Artificial Intelligence

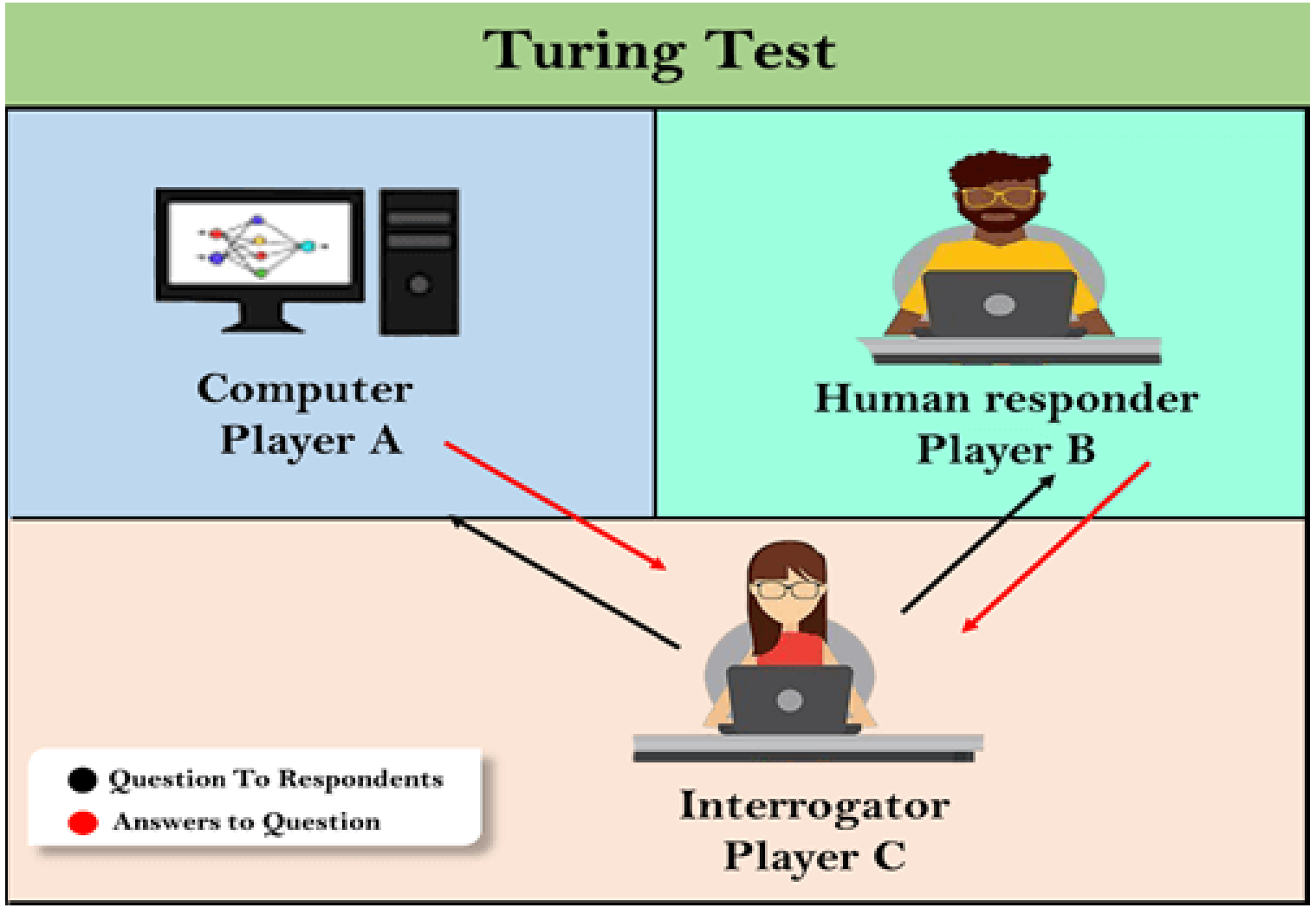
- Rationality

Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998) "AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Figure 1.1 Some definitions of artificial intelligence, organized into four categories.

Acting humanly: The Turing Test approach

- natural language processing to enable it to communicate successfully in English;
- knowledge representation to store what it knows or hears;
- automated reasoning to use the stored information to answer questions and to draw new conclusions;
- machine learning to adapt to new circumstances and to detect and extrapolate patterns
- computer vision to perceive objects,
- robotics to manipulate objects and move about.


Turing Test
Computer
Player A
Human responder
Player B
Interrogator
Player C
Question To Respondents
Answers to Question

Thinking humanly: The cognitive modeling approach

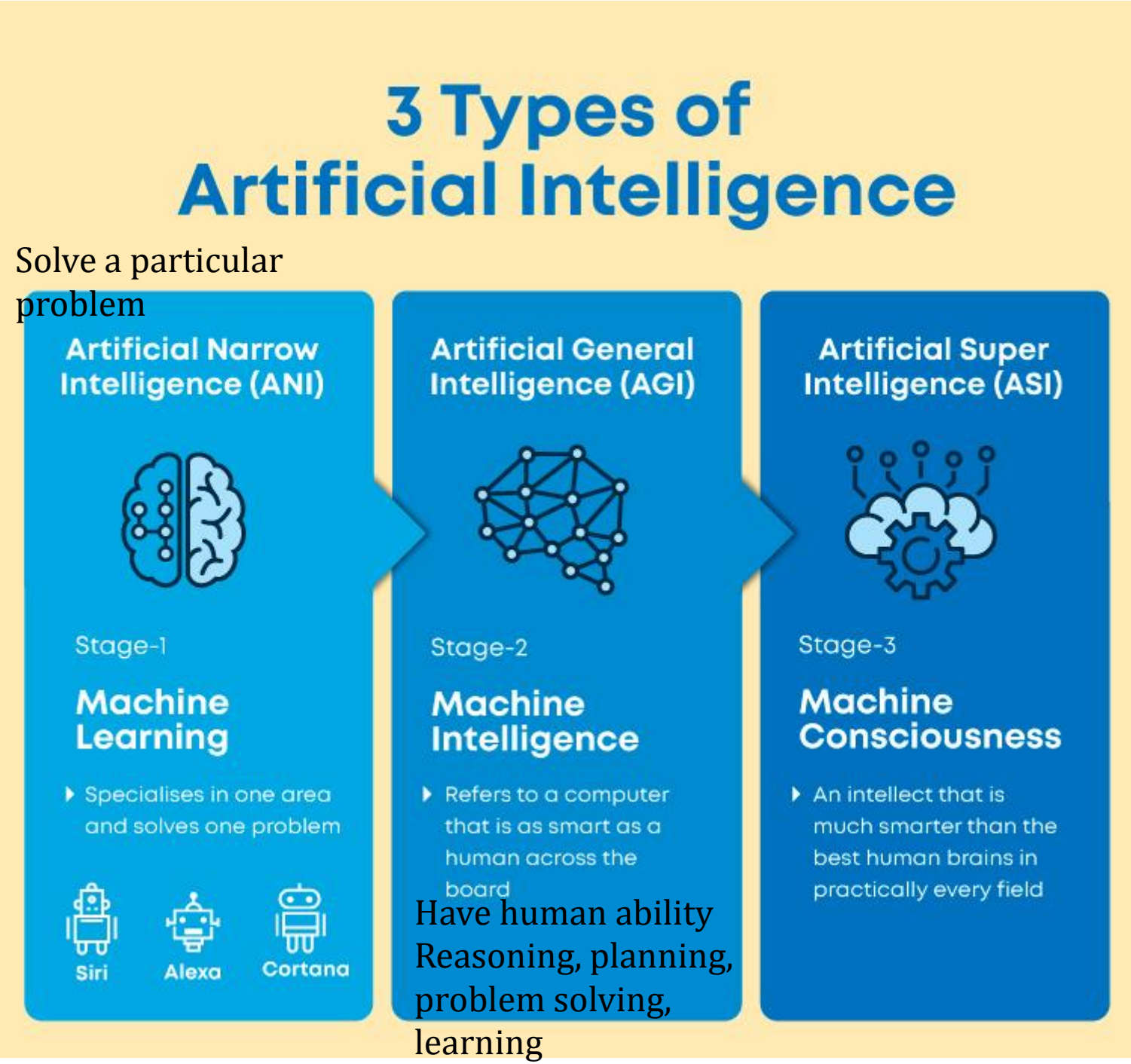
- The interdisciplinary field of cognitive science brings together computer models from AI and experimental techniques from psychology to construct precise and testable theories of the human mind.

Thinking rationally: The “laws of thought” approach

- His syllogisms provided patterns for argument structures that always yielded correct conclusions when given correct premises—for example, “Socrates is a man; all men are mortal; therefore, Socrates is mortal.”
- These laws of thought were supposed to govern the operation of the mind; their study initiated the field called logic.
- Right Thinking - Requires 100% Knowledge
- Too many computations required.

Acting rationally: The rational agent approach

- An agent is just something that acts (agent comes from the Latin agere, to do). Of course, all computer programs do something, but computer agents are expected to do more: operate autonomously, perceive their environment, persist over a prolonged time period, adapt to change, and create and pursue goals.
- A rational agent is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome.
- limited rationality



Solve a particular problem

Have human ability
Reasoning, planning, problem solving, learning

- There are various types and forms of AI. The various categories of AI can be based on the capacity of intelligent program or what the program is able to do. Consideration of the above factors there are three main categories:
- 1) Weak AI (Artificial Narrow Intelligence)
- 2) Strong AI (Artificial General Intelligence)
- 3) Artificial Super Intelligence

- Weak AI :
  - Weak AI is AI that focuses on a single task. It isn't an intellect that can be used in a variety of situations.
  - Narrow intelligence or weak AI refers to an intelligent agent that is designed to solve a specific problem or perform a certain task.
  - For example, it took years of AI research to beat the chess grandmaster, and humans still haven't beaten the machines at chess since then. But that's all it can do, and it does it exceptionally well.
- Strong AI :
  - Strong AI, often known as general AI, refers to machine intelligence proven in the performance of any cognitive task that a person can execute.
  - It is far more difficult to construct powerful AI than it is to develop weak AI.
  - Artificial general intelligence machines can display human qualities such as reasoning, planning, problem solving, grasping complicated ideas, learning from personal experiences, and so on by using artificial general intelligence.
  - Many corporations and companies are working on developing general intelligence, but they have yet to finish it.

