ARTIFICIAL INTELLIGENCE
UNIT-I

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Unit 1

- **INTRODUCTION**: Definition of AI, Goals of AI, Turing Test, History and Foundations of AI, Branches of AI, Applications of AI, Current Trends of AI, AI Programming Languages.

- **INTELLIGENT AGENTS**: Introduction, Intelligent Systems, The Concept of Rationality, Types of Agents, Environments and Its Properities , PEAS

Introduction

- In Information Communication Technology, AI has done some amazing changes which we didn't even think of.
- Nearly everywhere we look today, we see intelligent systems talking to us like "**Hello .....Siri :)**" or offering recommendations through Netflix and Amazon or even for winning game shows IBM's Watson helps and more interesting is watching sci-fi movies which uses AI.
- AI can be defined as an approach of creating an automatic robot, or a system, or a software, having intelligence same as humans and perform task with the same efficiency as human do.
- But in order to classify machine as "having its own intelligence," first we should understand the concept of Intelligence.

Intelligence

- Intelligence is the process or a part of the power to attain goals within the world.
- Different types and degrees of intelligence occur in folks (people), several animals, and a few machines. Intelligence is employed to resolve issues or solve **problems**.

What is Problem?

- In general, a problem is an obstacle that makes it troublesome/difficult to attain a desired goal, objective, or purpose. It refers to a state of affairs, condition, or issue that is however unresolved. Each problem has an answer or **solution**

What is a Solution?

- A procedure that makes the problem navigation towards the goal is called ***solution***

Types of Problem and Solution

Depending on the way in which the problems are solved, problems are classified into the following types:

1. Structured problem
2. Unstructured problem

Structured problem

- Structural problems are the ones for which there exists a specific algorithm to achieve the goal.
- The same algorithm is run against variety input data still giving a guarantee of the problem being solved.
- Since the structure of the solution (that is in the algorithm) remains the same, even if the input data changes, these problems are called *structured problems*.

For example-

- To sort the students according to their total marks, the details about the students may be stored in the database, the sort algorithm will then get the details of students from the database and will solve the problem.

General solution structured problem

Back end: Backend is a unit which can store data in static fashion. Static data is nothing but a fact (e.g., a backend can be a database system or a file system).

Front end: Front end is a unit that provides user interface and performs the complete business logic. It can be a program written in any programming language, such as C, C++, Java, etc. As a result, a user interacts with the front end of the system to access the backend.

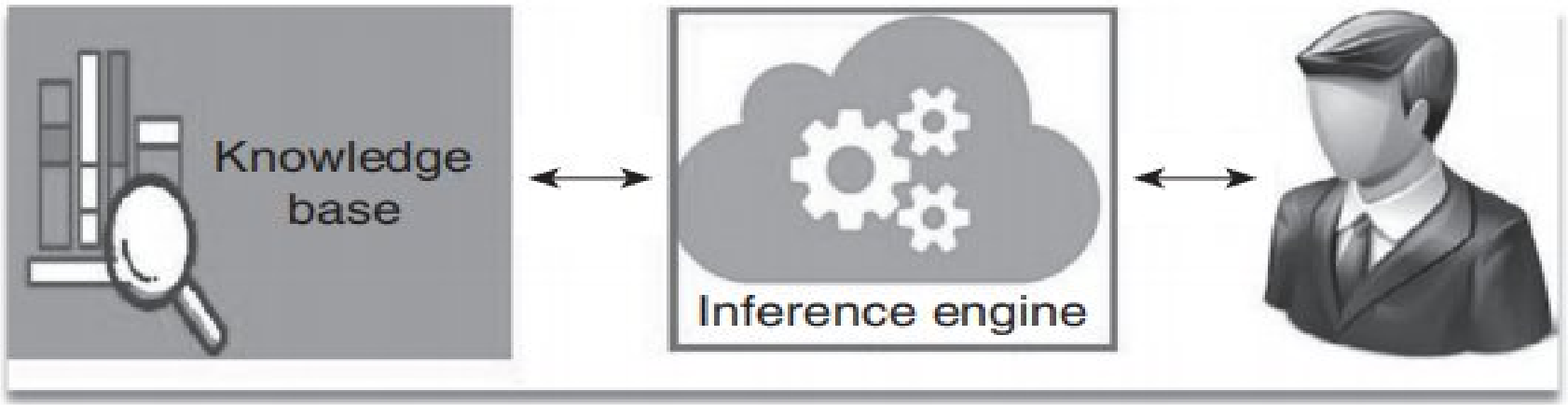
Unstructured problem

- Unstructured problems are the problems for which there does not exist a specific algorithm to achieve the goal.
- What step to take to achieve the goal depends on what is the current state of the problem.
- AI is an attempt to make a computer to solve unstructured problems.

For example-

A problem of playing chess or a problem to write a program to perform heart surgery, etc., are unstructured problems, because there does not exist any specific algorithm to solve it. Such problems are solved using a Knowledge Base .

A general solution to an unstructured problem



Knowledge base: It is the collection of facts (static data) as well as rules. Unlike database, Knowledge Base does not store only static data.

Inference engine: It is used to prove a goal (new fact) from the given facts and rules in the knowledge base.

Definitions of AI

- According to the father of Artificial Intelligence, John McCarthy, AI is ***The science and engineering of making intelligent machines, especially intelligent programs.***

- ***The study of mental facilities through the use of computational models. -Charniak and McDermott, 1985***

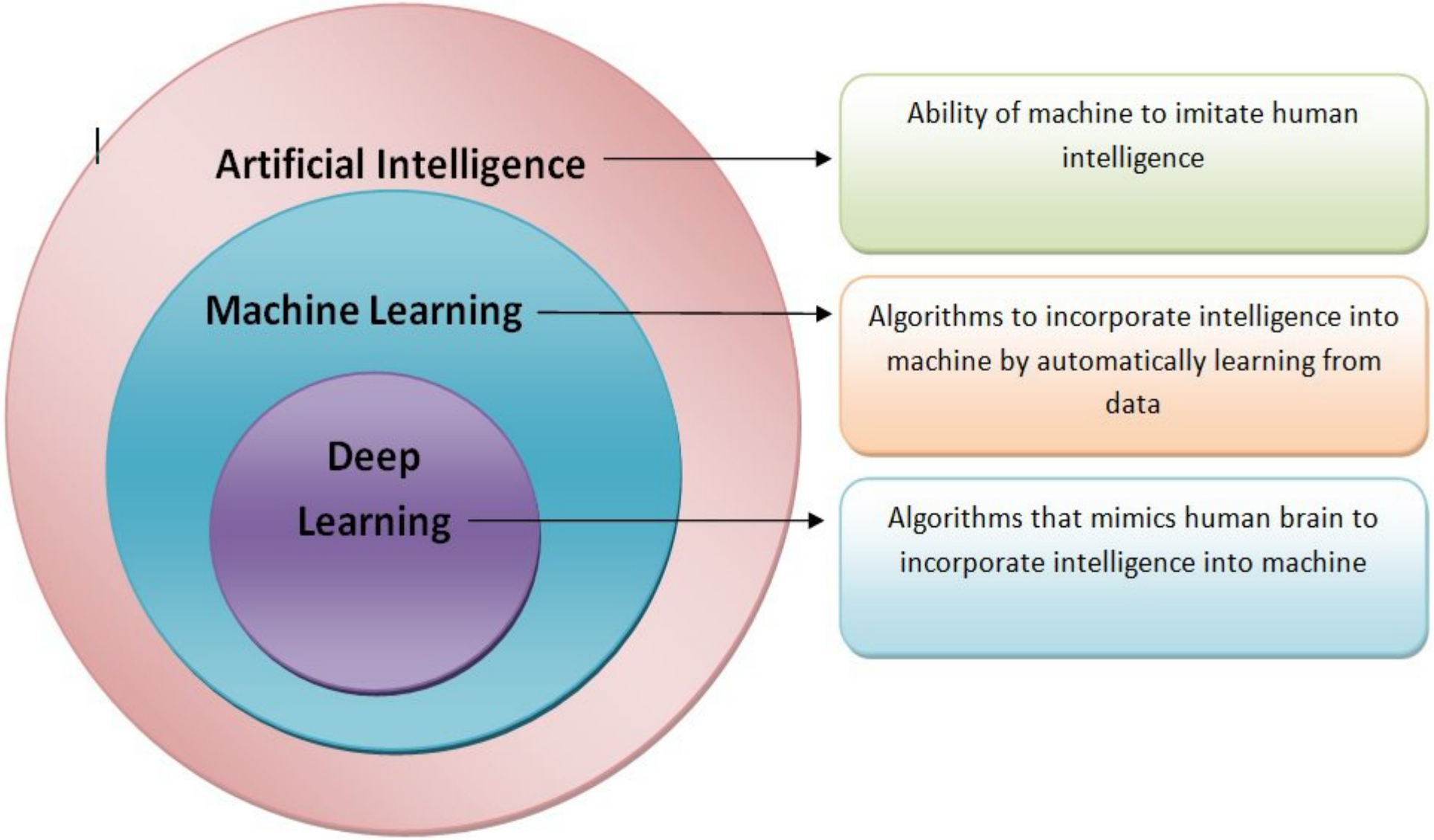
- ***The scientific understanding of the mechanisms underlying thought and their intelligent behavior and their embodiment in machines. - American Association of Artificial Intelligent (AAAI)***

Definition of AI

- 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**.“

Definition:

"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”.


