UNIT-I

Introduction to Artificial Intelligence

WHAT IS ARTIFICIAL INTELLIGENCE?

Artificial Intelligence is composed of two words Artificial and Intelligence, where **Artificial defines "man-made," and intelligence defines "thinking power"**, hence AI means "a man-made thinking power."

So, we can define AI as:

 "It is a branch of computer science by which we can create intelligent machines which can behave like a human, think like humans, and able to make decisions."

FOUNDATIONS OF AI (ARTIFICIAL INTELLIGENCE)

- Philosophy

- Mathematics & Statistics

- Economics

- Neuroscience

- Psychology

- Computer Science and Engineering

- Control Theory and Cybernetics

- Linguistics

FOUNDATIONS OF AI (**PHILOSOPHY**)

Philosophy- Philosophy is the very basic foundation of AI.

The study of fundamental nature of knowledge, reality and existence are considering for solving a specific problem is a basic thing in Artificial Intelligence.

Philosophy defines that how 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?

FOUNDATIONS OF AI (**MATHEMATICS & STATISTICS**)

- AI required Formal logic and probability for planning and learning.

- Computation required for analyzing relation and implementation.

- Knowlegde in Formal Representation are most required for writing actions for agents.

- In AI, Mathematics and Statistics are important for - proving theorems, writing algorithms, computation, decidability, tractability, modeling uncertainity, learning from data.

- What are the formal rules to draw conclusions?

- What can be computed?

- How do we reason with uncertain information?

FOUNDATIONS OF AI (ECONOMICS)

- Deals with investing the amount of money and Maximization of utility with minimal investment.

- While developing an AI product, we should make decisions for When to invest? How to invest? Where to invest? How much to invest?

- To answer these questions one should have knowledge about Decision Tree, Game Theory, Operation Research, and etc.

- How should we make decisions in accordance with our preferences?

- 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?

FOUNDATIONS OF AI (NEUROSCIENCE)

- Neuroscience is the study of the nervous system, particulary the human brain.

- Human brains are somehow different, when compared to other creatures, man has the largest brain in proportion to his size.

- The brain consisted largely of nerve cells, or neurons, and the observations of individual neuron can lead to thought, action, and consciousness of one's brain.

- How do brains process information?
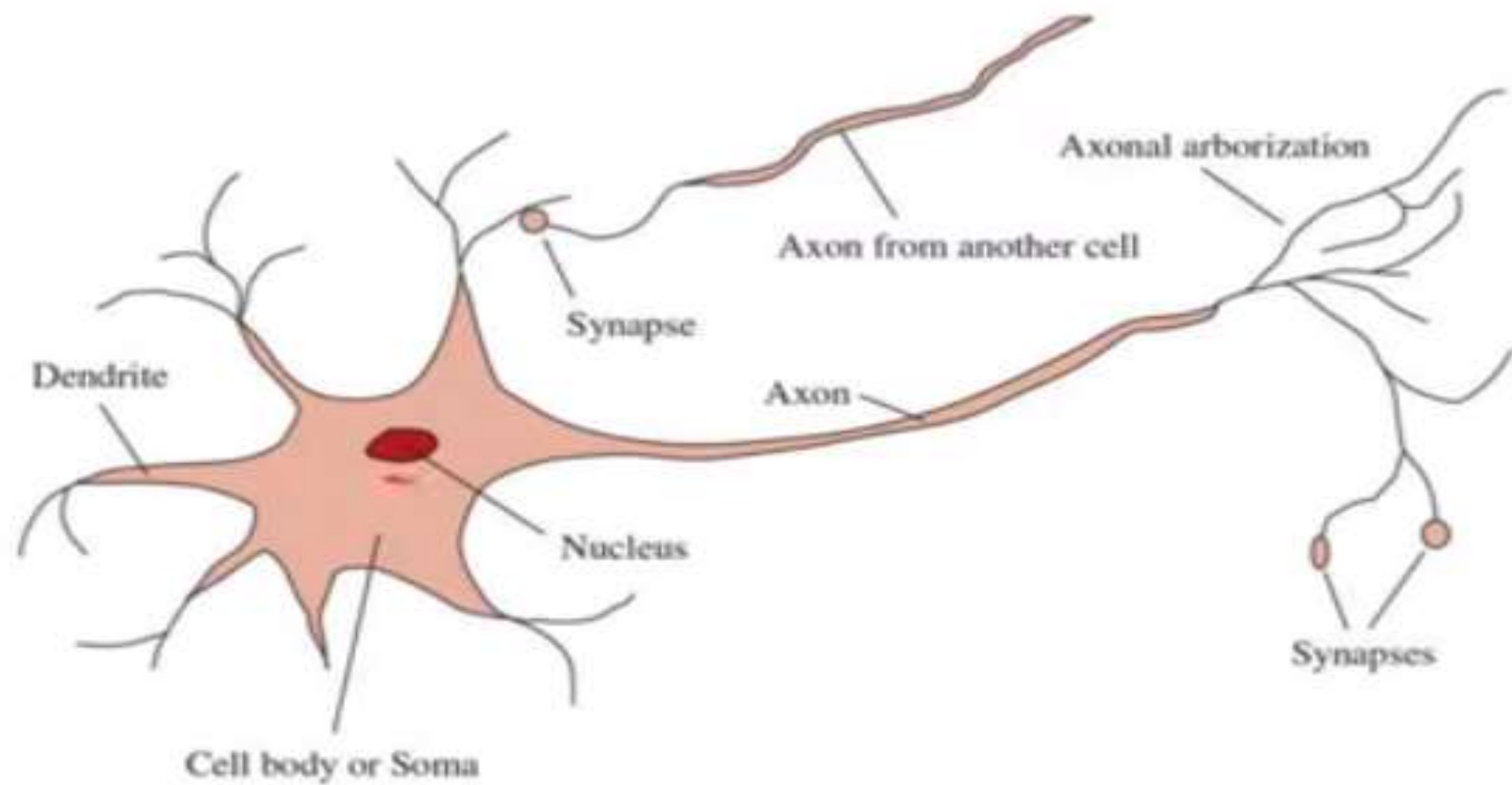
FOUNDATIONS OF AI (PSYCHOLOGY/COGNITIVE SCIENCE)

