Artificial Intelligence

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Course Assessment Methods:

Homework Assignments: There will be homework assignments, which will measure the level of understanding and the skills attained by the students related to the assignment topic. At least three assignments will be part of the assessment.

Quizzes: There will be at least three quizzes. The purpose of the quizzes is to motivate the students to study the course material timely and make sure that the learning process is reinforced. In this way, it also measures the level of understanding of the students related to course material.

Examinations: There will be a mid-term and final-term exam. The purpose of the exams

is to measure the level of understanding of the students related to the course material.

Introduction

Artificial Intelligence (AI) is a rapidly growing field that focuses on making machines smart like humans. It has many uses, from playing games to helping doctors diagnose illnesses. Unlike other sciences, AI has a lot of room for new discoveries. It's like a big umbrella that covers many different things.

What is AI?

Artificial Intelligence (AI) is a type of technology that tries to make machines think and act like intelligent beings. It involves creating computer programs and systems that can learn, understand, and perform tasks that usually require human intelligence, such as recognizing speech or images, understanding language, or playing games.

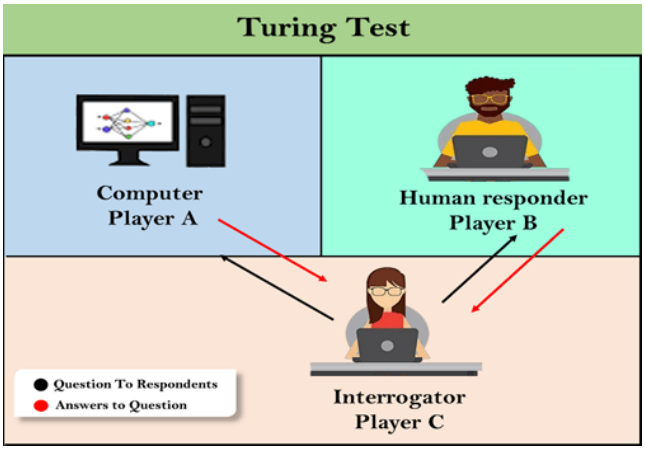
What is intelligence?

Intelligence is the ability of living beings, like humans, to learn, understand, and solve problems. It includes things like thinking, remembering, and making decisions.

So, while intelligence is what makes humans and animals smart, AI is about making machines smart by teaching them to do things that usually only humans can do.

1. **Acting humanly**: **The Turing test approach**

Turing test, which is a way to determine if a computer can think like a human. The test involves a human interrogator asking questions to both a person and a computer. If the interrogator cannot tell which responses come from the computer, then the computer is considered to have passed the test.



To pass the test, the computer needs certain capabilities, such as:

- **natural language processing** to understand and use human language;
- **knowledge representation** to store what it knows or hears;
- **automated reasoning** to answer questions and draw new conclusions;
- **machine learning** to learn from new situations;

- **computer vision** to interact with the real world requires computer vision, speech recognition;
- **robotics** to manipulate objects and move about;

2. Thinking humanly: The cognitive modeling approach

Thinking humanly refers to the ability of artificial intelligence (AI) systems to simulate or imitate human thinking processes. One approach to achieve this is known as cognitive modeling.

Cognitive modeling involves creating computer programs or algorithms that try to mimic the way humans think and solve problems. These models are built based on our understanding of human cognition, which refers to how our minds work, including processes like perception, memory, learning, and reasoning.

In the cognitive modeling approach, AI researchers' study and analyze human cognitive abilities and then try to replicate them in computer programs. They aim to create algorithms that can perform tasks in a similar way to how humans do it.

To distil the essence of the human mind, there are 3 approaches:

- **Introspection**: observing our thoughts, and building a model based on that
- **Psychological Experiments**: conducting experiments on humans and observing their behavior
- **Brain Imaging**: Using MRI to observe how the brain functions in different scenarios and replicating that through code.

For example, if we want a computer program to recognize objects in images like humans do, cognitive modeling would involve studying how humans perceive and recognize objects. Researchers would then create algorithms that try to replicate these processes, using techniques like pattern recognition and machine learning.

