

\*Note\* Environment with machine ~~factors~~.

\*AI: how we think, perceive, understand, predict, and manipulate.

### \* What is Intelligence?

→ Intelligence is the ability to understand and learn things.

### \* What is Artificial Intelligence?

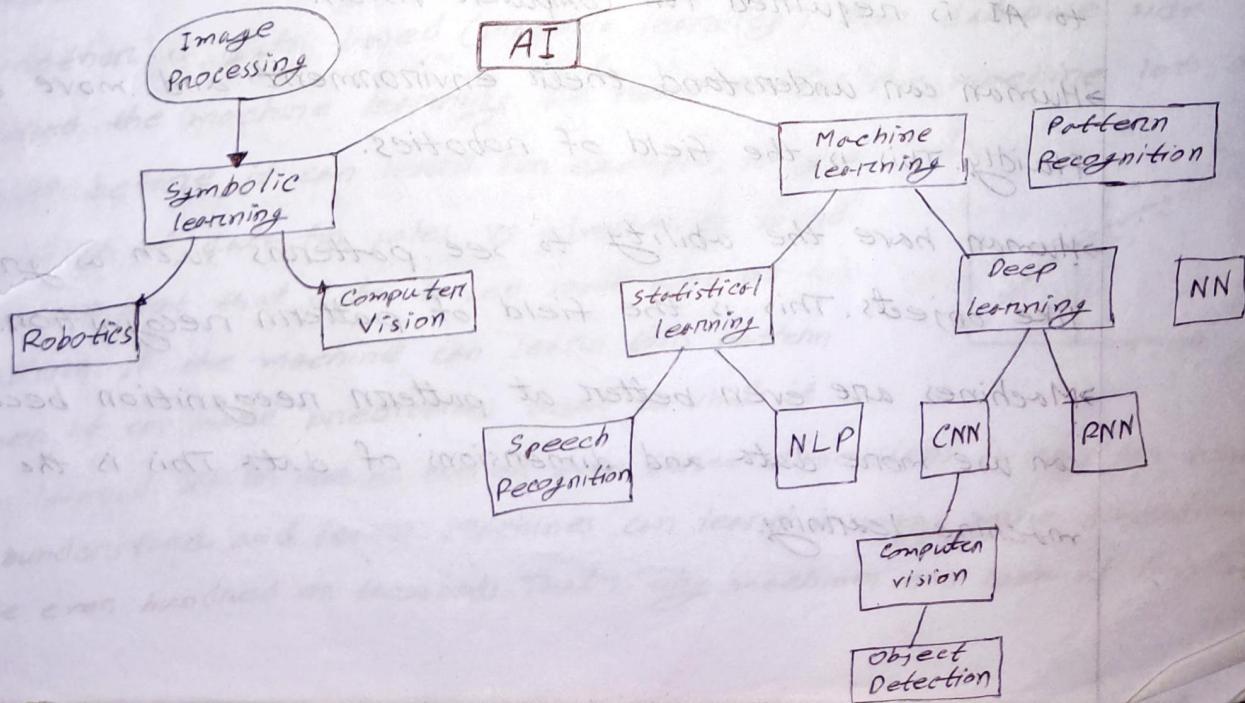
→ Artificial Intelligence is a branch of computer science by which we can create intelligence machines which can behave like a human, think like humans, and able to make decisions.

→ AI is a discipline that systematizes and automates intellectual tasks to create machines to:

→ Act like humans → Act rationally

→ Think like humans → Think rationally

\* The goal of AI is to create computer systems that perform functions that are assumed to require intelligence when done by humans.



\* Let's a machine that could organize your cupboard just as you like it, or serve every member of the house a customized cup of coffee. Makes your day easier. Doesn't it? These are the products of artificial intelligence. But why use the term artificial intelligence? Because these machines are artificially incorporated with human-like intelligence. To perform tasks as we do. This intelligence is built using complex algorithms and mathematical functions.

→ But AI may not be as obvious as in the previous examples. In fact AI is used in smartphones, cars, social media feeds, video games, banking, surveillance, and many other aspects of our daily life.

\* What does an AI do at its core?

→ Let's here is a robot that we built in our lab which is now dropped onto a field. Inspite of a variation in lighting landscape and dimensions of the field. The AI robot must perform as expected. This ability to react appropriately to a new situation is called generalized learning. The robot is now at a crossroad.