- The scientific method to the study of human vision.

- problem solving skills, how do people behave?

- perceive

- Process cognitive information and

- represent knowledge

- How do animals and humans think and act?

FOUNDATIONS OF AI (COMPUTER SCIENCE & ENGINEERING)

- Logic and inference theory, algorithms, programming languages, and system building are important parts of computer science.

- Computer hardware gradually changed for AI applications such as the Graphical processing unit (GPU), tensor Processing unit (TPU), and wafer scale engine (WSE).

- The amount of computing power used to train top machine learning applications and utilization doubled every 100 days.

- The Super computers and Quantum computers can solve every complicated AI problems.

- The software side of computer science, supplied operating systems, programming languages, and tools needed to write modern programs.

FOUNDATIONS OF AI (COMPUTER SCIENCE & ENGINEERING)

- AI has founded many ideas in modern and 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.

- How can we built an efficient computer?
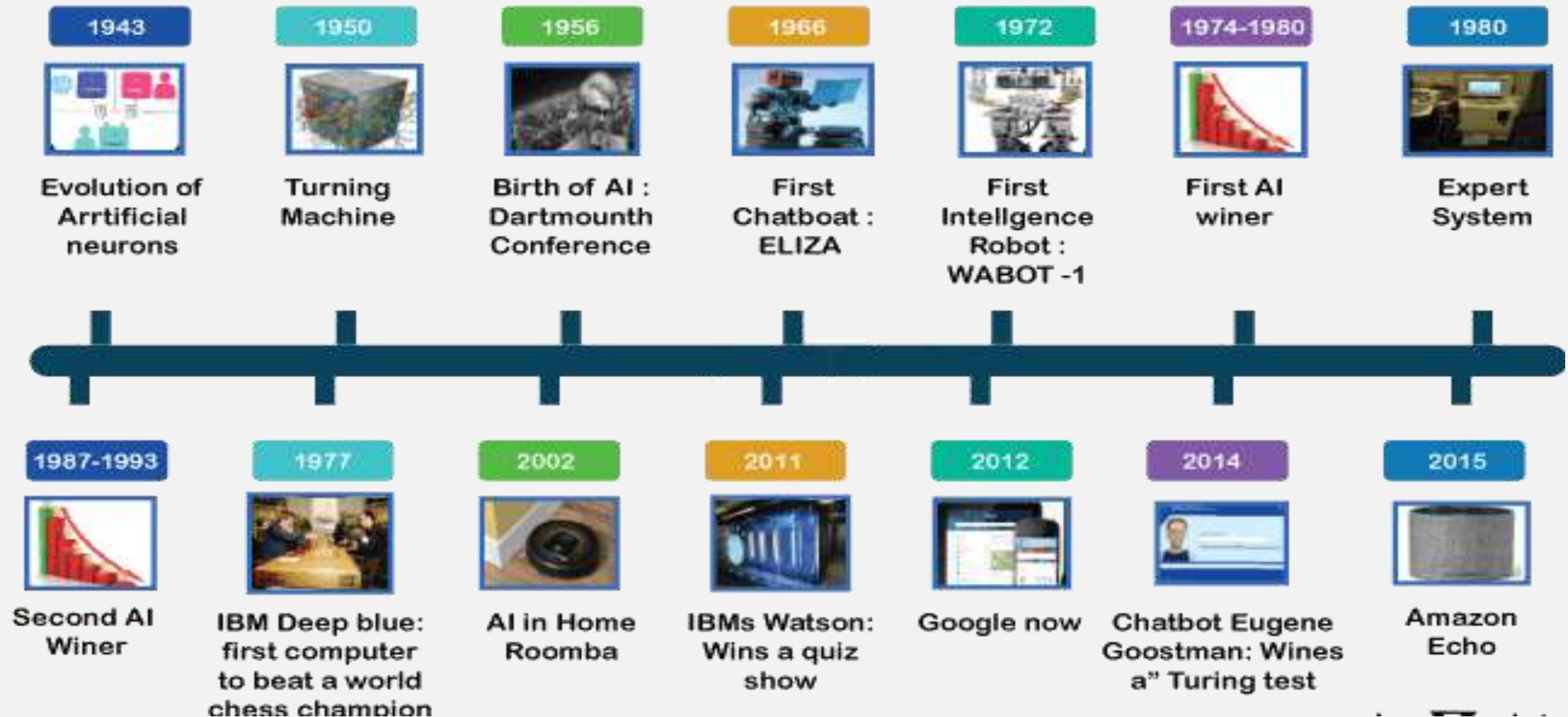
FOUNDATIONS OF AI (CONTROL THEORY AND CYBERNETICS)

- Control theory helps the system to analyze, define, debug and fix errors by itself.

- Developing self-controlling Machine, self-regulating feedback control systems and the submarine are some examples of control theory

- Calculas and Matrix Algebra, and the tools of control theory, provide themselves to systems that are describable by fixed sets of continuous variables are foundations of AI.

- Knowledge representation, grammars, computational linguistics or natural language processing (NLP) are significant to developing AI applications.

- The tools of logical inference and computation provide the language, vision and symbolic planning of agent programming.

