Unit - I

Basics of Artificial Intelligence

Outline

- Introduction to AI – concept of Intelligence
- Artificial Intelligence
- Foundational Areas of AI
- Approaches to AI- Rationalist
- Empiricist Approaches
- Applications of AI and
- Limitations of AI

- Intelligent Agents:
- Agents and Environments
- Examples
- The Concept of Rationality
- Nature of Environments
- The Structure of Agents

Introduction to AI-concept of Intelligence

- The concept of intelligence is defined as the ability to learn from experience, solve problems, and use our knowledge to adapt to new situations.
- **Intelligence is composed of:**

  Reasoning

  Learning

  Problem-Solving

  Perception

  Linguistic Intelligence
- Artificial intelligence is a branch of computer science that aims to create intelligent machines.
- AI is a technique that facilitates a machine to perform all cognitive functions such as multiple mental abilities, including learning, thinking, reasoning, remembering, problem solving, decision making, and attention that are performed by humans
- "The Science and Engineering of making intelligent machines, especially intelligent Computer programs is Artificial intelligence" –JOHN MC CARTHY [Father of AI]

- Computers execute certain tasks way better than humans

  e.g.: Sorting, computing, memorizing, indexing, finding patterns

  etc.
- While identifying of emotions, recognising faces, communication and conversation are unbeatable human skills.
- AI will play a crucial role to enable machines achieving equalling human capabilities.
- AI is concerned with construction and deployment of intelligent agents as computer programs, and also with understanding the behavior of these artifacts.
- The core scientific goal of AI is to understand the basic principles of intelligent behavior that apply equally to animal and artificial systems.

- Artificial Intelligence is a method of making a computer, a computer-controlled robot, or a software think intelligently like the human mind.
- AI is accomplished by studying the patterns of the human brain and by analyzing the cognitive process.
- The outcome of these studies develops intelligent software and systems Some of the tasks performed by AI-enabled devices include:
    - ✓ Speech recognition
    - ✓ Object detection
    - ✓ Solve problems and learn from the given data
    - ✓ Plan an approach for future tests to be done

➢ Difference between Human and Machine Intelligence

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

- Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think and act like humans. It involves the development of algorithms and computer programs that can perform tasks that typically require human intelligence such as visual perception, speech recognition, decision-making, and language translation.

Approaches of AI

Approaches of AI and that are as follows:

- Acting humanly (The Turing Test approach): This approach was designed by Alan Turing. The ideology behind this approach is that a computer passes the test if a human interrogator, after asking some written questions, cannot identify whether the written responses come from a human or from a computer.
- Thinking humanly (The cognitive modeling approach): The idea behind this approach is to determine whether the computer thinks like a human.
- Thinking rationally (The "laws of thought" approach): The idea behind this approach is to determine whether the computer thinks rationally i.e. with logical reasoning.
- Acting rationally (The rational agent approach): The idea behind this approach is to determine whether the computer acts rationally i.e. with logical reasoning.
- Machine Learning approach: This approach involves training machines to learn from data and improve performance on specific tasks over time.

  It is widely used in areas such as image and speech recognition, natural language processing, and recommender systems.

- Evolutionary approach: This approach is inspired by the process of natural selection in biology. It involves generating and testing a large number of variations of a solution to a problem, and then selecting and combining the most successful variations to create a new generation of solutions.
- Neural Networks approach: This approach involves building artificial neural networks that are modeled after the structure and function of the human brain. Neural networks can be used for tasks such as pattern recognition, prediction, and decision-making.
- Fuzzy logic approach: This approach involves reasoning with uncertain and imprecise information, which is common in real-world situations. Fuzzy logic can be used to model and control complex systems in areas such as robotics, automotive control, and industrial automation.
- Hybrid approach: This approach combines multiple AI techniques to solve complex problems. For example, a hybrid approach might use machine learning to analyze data and identify patterns, and then use logical reasoning to make decisions based on those patterns.

- Natural language processing (NLP): This approach deals with the interaction between computers and humans through natural language. It involves tasks such as text and speech recognition, translation, and sentiment analysis.
- Robotics: This approach involves the use of AI to design, build, and control robots. It involves tasks such as perception, decision-making, and movement.
- Computer vision: This approach deals with the processing and analysis of visual information from the real world. It involves tasks such as image recognition, object detection, and scene understanding.

Foundations of AI

- Philosophy
- Mathematics
- Economics
- Neuroscience
- Psychology
- Computer engineering
- Linguistics
- Control theory and cybernetics

➢ Philosophy

- Can formal rules be used to draw valid conclusions?
- How does the mind arise from a physical brain?
- Where does knowledge come from?
- How does knowledge lead to action?

Rationalism, Dualism, Materialism, Empiricism, Induction, Logical Positivism, Confirmation Theory.

➢ **Mathematics**

- What are the formal rules to draw valid conclusions?
- What can be computed?
- How do we reason with uncertain information?
- The main three fundamental areas are logic, computation and probability.
- ✒ Algorithm, incompleteness theorem, computable, tractability, NP completeness, Non deterministic polynomial and probability.

➢ **Economics**

- How should we make decisions so as to maximize payoff?
- How should we do this when others may not go along?
- How should we do this when the payoff may be far in the future?

✒ Utility, Decision Theory, Game Theory, Operations Research.

➢ **Neuroscience**

- How do brains process information?
- Neuroscience is the study of the nervous system, especially the brain. We are still a long way from understanding how cognitive processes actually work. The truly amazing conclusion is that a collection of simple cells can lead to thought, action, and consciousness or, brains cause minds. The only real alternative theory is mysticism: that minds operate in some mystical realm that is beyond physical science.

➢ **Psychology**

- How do humans and animals think and act?
- 🖋 Behaviourism, Cognitive psychology.
- The three key steps of a knowledge-based agent:
- I. the stimulus must be translated into an internal representation
- II. the representation is manipulated by cognitive processes to derive internal representations
- III. These are in turn retranslated back into action.

➢ **Computer engineering**

- How can we build an efficient computer?
- 🖋 Operational computer and operational programmable computer
- AI has pioneered many ideas that have made their way back to mainstream computer science, including time sharing, interactive interpreters, personal computers with windows and mice, rapid development environments, the linked list data type, automatic storage management, and key concepts of symbolic, functional, declarative, and object-oriented programming.

- Linguistics

How does language relate to thought?

