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.“*

- "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."

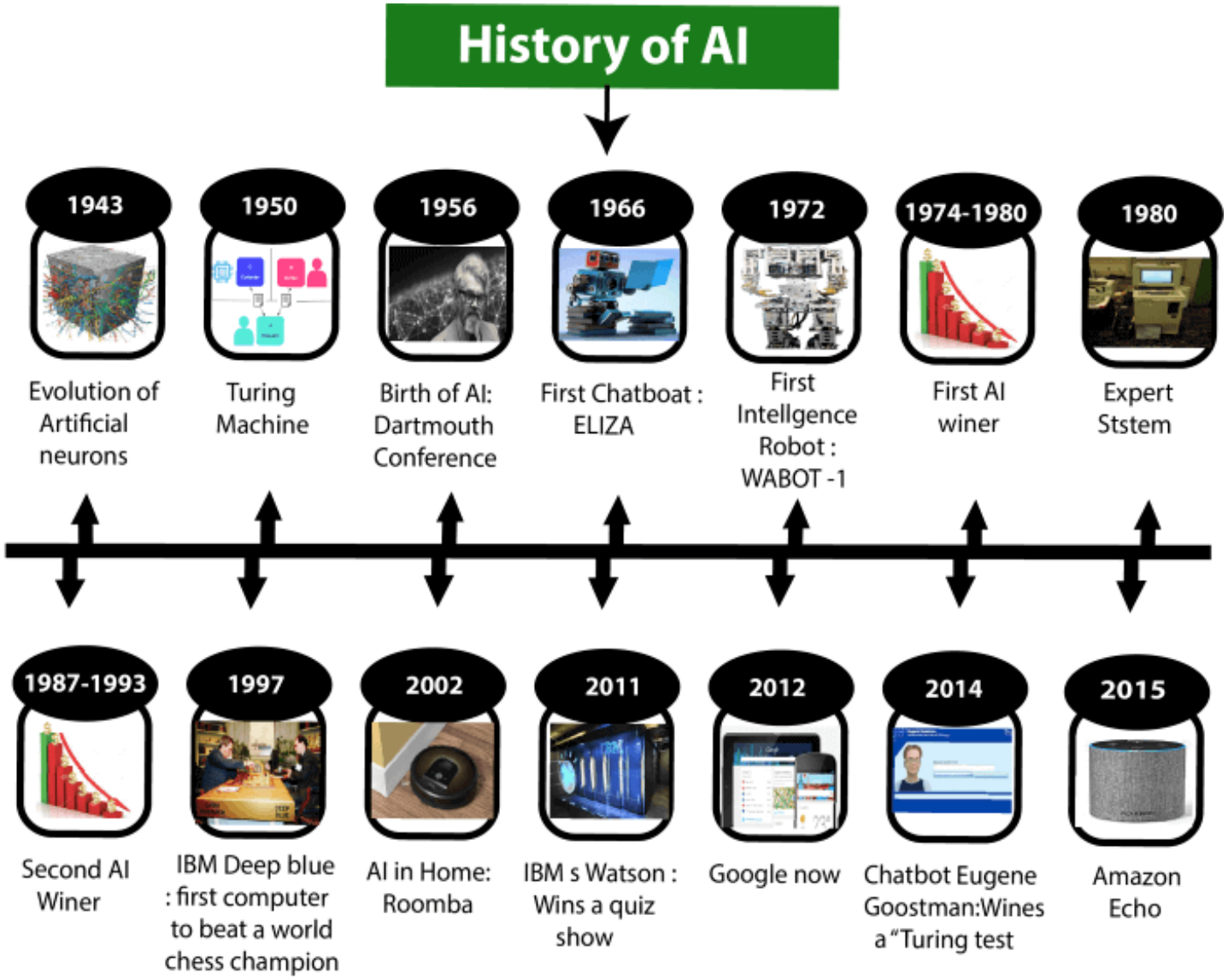
Advantages of Artificial Intelligence

- High Accuracy with less errors
- High-Speed
- High reliability
- Useful for risky areas
- Digital Assistant
- Useful as a public utility: self-driving car, facial recognition for security purpose, Natural language processing to communicate with the human in human-language etc

Disadvantages of Artificial Intelligence

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

Evolution of AI



Evolution of AI

- **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 1949:** Donald Hebb demonstrated an updating rule for modifying the connection strength between neurons. His rule is now called **Hebbian learning**.
- **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.