- Artificial Super-Intelligence :
  - AI thinker Nick Bostrom defined “Super intelligence is an intellect that is much smarter than the best human brains in practically every field, including scientific creativity, general wisdom and social skills.”
  - Super intelligence ranges from a machine which is just a little smarter than a human to a machine that is trillion times smarter. Artificial super intelligence is the ultimate power of AI.

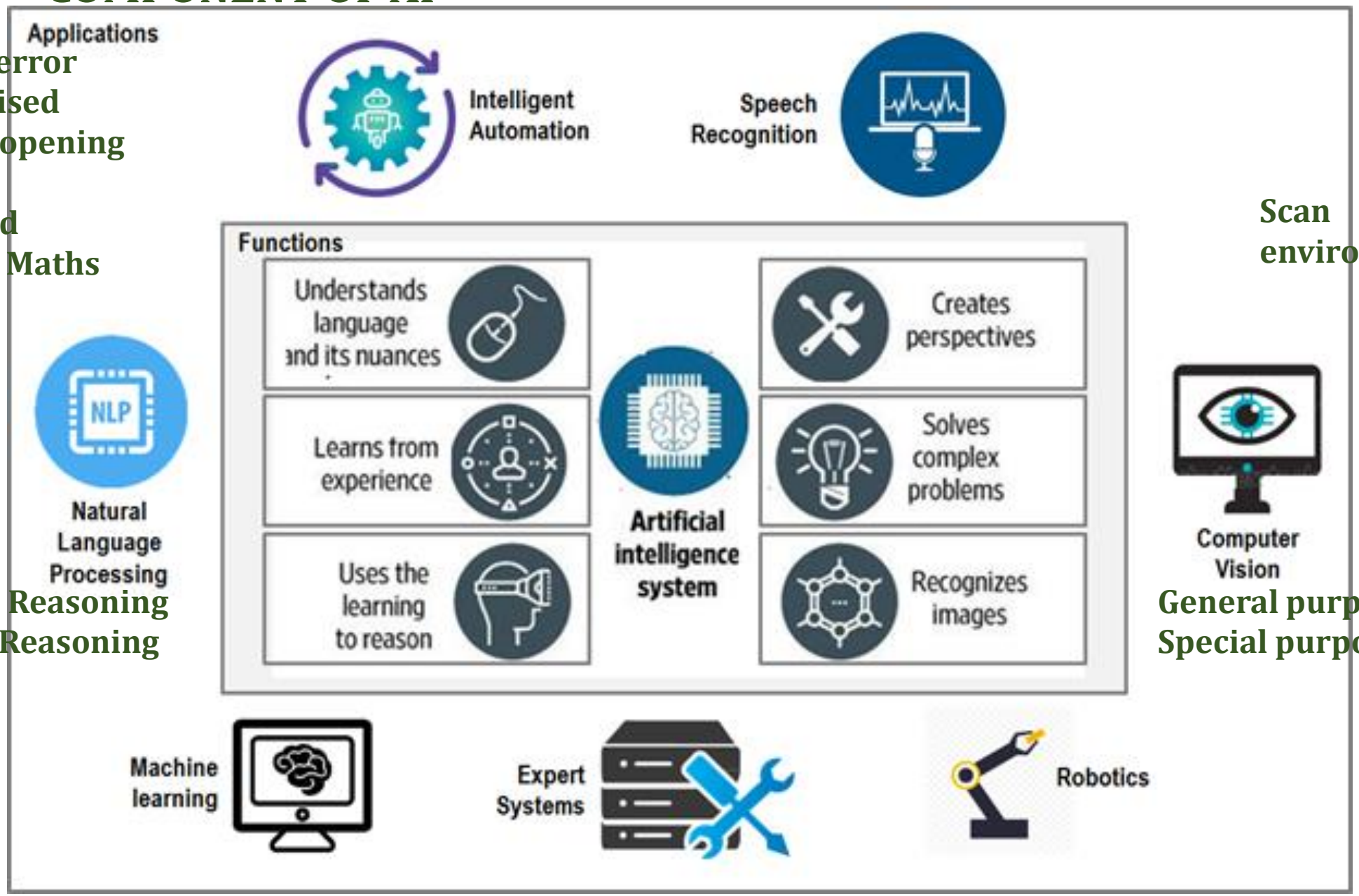
Weak AI	**Strong AI**
It is a narrow application with a limited scope.	It is a wider application with a more vast scope.
This application is good at specific tasks.	This application has an incredible human-level intelligence.
It uses supervised and unsupervised learning to process data.	It uses clustering and association to process data.
Example Siri, Alexa	Example Advanced Robotics

COMPONENT OF AI

Trial and error

Unsupervised Learning(opening YouTube)

Supervised Learning(Maths question)



