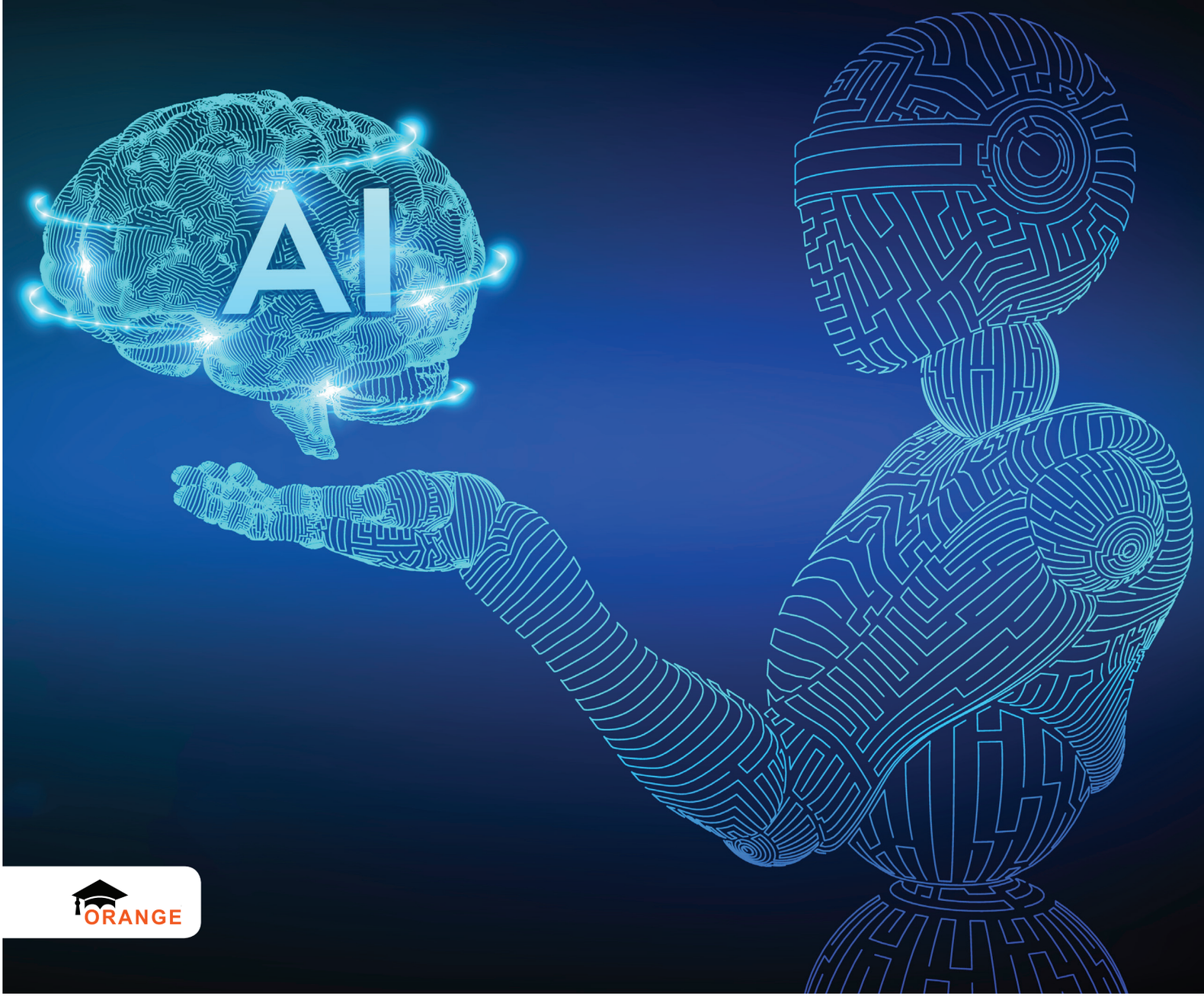
8

Artificial Intelligence & Robotics



ORANGE


2022
ChatGPT is available to public testing.
2020
GPT-3 tool for automated conversations is introduced.
2014
Amazon launches Alexa - intelligent virtual assistant that completes shopping tasks.
2011
Question answering computer Watson wins 1st place on TV show Jeopardy.
2011
Apple integrates into iPhone Siri - intelligent virtual assistant.
2002
The first mass- produced robotic vacuum cleaner Roomba learns to navigate homes.
1999
Sony launches the first robot pet dog AIBO whose personality and skills develop over time.
1997
A chess-playing computer Deep Blue defeats chess champion Garry Kasparov.
1964
Joseph Weizenbaum- chatbot capable of holding conversations with humans.
1956
John McCarthy introduces the term 'Artificial Intelligence
1950
Alan Turing test - if a machine tricks human into thinking it's a human, then it has intelligence.

1 AI AND ITS DOMAINS

Learning Outcomes

- Introducing AI
- Tasks Performed by AI
- Why Artificial Intelligence Matters?
- Types of Artificial Intelligence
- Domains of AI
- Brief History of AI
- Terminologies Associated with Artificial Intelligence
- Difference between Human Intelligence and AI
- Various Practices Involved in Artificial Intelligence
- Human-Machine Interaction (HMI)

Alice, look what your uncle has sent for you from the USA.

