precision.	Eyes, Hands.
Auction Bidding	Winning, Paying lowest price.	Opponents, Item, Auctioneer.	Budget, Item Value, Eagerness.	Eyes, Ears, Mouth, Knowledge of item.

Properties of Task Environment

- Fully observable vs Partially Observable
- Static vs Dynamic
- Discrete vs Continuous
- Deterministic vs Stochastic
- Single-agent vs Multi-agent
- Episodic vs sequential
- Known vs Unknown

Fully Observable Vs Partially Observable

- If an agent sensor can sense or access the complete state of an environment at each point of time then it is **a fully observable** environment, else it is **partially observable**.
- A fully observable environment is easy as there is no need to maintain the internal state to keep track history of the world.
- An agent with no sensors in all environments then such an environment is called as **unobservable**.
- **Chess –** the board is fully observable, and so are the opponent's moves.
- **Driving –** the environment is partially observable because what's around the corner is not known.

Static Vs Dynamic

- If the environment can change itself while an agent is deliberating then such environment is called a **dynamic environment** else it is called a **static environment.**
- **Static environments** are easy to deal because an agent does not need to continue looking at the world while deciding for an action.
- 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.

Discrete Vs Continuous

- If in an environment there are a finite number of percepts and actions that can be performed within it, then such an environment is called a **discrete environment** else it is called **continuous environment**.
- **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.

Deterministic Vs Stochastic

- If an agent's current state and selected action can completely determine the next state of the environment, then such environment is called a **deterministic environment.**
- **A stochastic environment** is random in nature and cannot be determined completely by an agent.
- In a deterministic, fully observable environment, agent does not need to worry about uncertainty.
- **Chess –** there would be only a 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

- If only one agent is involved in an environment, and operating by itself then such an environment is called **single agent environment.**
- However, if multiple agents are operating in an environment, then such an environment is called a **multi-agent environment.**
- **A person left alone in a maze** is an example of the single-agent system.
- **The game of football** is multi-agent as it involves 11 players in each team.

Episodic Vs Sequential

- In **an Episodic task environment**, each of the agent's actions is divided into atomic incidents or episodes. There is no dependency between current and previous incidents. In each incident, an agent receives input from the environment and then performs the corresponding action.
- In a **Sequential environment**, the previous decisions can affect all future decisions. The next action of the agent depends on what action he has taken previously and what action he is supposed to take in the future.
- **Pick and Place robot**, which is used to detect defective parts from the conveyor belts. Here, every time robot(agent) will make the decision on the current part i.e. there is no dependency between current and previous decisions.(Episodic)
- **Checkers-** Where the previous move can affect all the following moves. (Sequential)

Known Vs Unknown

- In a known environment, the output for all probable actions is given. Obviously, in case of unknown environment, for an agent to make a decision, it has to gain knowledge about how the environment works.