- How can artifacts operate under their own control?

FOUNDATIONS OF AI (LINGUISTICS)

- Speech recognition is a technology which enables a machine to understand the spoken language and translate into a machine readable format.

- It is a way to talk with a computer, and on the basis of that command, a computer can perform a specific task.

- It includes Speech to text and Text to Speech.

- How does language relate to thoughts?

HISTORY OF ARTIFICIAL INTELLIGENCE

History of AI

1943	1950	1956	1966	1972	1974-1980	1980
Evolution of Arrtificial neurons	Turning Machine	Birth of AI : Dartmounth Conference	First Chatboat : ELIZA	First Intelgence Robot : WABOT -1	First AI winer	Expert System

1987-1993	1977	2002	2011	2012	2014	2015
Second AI Winer	IBM Deep blue: first computer to beat a world chess champion	AI in Home Roomba	IBMs Watson: Wins a quiz show	Google now	Chatbot Eugene Goostman: Wines a" Turing test	Amazon Echo

STATE OF THE ART

What is State-Of-Art?

- State-of-art is a **state characterization**. This characterization is mostly used in technology, science, advertising, and marketing. **State-of-the-art means the "newest" or "latest" version of a device, technology, or theory.**

- Artificial intelligence technologies have been evolving for decades. They did not enter our lives suddenly. The term state-of-art is used to describe the latest state of these technologies and their newest, most up-to-date, and most advanced versions.

- Artificial intelligence technologies are widespread today and will become even more widespread in the future.

- The main reason behind this is that these technologies are now serving daily life. Whether it's in hospitals, retail, security, education, or agriculture, AI technologies are making our jobs easier in almost every field you can think of.