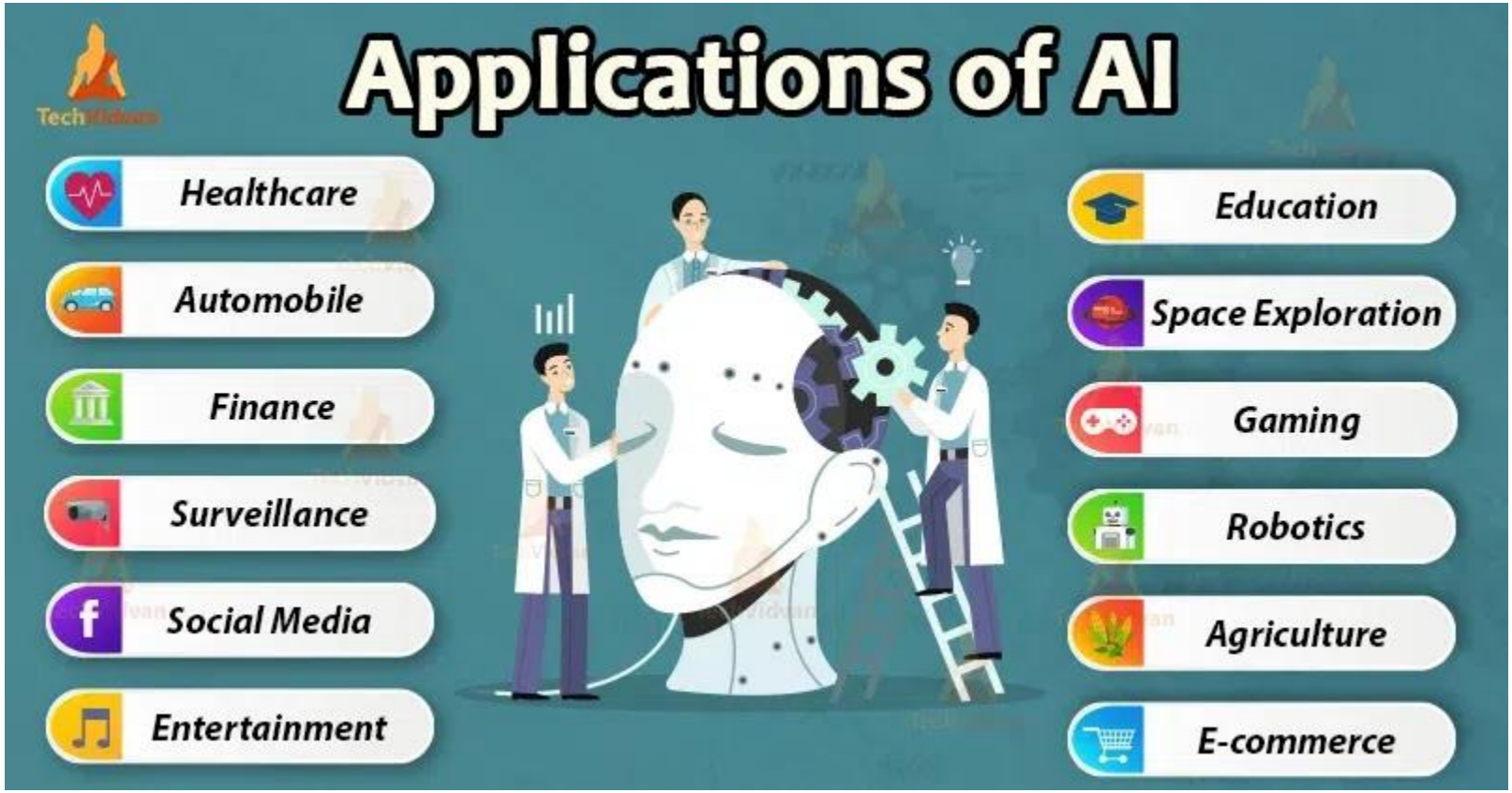
Verbal Behavior — behaviorist approach to language learning

✒ Computational linguistics or natural language processing and knowledge representation.

- Control theory and cybernetics

- How can artifacts operate under their own control?
- ✒ control Theory, Homeostatic and objective function.

Applications of AI



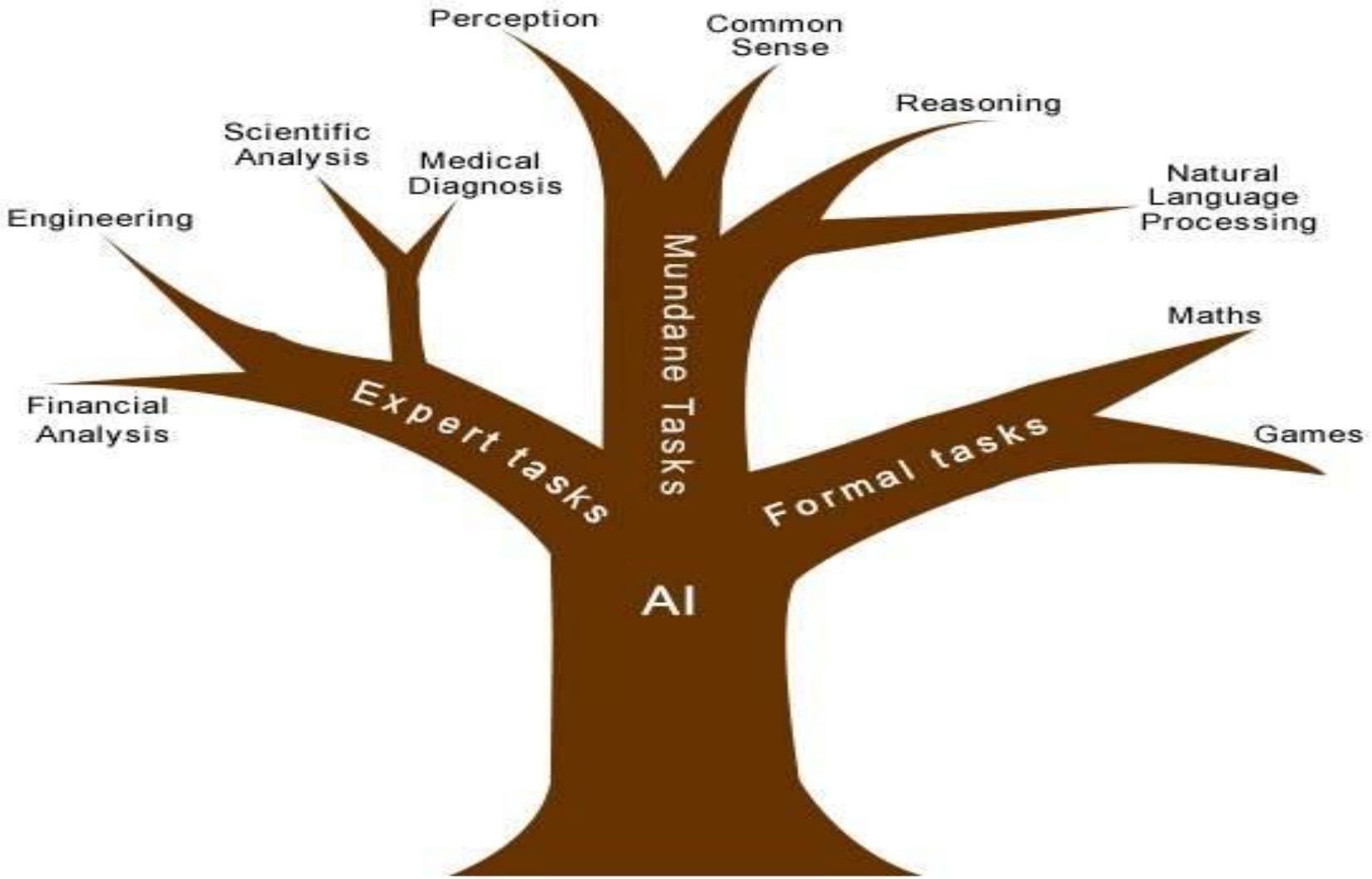
➢ Uses of Artificial Intelligence :