The cognitive modeling approach can help us understand human cognition better and create AI systems that can think and behave more like humans. It allows us to study and simulate human-like intelligence, which can be useful in fields such as psychology, education, and even improving AI technologies in various applications.

3. Thinking rationally: The "laws of thought" approach

Thinking rationally using the "laws of thought" approach is about applying logical principles to make intelligent decisions. Just as math has its rules, rational thinking has its own set of rules. These rules include principles like "something cannot be both true and false at the same time" or "if A is true, and B is true, then the combination of A and B is also true."

When AI systems think rationally, they follow these logical rules to process information and arrive at logical conclusions. By using these rules, the AI system can analyze data, make deductions, and determine the most reasonable outcomes. It ensures that the AI system's thinking is consistent, coherent, and aligned with the principles of logic. This logical approach allows AI systems to make smart decisions based on sound reasoning and reliable evidence, just like we do when we think critically and logically.

4. Acting rationally: The rational agent approach

Acting rationally using the rational agent approach means making smart choices to get the best results. Just like how we try to make the right decisions to achieve our goals, AI systems can do the same.

In this approach, AI systems act like "**smart agents**." They take in information from their surroundings, think about different options, and then choose the action that is most likely to give them the outcome they want. They use their knowledge and thinking abilities to make the best decision possible.

By following this approach, AI systems can make rational choices based on what they know and what they want to achieve. They consider different possibilities and pick the one that gives them the best chance of success. It's like having a helpful assistant that always tries to make the right choice for the best results.

The Foundations of Artificial Intelligence

The foundations of artificial intelligence (AI) are like the building blocks that make AI possible. They are the essential things that help computers and machines to be smart and make decisions.

Here are the basic foundations of AI:

1. **Math and Logic**: Computers use math and logic to solve problems and make sense of information. It's like following rules and doing calculations.
2. **Machine Learning**: Machines can learn from examples and experiences to get better at tasks. Just like how we learn from practice, machines can learn from data.
3. **Algorithms**: Algorithms are sets of instructions that tell computers what to do step by step. Different algorithms help machines do different things, like finding solutions or making choices.
4. **Statistics and Probability**: These help machines understand uncertainty and make guesses based on available information. It's like when we make predictions based on what we know.
5. **Cognitive Science and Psychology**: AI learns from how humans think and behave. It studies things like memory, problem-solving, and understanding to make computers smarter.
6. **Natural Language Processing**: It helps computers understand and communicate with humans using languages. This is important for things like virtual assistants and language translation.
7. **Robotics**: AI can be used to control robots, which are machines that can move and interact with the physical world. Robots can do tasks that require intelligence and physical abilities.
8. **Ethics and Responsible AI**: This is about making sure AI is used in a fair and responsible way. It involves considering things like privacy, fairness, and making sure AI doesn't cause harm.

By combining these foundations and improving them over time, we can create AI systems that can do things like understand language, solve problems, make decisions, and even interact with us in smart ways.

The History of Artificial Intelligence

Maturation of Artificial Intelligence (1943-1952)

- 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**.

The birth of Artificial Intelligence (1952-1956)

- Year 1955: An Allen Newell and Herbert A. Simon created the "first artificial intelligence program “Which was named as **Logic Theorist**". This program had proved 38 of 52 Mathematics theorems, and find new and more elegant proofs for some theorems.
- 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. At that time high-level computer languages such as FORTRAN, LISP, and COBOL were invented. And the enthusiasm for AI was very high at that time.

The golden years-Early enthusiasm (1956-1974)

- 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 first AI winter (1974-1980)

- 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.

A boom of AI (1980-1987)

- 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 second AI winter (1987-1993)

- 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.

The emergence of intelligent agents (1993-2011)

- 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.

