ARTIFICIAL INTELLIGENCE: STUDY MATERIAL

CLASS XI

LEVEL 1: AI INFORMED (UNIT 1 – UNIT 5)

TEACHER INSTRUCTION MANUAL

INDEX

Unit 1: Introduction: Artificial intelligence for Everyone

Title: Introduction – AI for everyone	**Approach: Interactive/ Collaborative / Activity**
Summary: The imminent world that forecasts the future era is different from the one we can predict and see today. Artificial Intelligence is the driving force that will lead the future generations. Self-driving cars, widespread automation, robotic gadgets will become an integral part of day to day life of the human race. Trade, work, professions, employment will see a massive transformation. Fast adaptability is crucial for the forthcoming cohort as they will be widely affected by this change. We the mentors shoulder this responsibility to equip them to handle the future tools with care and intellectual pride. We are confident that the prospective children will empower themselves for future to come and will understand key concepts underlying this new technology- AI. What is AI? This unit will lay down the foundations of AI by discussing its history and setting ground for forthcoming units.	
Objective: 1. Understand the definition of Artificial Intelligence and Machine Learning 2. Evaluate the impact of AI on society 3. Unfold the AI terminology - Machine Learning (ML), Deep Learning (DL), Supervised Learning, Un-supervised Learning etc. 4. Understand the strengths and limitations of AI and ML 5. Identify the difference between AI on one side and Machine Learning (ML), Deep Learning (DL) on other	
Learning Outcome: 1. To get introduced to the basics of AI and its allied technologies 2. To understand the impact of AI on society	
Pre-requisites: Reasonable fluency in English language and basic computer skills	
Key Concepts: Artificial Intelligence (AI) , Machine Learning (ML) and Deep Learning (DL)	

1. What is Artificial Intelligence (AI)

1. What movies have you seen about artificial intelligence?

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2. How intelligent will artificial intelligence become by 2030, any guess?

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3. At present, in what activities are computers better at than humans?

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4. At present, in what activities are human better at than computers?

So, how do we define Artificial Intelligence [AI?]

AI is a technique that facilitates a machine to perform all cognitive functions such as perceiving, learning and reasoning that are otherwise performed by humans.

"The Science and Engineering of making intelligent machines, especially intelligent Computer programs is Artificial intelligence" –JOHN MC CARTHY [Father of AI]

The yardstick to achieve true AI still seems decades away. Computers execute certain tasks way better than humans e.g.: Sorting, computing, memorizing, indexing, finding patterns etc. While identifying of

emotions, recognising faces, communication and conversation are unbeatable human skills. This is where AI will play a crucial role to enable machines achieving equalling human capabilities.

World Famous AI Machines [naming a few of them]:

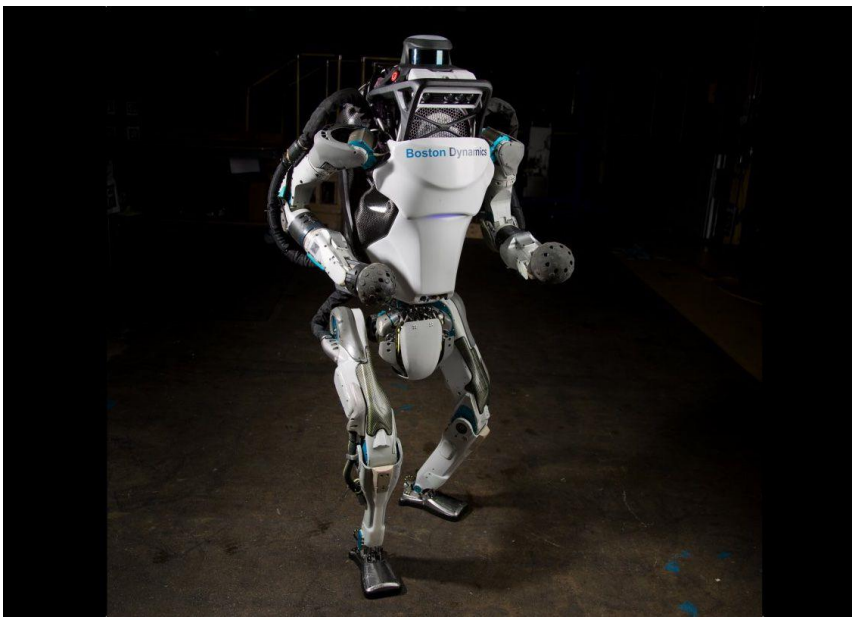
- IBM Watson (https://www.youtube.com/watch?v=s_wgf75GwCM)