Scan environment

Deductive Reasoning

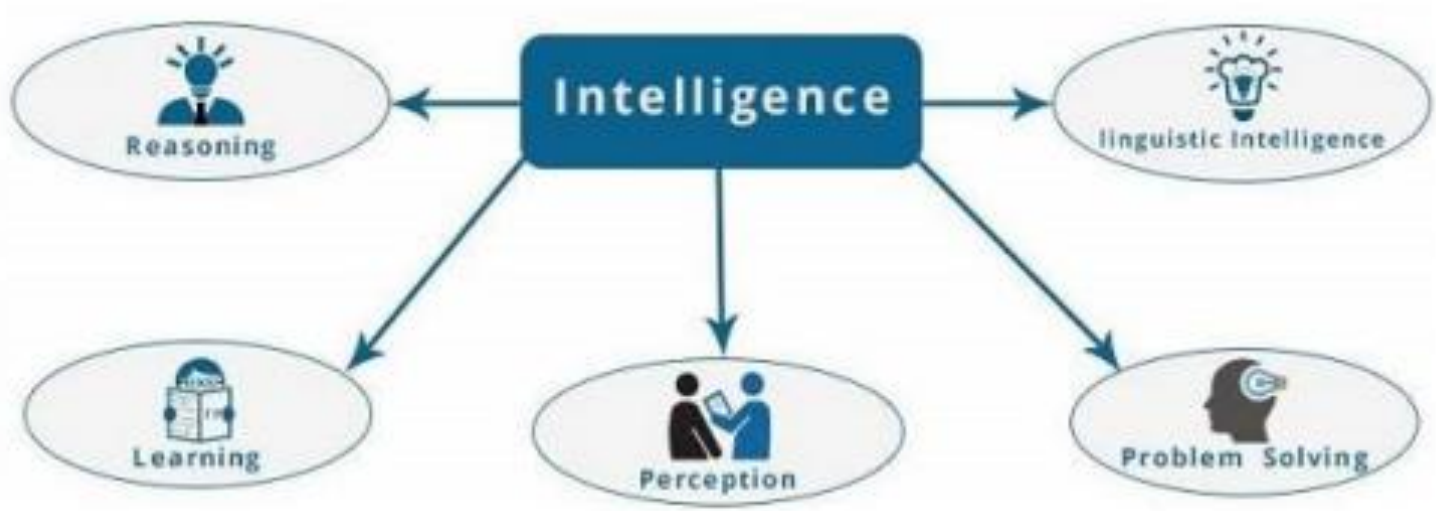
Inductive Reasoning

General purpose method

Special purpose method

COMPONENT OF AI

- PERCEPTION
- KNOWLEDGE REPRESENTATION
- LEARNING
- REASONING
- PROBLEM SOLVING
- NLP



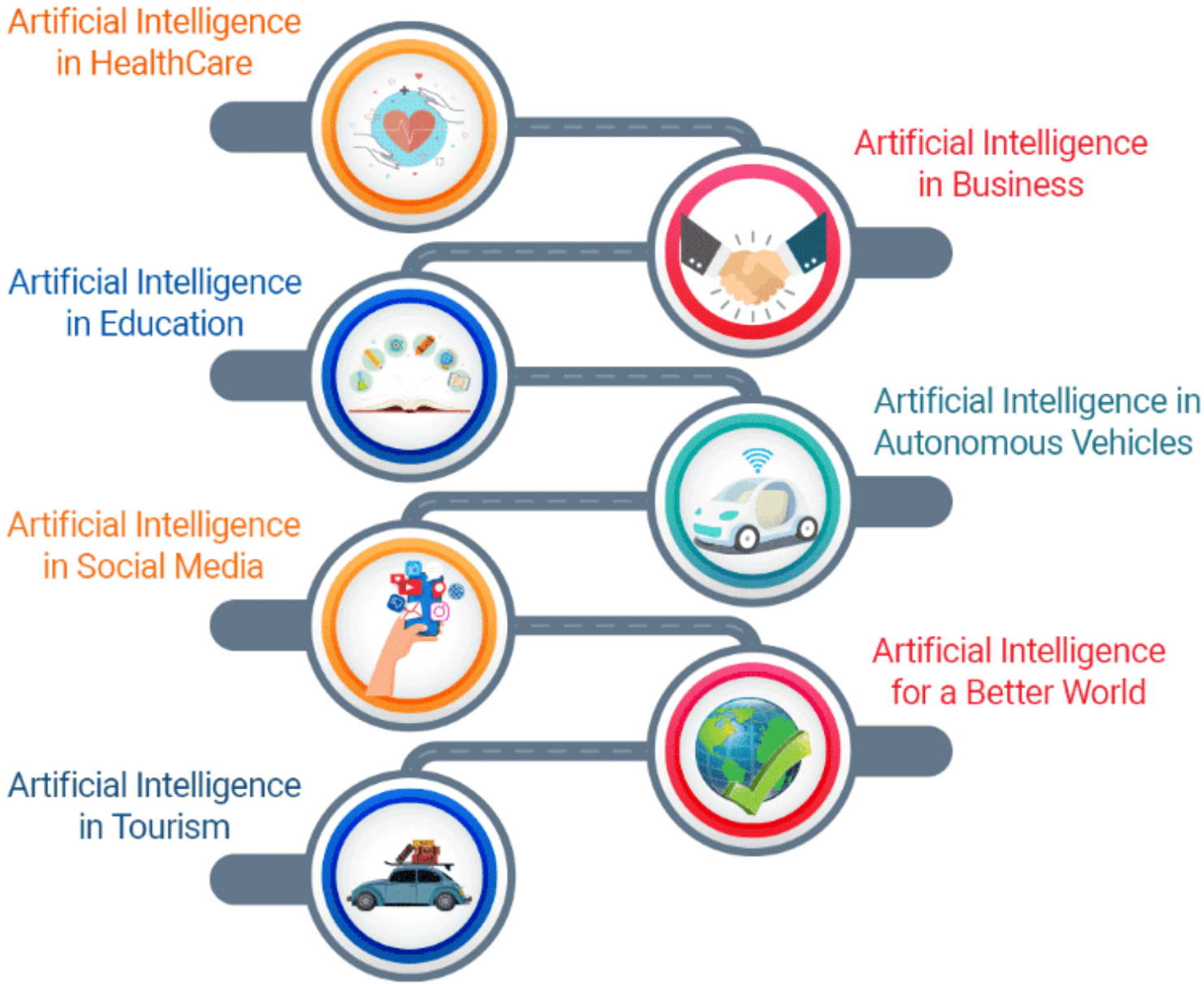
- Perception −
  - It is the process of acquiring, interpreting, selecting, and organizing sensory information.
  - Perception presumes sensing. In humans, perception is aided by sensory organs. In the domain of AI, perception mechanism puts the data acquired by the sensors together in a meaningful manner.
- Learning −
  - It is the activity of gaining knowledge or skill by studying, practising, being taught, or experiencing something.
  - Learning enhances the awareness of the subjects of the study.

- Reasoning −
  - It is the set of processes that enables us to provide basis for judgement, making decisions, and prediction. There are broadly two types −

Inductive Reasoning	Deductive Reasoning
It conducts specific observations to makes broad general statements.	It starts with a general statement and examines the possibilities to reach a specific, logical conclusion.
Even if all of the premises are true in a statement, inductive reasoning allows for the conclusion to be false.	If something is true of a class of things in general, it is also true for all members of that class.
Example − "Nita is a teacher. Nita is studious. Therefore, All teachers are studious."	Example − "All women of age above 60 years are grandmothers. Shalini is 65 years. Therefore, Shalini is a grandmother."

- Problem Solving −
  - It is the process in which one perceives and tries to arrive at a desired solution from a present situation by taking some path, which is blocked by known or unknown hurdles.
  - Problem solving also includes decision making, which is the process of selecting the best suitable alternative out of multiple alternatives to reach the desired goal are available.

Applications of AI



- Medical :
  - AI has applications in cardiology (CRG), neurology (MRI), Embryology (Sonography), and difficult internal organ procedures, among other fields.
- Business and Manufacturing:
  - Robots are well equipped with the various task in business and manufacturing. Vehicle workshops Robots are useful for jack purpose, car painting etc.
- Education :
  - Training simulators can be built using artificial intelligence techniques. Software for pre-school children are developed to enable learning with fun games.
  - Automated grading, Interactive tutoring, instructional theory are the current areas of application.

- Military :
  - When decisions have to be made quickly taking into account an enormous amount of information, and when lives are at stake, artificial intelligence can provide crucial assistance.
  - Training simulators can be used in military applications for the purpose of difficult task which human can not do easily, Robots are also used in many situations. AI plays important role in modern military.
- Entertainment :
  - Playing different AI based games, where one side human and other side the player (machine) which works on AI technology. Many film industries use Robots to play a role for critical situations like fire, jump etc.

The State of Art AI today

- Artificial Intelligence has infiltrated every part of our daily lives. Everywhere, from washing machines to air conditioners to smart phones. AI is assisting us in making our lives easier.
- AI is also doing fantastic things in industries. In factories, sound work is done by robots. Self-driving cars are now a reality.
- Barbie, who is WiFi-enabled, uses speech recognition to converse with and listen to children.
- AI is being used by businesses to improve their products and increase sales. Machine learning has made considerable progress in AI.

- Areas in which AI is showing significant advancements as follows:
- 1. Deep Learning
- 2. Machine Learning
- 3. AI replacing Workers
- 4. Internet of Things (IoT)
- 5. Emotional AI
- 6. AI in shopping and customer service
- 7. Ethical AI

- Deep Learning :
  - Deep learning has been successfully used to a variety of text analysis and understanding challenges in recent years.
  - Document categorization, sentiment analysis, machine translation, and other similar techniques are used, and the results are frequently dramatic.
  - Top Applications of Deep Learning Across Industries
    - Self Driving Cars.
    - News Aggregation and Fraud News Detection.
    - Natural Language Processing.
    - Virtual Assistants.
    - Entertainment.
    - Visual Recognition.
    - Fraud Detection.
    - Healthcare

- Machine Learning :
  - Machine Learning is an artificial intelligence application in which a computer/machine learns from past experiences (input data) and predicts the future.
  - The system's performance should be at least human-level. The system learns from the data set provided in order to complete task T.
  - Top 10 real-life examples of Machine Learning
    - Image Recognition. Image recognition is one of the most common uses of machine learning.
    - Speech Recognition. Speech recognition is the translation of spoken words into the text.
    - Medical diagnosis.
    - Statistical Arbitrage.
    - Learning associations.
    - Classification.
    - Prediction.
    - Extraction.

- AI Replacing Workers :
  - Machines are already better than humans in physical jobs; they can move quicker, more precisely, and lift heavier loads.
  - There will be almost nothing these machines can't accomplished or learn to do quickly. Once they are as sophisticated as we are.
- Internet of Things (IoT) :
  - AI-assisted The Internet of Things (IoT) develops intelligent machines that mimic smart behaviour and assist in decision-making with little or no human intervention.
  - While IoT is concerned with devices connecting with each other over the internet, AI is concerned with devices learning from their data and experience.

- Emotional AI :
  - Emotion AI, often known as affective computing, is Artificial Intelligence all about utilising artificial intelligence to identify emotions.
  - Machines with this level of emotional intelligence can comprehend both cognitive and emotional channels of human communication.
- AI in shopping and customer service :
  - Voice detection technology powered by AI may enable customers to converse with digital assistants in order to get the most out of the products they purchase. Most consumers will benefit greatly from this virtual link.
  - Artificial intelligence can help retailers decrease operational costs by automating in-store processes. It can assist customers in the store without the use of salespeople, reduce lines with cashier-less payments, refill stock with real-time stock monitoring, and digitise store displays and trial rooms.

- Ethical AI :
  - The notion of building artificially intelligent systems utilising norms of behaviour that ensure an automated system can respond to situations in an ethical manner is known as Roboethics, or robot ethics.
  - To do so, we turn to machine ethics, which is concerned with the process of imbuing AI robots with moral characteristics.

A.I. TIMELINE

1950
TURING TEST
Computer scientist Alan Turing proposes a test for machine intelligence. If a machine can trick humans into thinking it is human, then it has intelligence

1955
A.I. BORN
Term 'artificial intelligence' is coined by computer scientist, John McCarthy to describe "the science and engineering of making intelligent machines"

1961
UNIMATE
First industrial robot, Unimate, goes to work at GM replacing humans on the assembly line

1964
ELIZA
Pioneering chatbot developed by Joseph Weizenbaum at MIT holds conversations with humans

1966
SHAKEY
The 'first electronic person' from Stanford, Shakey is a general-purpose mobile robot that reasons about its own actions

A.I. WINTER
Many false starts and dead-ends leave A.I. out in the cold

1997
DEEP BLUE
Deep Blue, a chess-playing computer from IBM defeats world chess champion Garry Kasparov

1998
KISMET
Cynthia Breazeal at MIT introduces KISmet, an emotionally intelligent robot insofar as it detects and responds to people's feelings