- This brings with it the need to facilitate the use of these technologies. Machine-human communication cannot be limited to people who know to code and work in this field. Thanks to recent developments, this is no longer the case.

- The most up-to-date state-of-the-art artificial intelligence technologies are with us in many areas, such as text recognition, human detection, object detection, face recognition, emotion recognition, and photo editing.

RISKS OF AI

- Job Losses Due to AI Automation

- Social Manipulation Through AI Algorithms

- Social Surveillance With AI Technology

- Lack of Data Privacy Using AI Tools

- Biases Due to AI

- Socioeconomic Inequality as a Result of AI

- Weakening Ethics and Goodwill Because of AI

- Autonomous Weapons Powered By AI

- Financial Crises Brought About By AI Algorithms

- Loss of Human Influence

- Uncontrollable Self-Aware AI

BENEFITS OF AI

- High Accuracy with less errors

- High-Speed

- High reliability

- Useful for risky areas

- Digital Assistant

- Useful as a public utility

- Enhanced Security

- Aid in Research

AGENTS AND ENVIRONMENT

An agent is anything that can perceive its environment through sensors and acts upon that environment through effectors/actuators.

Examples of agents:-

- A human agent has sensory organs such as eyes,

ears, nose, tongue and skin parallel to the sensors,

and other organs such as hands, legs, mouth,

for effectors.

- A robotic agent replaces cameras and

infrared range finders for the sensors, and various motors

and actuators for effectors.

- A software agent has encoded bit strings as its programs and actions.
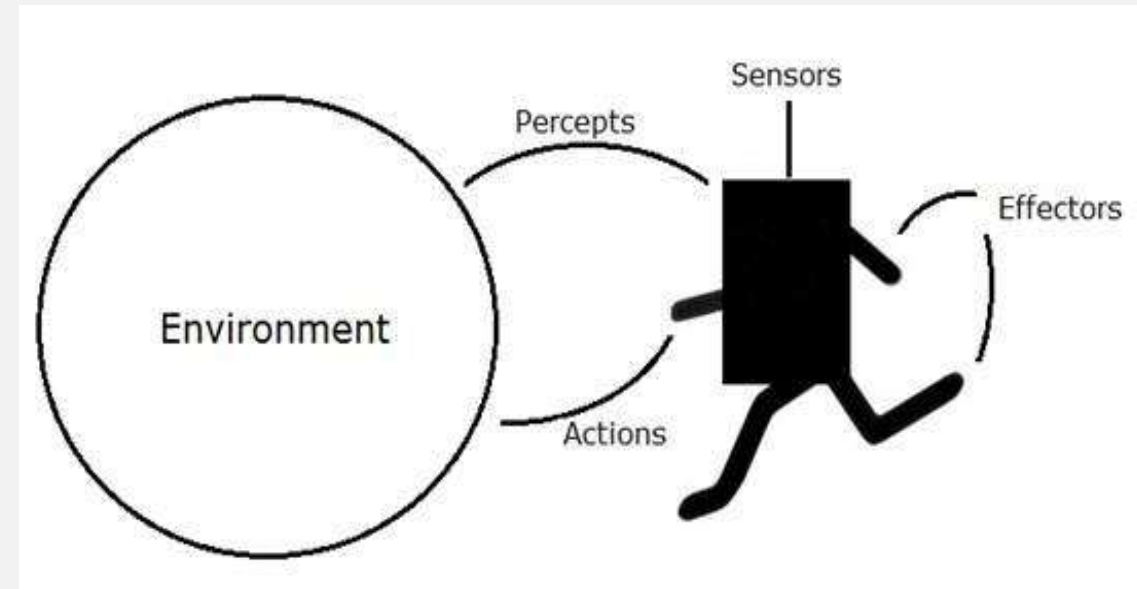
CLASSIFICATION /TYPES OF AGENTS

Agents can be classified into different types based on their characteristics, such as whether they are reactive or proactive, whether they have a fixed or dynamic environment, and whether they are single or multi-agent systems.

- Reactive agents are those that respond to immediate stimuli from their environment and take actions based on those stimuli. Proactive agents, take initiative and plan ahead to achieve their goals. The environment in which an agent operates can also be fixed or dynamic. Fixed environments have a static set of rules that do not change, while dynamic environments are constantly changing and require agents to adapt to new situations.