OMG! It's a robot!

Yes, she is Vincy and she is here to assist you. She will arrange your closet according to the seasons, mood and clothes last worn.

Amazing! This is the best birthday gift anyone can have! Vincy, can you bring my favourite drink in the morning?

Sure, I will bring chocolate shake for you.

How do you know that I love chocolate shake?

I know this because your uncle programmed your likes and dislikes into my system.

Ever since machines were invented, humans have been trying to make machines smarter like themselves. Thus we can say artificial intelligence is associating machines with human thinking process like decision making, problem solving and learning through the available database. In other words, we can say AI is the study of how to make computers think like humans in the fields at which they are better like decision making and logical thinking.

Introducing AI

"One of our big goals in search is to make search that really understands exactly what you want, understands everything in the world. As computer scientists, we call that artificial intelligence."

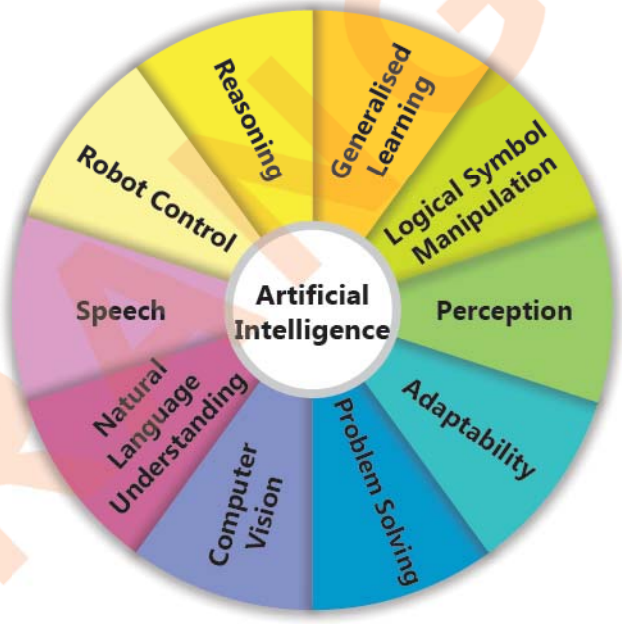
—Larry Page, Google Co-founder

In simple terms, we can define AI as a machine that can simulate human thought process and can take actions based on those thoughts and even draw conclusions. It should also be able to correct itself, if it makes a mistake. This also means that AI-based computer would be able to make a decision in a given situation like human beings and in some cases even better.

Tasks Performed by AI

Although AI is still evolving but the AI machines are expected to perform the following tasks:

- **Generalised Learning:** This model of AI is capable of drawing conclusions from the existing data and producing new results based on the new data.
- **Reasoning:** This model of AI can make decisions based on some rules and give proper results in some really difficult situations.
- **Problem Solving:** This model of AI is specifically built to handle problematic situations and figure out the most efficient path to handle the situation.
- **Adaptability:** This model of AI is designed to adapt to the conditions it is put in and draw conclusions based on these data.
- **Perception:** This model of AI is usually found in robots. They are designed to perceive the environment around them and gather data for a higher cause.
- **Computer Vision:** This model of AI can analyse and understand images just like human beings.
- **Speech:** This model of AI can interpret speech and convert text to speech.



- **Natural Language Understanding:** This model of AI is designed to accept and comprehend data in the form of speech or text and provide results in human understandable form.
- **Logical Symbol Manipulation:** This model of AI is proficient in interpreting symbols and provides results based on these symbols. Symbols here, refer to the signs that are used to describe data.
- **Robot Control:** This model of AI specialises in controlling robots and such machines.

Terminologies Associated with Artificial Intelligence

Some common terms associated with the definition of AI are **Intelligence**, **Learning** and **Understanding**. Let us learn about these:

- **Intelligence** means the ability to apply knowledge and skills. Humans are the most intelligent species who can understand, analyse and make decisions. An intelligent machine will perform the given task by understanding the environment and adjust its behaviour according to its senses. One such example of an intelligent machine is an industrial robot.
- **Learning** is the process of acquiring new knowledge, behaviour, skills, values and preferences. Machine learning is making the machine learn from its data bank rather than through explicit programming. Here, the performance automatically improves through experience.
- **Understanding** is deep inner knowledge of oneself. For example, an AI-driven car would be capable of suggesting easy and short route from one place to another and a robot would understand the human voice and tell who the speaker is.

There are some more terms associated with the learning of Artificial Intelligence. They are:

- **Chatbots:** These are AI programs that are designed to have a conversation with a human being. These are deployed by many organisations to resolve customer queries.
- **Internet of Things (IoT):** Nowadays, we have a plethora of devices that can connect to the Internet and access information. These interconnected devices are known as IoT. Amazon Echo, wearable fitness bands being among many such examples.
- **Big Data:** As the name suggests, these are huge clusters of data. Example of such data can be global stock market data or climate data of the entire world for weather forecasting etc.
- **Programming Language:** There are many programming languages used to program AI-based systems. One must learn these to be able to create AI-based system. One of the most popular languages is Python.
- **Data Mining:** This refers to the act of extracting useful information from a pile of data.
- **Machine Learning:** This refers to the ability of an AI to learn and draw conclusion on its own without being programmed every time.