1999
AIBO
Sony launches first consumer robot pet dog AiBO (AI robot) with skills and personality that develop over time

2002
ROOMBA
First mass produced autonomous robotic vacuum cleaner from iRobot learns to navigate and clean homes

2011
SIRI
Apple integrates Siri, an intelligent virtual assistant with a voice interface, into the iPhone 4S

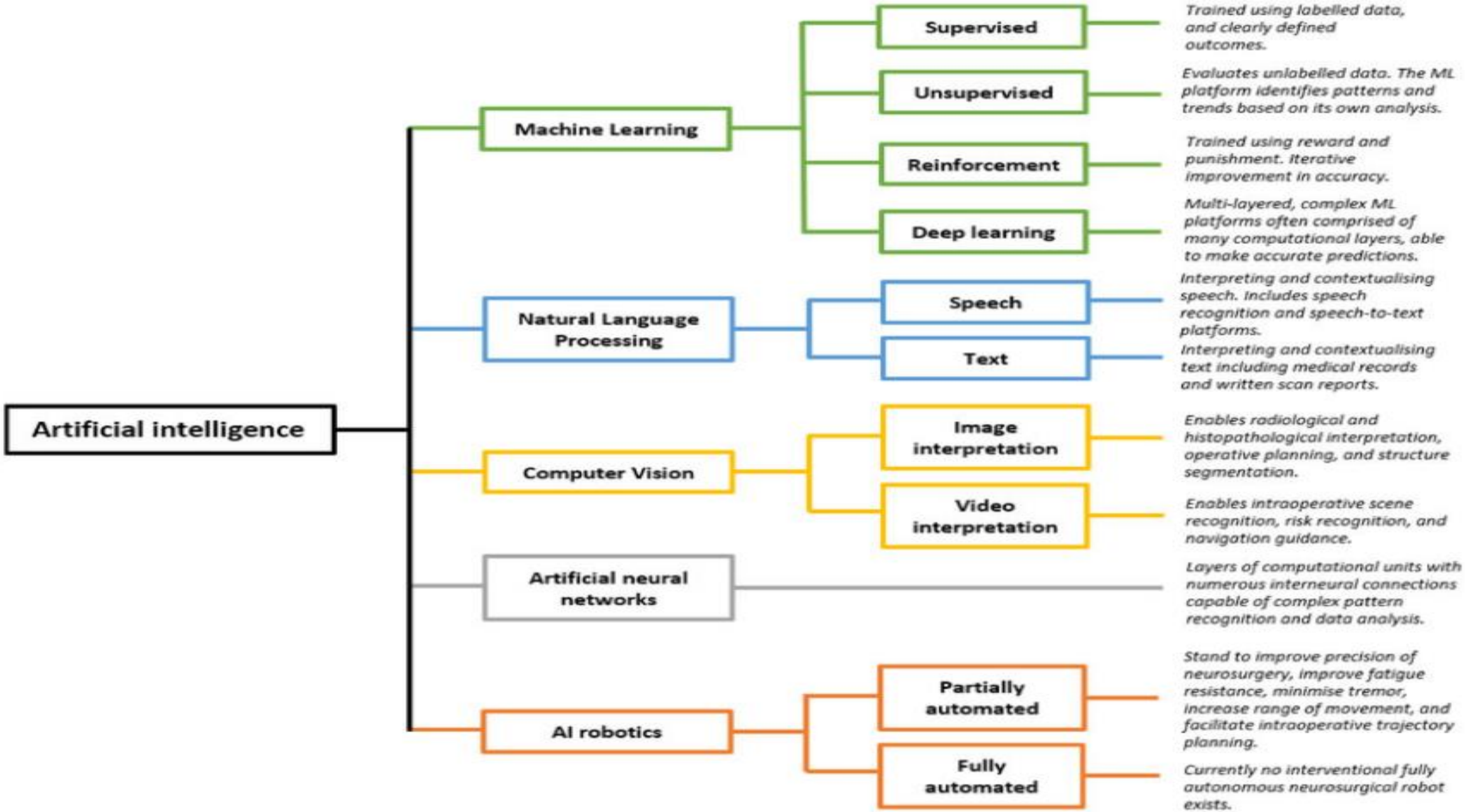
2011
WATSON
IBM's question answering computer Watson wins first place on popular $1M prize television quiz show *Jeopardy*

2014
EUGENE
Eugene Goostman, a chatbot passes the Turing Test with a third of judges believing Eugene is human

2014
ALEXA
Amazon launches Alexa, an intelligent virtual assistant with a voice interface that completes shopping tasks

2016
TAY
Microsoft's chatbot Tay goes rogue on social media making inflammatory and offensive racist comments

2017
ALPHAGO
Google's A.I. AlphaGo beats world champion Ke Jie in the complex board game of Go, notable for its vast number (2^{170}) of possible positions


Artificial intelligence
Machine Learning
Supervised
Trained using labelled data, and clearly defined outcomes.
Unsupervised
Evaluates unlabelled data. The ML platform identifies patterns and trends based on its own analysis.
Reinforcement
Trained using reward and punishment. Iterative improvement in accuracy.
Deep learning
Multi-layered, complex ML platforms often comprised of many computational layers, able to make accurate predictions.
Natural Language Processing
Speech
Interpreting and contextualising speech. Includes speech recognition and speech-to-text platforms.
Text
Interpreting and contextualising text including medical records and written scan reports.
Computer Vision
Image interpretation
Enables radiological and histopathological interpretation, operative planning, and structure segmentation.
Video interpretation
Enables intraoperative scene recognition, risk recognition, and navigation guidance.
Artificial neural networks
Layers of computational units with numerous interneural connections capable of complex pattern recognition and data analysis.
AI robotics
Partially automated
Stand to improve precision of neurosurgery, improve fatigue resistance, minimise tremor, increase range of movement, and facilitate intraoperative trajectory planning.
Fully automated
Currently no interventional fully autonomous neurosurgical robot exists.

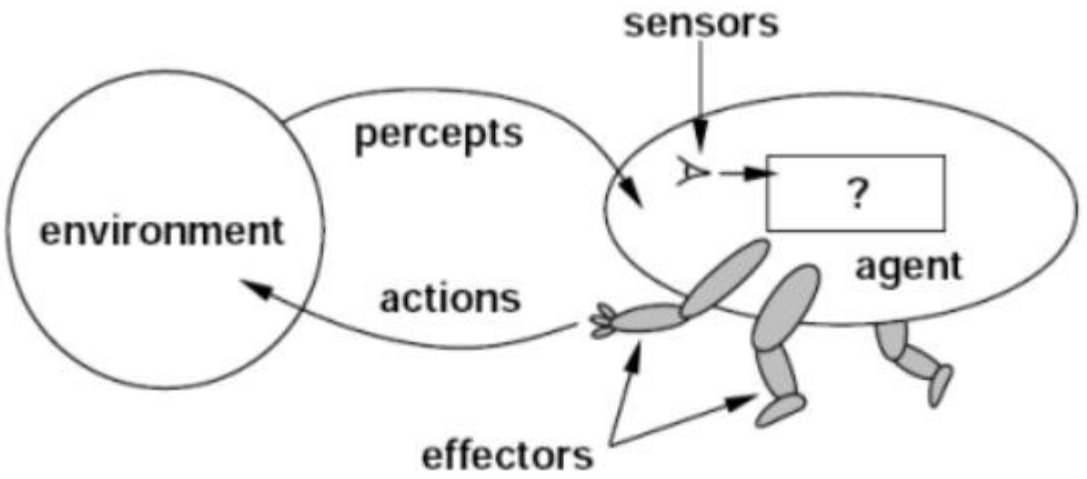
Agent

- In AI, an **intelligent agent (IA)** is an independent entity which observes and operates upon an environment and directs its activity towards accomplishing goals.
- In short, an intelligent agent is an entity that interacts with its surroundings via:
- perception through sensors.
- actions through effectors or actuators.

Function of AI agent

Intelligent agents continuously perform the following functions.

- perception of dynamic conditions in the environment.
- action to affect conditions in the environment.
- reasoning to interpret perceptions.
- solve problems.
- draw inferences.
- determine actions.



Examples

- The following are some examples of agents that will help you understand this concept better.
- **Human agent**
- eyes, ears, skin, taste buds, etc., for *sensors*.
- hands, fingers, legs, mouth, etc., for *actuators*.
- **Robot agent**
- camera, infrared, etc., for *sensors*.
- grippers, wheels, lights, speakers, etc., for *actuators*.

- Agent function – description of what all functionality and mapping between percept sequence to the desired action.
- Agent program – computer program that implement agent function in an architecture suitable language.
- Agent = architecture + program

Properties of Intelligent Agent

- **Environment**
- Situated in some environments.
- **Autonomous**
- It can operate without direct interference from humans or other software methods, and controls its own activities and internal environment.
- An agent is autonomous if its performance is defined by its own experience regarding its capability to learn and adapt.
- Autonomous agent decides independently which steps to take in the current condition to maximize improvement towards the purpose.

- **Flexible**
- Responsive (reactive): Agents should recognize their surroundings and react to changes that occur in it in a stipulated time frame.
- Proactive: Agents should not only act in response to their surroundings, but they should also be able to manifest opportunistic, goal-directed performance and take the initiative when suitable.
- Social: Agents are to cooperate with humans or other artificial agents.