- Google's Driverless car (https://www.youtube.com/watch?v=cdgQpa1pUUE)
- Sophia, the humanoid Robot (https://www.youtubeom/watch?v=cdgQpa1pUUE)

- The assistant / Chabot - Alexa, Siri, Google's Home

- Honda Asimo (https://www.youtube.com/watch?v=1urL_X_vp7w)

- Boston Dynamics AI Robot (https://www.youtube.com/watch?v=NR32ULxbjYc)



Activity

Let's get imaginative and create an intelligent motorbike. It is the year 2030, add features to create a machine that races against time.

2. History of AI

In 1950's

The modern-day AI got impetus since 50s of the previous centuries, once Alan Turning introduced "Turning Test" for assessment of intelligence.

In 1955

John McCarthy known as the founder of Artificial Intelligence introduced the term 'Artificial Intelligence'. McCarthy along with Alan Turing, Allen Newell, Herbert A. Simon, and Marvin Minsky too has the greatest contribution to present day machine intelligence. Alan suggested that if humans use accessible information, as well as reason, to solve problems to make decisions – then why can't it be done with the help of machines?

In 1970's

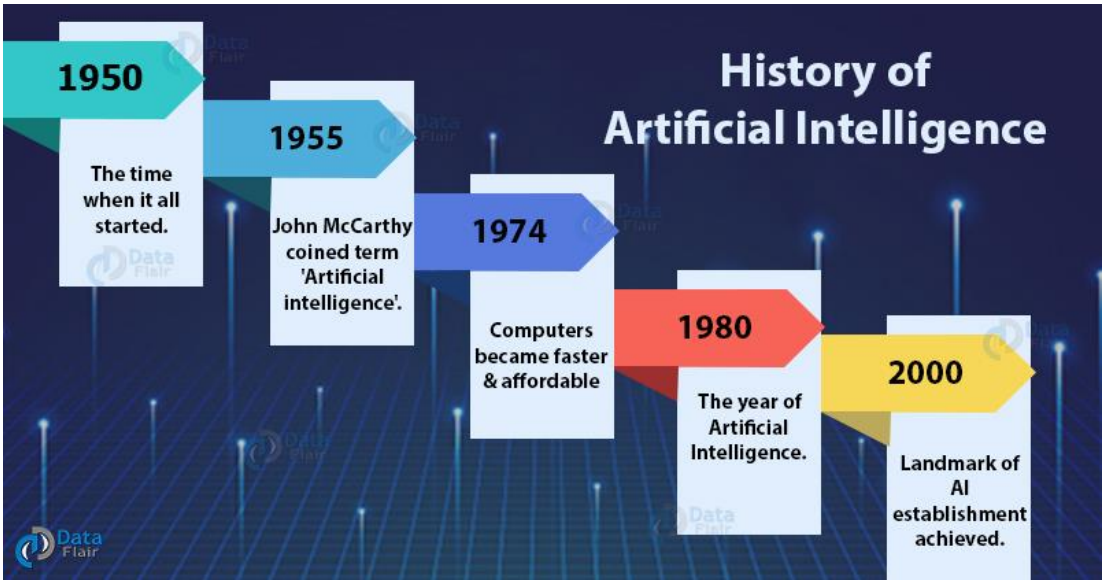
70 s saw an upsurge of computer era. These machines were much quicker, affordable and stowed more information. They had an amazing character to think abstract, could self-recognize and accomplished natural language processing.

In 1980's

These were the years that saw flow of funds for research and algorithmic tools. The learning skills were enhanced and computers improved with deeper user experience.

In 2000's

Many unsuccessful attempts, Alas! The technology was successfully established by years 2000.The milestones were realised, that needed to be accomplished. AI could somehow manage to thrive despite lack of government funds and public appreciation.



(Image Source: www.data-flair.com)

3. Machine Learning

Example 1:

Let's play a game. Find the missing number

2, 4, 8, 16, 32,**?**

And I am sure, you would have guessed the correct answer which is 64. But how did you arrive at 64? This calculation must have taken place inside your brain cells and the technique you used to decipher this puzzle, has actually helped you to decode Machine Learning (ML).