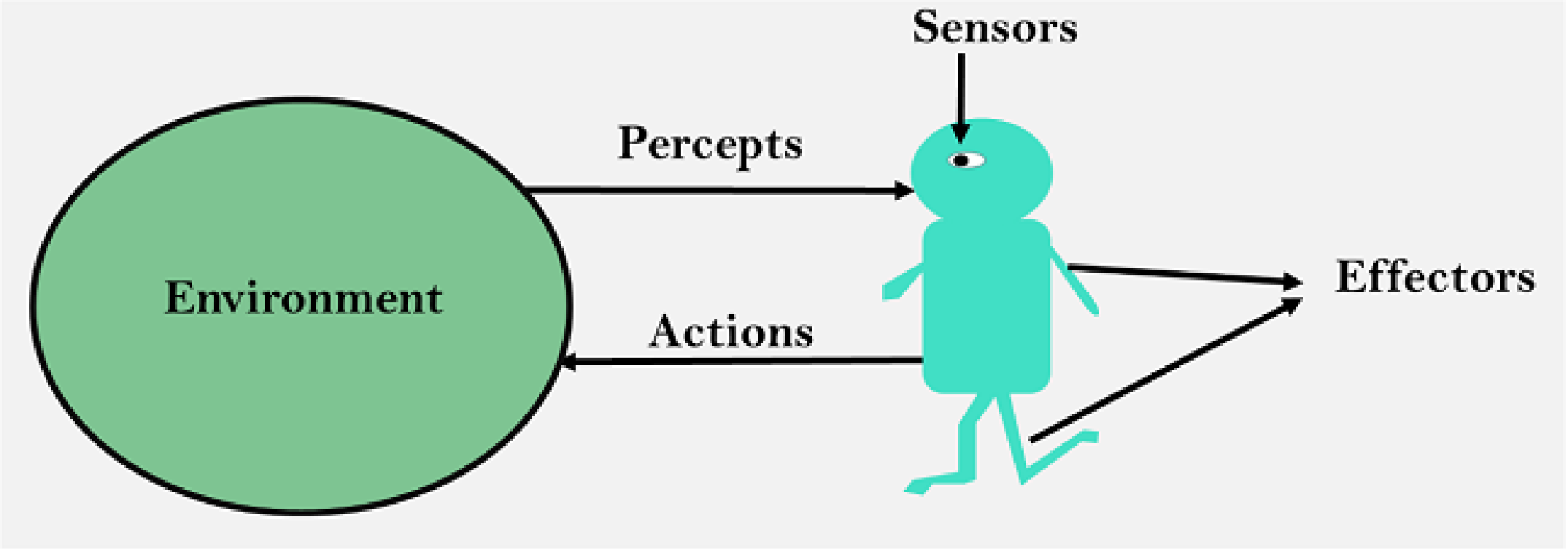
Continue..

- The first AI winter (1974-1980)
- **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.
- The second AI winter (1987-1993)
- **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, AI entered the home in the form of Roomba, a vacuum cleaner.
- **Year 2006:** AI came in the Business world till the year 2006. Companies like Facebook, Twitter, and Netflix also started using AI.

Continue..

- **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.
- **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.

Agent



What is 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

- **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.

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.

Types of Environment

1. Fully observable / Partially Observable
2. Deterministic / Stochastic
3. Episodic / Sequential
4. Single-agent / Multi-agent
5. Static / Dynamic
6. Discrete / Continuous

Fully observable / Partially Observable

Fully observable

- An agent can always see the entire state of an environment.
- **Example**: Chess

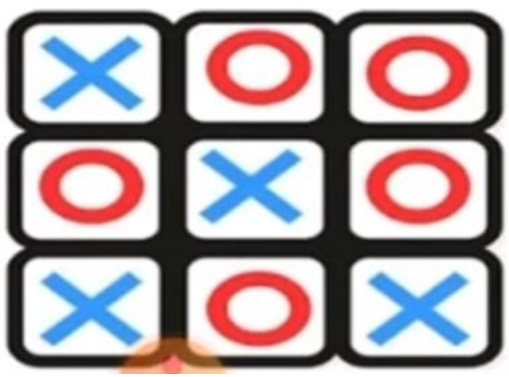
Partially Observable

- An agent can never see the entire state of an environment.
- **Example**: Card game

