INTRODUCTION TO AI

Lecture-01

Conduct by

Khawja Imran Masud

Lecturer, Department of CSE

Dhaka University of Engineering & Technology, Gazipur

Email: kimasud.cse@duet.ac.bd , eimran.cse@gmail.com

Course at a glance!

1

Course Details:

Artificial Intelligence
Course Code: CSE-4623
Credit: 3.00

2

Class Time & Location:

Every Tuesday at 11:00 AM
via Zoom

3

Tutor Contact:

Khawja Imran Masud
Room# 7025, New Academic Building, DUET
☎ 01925527821
✉ kimasud.cse@duet.ac.bd

5

Prerequisites:

* Algorithms and data structures
* Basic mathematical concepts
* Programming skills

4

Reference Book:

Artificial Intelligence – A Modern Approach
By- Stuart Russell & Peter Norvig (3rd edition)

Course related links!

1

- **E-Learning Platform:**

https://elp.duetbd.org

2

- **Course Materials:**

Lecture Slides and Ref. Book & Videos:
https://drive.google.com/drive/folders/1pw--AcsR5oNud-jnwu4T4m1d2f89Ro1a?usp=sharing

3

- **Zoom**

Online Class:
https://bdren.zoom.us/j/69976591053?pwd=eDFyK3RlTzNLekoxQmt6Z1BDSkg2Zz09

4

- **Resource-1:**

https://dmi.unibas.ch/en/academics/computer-science/courses-in-spring-semester-2020/lecture-foundations-of-artificial-intelligence

5

- **Resource-2:**

https://cms.sic.saarland/ai_20/materials

Outline

01 **What is AI**

About AI, Human Brain, The nature of environments, Intelligence, History

02 **Applications of AI**

AI contributions , Different applications of Artificial Intelligence

03 **Agent**

About agent, Structure of agent, Rational agent

04 **PEAS**

Specifying the task environment

05 **Environment types**

About different types of environment in Artificial Intelligence

06 **Agent types**

About different types of agent in Artificial Intelligence

01

WHAT IS AI

About AI, Human Brain, The nature of environment, Intelligence, Brief History of AI

What is Artificial Intelligence?

- According to the father of Artificial Intelligence John McCarthy, it is "The **science and engineering of making intelligent machines**, especially intelligent computer programs".
- Artificial Intelligence is a way of **making a computer, a computer-controlled robot, or a software think intelligently**, in the similar manner the intelligent humans think. (making computers do things which, at the moment, people do better).
- AI is accomplished by studying how **human brain thinks**, and how humans learn, decide, and work while trying to solve a problem, and then using the outcomes of this study as a basis of developing intelligent software and systems.

AI : Humanly vs. Rationally; Thinking vs. Acting

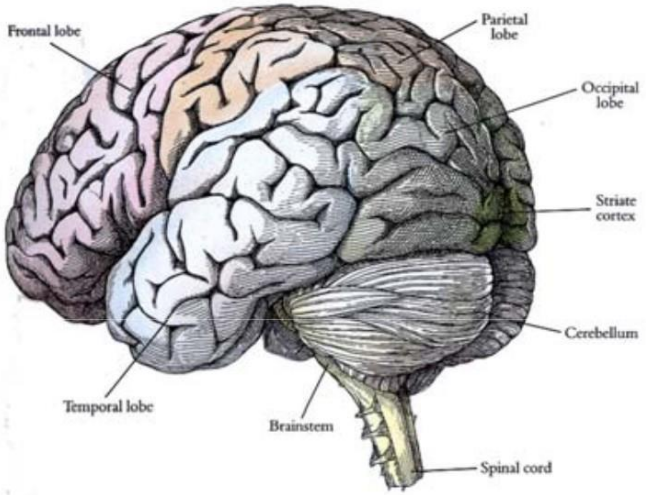
"[the automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning" (Bellman, 1978)	"the study of mental faculties through the use of computational models" (Charniak & McDermott, 1985)
"the study of how to make computers do things at which, at the moment, people are better" (Rich & Knight, 1991)	"the branch of computer science that is concerned with the automation of intelligent behavior" (Luger & Stubblefield, 1993)

four typical categories:

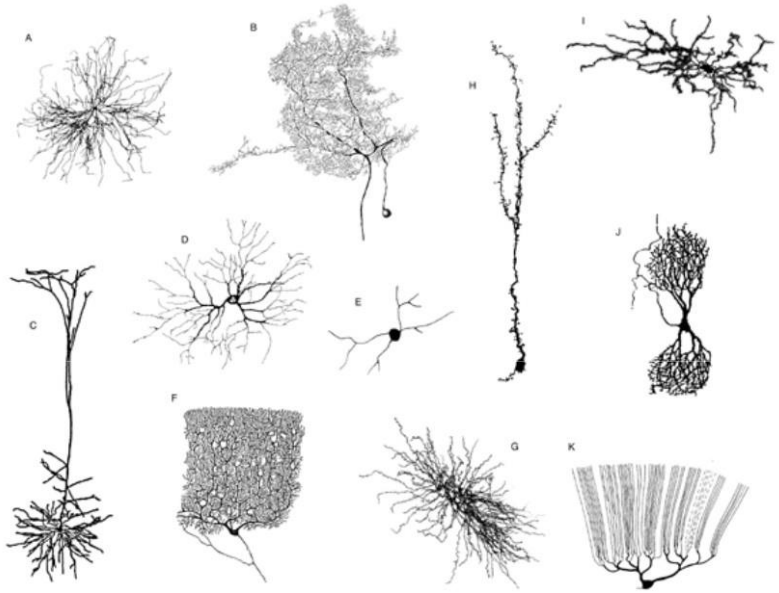
thinking humanly	thinking rationally
acting humanly	acting rationally

Human Brain

- The brain consists of networks of networks of neurons
- The human brain contains around 10^{11} neurons and 10^{15} synapses
- A neuron receives around 10,000 connections from other neurons



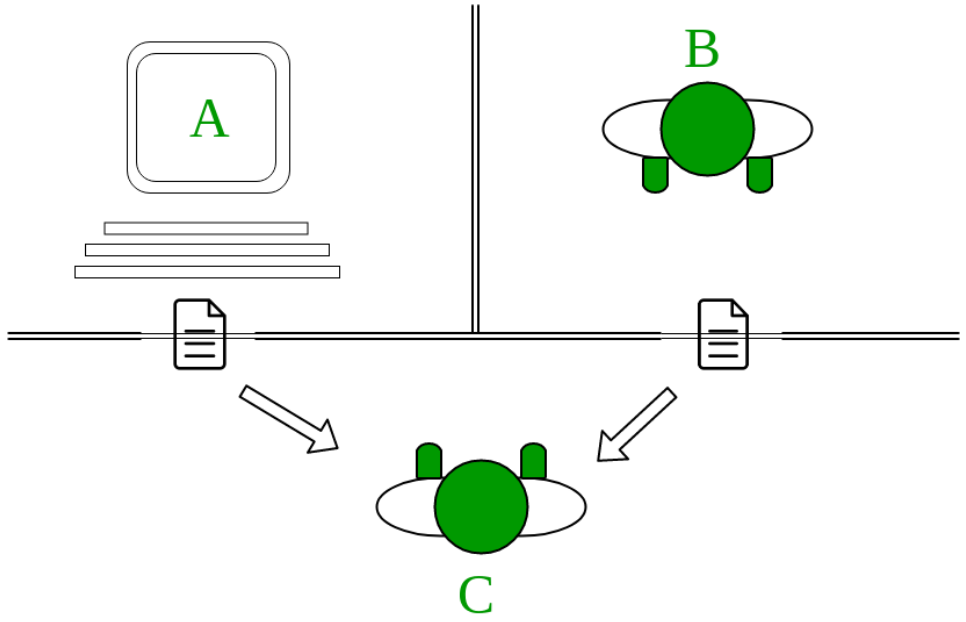
- Neurons are biological cells that a specialised to form networks and send electrical signals to each other
- They come in many different shapes and sizes