That's exactly the kind of behaviour that we are trying to teach the machines. 'Learn from experience' is what we want machines to acquire.

Example 2:

Let us take another example from Cricket. Assume you are the batsman facing a baller. By looking at the baller's body movement and action, you predict and move either left or right to hit the ball. But if the baller throws a straight ball, what will you do? Apart from the baller's body movement, you also try to find out the patterns in baller's bowling habit, that after 2 consecutive left side balls, he/she throws a straight ball and you prepare yourself to face the next ball. So what you are doing is learning from past experience in order to perform better in the future.

When a computer does this, it is called Machine Learning. You let the computer to learn from its past experience / data.

Example 3:

Now let us go for a slightly more complicated example:

I am Mr. XYZ and I want to buy a house. I try to calculate how much I need to save monthly for that. I did my research work and got to know that a new house would cost me anything between Rs. 30 Lakh to Rs. 100 Lakh. A 5-year old house would cost me between Rs. 20 Lakh to 50 Lakh, a house in Delhi would cost me .....and buying a house in Mumbai would be .....and so on.

Now my brain starts working and suddenly I am able to make out a pattern:

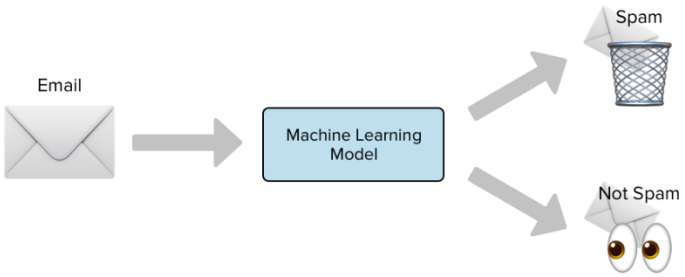
- So, the price of the house depends on its age, location, built up area, facilities, depreciation (which means that price could drop by Rs. 2 Lakh every year, but it would not go below Rs. 20 Lakh.)
- In machine learning terms, Mr. XYZ has stumbled upon regression – he predicted a value (price) based on the available historical data. People do it all the time, when trying to estimate a reasonable cost for a used phone or a car or figure out how many cakes to buy for a birthday party, which might be 200 grams per person, so how many kilograms for a party of 50 persons?

Let's get back to the pricing of the house. The problem is that the construction dates are different, dozens of options are available, locations are multiple, seasonal demands spike, and an array of many more hidden factors.

Humans may not be able to keep all that data in mind, while calculating the price for prospective houses. So we need robots to do the mathematics for us. Let's go the computational way and provide the machine some data and ask it to find all hidden patterns related to the price, and it works! The most exciting thing is that a machine copes with this task much better than a real person does when carefully analysing all the dependencies in his/her mind. This heralds the birth of machine learning!

- **Do you know this?**

1. **Gmail** automatically classifying emails as 'Spam' and 'Not Spam'. Spam emails being automatically sent to the Spam folder saving a lot of your time.



2. **YouTube** recommending you to watch videos of certain genre and the recommended videos matching your choice of videos to a great extent.

3**. Flipkart or Amazon** recommending you to buy products of your choice. How do they come to know your buying preferences? Did you shop together?

4. When you upload photos to **Facebook**, the service automatically highlights faces and suggests which friends to tag. How does it instantly identify your friends in the photos? You might be thinking that Facebook is a magician. Isn't it?

If you haven't realized as yet, then it is time for you to know that Machine learning is behind all the surprises sprung up by Google, Amazon and Flipkart. Even you can create this magic by learning a little about mathematics and a computer programming language.