Deterministic / Stochastic

Deterministic

- An agent's current state and selected action can completely determine the next state of the environment.
- **Example:** Tic tac toe



Stochastic

- A stochastic environment is random in nature and cannot be determined completely by an agent.
- **Example**: Ludo (Any games that involve dice)

Episodic / Sequential

Episodic

- Only the current percept is required for the action
- Every episode is independent of each other
- **Example**: part picking robot

Sequential

- An agent requires memory of past actions to determine the next best actions.
- The current decision could affect all future decisions.
- **Example**: Chess

Single-agent / Multi-agent

Single-agent

- If only one agent is involved in an environment, and operating by itself then such an environment is called single agent environment.
- **Example**: maze

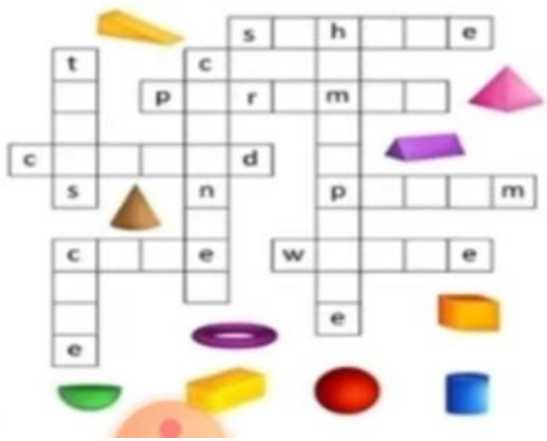
Multi-agent

- if multiple agents are operating in an environment, then such an environment is called a multi-agent environment.
- **Example**: football

Static / Dynamic

Static

- The environment does not change while an agent is acting
- **Example**: Crossword puzzles



Dynamic

- The environment may change over time

- **Example**: roller coaster ride

  Taxi driving

Discrete / Continuous

Discrete

- The environment consists of a finite number of actions that can be deliberated in the environment to obtain the output.
- **Example**: chess

Continuous

- The environment in which the actions performed cannot be numbered ie.,is not discrete, is said to be continuous.
- **Example**: Self-driving cars

Known / Unknown

Known

- In a known environment, the results for all actions are known to the agent.
- **Example**: Card game

Unknown

- In unknown environment, agent needs to learn how it works in order to perform an action.
- **Example**: A new video game

Intelligent Agents:

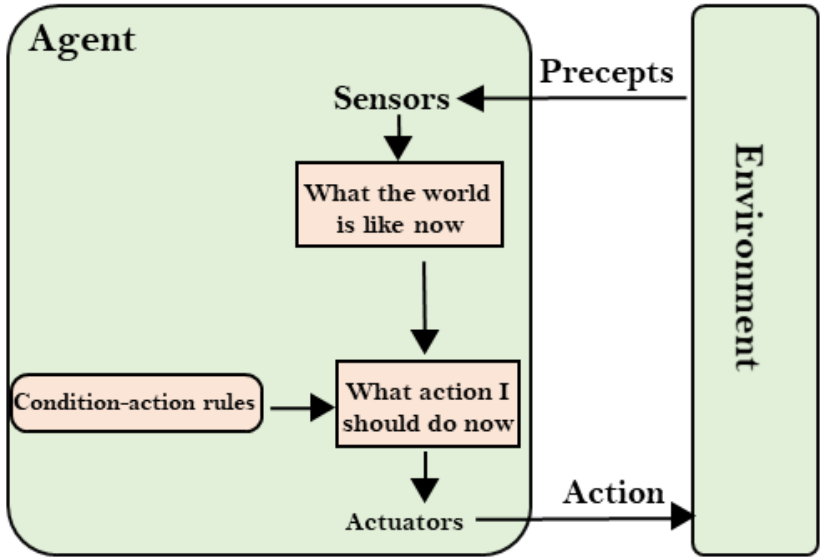
- An intelligent agent is an autonomous entity which act upon an environment using sensors and actuators for achieving goals. An intelligent agent may learn from the environment to achieve their goals.
- Following are the main four rules for an AI agent:
- **Rule 1:** An AI agent must have the ability 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