One that is paved and the other rocky. The robot must determine which path to take based on the ~~the~~ circumstances. This portrays the robot's reasoning ability. After a short stroll

the robot, now encounters a stream that it cannot swim across using the plank provided as an input. The robot is able to across this stream. So our robot uses the given input and finds the solution for a problem this is problem solving. These three capabilities make the robot artificially intelligent.

→ In short, AI provides machines with the capability to adapt, reason, and provide solutions.

→ Let's have a look at the two broad categories an AI classified into: Weak AI, also called narrow AI, focuses solely on one task. For example, AlphaGo is a maestro of the game go but you can't expect it to be even remotely good at chess. This makes AlphaGo is a weak AI. Another example, we might say Alexa is definitely not a weak AI since it can perform multiple tasks. But that's not really true when we ask Alexa to play despacito. It picks up the keywords 'play' and 'despacito' and runs a program and is trained to. Alexa cannot respond to a question. It isn't trained to answer. For instance, try asking Alexa the status of traffic from work to home. Alexa cannot provide you this information as she is not trained to and that brings us to our second category of AI which is strong AI. Now this is much like the robots that only exist in fiction as of now. Ultron from avengers is an ideal example of a strong AI. That's because it's self-aware and eventually even develops emotions. This makes the AI's response unpredictable. You must be wondering,

→ How artificial intelligence different from machine learning and deep learning?

→ We know what AI is. Machine learning is a technique to achieve AI. And deep learning in turn is a subset of machine learning. Machine learning provides a machine with the capability to learn from data and experience through algorithms. Deep learning does this learning through ways inspired by the human brain. This means through

deep learning data and patterns can be better perceived.

\* Agent: An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators.

→ An agent runs in the cycle of perceiving, thinking, and acting. An agent can be:

① Human-Agent: A human agent has eyes, ears, and other organs which work for sensors and hand, legs, mouth, vocal tract work and other body parts for actuators.

② Robotic Agent: A robotic agent can have cameras, infrared range finders, NLP for sensors and various motors for actuators.

Example: Cog-MIT, Aibo-Sony.

③ 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.

\* The main characteristics of AI agent are:

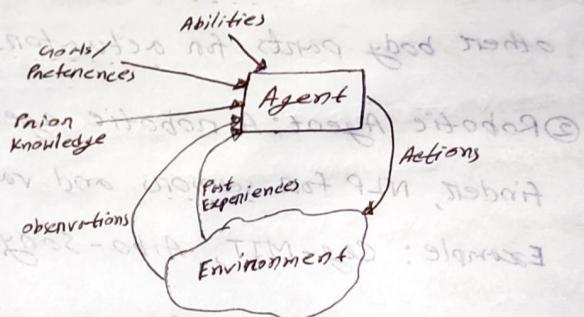
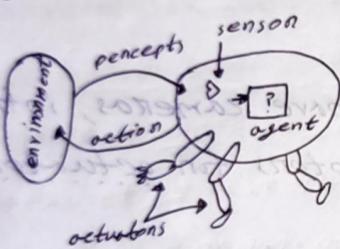
① Sensor: Sensor is a device which detects the change in the environment and sends the information to other electronic devices. An agent observes its environment through sensors.

② Actuators: Actuators are the component of machines that converts energy into motion. The actuators are only responsible for moving and controlling a system. It can be an electric motor, gears, nail, etc.

③ **Percepts**: Percepts refer to the agent's perceptual inputs from environment at any given instant. An agent's percept sequence is the complete history of everything the agent has ever perceived.

④ **Action**: The action that agent performs after any given sequence of percepts.

⑤ **Environment**: An environment is the surrounding of the agent. The agent takes input from the environment through sensors and delivers the output to the environment through actuators.



What is an intelligent agent?

An intelligent agent is an autonomous entity which act upon an environment using sensors and actuators for achieving goals.

Four rules for an AI agents:

- ① An AI agent must have the ability to perceive the environment.
- ② The observation must be used to make decisions.
- ③ Decision should result in an action.
- ④ The action taken by an AI agent must be a natural action.

\* A Rational Agent is an agent which has clear preferences models uncertainty, and acts in a way to maximize its performance measure with all possible actions. A rational agent is said to perform the right things.

→ 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.

→ The rationality of an agent is measured by its performance measure.

→ Rationality can be judged on the basis of following points:

① The performance measure that defines the criterion of success.

② The agent's prior knowledge of the environment.

③ The actions that the agent can perform.

④ The agent's percept sequence to date.

⑤ The agent's performance measure.