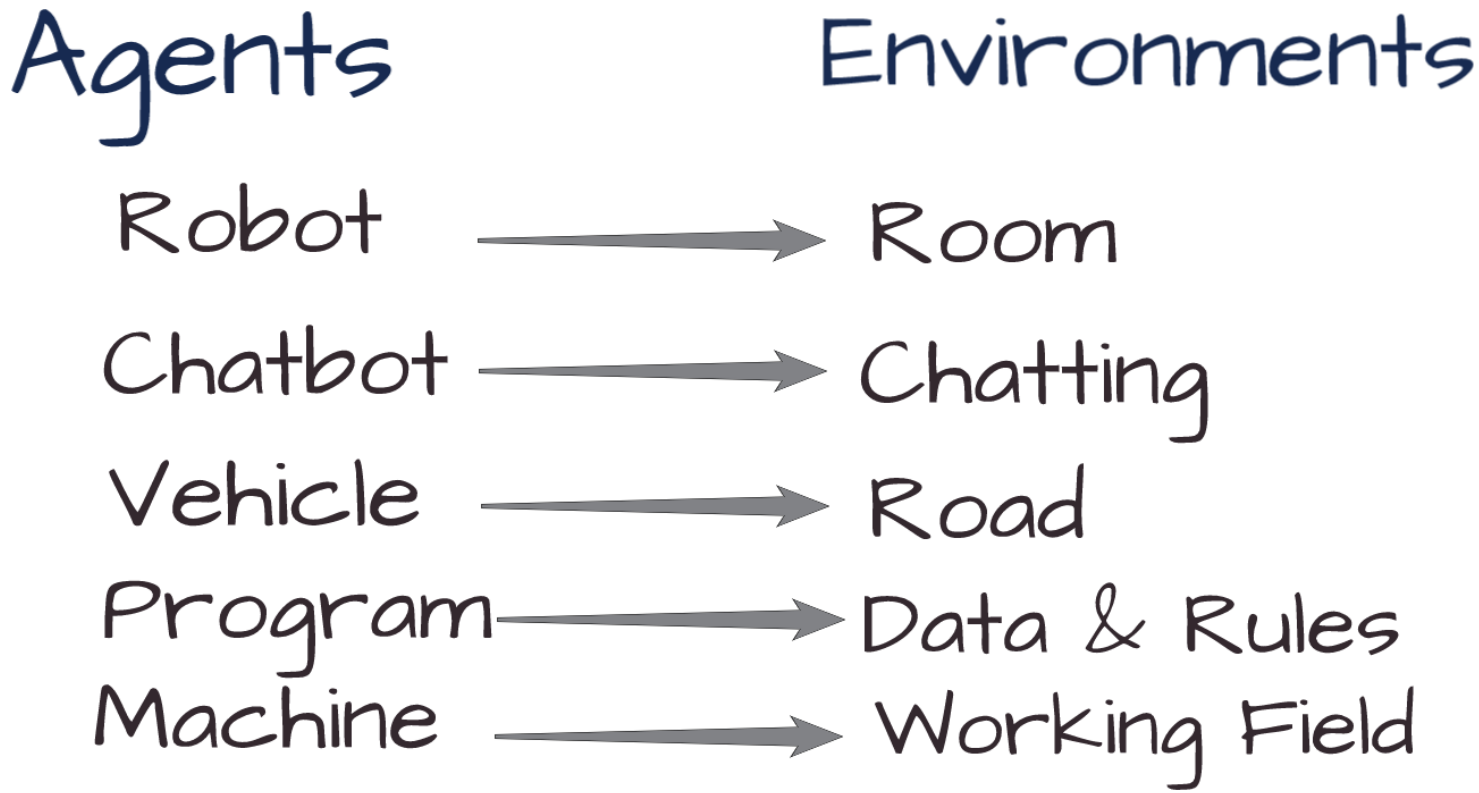
Reactive

- A **reactive system** is one that maintains ongoing interaction with its environment and responds to changes that occur in it (in time for the response to be useful).
- A program's environment can be guaranteed. It doesn't have to be worried about its own success or failure. An example of a guaranteed environment is compilers.
- Most environments are dynamic, in which things change, and information is incomplete.
- It is hard to build software for dynamic domains.
- Programs must take into account the probability of failure.

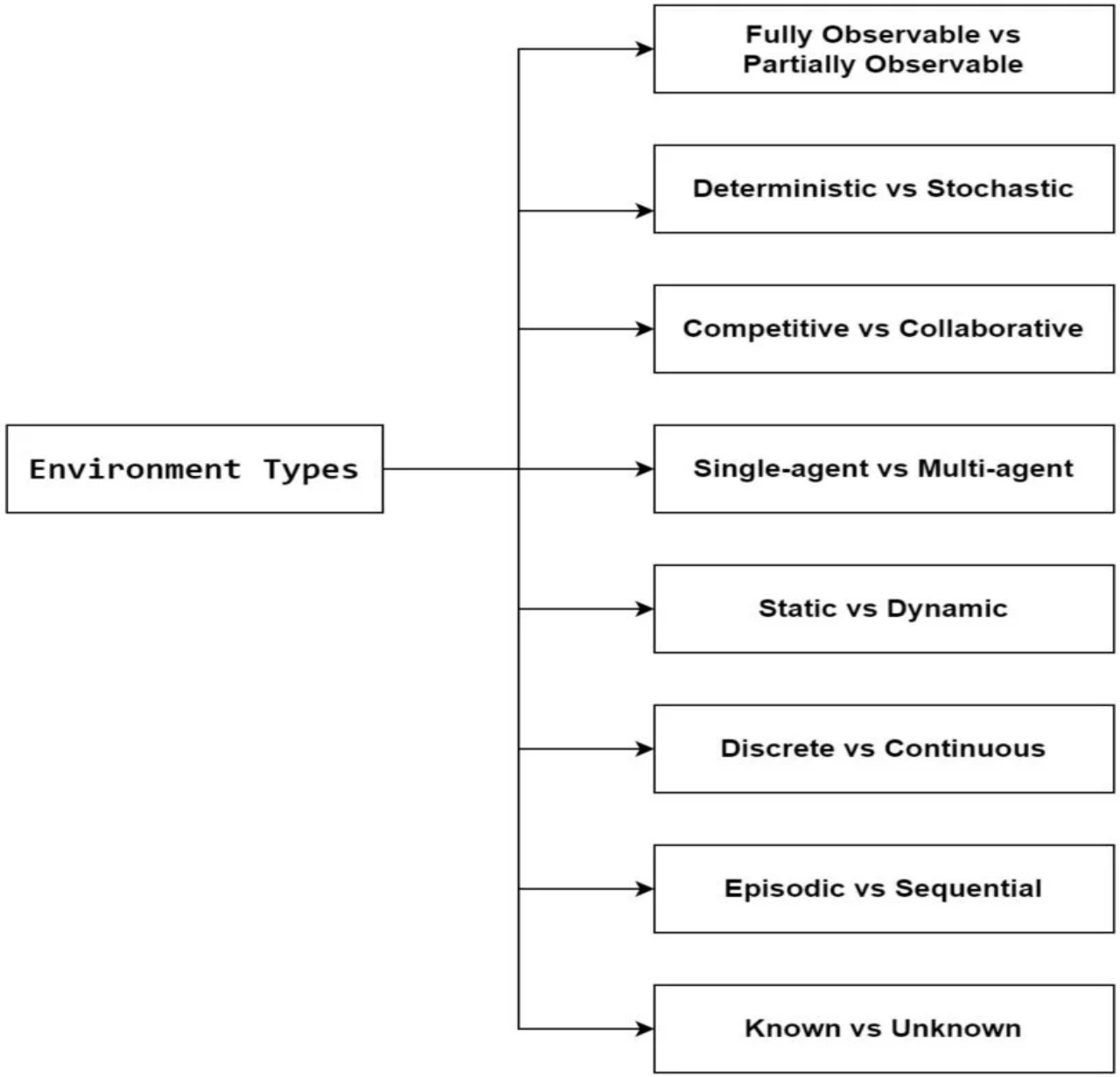
Pro-activeness

- Pro-activeness is to take the initiative to generate and attempt the goals.
- Reacting to an environment is easy.

- Other than the properties mentioned above, an agent has:
- **Mobility**
  - The capacity of an agent to actuate around a system.
- **Veracity**
  - An agent will not communicate when it has false information.
- **Benevolence**
  - Agents do not have conflicting goals, and every agent will therefore always try to do what is asked for.
- **Rationality**
  - The agent will perform to accomplish its goals and will not work in such a fashion as to block its goals.
- **Learning**
  - An agent must be able to learn.


Agents
Environments
Robot
Room
Chatbot
Chatting
Vehicle
Road
Program
Data & Rules
Machine
Working Field

Nature of environment



Fully Observable vs Partially Observable

- When an agent sensor is capable to sense or access the complete state of an agent at each point in time, it is said to be a fully observable environment else it is partially observable.
- Maintaining a fully observable environment is easy as there is no need to keep track of the history of the surrounding.
- An environment is called **unobservable** when the agent has no sensors in all environments.
- **Examples:**
  - **Chess –** the board is fully observable, and so are the opponent's moves.
  - **Driving –** the environment is partially observable because what's around the corner is not known.

Deterministic vs Stochastic

- When a uniqueness in the agent's current state completely determines the next state of the agent, the environment is said to be deterministic.
- The stochastic environment is random in nature which is not unique and cannot be completely determined by the agent.
- **Examples:**
  - **Chess –** there would be only a few possible moves for a coin at the current state and these moves can be determined.
  - **Self-Driving Cars-** the actions of a self-driving car are not unique, it varies time to time.

Competitive vs Collaborative

- An agent is said to be in a competitive environment when it competes against another agent to optimize the output.
- The game of chess is competitive as the agents compete with each other to win the game which is the output.
- An agent is said to be in a collaborative environment when multiple agents cooperate to produce the desired output.
- When multiple self-driving cars are found on the roads, they cooperate with each other to avoid collisions and reach their destination which is the output desired.

Single-agent vs Multi-agent

- An environment consisting of only one agent is said to be a single-agent environment.
- A person left alone in a maze is an example of the single-agent system.
- An environment involving more than one agent is a multi-agent environment.
- The game of football is multi-agent as it involves 11 players in each team.

Dynamic vs Static

- An environment that keeps constantly changing itself when the agent is up with some action is said to be dynamic.
- A roller coaster ride is dynamic as it is set in motion and the environment keeps changing every instant.
- An idle environment with no change in its state is called a static environment.
- An empty house is static as there’s no change in the surroundings when an agent enters.

Discrete vs Continuous

- If an environment consists of a finite number of actions that can be deliberated in the environment to obtain the output, it is said to be a discrete environment.
- The game of chess is discrete as it has only a finite number of moves. The number of moves might vary with every game, but still, it’s finite.
- The environment in which the actions are performed cannot be numbered i.e. is not discrete, is said to be continuous.
- Self-driving cars are an example of continuous environments as their actions are driving, parking, etc. which cannot be numbered.