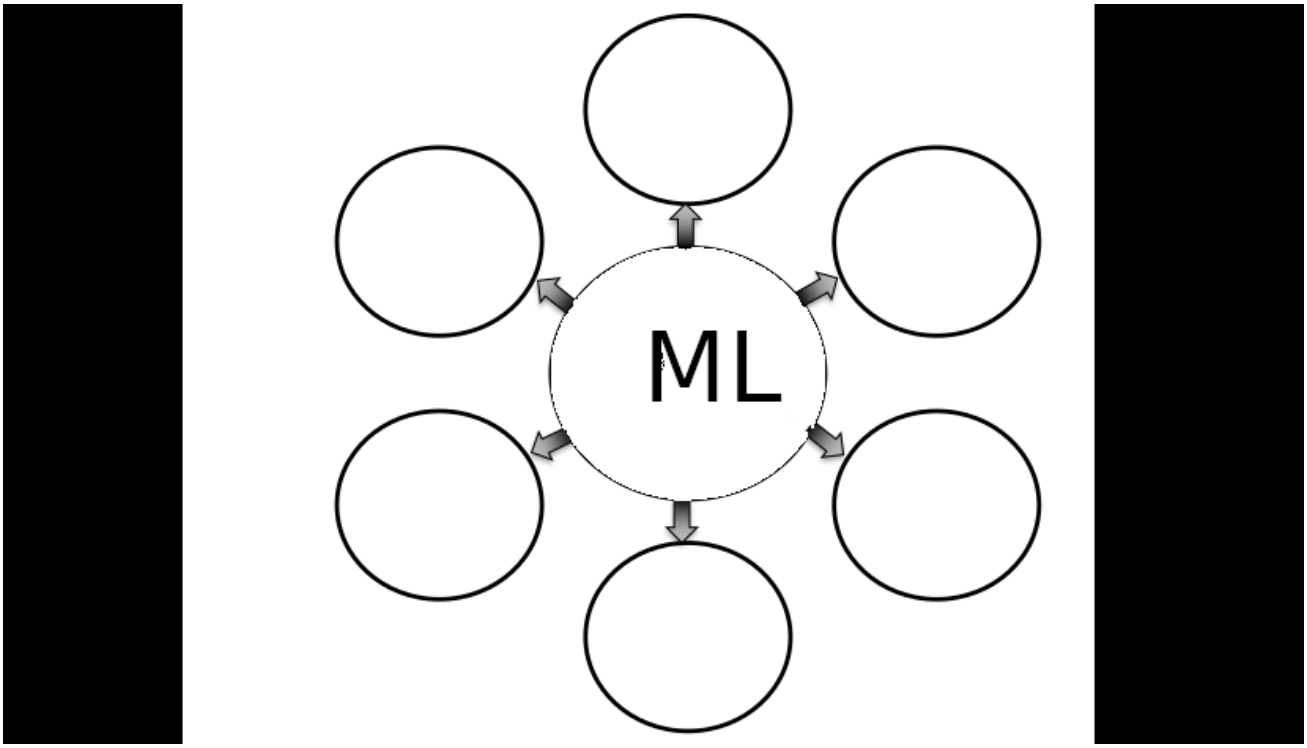
I am sure, by now you have some insight into ML. **So, what is ML?**

"Machine Learning is a discipline that deals with programming the systems so as to make them automatically learn and improve with experience. Here, learning implies understanding the input data and taking informed decisions based on the supplied data". In simple words, Machine Learning is a subset of AI which predicts results based on incoming data.

The utilities of ML are numerous. So as to detect spam emails, forecast stock prices or to project class attendance one can achieve results by means of earlier collected spam messages, previous price history records or procure 5 years or more attendance data of a class. ML will predict the results based upon previous data base experience available with it.

Activity

Based on the understanding you have developed till now, how do you think Machine Learning could help some of the problems being faced currently by your school. Fill the problems in the blank circles given below:



3.1. Difference between Conventional programming and Machine Learning

Conventional programming and ML coding both are computer programs but their approach and objective are different. Like your school dress and your casual dress – both are clothes, made from threads but their purpose is different.

If you ned to develop a website for your school, you will take the Conventional programming approach. But if you want to develop an application to forecast the attendance percentage of your school for a particular month (based on historical attendance data) you will use the ML approach.

Conventional Programming Approach

Conventional Programming refers to any manually created program which uses input data, runs on a computer and produces the output. What does it mean? Let us understand it by illustration below:

A programmer accepts the input, gives the instruction (through Code / Computer language) to the computer to produce an output/destination.

Take a look at an example. Below are the steps to convert Celcius scale to Fahrenheit scale

Step -1: Take input (Celcius)

Step-2: Apply the conversion formula: Fahrenheit = Celcius * 1.8 + 32

Step -3: Print the Output (Fahrenheit)

Did you notice, we are telling the computer what to do on the input data i.e. multiply Celcius with 1.8 and then add 32 to obtain the value in Fahrenheit.