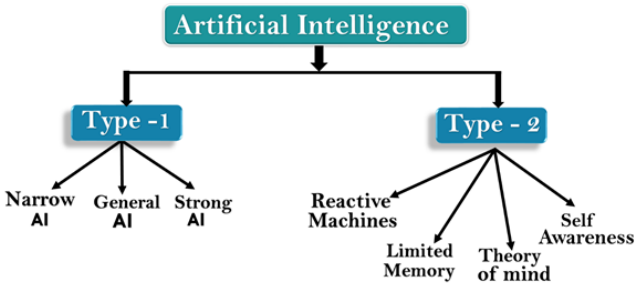
Deep learning, big data and artificial general intelligence (2011-present)

- 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."
- Year 2018: The "**Project Debater**" from IBM debated on complex topics with two master debaters and also performed extremely well.
- Google has demonstrated an AI program "**Duplex**" which was a virtual assistant and which had taken hairdresser appointment on call, and lady on other side didn't notice that she was talking with the machine.

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.

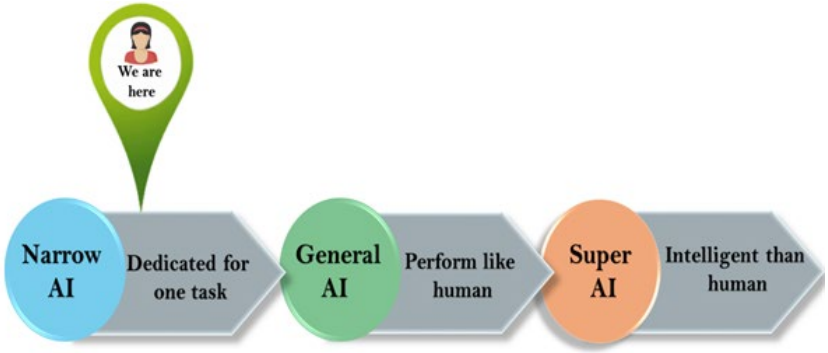
Types of Artificial Intelligence:

Artificial Intelligence can be divided in various types, there are mainly two types of main categorization which are based on capabilities and based on functionally of AI. Following is flow diagram which explain the types of AI.



AI type-1: Based on Capabilities

1. **Weak AI or Narrow AI:**
   - Narrow AI is a type of AI which is able to perform a dedicated task with intelligence. The most common and currently available AI is Narrow AI in the world of Artificial Intelligence.
   - Narrow AI cannot perform beyond its field or limitations, as it is only trained for one specific task. Hence it is also termed as weak AI. Narrow AI can fail in unpredictable ways if it goes beyond its limits.
   - Apple Siri is a good example of Narrow AI, but it operates with a limited pre-defined range of functions.
   - IBM's Watson supercomputer also comes under Narrow AI, as it uses an Expert system approach combined with Machine learning and natural language processing.
   - Some Examples of Narrow AI are playing chess, purchasing suggestions on e-commerce site, self-driving cars, speech recognition, and image recognition.
2. **General AI:**
   - General AI is a type of intelligence which could perform any intellectual task with **efficiency like a human**.
   - The idea behind the general AI to make such a system which could be **smarter and think like a human by its own**.
   - Currently, there is **no such system exist** which could come under general AI and can perform any task as perfect as a human.
   - The worldwide **researchers are now focused** on developing machines with General AI.
   - As systems with general AI are **still under research**, and it will take lots of efforts and time to develop such systems.
3. **Super AI:**
   - Super AI is a level of Intelligence of Systems at which **machines could surpass human intelligence**, and can perform any **task better than human** with cognitive properties. It is an outcome of general AI.
   - Some key characteristics of strong AI include capability include the **ability to think**, to **reason**, **solve the puzzle**, **make judgments**, **plan**, **learn**, and **communicate by its own**.
   - Super AI is still a **hypothetical concept** of Artificial Intelligence. Development of such systems in real is still world changing task.



Artificial Intelligence type-2: Based on functionality

1. Reactive Machines

- Purely reactive machines are the **most basic types** of Artificial Intelligence.
- Such AI systems **do not store memories or past experiences** for future actions.
- These machines only **focus on current scenarios** and react on it as per possible best action.
- **IBM's Deep Blue system** is an example of reactive machines.
- Google's **AlphaGo** is also an example of reactive machines.