- Multi-agent systems involve multiple agents working together to achieve a common goal. These agents may have to coordinate their actions and communicate with each other to achieve their objectives. Agents are used in a variety of applications, including robotics, gaming, and intelligent systems. They can be implemented using different programming languages and techniques, including machine learning and natural language processing.

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.

- **Percept Sequence** − It is the history of all that an agent has perceived till date.

- **Agent Function** − It is a map from the precept sequence to an action.

RATIONALITY : GOOD BEHAVIOUR

- Rationality is nothing but status of being reasonable, sensible, and having good sense of judgment.

- Rationality is concerned with expected actions and results depending upon what the agent has perceived.

- Performing actions with the aim of obtaining useful information is an important part of rationality.

What is Ideal Rational Agent?

An ideal rational agent is the one, which is capable of doing expected actions to maximize its performance measure, on the basis of −

- Its percept sequence

- Its built-in knowledge base

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 the agent solves is characterized by P- Performance Measure, E – Environment , A- Actuators, and S - Sensors (PEAS).

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.

- 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 is mostly said to be non-feministic.

Features of Environment

As per Russell and Norvig, an environment can have various features from the point of view of an agent:

- Fully observable vs Partially Observable

- Static vs Dynamic

- Discrete vs Continuous

- Deterministic vs Stochastic

- Single-agent vs Multi-agent

- Episodic vs sequential

- Known vs Unknown

- Accessible vs Inaccessible

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.

THE STRUCTURE OF INTELLIGENT AGENTS

Agent's structure can be viewed as –

- **Agent = Architecture + Agent Program**

- **Architecture = the machinery that an AI agent executes on.**

- **Agent Program = an implementation of an agent function.**

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

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

$$f:P^* \rightarrow A$$

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.
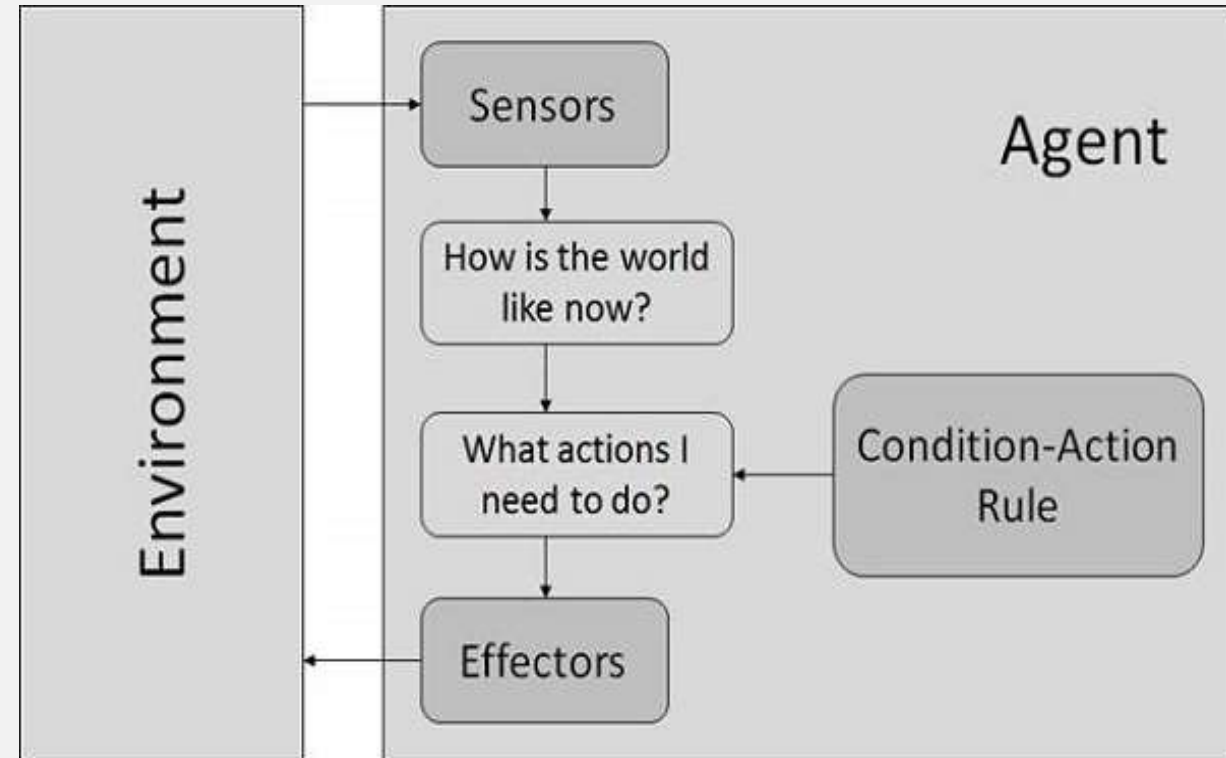
GOAL BASED AGENTS

- 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.