The Nature of Environment

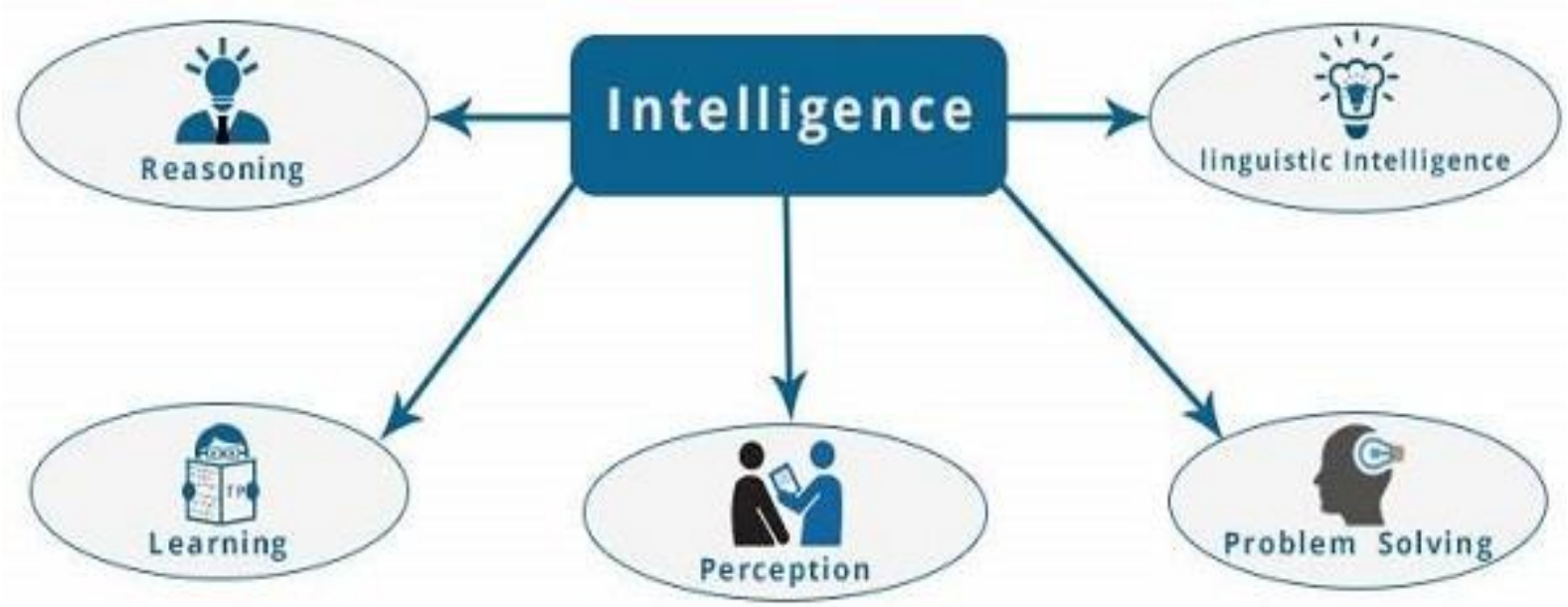
- A Turing Test is a method of inquiry in artificial intelligence (AI) for determining whether or not a computer is capable of thinking like a human being.

The most famous artificial environment is the Turing Test environment, in which one real and another artificial agents are tested on equal ground. This is a very challenging environment as it is highly difficult for a software agent to perform as well as a human.



What is Intelligence?

- The ability of a system to calculate, reason, perceive relationships and analogies, learn from experience, store and retrieve information from memory, solve problems, comprehend complex ideas, use natural language fluently, classify, generalize, and adapt new situations.



What is Intelligence?

- **Reasoning** – It is the set of processes that enables us to provide basis for judgement, making decisions, and prediction.
- **Learning** – It is the activity of gaining knowledge or skill by studying, practicing, being taught, or experiencing something. Learning enhances the awareness of the subjects of the study.
- **Problem Solving** – It is the process in which one perceives and tries to arrive at a desired solution from a present situation by taking some path, which is blocked by known or unknown hurdles. Problem solving also includes **decision making**, which is the process of selecting the best suitable alternative out of multiple alternatives to reach the desired goal are available.
- **Perception** – It is the process of acquiring, interpreting, selecting, and organizing sensory information. Perception presumes **sensing**. In humans, perception is aided by sensory organs. In the domain of AI, perception mechanism puts the data acquired by the sensors together in a meaningful manner.
- **Linguistic Intelligence** – It is one's ability to use, comprehend, speak, and write the verbal and written language. It is important in interpersonal communication.

Difference between Human and Machine Intelligence

- The Human intelligence and Machine intelligence can be explain in following ways −

