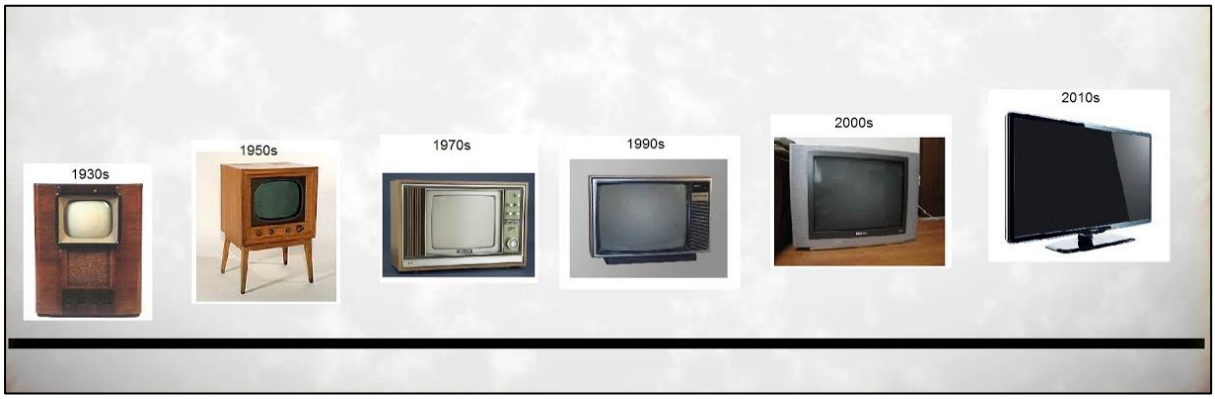
Introduction to AI: Foundational Concepts

What is Intelligence?

Humans have been developing machines which can make their lives easier. Machines are made with an intent of accomplishing tasks which are either too tedious for humans or are time consuming. Hence, machines help us by working for us, thereby sharing our load and making it easier for us to fulfil such goals.



Life without machines today is unimaginable, and because of this, humans have been putting efforts into making them even more sophisticated and smart. As a result, we are surrounded by smart devices and gadgets like smartphones, smartwatches, smart TV, etc. But what makes them smart?



For example, how is a smartphone today different from the telephones we had in the last century?

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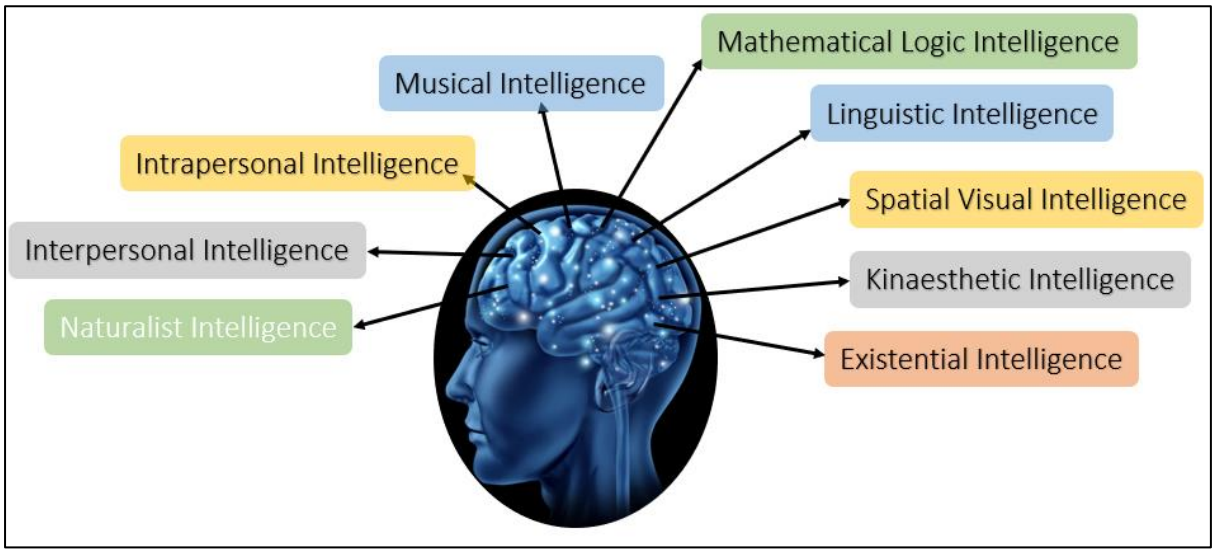
Today's phones can do much more than just call-up people. They can help us in navigating, recommend which songs we should listen to or which movies we should watch according to our own likes and dislikes. Our phones can help us connect with like-minded people, make our selfies fun with face filters, help us maintain a record of our health and fitness and a lot more. These drastic technological advancements lead us to recognize one key concept: the concept of **Artificial Intelligence**.

What is Artificial Intelligence anyway? Well, the answer lies in the term itself. If we break up this term up, we get the words "Artificial" and "Intelligence". Artificial is something which is man-made, which does not occur naturally. But what about Intelligence, how do we define that?