Artificial Intelligence has many practical applications across various industries and domains, including:

- **Healthcare:** AI is used for medical diagnosis, drug discovery, and predictive analysis of diseases.
- **Finance:** AI helps in credit scoring, fraud detection, and financial forecasting.
- **Retail:** AI is used for product recommendations, price optimization, and supply chain management.
- **Manufacturing:** AI helps in quality control, predictive maintenance, and production optimization.
- **Transportation:** AI is used for autonomous vehicles, traffic prediction, and route optimization.
- **Customer service:** AI-powered chatbots are used for customer support, answering frequently asked questions, and handling simple requests.
- **Security:** AI is used for facial recognition, intrusion detection, and cybersecurity threat analysis.
- **Marketing:** AI is used for targeted advertising, customer segmentation, and sentiment analysis.
- **Education:** AI is used for personalized learning, adaptive testing, and intelligent tutoring systems.

Task Classification of AI

The domain of AI is classified into **Formal tasks, Mundane tasks,** and **Expert tasks**



Agents

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

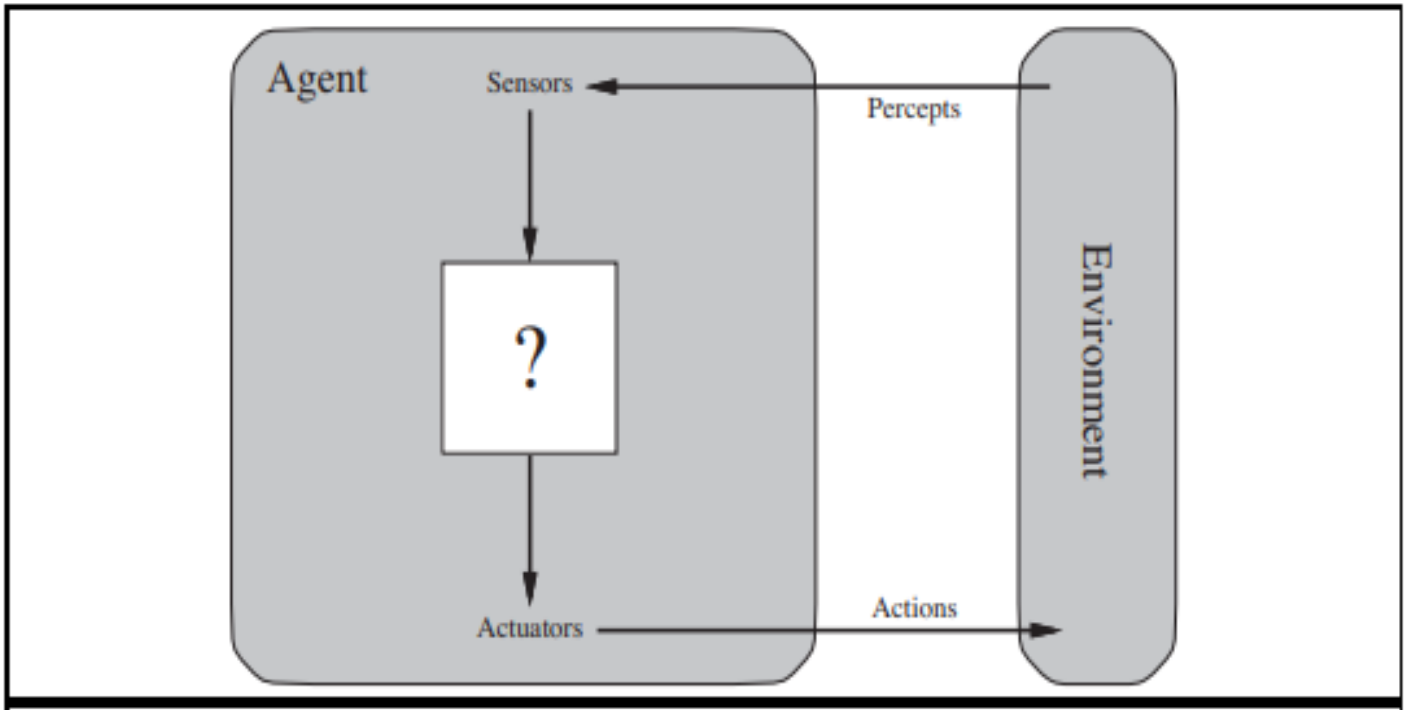


Figure 1.1 Agents interact with environments through sensors and actuators

Agents

- human agent

  A human agent has eyes, ears, and other organs for sensors and hands, legs, vocal tract, and so on for actuators.

- Robotic agent

  A Robotic agent might have cameras and infrared range finders for sensors and various motors for actuators.