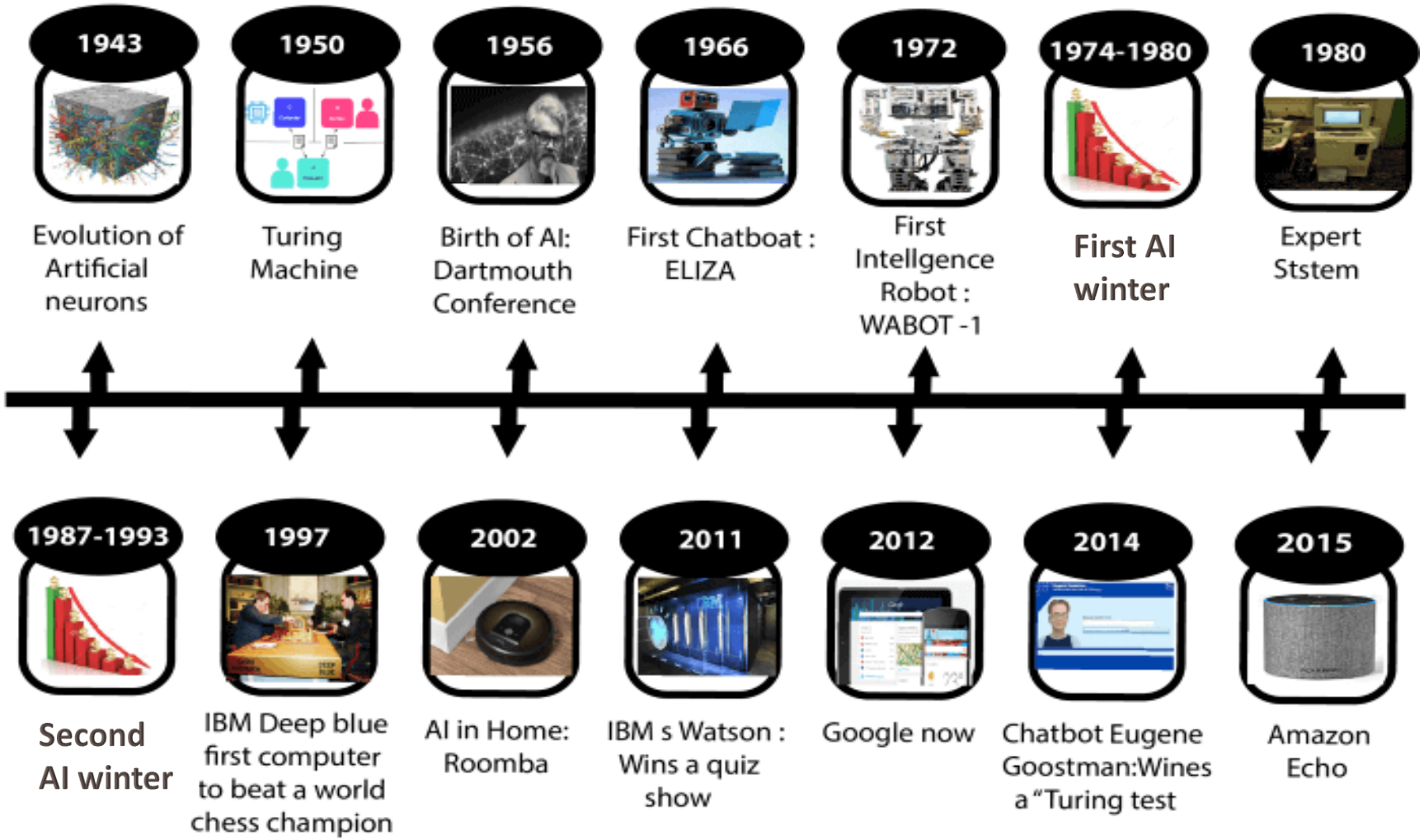
Human intelligence	Machine intelligence
Humans perceive by patterns.	Machines perceive by set of rules and data.
Humans store and recall information by patterns.	Machines do it by searching algorithms.
Humans can figure out the complete object even if some part of it is missing or distorted.	Machines cannot do it correctly as human can.

Programming Without and With AI

- The programming without and with AI is different in following ways –

Programming Without AI	Programming With AI
A computer program without AI can answer the specific questions it is meant to solve.	A computer program with AI can answer the generic questions it is meant to solve.
Modification in the program leads to change in its structure.	AI programs can absorb new modifications by putting highly independent pieces of information together. Hence you can modify even a minute piece of information of program without affecting its structure.
Modification is not quick and easy. It may lead to affecting the program adversely.	Quick and Easy program modification.

History of Artificial Intelligence



History of Artificial Intelligence

- **Year 1943:** The first work which is now recognized as AI was done by Warren McCulloch and Walter pits in 1943. They proposed a model of artificial neurons.
- **Year 1950:** The Alan Turing who was an English mathematician and pioneered Machine learning in 1950. Alan Turing publishes "Computing Machinery and Intelligence" in which he proposed a test. The test can check the machine's ability to exhibit intelligent behavior equivalent to human intelligence, called a Turing test.
- **Year 1956:** The word "Artificial Intelligence" first adopted by American Computer scientist John McCarthy at the Dartmouth Conference. For the first time, AI coined as an academic field.
- **Year 1966:** The researchers emphasized developing algorithms which can solve mathematical problems. Joseph Weizenbaum created the first chatbot in 1966, which was named as ELIZA.
- **Year 1972:** The first intelligent humanoid robot was built in Japan which was named as WABOT-1.
- **The duration between years 1974 to 1980** was the first AI winter duration. AI winter refers to the time period where computer scientist dealt with a severe shortage of funding from government for AI researches. During AI winters, an interest of publicity on artificial intelligence was decreased.

History of Artificial Intelligence

- **Year 1980:** After AI winter duration, AI came back with "Expert System". Expert systems were programmed that emulate the decision-making ability of a human expert. In the Year 1980, the first national conference of the American Association of Artificial Intelligence was held at Stanford University.
- **The duration between the years 1987 to 1993** was the second AI Winter duration. Again Investors and government stopped in funding for AI research as due to high cost but not efficient result. The expert system such as XCON was very cost effective.
- **Year 1997:** In the year 1997, IBM Deep Blue beats world chess champion, Gary Kasparov, and became the first computer to beat a world chess champion.
- **Year 2002:** for the first time, A I entered the home in the form of Roomba, a vacuum cleaner. AI came in the Business world till the year 2006. Companies like Facebook, Twitter, and Netflix also started using AI.
- **Year 2011:** In the year 2011, IBM's Watson won jeopardy, a quiz show, where it had to solve the complex questions as well as riddles. Watson had proved that it could understand natural language and can solve tricky questions quickly.

History of Artificial Intelligence

- **Year 2012:** Google has launched an Android app feature "Google now", which was able to provide information to the user as a prediction.
- **Year 2014:** In the year 2014, Chatbot "Eugene Goostman" won a competition in the infamous "Turing test."
- **Year 2018:** The "Project Debater" from IBM debated on complex topics with two master debaters and also performed extremely well.

Now, AI has developed to a remarkable level. The concept of Deep learning, big data, and data science are now trending like a boom. Nowadays companies like Google, Facebook, IBM, and Amazon are working with AI and creating amazing devices. The future of Artificial Intelligence is inspiring and will come with high intelligence.

