ARTIFICIAL INTELLIGENCE

UNIT – I Introduction

- ✓ **What is AI,**
- ✓ **History of AI,**
- ✓ **Intelligent Agents: Agents**
- ✓ **Environments,**
- ✓ **Good Behavior: The Concept of Rationality**
- ✓ **The Nature of** Environments,
- ✓ The Structure of Agents.
- ✓ Problem solving agents
- ✓ Problem formulation

What is ARTIFICIAL INTELLIGENCE

ARTIFICIAL INTELLIGENCE ---The term was coined by McCarthy in 1956.

There are two terms

- Artificial
- Intelligence

❖**Artificial :- Not Natural -> MAN MADE**

ARTIFICIAL INTELLIGENCE means : **Man made systems are building intelligence into them.**

Or

Artificial Intelligence is concerned with the design of intelligence in an artificial device.

❖ **INTELLIGENCE ? :**

❖INTELLEGENCE:

if we take human beings to be intelligent

i.e AI means having behavior which is like a humans

We consider it in two ways:

1. **To have a machine / System that behaves like a human.**
2. **AI concern with intelligence which is the ideal or the best behavior or the rational behavior**

about the behavior :-What type of behavior ?

1. **Thinking :**
   - Estimating
   - reasoning
   - Decision Making

   in order to come up with a solution.

2. **Action** : how the system actually acts/ behaves .

❖ **performance**

(Human like) **Vs** **Ideal Performance (Rational)**

❖ **Thinking** **Vs** **(ACTION)**

What is Artificial Intelligence ?

	HUMAN	RATIONAL
Thinking	Systems that think like humans	Systems that think rationally
ACTIONS	Systems that acts like human	Systems that act rationally

What is AI? Four Approches

Human-centered approaches (Empirical Science) that involves : Hypothesis and Experimental confirmation

Acting Humanly: The Turing Test
Thinking Humanly: Cognitive Science

Rationalist approach that involves: Combination of Mathematics and Engineering

Thinking Rationally: Laws of Thought
Acting Rationally: The Rational Agent

What is AI?

(Some Definitions of AI, Organized into 4 Categories)

Systems that think like human (cognitive science)	**Systems that think rationally (laws of thoughts)**
•"The exciting new effort to make computers thinks … *machine with minds,* in the full and literal sense" (Haugeland 1985) •"The automation of activities that we associate with human thinking, activities: decision-making, problem-solving, learning…." (Bellman 1978)	•"The study of mental faculties through the use of computational models" (Charniak et al. 1985) •"The study of the computations that make it possible to perceive,reason, and act." (Winston 1992)
Systems that act like human (Turing Test)	**Systems that act rationally (RATIONAL AGENT)**
• "The art of creating machines that perform functions that require intelligence when performed by people" (Kurzweil, 1990) • "The study of how to make computers do things at which, at the moment, people are better." (Rich&Knight 1991)	• A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes" (Schalkol, 1990) • "AI ….. Is concerned with intelligent behavior in artifacts." (Nilsson 1998)

- ✓ In computer science, Artificial Intelligence **(AI)**, sometimes called **machine intelligence**, is intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans.

- ✓ It also defined as the field as the study of **“Intelligent agents”:** any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals.

Foundations of AI…

i. Philosophy
ii. Mathematics
iii. Economics
iv. Neuroscience
v. Psychology
vi. Computer engineering
vii. Control theory and Cybernetics
viii. Linguistics

History of Artificial Intelligence(AI)

Prehistory of AI

- 4th cent. B.C : **Aristotle studied mind & thought, defined formal logic**

  (the study of arguments.).

- 14th–16th cent : **New thought built on the idea that all natural or artificial processes could be mathematically analyzed and understood.**

- 18th cent : **distinction between mind & brain.**

The Modern Birth of AI

- **19th cent** : **Babbage's Analytical Engine proposed a general-purpose, programmable computing machine - metaphor for the brain. (Incomplete)**
- **19th-20th cent** : **Many advances in logic formalisms, including Boole's algebra, predicate calculus**
- **20th cent** : **Turing wrote seminar paper on thinking machines (1950). Marvin Minsky & John McCarthy organized the Dartmouth Conference in 1956**

Introduction

- AI is an evolving discipline with a rich historical background.
- The contributions of other fields, e.g. Mathematics, Philosophy, Psychology, Neuroscience, etc. to the development of AI have been so significant that its history is sometimes recounted from the time of Aristotle (350 B.C.)We will focus the period from 1943-present.