Humans are said to be an intelligent species, so what is it that makes us intelligent?

According to researchers, intelligence is the *'ability to perceive or infer information, and to retain it as knowledge to be applied towards adaptive behaviours within an environment or context.'*

If we try to define intelligence with the help of its traits, these are the abilities that are involved in intelligence:



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Let us define each term mentioned above to get a proper understanding:

Mathematical Logical Reasoning	•A person's ability to regulate, measure, and understand numerical symbols, abstraction and logic.
Linguistic Intelligence	•Language processing skills both in terms of understanding or implementation in writing or verbally.
Spatial Visual Intelligence	•It is defined as the ability to perceive the visual world and the relationship of one object to another.
Kineasthetic Intelligence	•Ability that is related to how a person uses his limbs in a skilled manilr.
Musical Intelligence	•As the name suggests, this intelligence is about a person's ability to recognize and create sounds, rhythms, and sound patterns.
Intrapersonal Intelligence	•Describes how high the level of self-awareness someone has is. Starting from realizing weakness, strength, to his own feelings.
Existential Intelligence	•An additional category of intelligence relating to religious and spiritual awareness.
Naturalist Intelligence	•An additional category of intelligence relating to the ability to process information on the environment around us.
Interpersonal intelligence	•Interpersonal intelligence is the ability to communicate with others by understanding other people's feelings & influence of the person.

But even though one is more skilled in intelligence than the other, it should be noted that in fact all humans have all 9 of these intelligences only at different levels. One might be an expert at painting, while the other might be an expert in mathematical calculations. One is a musician, the other is an expert dancer.

In other words, we may define intelligence as:

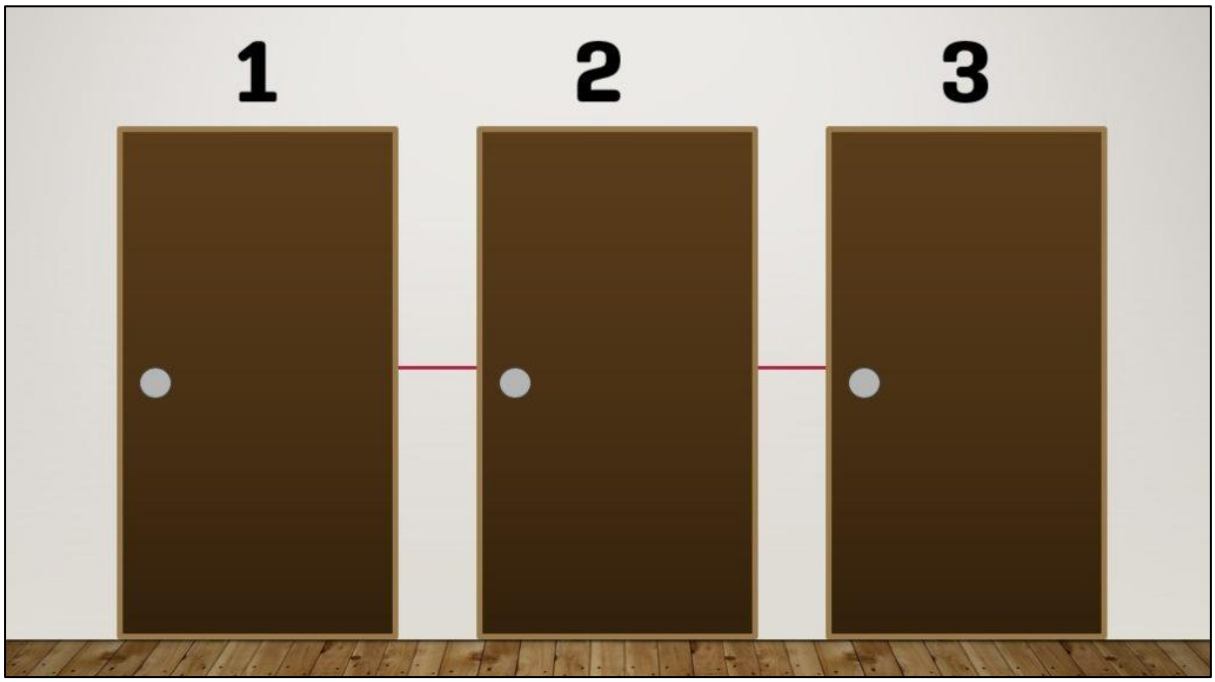
- Ability to interact with the real world
    - To perceive, understand and act
        - Example: Speech Recognition – Understanding and synthesis
        - Example: Image Recognition
        - Example: Ability to take action: to have an effect
- Reasoning and planning
    - Modelling the external world, given input
        - Solving new problems, planning and making decisions
        - Ability to deal with unexpected problems, uncertainties
- Learning and adaptation
    - Continuous learning and adapting graph
        - Our internal models are always being updated
        - Example: Baby learning to categorize and recognise animals

For example, if someone starts talking to us, we know how to keep the conversation going. We can understand what people mean and can reply in the same way. When we are hungry, we can come up

with various options on what to eat depending upon the food we have at our homes. When we read something, we are able to understand its meaning and answer anything regarding it.