Artificial Intelligence
Machine Learning
Deep Learning
Ability of machine to imitate human intelligence
Algorithms to incorporate intelligence into machine by automatically learning from data
Algorithms that mimics human brain to incorporate intelligence into machine

Goals of AI

1. Scientific goal:

Scientific goal is to determine which ideas about knowledge representation, learning, rule systems, search, and so on, explain various sorts of real intelligence (e.g., implementation of Expert Systems which exhibit intelligent behavior, learn, demonstrate, explain, and advice its users).

2. Engineering goal:

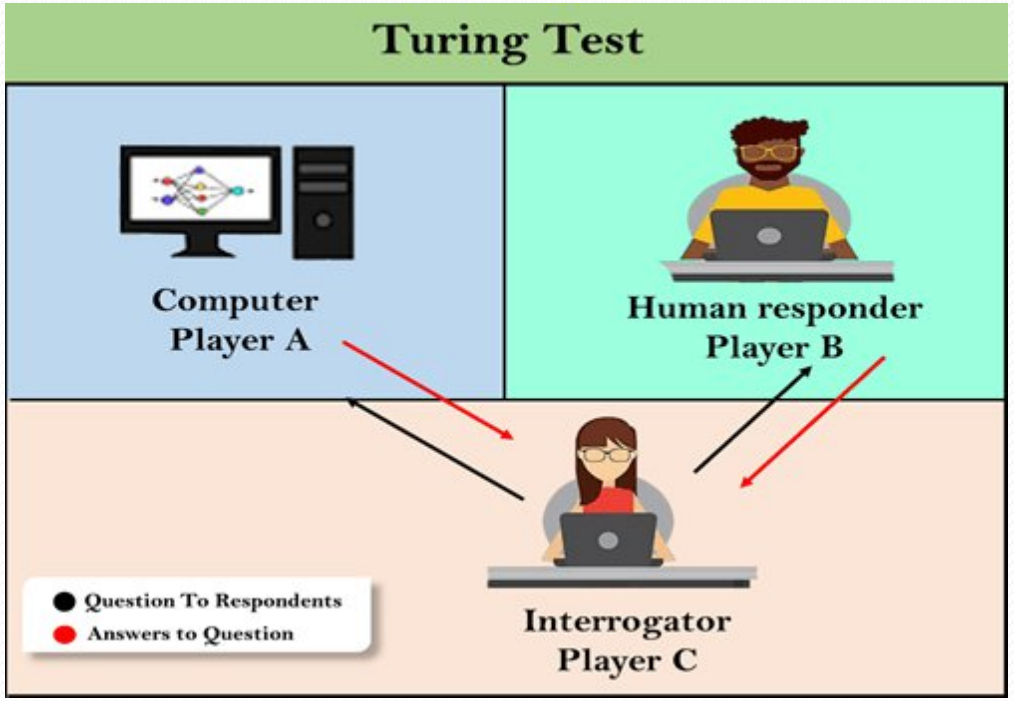
Engineering goal is to solve real-world problems by using AI techniques, such as knowledge representation, learning, rule systems, search, and so on. For example, implementation of Human Intelligence in Machines, which means creating systems that understand, think, learn, and behave like humans.

Goals of AI:

1. Replicate human intelligence
2. Solve Knowledge-intensive tasks
3. An intelligent connection of perception and action
4. Building a machine which can perform tasks that requires human intelligence such as:
    1. Proving a theorem
    2. Playing chess
    3. Plan some surgical operation
    4. Driving a car in traffic
5. Creating some system which can exhibit intelligent behavior, learn new things by itself, demonstrate, explain, and can advise to its user.

Turing Test

- Turing Test was introduced by **Alen Turing** in his 1950 paper, "Computing Machinery and Intelligence," which considered the question, "Can Machine think?"
- The Turing test is based on a party game "Imitation game," with some modifications.
- This game involves three players in which one player is Computer (player A), another player is human responder (player B), and the third player is a human Interrogator (player C), who is isolated from other two players and his job is to **find that which player is machine among two of them.**



Turing Test

- The test result does not depend on each correct answer, but only how closely its responses like a human answer. The computer is permitted to do everything possible to force a wrong identification by the interrogator.
- The questions and answers can be like:

  Interrogator: Are you a computer?

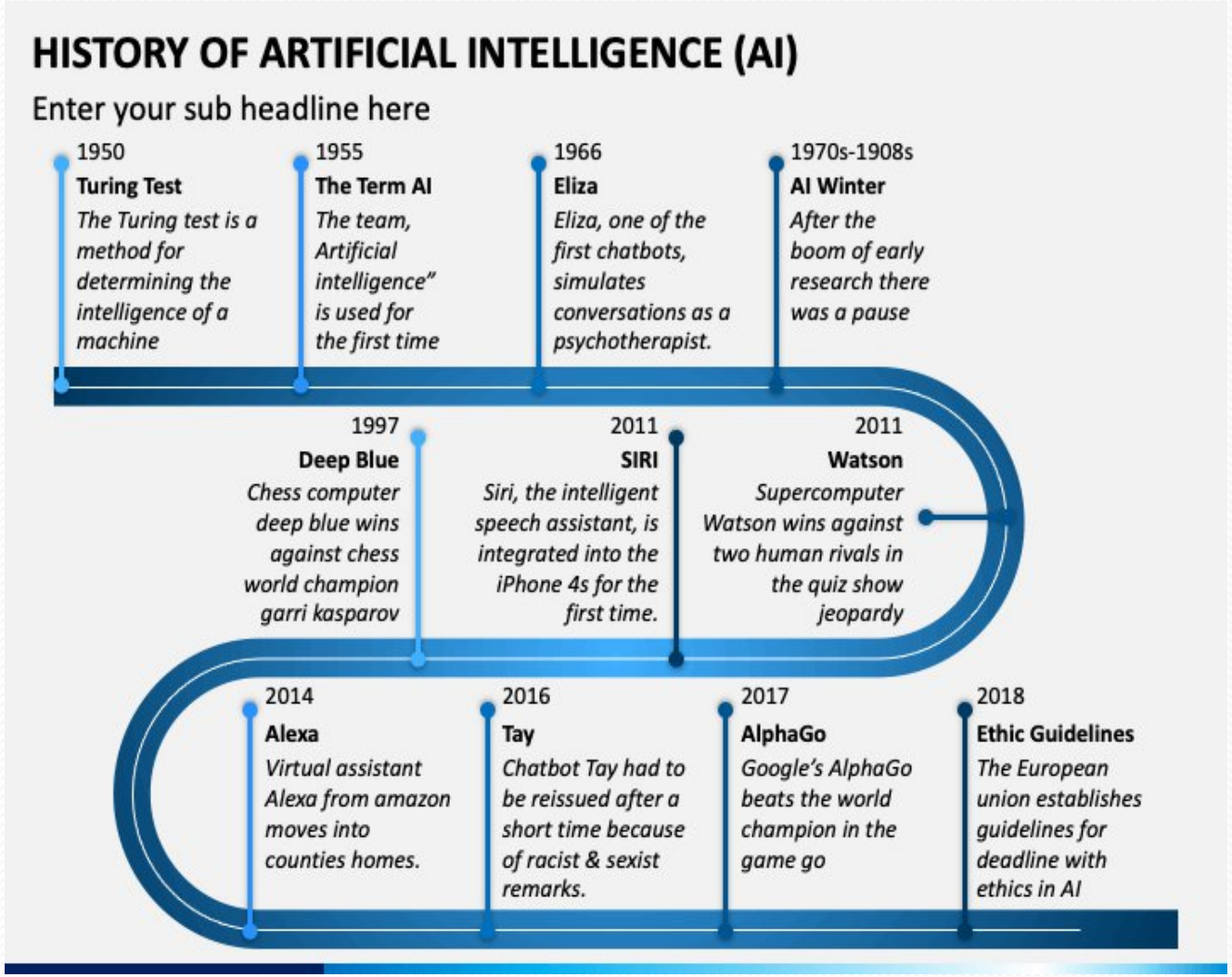
  Player A (Computer): No

  Interrogator: Multiply two large numbers such as (256896489*456725896)