Machine Learning (or AI) Approach

On the contrary, in Machine Learning (ML), the input data and the output data are fed to an algorithm (Machine learning algorithm) to create a program. Unlike conventional programming, Machine Learning is an automated process where a programmer feeds the computer with 'The Input + The Output' and computer generates the algorithm as to how the 'The Output' was achieved.

For example, if the same Python program above is to be written using the Machine Learning approach, the code will look like this:

Step 1: Feed lot many values in Celcius (i.e. -40, -10, 0, 8, 15, 22, 38)

Step -2: Feed corresponding Fahrenheit values (i.e. -40, 14, 32, 46, 59, 72, 100)

Step -3: Pass these 2 sets of values to Machine Learning (ML) algorithm

Step- 4: Now you ask the ML program to predict (convert) any other celcius value to Fahrenheit, and program will tell you the answer.

For example, ask the computer to predict (convert) 200 Celcius to Fahrenheit, and you will get the answer as 392.

Can you notice - in the ML approach, nowhere this conversion step (F = C*1.8 +32) has been mentioned. Code was provided with the input date (Celcius) and corresponding output data (Fahrenheit) and the model (ML code) automatically generates the relationship between Celsius and Fahrenheit.

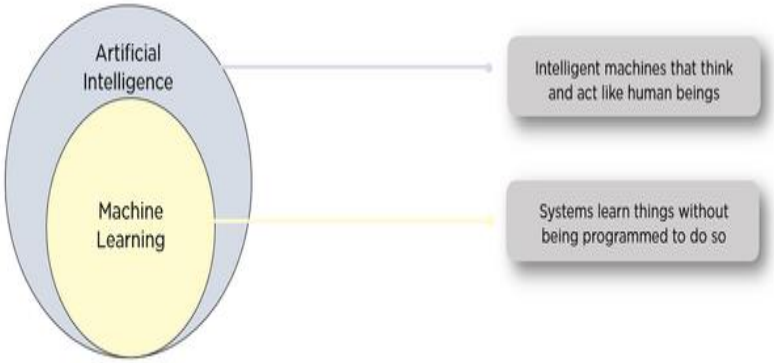
3.2. How is machine learning related to AI?

There is a lot of debate regarding the difference between Machine Learning and Artificial Intelligence. But the truth is that Machine Learning and Artificial Intelligence are not essentially two different things as it is understood to be. Machine Learning is a tool for achieving Artificial Intelligence.

AI is a technology to create intelligent machines that can recognize human speech, can see (vision), assimilate knowledge, strategize and solve problems as humans do. Broadly, AI entails all those technologies or fields that aim to create intelligent machines.

Machine learning provides machines the ability to learn, forecast and progress on their own without specifically being programmed. In a nutshell, ML is more about learning and nothing else. ML system primarily starts with a 'slow state' (like a child) and gradually improve by learning from examples to become 'superior' (like an adult).

Imagine you have to make a robot that can see, talk, walk, sense and learn. What application will you apply? In order to achieve this task of making such a robot, one have to apply numerous technologies but for the learning part, you will apply machine learning.



4. Data

Modern day scholars have coined the phrase 'Data is the new oil'. If everyone is talking so highly about data, then it must be something precious! But what is this data?

Activity

Let us create a students' dataset for your class (the one given below is a sample, you can create one of your own)