While understanding the term intelligence, it must be noticed that decision making comprises of a crucial part of intelligence. Let us delve deeper into it.

Decision Making



You're trapped. All the doors seem to have started shrinking and only one of them leads you out. Which door would you pick?

How do you make decisions?

The basis of decision making depends upon the availability of information and how we experience and understand it. For the purposes of this article, 'information' includes our past experience, intuition, knowledge, and self-awareness.

We can't make "good" decisions without information because then we have to deal with unknown factors and face uncertainty, which leads us to make wild guesses, flipping coins, or rolling a dice. Having knowledge, experience, or insights given a certain situation, helps us visualize what the outcomes could be. and how we can achieve/avoid those outcomes.

Make Your Choices!

Scenario 1

You are locked inside a room with 3 doors to move out of the locked room and you need to find a safe door to get your way out. Behind the 1st door is a lake with a deadly shark. The 2nd door has a mad psychopath ready to kill with a weapon and the third one has a lion that has not eaten since the last 2 months.

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Which door would you choose? and Why?



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The answer is gate number 3. The reason being that since the lion has not eaten for 2 months, he wouldn't have survived till now and would already be dead . This makes going out from gate 3 the correct option.

Scenario 2

Aarti invited four of her friends to her House.. They hadn't seen each other in a long time, so they chatted all night long and had a good time. In the morning, two of the friends Aarti had invited, died. The police arrived at the house and found that both the friends were poisoned and that the poison was in the strawberry pie. The three surviving friends told the police that they hadn't eaten the pie. The police asked," Why didn’t you eat the pie ?". Shiv said, " I am allergic to strawberries.". Seema said, " I am on a diet." And Aarti said, "I ate too many strawberries while cooking the pie, I just didn't want anymore."

The policemen looked at the pictures of the party and immediately identified the murderer.

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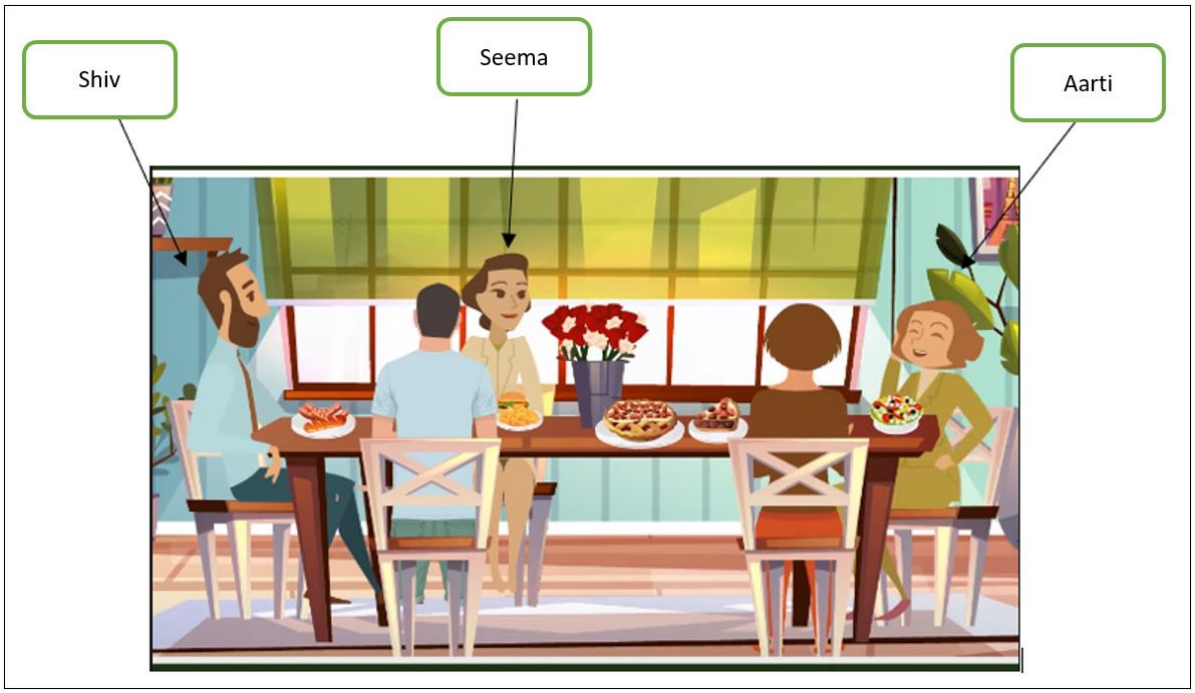

Look at the picture and identify who is the murderer? Also state why do you think this is the murderer?