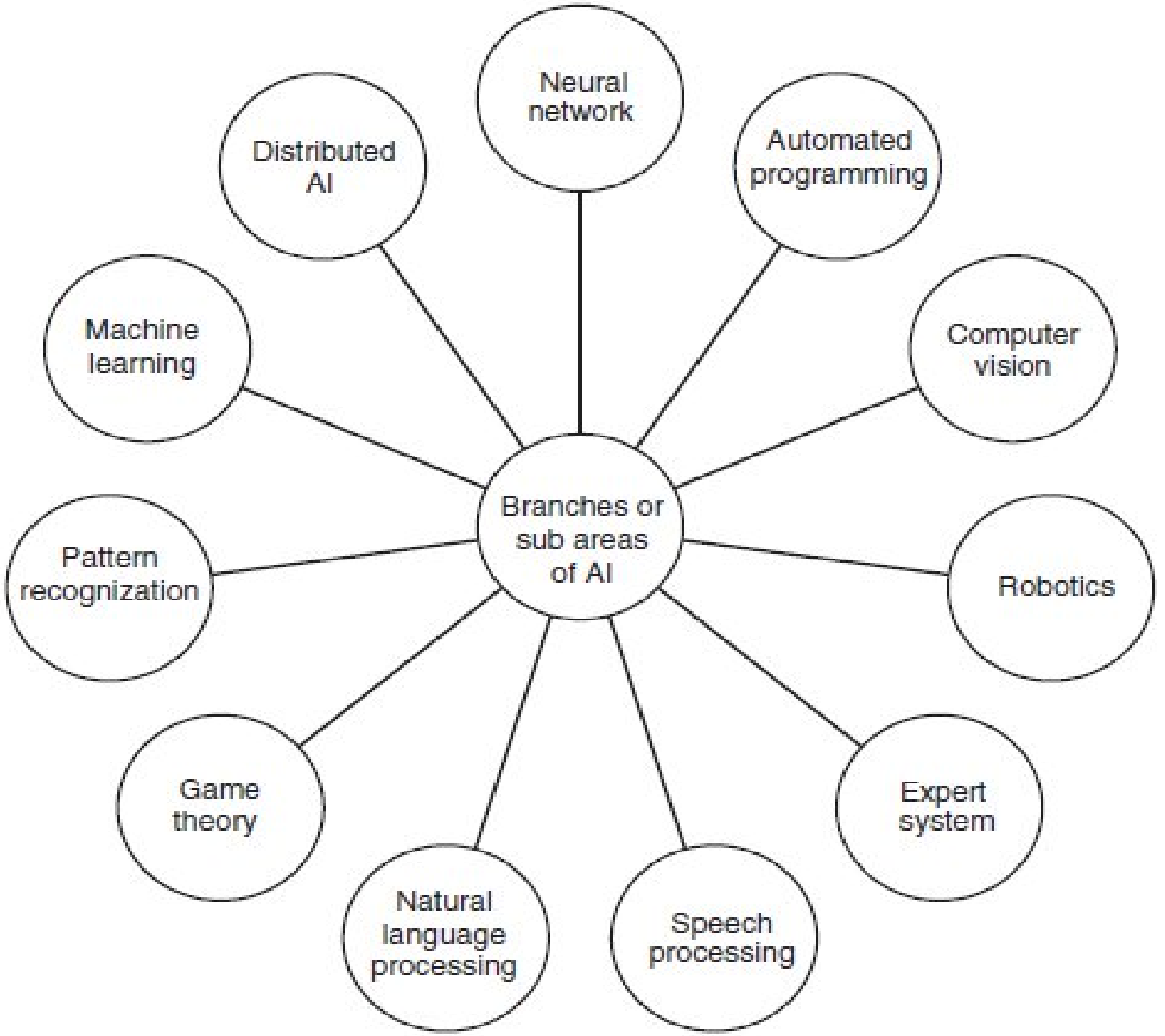
  Player A: Long pause and give the wrong answer.
- In this game, if an interrogator would not be able to identify which is a machine and which is human, then the computer passes the test successfully, and the machine is said to be intelligent and can think like a human.

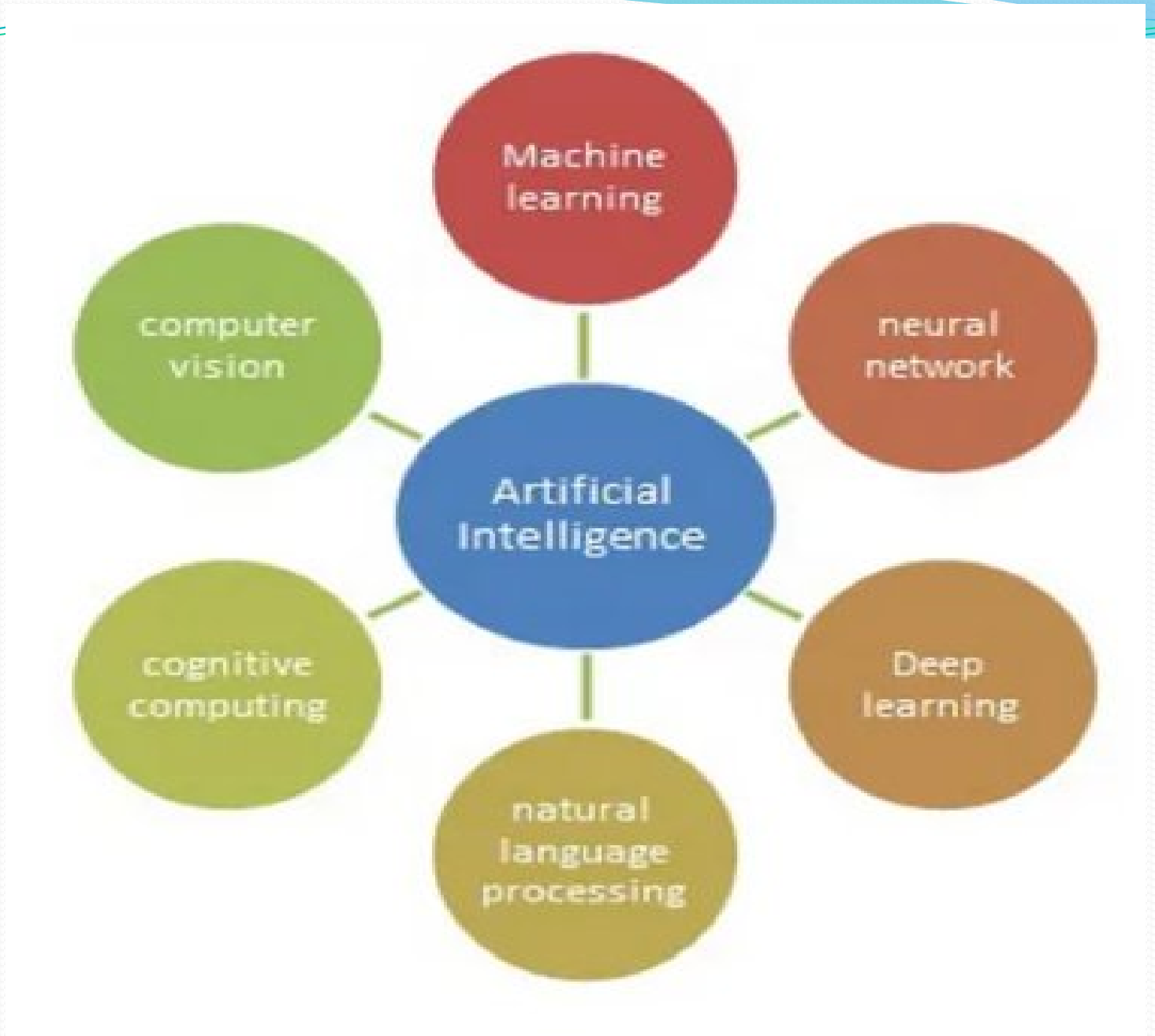
History and foundations of AI

1. **Beginning:** 1943–1952
2. **1952–1969:** Early enthusiasm, high hopes – ELIZA chatterbot
3. **1952–1969:** Sobering up
4. **1970–1979:** Knowledge-based systems
5. **1980–2010:** (AI becomes an industry – era of Intelligent Agents, Machine Learning, Robotics)
6. **2010–till date:** (era of Deep Learning)



Branches of AI




Machine learning
computer vision
neural network
Artificial Intelligence
cognitive computing
Deep learning
natural language processing

Sub-Areas/ Branches of AI

- **Expert Systems:**
  - **Expert Systems is an Artificial Intelligence (AI-based) system that learns and mimics a human's decision-making ability.**
  - **Expert Systems does not use conventional programming for solving complex problems but instead use logical notations for achieving such a goal.**
- **Robotics:**
  - **Robotics deals with robot design, construction, and operation by incorporating science and engineering methodologies.**
  - **The goal of deploying robots is to assist humans with tedious and bulky tasks. These tasks include controlling computer systems, information transformation, and manufacturing automobiles.**

Sub-Areas/ Branches of AI

- **Machine Learning:**
  - It is the science that allows machines and computer systems to process, analyze, and interpret data to provide solutions for real-life challenges.
  - Computer systems can learn and take actions on their own because of the level of enough data provided through Machine Learning. The algorithm is set up so machines can predict results based on past occurrences.