- software agent

  A software agent receives keystrokes, file contents, and network packets as sensory inputs and acts on the environment by displaying on the screen, writing files, and sending network packets

Agent Terminology

- **Performance Measure of Agent** − It is the criteria, which determines how successful an agent is.
- **Behavior of Agent** − It is the action that agent performs after any given sequence of percepts.
- **Percept** − It is agent's perceptual inputs at a given instance.

  percepts include **inputs from**

  - ✓ **touch sensors,**
  - ✓ **cameras,**
  - ✓ **infrared sensors (An infrared (IR) sensor is an electronic device used to measure and detect infrared radiation in its surrounding environment)**
  - ✓ **sonar (sound Navigation and Ranging)**
  - ✓ **microphones,**
  - ✓ **mice, and keyboards.**

  A percept can also be a higher-level feature of the data, such as lines, depth, objects, faces

- **Percept Sequence** - It is the sequence of percept inputs.
- **Agent Function** - It is a map from the precept sequence to an action

➢ 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

➢ Actuators :

These are **components through which energy is converted into motion**.

They perform the role of controlling and moving a system.

Examples : rails, motors, and gears.

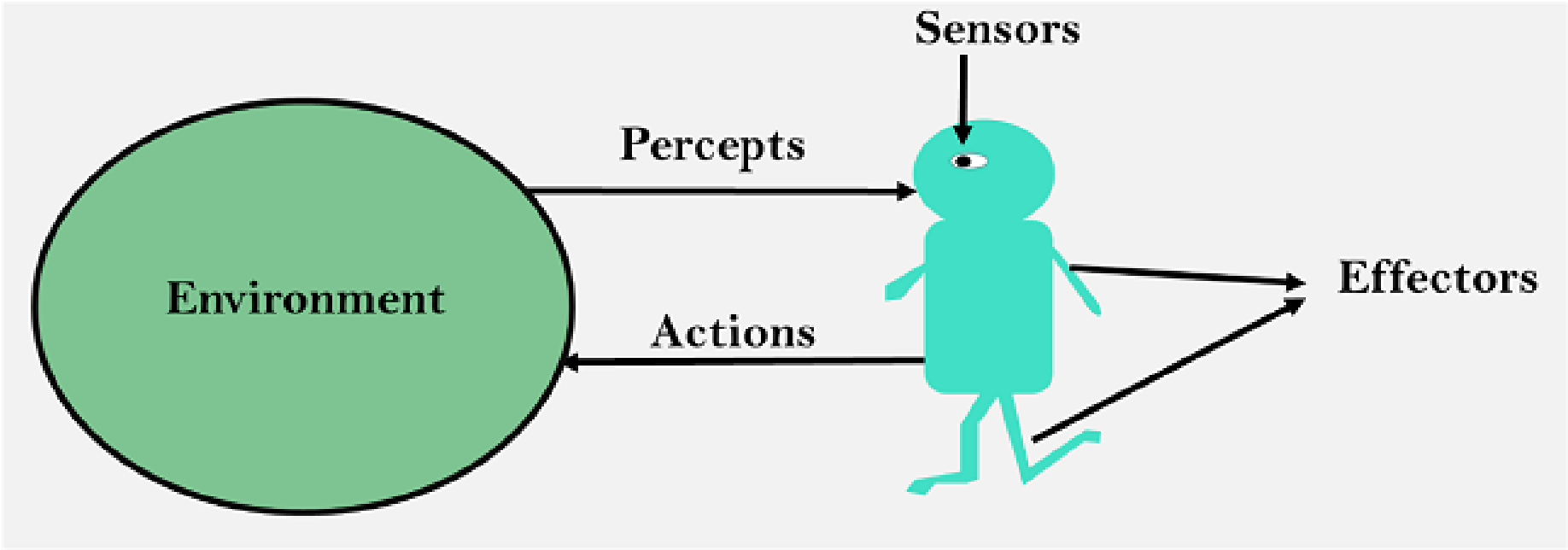
➢ Effectors:

The environment is affected by effectors.

Examples : legs, fingers, wheels, display screen.

- Sensor:

  it is a device or organ, that detects or measures a physical property and records, indicates, or otherwise responds to it.



Rationality

- A Rational agent is one which is capable of doing excepted actions to maximize its performance measure , on the basis of

  1) Its percept sequence

  2) Its built-in knowledge base

- 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.

Obviously, doing the right thing is better than doing the wrong thing .

percept ⟶ Agents ⟶ action

Rationality of an agent depends on the following :

- ✓ The **performance measures**, which determine the degree of success.
- ✓ Agent's **Percept Sequence** till now.
- ✓ The agent's **prior knowledge about the environment**.
- ✓ The **actions** that the agent can carry out.

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)

- The problem solving by the agent is characterized by Performance Measure, Environment, Actuators, and Sensors (PEAS).
- Performance Measure :

Agent --[percept the i/p]----> Environment(State-S) ---[Action]----> Changes in Environment(S' S'' S''')

The Nature of Environments

- **Environment are two types**

  1) Artificial environment

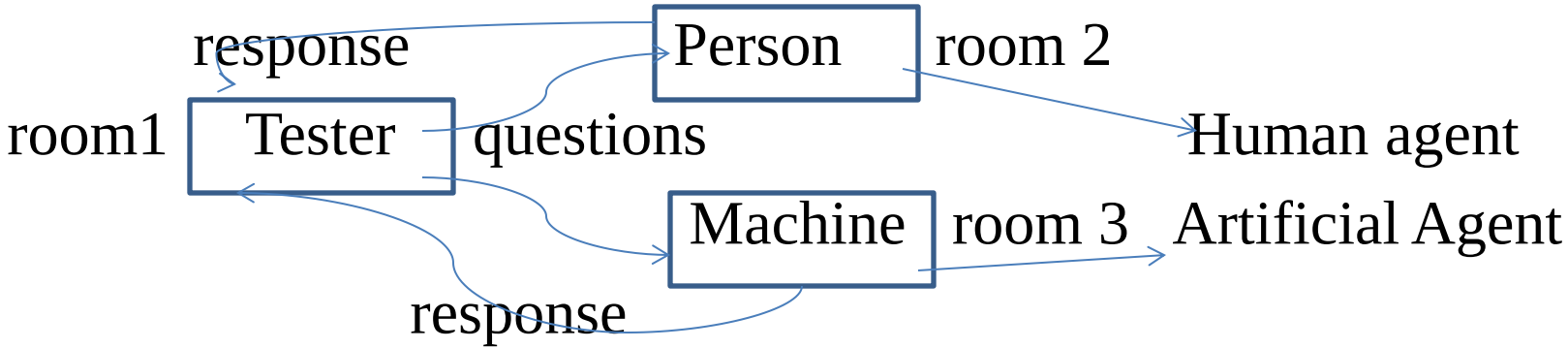
  2) Natural environment

- **Artificial environment**

  The most famous **artificial environment** is the **Turing Test environment**, in which one real and other artificial agents are tested on equal ground.