Types of AI Agents

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

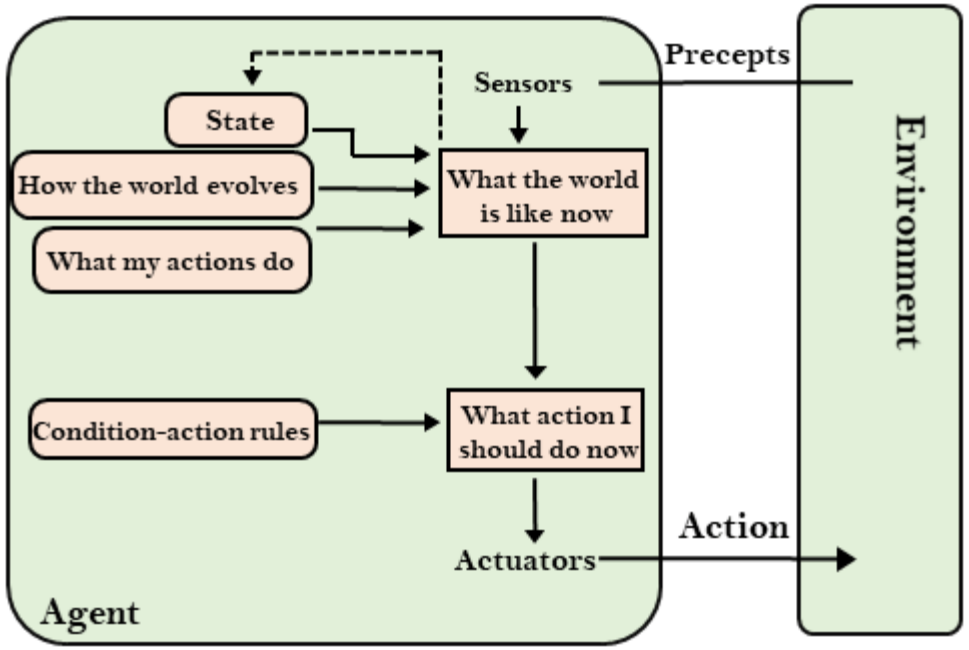
1. Simple Reflex agent:

- 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(If-then) 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 roor



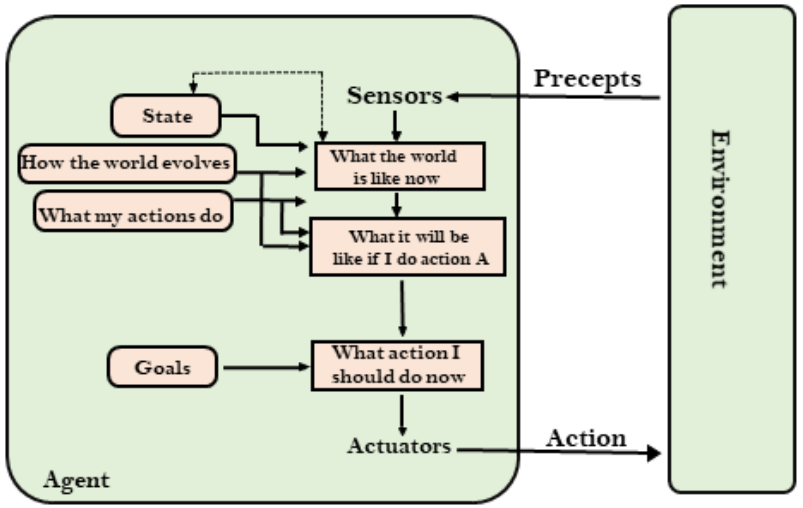
2. Model-based reflex agent

- 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.(Based on history)
  - **Internal State:** It is a representation of the current state based on percept history.