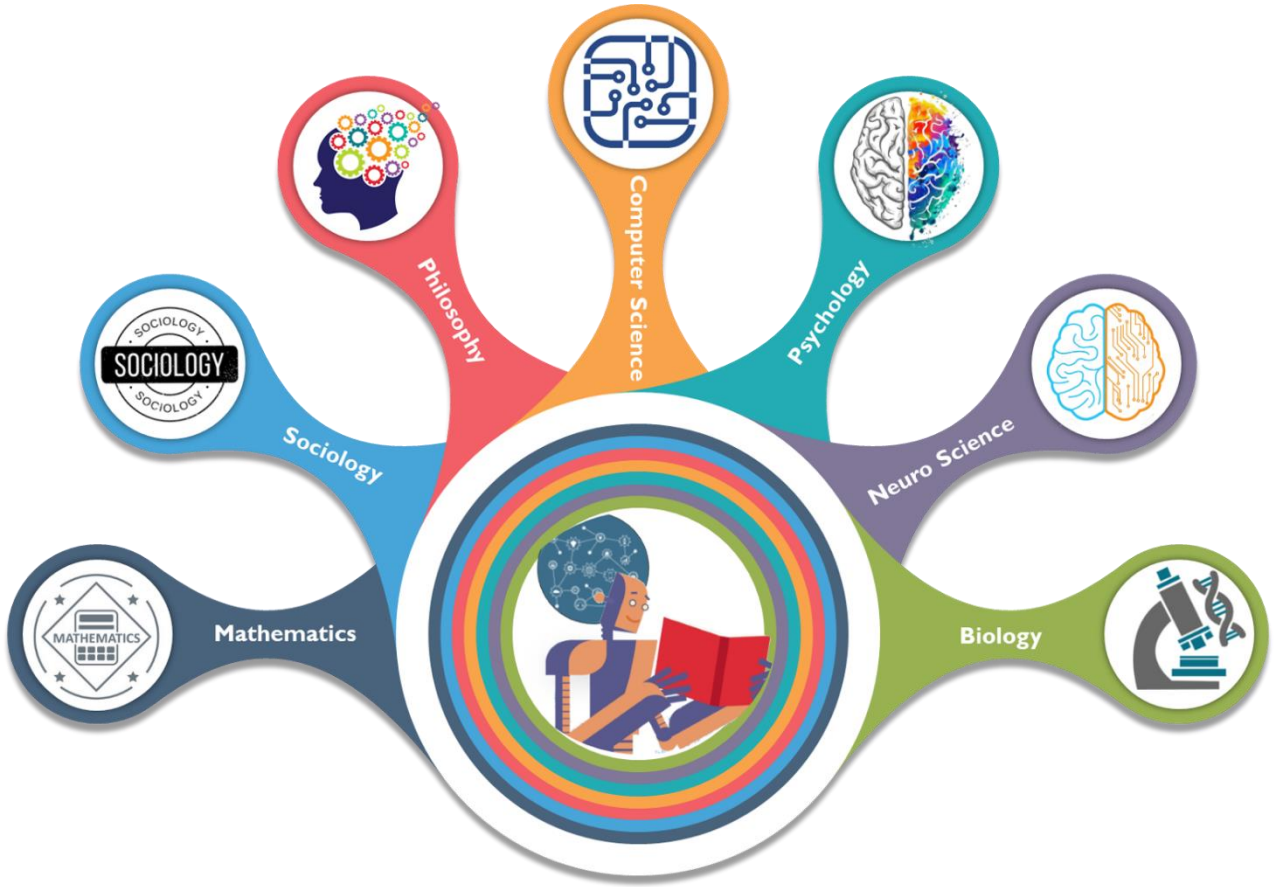
02

APPLICATIONS OF AI

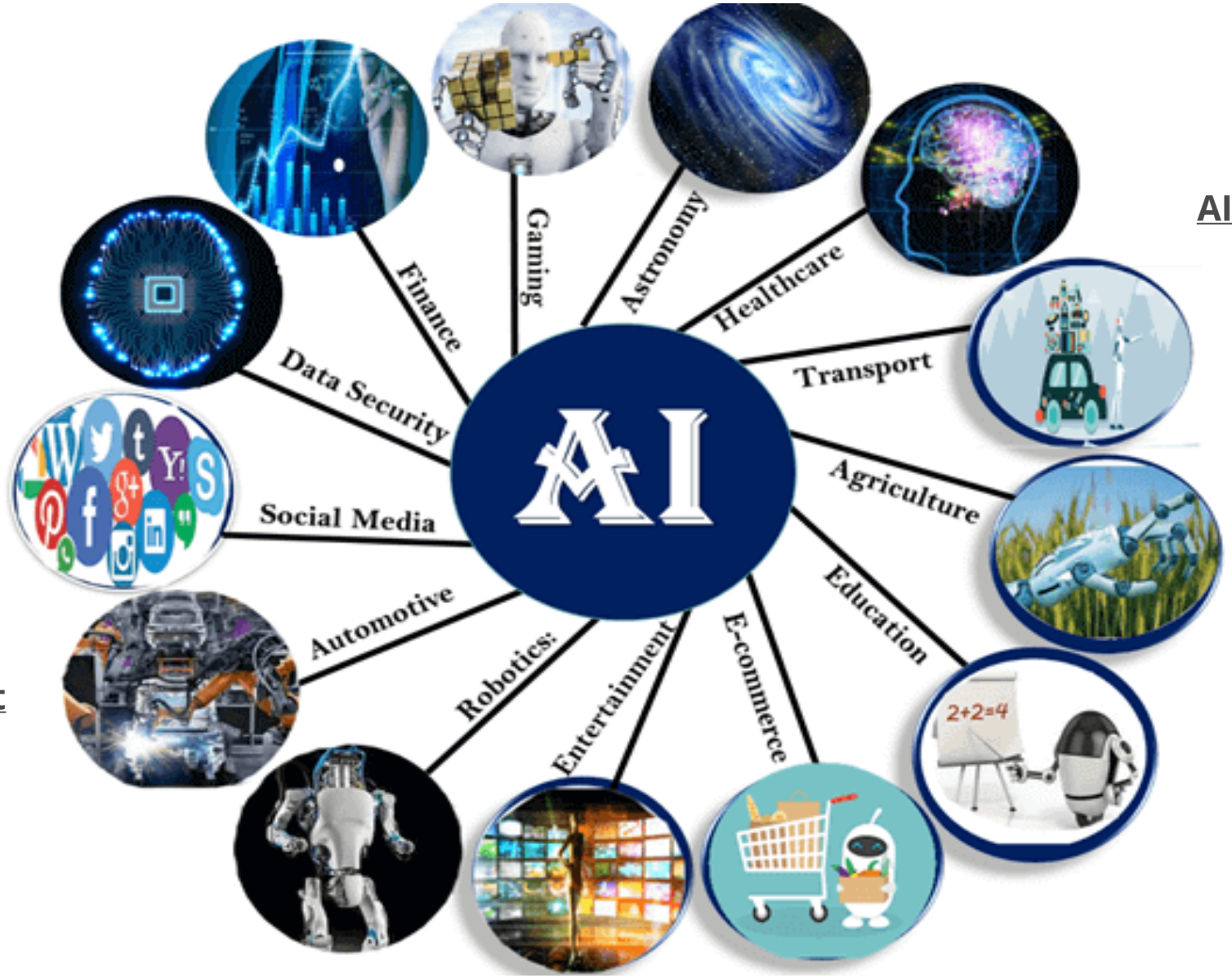
AI contributions , Different applications of Artificial Intelligence

What Contributes to AI?

- Artificial intelligence is a science and technology based on disciplines such as Computer Science, Biology, Psychology, Neuron Science, Mathematics, Sociology, Philosophy and Engineering.