Turing Test

- The success of an intelligent behavior of a system can be measured with Turing Test.
- Two persons and one machine to be evaluated participate in the test. Out of the two persons, one plays the role of the tester. Each of them sits in different rooms. The tester is unaware of who is machine and who is a human.
- He interrogates the questions by typing and sending them to both intelligences, to which he receives typed responses.



- This test aims at fooling the tester. If the tester fails to determine machine's response from the human response, then the machine is said to be intelligent.

Natural environment

There are several types of environments:

- Fully Observable vs Partially Observable
- **Static / Dynamic**
- **Single agent / Multiple agents**
- **Deterministic / Non-deterministic**
- Discrete vs Continuous
- Episodic vs Sequential
- Known vs Unknown

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➢Fully Observable vs Partially Observable

Fully Observable	Partially Observable
An agent can always see the entire state o the environment	An agent can ‘t see the entire state o the environment
Example : Chess 	Example : Card game 

Static / Dynamic

Static	**Dynamic**
If the environment does not change while an agent is acting, then it is static	If the environment is change while an agent is acting, then it is dynamic
Example : Cross word puzzles 	Example : A roller coaster ride is dynamic Taxi driving 

Single agent / Multiple agents

Single agent	Multiple Agents
If only one agent is involved in an environment, and operating by itself then such an environment is called single agent environment	If multiple agents are operating in an environment ,then such an environment is called a multi_agent environment
Example : Maze 	Example : football 

Deterministic / Non-deterministic

Deterministic	**Non-deterministic**
If the next state of the environment is completely determined by the current state and the actions of the agent, then the environment is deterministic	**Non-deterministic is random in nature and cannot be determine completely by an agent.**
Example : Tic Tac toe 	Example : Ludo (Any game that involve dice) 

Discrete vs Continuous

Discrete	Continuous
✓The environment consists of a finite number of actions that can be deliberated in the environment to obtain the output. ✓If there are a limited number of distinct, clearly defined, states of the environment, the environment is discrete	✓ the environment in which the actions performed cannot be numbered i.e . , is not discrete, is said to be continuous
Example: chess 	Example: Self-driving cars 

Episodic vs Sequential

Episodic	Sequential
✓ only the current percept is required for the action ✓ every episode is independent of each other	✓An agent requires memory of past actions to determine the next best actions. ✓ The current decision could affect all future decisions
Example : Part picking robot 	Example : Chess 

Known vs Unknown

Known	Unknown
In Known environment, the results for all actions are known to the agent	In unknown environment, agent needs to learn how it works in order to perform an action
Example : Card game 	Example : A new video game 

The Structure of Agents

- The intelligent agents (IA) structure consists of three main parts:
  - ✓ **Architecture,**
  - ✓ **Agent function,**
  - ✓ **Agent program**.
- **Architecture:** This refers to machinery or devices that consists of actuators and sensors. The intelligent agent executes on this machinery.

  Examples : a personal computer, a car, or a camera.
- **Agent function:** This is a function in which actions are mapped from a certain percept sequence.
- **Agent program:** This is an implementation or execution of the agent function.

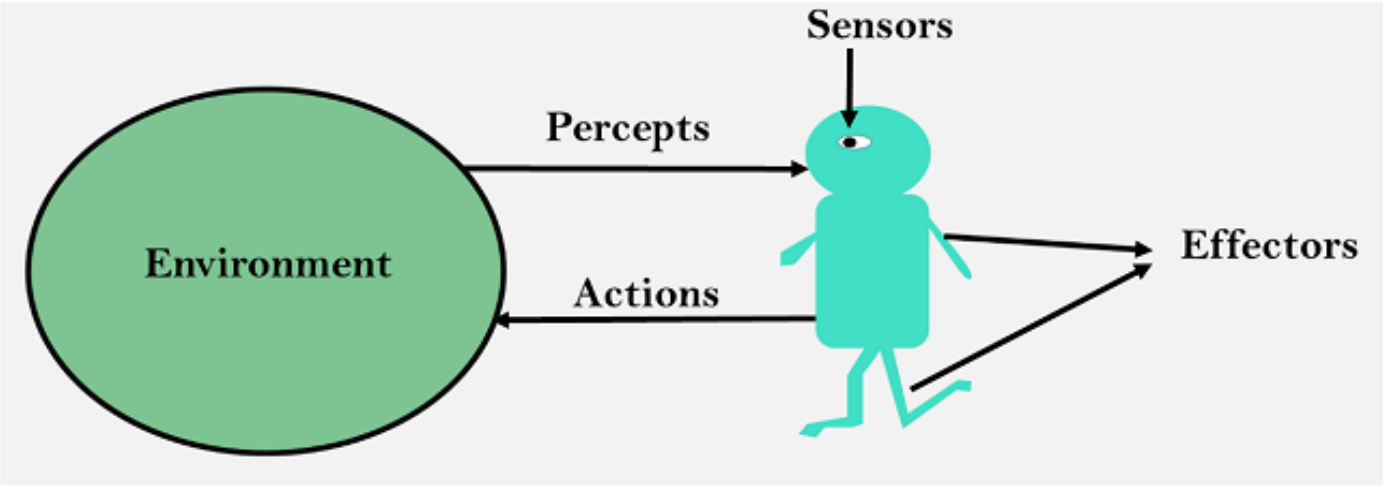
The agent function is produced through the agent program's execution on the physical architecture.

- The structure of an intelligent agent is a combination of architecture and agent program

  Agent's structure can be viewed as −

  - Agent = Architecture + Agent Program
  - Architecture = the machinery that an agent executes on.
  - Agent Program = an implementation of an agent function.