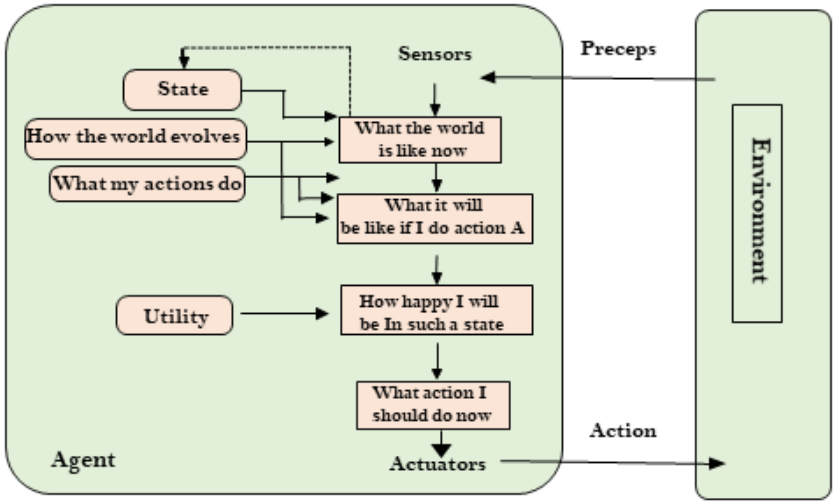
3. Goal-based agents

- 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.(searching and planning)
- These agents may have to consider a long sequence of possible actions before deciding whether the goal is achieved or not.



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.

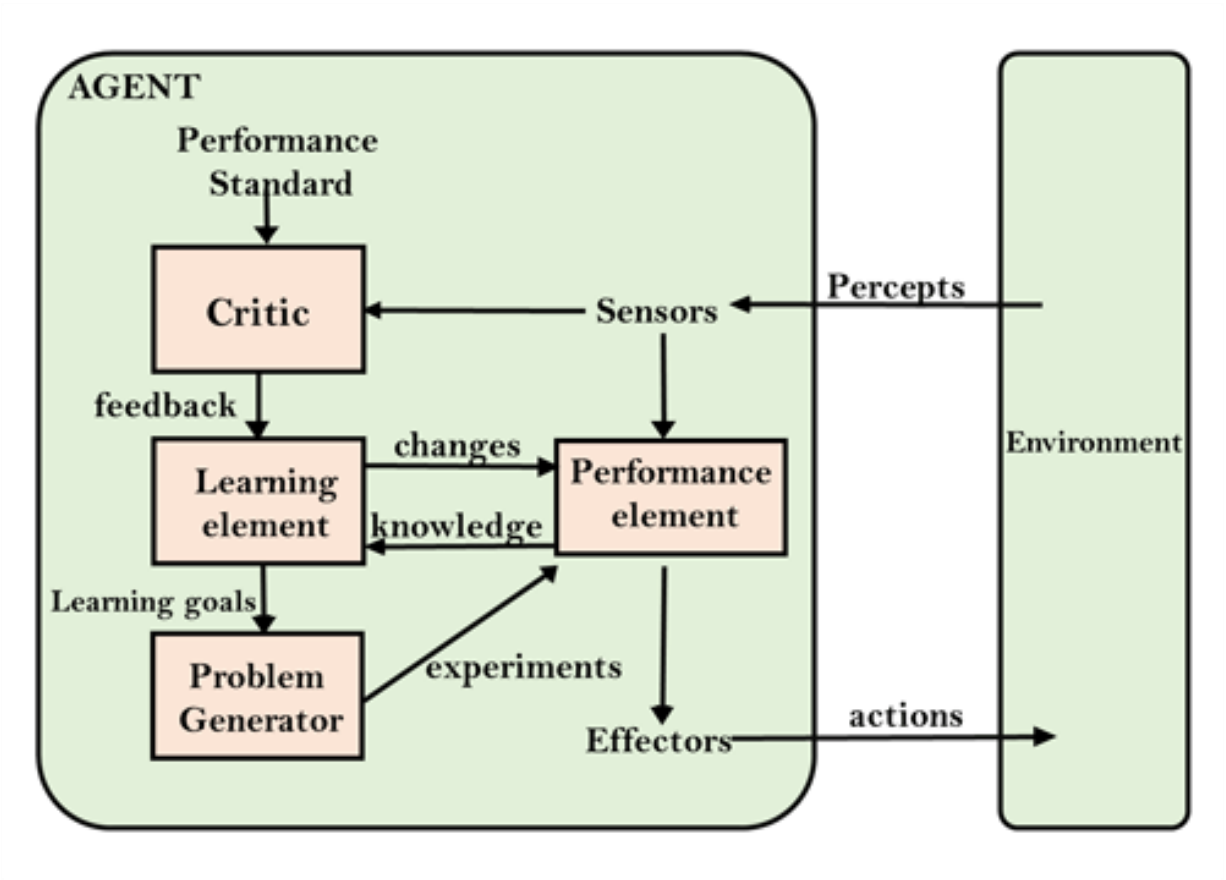


5. Learning Agents

- 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:

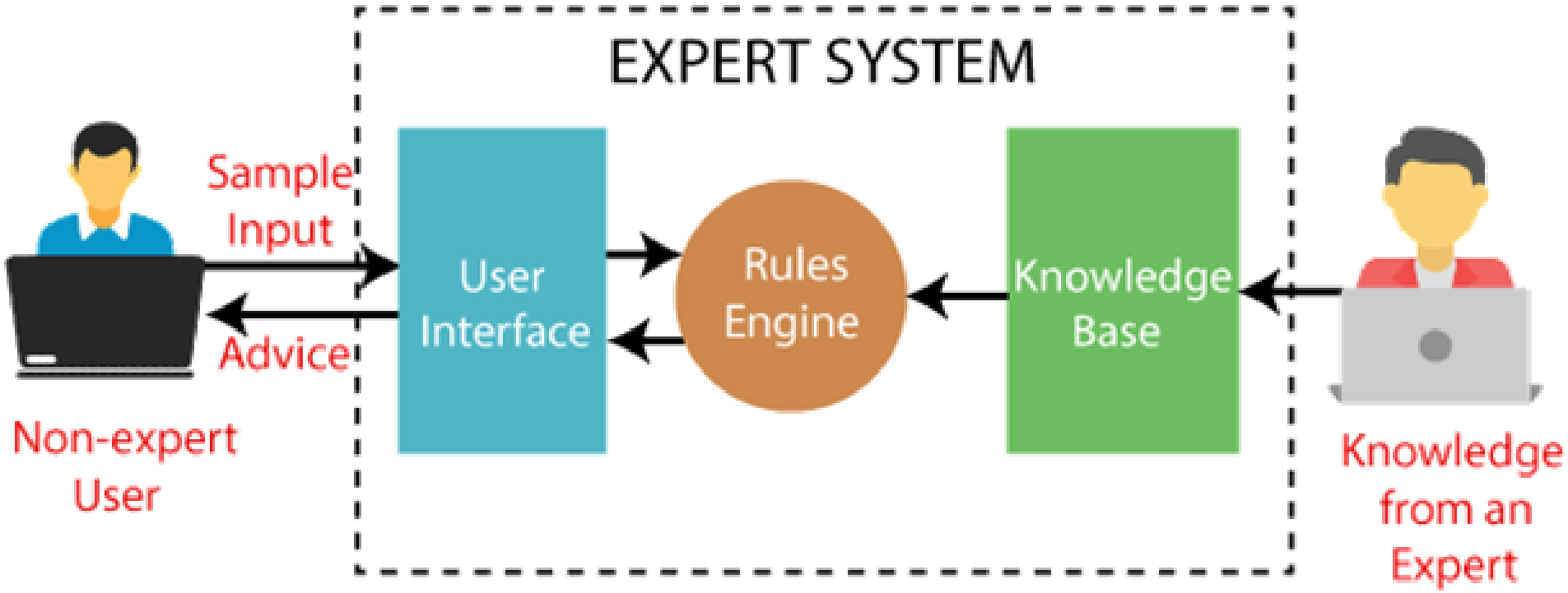
  - **Learning element:** It is responsible for making improvements by learning from environment(when to do what)
  - **Critic:** Learning element takes feedback from critic which describes that how well the agent is doing with respect to a fixed performance standard.(take feedback from environment)
  - **Performance element:** It is responsible for selecting external action(How to do everything)
  - **Problem generator:** This component is responsible for suggesting actions that will lead to new and informative experiences.

Continue..