Applications of Artificial Intelligence



- AI in Astronomy
- AI in Healthcare
- AI in Gaming
- AI in Finance
- AI in Social Media
- AI in Travel & Transport

- AI in Automotive Industry
- AI in Entertainment
- AI in education
- AI in Robotics
- AI in Agriculture
- AI in E-commerce
- AI in Data Security

Applications of Artificial Intelligence

- There are various applications of Artificial Intelligence in the Industry, here are a few of the important ones that are present in our Day to Day tasks.

Speech Recognition

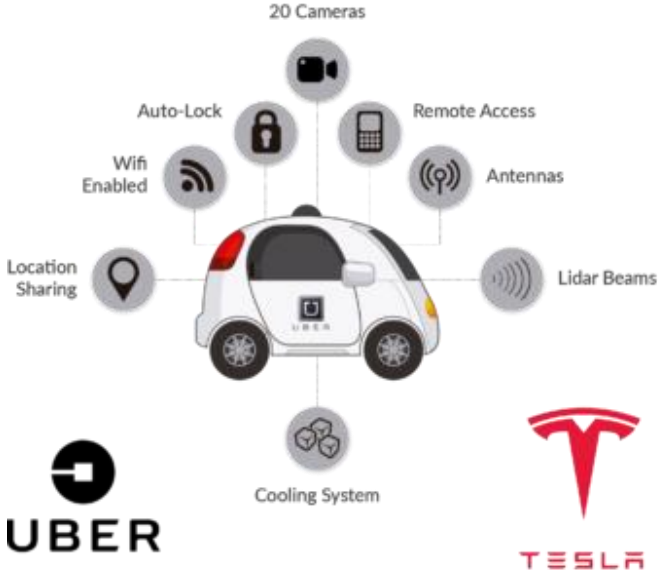
Machine Translation

Applications of Artificial Intelligence

Facial Recognition and Automatic Tagging

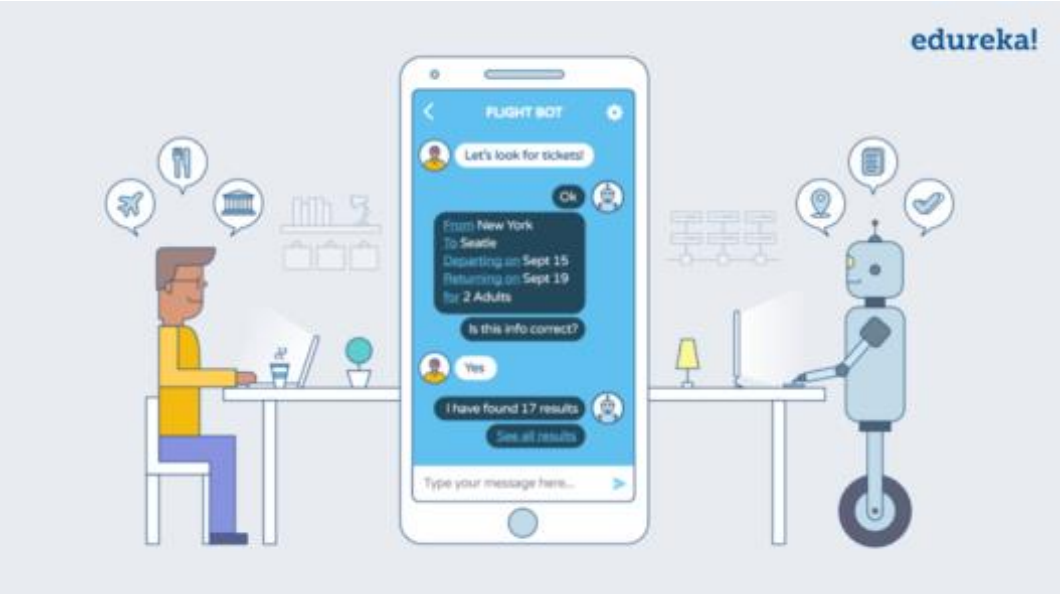
Virtual Personal Assistants

Self Driving Car



Applications of Artificial Intelligence

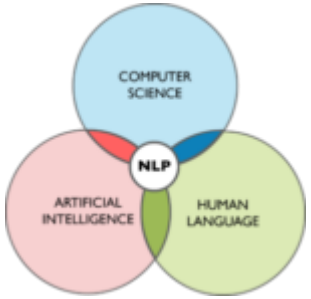
Chatbots



Robotics

Expert Systems

Natural Language Processing



03

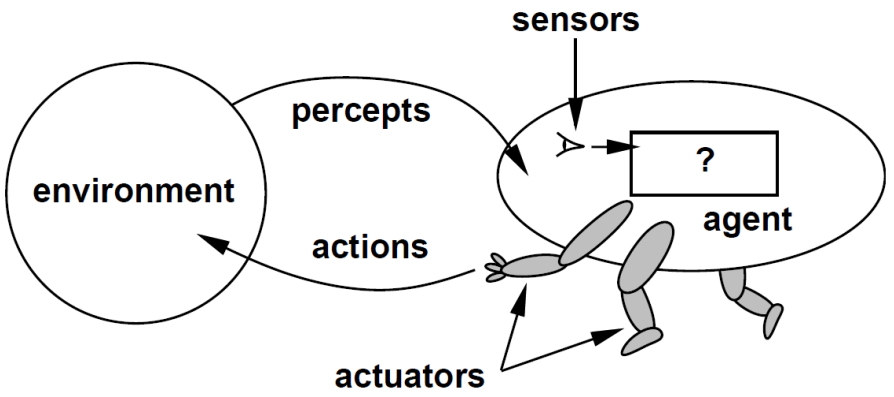
AGENT

About agent, Structure of agent, Rational agent

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.

Structure of Agent

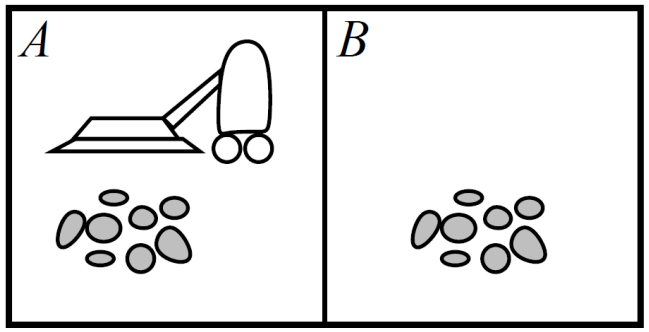


Architecture is the machinery that the agent executes on. It is a device with sensors and actuators, for example : a robotic car, a camera, a PC.

Agent program is an implementation of an agent function. *Agent function* is a map from the percept sequence (history of all that an agent has perceived till date) to an action. The agent program runs on the physical architecture to produce f. If f is agent function which maps from percept histories P to actions is denoted by **[f: P* → A]**

Agent = architecture + program

Example Vacuum Cleaning Robotic Agent



A vacuum-cleaner world with just two locations.