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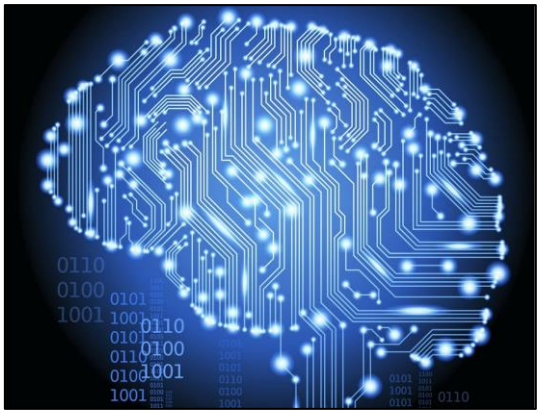
The answer is Seema, can you guess how the police could tell? It's because she said she is on a diet and in the picture, she is eating a burger and fries which means she lied.

The above scenarios show that it's the information which helps humans take good decisions.

What is Artificial Intelligence?



When a machine possesses the ability to mimic human traits, i.e., make decisions, predict the future, learn and improve on its own, it is said to have artificial intelligence.

In other words, you can say that a machine is artificially intelligent when it can accomplish tasks by itself - collect data, understand it, analyse it, learn from it, and improve it. You will get to know more about it in the next unit.

But, what makes a machine intelligent?

How do machines become Artificially Intelligent?

Humans become more and more intelligent with time as they gain experiences during their lives.

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For example, in elementary school, we learn about alphabets and eventually we move ahead to making words with them. As we grow, we become more and more fluent in the language as we keep learning new words and use them in our conversations.

Another example is how we learn walking. Initially a baby struggles to walk. He takes help from others while learning how to walk and once he knows it, he keeps on upgrading it by learning how to run, jump, etc.



Similarly, machines also become intelligent once they are trained with some information which helps them achieve their tasks. AI machines also keep updating their knowledge to optimise their output.

Applications of Artificial Intelligence around us

Whether we notice it or not, we are surrounded by machines that work on AI. They are becoming a crucial part of our everyday life and provide us with an ease of having even some of the most complicated and time-consuming tasks being done at the touch of a button or by the simple use of a sensor.

Every now and then, we surf the internet for things on Google without realizing how efficiently Google always responds to us with accurate answers. Not only does it come up with results to our search in a matter of seconds, it also suggests and auto-corrects our typed sentences.

We nowadays have pocket assistants that can do a lot of tasks at just one command. Alexa, Google Assistant, Cortana, Siri are some very common examples of the voice assistants which are a major part of our digital devices.



To help us navigate to places, apps like UBER and Google Maps come in haman. Thus, one no longer needs to stop repeatedly to ask for directions.

AI has completely enhanced the gaming experience for its users. A lot of games nowadays are backed up with AI which helps in enhancing the graphics, come up with new difficulty levels, encourage gamers, etc.

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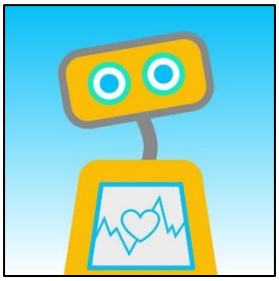
AI has not only made our lives easier but has also been taking care of our habits, likes, and dislikes. This is why platforms like Netflix, Amazon, Spotify, YouTube etc. show us recommendations on the basis of what we like.

Well, the recommendations are not just limited to our preferences, they even cater to our needs of connecting with friends on social media platforms with apps like Facebook and Instagram. They also send us customized notifications about our online shopping details, auto-create playlists according to our requests and so on. Taking selfies was never this fun as Snapchat filters make them look so cool.

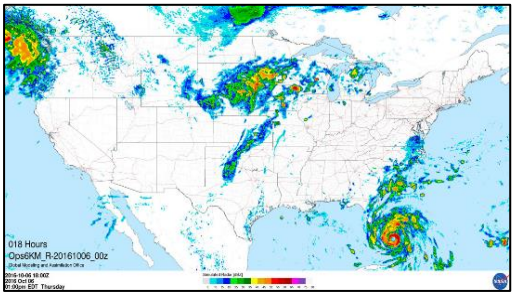




This isn't all. AI is also being used to monitor our health. A lot of chatbots and other health apps are available, which continuously monitor the physical and mental health of its users.



These applications are not limited to smart devices but also vary to humanoids like Sophia, the very first humanoid robot sophisticated enough to get citizenship, biometric security systems like the face locks we have in our phones, real-time language translators, weather forecasts, and whatnot! This list is huge, and this module will go on forever if we keep tabulating them. So, take some time, discuss with a friend and identify more and more AI applications around you!



What is not AI?

Since we have a lot of different technologies which exist around us in today's time, it is very common for us to misunderstand any other technology as AI. That is why, we need to have a clear distinction between what is AI and what is not.

As we discussed earlier, any machine that has been trained with data and can make decisions/predictions on its own can be termed as AI. Here, the term 'training' is important.