Why Artificial Intelligence Matters?

Artificial Intelligence has already stepped into our lives. It makes a machine capable of learning from experience, understanding new inputs and performing tasks more like humans. Speech recognition, decision making and visual perception are some areas where AI is doing wonders.

Minimizing human error is one of the advantages of using AI over human intelligence. There are some geographical areas where humans cannot operate. In such scenarios, AI can be very helpful. The speed at which AI system works on huge data is better than humans.

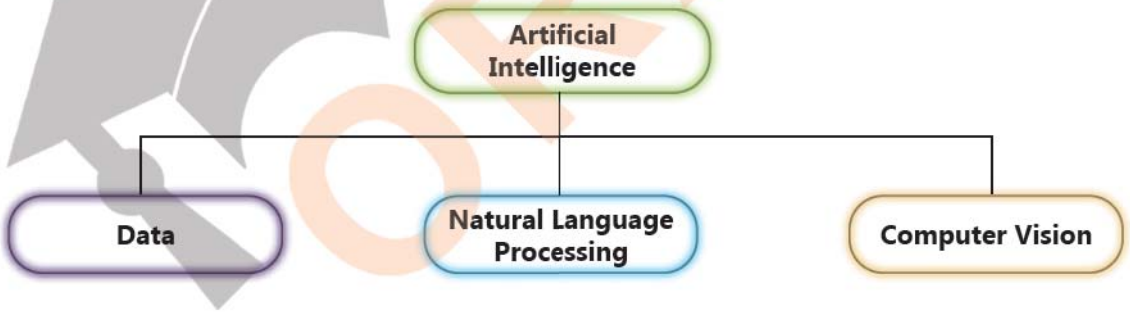
Difference between Human Intelligence and AI

Let us learn about the differences between human intelligence and artificial intelligence.

Parameter	Human Intelligence	Artificial Intelligence
Nature	Human intelligence adjusts with new environment using different cognitive skills.	AI aims to build machines that can mimic human behaviour.
Brain	Human brain is analogous.	AI-based machines are digital.
Functioning	Humans use brain's memory, ability to think and computational power.	AI-based machines depend on the huge data bank and specific instructions are fed into the system.
Tasks	Human beings perform various tasks using past experience, using trial and error methods and the learning continues throughout their life.	AI machines perform various tasks by learning through data and continuous training.
Change in the environment	Human insight takes less time to adapt to the changed environment.	AI machines take much more time to adjust to the changed environment.
Speed	Human beings take more time to process huge data manually.	AI-based machine's processing speed is much faster than that of human beings.

Domains of AI

Any AI machine is developed with the objective of replicating human intelligence. To replicate human intelligence, 3 different domains are brought together to construct one single entity called AI. In this chapter, you will learn about 3 major domains and their real-life usage.



Data

Data are the facts and figures which are processed to find meaningful results. Data plays a pivotal role in the field of AI. Data collection is the process of collecting and sourcing information from numerous sources. **'Big Data'** is the term used to represent huge or voluminous data.

Quality of data plays an important role when it comes to AI applications. The data should be error free and contain relevant information for the given task. The accuracy of results depends on the quality of the data. Thus, we can say that data is the lifeblood of AI because an AI system needs to learn from the data that is provided to it. If we provide incorrect data to the system, we will never get correct results.

These data can be numeric (temperature, loan amount, etc.), categorical (gender, colour, etc.), or even free text (like doctor's notes, prescriptions, opinion surveys, etc.)

Natural Language Processing (NLP)

Natural Language Processing, usually shortened as NLP, is a domain of AI which works with the interactions between humans and computer systems using natural language. Most of the voice recognition apps like Siri, Alexa, Cortana, etc., use NLP to process the audio input. It is the sub field of AI that uses computer-based methods to analyse and understand language in speech and text.

The aim of NLP is to read, decode, understand and bring logical results of the human languages to make sense.