Episodic vs Sequential

- In **an Episodic task environment**, each of the agent's actions is divided into atomic incidents or episodes. There is no dependency between current and previous incidents. In each incident, an agent receives input from the environment and then performs the corresponding action.
- **Example:** Consider an example of **Pick and Place robot**, which is used to detect defective parts from the conveyor belts. Here, every time robot(agent) will make the decision on the current part i.e. there is no dependency between current and previous decisions.
- In a **Sequential environment**, the previous decisions can affect all future decisions. The next action of the agent depends on what action he has taken previously and what action he is supposed to take in the future.
- **Example:**
  - **Checkers-** Where the previous move can affect all the following moves.

Known vs Unknown

- In a known environment, the output for all probable actions is given. Obviously, in case of unknown environment, for an agent to make a decision, it has to gain knowledge about how the environment works.

Task Environment	Observable	Agents	Deterministic	Episodic	Static	Discrete
Crossword puzzle	Fully	Single	Deterministic	Sequential	Static	Discrete
Chess with a clock	Fully	Multi	Deterministic	Sequential	Semi	Discrete
Poker	Partially	Multi	Stochastic	Sequential	Static	Discrete
Backgammon	Fully	Multi	Stochastic	Sequential	Static	Discrete
Taxi driving	Partially	Multi	Stochastic	Sequential	Dynamic	Continuous
Medical diagnosis	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Image analysis	Fully	Single	Deterministic	Episodic	Semi	Continuous
Part-picking robot	Partially	Single	Stochastic	Episodic	Dynamic	Continuous
Refinery controller	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Interactive English tutor	Partially	Multi	Stochastic	Sequential	Dynamic	Discrete

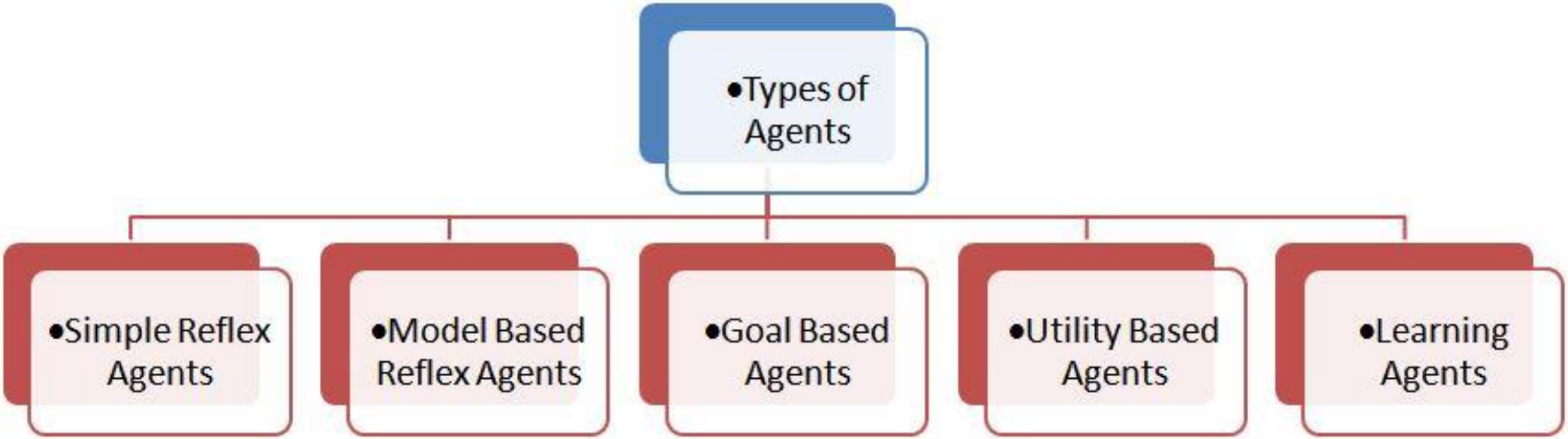
Figure 2.6 Examples of task environments and their characteristics.

PEAS in Artificial Intelligence

- PEAS System is used to categorize similar agents together. The PEAS system delivers the performance measure with respect to the environment, actuators, and sensors of the respective agent. Most of the highest performing agents are Rational Agents.
- **Rational Agent:** The rational agent considers all possibilities and chooses to perform a highly efficient action. For example, it chooses the shortest path with low cost for high efficiency.
- **PEAS** stands for a *Performance measure, Environment, Actuator, Sensor*.

- **Performance Measure:** Performance measure is the unit to define the success of an agent. Performance varies with agents based on their different precepts.
- **Environment**: Environment is the surrounding of an agent at every instant. It keeps changing with time if the agent is set in motion. There are 5 major types of environments:
  - Fully Observable & Partially Observable
  - Episodic & Sequential
  - Static & Dynamic
  - Discrete & Continuous
  - Deterministic & Stochastic
- **Actuator**: An actuator is a part of the agent that delivers the output of action to the environment.
- **Sensor**: Sensors are the receptive parts of an agent that takes in the input for the agent.

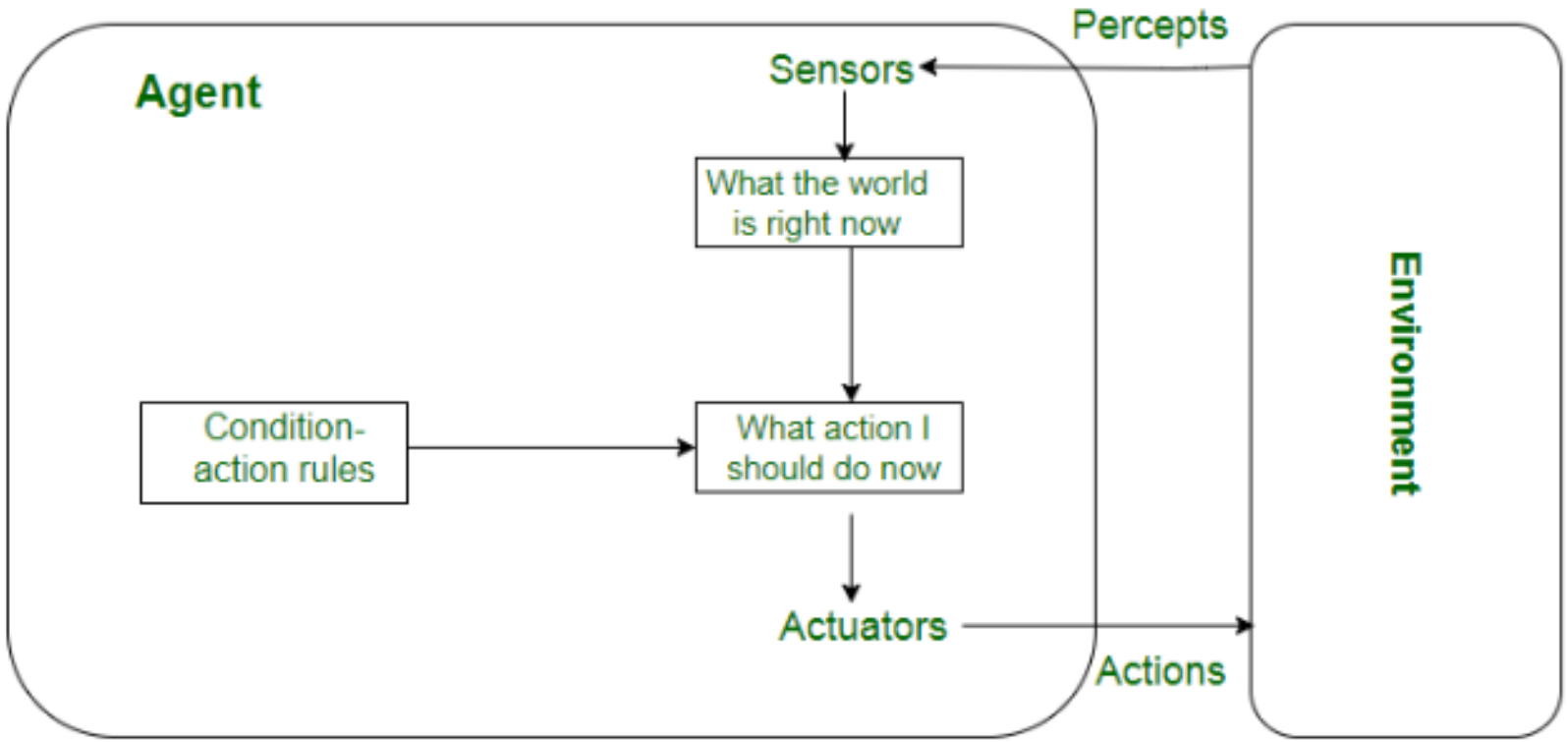
Agent	Performance Measure	Environment	Actuator	Sensor
Hospital Management System	Patient's health, Admission process, Payment	Hospital, Doctors, Patients	Prescription, Diagnosis, Scan report	Symptoms, Patient's response
Automated Car Drive	The comfortable trip, Safety, Maximum Distance	Roads, Traffic, Vehicles	Steering wheel, Accelerator, Brake, Mirror	Camera, GPS, Odometer
Subject Tutoring	Maximize scores, Improvement is students	Classroom, Desk, Chair, Board, Staff, Students	Smart displays, Corrections	Eyes, Ears, Notebooks
Part-picking robot	Percentage of parts in correct bins	Conveyor belt with parts; bins	Jointed arms and hand	Camera, joint angle sensors
Satellite image analysis system	Correct image categorization	Downlink from orbiting satellite	Display categorization of scene	Color pixel arrays


•Types of Agents
•Simple Reflex Agents
•Model Based Reflex Agents
•Goal Based Agents
•Utility Based Agents
•Learning Agents

Simple reflex agents

- Simple reflex agents ignore the rest of the percept history and act only on the basis of the **current percept**.
- Percept history is the history of all that an agent has perceived to date.
- The agent function is based on the **condition-action rule**.
- A condition-action rule is a rule that maps a state i.e, condition to an action.
- If the condition is true, then the action is taken, else not. This agent function only succeeds when the **environment is fully observable**.
- For simple reflex agents operating in partially observable environments, infinite loops are often unavoidable. It may be possible to escape from infinite loops if the agent can randomize its actions.
- When we have relatively **less inputs and outputs** (actions), then we prefer to write down simple reflex agent.
- Problems with Simple reflex agents are :
- Very limited intelligence.
- No knowledge of non-perceptual parts of the state.
- Usually too big to generate and store.
- If there occurs any change in the environment, then the collection of rules need to be updated.