A fully automatic washing machine can work on its own, but it requires human intervention to select the parameters of washing and to do the necessary preparation for it to function correctly before each wash, which makes it an example of automation, not AI.

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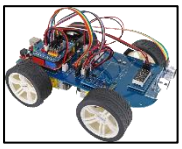
An air conditioner can be turned on and off remotely with the help of internet but still needs a human touch. This is an example of Internet of Things (IoT). Also, every now and then we get to know about robots which might follow a path or maybe can avoid obstacles but need to be primed accordingly each time.

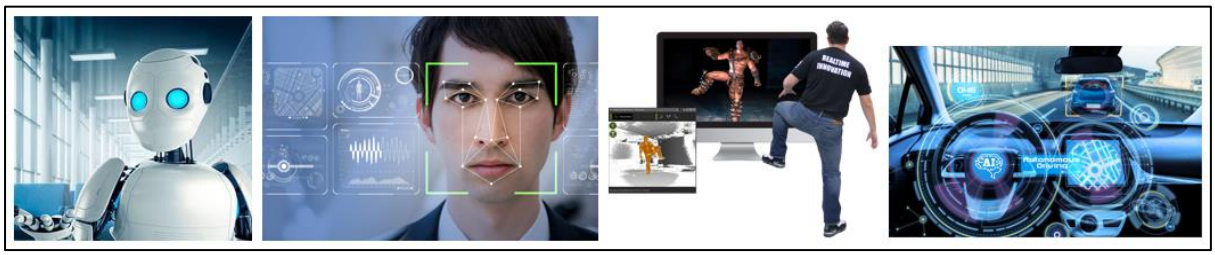


We also get to see a lot of projects which can automate our surroundings with the help of sensors. Here too, since the bot or the automation machine is not trained with any data, it does not count as AI.

Also, it would be valid to say that not all the devices which are termed as "smart" are AI-enabled. For example, a TV does not become AI-enabled if it is a smart one, it gets the power of AI when it is able to think and process on its own.

Just as humans learn how to walk and then improve this skill with the help of their experiences, an AI machine too gets trained first on the training data and then optimises itself according to its own experiences which makes AI different from any other technological device/machine.

But well, surely these other technologies too can be integrated with AI to provide the users with a much better and immersive experience!



Robotics and AI can definitely open the doors to humanoids and self-driving cars, AI when merged with Internet of things can give rise to cloud computing of data and remote access of AI tools, automation along with AI can help in achieving voice automated homes and so on. Such integrations can help us get the best of both worlds!

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Introduction to AI: Basics of AI

As discussed in the last chapter, Artificial Intelligence has always been a term which intrigues people all over the world. Various organisations have coined their own versions of defining Artificial Intelligence. Some of them are mentioned below:

NITI Aayog: National Strategy for Artificial Intelligence

AI refers to the ability of machines to perform cognitive tasks like thinking, perceiving, learning, problem solving and decision making. Initially conceived as a technology that could mimic human intelligence, AI has evolved in ways that far exceed its original conception. With incredible advances made in data collection, processing and computation power, intelligent systems can now be deployed to take over a variety of tasks, enable connectivity and enhance productivity.

World Economic Forum

Artificial intelligence (AI) is the software engine that drives the Fourth Industrial Revolution. Its impact can already be seen in homes, businesses and political processes. In its embodied form of robots, it will soon be driving cars, stocking warehouses and caring for the young and elderly. It holds the promise of solving some of the most pressing issues facing society, but also presents challenges such as inscrutable "black box" algorithms, unethical use of data and potential job displacement. As rapid advances in machine learning (ML) increase the scope and scale of AI's deployment across all aspects of daily life, and as the technology itself can learn and change on its own, multi-stakeholder collaboration is required to optimize accountability, transparency, privacy and impartiality to create trust.

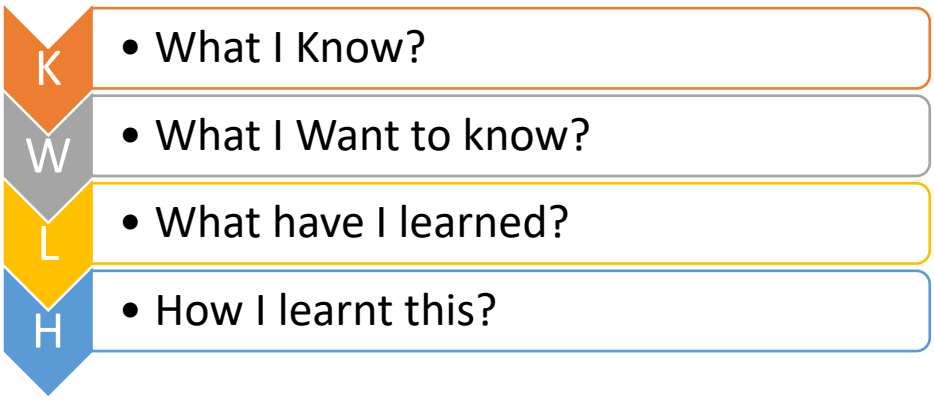
European Artificial Intelligence (AI) leadership, the path for an integrated vision

AI is not a well-defined technology and no universally agreed definition exists. It is rather a cover term for techniques associated with data analysis and pattern recognition. AI is not a new technology, having existed since the 1950s. While some markets, sectors and individual businesses are more advanced than others, AI is still at a relatively early stage of development, so that the range of potential applications, and the quality of most existing applications, have ample margins left for further development and improvement.