- **Neural Network:**
  - Neural Network assists the machines process how the human brain operates. This type of AI also includes implementing mathematical functions and statistical techniques for solving real-world problems.

Sub-Areas/ Branches of AI

- **Fuzzy Logic:**
  - This Branches of Artificial Intelligence is the technique to modify and represent uncertain information by analyzing the degree to which the hypothesis is true. Fuzzy Logic offers a certain level of reasoning flexibility when faced with uncertainties.
- **Natural Language Processing:**
  - Communicating with someone who doesn't understand your language can be very challenging, and the same can be said of humans trying to connect with a computer system. A computer will find it tough to interpret words because it only understands the language of binary digits.

Applications of AI

- Game playing
- Mathematics
- Autonomous control
- Diagnosis
- Logistics planning
- Autonomous planning and scheduling
- Language understanding and problem solving
- Robotics
- Natural Language Generation
- Speech recognition
- Virtual agents
- Text analytics and NLP
- Robotic process automation
- Biometrics
- Deep learning platforms
- Decision management
- AI-optimized hardware
- Machine-learning platforms

Categorization of AI

1. Sensing - Through the sensor taking in data about the world which includes: In speech recognition filtering out the noise and then recognizing specific words from the input speech. Some examples of other sensors are robotics, sonar, accelerometers, balance detection, etc.

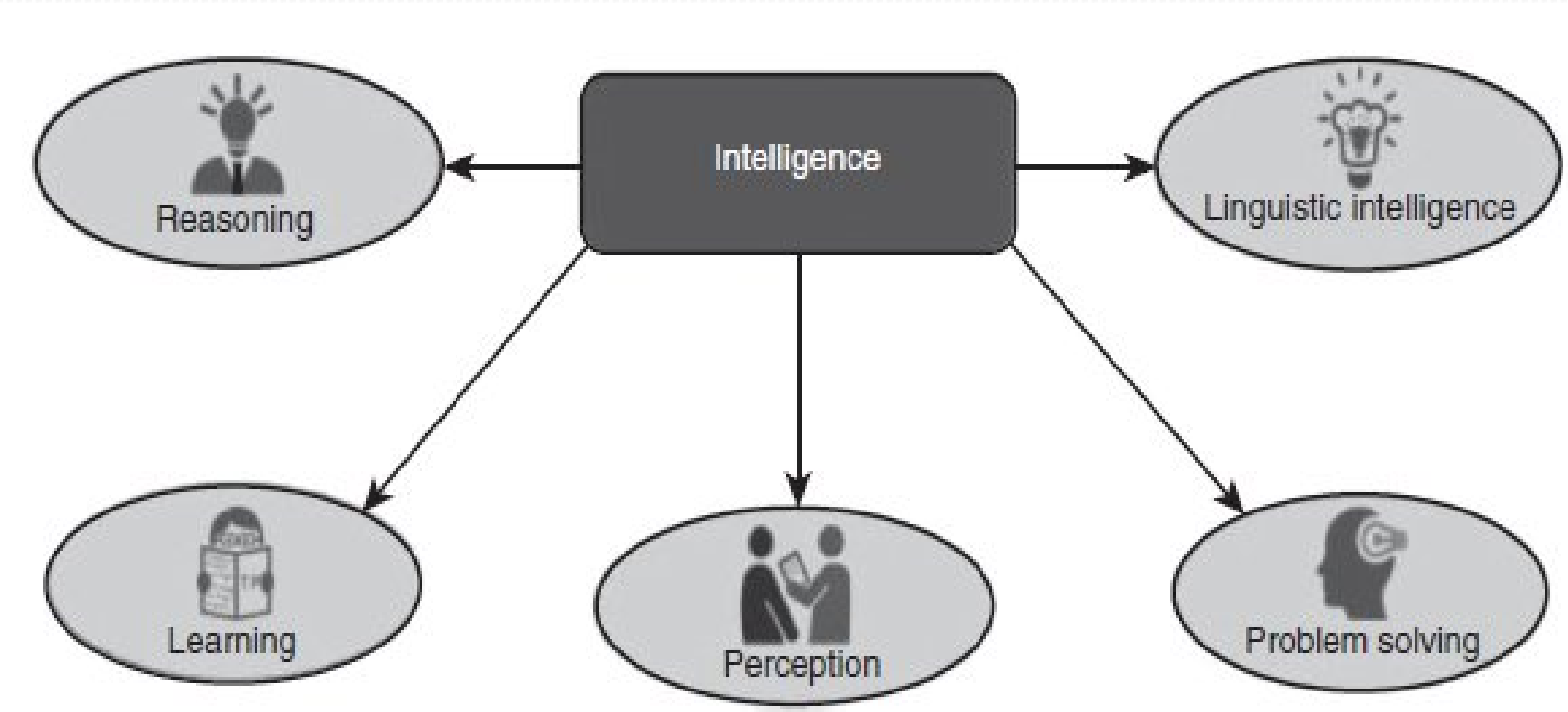
2. Reasoning- Reasoning is thinking or process the data sensed by the sensor. In logic-based inference, reasoning is deciding that something is true because, logically, it must be true. In evidence-based inference, reasoning is deciding that something is true based on the weight of evidence at hand.

3. Acting- On the basis of input and reasoning, acting is generating and controlling actions in the environment. In robotic control, action is moving and managing the different effectors that move you about the world.

Components of AI

In AI, the intelligence is intangible which is composed of mainly five techniques as follows

- **Reasoning**
- **Learning**
- **Problem solving**
- **Perception**
- **Linguistic intelligence**



Components of AI

1. Reasoning- Reasoning is the set of processes that enables an intelligent system to help or to provide basis for actions, making decisions, and prediction. Reasoning is of two types: Inductive Reasoning and Deductive Reasoning.

2. Learning- Learning is the process of gaining knowledge by understanding, practicing, being taught, or experiencing one thing. Learning enhances the awareness of any topic.

3. Problem solving- Problem solving is the method during which one perceives and tries to make a desired answer from a present state of affairs by taking some path, that is blocked by known or unknown hurdles.

Components of AI

4. Perception- Perception is the method of acquiring, decoding, selecting, and organizing sensory data. Perception presumes sensing. Within the domain of AI, perception mechanism puts the info acquired by the sensors along in a very meaningful manner.

5. Linguistic intelligence- Linguistic intelligence is one's ability to use, comprehend, speak, and write the verbal and written language. It is important in interpersonal communication.

Current trends of AI

1 Less Hype More Action

As machine learning and neural network technology takes on more routine tasks, real progress towards augmenting human productivity and driving value from tedious tasks will be seen in 2018.

2 Human-Free Interactions

Gartner predicts that 85% of customer interactions will be managed without a human in the next few years. More businesses plan to harness the power of conversational AI chatbots and other virtual assistants to manage the routine work.

3 Explainable AI

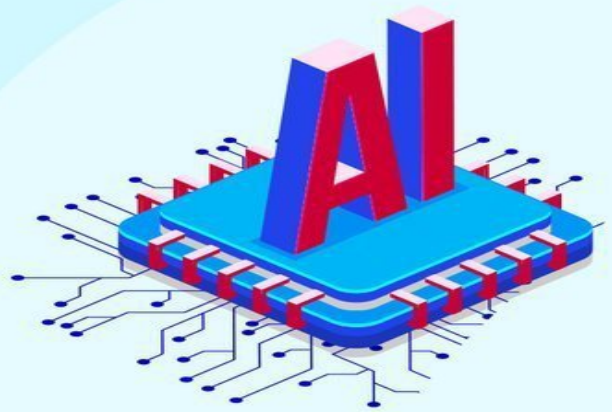
Explainable AI plans to develop machine learning techniques that offer more explainable AI models whilst upholding prediction accuracy. Explainable and transparent AI will encourage wider adoption of machine learning techniques.

4 Prescriptive Analytics for Businesses

Businesses will incorporate prescriptive analytics tools into their operations to optimize business processes.

5 AI in Medicine

By the end of 2019, half of the leading healthcare systems will have employed some level of AI within their diagnostic groups with solutions for population health, hospital operations and an extensive range of clinical specialties.