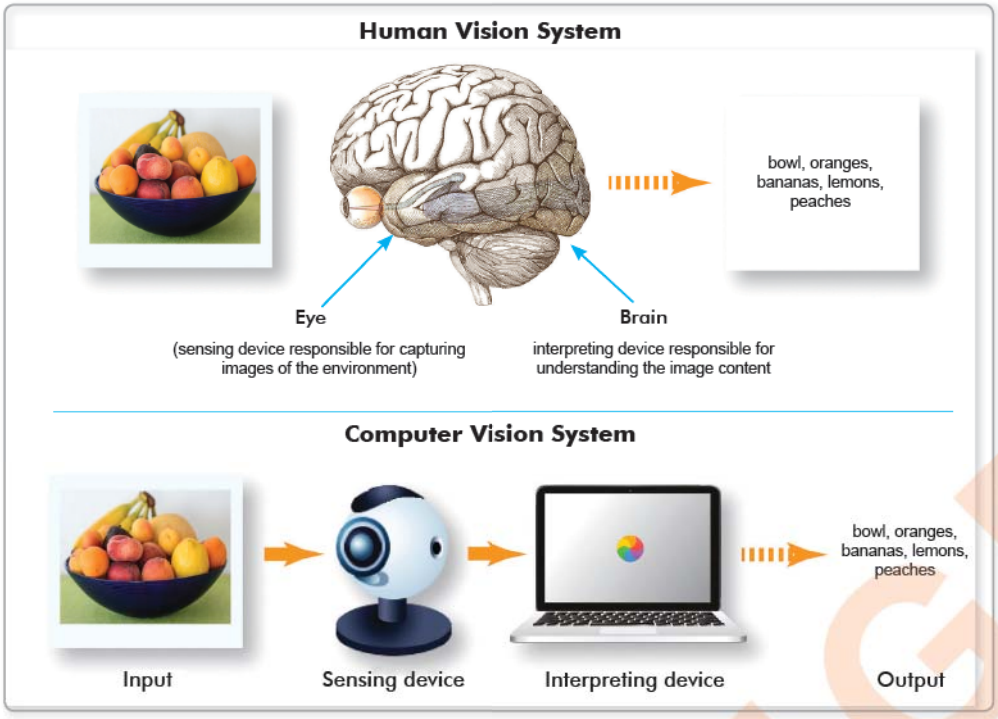
Different types of NLP include:

- **Optical Character Recognition** for converting written and printed text into data.
- **Speech Recognition** involves converting spoken words into data.
- **Machine Translation** where the source language is translated into target language without human interference.
- **Natural Language Generation** is a software process which converts structured data into natural language.
- **Sentiment Analysis** is a process used to determine whether a piece of text is positive, negative or neutral.
- **Semantic Search** is understanding the intention behind any search. It also optimises the search operation by giving possible search predictions.

Computer Vision (CV)

Computer Vision is a field of AI which deals with how computers can develop a high level of understanding from digital images or videos just like humans do. Larry Roberts is commonly considered as the father of Computer Vision. The basic idea of using Computer Vision is to give any machine the ability to "see" and interpret the world around it. It also involves teaching computers to understand and process an image at a pixel level.

This diagram clearly shows how CV works.



The tasks performed by CV

A CV can perform the following tasks:

- **Object Classification:** It can analyse and identify a particular object among many in an image or a video. For example, CV system can identify an apple amongst a bunch of flowers in an image.
- **Object Identification:** The system analyses visual content and identifies a particular object of an image or a video. For example, the system tries to find a green apple among the apples in the image.
- **Object Tracking:** The system processes any given video and finds the object that matches the searching criteria and then tracks its movements.

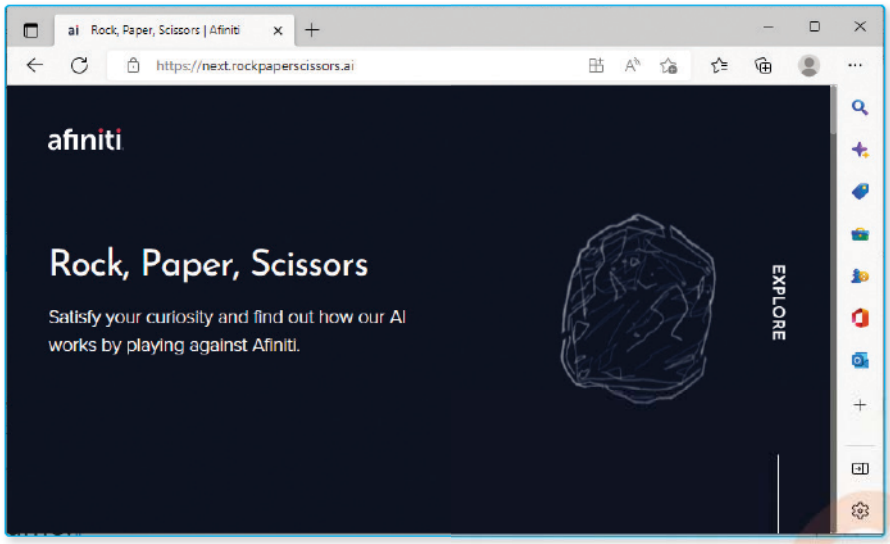
Experiential Learning

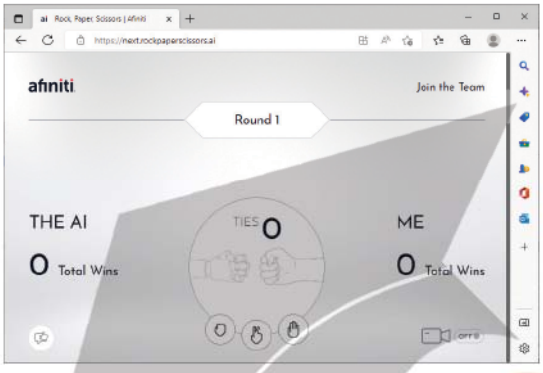
Ai GAME 01 **Rock Paper Scissors**

About the game

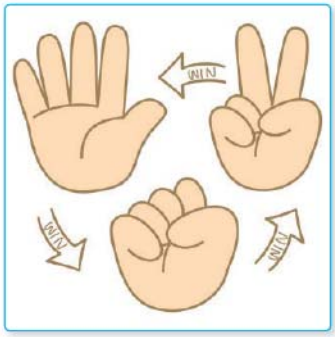
Rock paper scissors is a simple game based on the data domain of AI and usually played between 2 players in which each player simultaneously forms one of the three shapes with an outstretched hand. These shapes are "rock", "paper", and "scissors".