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

Expert System

- An expert system is a computer program that is designed to solve complex problems and to provide decision-making ability like a human expert. It performs this by extracting knowledge from its knowledge base using the reasoning and inference rules according to the user queries.
- The performance of an expert system is based on the expert's knowledge stored in its knowledge base. The more knowledge stored in the KB, the more that system improves its performance. One of the common examples of an ES is a suggestion of spelling errors while typing in the Google search box.


EXPERT SYSTEM
Sample
Input
Advice
User
Interface
Rules
Engine
Knowledge
Base
Non-expert
User
Knowledge
from an
Expert

Components of Expert System

1. User Interface

- With the help of a user interface, the expert system interacts with the user, takes queries as an input in a readable format, and passes it to the inference engine. After getting the response from the inference engine, it displays the output to the user. In other words, **it is an interface that helps a non-expert user to communicate with the expert system to find a solution**.

2. Inference Engine(Rules of Engine)

- The inference engine is known as the brain of the expert system as it is the main processing unit of the system. It applies inference rules to the knowledge base to derive a conclusion or deduce new information. It helps in deriving an error-free solution of queries asked by the user.
- With the help of an inference engine, the system extracts the knowledge from the knowledge base

3. Knowledge Base

- The knowledgebase is a type of storage that stores knowledge acquired from the different experts of the particular domain. It is considered as big storage of knowledge. The more the knowledge base, the more precise will be the Expert System.
- It is similar to a database that contains information and rules of a particular domain or subject.

Examples of Expert System

some popular examples of the Expert System:

- **DENDRAL:** It was an artificial intelligence project that was made as a chemical analysis expert system. It was used in organic chemistry to detect unknown organic molecules with the help of their mass spectra and knowledge base of chemistry.
- **MYCIN:** It was one of the earliest backward chaining expert systems that was designed to find the bacteria causing infections like bacteraemia and meningitis. It was also used for the recommendation of antibiotics and the diagnosis of blood clotting diseases.
- **PXDES:** It is an expert system that is used to determine the type and level of lung cancer. To determine the disease, it takes a picture from the upper body, which looks like the shadow. This shadow identifies the type and degree of harm.
- **CaDeT:** The CaDet expert system is a diagnostic support system that can detect cancer at early stages.

Stages in the development of Expert Systems

1. Identification
2. Conceptualisation
3. Formalisation (Designing)
4. Implementation
5. Testing (Validation, Verification and Maintenance)

1. Identification

It is not enough simply to feel that the system would be helpful in a certain situation; we must determine the exact nature of the problem and state the precise goals that indicate exactly how we expect the expert system to contribute to the solution.

2. Conceptualisation

In the conceptualization stage, the knowledge engineer frequently creates a diagram of the problem to depict graphically the relationships between the objects and processes

It is often helpful at this stage to divide the problem into a series of sub-problems and to diagram both the relationships among the pieces of each sub-problem and the relationships among the various sub-problems

3. Formalization

During the formalization stage, the problem is connected to its proposed solution, an expert system, by analyzing the relationships depicted in the conceptualization stage.

4. Implementation

During the implementation stage, the formalized concepts are programmed onto the computer that has been chosen for system development, using the predetermined techniques and tools to implement a “first pass” prototype of the expert system.

5.Testing

Testing provides opportunities to identify the weakness in the structure and implementation of the system and to make the appropriate corrections.

Difficulties in development of expert system

1. Knowledge acquisition
2. Knowledge representation
3. Uncertainty
4. Maintenance
5. Integration

1.Knowledge acquisition

One of the main challenges in developing an expert system is acquiring the domain knowledge required to solve problems in that domain. This knowledge may be scattered across various sources and may be difficult to capture in a formal, computer-readable format.

2.Knowledge representation

Once the knowledge has been acquired, it needs to be represented in a way that the expert system can use. The representation must be able to capture the complex relationships between different pieces of knowledge and be efficient enough to allow the system to reason with the knowledge in a reasonable amount of time.

3.Uncertainty

Many real-world problems involve uncertain or incomplete information, and expert systems need to be able to handle this uncertainty. This can be challenging because there are different ways to represent uncertainty, and different approaches may be more appropriate depending on the domain.