2. Limited Memory

- Limited memory machines can **store past experiences** or some **data for a short period** of time.
- These machines can use stored **data for a limited time period** only.
- **Self-driving cars** are one of the best **examples of Limited Memory systems**. These cars can store recent speed of nearby cars, the distance of other cars, speed limit, and other information to navigate the road.

3. Theory of Mind

- Theory of Mind AI should understand the human emotions, people, beliefs, and be able to interact socially like humans.
- This type of AI machines are **still not developed**, but researchers are making lots of efforts and improvement for developing such AI machines.

4. Self-Awareness

- Self-awareness AI is the **future of Artificial Intelligence**. These machines will be super intelligent, and will have their own consciousness, sentiments, and self-awareness.
- These machines will be **smarter than human mind**.
- Self-Awareness AI **does not exist in reality** still and it is a **hypothetical concept**.

Agents in Artificial Intelligence

An AI system can be defined as the **study of the rational agent and its environment**. The agents sense the **environment** through **sensors** and **act** on their environment through **actuators**. An AI agent can have mental properties such as knowledge, belief, intention, etc.

What is an Agent in AI?

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.

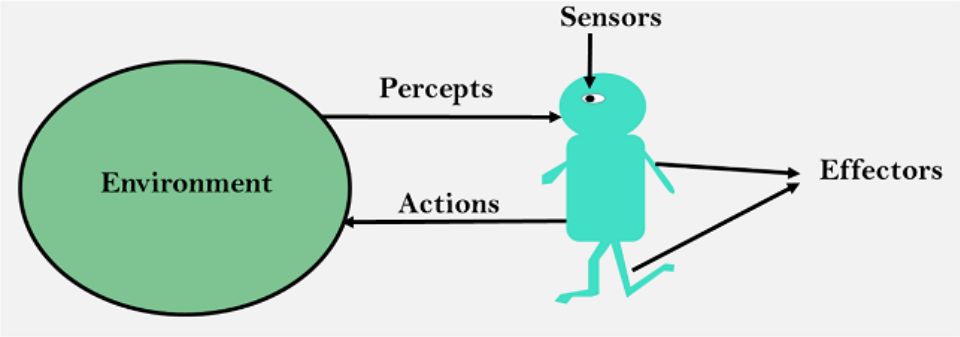
Hence the world around us is full of agents such as thermostat, cellphone, camera, and even we are also agents.

Before moving forward, we should first know about sensors, effectors, and actuators.

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.



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.

Rational Agent:

A Rational Agent is an Intelligent Agent that makes decisions based on logical reasoning and optimizes its behavior to achieve a specific goal.

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.

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.

Structure of an AI Agent

The task of AI is to design 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.

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

Agent program: An 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 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

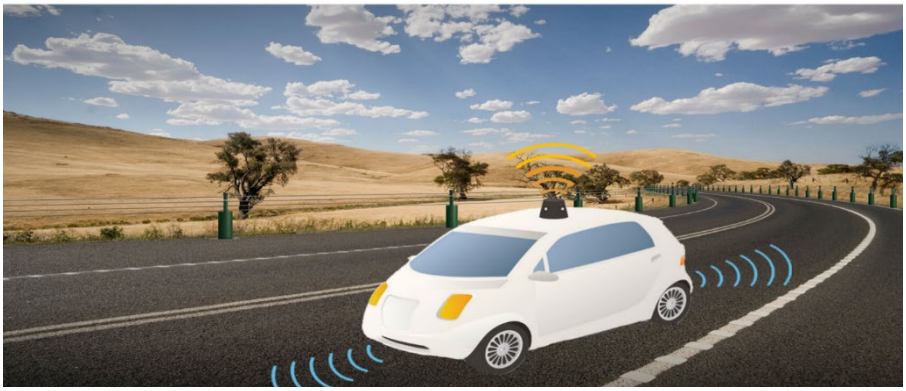
E: Environment

A: Actuators

S: Sensors

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

PEAS for self-driving cars:



Let's suppose a self-driving car then PEAS representation will be:

Performance: Safety, time, legal drive, comfort

Environment: Roads, other vehicles, road signs, pedestrian

Actuators: Steering, accelerator, brake, signal, horn

Sensors: Camera, GPS, speedometer, odometer, accelerometer, sonar.