A study revealed that people follow certain patterns while playing this game, so one can predict and win more games.





It can be played online where one player is human and the other is computer. Here, AI analyses the moves of human and picks the next move for computer.



Follow these steps to play the game:

- Open a Web browser
- Type the link given below:

Visit https://next.rockpaperscissors.ai/ or scan the QR code to play the game.

OR

On you cell phone:

- Open Google Play Store/App Store (for iPhone).

- Type rock, paper, scissors and click search.
- You get the App icon, install it as you install other apps.

What is the role of AI in this game?

This game enlightens the power of Artificial Intelligence. When you play this game, it's researched that you follow a typical pattern, the computer searches the patterns in its databank and uses it to defeat you.

Experiment

- Try different patterns like Scissors → Scissors → Paper → Scissors
- Change the pattern every time and observe how computer learns and plays.
- Note down how many times you were able to defeat computer and vice versa.

Research and Relate

Research and relate that how this kind of pattern study can help e-commerce websites like Flipkart, Myntra, etc. Write an article and show it to your computer teacher.

AI GAME 02 Animal Mystery

Experiential Learning

About the game

Go to your computer lab & do the following:

Open web browser and play the game—Mystery Animal. To play the game visit https://www.gamestolearnenglish.com/animal-mystery/ or scan the QR code to play the game.

AI GAME 03 Emoji Scavenger Hunt

Experiential Learning

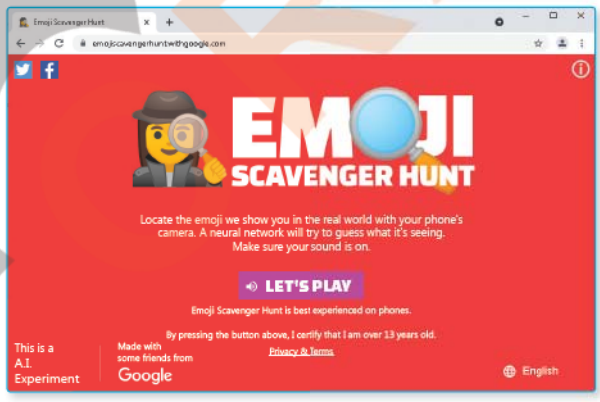
About the game

The game uses Computer Vision tool to identify and capture image from the Camera App. It then understands, matches and predicts if it's the same image which is asked to search. It is a very nice game to establish the Human-Machine Interaction.

How to play?

This game can be best enjoyed on a cell phone.

1. Visit https://emojiscavengerhunt.withgoogle.com or scan the QR code to play the game.
2. From the home screen click "Let's Play".

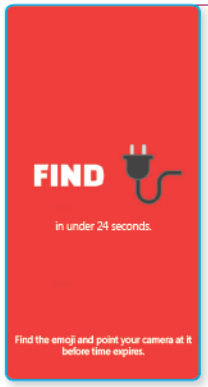


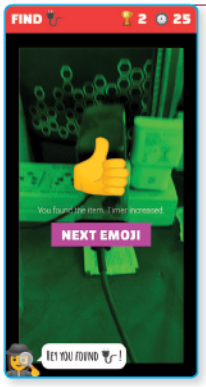
3. Allow the App to use your Camera App.
4. App will display the object that has to be searched.

5. Find the object and let the camera of your cell phone detect it, once found it will display message.

Where is AI in this game?

AI's Computer Vision tool is used to identify the images and process them. It also helps the computer to understand the human vision to differentiate between similar kind of different objects and locate the exact match.



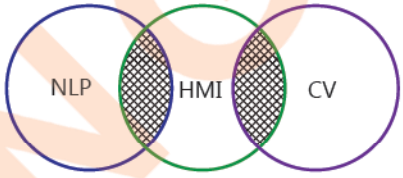


Human-Machine Interaction (HMI)

HMI can be defined as the interaction and communication between a human and a machine. It is a dynamic technical system which finds novel methods to let the communication take place between humans and computers. Human-Machine Interaction consists of all possible interactions between a human and a computer. Touchscreens are also a form of human-computer interaction.

Tools Related to HMI

There are 2 tools that make the HMI process better. These tools are NLP and CV.