Overview of Chronology

A. **The gestation of AI (1943-1955)**
B. **The birth of AI (1956)**
C. **Early enthusiasm (1952-1969)**
D. **A dose of reality (1966-1973)**
E. **Knowledge-based systems (1969-1979)**
F. **AI becomes an industry (1980-present)**
G. **The return of Neural Networks (1986-present)**
H. **AI becomes a science (1987-present)**
I. **The emergence of Intelligent Agents (1995-present)**

Gestation of AI

- Warren McCulloch and Walter Pitts (1943) gave the concept of artificial neural networks. They suggested that suitably defined networks could learn.
- Alan Turing was the first to put forward a complete vision of AI in his 1950 article "Computing Machinery and Intelligence." Therein, he introduced the Turing test, machine learning. genetic algorithms, and reinforcement learning.
- Two graduate students in the Princeton mathematics department, Marvin Minsky and Dean Edmonds, built the first neural network computer in 1951 called SNARC. (**SNARC** :Stochastic Neural Analog Reinforcement Calculator)

The birth of AI (1956)

- U.S. researchers interested in automata theory, neural nets, and the study of intelligence were brought together in a workshop at Dartmouth in the summer of 1956 where John McCarthy proposed the name for the field as "**Artificial Intelligence.**"

Early enthusiasm (1952-1969)

- Starting in 1952. Arthur Samuel wrote a series of programs for checkers (draughts) that eventually learned to play at a strong amateur level.
- McCarthy in 1958 defined a high level language LISP, a dominant AI programming language
- At IBM, Nathaniel Rochester and his colleagues produced some of the first AI programs. Geometry Theorem Prover.
- Newell and Simon developed Logic Theorist (1963)
- James Slagle's SAINT program (1963) solved integration problems.
- Daniel Bobrow's STUDENT program (1967) solved algebra problems.

.A Dose of Reality

- In 1966 the failure of machine translation project brought an end to the US government's funding of the project.
- Minsky and Papert's book: *'Perceptrons'* (1969) proved that. although perceptrons (a simple form of neural network) could be shown to learn anything they were capable of representing, they could represent very little.
- In 1973 Lighthill report entailed cutting of British funding to AI research in all but two universities in the Great Britain.

Knowledge-based Systems (1969-1979)

- MYCIN was developed in mid 1970s at Stanford that diagnosed blood infections. MYCIN was able to perform as well as some experts, and considerably better than junior doctors.

AI becomes an industry **(1980-present)**

- The first successful commercial expert system R1 began operation at the Digital Equipment Corporation (McDermott, 1982).
- Nearly every major U.S. corporation had its own AI group and was either using or investigating expert systems.
- In 1981, the Japanese announced the "Fifth Generation" project, a 10-year plan to build intelligent computers running Prolog.
- United States formed the Microelectronics and Computer Technology Corporation (MCC) as a research consortium.

- Alvey report reinstated the funding that was cut by the Lighthill report.
- The AI industry boomed from a few million dollars in 1980 to billions of dollars in 1988. Soon after that came a period called the "AI Winter." in which many companies suffered as they failed to deliver on extravagant promises.
- Judea Pearl's (1988) *Probabilistic Reasoning in Intelligent Systems* led to a new acceptance of probability and decision theory in AI.
- In terms of methodology, AI has finally came firmly under the scientific method. To be accepted, hypotheses must be subjected to rigorous empirical experiments, and the results must be analyzed statistically for their importance (Cohen. 1995).
- A better understanding of the problems and their complexity properties, combined with increased mathematical sophistication, has led to workable research agendas and robust methods.

The emergence of Intelligent Agents (1995-present)

- The work of Allen Newell, John Laird, and Paul Rosenbloom on SOAR (Newell. 1990: Laird *el al.,* 1987) is the best-known example of a complete agent architecture.
- AI technologies underlie many Internet tools, such as search engines, recommender systems, and web site construction systems.
- A hundred million miles from Earth, NASA's Remote Agent program became the first on-board autonomous planning program to control the scheduling of operations for a .spacecraft (Jonsson *el at.,* 2000).

Why Artificial Intelligence?

Before Learning about Artificial Intelligence, we should know that what is the importance of AI and why should we learn it.