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.

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.

Features of Environment

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

1. Fully observable vs Partially Observable

2. Static vs Dynamic
3. Discrete vs Continuous
4. Deterministic vs Stochastic
5. Single-agent vs Multi-agent
6. Episodic vs sequential
7. Known vs Unknown
8. Accessible vs Inaccessible

1. 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.

2. 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.

3. 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.

4. 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.

5. 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.

6. 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.

7. 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.

8. 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.

Types of Agents in AI

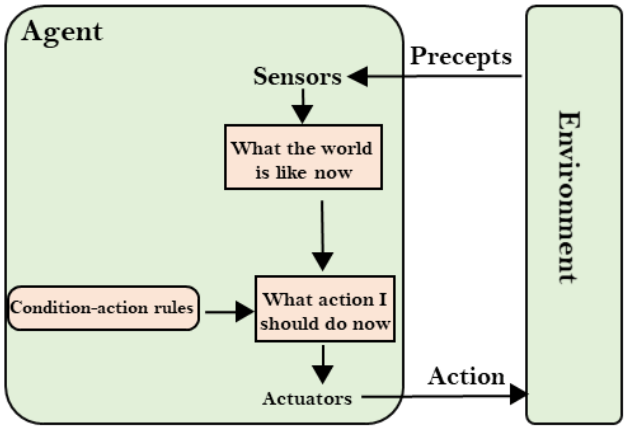
Agents can be grouped into five classes based on their degree of perceived intelligence and capability. All these agents can improve their performance and generate better action over the time. These are given below:

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

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 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.
- Problems for the simple reflex agent design approach:
    - They have very limited intelligence
    - They do not have knowledge of non-perceptual parts of the current state
    - Not adaptive to changes in the environment.



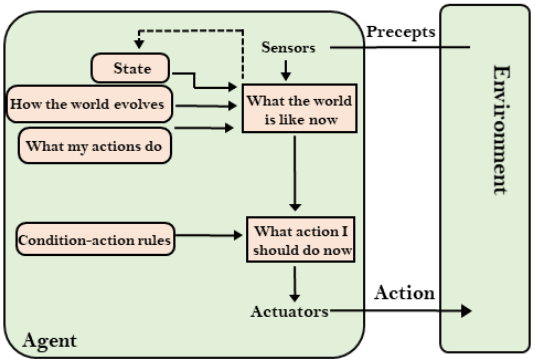

```
function SIMPLE-REFLEX-AGENT(percept) returns an action
  persistent: rules, a set of condition–action rules

  state ← INTERPRET-INPUT(percept)
  rule ← RULE-MATCH(state, rules)
  action ← rule.ACTION
  return action
```

Figure 2.10 A simple reflex agent. It acts according to a rule whose condition matches the current state, as defined by the percept.

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.
    - 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.



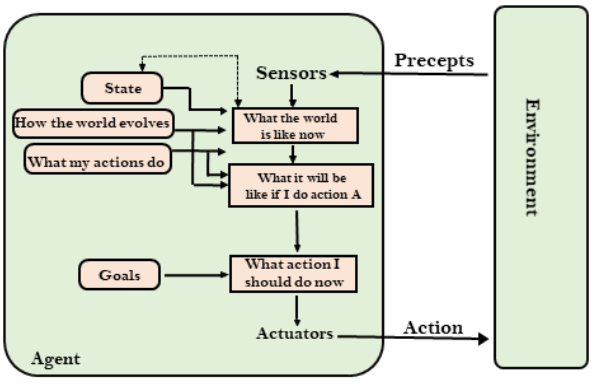

```
function MODEL-BASED-REFLEX-AGENT(percept) returns an action
  persistent: state, the agent's current conception of the world state
              transition_model, a description of how the next state depends on
                    the current state and action
              sensor_model, a description of how the current world state is reflected
                    in the agent's percepts
              rules, a set of condition–action rules
              action, the most recent action, initially none

  state ← UPDATE-STATE(state, action, percept, transition_model, sensor_model)
  rule ← RULE-MATCH(state, rules)
  action ← rule.ACTION
  return action
```

Figure 2.12 A model-based reflex agent. It keeps track of the current state of the world, using an internal model. It then chooses an action in the same way as the reflex agent.

