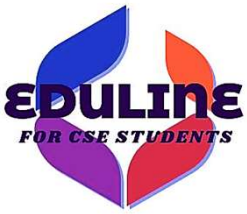
MODULE 1

INTRODUCTION TO ARTIFICIAL INTELLIGENCE (AI)

CO – Students will be able to summarize the history of intelligent systems



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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.
- The term "artificial intelligence" is used to describe machines that mimic "cognitive" functions that humans associate with other human minds, such as "learning" and "problem solving".

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- AI is the branch of computer science that is concerned with the automation of intelligent behavior
- AI is the part of computer science concerned with designing intelligent computer systems, that is, computer systems that exhibit the characteristics we associate with intelligence in human behavior such as understanding language, learning, reasoning and solving problems.
- AI is the exciting new effort to make computers think machines with minds, in the full and literal sense
- AI is the study of the computations that make it possible to perceive, reason, and act.

❖AI has three different levels:

- **Narrow AI:** Artificial intelligence is said to be narrow when the machine can perform a specific task better than a human. The current research of AI is here now.
- **General AI:** Artificial intelligence reaches the general state when it can perform any intellectual task with the same accuracy level as a human would.
- **Strong AI:** Artificial intelligence is strong when it can beat humans in many tasks.

❖Goals of AI

- To Create Expert Systems – The systems which exhibit intelligent behavior, learn, demonstrate, explain, and advice its users.
- To Implement Human Intelligence in Machines – Creating systems that understand, think, learn, and behave like humans.
- General-purpose AI like the robots of science fiction is incredibly hard Human brain appears to have lots of special and general functions, integrated in some amazing way that we really do not understand at all (yet).
- Special-purpose AI is more doable (non-trivial) E.g., chess/poker playing programs, logistics planning, automated translation, voice recognition, web search, data mining, medical diagnosis, keeping a car on the road.

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HISTORY OF AI

- **1943:** early beginnings McCulloch & Pitts: Boolean circuit model of brain
- **1950:** Turing Turing's "Computing Machinery and Intelligence“
- **1956:** birth of AI Dartmouth meeting: "Artificial Intelligence“ name adopted
- **1950s:** initial promise

  Early AI programs, including

  - o Samuel's checkers program
  - o Newell & Simon's Logic Theorist

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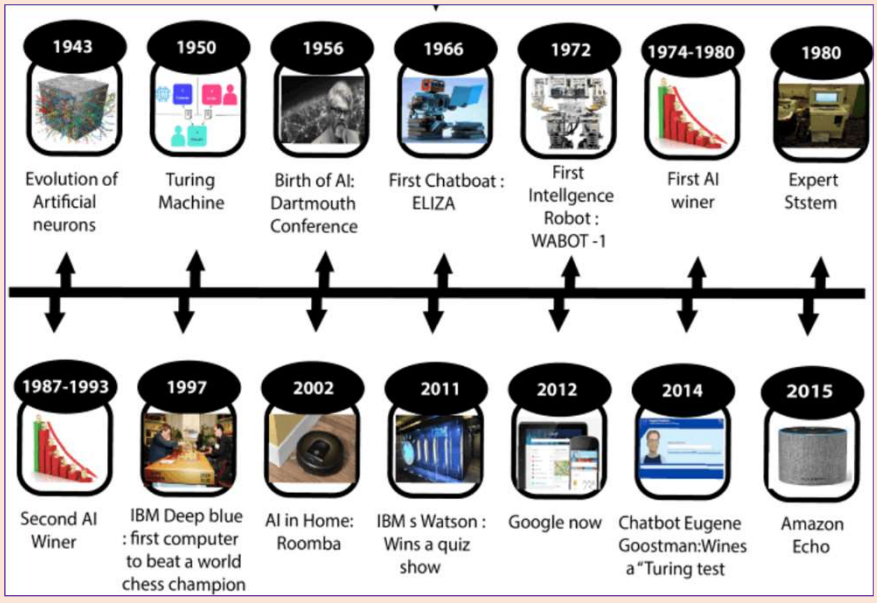
- **1955-65:** "great enthusiasm"
  - o Newell and Simon: GPS, general problem solver
  - o Gelertner: Geometry Theorem Prover
  - o McCarthy: invention of LISP - History of AI
- **1966—73:** Reality dawns
  - o Realization that many AI problems are intractable.
  - o Limitations of existing neural network methods identified
- **1969—85:** Adding domain knowledge
  - o Development of knowledge-based systems
  - o Success of rule-based expert systems, E.g., DENDRAL, MYCIN