- The job of AI is to design an agent program that implements the agent function—the mapping from percepts to actions



Types of intelligent agent

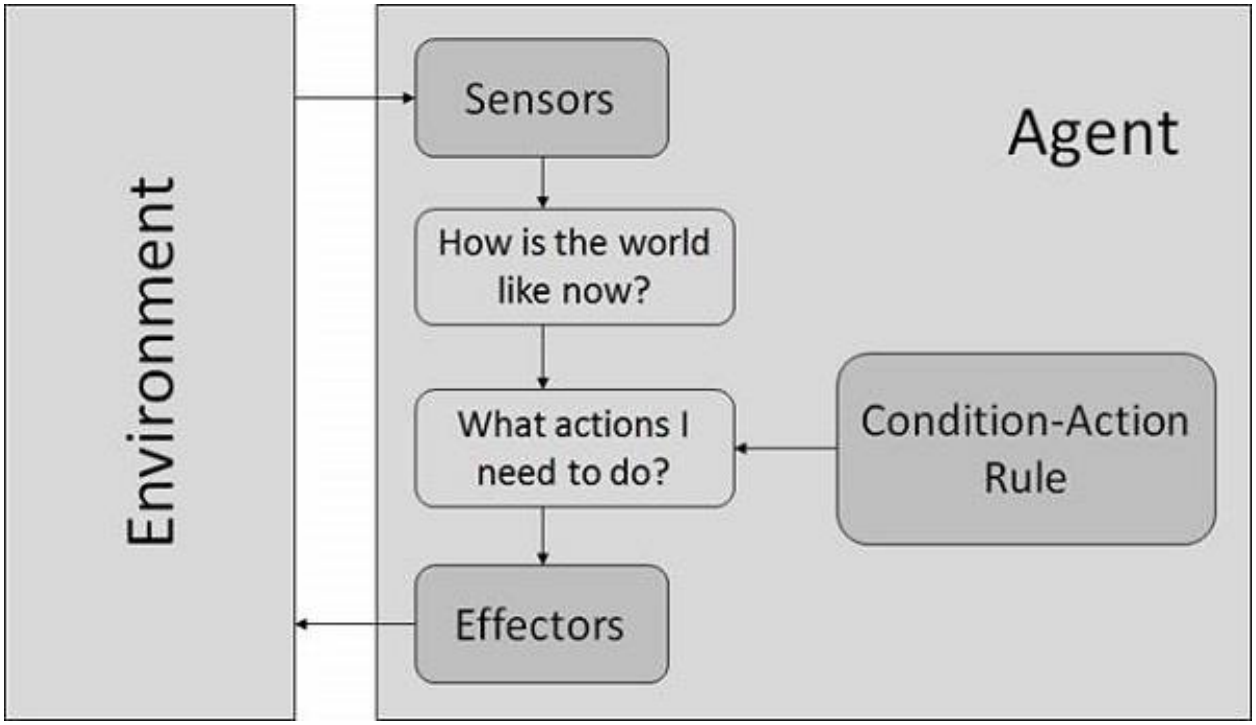
- Simple Reflex Agents.
- Model-Based Reflex Agents.
- Goal-Based Agents.
- Utility-Based Agents.
- Learning Agents.

Simple Reflex Agents

- They choose actions only based on the current percept.
- They are 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

Simple Reflex Agents



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

Model Based Reflex Agents

- They use a model of the world to choose their actions. They maintain an internal state.

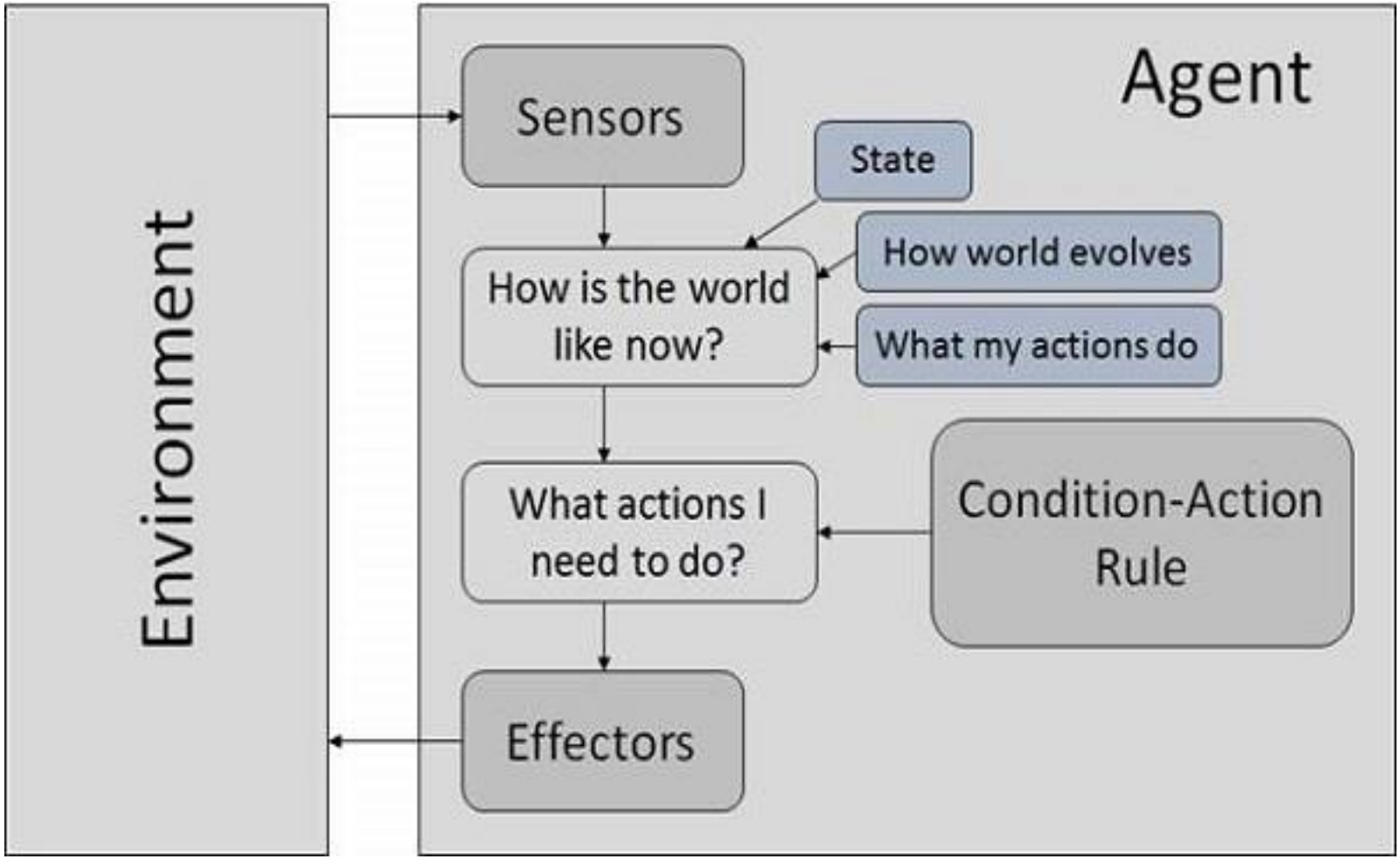
Model − knowledge about "how the things happen in the world".

Internal State − It is a representation of unobserved aspects of current state depending on percept history.