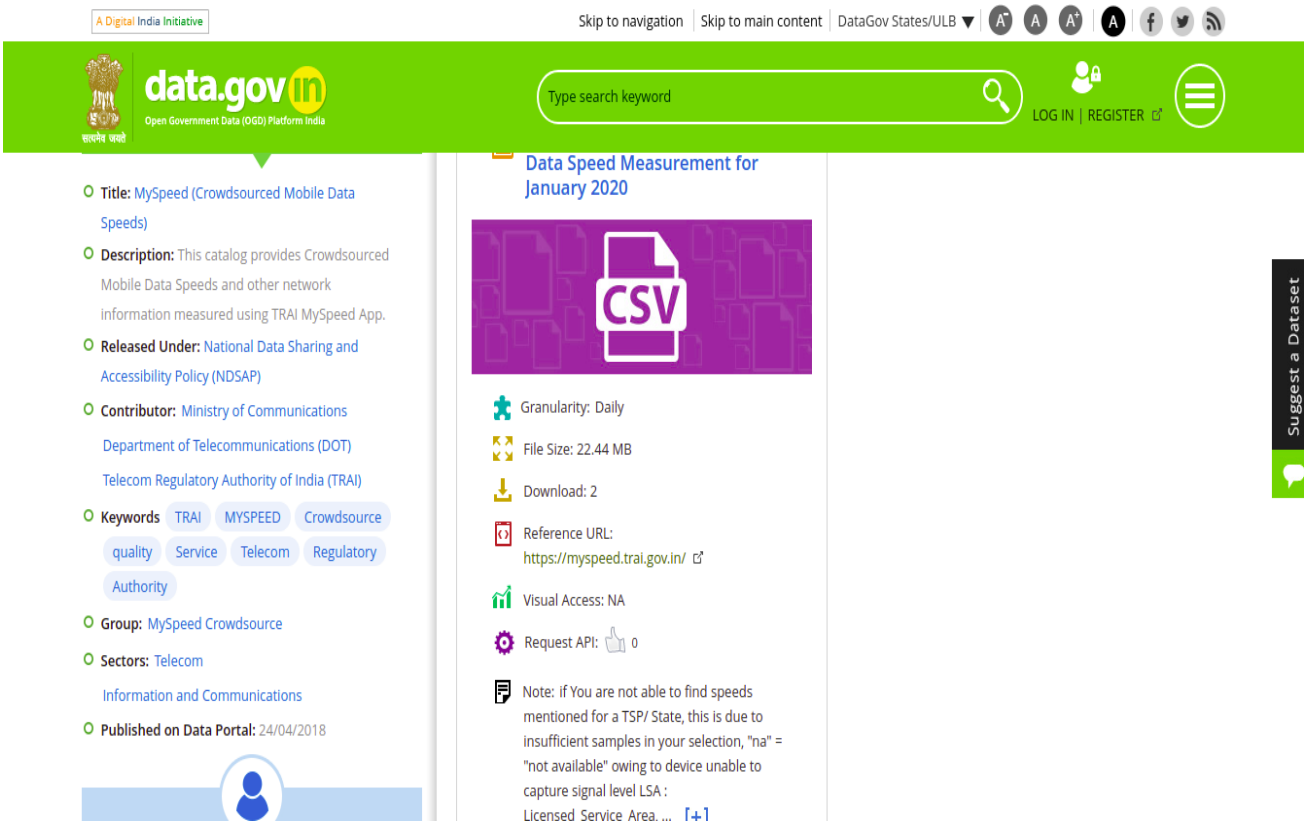
Name of Students	Attendance (%) as of April, 2020	Gender	Total Marks (%) obtained in Grade X	Participation in Sports
A	76	Male	92	N
B	82	Male	88	Y
C	57	Male	65	N
D	97	Female	97	N
E	56	Male	62	Y
F	76	Female	85	N
G	51	Male	56	Y

Does this dataset tell you a story?

- Do you think it mirrors an association between marks obtained and attendance?
- Can you extract 5 observations from this dataset? *[Although this is a very small dataset, can you still take a shot at it?]*

Activity

Open the URL https://data.gov.in/node/6721404 in your web browser. It should open the following page



The page you opened, has a link Reference URL: https://myspeed.trai.gov.in/ - Click on this link.

Now answer a few questions:

1. Who owns and maintains this dataset?
2. What kind of data does it hold?
3. Why the Government of India stores these data?
4. Why has the government made this data public?
5. Do you see the use of such archives in Artificial Intelligence Machine Learning?
6. Can you do a simple web search and find three other such sources of data?

Now that we have engaged in two activities related to data, let us try and define Data.

What is Data? Define it.

Data can be defined as a representation of facts or instructions about some entity (students, school, sports, business, animals etc.) that can be processed or communicated by human or machines. Data is a collection of facts, such as numbers, words, pictures, audio clips, videos, maps, measurements, observations or even just descriptions of things.

Data maybe represented with the help of characters such as alphabets (A-Z, a-z), digits (0-9) or special characters (+, -, /, *, <,>, = etc.)