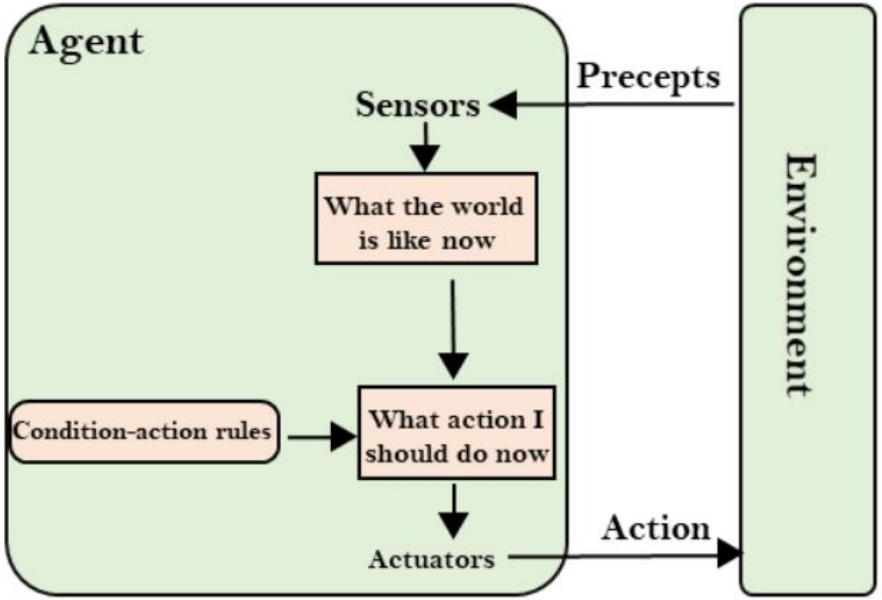
Properties of Task Environment

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

Types of Agent Program

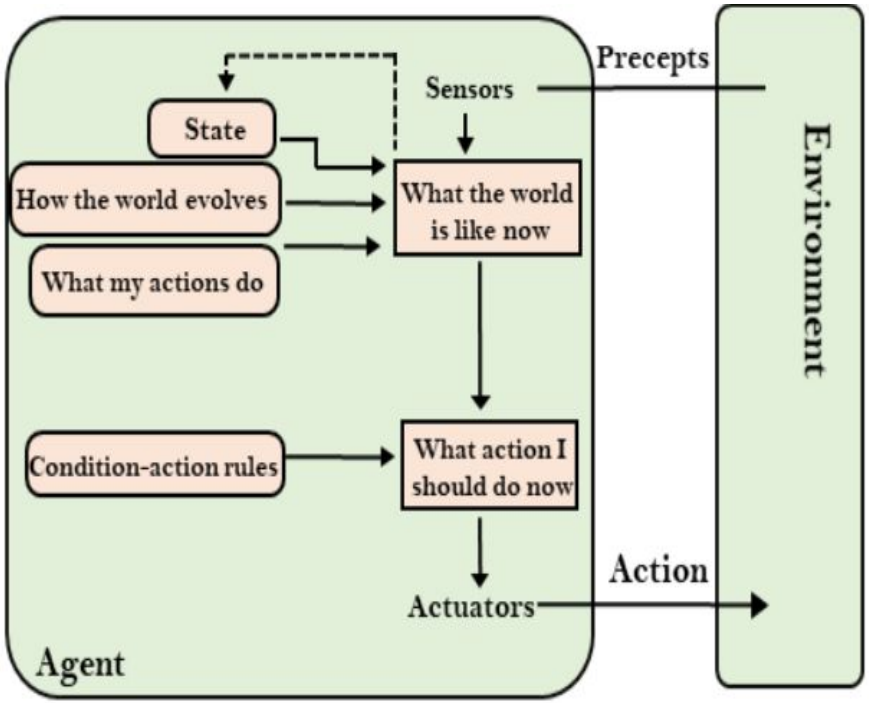
- Simple Reflex Agent
- Model-based reflex agent
- Goal-based agents
- Utility-based agent
- Learning agent

Simple Reflex Agents



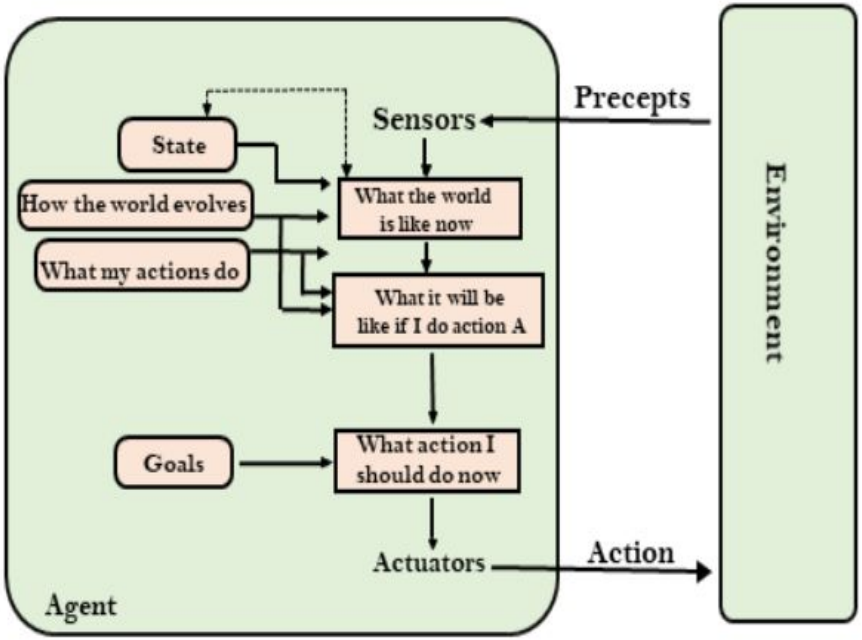
- simplest agent
- agents take decisions on the basis of the current percepts and ignore the rest of the percept history
- succeed in the fully observable environment.
- does not consider any part of percepts history during their decision and action process.
- works on Condition-action rule, which means it maps the current state to action.
- a Room Cleaner agent, it works only if there is dirt in the room.
- limited intelligence