Percepts P = {[A,Clean], [A,Dirty], [B,Clean], [B,Dirty]}

Actions A = {Left, Right, Suck, NoOp}

Agent function = f: P* → A

Observations	Actions
f([A, dirty]) =	Suck
f([A, clean]) =	Right
f([B, dirty]) =	Suck
f([B, clean]) =	Left
f([A, clean], [B, dirty]) =	Suck

Rational Agent

A **rational agent** is one that does the right thing-conceptually speaking, every entry in the table for the agent function is filled out correctly.

Formal 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.

What is rational at any given time depends on four things:

- The performance measure that defines the criterion of success.
- The agent's prior knowledge of the environment.
- The actions that the agent can perform.
- The agent's percept sequence to date.

04

PEAS

Specifying the task environment

PEAS

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

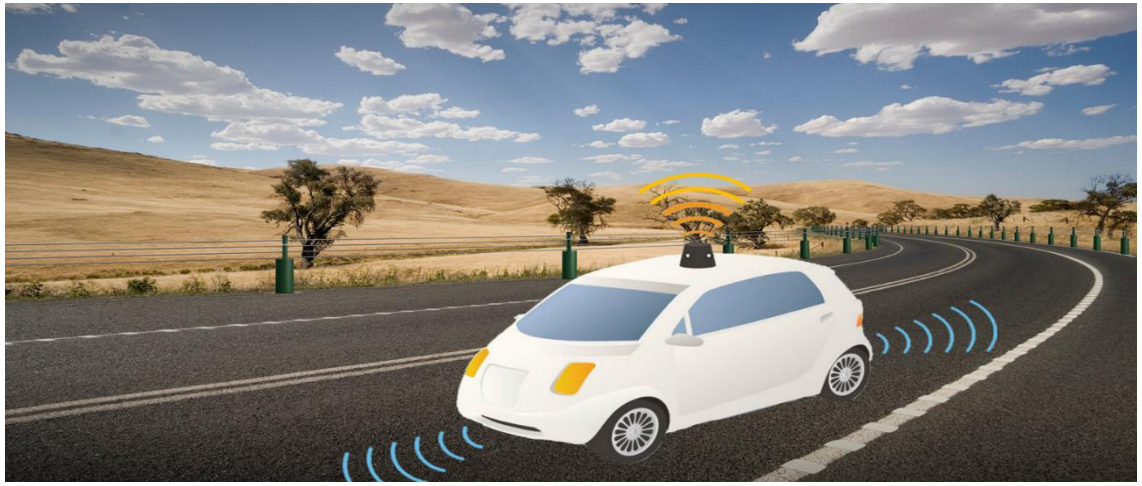
A: Actuators

S: Sensors

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

In designing an agent, the first step must always be to specify the task environment as fully as possible.

PEAS for an automated taxi driver:



Performance measure: Safe, fast, legal, comfortable trip, maximize profits

Environment: Roads, other traffic, pedestrians, customers

Actuators: Steering wheel, accelerator, brake, signal, horn

Sensors: Cameras, sonar, speedometer, GPS, odometer, engine sensors, keyboard

Example of Agents with their PEAS representation

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.
4. Interactive English tutor	•Maximize student's score on test	•Set of students	•Screen display (exercises, suggestions, corrections)	•Keyboard

05

ENVIRONMENT TYPES

About different types of environment in Artificial Intelligence

Agent Environment in AI

An environment is everything in the world which surrounds the agent, but it is not a part of an agent itself. An environment can be described as a situation in which an agent is present. The environment is where agent lives, operate and provide the agent with something to sense and act upon it. An environment can have various features from the point of view of an agent:

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

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**.
- Example:
  chess – the board is fully observable, as are opponent's moves.
  Driving – what is around the next bend is not observable (yet).

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.
- Example:
  Non-deterministic environment: Robot on Mars
  Deterministic environment: Tic Tac Toe game

Episodic vs sequential

- In an episodic environment, there is a series of one-shot actions, and only the current percept is required for the action.
- However, in Sequential environment, an agent requires memory of past actions to determine the next best actions.
- Examples:
  Episodic environment: mail sorting system
  Non-episodic environment: chess game

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.

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.

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.
- The agent design problems in the multi-agent environment are different from single agent environment.
- Examples:
  Single-agent: Part-picking robot
  Multi-agent: Taxi driving

Known vs Unknown

- Known and unknown are not actually a feature of an environment, but it is an agent's state of knowledge to perform an action.
- In a known environment, the results for all actions are known to the agent. While in unknown environment, agent needs to learn how it works in order to perform an action.
- It is quite possible that a known environment to be partially observable and an Unknown environment to be fully observable.
- Examples:
  Known: Part-picking robot
  Unknown: Taxi driving

Accessible vs Inaccessible

- If an agent can obtain complete and accurate information about the state's environment, then such an environment is called an Accessible environment else it is called inaccessible.
- 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.

Examples of task environments and their characteristics

Task Environment	Observable	Deterministic	Episodic	Static	Discrete	Agents
Crossword puzzle	Fully	Deterministic	Sequential	Static	Discrete	Single
Chess with a clock	Fully	Stochastic	Sequential	Static	Discrete	Multi
Poker	Partially	Stochastic	Sequential	Static	Discrete	Multi
Backgammon	Fully	Stochastic	Sequential	Static	Discrete	Multi
Taxi driving	Partially	Stochastic	Sequential	Dynamic	Continuous	Multi
Medical diagnosis	Partially	Stochastic	Sequential	Dynamic	Continuous	Single
Image-analysis	Fully	Deterministic	Episodic	Static	Continuous	Single
Part-picking robot	Partially	Stochastic	Episodic	Dynamic	Continuous	Single
Refinery controller	Partially	Stochastic	Sequential	Dynamic	Continuous	Single
Interactive English tutor	Partially	Stochastic	Sequential	Dynamic	Discrete	Multi