Activity

Create a dataset about yourself with the following attributes (fields):

Attribute Name	Size of the Field	Data Type
Name	100	Character
Age	3	Number
Address	200	String
Class	3	Character
Number of friends	3	Number
Number of FB posts	3	Number
Type of FB posts	Can you Guess	Can you Guess
Number of word docs you created	4	Number
Type of word docs you created	Can you Guess	Can you Guess

Now that you have created a dataset of your own, it is the time to categorise the data. Data can be sorted into one of the two categories stated below:

- Structured Data
- Unstructured Data

'Structured data' is most often categorized as quantitative data, and it's the type of data most of us work with every day. Structured data has predefined data types and format so that it fits well in the column/ fields of database or spreadsheet. They are highly organised and easily analysed.

In above Activity- name, age, address etc. are examples of 'Structured data'. The data is structured in accurately defined fields. The data that can be stored in relational databases or spread sheets (like Excel) is the best example of structured data.

However, for the field of 'Type of Facebook posts' - Do you have any predefined data type? In fact, your Facebook post can carry anything – text, picture, video, audio etc. You can't have one fixed data type for such data and that's why you call it 'Unstructured data' - where neither size is fixed not datatype is predefined.

'Unstructured data' is most often categorized as qualitative data, and it cannot be processed and analysed using conventional relational database (RDBMS) methods.

Examples of unstructured data include text, video, audio, mobile activity, social media activity, satellite imagery, surveillance imagery and the list goes on. Unstructured data is difficult to deconstruct because

it has no pre-defined model, meaning it cannot be organized in relational databases. Instead, non-relational, or NOSQI databases, are best fit for managing unstructured data.

5. Terminology and Related Concepts

5.1. Machine Learning

"Machine learning is the science of getting computers to act without being explicitly programmed." – Stanford University

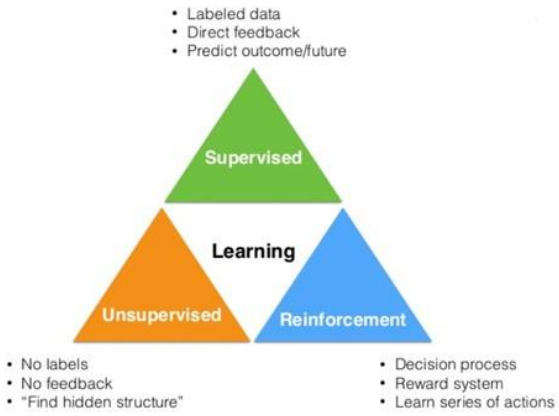
"Machine learning algorithms can figure out how to perform important tasks by generalizing from examples." – University of Washington

Of late, machine learning has achieved a great deal of popularity, but the first attempt to develop a machine that imitated the behaviour of a living being was made in the 1930s by Thomas Ross. Machine Learning (ML) is a term used today to describe an application of AI which equips the system with the ability to learn and improve from experience using the data that is accessible to it.

For more, please refer to section 3.

5.2. Supervised, Unsupervised and Reinforcement learning

Machine learning is often divided into three categories – Supervised, Unsupervised and Reinforcement learning.



5.2.1. Supervised Learning

As the name specifies, Supervised Learning occurs in the presence of a supervisor or a teacher. We train the machine with labeled data (i.e. some data is already tagged with correct answer). It is then compared to the learning which takes place in the presence of a supervisor or a teacher. A supervised learning algorithm learns from labelled training data, and then becomes ready to predict the outcomes for unforeseen data.

Example 1

Remember the time when you used to go to school? The time when you first learnt what an apple looked like? The teacher probably showed a picture of an apple and told you what it was, right? And you could identify the particular fruit ever since then.

That's exactly how supervised learning works.

As you can see in the image below

Step 1: You provide the system with data that contains photos of apples and let it know that these are apples. This is called labelled data.

Step 2: The model learns from the labelled data and the next time you ask it to identify an apple, it can do it easily.

Example 2

For instance, suppose you are given a basket full of different kinds of fruits. Now the first step is to train the machine to identify all the different fruits one by one in the following manner:

- If the shape of the object is round with depression at the top and its color being Red, then it will be labelled – Apple.
- If shape of object resembles a long-curved cylinder with tapering ends and its colour being Green or Yellow, then it will be labelled – Banana.

Now suppose after training, you bring a banana and ask the machine to identify it, the machine will classify the fruit on the basis of its shape and colour and would confirm the fruit to be BANANA and place it in the Banana category.