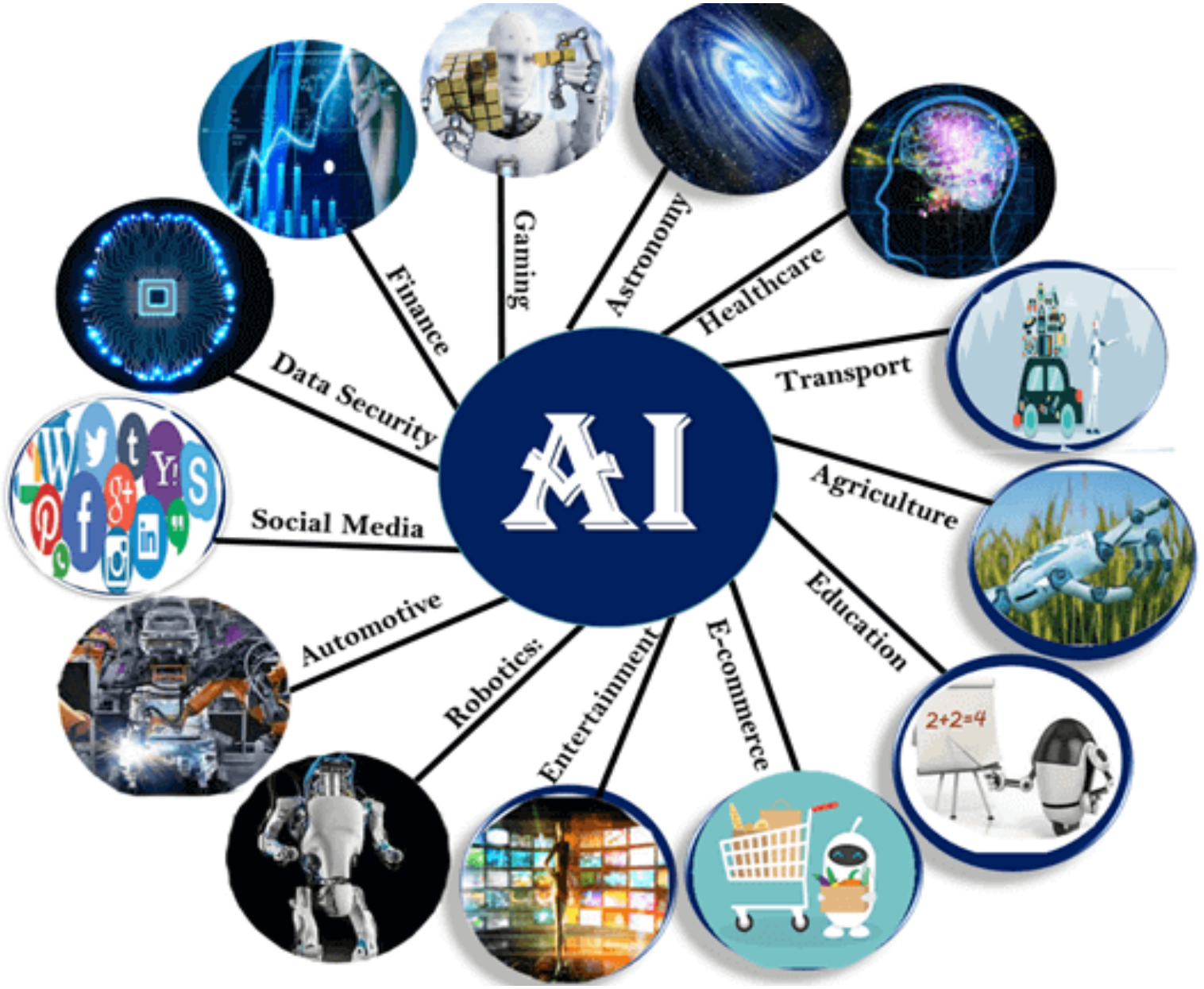
4. Maintenance

Expert systems need to be maintained over time as the domain knowledge and problem-solving methods evolve. This can be a significant challenge because it may require updating the system's knowledge base, retraining the system's reasoning algorithms, and ensuring that the system continues to work correctly with changes in the environment or user requirements.

5.Integration

Expert systems need to be integrated with other systems and processes in the organization to be useful. This can be challenging because the expert system may require data from other systems, and the output of the expert system may need to be integrated with other processes.

Applications of AI



- 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.