06

AGENT TYPES

About different types of agent in Artificial Intelligence

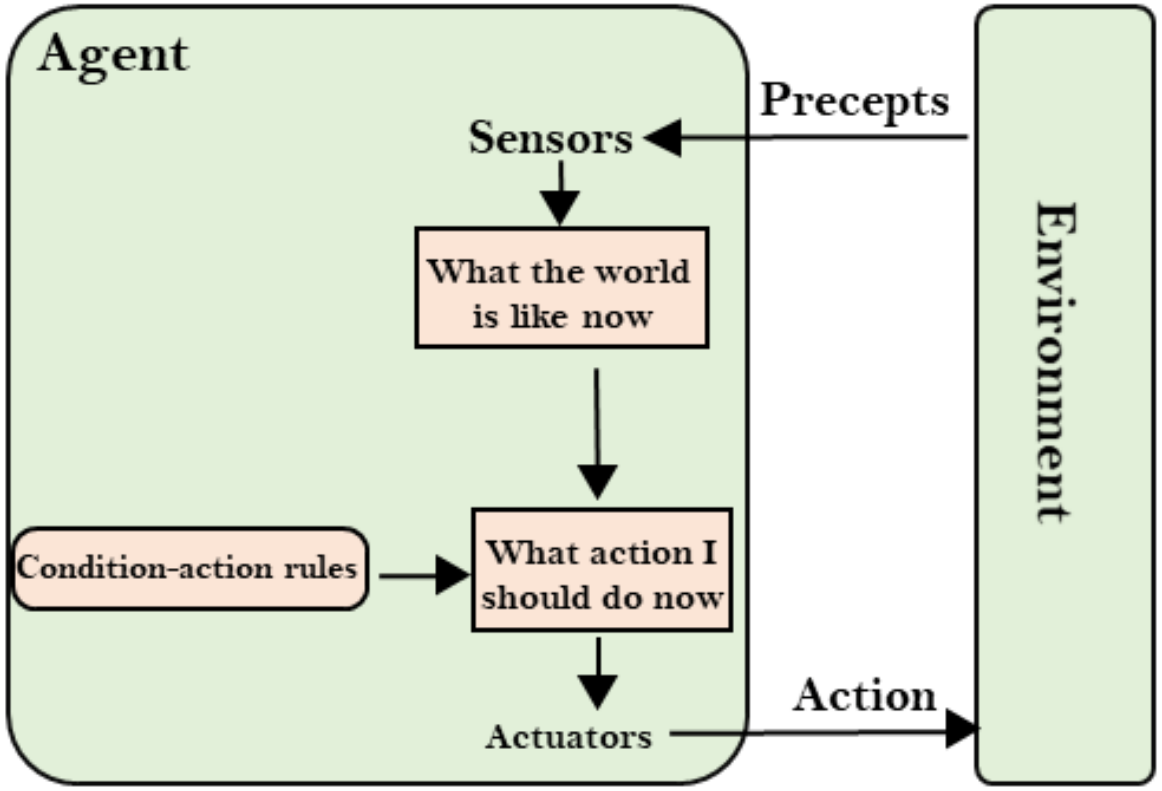
Agent types

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

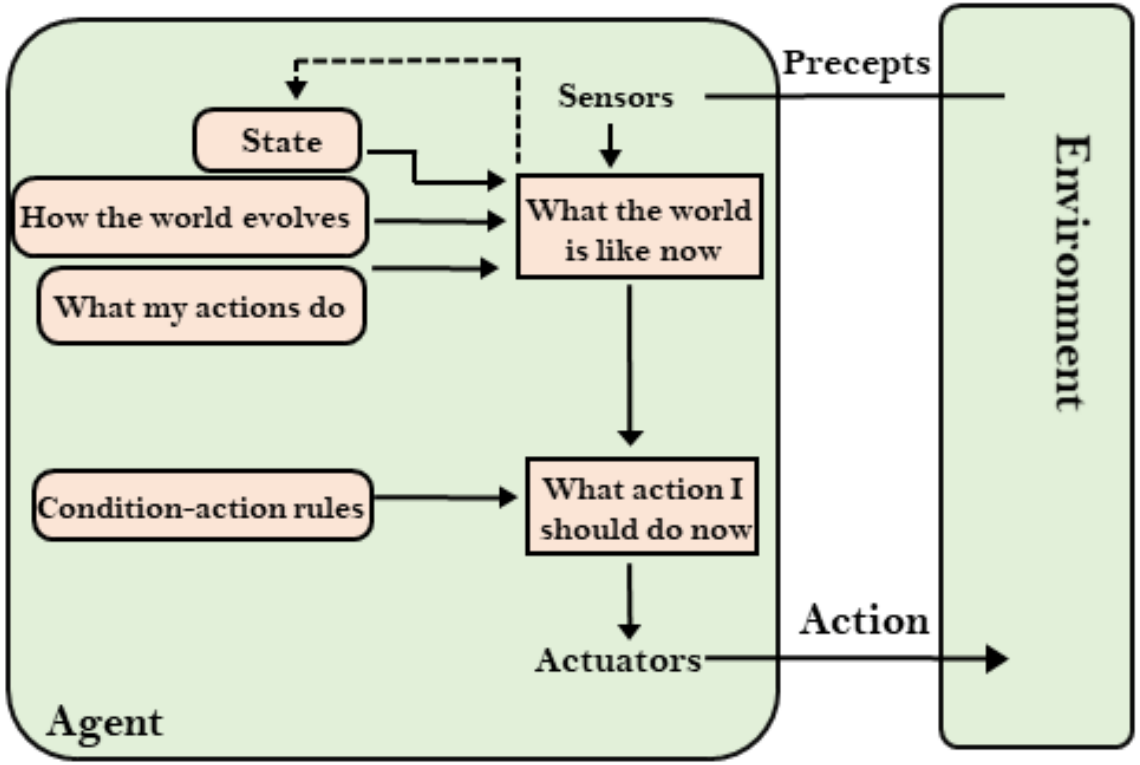
Simple Reflex Agent

- 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.



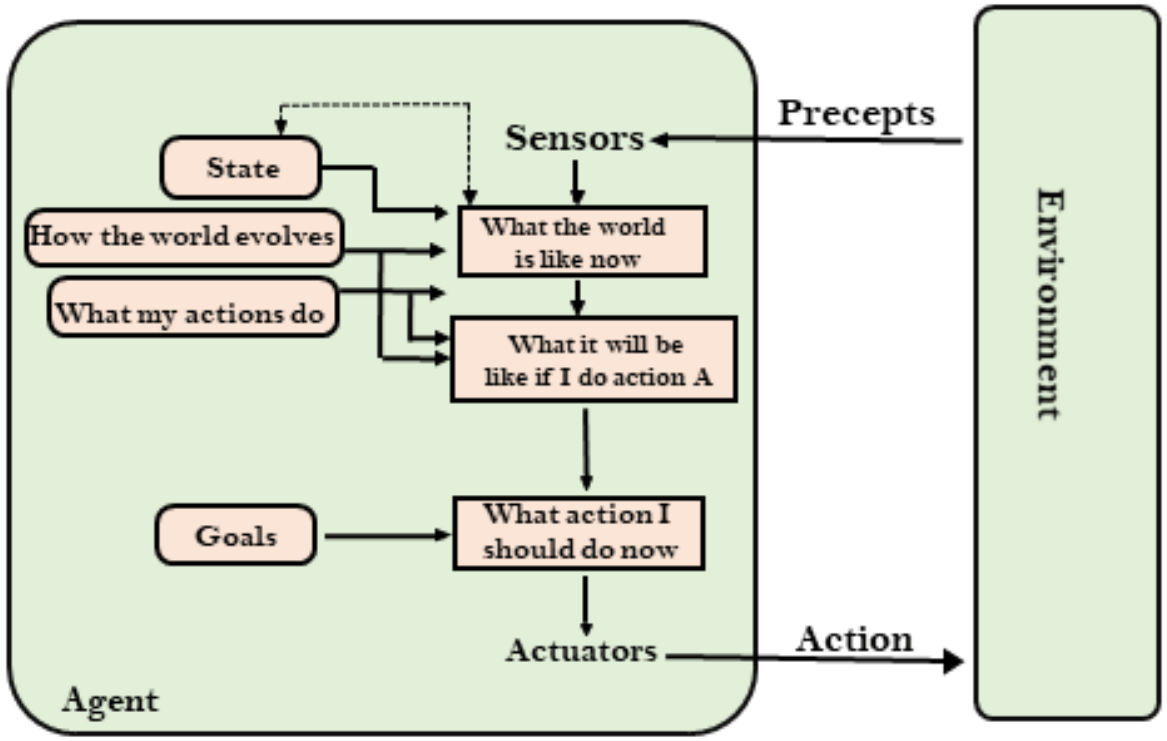
Model-based reflex agent

- 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:
  - How the world evolves
  - How the agent's action affects the world.