Following are some main reasons to learn about AI:

- With the help of AI, you can create such software or devices which can solve real-world problems very easily and with accuracy such as health issues, marketing, traffic issues, etc.
- With the help of AI, you can create your personal virtual Assistant, such as Cortana, Google Assistant, Siri, etc.
- With the help of AI, you can build such Robots which can work in an environment where survival of humans can be at risk.
- AI opens a path for other new technologies, new devices, and new Opportunities.

Goals of Artificial Intelligence

Following are the main goals of Artificial Intelligence:

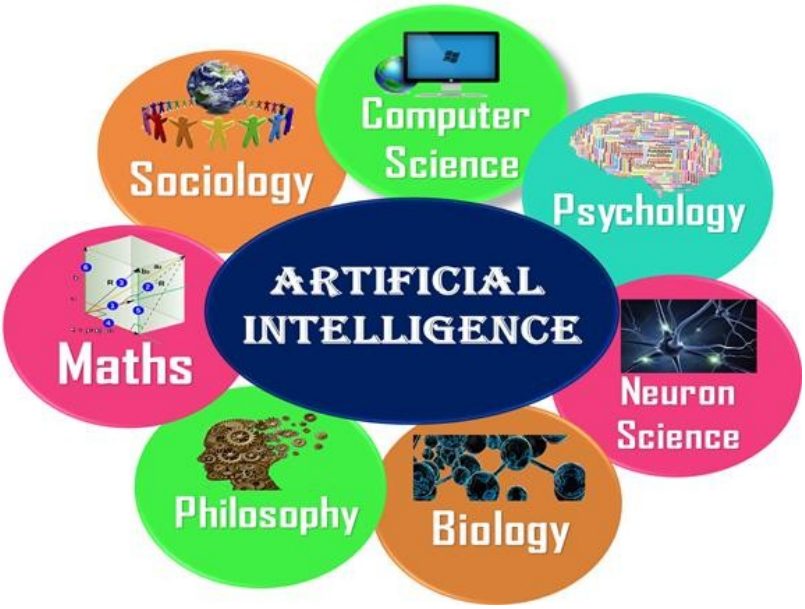
1. Replicate human intelligence
2. Solve Knowledge-intensive tasks
3. An intelligent connection of perception and action
4. Building a machine which can perform tasks that requires human intelligence such as:
    - Proving a theorem
    - Playing chess
    - Plan some surgical operation
    - Driving a car in traffic
5. Creating some system which can exhibit intelligent behavior, learn new things by itself, demonstrate, explain, and can advise to its user.

What Comprises to Artificial Intelligence?

Artificial Intelligence is not just a part of computer science even it's so vast and requires lots of other factors which can contribute to it. To create the AI first we should know that how intelligence is composed, so the Intelligence is an intangible part of our brain which is a combination of Reasoning, learning, problem-solving perception, language understanding, etc.

To achieve the above factors for a machine or software Artificial Intelligence requires the following discipline:

- Mathematics
- Biology
- Psychology
- Sociology
- Computer Science
- Neurons Study
- Statistics



Advantages of Artificial Intelligence

Following are some main advantages of Artificial Intelligence:

- High Accuracy with less error: AI machines or systems are prone to less errors and high accuracy as it takes decisions as per pre-experience or information.
- High-Speed: AI systems can be of very high-speed and fast-decision making; because of that AI systems can beat a chess champion in the Chess game.
- High reliability: AI machines are highly reliable and can perform the same action multiple times with high accuracy.
- Useful for risky areas: AI machines can be helpful in situations such as defusing a bomb, exploring the ocean floor, where to employ a human can be risky.
- Digital Assistant: AI can be very useful to provide digital assistant to the users such as AI technology is currently used by various E-commerce websites to show the products as per customer requirement.
- Useful as a public utility: AI can be very useful for public utilities such as a self-driving car which can make our journey safer and hassle-free, facial recognition for security purpose, Natural language processing to communicate with the human in human-language, etc.

Disadvantages of Artificial Intelligence

Every technology has some disadvantages, and the same goes for Artificial intelligence. Being so advantageous technology still, it has some disadvantages which we need to keep in our mind while creating an AI system.

Following are the disadvantages of AI:

- High Cost: The hardware and software requirement of AI is very costly as it requires lots of maintenance to meet current world requirements.
- Can't think out of the box: Even we are making smarter machines with AI, but still they cannot work out of the box, as the robot will only do that work for which they are trained, or programmed.
- No feelings and emotions: AI machines can be an outstanding performer, but still it does not have the feeling so it cannot

make any kind of emotional attachment with human, and may sometime be harmful for users if the proper care is not taken.