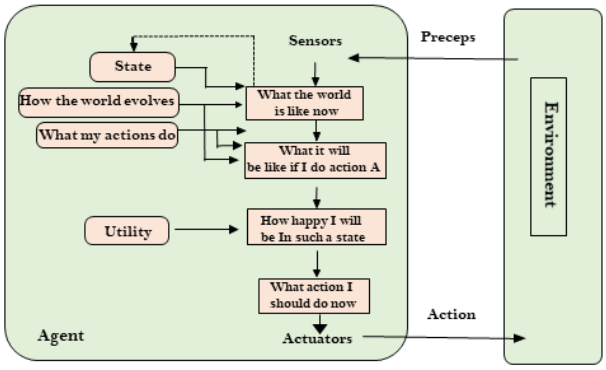
3. Goal-based agents

- 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.
- 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.



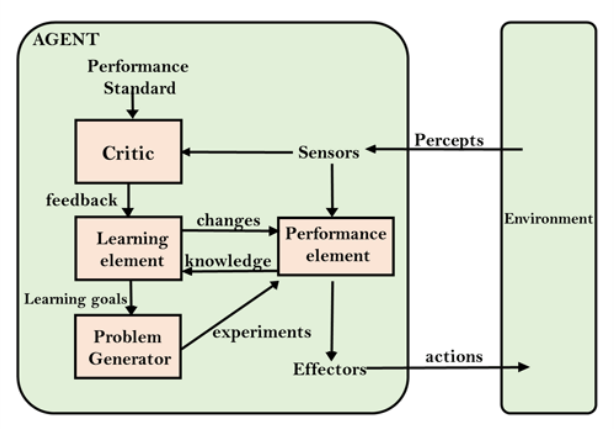
4. Utility-based agents

- 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.
- The utility function maps each state to a real number to check how efficiently each action achieves the goals.



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



Takeaways

- ✓ AI involves creating computer programs and systems that can learn, understand, and perform tasks that typically require human intelligence.
- ✓ There are four approaches to AI: acting humanly, thinking humanly, thinking rationally, and acting rationally.
- ✓ The foundations of AI include math and logic, machine learning, algorithms, statistics and probability, cognitive science and psychology, natural language processing, robotics, and ethics.
- ✓ The history of AI has seen significant milestones and developments, including the Turing test, the creation of the first AI program, expert systems, and advancements in robotics and machine learning.
- ✓ AI can be categorized into different types based on capabilities (weak AI/narrow AI, general AI, super AI) and functionality (reactive machines, limited memory machines, theory of mind, self-awareness).
- ✓ Agents in AI perceive their environment through sensors and act upon it through actuators. The PEAS representation model categorizes agents based on their performance measures, environment, actuators, and sensors.

- ✓ Intelligent agents can be categorized into simple reflex agents, model-based reflex agents, goal-based agents, utility-based agents, and learning agents.
- ✓ The structure of an AI agent includes the architecture, agent function, and agent program.
- ✓ The environment in AI can have various features such as observability, determinism, episodic vs. sequential, single-agent vs. multi-agent, static vs. dynamic, discrete vs. continuous, known vs. unknown, and accessible vs. inaccessible.

Homework---1

1.7 Examine the AI literature to discover whether the following tasks can currently be solved by computers:

a. Playing a decent game of table tennis (ping-pong).
b. Driving in the center of Cairo.
c. Buying a week's worth of groceries at the market.
d. Buying a week's worth of groceries on the web.
e. Playing a decent game of bridge at a competitive level.
f. Discovering and proving new mathematical theorems.
g. Writing an intentionally funny story.
h. Giving competent legal advice in a specialized area of law.
i. Translating spoken English into spoken Swedish in real time.
j. Performing a complex surgical operation.

For the currently infeasible tasks, try to find out what the difficulties are and predict when, if ever, they will be overcome.