Encyclopaedia Britannica

Artificial intelligence (AI), is the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. The term is frequently applied to the project of developing systems endowed with the intellectual processes characteristic of humans, such as the ability to reason, discover meaning, generalize, or learn from past experience.

As you can see, Artificial Intelligence is a vast domain. Everyone looks at AI in a different way according to their mindset. Now, according to your knowledge of AI, start filling the KWLH chart:



What do you know about Artificial Intelligence (AI)?

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What do you want to know about AI?

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What have you learnt about AI?

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How have you learnt this about AI?

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In other words, AI can be defined as:

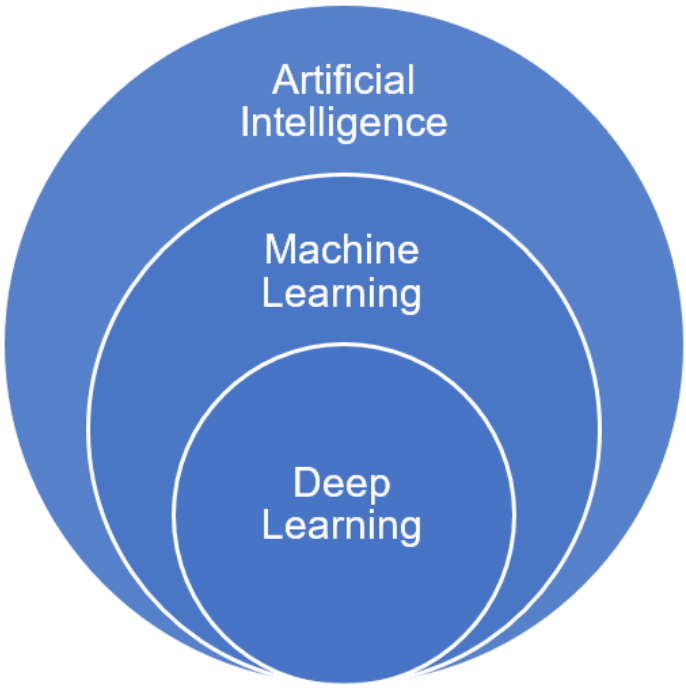
AI is a form of Intelligence; a type of technology and a field of study.

AI theory and development of computer systems (both machines and software) enables machines to perform tasks that normally require human intelligence.

Artificial Intelligence covers a broad range of domains and applications and is expected to impact every field in the future. Overall, its core idea is building machines and algorithms which are capable of performing computational tasks that would otherwise require human like brain functions.

AI, ML & DL

As you have been progressing towards building AI readiness, you must have come across a very common dilemma between Artificial Intelligence (AI) and Machine Learning (ML). Many times, these terms are used interchangeably but are they the same? Is there no difference in Machine Learning and Artificial Intelligence? Is Deep Learning (DL) Also Artificial Intelligence? What exactly is Deep Learning? Let us see.



Artificial Intelligence (AI)

Refers to any technique that enables computers to mimic human intelligence. It gives the ability to machines to recognize a human's face; to move and manipulate objects; to understand the voice commands by humans, and also do other tasks. The AI-enabled machines think algorithmically and execute what they have been asked for intelligently.

Machine Learning (ML)

It is a subset of Artificial Intelligence which enables machines to improve at tasks with experience (data). The intention of Machine Learning is to enable machines to learn by themselves using the provided data and make accurate Predictions/ Decisions.

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Deep Learning (DL)

It enables software to train itself to perform tasks with vast amounts of data. In Deep Learning, the machine is trained with huge amounts of data which helps it in training itself around the data. Such machines are intelligent enough to develop algorithms for themselves. Deep Learning is the most advanced form of Artificial Intelligence out of these three. Then comes Machine Learning which is intermediately intelligent and Artificial Intelligence covers all the concepts and algorithms which, in some way or the other mimic human intelligence.

There are a lot of applications of AI out of which few are those which come under ML out of which very few can be labelled as DL. Therefore, Machine Learning (ML) and Deep Learning (DL) are part of Artificial Intelligence (AI), but not everything that is Machine learning will be Deep learning.

Introduction to AI Domains

Artificial Intelligence becomes intelligent according to the training which it gets. For training, the machine is fed with datasets. According to the applications for which the AI algorithm is being developed, the data which is fed into it changes. With respect to the type of data fed in the AI model, AI models can be broadly categorised into three domains:



Data Sciences

Data sciences is a domain of AI related to data systems and processes, in which the system collects numerous data, maintains data sets and derives meaning/sense out of them.