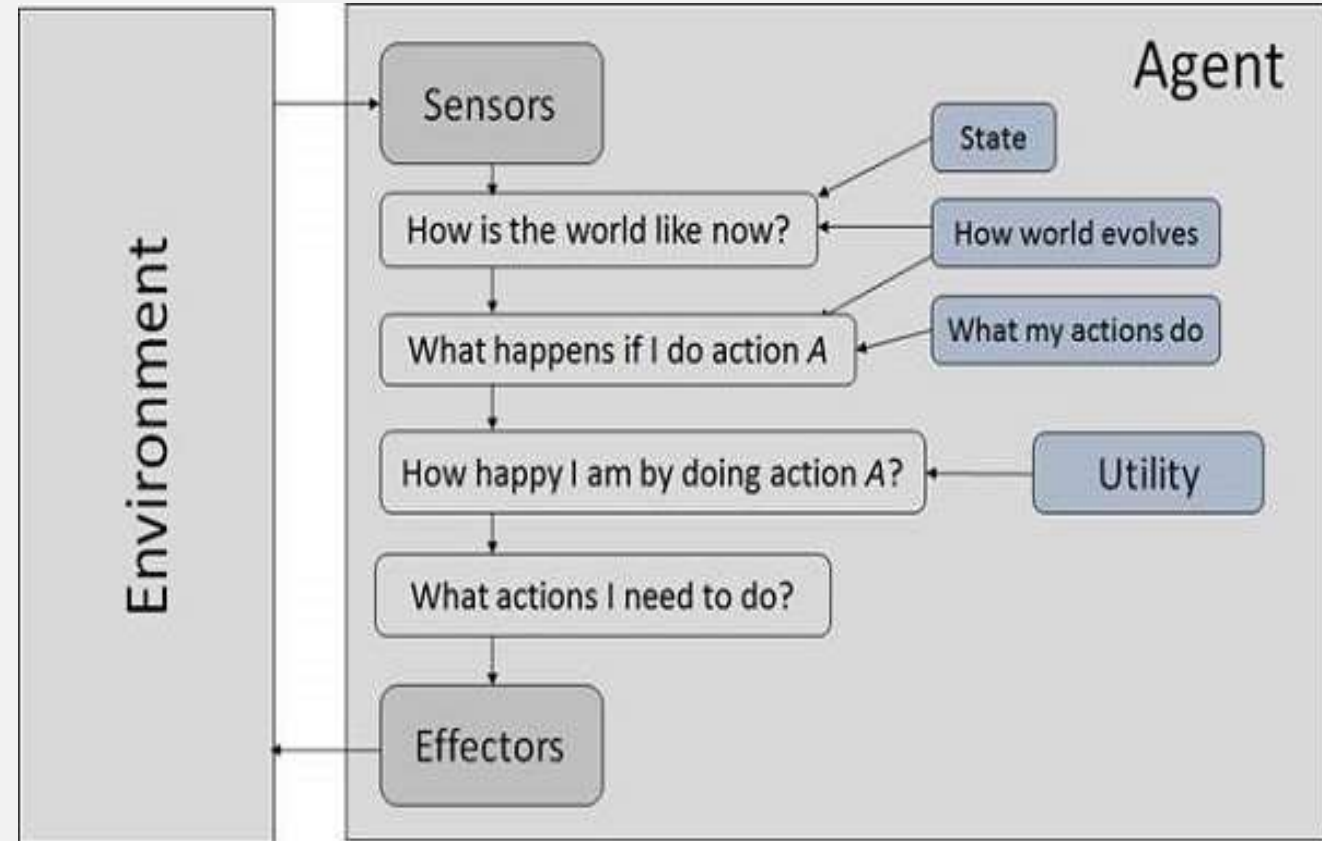- **Goal** − It is the description of desirable situations.
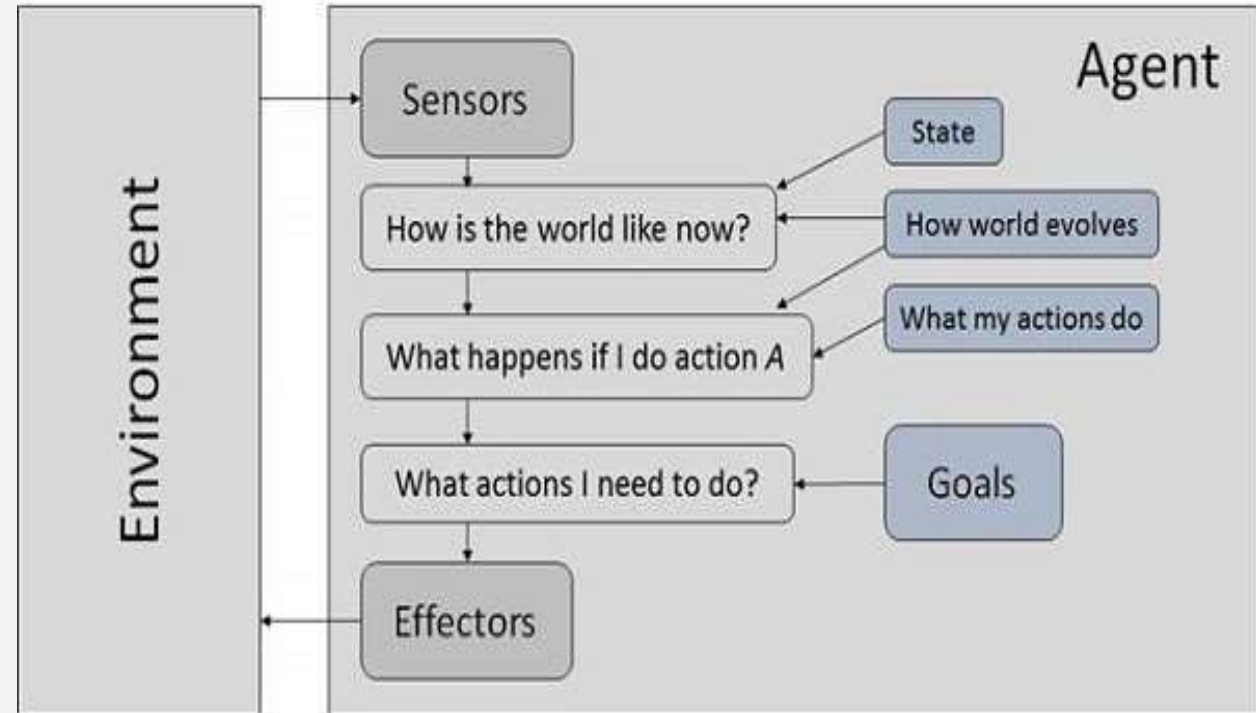
UTILITY BASED AGENTS