At a Glance

- Artificial intelligence is associating machines with human thinking process like decision making, problem solving and learning through the available database.
- The AI machines are expected to perform tasks like Learning, Reasoning, Problem Solving, Adaptability, etc.
- Machine learning is making the machine learn from its data bank rather than through explicit programming.
- Artificial Intelligence is broadly classified as Weak or Narrow AI, Strong or General AI and Super AI.
- Artificial Intelligence touches almost all disciplines like Computer Science, Economics, Humanities, etc.
- HMI can be defined as the interaction and communication between a human and a machine.
- Artificial Intelligence hugely depends on big data to learn and process information.
- The data can be numeric (temperature, loan amount, etc.), categorical (gender, colour, etc.), or even free text (like doctor's notes, prescriptions, opinion surveys, etc.).
- A sub-field of AI which works with the interactions between humans and computer systems using natural language is called Natural Language Processing.
- Computer Vision is a field of AI which deals with how computers can develop a high level of understanding from digital images or videos just like humans do.

AI Quiz

Tick (✓) the correct option.

1. Who coined the term AI?
   a. Alan Turing ◯ b. John McCarthy ◯
   c. Marvin Minsky ◯ d. None of them ◯
2. When was WABOT-1 created?
   a. 1971 ◯ b. 1972 ◯
   c. 1973 ◯ d. 1974 ◯
3. Which of the following is the first chatbot to win the Turing test?
   a. WABOT-1 ◯ b. ELIZA ◯
   c. Eugen Goostman ◯ d. None of these ◯
4. Which of the following AI systems are commonly used?
   a. Narrow AI ◯ b. Strong AI ◯
   c. None of these. ◯ d. Both of these ◯
5. Which of these techniques make AI capable of learning on its own?
   a. Neural networks ◯ b. Big data ◯
   c. Data mining ◯ d. Machine learning ◯
6. What does NLP stand for?
   a. Natural Language Processing ◯ b. Near Letter Product ◯
   c. Next Letter Principal ◯ d. Never Left Product ◯
7. Which of the following is converted from spoken words with the help of Speech Recognition?
   a. Big Data ◯ b. Information ◯
   c. Data ◯ d. Program ◯
8. Semantic Search ..... the search operation by giving possible search predictions.
   a. Optimises ◯ b. Extends ◯
   c. Converts ◯ d. Removes ◯
9. What is the primary interactive method of communication used by humans?
   a. Reading ◯ b. Speaking ◯
   c. Writing ◯ d. All of the mentioned ◯
10. Which of the following is a software process which converts structured data into natural language?
    a. Natural Language Generation ◯ b. Machine Translation ◯
    c. Optical Character Recognition ◯ d. None of these ◯
11. How many tools are there in HMI?
    a. 1 ◯ b. 2 ◯
    c. 3 ◯ d. 4 ◯

12. ..... processes any given video and finds the object that matches the searching criteria and then tracks its movements.

a. Object Classification ◯ b. Object Identification ◯

c. Object Tracking ◯ d. None of these ◯

Exercise

A. State whether these statements are true or false.

1. AI is only useful for robotics. .....
2. Artificial Intelligence tries to imitate the thinking capability of a human. .....
3. In 1950, Alan Turing submitted a paper about the possibility of creating a machine that could think. .....
4. AI can process a large amount of data very quickly. .....
5. AI was built to replicate human emotions. .....
6. Artificial Intelligence hugely depends on big data to learn and process information. .....
7. Sentiment Analysis is a process used to determine whether a piece of text is positive, negative or neutral. .....
8. Most voice recognition application uses NLP. .....
9. Harry Roberts is commonly considered as the father of Computer Vision. .....

B. Fill in the blanks.

1. Rock paper scissors is a simple game based on the ..... domain of AI.
2. Artificial Intelligence is associating machine with human thinking ..... .
3. ..... AI systems are the type of AI that are set to work on a very limited area.
4. ..... refers to the extraction of pulling out useful information from a huge pile of data.
5. ..... is considered as the father of AI.
6. HMI stands for ..... .
7. Source language translation into target language is known as ..... .
8. Packaging and product quality, etc., are also monitored using ..... in manufacturing company.
9. ..... are designed to perform repetitive tasks with accuracy and high speed.

C. Answer the following questions:

1. Define AI.
2. Name the types of AI.
3. What is Strong AI?
4. Briefly explain the tasks performed by AI.
5. Write three domains of AI.
6. Define the term DATA.

7. What are the different types of NLP?
8. Define HMI.

Ai Lab

Subject Enrichment

1. In light of the current advancements, write your views in 10 sentences on how AI can improve over the current technology. Use Google Docs or MS Word to write your views and share with your class.
2. What is the difference between reasoning and problem solving? How can these two factors affect the AI systems? Write your views supporting some real-life examples.
3. Visit your computer lab and find out how the students and the teachers interact with the machines present there. Create a list and note down the type of interactions that takes place.
4. Open your internet browser and find out various games that come under Human-Machine Interaction. Create a list of such games and play these games with your friends and teachers during the lab.

2 PARTS OF ROBOTS

Learning Outcomes

- Difference Between Humans and Robots
- Essential Parts of Robots

What happened to your hand Vincy?

Oh! I removed my arm as it stopped rotating.

Ha! Ha! You robots are blessed in that way. You can anytime remove and get your parts repaired, unlike humans.

Yup! That's the reason humans are unique, and robots are machines.

When I said hand, you said arm. Why? Do you have some specific terms for your other body parts too?

Yes, of course, I have. Let me tell you about my various body parts in this chapter.