\* Features of Environment: An environment can have various features from the point of view of an agent:

→ Fully observable vs Partially observable

→ Static vs Dynamic

→ Discrete vs Continuous

Deterministic vs Stochastic

→ Single-agent vs Multi-agent

→ Episodic vs sequential

→ Known vs Unknown

→ Accessible vs Inaccessible.

### → Fully 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.

### → Deterministic vs stochastic:

- If an agents 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.

### → 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.

#### 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.

#### 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 ~~agent~~ action.

→ However for dynamic environment, agents need to keep looking at the world at each action.

→ 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.

#### Known vs Unknown:

→ 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.

→ 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.

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
Pant-picking robot	Partially	single	stochastic	Episodic	Dynamic	Continuous
Refinery control	Partially	single	stochastic	Sequential	Dynamic	Continuous
Interactive English tutor	Partially	Multi	stochastic	Sequential	Dynamic	Discrete

\* Agents can be grouped into five classes based on their degree of perceived intelligence and capability. Which are:

- ① Simple Reflex Agent
- ② Model-based Reflex Agent
- ③ Goal-based Agents
- ④ Utility-based Agent
- ⑤ Learning Agent.

① Simple Reflex Agent: 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. It does not consider any part of percepts history during their decision and action process.

→ It 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.

→ There are some limitation. ~~they~~ In a fully observable environment the agent can see the world perfectly. On the other hand, a resource device ~~it's~~ ~~agent~~ is often difficult to detect.

#### \* Simple reflex agent vs model-based reflex agent:

A simple reflex agent selects actions based on the agent's current perception of the world and not based on past perceptions. It can handle a full observation environment. On the other hand, a model-based reflex agent is designed to deal with partial accessibility. They do this by keeping track of the part of the world it can see now.

#### \* Goal-based agent vs utility-based agent:

A goal-based agent takes it a step further by using a goal in the future to help make decisions about how best to reach that outcome. On the other hand, a utility-based agent is an agent that acts based not only on what the goal is, but the best way to reach that goal. Goal-based agents act in order to achieve their goal. Utility-based agents maximize their own utility function.

\* PEAS = Performance measure, Environment, Actuators, Sensors

→ The tasks of designing an automated taxi driver:

- Performance measure: safe, fast, legal, comfortable trip, maximize profits.
- Environment: Roads, other traffic, pedestrians, customers
- Actuators: steering wheel, accelerator, break, signal, horn.
- Sensors: cameras, sonar, speedometer, GPS, odometer, engine sensors, keyboard.

→ The tasks of designing an Medical diagnosis system:

- Performance measure: Healthy patient, minimize costs, lawsuits.
- Environment: Patient, hospital, staff.
- Actuators: screen display (question), tests, diagnoses, treatments.
- Sensors: keyboard (entry of symptoms, findings), patients answers.

→ The tasks of designing an vacuum cleaner:

- Performance measure: cleanliness, efficiency, battery life, security.
- Environment: Room, table, wood floor, carpet.
- Actuators: wheels, Brushes, Vacuum extraction.
- Sensors: camera, dirt detection sensor, cliff sensor, bump sensor, infrared wall sensor.

\* What is turing test?

→ The turing test is a deceptively simple method of determining whether a machine can demonstrate human intelligence.

\* What are the capabilities that an ~~algorithm~~ intelligent machine should possess to pass the Turing Test?

→ Here are some features that ~~should~~ would be required for an intelligent machine to pass the turing test:

1. Natural language processing; to enable it, to communicate successfully in english.

2. Knowledge representation to store what it knows or hears.

3. Automated reasoning to use the stored information to answer questions and to draw new conclusions.

4. Machine learning to adapt to new circumstances and to detect and extrapolate patterns.

\* What are the additional capabilities to pass the Total turing Test?

→ Total turing test include a video signal, so that the interrogation can test the subject's perceptual abilities.

Additional capabilities to pass total turing test:

1. computer vision to perceive object and environment.

2. robotics to manipulate and move object.

\* Knowledge is the perception about and understanding of a subject.  
→ consists of facts, concepts, rules.

\* Rules as knowledge Representation:

→ IF "traffic light" is green THEN action is go.

→ IF "traffic light" is red THEN action is stop.

→ IF car is dead AND "fuel tank" is empty  
THEN action is "refuel the car".

\* Importance of knowledge:

→ Essential for intelligent behavior

→ To perform a complex robotics task

→ To develop a plan to complete a sequence of intricate operations.