- But were brittle and did not scale well in practice
- **1986** - Rise of machine learning
  - o Neural networks return to popularity
  - o Major advances in machine learning algorithms and applications
- **1990** - Role of uncertainty
  - o Bayesian networks as a knowledge representation framework.
- **1995** - AI as Science
  - o Integration of learning, reasoning, knowledge representation
- **1995 –2011** Intelligent agents

- **2011–present:** Deep learning, big data and artificial general intelligence
- **Latest Achievements in AI (2018)**
- Alibaba language processing AI outscores top humans at a Stanford University reading and comprehension test, scoring 82.44 against 82.304 on a set of 100,000 questions.
- Announcement of Google Duplex, a service to allow an AI assistant to book appointments over the phone.
- The LA Times judges the AI's voice to be a "nearly flawless" imitation of human-sounding speech.



APPROACHES TO AI

Thinking Humanly	Thinking Rationally
'The exciting new effort to make computers think… *machines with minds*, in the full and literal sense.' (Haugeland, 1985) '[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 the computations that make it possible to perceive, reason, and act.' (Winston, 1992)
Acting Humanly	**Acting Rationally**
'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)	'Computational Intelligence is the study of the design of intelligent agents.' (Poole, et al., 1998) 'AI… is concerned with intelligent behavior in artifacts.' (Nilsson, 1998)

❖Approach #1: Thinking Humanly

- AI is: "The exciting new effort to make computers think , machines with minds, in the full and literal sense." (Haugeland, 1985)
- AI is: "The automation of activities that we associate with human thinking, activities such as decision-making, problem solving, learning." (Bellman, 1978)
- **Goal is to build systems that function internally in some way similar to human mind.**

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Cognitive Intelligence: Workings of the human mind

- Traditional computer game players typically work much differently than human players
- Massive look-ahead, minimal "experience"
- People think differently in experience, "big picture", etc.
- Cognitive science tries to model human mind based on experimentation
- Cognitive modeling approach tries to act intelligently while actually internally doing something similar to human mind

❖Approach #2: Acting Humanly

- "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 and Knight, 1991)
- Ultimately to be tested by the Turing Test.
- To provide a satisfactory operational definition of intelligence

Intelligent capabilities

➢The computer would need to possess the following capabilities:

- Natural language processing: to enable it to communicate successfully in English.
- Knowledge representation: to store what it knows or hears.
- Automated reasoning: to use the stored information to answer questions and to draw new conclusions.
- Machine learning: to adapt to new circumstances and to detect and extrapolate patterns.
- Intelligence takes many forms, which are not necessarily best tested this way.

❖Approach #3: Thinking rationally: The "laws of thought" approach

- AI is: "The study of mental faculties through the use of computational models.“ (Chamiak and McDermott, 1985).
- "The study of the computations that make it possible to perceive, reason, and act.” (Winston, 1992).
- Approach firmly grounded in logic.

❖Approach #4: Acting rationally

- AI is: "Computational Intelligence is the study of the design of intelligent agents." (Poole et al., 1998)
- Agents: something that acts i.e. perform some action.
- Rational agent is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome.
- "AI is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Acting rationally

- In solving actual problems, it's what really matters.
- Behavior is more scientifically testable than thought.
- More general: rather than imitating humans trying to solve hard problems, just try to solve hard problems.

Advantages of Artificial Intelligence

- High Accuracy with less errors
- High-Speed
- High reliability
- Useful for risky areas
- Digital Assistant
- Useful as a public utility

Disadvantages of Artificial Intelligence

- High Cost
- Can't think out of the box
- No feelings and emotions
- Increase dependency on machines
- No Original Creativity

APPLICATIONS OF AI

- **Gaming** – AI plays crucial role in strategic games such as chess, poker, tic-tac-toe, etc., where machine can think of large number of possible positions based on heuristic knowledge.
- **Natural Language Processing** – It is possible to interact with the computer that understands natural language spoken by humans.
- **Expert Systems** – There are some applications which integrate machine, software, and special information to impart reasoning and advising. They provide explanation and advice to the users.