As you all know, a robot is a programmable machine capable of performing tasks and interacting with its surroundings. Robotics is the science and technology behind designing, manufacturing, and applying robots. Robots cannot do anything by themselves. Different parts of Robots are meant to perform different tasks.

First, let us understand the difference between humans and robots.

Difference Between Humans and Robots

The following table shows some of the common differences between humans and robots:

S.No.	Humans	Robots
1.	Humans are organic entities.	Robots are mechanical devices.
2.	Once the human body dies, it never comes back to life.	A robot can be repaired.
3.	Humans have a highly developed brain.	Robots have a trained brain.
4.	Humans are social beings.	Robots do not socialise.
5.	Humans are capable of performing creative and innovative tasks.	Robots can handle only specialised tasks.
6.	Emotions and feelings are the domains of humans.	Robots do not display any such qualities.

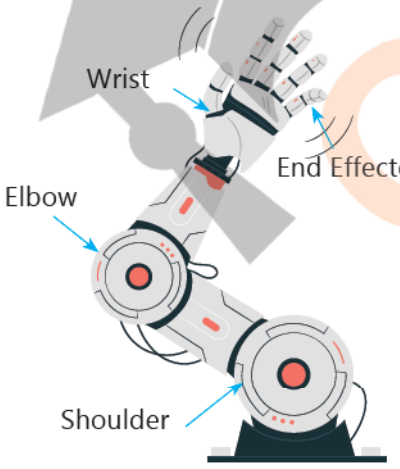
Essential Parts of Robots

Humans have set body parts, whereas robots have body parts according to their needs. This is the reason robots come in different sizes and shapes. Industrial robots look very different from Astronaut robots.

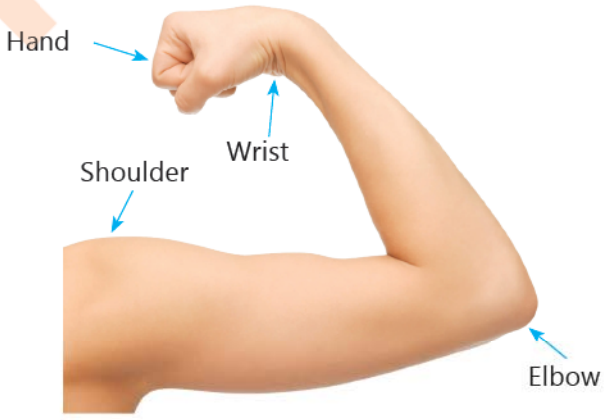
Let us study about some of the essential parts of Robots.

Manipulator

The robot's Manipulator is just like a human arm and has several joints and links. They are electronically controlled devices consisting of multiple sections. A manipulator uses strong links connected by joints with one fixed end and one free end to perform a given job, such as moving a box from one location to another.



Robotic Arm



Human Arm

End Effector

End effector is fixed at the end of the manipulator. Manipulators are usually set and End effectors are free to end. They are expected to perform the tasks traditionally performed by human fingers and palm of a human hand. The end effectors usually do the work. They are attached to the robot's wrist and controlled through a computer.

Different types of End Effectors

There are mainly two categories of end effectors which are grippers and tools. Gripper, at the end of a robotic arm, is the most commonly used end effector in various robots like Mars rovers in the form of hammers and shovels. On the other hand, Medical robots have specialised end effectors such as tools for cutting in surgery and suturing incisions.

Locomotion Device

Human beings use muscles to give movements to their arms, palms and fingers. For a robot, the power comes from motors. Three fuels are used in locomotion, depending on the energy source.

There are three widespread types of Locomotive devices.

- **Electric:** This uses magnets and electric current to facilitate movement. They are noiseless and easy to program.
- **Hydraulic:** This uses oil to facilitate movement. They are used in heavy machinery, which includes mining and construction equipment.
- **Pneumatic:** This uses air to facilitate movement. They are used in Rock drills, pavement breakers, paint sprayers, etc.

Controller

Human beings and animals sense their surroundings through their sense organs and then react accordingly based on the sense organs' feedback. Robots use the same response system as human beings-the feedback system. The CPU of a robot does the same thing based on data collected by its sensors.

There are mainly two types of controllers that determine the robot's behaviour. They are:

- **Simple Controller:** Pre-Programmed robots use the simplest form of controller. These controllers repeat the same operation over and over. Pre-Programmed robots are insensitive to their changing environment. Car manufacturing robots are such kinds of robots.
- **Strong Sensory Controller:** Autonomous robots are intelligent and change their response according to their ever-changing environment. These robots have robust sensory tools that allow detecting changes in the background. Humanoids, astronaut robots and robots used in the educational and medical fields come under this category.

Sensors

Without the data supplied by the sense organs, the human brain cannot perform intelligently in any given situation. Similarly, controllers would be unable to perform if the robot's sensors do not constantly feed the controller about their position, force, temperature, etc. The sensors are the powerhouse of a robot's feedback system and act as eyes and ears. A wide range of sensors is used in a robot system to perform the tasks. These include:

- Cameras allow a robot to construct a visual picture of its background.
- Microphones are used to detect sounds.
- Thermometers in some robots are used to sense temperature.
- Light sensors use laser light to detect objects in the pathway.
- Sound sensors or Supersonic sensors use high-frequency sounds to detect objects.
- Temperature sensors sense temperature.
- Contact sensors are one of the most common sensors in robotics. They are used to detect changes in position, velocity, force, etc.
- Proximity sensors are used to measure the distance of any object from a robot.
- Pressure sensors sense pressure.
- Positioning sensors are used in the automation industries for accurate robotic arm movement.