Latest Artificial Intelligence Trends

Automation

- AutoML
- AIOps
- RPA(Robotic Process Automation)

Personalization

- Big Data Analytics
- Personalized Digital Experiences

CognitiveServices

- Vision $ Speech
- Language
- Data Insights

Natural Language Processing

- Chatbots
- Document Intelligence
- Sentiment Analysis

IoT

- Smart Devices
- Edge Computing
- Big Data Convergence

Current trends of AI

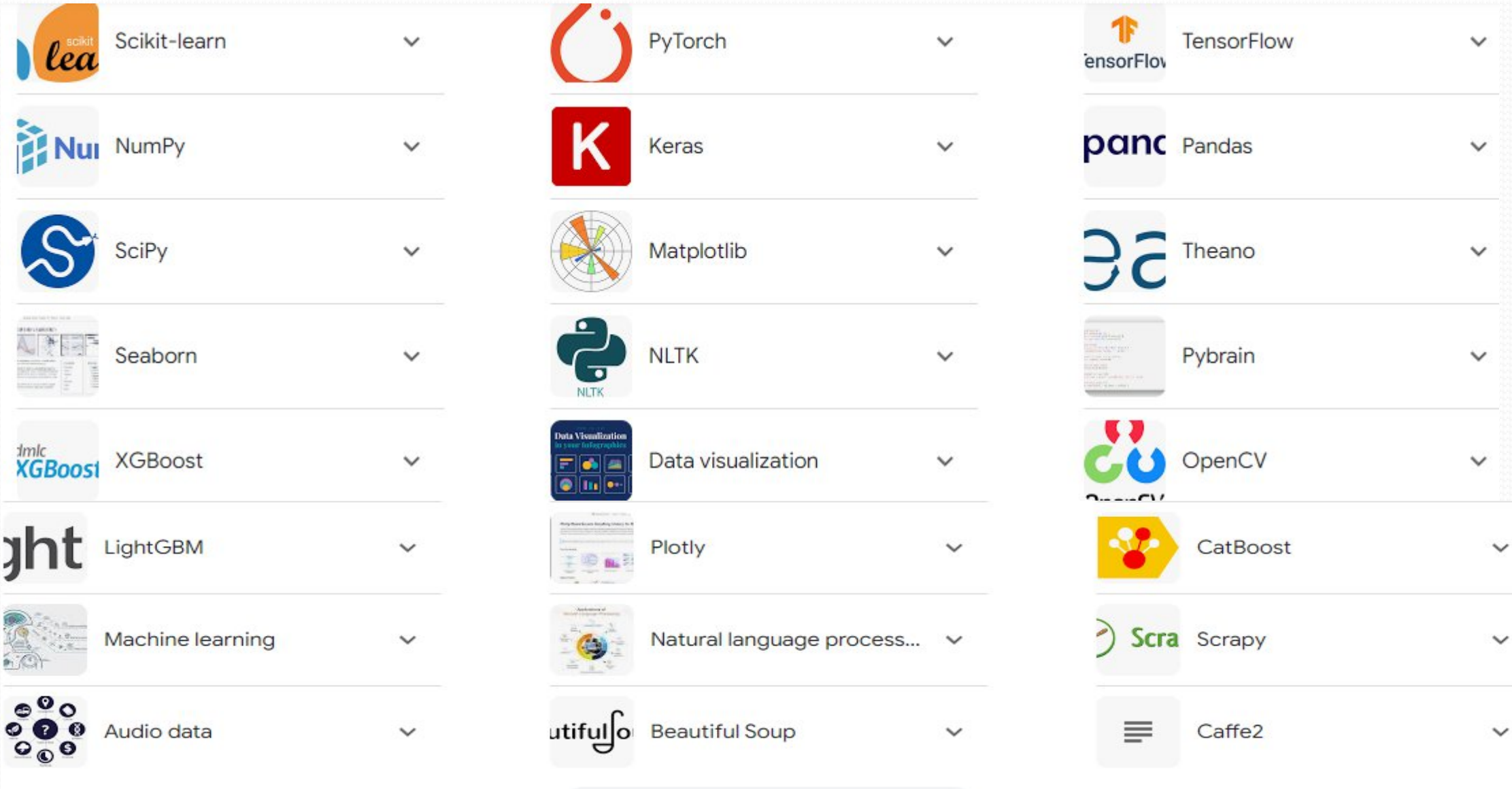
- There is a large array of applications where AI is serving common people in their day-to-day lives which can be grouped into the following categories.

Applications	*Example*
Expert systems	Flight-tracking systems, clinical systems
Natural language processing	Google Now feature, speech recognition, automatic voice output
Neural networks	Pattern recognition systems such as face recognition, character recognition, handwriting recognition
Fuzzy logic	Consumer electronics, automobiles, etc.
Robotics	Industrial robots for moving, spraying, painting, precision checking, drilling, cleaning, coating, carving, etc.

AI Programming languages

- A number of programming languages exist that are used to build AI systems. General programming languages, such as C++, R, Java, Python, and LISP (List Processing) are frequently used, because these are the languages with which most computer scientists have got experience.
- Here are some languages that are most typically used for creating the AI projects:
  - PROLOG
  - LISP
  - R
  - Python
  - Java
  - C++

Python Libraries for AI



Steps in Developing an AI Problem

1

Step 1: Define the Problem

Understand your challenge: NLP, computer vision, or predictive modeling. Delve deep into the problem's core.

2

Step 2: Collect and Preprocess Data

Gather relevant data, clean, preprocess, and split it. Use data augmentation if necessary.

3

Step 3: Choose an AI Model

Select the right AI model—CNN, RNN, transformers, etc., suitable for your task.

4

Step 4: Train the AI Model

Dedicate time to training, using advanced techniques for better optimization.

5

Step 5: Evaluate the AI Model

Measure the model's performance using advanced metrics like F1 score, precision, recall, and AUC-ROC.

6

Step 6: Test the AI Model

Ensure model robustness with advanced testing techniques, including adversarial testing.

7

Step 7: Deploy the AI Model

Make the model public, utilize containerization, and validate its real-world performance.

8

Step 8: Monitor and Refine

Keep a tab on the model's efficiency over time.

Examples of AI projects using Python

Sentiment Analysis

Analyze sentiment in text data like reviews.

Image Recognition

Classify images by content.

Chatbot

Conversational agents for user interaction.

Recommendation Engine

Suggest products based on user behavior.

Fraud Detection

Detect fraud in transactions.

Predictive Analytics

Forecast future trends from data.

Autonomous Drone Navigation

Drones navigate without human input.

Speech Recognition

Transcribe and recognize spoken language.

Music Generation

Generate music from existing styles.

Autonomous Vehicle Control

AI-controlled self-driving cars.

INTELLIGENT AGENTS

What is Agent/Intelligent Agent?

- An Agent/Intelligent 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/Intelligent 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

Intelligent Agent:

- 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.

Sensors, Actuators and Effectors:

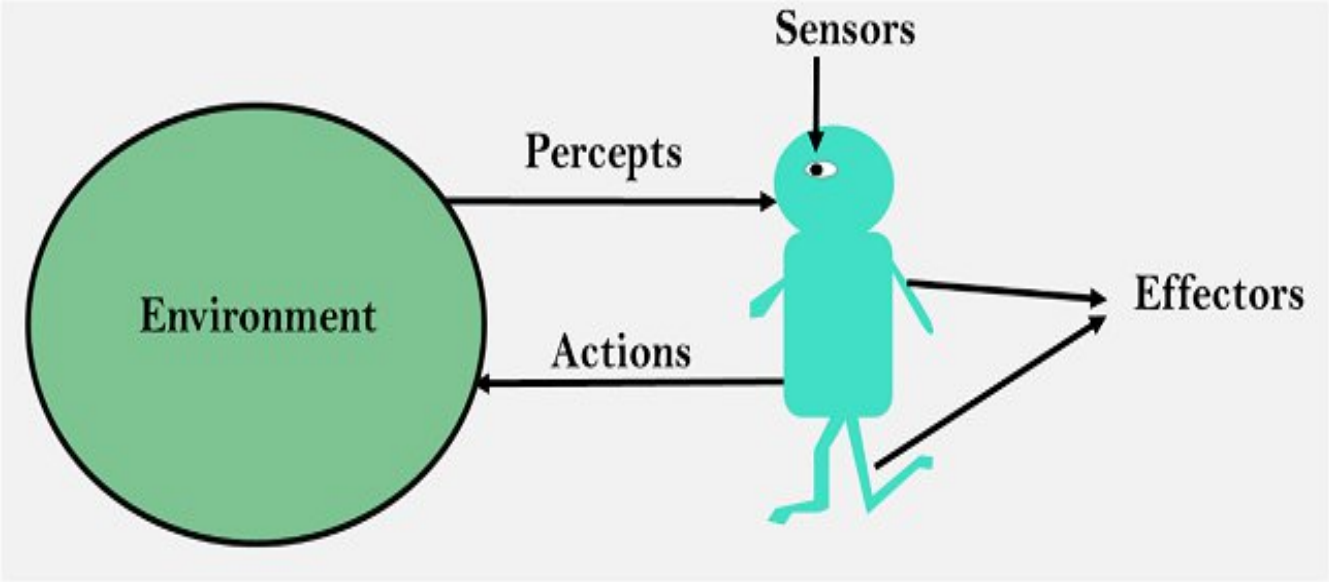
- **Sensor:** Sensor is a device which detects the change in the environment and sends the information to other electronic devices.
- **Actuators:** Actuators used to convert energy into motion. The actuators are only responsible for moving and controlling a system.
- **Effectors:** Effectors can be legs, wheels, arms, fingers, wings, fins, and display screen.