- 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.

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.
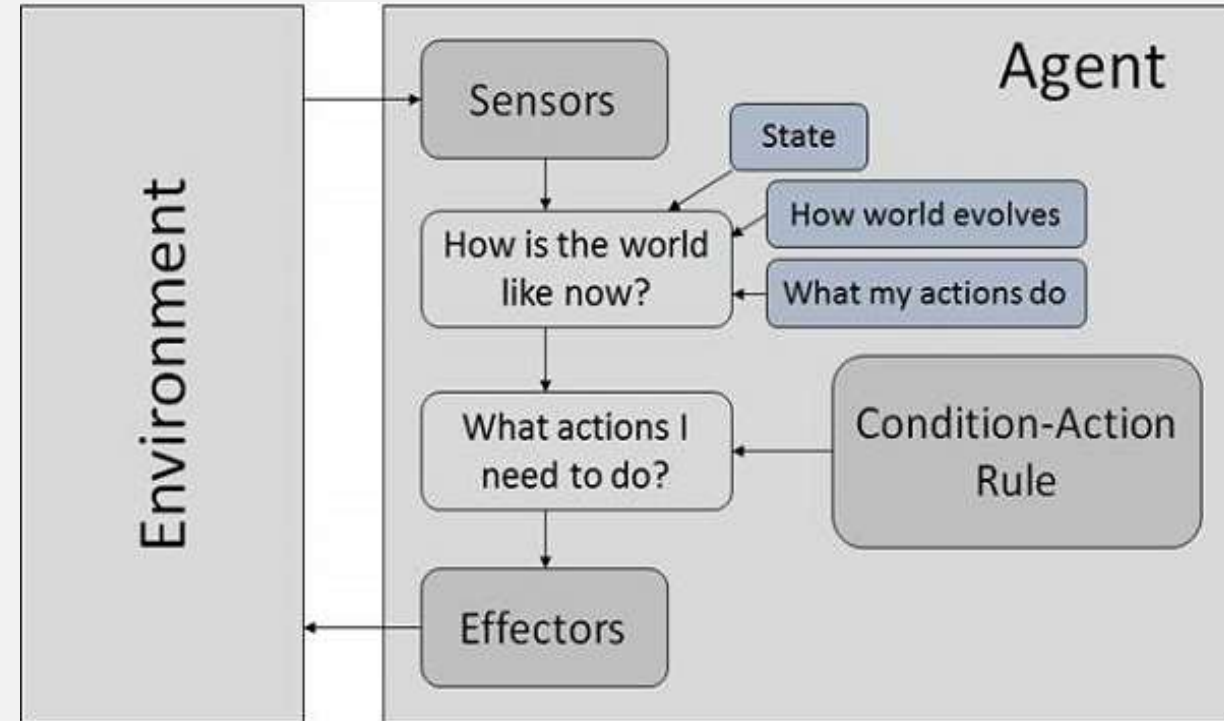
LEARNING AGENT