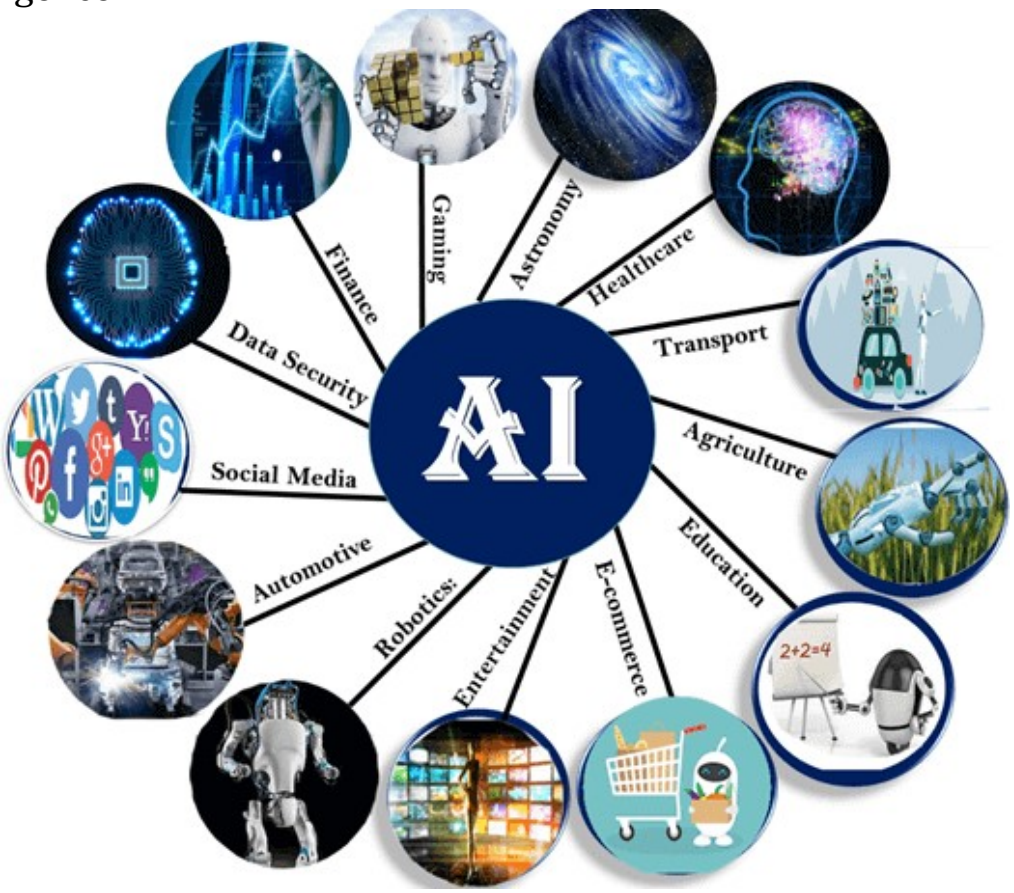
- Increase dependency on machines: With the increment of technology, people are getting more dependent on devices and hence they are losing their mental capabilities.
- No Original Creativity: As humans are so creative and can imagine some new ideas but still AI machines cannot beat this power of human intelligence and cannot be creative and imaginative.

Application of AI

Artificial Intelligence has various applications in today's society.

It is becoming essential for today's time because it can solve complex problems with an efficient way in multiple industries, such as Healthcare, entertainment, finance, education, etc.
AI is making our daily life more comfortable and fast.

Following are some sectors which have the application of Artificial Intelligence:



1. AI in Astronomy
   - Artificial Intelligence can be very useful to solve complex universe problems. AI technology can be helpful for understanding the universe such as how it works, origin, etc.

2. AI in Healthcare
   - In the last, five to ten years, AI becoming more advantageous for the healthcare industry and going to have a significant impact on this industry.

   - Healthcare Industries are applying AI to make a better and faster diagnosis than humans. AI can help doctors with diagnoses and can inform when patients are worsening so that medical help can reach to the patient before hospitalization.

3. AI in Gaming
   - AI can be used for gaming purpose. The AI machines can play strategic games like chess, where the machine needs to think of a large number of possible places.