Updating the state requires the information about −

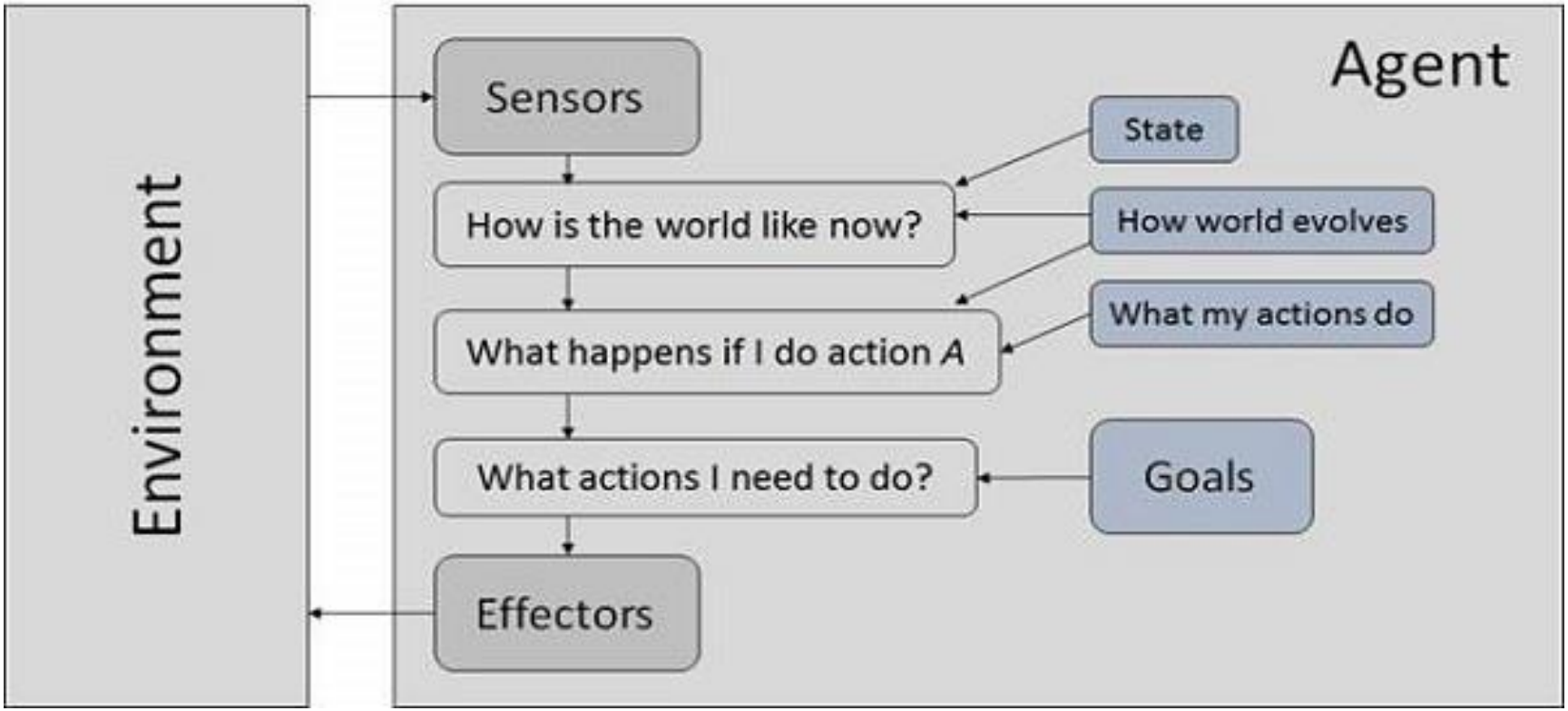
- How the world evolves.
- How the agent's actions affect the world.

Model Based Reflex Agents



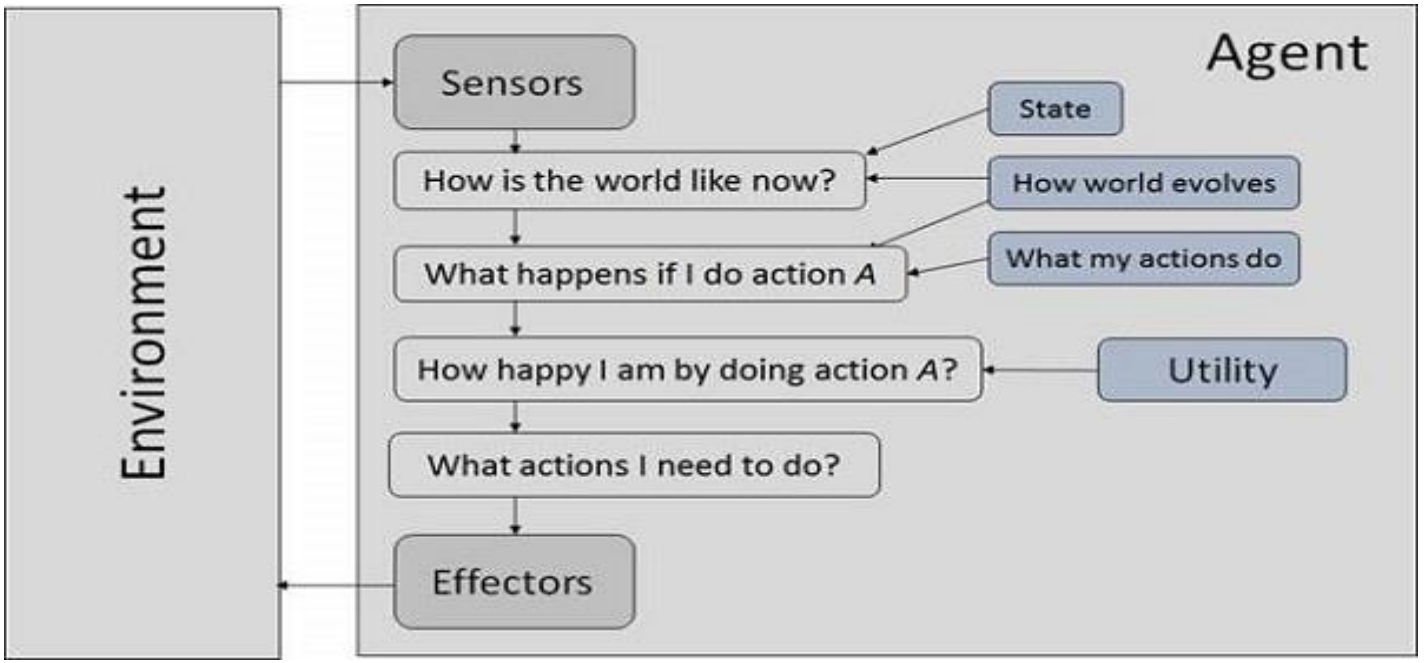
Goal Based Agents

- They 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 modeled, thereby allowing for modifications.
- **Goal** – It is the description of desirable situations