Goals of Agent:

-> High Performance

-> Optimized Result

-> Rational Agent



INTELLIGENT SYSTEMS

- An intelligent system is an advanced computer system that can gather, analyze and respond to the data it collects from its surrounding environment.
- It can work and communicate with other agents, such as users or other computer systems.
- It can also learn from experience and adapt according to current data

The concept of Rationality

- ***A rational Agent is one that does the right thing***. AI is about creating rational agents to use for game theory and decision theory for various real-world scenarios.
- 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.

Definition of rational agent

- For each possible percept sequence, a rational agent should select an action that is expected to maximize its performance measure, given the evidence provided by the percept sequence and whatever built in knowledge the agent has.

Performance Measure

- Performance measure of rational agent is the criteria, which determines how successful agent is.

Performance measure of an agent includes following factors:

- Agent has to take initiative to perceive information from the environment
- Agent has to generate a sequence of actions according to the percepts it receives
- This sequence of actions causes the environment to go through a sequence of states
- If the sequence is desirable then the agent has performed well.

The Structure of Intelligent Agents

- 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.

Types of Agents:

Agents can be grouped into five classes based on their degree of perceived intelligence and capability

1. Simple Reflex Agent
2. Model-based reflex agent
3. Goal-based agents
4. Utility-based agent
5. Learning agent

1. Simple Reflex Agents

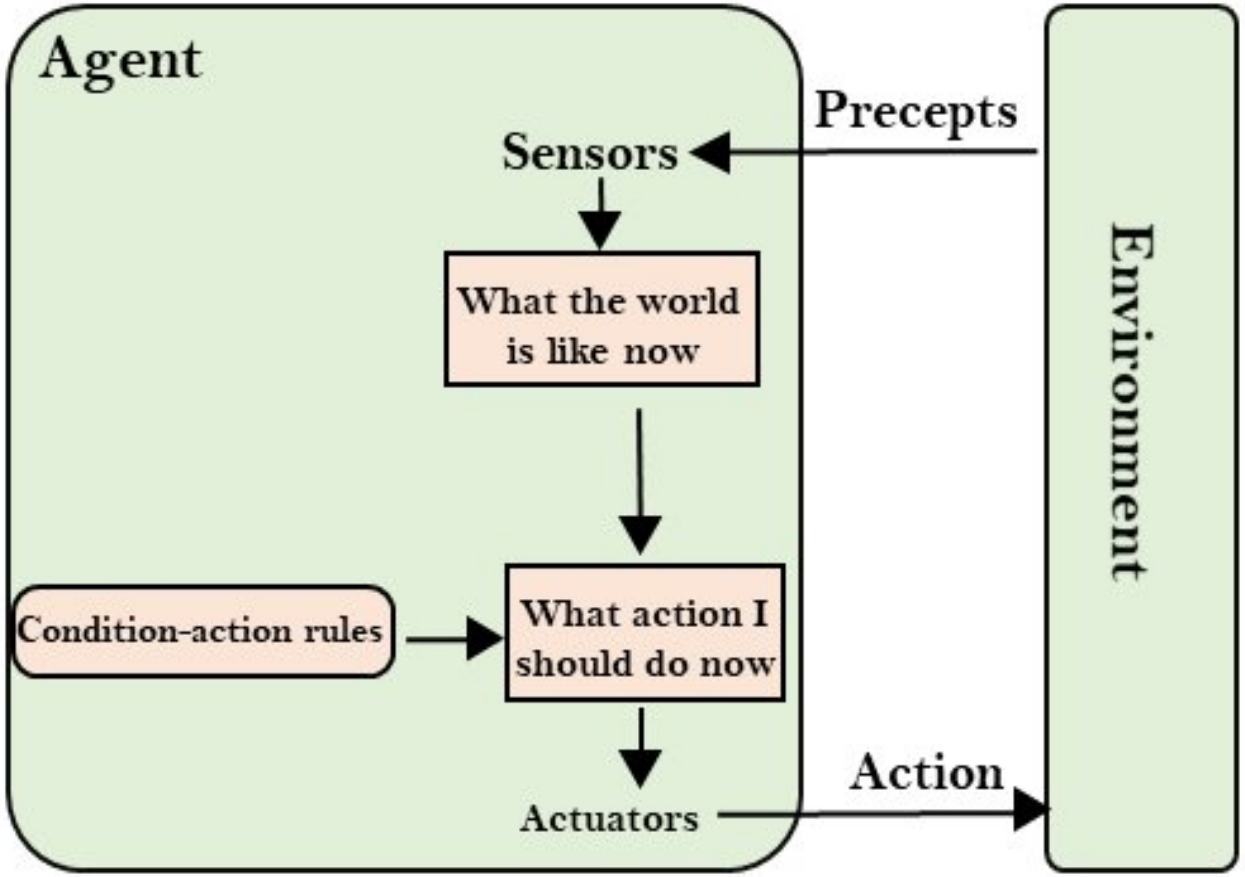
- They choose actions only based on the current percept.
- They are rational only if a correct decision is made only on the basis of current precept.
- Their environment is completely observable.
- **Condition-Action Rule** – It is a rule that maps a state (condition) to an action.

Simple Reflex agent:

These agents take decisions on the basis of the current percepts and ignore the rest of the percept history.

Problems:

- Very limited intelligence
- Too big to generate and to store.
- Not adaptive to changes in the environment.

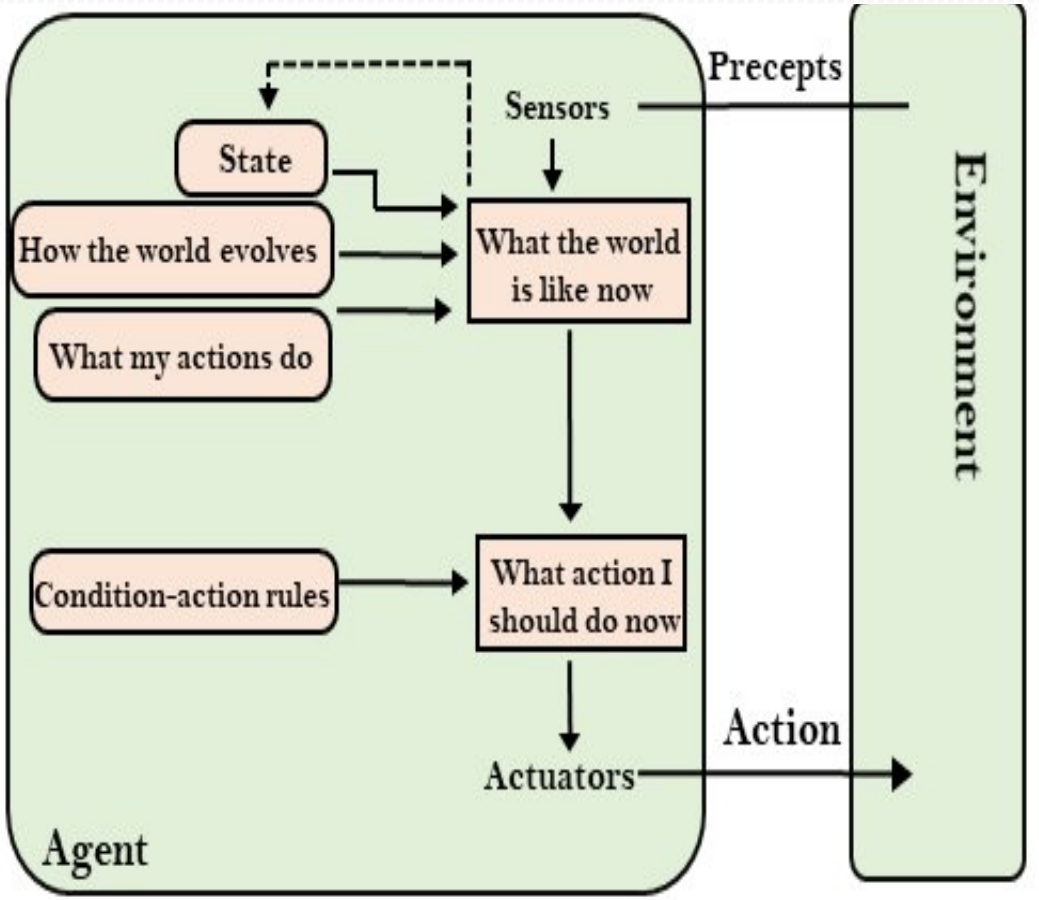


2. Model-based reflex agent

- 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 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,"
  - **Internal State:** It is a representation of the current state based on percept history.