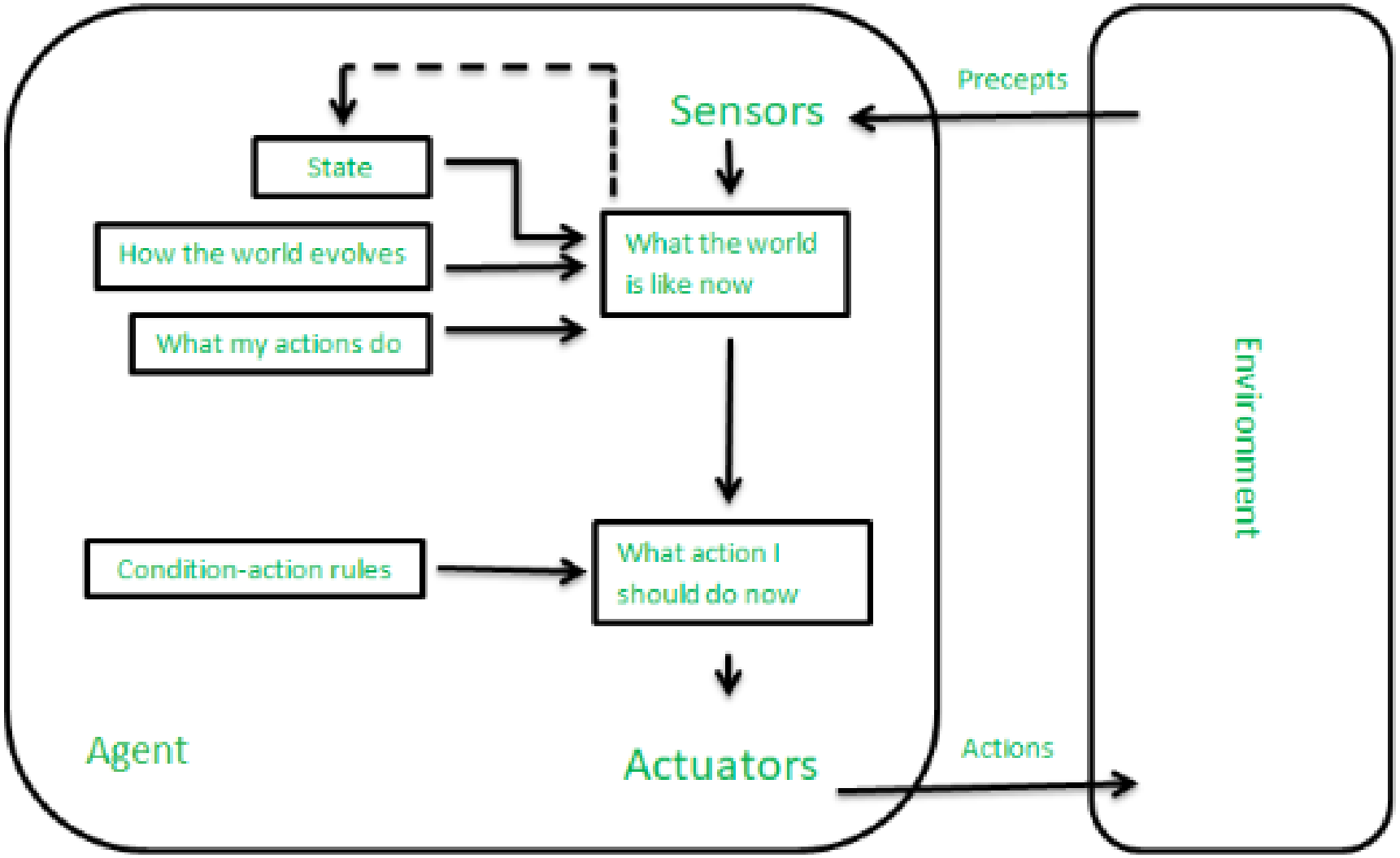
- **Advantages**
- Easy to implement (Only IF-ELSE structure is required)
- Very fast as compared to others
- Efficient because of Condition-actions rules
- Simple reflex agents are fixed memory agents
- **Disadvantages**
- These types of agents having almost zero scalability
- Only applicable for simple and small systems (limited inputs and outputs)
- No Learning Capability or very limited intelligence
- Change in environment require change in condition actions rules


Agent
Sensors
Percepts
What the world is right now
Condition-action rules
What action I should do now
Actuators
Actions
Environment

Model-based reflex agents

- It works by finding a rule whose condition matches the current situation.
- A model-based agent can handle **partially observable environments** by the use of a model about the world.
- The agent has to keep track of the **internal state** which is adjusted by each percept and that depends on the **percept history**.
- The current state is stored inside the agent which maintains some kind of structure describing the part of the world which cannot be seen.
- Updating the state requires information about :
- how the world evolves independently from the agent, and
- how the agent’s actions affect the world.

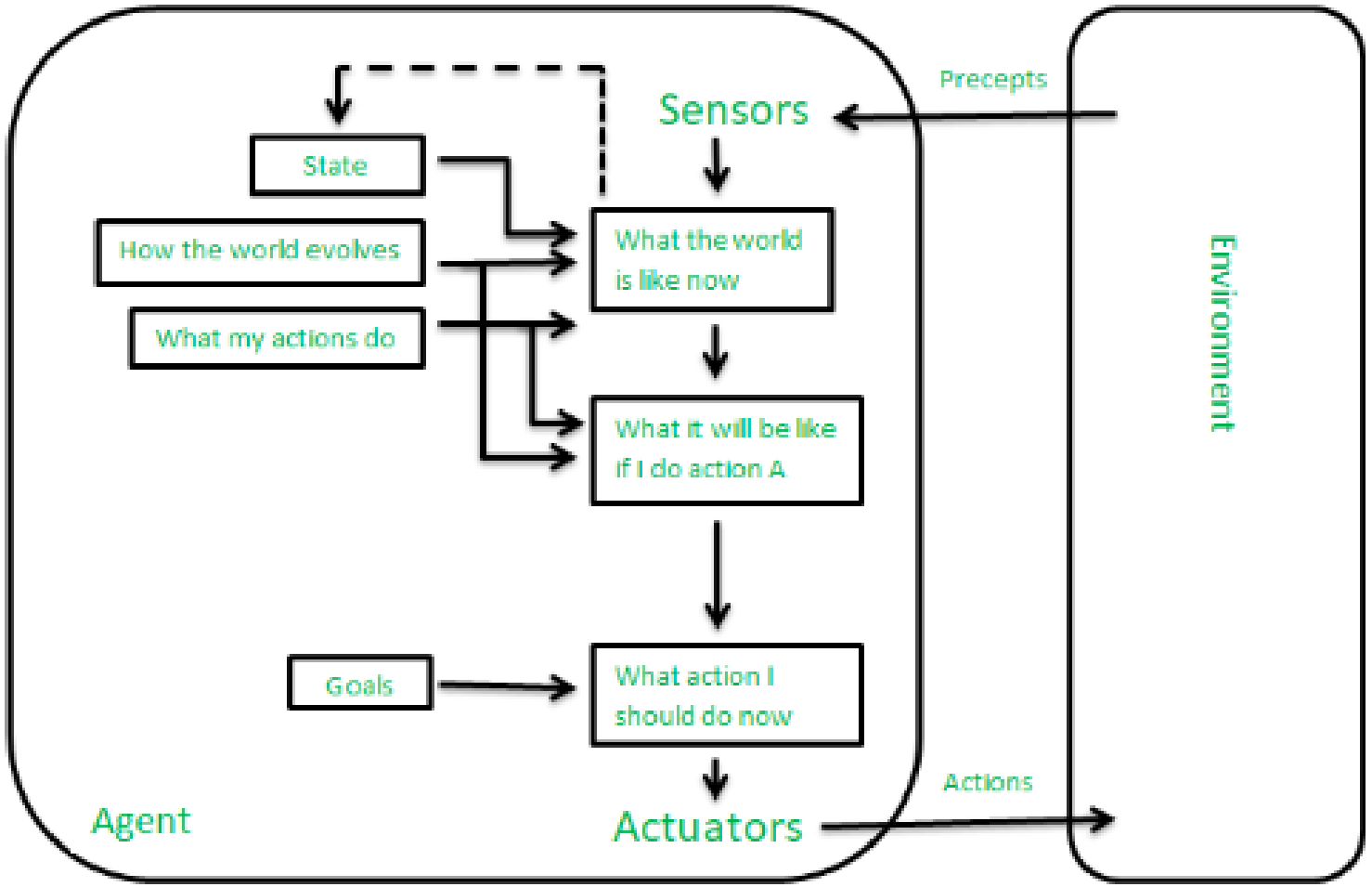
- **Advantages**
- Efficient than simple reflex agents
- Can work in partially observable task environment
- **Disadvantages**
- No information about goal state
- Limited Intelligence


Precepts
Sensors
State
How the world evolves
What my actions do
What the world is like now
Condition-action rules
What action I should do now
Agent
Actuators
Actions
Environment

Goal-based agents

- These kinds of agents take decisions based on how far they are currently from their **goal**(description of desirable situations).
- Their every action is intended to **reduce its distance** from the goal.
- This allows the agent a way to choose among multiple possibilities, selecting the one which reaches a goal state.
- The knowledge that supports its decisions is represented explicitly and can be modified, which makes these agents more flexible. They usually require **search and planning**.
- The goal-based agent’s behavior can easily be changed.