The information extracted through data science can be used to make a decision about it.

Example of Data Science



Price Comparison Websites

These websites are being driven by lots and lots of data. If you have ever used these websites, you would know, the convenience of comparing the price of a product from multiple vendors at one place. PriceGrabber, PriceRunner, Junglee, Shopzilla, DealTime are some examples of price comparison websites. Now a days, price comparison website can be found in almost every domain such as technology, hospitality, automobiles, durables, apparels etc.

Computer Vision

Computer Vision, abbreviated as CV, is a domain of AI that depicts the capability of a machine to get and analyse visual information and afterwards predict some decisions about it. The entire process involves image acquiring, screening, analysing, identifying and extracting information. This extensive processing helps computers to understand any visual content and act on it accordingly. In computer vision, Input to machines can be photographs, videos and pictures from thermal or infrared sensors, indicators and different sources.

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Computer vision related projects translate digital visual data into descriptions. This data is then turned into computer-readable language to aid the decision-making process. The main objective of this domain of AI is to teach machines to collect information from pixels.

Examples of Computer Vision



Self-Driving cars/ Automatic Cars

CV systems scan live objects and analyse them, based on whether the car decides to keep running or to stop.



Face Lock in Smartphones

Smartphones nowadays come with the feature of face locks in which the smartphone's owner can set up his/her face as an unlocking mechanism for it. The front camera detects and captures the face and saves its features during initiation. Next time onwards, whenever the features match, the phone is unlocked.

Natural Language Processing

Natural Language Processing, abbreviated as NLP, is a branch of artificial intelligence that deals with the interaction between computers and humans using the natural language. *Natural language* refers to language that is spoken and written by people, and natural language processing (NLP) attempts to extract information from the spoken and written word using algorithms.

The ultimate objective of NLP is to read, decipher, understand, and make sense of the human languages in a manilr that is valuable.

Examples of Natural Language Processing



Email filters

Email filters are one of the most basic and initial applications of NLP online. It started out with spam filters, uncovering certain words or phrases that signal a spam message.

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Smart assistants

Smart assistants like Apple's Siri and Amazon's Alexa recognize patterns in speech, then infer meaning and provide a useful response.

AI Ethics

Nowadays, we are moving from the Information era to Artificial Intelligence era. Now we do not use data or information, but the intelligence collected from the data to build solutions. These solutions can even recommend the next TV show or movies you should watch on Netflix.

We can proudly say that India is leading in the AI usage trends, so we need to keep aspects relating to ethical practices in mind while developing solutions using AI. Let us understand some of the ethical concerns in detail.

Moral Issues: Self-Driving Cars

Scenario 1:

Let us imagine that we are in year 2030. Self-Driving cars which are just a concept in today's time are now on roads. People like us are buying them for ease and are using it for our daily transits. Of-course because of all the features which this car has, it is expensive. Now, let us assume, one day your father is going to office in his self-driving car. He is sitting in the back seat as the car is driving itself. Suddenly, a small boy comes in front of this car. The incident was so sudden that the car is only able to make either of the two choices:

1. Go straight and hit the boy who has come in front of the car and injure him severely.

2. Take a sharp right turn to save the boy and smash the car into a metal pole thus damaging the car as well as injuring the person sitting in it.

With the help of this scenario, we need to understand that the developer of the car goes through all such dilemmas while developing the car's algorithm. Thus, here the morality of the developer gets transferred into the machine as what according to him/her is right would have a higher priority and hence would be the selection made by the machine.

If you were in the place of this developer and if there was no other alternative to the situation, which one of the two would you prioritise and why?

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Scenario 2:

Let us now assume that the car has hit the boy who came in front of it. Considering this as an accident, who should be held responsible for it? Why?

1. The person who bought this car
2. The Manufacturing Company
3. The developer who developed the car's algorithm
4. The boy who came in front of the car and got severely injured

Here, the choices might differ from person to person and one must understand that nobody is wrong in this case. Every person has a different perspective and hence he/she takes decisions according to their moralities.

Data Privacy

The world of Artificial Intelligence revolves around Data. Every company whether small or big is mining data from as many sources as possible. More than 70% of the data collected till now has been collected in the last 3 years which shows how important data has become in recent times. It is not wrongly said that *Data is the new gold*. This makes us think:

Where do we collect data from?

Why do we need to collect data?

One of the major sources of data for many major companies is the device which all of us have in our hands all the time: Smartphones. Smartphones have nowadays become an integral part of our lives. Most of us use smartphones more than we interact with people around us. Smartphones in today's era provide us with a lot of facilities and features which have made our lives easier. Feeling hungry? Order food online. Want to shop but don't have time to go out? Go shopping online. From booking tickets to watching our favourite shows, everything is available in this one small box loaded with technology.