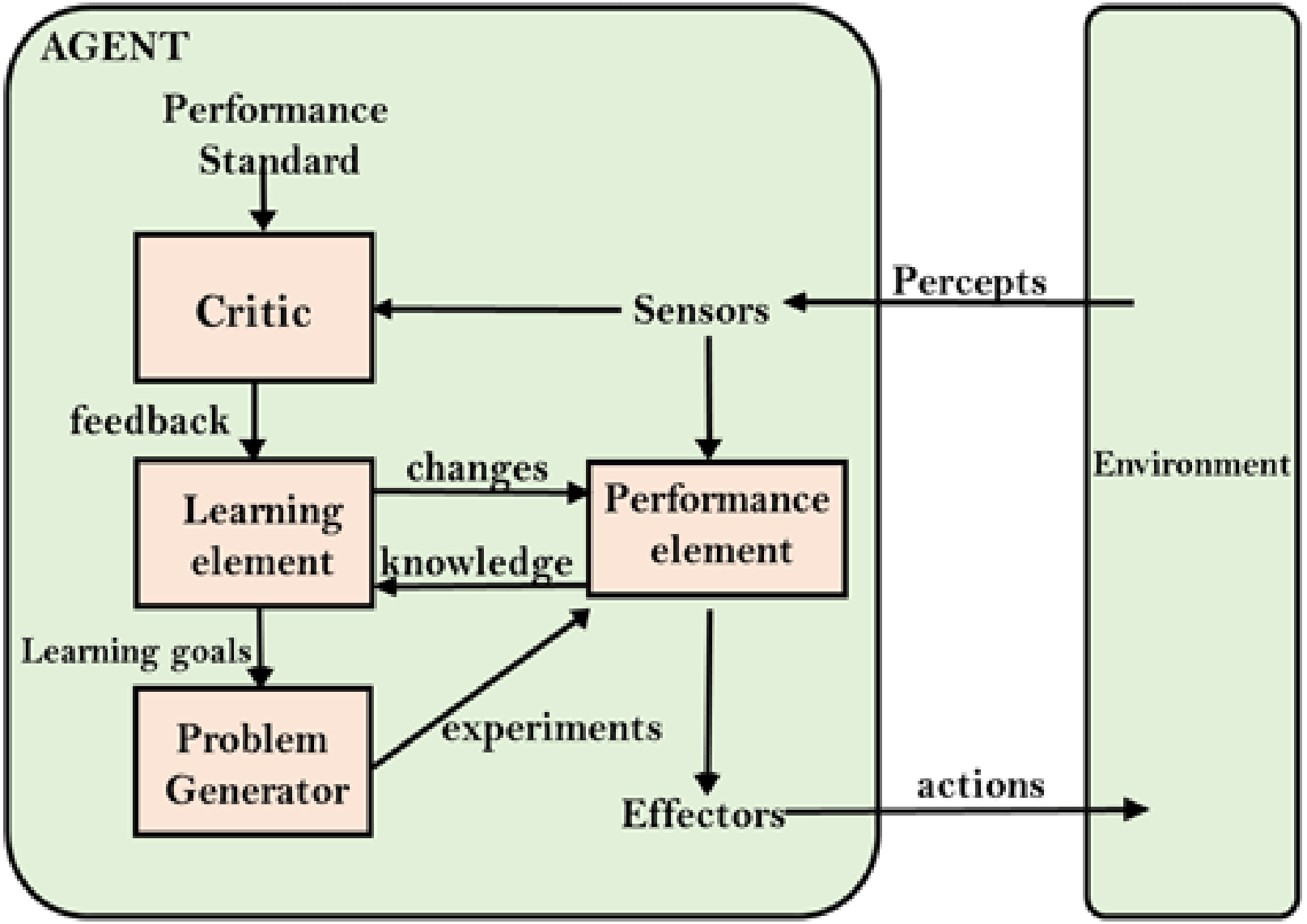
Utility Based Agents

- They 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.



Learning Agent

- A learning agent in AI is the type of agent that can learn from its past experiences or it has learning capabilities.
- It starts to act with basic knowledge and then is 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 the environment
  - ✓ **Critic:** The learning element takes feedback from critics which describes 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.


AGENT
Performance Standard
Critic
Sensors
Percepts
feedback
Learning element
changes
Performance element
knowledge
Environment
Learning goals
Problem Generator
experiments
Effectors
actions

Disadvantages of Artificial Intelligence

- High Costs

The ability to create a machine that can simulate human intelligence is no small feat. It requires plenty of time and resources and can cost a huge deal of money. AI also needs to operate on the latest hardware and software to stay updated and meet the latest requirements, thus making it quite costly.

- No Creativity

A big disadvantage of AI is that it cannot learn to think outside the box. AI is capable of learning over time with pre-fed data and past experiences, but cannot be creative in its approach

- Unemployment

One application of artificial intelligence is a robot, which is displacing occupations and increasing unemployment (in a few cases). Therefore, some claim that there is always a chance of unemployment as a result of chatbots and robots replacing humans.

- **Make Humans Lazy**

AI applications automate the majority of tedious and repetitive tasks. Since we do not have to memorize things or solve puzzles to get the job done, we tend to use our brains less and less. This addiction to AI can cause problems to future generations.

- **No Ethics**

Ethics and morality are important human features that can be difficult to incorporate into an AI. The rapid progress of AI has raised a number of concerns that one day, AI will grow uncontrollably, and eventually wipe out humanity. This moment is referred to as the AI singularity.

- **Emotionless**

Since early childhood, we have been taught that neither computers nor other machines have feelings. Humans function as a team, and team management is essential for achieving goals. However, there is no denying that robots are superior to humans when functioning effectively, but it is also true that human connections, which form the basis of teams, cannot be replaced by computers.

➢ No Improvement

Humans cannot develop artificial intelligence because it is a technology based on pre-loaded facts and experience. AI is proficient at repeatedly carrying out the same task, but if we want any adjustments or improvements, we must manually alter the codes. AI cannot be accessed and utilized akin to human intelligence, but it can store infinite data.

Machines can only complete tasks they have been developed or programmed for; if they are asked to complete anything else, they frequently fail or provide useless results, which can have significant negative effects. Thus, we are unable to make anything conventional.