4. AI in Finance
   - AI and finance industries are the best matches for each other. The finance industry is implementing automation, chatbot, adaptive intelligence, algorithm trading, and machine learning into financial processes.

5. AI in Data Security
   - The security of data is crucial for every company and cyber-attacks are growing very rapidly in the digital world. AI can be used to make your data more safe and secure. Some examples such as AEG bot, AI2 Platform, are used to determine software bug and cyber-attacks in a better way.

6. AI in Social Media
   - Social Media sites such as Facebook, Twitter, and Snapchat contain billions of user profiles, which need to be stored and managed in a very efficient way. AI can organize and manage massive amounts of data. AI can analyze lots of data to identify the latest trends, hashtag, and requirement of different users.

7. AI in Travel & Transport
    - AI is becoming highly demanding for travel industries. AI is capable of doing various travel related works such as from making travel arrangement to suggesting the hotels, flights, and best routes to the customers. Travel industries are using AI-powered chatbots which can make human-like interaction with customers for better and fast response.

8. AI in Automotive Industry
    - Some Automotive industries are using AI to provide virtual assistant to their user for better performance. Such as Tesla has introduced TeslaBot, an intelligent virtual assistant.

    - Various Industries are currently working for developing self-driven cars which can make your journey more safe and secure.

9. AI in Robotics:
    - Artificial Intelligence has a remarkable role in Robotics. Usually, general robots are programmed such that they can perform some repetitive task, but with the help of AI, we can create intelligent robots which can perform tasks with their own experiences without pre-programmed.

    - Humanoid Robots are best examples for AI in robotics, recently the intelligent Humanoid robot named as Erica and Sophia has been developed which can talk and behave like humans.

10. AI in Entertainment
    - We are currently using some AI based applications in our daily life with some entertainment services such as Netflix or Amazon. With the help of ML/AI algorithms, these services show the recommendations for programs or shows.

11. AI in Agriculture
    - Agriculture is an area which requires various resources, labor, money, and time for best result. Now a day's agriculture is becoming digital, and AI is emerging in this field. Agriculture is applying AI as agriculture robotics, solid and crop monitoring, predictive analysis. AI in agriculture can be very helpful for farmers.

12. AI in E-commerce
    - AI is providing a competitive edge to the e-commerce industry, and it is becoming more demanding in the e-commerce business. AI is helping shoppers to discover associated products with recommended size, color, or even brand.

13. AI in education:
    - AI can automate grading so that the tutor can have more time to teach. AI chatbot can communicate with students as a teaching assistant.
    - AI in the future can be work as a personal virtual tutor for students, which will be accessible easily at any time and any place.

Agents in Artificial Intelligence

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

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.

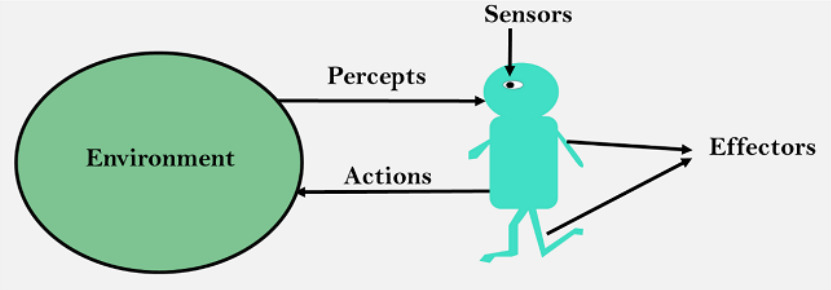
Hence the world around us is full of agents such as thermostat, cellphone, camera, and even we are also agents.

Before moving forward, we should first know about sensors, effectors, and actuator

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 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. A thermostat is an example of an 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.

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.

> Note: Rational agents in AI are very similar to intelligent agents.

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.

Structure of an AI Agent

The task of AI is to design an agent program which implements the agent function. The structure of an intelligent agent is a combination of architecture and agent program. It can be viewed as:

Agent = Architecture + Agent program

Following are the main three terms involved in the structure of an AI agent:

Architecture: Architecture is machinery that an AI agent executes on.

Agent Function: Agent function is used to map a percept to an action.

$f:P^* \rightarrow A$

Agent program: Agent program is an implementation of agent function. An agent program executes on the physical architecture to produce function f.