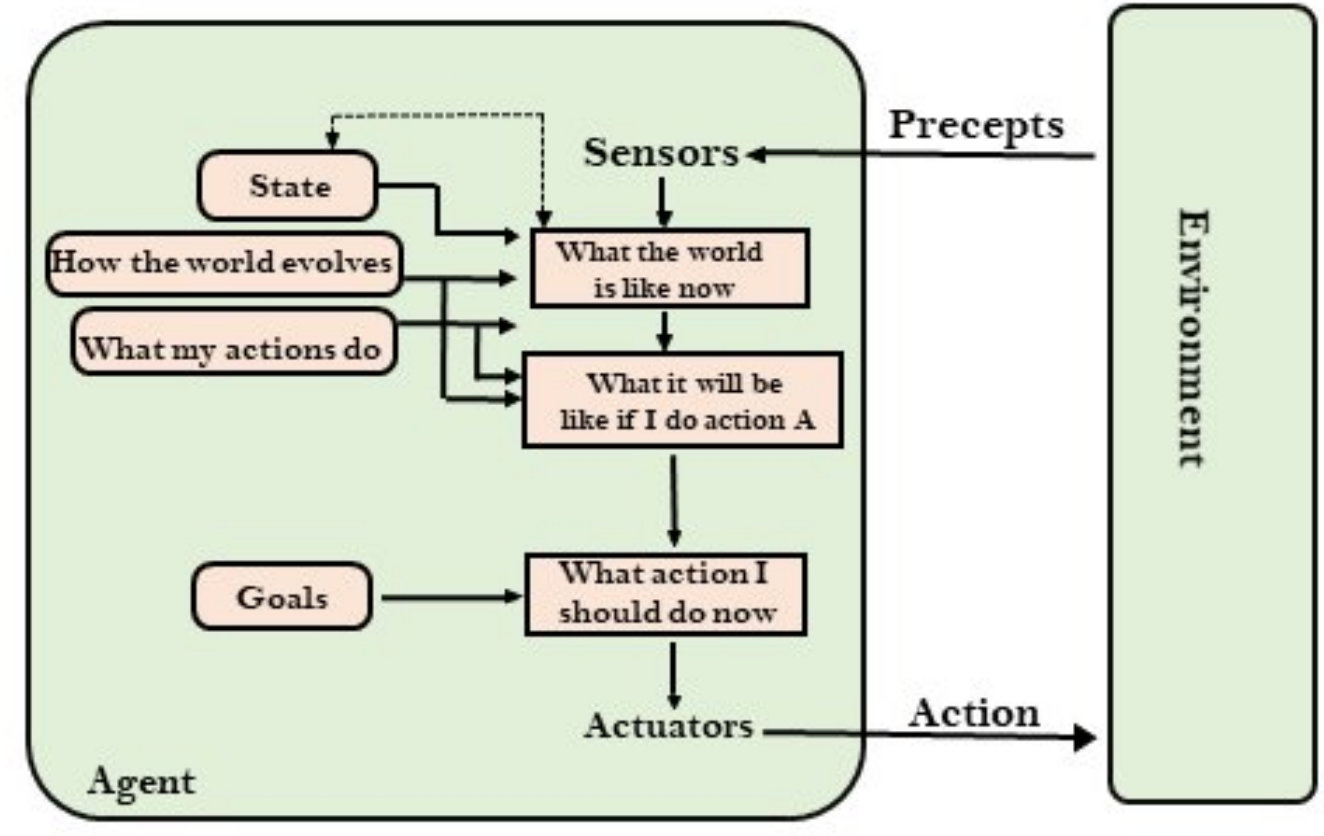


3. Goal-based agents:

- 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.

Goal-based agents:

- 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.

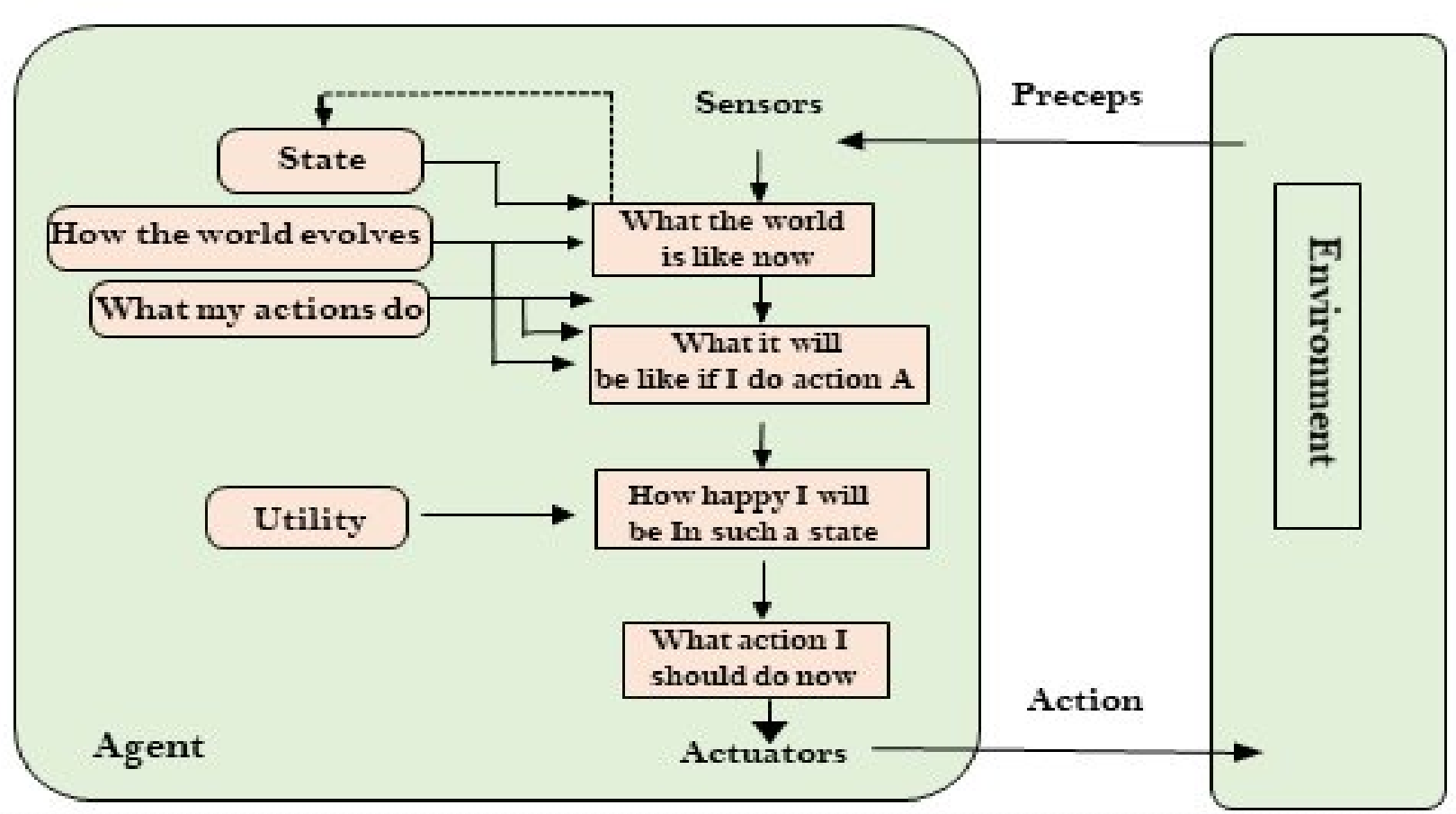


4. Utility-based agent

- 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.