❖**Vision Systems** – These systems understand, interpret, and comprehend visual input on the computer.

- For example, A spying aero plane takes photographs, which are used to figure out spatial information or map of the areas.
- Doctors use clinical expert system to diagnose the patient.
- Police use computer software that can recognize the face of criminal with the stored portrait made by forensic artist.

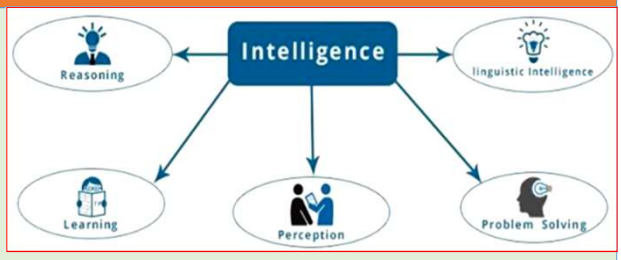
❖**Speech Recognition** – Some intelligent systems are capable of hearing and comprehending the language in terms of sentences and their meanings while a human talks to it. It can handle different accents, slang words, noise in the background, change in human's noise due to cold, etc.

❖**Handwriting Recognition** – The handwriting recognition software reads the text written on paper by a pen or on screen by a stylus. It can recognize the shapes of the letters and convert it into editable text.

❖**Intelligent Robots** – Robots are able to perform the tasks given by a human. They have sensors to detect physical data from the real world such as light, heat, temperature, movement, sound, bump, and pressure. They have efficient processors, multiple sensors and huge memory, to exhibit intelligence. In addition, they are capable of learning from their mistakes and they can adapt to the new environment.

INTELLIGENT AGENTS

❖INTELLIGENCE



Ability of a system to:

- calculate
- reason
- perceive relationships and analogies
- learn from experience
- solve problems, comprehend complex ideas
- classify, generalize
- adapt new situations

❖AGENTS

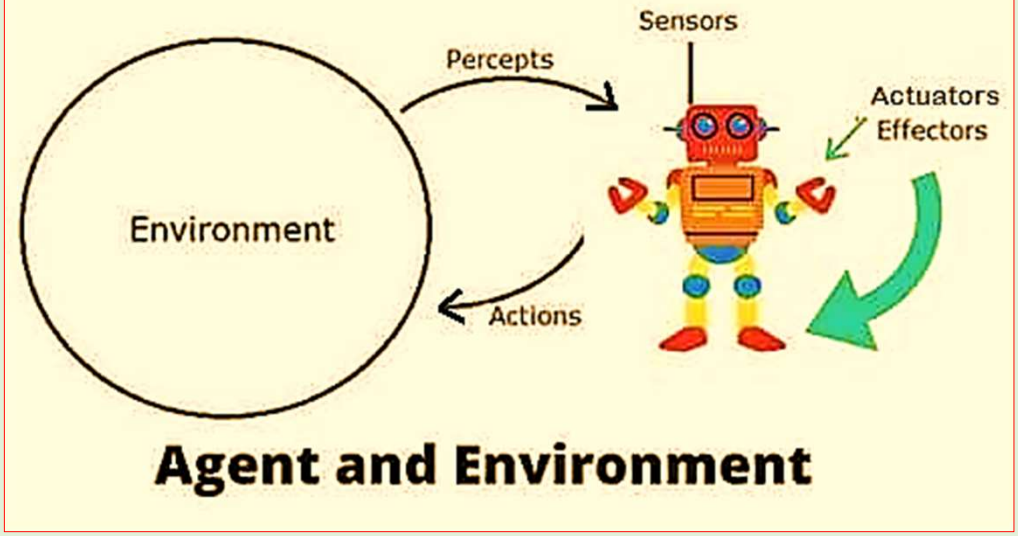
- An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators

➢Operates in an environment

➢**Perceive** its environment through **sensors**

➢**Acts** upon its environment through **actuators/ effectors**

➢Has Goals



Agent and Environment

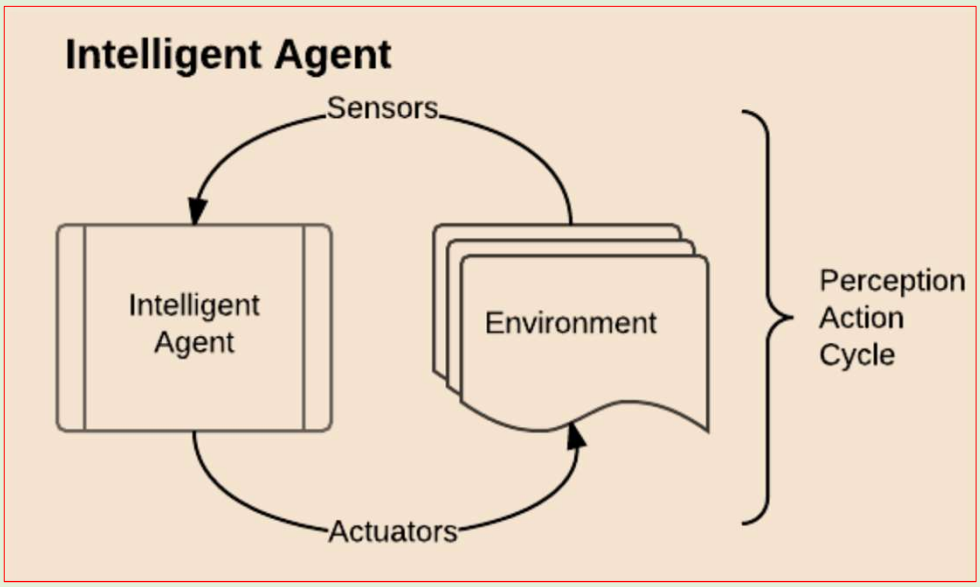
❖INTELLIGENT AGENTS

- 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.

➢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.

➢A thermostat is an example of an intelligent agent.



➢Sensor and actuators

- An agent perceives its environment through sensors
- The complete set of inputs at a given time is called a percept
- The current percept or Sequence of percepts can influence the action of an agent
- It can change the environment through actuators/ effectors
- An operation involving an actuator is called an action
- Action can be grouped into action sequences

❖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.

- A rational agent is an agent which has clear preferences and models uncertainty via expected values.
- A rational agent can be anything that makes decisions, typically a person, firm, machine, or software.
- A rational agent always performs right action, where the right action means the action that causes the agent to be most successful in the given percept sequence.
- Rational agent is capable of taking best possible action in any situation.
- Performing actions with the aim of obtaining useful information is an important part of rationality.

➢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.
- Rationality differs from Omniscience because an Omniscient agent knows the actual outcome of its action and act accordingly, which is not possible in reality.

❖Structure of an AI Agent

- 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* → 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 an AI agent or rational agent is defined, then its properties can be under PEAS representation model.
- It is made up of four words:

➢**P : Performance measure**

➢**E : Environment**

➢**A : Actuators**

➢**S : Sensors**

- Performance measure is the objective for the success of an agent's behavior.

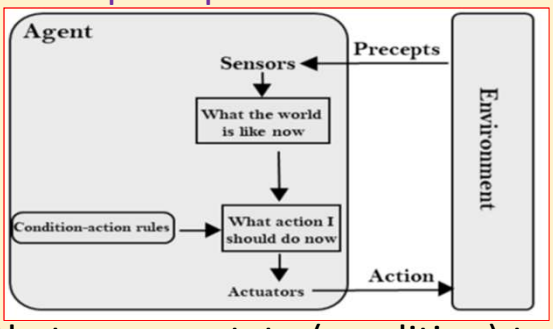
➢PEAS description of the task environment for an automated taxi

Agent Type	Performance Measure	Environment	Actuators	Sensors
Taxi driver	Safe, fast, legal, comfortable trip, maximize profits	Roads, other traffic, pedestrians, customers	Steering, accelerator, brake, signal, horn, display	Cameras, sonar, speedometer, GPS, odometer, accelerometer, engine sensors, keyboard