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
- **S:** Sensors

Here performance measure is the objective for the success of an agent's behavior.

PEAS for self-driving cars:

Let's suppose a self-driving car then PEAS representation will be:

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 Type	Performance Measure	Environment	Actuators	Sensors
Medical diagnosis system	Healthy patient, minimize costs, lawsuits	Patient, hospital, staff	Display questions, tests, diagnoses, treatments, referrals	Keyboard entry of symptoms, findings, patient's answers
Satellite image analysis system	Correct image categorization	Downlink from orbiting satellite	Display categorization of scene	Color pixel arrays
Part-picking robot	Percentage of parts in correct bins	Conveyor belt with parts; bins	Jointed arm and hand	Camera, joint angle sensors
Refinery controller	Maximize purity, yield, safety	Refinery, operators	Valves, pumps, heaters, displays	Temperature, pressure, chemical sensors
Interactive English tutor	Maximize student's score on test	Set of students, testing agency	Display exercises, suggestions, corrections	Keyboard entry

Figure 2.5 Examples of agent types and their PEAS descriptions.

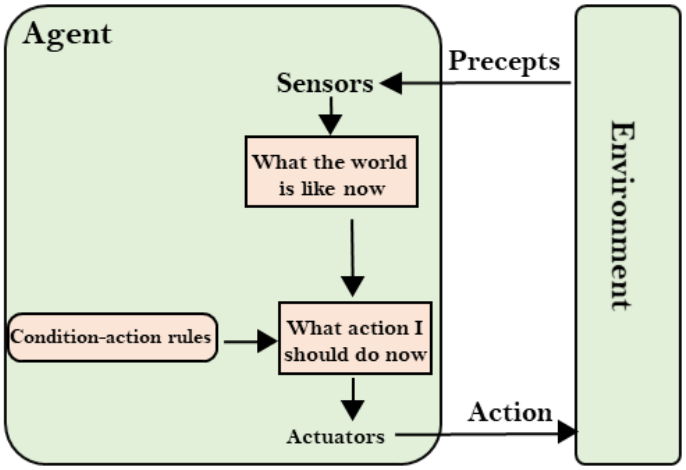
Types of AI Agents

Agents can be grouped into five classes based on their degree of perceived intelligence and capability. All these agents can improve their performance and generate better action over the time. These are given below:

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

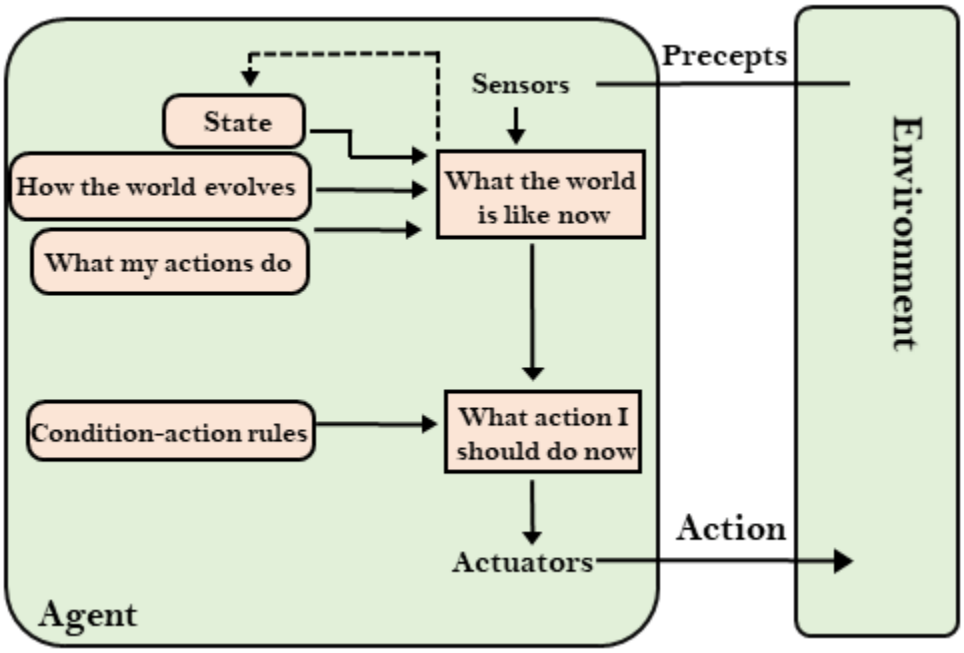
1. Simple Reflex agent:

- The Simple reflex agents are the simplest agents. These agents take decisions on the basis of the current percepts and ignore the rest of the percept history.
- These agents only succeed in the fully observable environment.
- The Simple reflex agent does not consider any part of percepts history during their decision and action process.
- The Simple reflex agent works on Condition-action rule, which means it maps the current state to action. Such as a Room Cleaner agent, it works only if there is dirt in the room.
- Problems for the simple reflex agent design approach:
    - They have very limited intelligence
    - They do not have knowledge of non-perceptual parts of the current state
    - Mostly too big to generate and to store.
    - Not adaptive to changes in the environment.



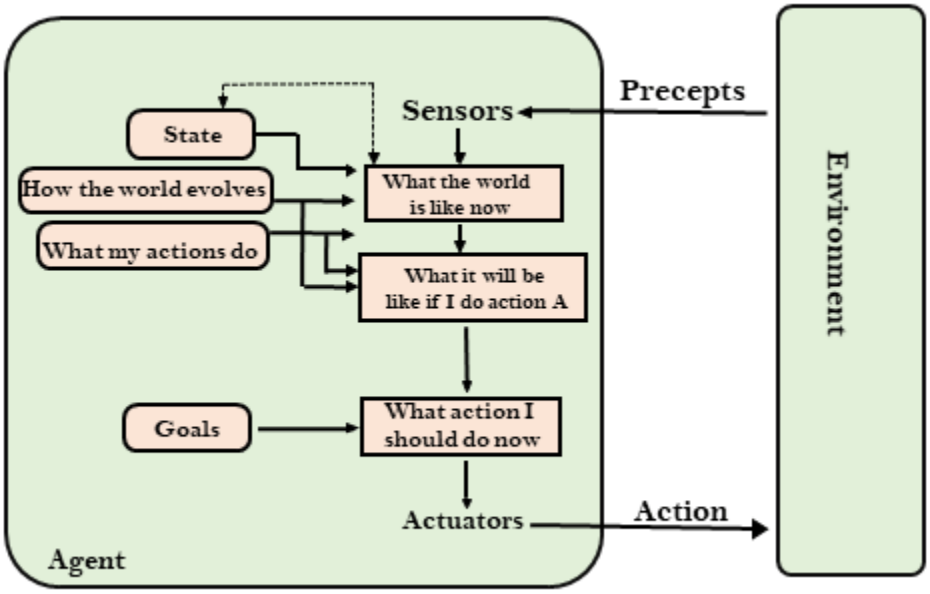
2. Model-based reflex agent

- The Model-based agent can work in a partially observable environment, and track the situation.
- A model-based agent has two important factors:
    - **Model:** It is knowledge about "how things happen in the world," so it is called a Model-based agent.
    - **Internal State:** It is a representation of the current state based on percept history.
- These agents have the model, "which is knowledge of the world" and based on the model they perform actions.
- Updating the agent state requires information about:
    a. How the world evolves
    b. How the agent's action affects the world.



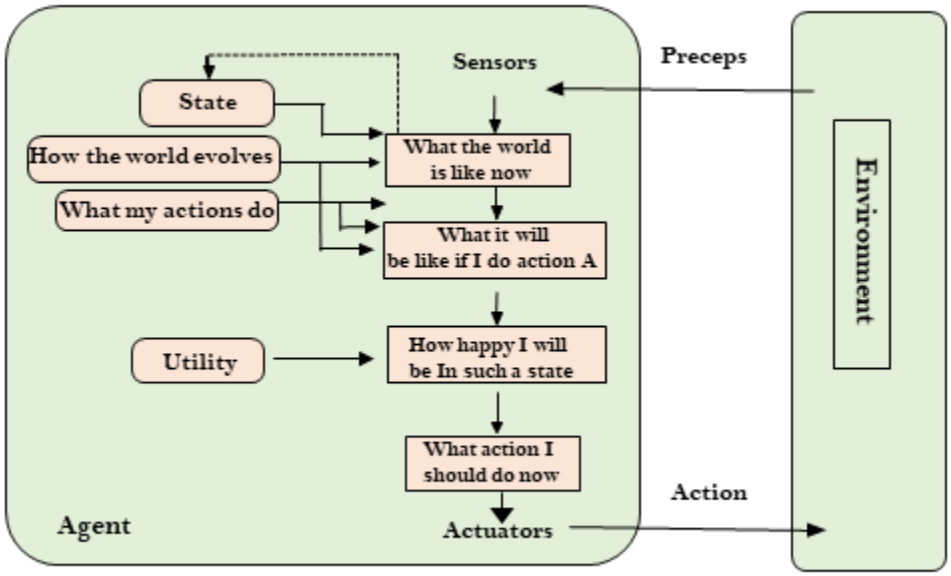
3. Goal-based agents

- The knowledge of the current state environment is not always sufficient to decide for an agent to what to do.
- 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.
- These agents may have to 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.