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.
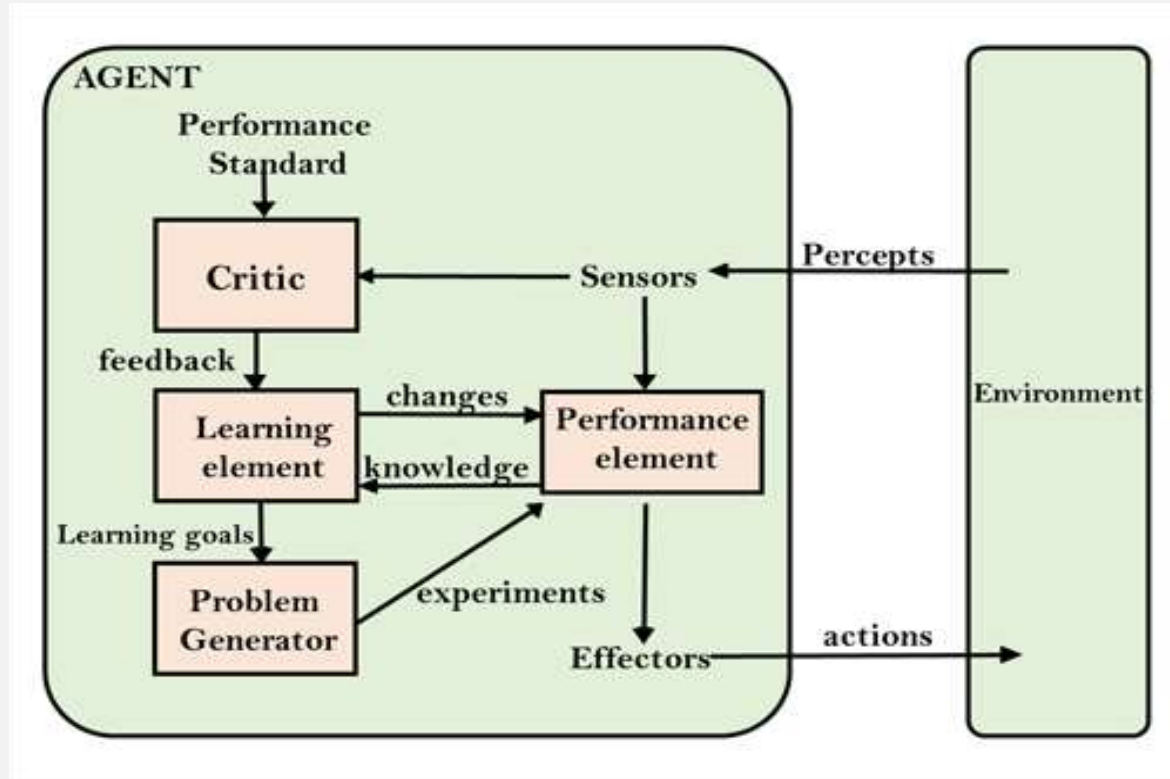
PROBLEM SOLVING APPROACH TO TYPICAL AI PROBLEMS