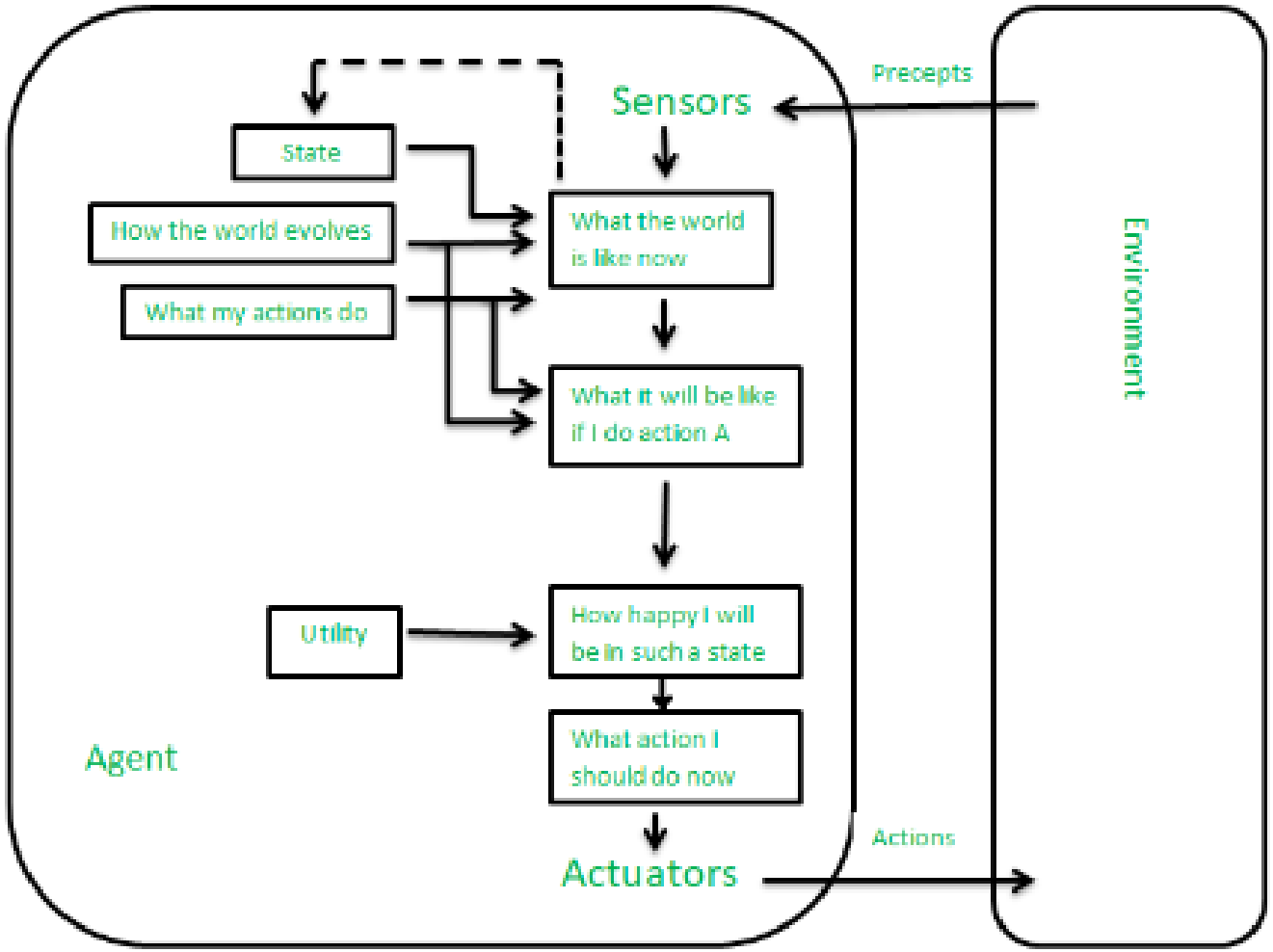
- **Advantages**
- Efficient than previous agents discussed
- **Disadvantages**
- Cannot differentiate between two states that which one is best
- No Learning Capabilities (Limited Intelligence)


Precepts
Sensors
State
How the world evolves
What my actions do
What the world is like now
What it will be like if I do action A
Goals
What action I should do now
Actuators
Actions
Agent
Environment

Utility-based agents

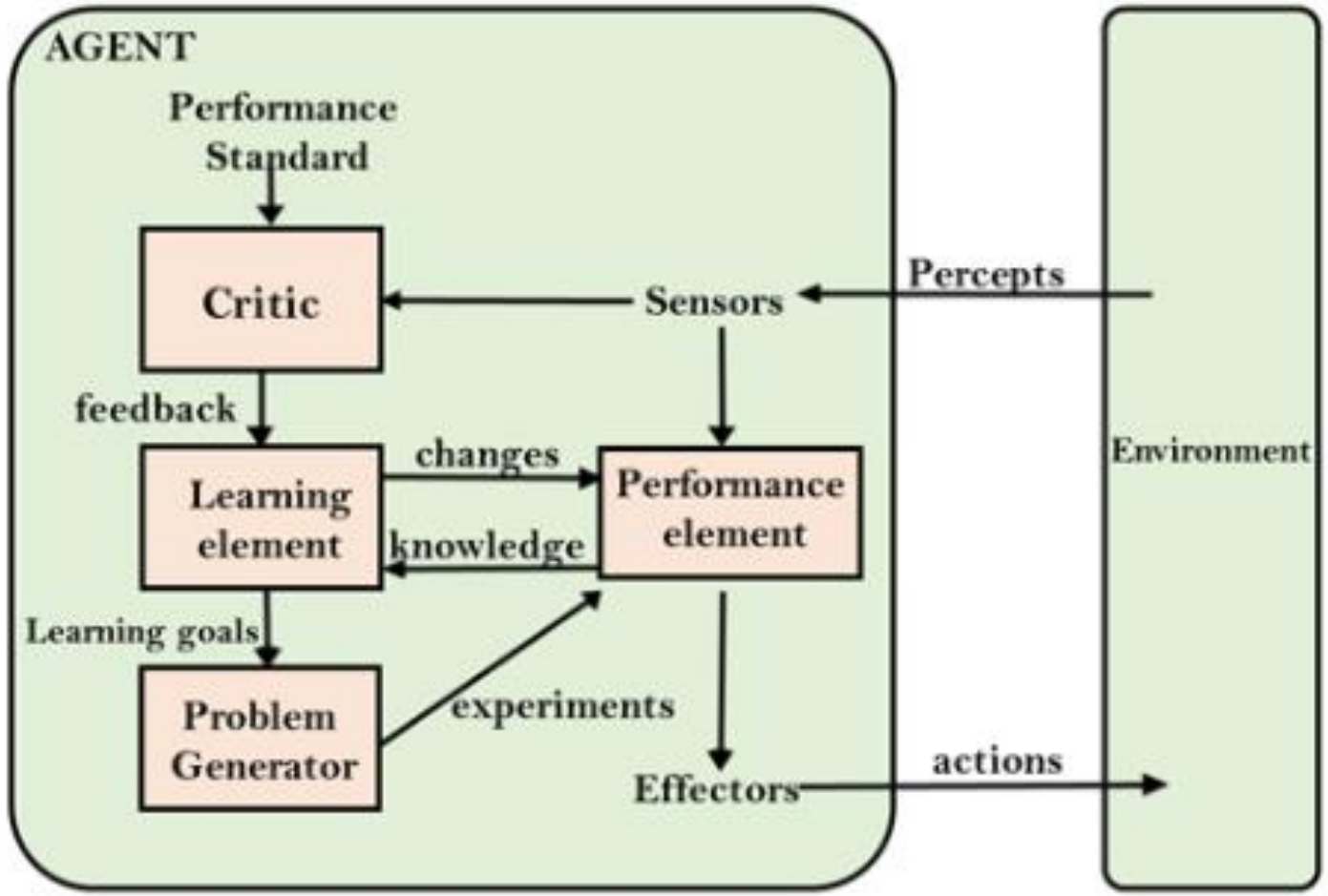
- The agents which are developed having their end uses as building blocks are called utility-based agents.
- When there are multiple possible alternatives, then to decide which one is best, utility-based agents are used.
- They choose actions based on a **preference (utility)** for each state.
- Sometimes achieving the desired goal is not enough. We may look for a quicker, safer, cheaper trip to reach a destination.
- Agent happiness should be taken into consideration.
- Utility describes how **“happy”** the agent is.
- Because of the uncertainty in the world, a utility agent chooses the action that maximizes the expected utility. A utility function maps a state onto a real number which describes the associated degree of happiness.

- **Advantages**
- Find best state using evaluation function or utility function
- Can work efficiently in Continuous environment
- **Disadvantages**
- Limited Intelligence


Precepts
Sensors
State
How the world evolves
What my actions do
What the world is like now
What it will be like if I do action A
Utility
How happy I will be in such a state
What action I should do now
Agent
Actuators
Actions
Environment

Learning Agent :

- A learning agent in AI is the type of agent that can learn from its past experiences or it has learning capabilities.
- It starts to act with basic knowledge and then is able to act and adapt automatically through learning.
  A learning agent has mainly four conceptual components, which are:
- **Learning element:** It is responsible for making improvements by learning from the environment
- **Critic:** The learning element takes feedback from critics which describes how well the agent is doing with respect to a fixed performance standard.
- **Performance element:** It is responsible for selecting external action
- **Problem Generator:** This component is responsible for suggesting actions that will lead to new and informative experiences.


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