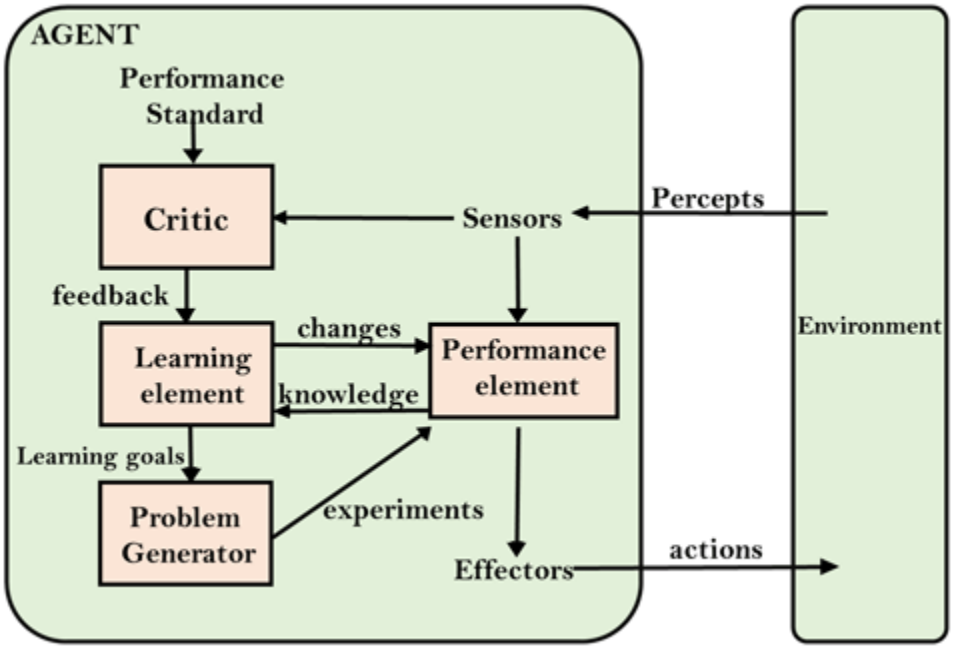
4. Utility-based agents

- These agents are similar to the goal-based agent but provide an extra component of utility measurement which makes them different by providing a measure of success at a given state.
- 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.



5. Learning Agents

- 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:
    a. **Learning element:** It is responsible for making improvements by learning from environment
    b. **Critic:** Learning element takes feedback from critic which describes that how well the agent is doing with respect to a fixed performance standard.
    c. **Performance element:** It is responsible for selecting external action
    d. **Problem generator:** This component is responsible for suggesting actions that will lead to new and informative experiences.
- Hence, learning agents are able to learn, analyze performance, and look for new ways to improve the performance.



AI environment

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
- Episodic vs Sequential
- Known vs Unknown

1. Fully Observable vs Partially Observable

- When an agent sensor is capable to sense or access the complete state of an agent at each point in 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.

Examples:

- **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.

2. Deterministic vs Stochastic

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

Examples:

- **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.

3. Competitive vs Collaborative

- An agent is said to be in a competitive environment when it competes against another agent to optimize the output.
- The game of chess is competitive as the agents compete with each other to win the game which is the output.

- An agent is said to be in a collaborative environment when multiple agents cooperate to produce the desired output.
- When multiple self-driving cars are found on the roads, they cooperate with each other to avoid collisions and reach their destination which is the output desired.

4. 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 the 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 11 players in each team.

5. 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 its state is called a static environment.
- An empty house is static as there's no change in the surroundings when an agent enters.

6. 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 are performed cannot be numbered i.e. 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.

7.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.
  Example: Consider an example of **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.

- 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.

Example:

- **Checkers-** Where the previous move can affect all the following moves.

8. 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.