Model Based Reflex Agent



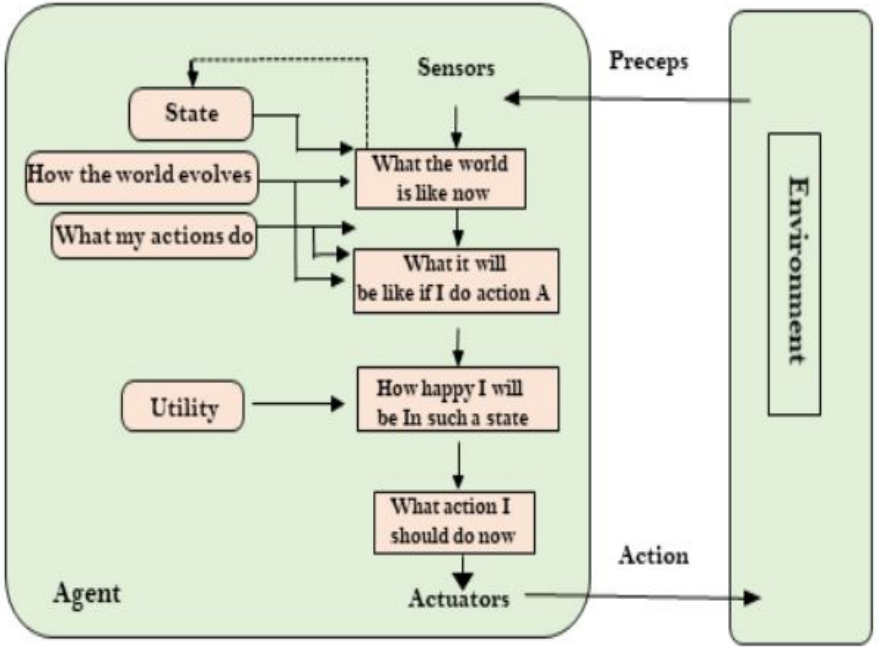
- can work in a partially observable environment
- track the situation.
- two important factors:
  - **Model:** knowledge about "how things happen in the world," so it is called a Model-based agent.
  - **Internal State:** representation of the current state based on percept history.
- Updating the agent state requires information about:
  - How the world evolves
  - How the agent's action affects the world.

Goal Based Agent



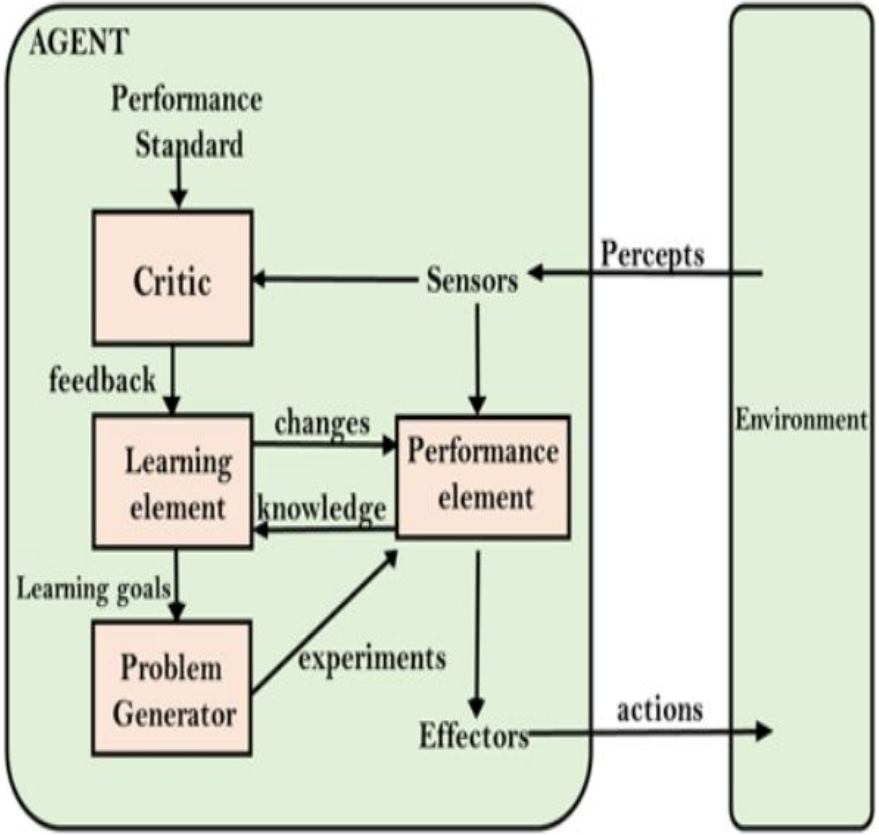
- knowledge of the current state environment is not always sufficient to decide for an agent to what to do.
- agent needs to know its goal which describes desirable situations
- expand the capabilities of the model-based agent by having the "goal" information
- choose an action, so that they can achieve the goal
- consider a long sequence of possible actions before deciding whether the goal is achieved or not.
- Such considerations of different scenario are called searching and planning, which makes an agent proactive.

Utility Based Agent



- similar to the goal-based agent but provide an extra component of utility measurement
- Utility measurement: providing a measure of success at a given state.
- act based on not only goals but also the best way to achieve the goal.
- useful when there are multiple possible alternatives and an agent has to choose in order to perform the best action.

Learning Agent



- learn from its past experiences, or it has learning capabilities.
- starts to act with basic knowledge and then able to act and adapt automatically through learning.
- four conceptual components:
- **Learning element:** responsible for making improvements by learning from environment
- **Critic:** Learning element takes feedback from critic which describes that how well the agent is doing with respect to a fixed performance standard.
- **Performance element:** responsible for selecting external action
- **Problem generator:**responsible for suggesting actions that will lead to new and informative experiences.
- able to learn, analyze performance, and look for new ways to improve the performance.