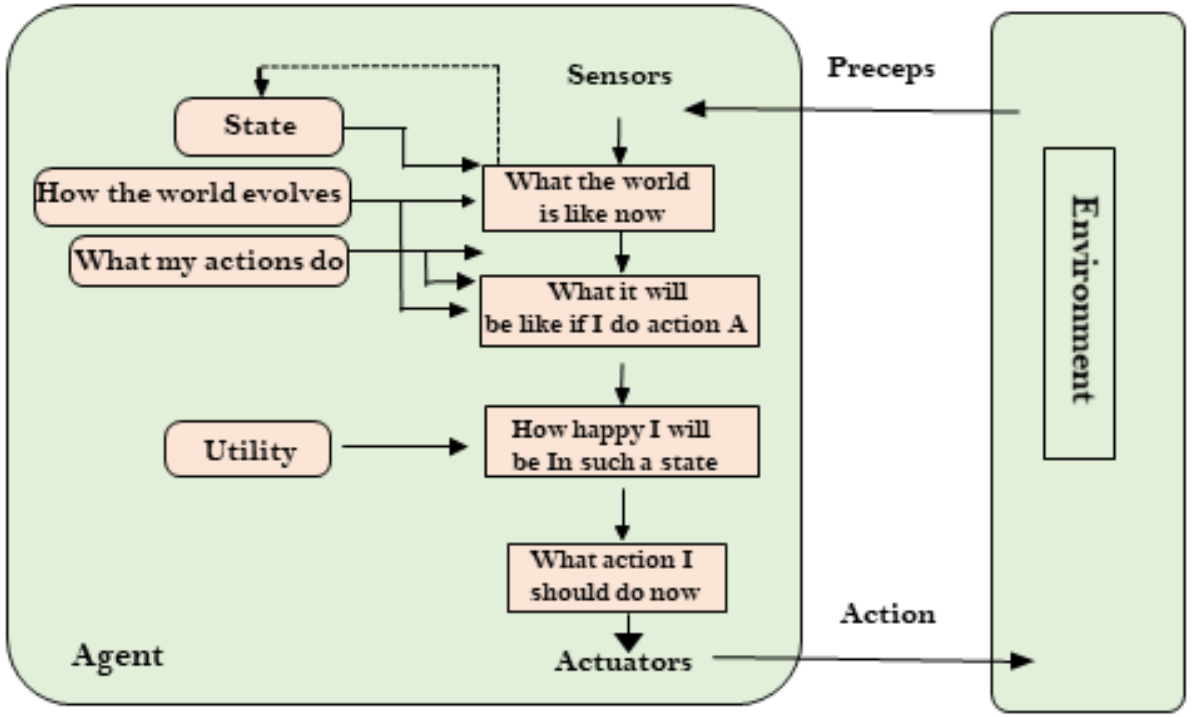
Goal-based agents

- 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.



Utility-based agent

- 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.

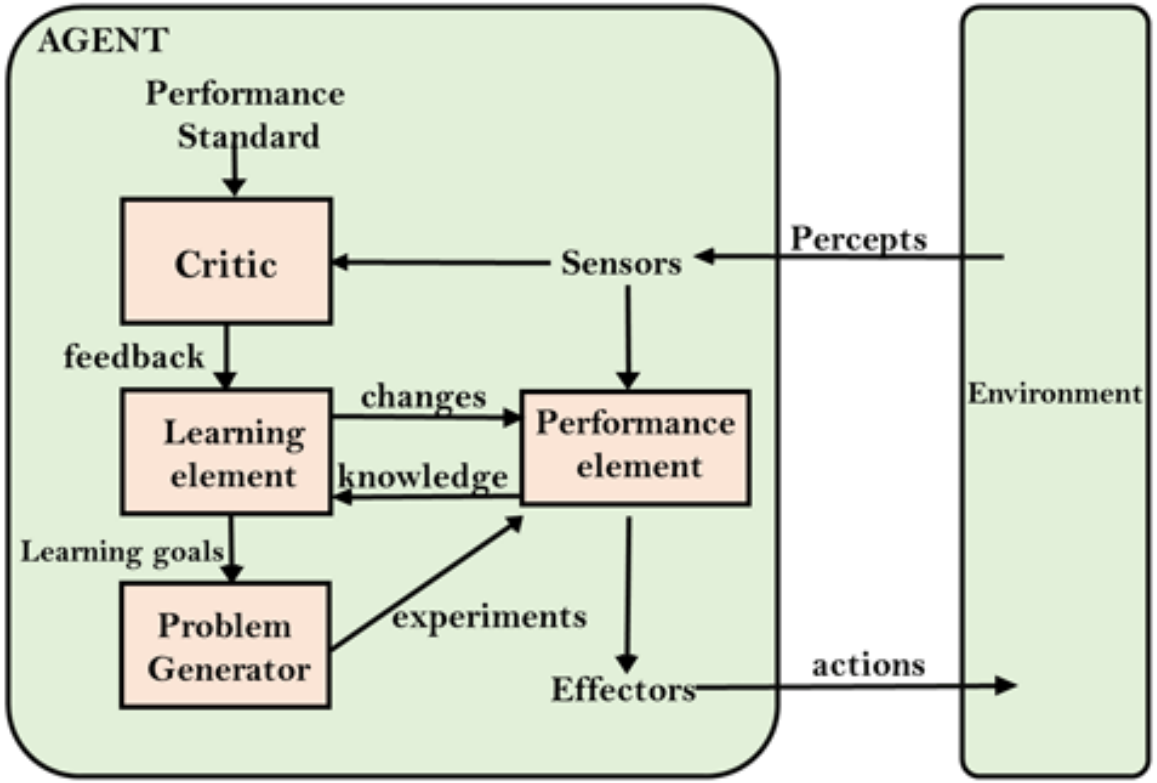


Learning agent

- 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.
- Hence, learning agents are able to learn, analyze performance, and look for new ways to improve the performance.

Learning agent

- A learning agent has mainly four conceptual components, which are:
  - Learning element: It is 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: It is responsible for selecting external action
  - Problem generator: This component is responsible for suggesting actions that will lead to new and informative experiences.



THANK YOU!

Any Questions?