TYPES OF AI AGENTS

1. Simple Reflex Agent

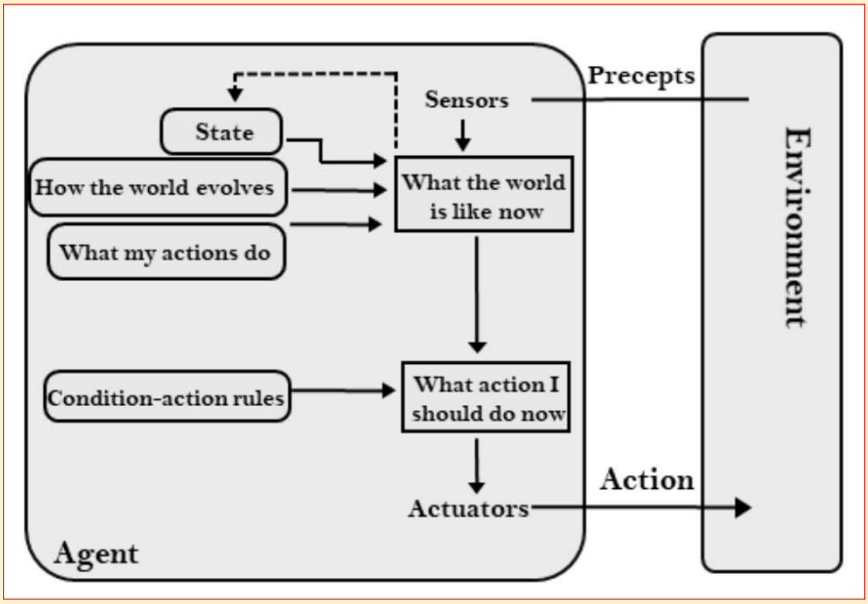
- Choose actions only based on the current percept.
- Rational only if a correct decision is made only on the basis of current precept.
- Their environment is completely observable.



- Condition-Action Rule – It is a rule that maps a state (condition) to an action.

2. Model-based reflex agent

- A model of the world to choose their actions. They maintain an internal state.
- Model – knowledge about "how the things happen in the world".
- Internal State – It is a representation of unobserved aspects of current state depending on percept history.
- Updating the state requires the information about
  - How the world evolves.
  - How the agent's actions affect the world.



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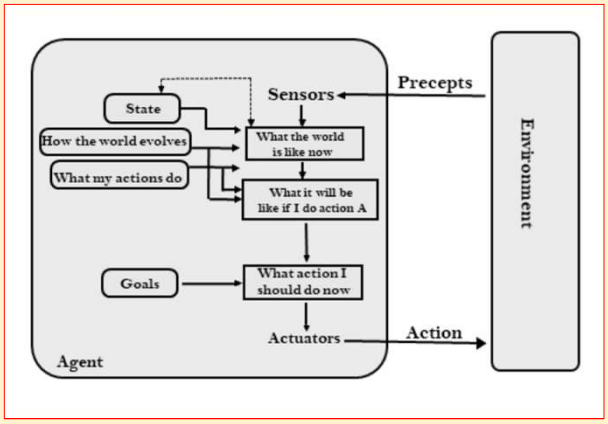
3. Goal-based agents

- Choose their actions in order to achieve goals.
- Goal-based approach is more flexible than reflex agent since the knowledge supporting a decision is explicitly modelled, thereby allowing for modifications.
- Goal – It is the description of desirable situations.



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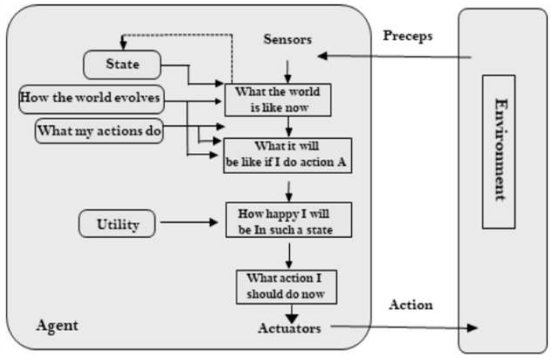
4. Utility-based agent

- Choose actions based on a preference (utility) for each state.
- Goals are inadequate when there are conflicting goals, out of which only few can be achieved.
- Goals have some uncertainty of being achieved and you need to weigh likelihood of success against the importance of a goal.



5. 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.
- 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.