Power Supply

Just like human beings consume food when they need energy, robots need energy too to function. Electricity is the primary source of energy for most robots. Stationary robots used in the factories use direct power. Mobile robots use high-capacity batteries. Robotic spacecrafts and satellites are generally equipped with solar panels.

Experiential Learning

AI GAME

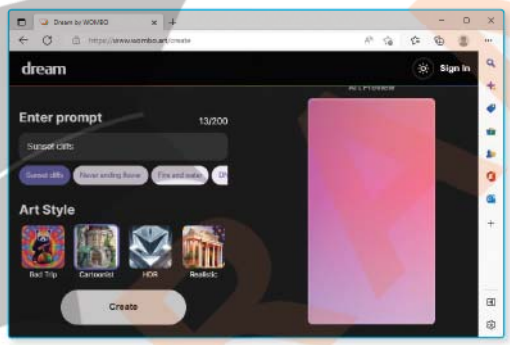
WOMBO Dream

WOMBO Dream is an AI-based artwork tool. You can create beautiful artwork using this tool without any effort. You just need to type a keyword related to your idea and select a style for your art work. All work is done by the WOMBO Dream to turn your idea into an AI-powered painting. Perform the following steps to use this tool:

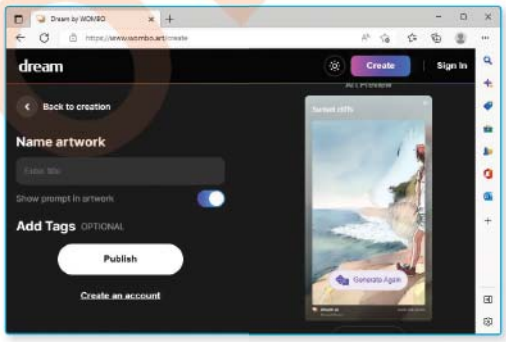
Step 1 Visit the following link OR scan the QR code to use this tool.
https://app.wombo.art/

Step 2 Type a keyword related to your idea in the **Enter prompt** box.

Step 3 Select a style from the given Art Styles.



Step 4 Click on the **Create** button.



Now, you can download your drawing.

At a Glance

- A robot is a programmable machine.
- Humans have set body parts, whereas robots have body parts according to their needs.
- Robots vary in size, shape and function.
- Manipulators are like human arms and have several joints and links.
- An end effector is attached with the robot's wrist and controlled through a computer.
- The CPU works as a controller for a robot.
- Sensors work as the sense organ for a robot system.

Ai Quiz

Tick (✓) the correct option.

1. Which of the following are fixed at the end of the manipulator?
   a. End effectors ◯ b. Sensors ◯
   c. Controllers ◯ d. None of these ◯
2. Which of the following sensors are used to measure the distance of any object from a robot?
   a. Camera ◯ b. Microphones ◯
   c. Proximity ◯ d. Positioning ◯
3. The visual picture of the background is constructed by the ..... part of a robot.
   a. Microphone ◯ b. Thermometers ◯
   c. Camera ◯ d. All of these ◯
4. Which of the following sensors are used in the automation industries for accurate movement of the robotic arm?
   a. Pressure ◯ b. Positioning ◯
   c. Proximity ◯ d. Light ◯
5. ..... is the primary source of energy for most robots.
   a. Electricity ◯ b. Battery ◯
   c. Solar panel ◯ d. Gasoline ◯

Exercise

A. State whether these statements are true or false.

1. End effectors are controlled through a computer. .....
2. Robots use the feedback system to respond to their surroundings. .....

3. Any robot can function without sensors. .....
4. Satellites get their power from solar panels. .....

B. Fill in the blanks.

arm CPU Electricity programmable Hydraulic

1. Robots are ..... machines.
2. Manipulators are just like human ..... .
3. ..... locomotion device uses oil to facilitate movement.
4. The ..... of a robot responds on the basis of data collected by its sensors.
5. ..... is the primary source of energy for most robots.

C. Answer the following questions:

1. What is an end effector?

.....

.....

2. What is a manipulator?

.....

.....

3. Write any two differences between humans and robots.

.....

.....

4. Write a short note on the Locomotion device.

.....

.....

5. How are sensors important to robots?

.....

.....

.....

Ai Lab

Inter-Disciplinary

- Write an e-mail to the Prime Minister of India explaining to provide free lab sessions to students to learn to make robots. Also, mention how the society can be benefitted at large from this movement.

Ai Task

Subject Enrichment

Write a letter to your future self: "Imagining a world in 2030". Be sure to mention things that you think your future self would probably be doing and experiencing in daily life. You may include your hobbies, your pets, your surroundings, the role of AI in your life, etc.

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