Another feature of smartphones nowadays is that they provide us with customised recommendations and notifications according to our choices. Let us understand this with the help of some examples:

1. When you are talking to your friend on a mobile network or on an app like WhatsApp. You tell your friend that you wish to buy new shoes and are looking for suggestions from him/her. You discuss about shoes and that is it. After some time, the online shopping websites start giving you notifications to buy shoes! They start recommending some of their products and urge you to you buy some.
2. If you search on Google for a trip to Kerala or any other destination, just after the search, all the apps on your phone which support advertisements, will start sending messages about packages that you can buy for the trip.
3. Even when you are not using your phone and talking to a person face-to-face about a book you've read recently while the phone is kept in a locked mode nearby, the phone will end up giving notifications about similar books or messages about the same book once you operate it.

In all such examples, how does the smartphone get to know about the discussions and thoughts that you have? Remember whenever you download an app and install it, it asks you for several permissions to access your phone's data in different ways. If you do not allow the app these permissions, you normally cannot access it. And to access the app and make use of it, we sometimes don't even give it a thought and allow the app to get all the permissions that it wants. Hence every now and then, the app has the permission to access various sensors which are there in your smartphone and gather data about you and your surroundings. We forget that the smartphone which we use is a box full of sensors which are powered all the time while the phone is switched on.

This leads us to a crucial question: Are we okay with sharing our data with the external world?

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Why do these apps collect data?

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We need to understand that the data which is collected by various applications is ethical as the smartphone users agree to it (by clicking on allow when it asks for permission and by agreeing to all the terms and conditions). But at the same time if one does not want to share his/her data with anyone, he/she can opt for alternative applications which are of similar usage and keep your data private. For example, an alternative to WhatsApp is the Telegram app which does not collect any data from us. But since WhatsApp is more popular and used by the crowd, people go for it without thinking twice.

AI Bias

Another aspect to AI Ethics is bias. Everyone has a bias of their own no matter how much one tries to be unbiased, we in some way or the other have our own biases even towards smaller things. Biases are not negative all the time. Sometimes, it is required to have a bias to control a situation and keep things working.

When we talk about a machine, we know that it is artificial and cannot think on its own. It can have intelligence, but we cannot expect a machine to have any biases of its own. Any bias can transfer from the developer to the machine while the algorithm is being developed. Let us look at some of the examples:

1. Majorly, all the virtual assistants have a female voice. It is only now that some companies have understood this bias and have started giving options for male voices but since the virtual assistants came into practice, female voices are always preferred for them over any other voice. Can you think of some reasons for this?

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2. If you search on Google for salons, the first few searches are mostly for female salons. This is based on the assumption that if a person is searching fora salon, in all probability it would be a female. Do you think this is a bias? If yes, then is it a Negative bias or Positive one?

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Various other biases are also found in various systems which are not thought up by the machine but have got transferred from the developer intentionally or unintentionally.

AI Access

Since Artificial Intelligence is still a budding technology, not everyone has the opportunity to access it. The people who can afford AI enabled devices make the most of it while others who cannot are left behind. Because of this, a gap has emerged between these two classes of people and it gets widened with the rapid advancement of technology. Let us understand this with the help of some examples:

AI creates unemployment

AI is making people's lives easier. Most of the things nowadays are done in just a few clicks. In no time AI will manage to be able to do all the laborious tasks which we humans have been doing since long. Maybe in the coming years, AI enabled machines will replace all the people who work as labourers. This may start an era of mass unemployment where people having little or no skills may be left without jobs and others who keep up with their skills according to what is required, will flourish.

This brings us to a crossroads. On one hand where AI is advancing and improving the lives of people by working for them and doing some of their tasks, the other hand points towards the lives of people who are dependent on laborious jobs and are not skilled to do anything else.

Should AI replace laborious jobs? Is there an alternative for major unemployment?

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Should AI not replace laborious jobs? Will the lives of people improve if they keep on being unskilled?

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Here, we need to understand that to overcome such an issue, one needs to be open to changes. As technology is advancing with time, humans need to make sure that they are a step ahead and understand this technology with its pros and cons.

AI for kids

As we all can see, kids nowadays are smart enough to understand technology from a very early age. As their thinking capabilities increase, they start becoming techno-savvy and eventually they learn everything more easily than an adult. But should technology be given to children so young?

Consider this: A young boy in class 3 has got some Maths homework to finish. He is sitting at a table which has the Google chat bot - Alexa on it, and he is struggling with his homework. Soon, he starts asking Alexa to answer all his questions. Alexa replies with answers and the boy simply writes them down in his notebook.

While this scenario seems funny, it still has some concerns related to it. On one hand where it is good that the boy knows how to use technology effectively, on the other hand he uses it to complete his

homework without really learning anything since he is not applying his brain to solve the Math problems. So, while he is smart, he might not be getting educated properly.

Is it ethical to let the boy use technology to help in this manilr?

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Conclusion

Despite AI's promises to bring forth new opportunities, there are certain associated risks that need to be mitigated appropriately and effectively. To give a better perspective, the ecosystem and the socio-technical environment in which the AI systems are embedded needs to be more trustworthy.