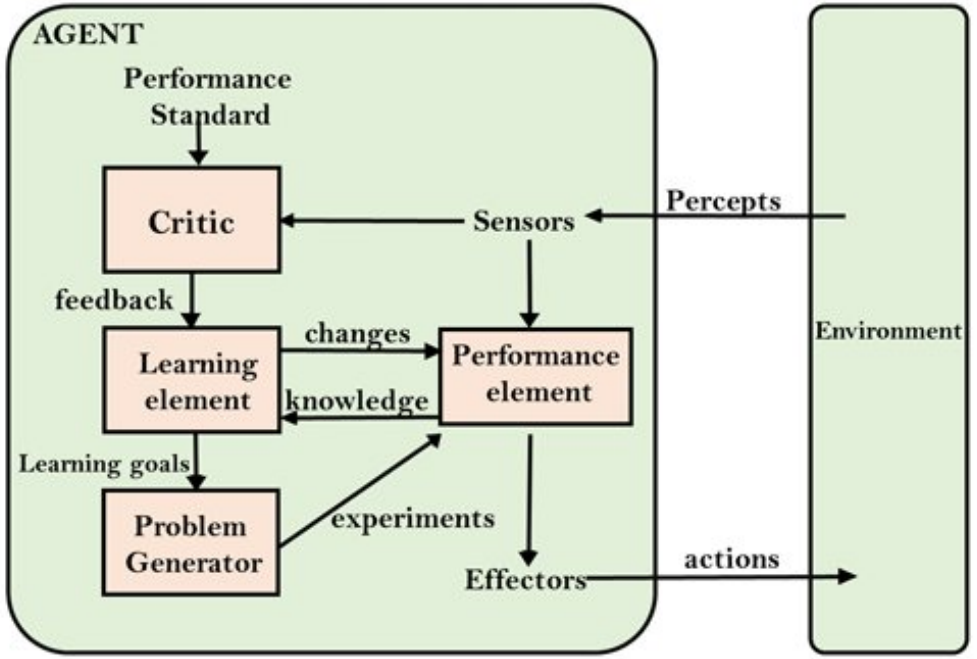
Utility-based agent

- 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

- 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:** 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:** responsible for suggesting actions that will lead to new and informative experiences.



Environment

- The surroundings or circumstances in which an AI system functions are referred to as the
- There are three basic types of environment:
  - real-world/ physical
  - virtual
  - simulated

The Physical Environment

- The tangible reality in which AI systems function is referred to as the physical environment.
- It features authentic environments including houses, workplaces, factories, and outdoor areas.
- When used in real situations, AI systems must use sensors to sense their surroundings and interact with people and objects in a useful way.
- These surroundings frequently provide difficulties like noise, shifting weather patterns, and significant safety risks.

Virtual Environment

- Computer-generated settings that resemble real-world scenes are called virtual environments.
- They make it possible for AI systems to communicate with made-up things and entities.
- Before deploying AI models and testing algorithms in the actual world, virtual environments are frequently used.
- They offer engineers a safe space for testing and allow them to make adjustments to AI systems without worrying about the impact on the real world.

Simulated Environment

- Realistic and highly specialized virtual places are called simulated environments.
- They generate intricate situations that could be risky or impossible to recreate in the real world.
- Simulated environments are especially useful for teaching AI systems in fields like robotics, aerospace, and autonomous vehicles.
- Developers can improve AI systems' adaptability and get them ready for difficulties in the real world by exposing them to a variety of simulated settings.

Environment and its Properties

1. ***Accessible and Inaccessible Environments***
2. ***Deterministic Environment and Nondeterministic Environment***
3. ***Episodic and Non-episodic Environment***
4. ***Static versus Dynamic Environment***
5. ***Discrete versus Continuous Environment***
6. ***Single Agent versus Multi-agent Environment***

Environment and its Properties

- **Discrete / Continuous** − If there are a limited number of distinct, clearly defined, states of the environment, the environment is discrete (For example, chess); otherwise it is continuous (For example, driving).
- **Observable / Partially Observable** − If it is possible to determine the complete state of the environment at each time point from the percepts it is observable; otherwise it is only partially observable.
- **Static / Dynamic** − If the environment does not change while an agent is acting, then it is static; otherwise it is dynamic.
- **Single agent / Multiple agents** − The environment may contain other agents which may be of the same or different kind as that of the agent.

Environment and its Properties

- **Accessible / Inaccessible** − If the agent's sensory apparatus can have access to the complete state of the environment, then the environment is accessible to that agent.
- **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; otherwise it is non-deterministic.
- **Episodic / Non-episodic** − In an episodic environment, each episode consists of the agent perceiving and then acting. The quality of its action depends just on the episode itself. Subsequent episodes do not depend on the actions in the previous episodes. Episodic environments are much simpler because the agent does not need to think ahead.

Environment Types-I (Fully observable (accessible) vs. partially observable (inaccessible)

- Fully observable, if agents sensors detect all aspects of environment relevant to choice of action
- Could be partially observable due to noisy, inaccurate or missing sensors, or inability to measure everything that is needed
- Model can keep track of what was sensed previously, cannot be sensed now, but is probably still true.
- Often, if other agents are involved, their intentions are not observable, but their actions are

E.g chess – the board is fully observable, as are opponent's moves.

Environment Types-II: Deterministic vs. stochastic (non-deterministic)

- Deterministic: the next state of the environment is completely predictable from the current state and the action executed by the agent
- Stochastic = the next state has some uncertainty associated with it. Uncertainty could come from randomness, lack of a good environment model, or lack of complete sensor coverage
- Strategic environment if the environment is deterministic except for the actions of other agents.
- Examples: Non-deterministic environment: physical world, Robot on Mars

  Deterministic environment: Tic Tac Toe game

Environment Types-III : Episodic vs. sequential

- The agent's experience is divided into atomic "episodes" (each episode consists of the agent perceiving and then performing a single action) and the choice of action in each episode depends only on the episode itself.
- Sequential if current decisions affect future decisions, or rely on previous ones
- Examples of episodic are expert advice systems – an episode is a single question and answer
- Most environments (and agents) are sequential
- Many are both – a number of episodes containing a number of sequential steps to a conclusion
- Examples: Episodic environment: mail sorting system

  Non-episodic environment: chess game

Environment Types-IV: Discrete vs. continuous

- Discrete = time moves in fixed steps, usually with one measurement per step (and perhaps one action, but could be no action). E.g. a game of chess
- Continuous = Signals constantly coming into sensors, actions continually changing. E.g. driving a car

Environment types-V: Static vs. dynamic:

- Dynamic if the environment may change over time. Static if nothing (other than the agent) in the environment changes
- Other agents in an environment make it dynamic
- The goal might also change over time
- Not dynamic if the agent moves from one part of an environment to another, though it has a very similar effect
- E.g. – Playing football, other players make it dynamic, mowing a lawn is static (unless there is a cat…), expert systems usually static (unless knowledge changes)

Environment types-VI: Single agent vs. multi agent:

- An agent operating by itself in an environment is single agent!
- Multi agent is when other agents are present!
- A strict definition of an other agent is anything that changes from step to step. A stronger definition is that it must sense and act
- Competitive or co-operative Multi-agent environments
- Human users are an example of another agent in a system
- E.g. Other players in a football team (or opposing team), wind and waves in a sailing agent, other cars in a taxi driver

Examples of task environment

Task Environment	Observable	Determines	Episodic	Static	Discrete	Agent
Crossword Puzzle	Fully	Determines	Sequential	Static	Discrete	Single
Chess with clock	Fully	Strategic	Sequential	Static	Discrete	Multi
Poker	Partially	Strategic	Sequential	Static	Discrete	Multi
Backgammon	Fully	Stochastic	-	Static	Discrete	Multi
Taxi driving	Partially	Stochastic	Sequential	Dynamic	Con	Multi
Medical Diagnosis	Partially	Stochastic	Sequential	Dynamic	Con	Single
Image Analysis	Fully	Deterministic	Episodic	Semi	Con	Single
Part pick mg robot	Partially	Stochastic	Episodic	Dynamic	Con	Single
Refing controller	Partially	Stochastic	Sequential	Dynamic	Con	Single
Interstice English tutor	Partially	Stochastic	Sequential	Dynamic	Discrete	Multi

PEAS representation:

- PEAS is a type of model on which an AI agent works upon.
- When we define an AI 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

PEAS Descriptors for automated Taxi Driver	
Performance Measure	**Safety, time, legal drive, comfort**
Environment	**Roads, other cars, pedestrians, road signs**
Actuators	**Steering, accelerator, brake, signal, horn**
Sensors	**Camera, sonar, GPS, Speedometer, odometer, accelerometer, engine sensors, keyboard**

PEAS for vacuum cleaner	
Performance Measure	cleanness, efficiency: distance traveled to clean, battery life, security
Environment	room, table, wood floor, carpet, different obstacles
Actuators	wheels, different brushes, vacuum extractor
Sensors	camera, dirt detection sensor, cliff sensor, bump sensors, infrared wall sensors

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

Agent Type	Performance Measure	Environment	Actuators	Sensors
Medical diagnosis system	Healthy patient, reduced costs	Patient, hospital, staff	Display of questions, tests, diagnoses, treatments, referrals	Keyboard entry of symptoms, findings, patient's answers
Satellite image analysis system	Correct image categorization	Downlink from orbiting satellite	Display of scene categorization	Color pixel arrays
Part-picking robot	Percentage of parts in correct bins	Conveyor belt with parts; bins	Jointed arm and hand	Camera, joint angle sensors
Refinery controller	Purity, yield, safety	Refinery, operators	Valves, pumps, heaters, displays	Temperature, pressure, chemical sensors
Interactive English tutor	Student's score on test	Set of students, testing agency	Display of exercises, suggestions, corrections	Keyboard entry

THANK YOU