Activity 1

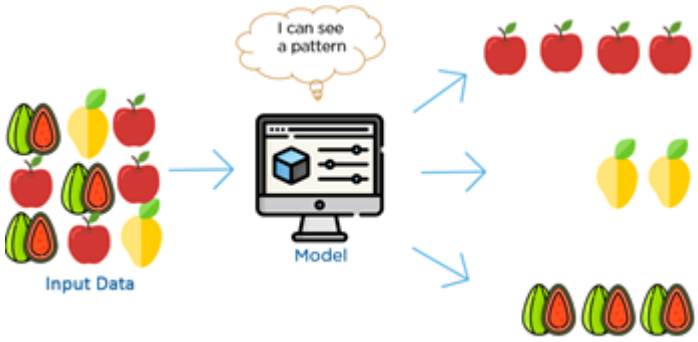
Suppose you have a data set entailing images of different bikes and cars. Now you need to train the machine on how to classify all the different images. How will you create your labelled data?

[**Hint** – If there are 2 wheels and 1 headlight on the front it will be labelled as a 'Bike']

5.2.2. Unsupervised Machine Learning

Many a times, perfectly labelled data sets are hard to find. In such situations, data used to train the machine are neither labelled nor classified. Unsupervised learning is a ML technique where we don't need to supply labelled data, instead we allow the machine learning model (algorithm) to discover the patterns on its own. The task of the machine is to assemble unsorted information according to resemblances, patterns and variances without any former training of data.

In this kind of learning, the machine is restricted to find a hidden structure in the **unlabelled** data without guidance or supervision.



Example 1

If somebody gives you a basket full of different fruits and asks you to separate them, you will probably do it based on their colour, shape and size, right?

Unsupervised learning works in the same way. As you can see in the image:

Step 1: You provide the system with a data that contains photos of different kinds of fruits and ask it to segregate it. Remember, in case of unsupervised learning you don't need to provide labelled data.

Step 2: The system will look for patterns in the data. Patterns like shape, colour and size and group the fruits based on those attributes.

Example 2

For instance, suppose the machine is given an image having both dogs and cats which it has not seen before. Logically the machine has no idea about the physical characteristics of dogs and cats and therefore it cannot categorize the animals. But it can surely categorize them according to their similarities, patterns, and differences i.e. we can easily categorize this above picture into two parts. First category may contain all pictures having dogs in it and second category may contain all pictures having cats in it. Here you didn't learn anything before, means no training data or examples were provided for prior training.

Let us take another example - a friend invites you to his party, where you meet a stranger. Now you will classify this person using unsupervised learning (without prior knowledge) and this classification can be on the basis of gender, age group, dressing style, educational qualification or whichever way you prefer.

Why is this learning different from Supervised Learning?
Since you didn't use any past/prior knowledge about the person and classified them "on-the-go".

Activity 1

Let's suppose you have never seen a Cricket match before and by chance watch a video on the internet. Can you classify players on the basis of different criterion?

Hint: [Players wearing similar outfits belong to a team, players performing different types of action – batting, bowling, fielding, and wicket keeping.]

5.2.3. Reinforcement Machine Learning

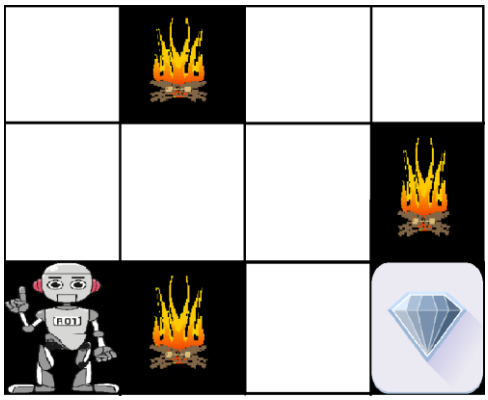
Wikipedia defines Reinforcement learning as "Reinforcement learning (RL)" as an area of machine learning concerned with how software agents ought to take actions in an environment in order to maximize some notion of cumulative reward. Reinforcement learning is one of three basic machine learning paradigms, alongside supervised learning and unsupervised learning."

In reinforcement learning, the machine is not given examples of correct input-output pairs, but a method is provided to the machine to measure its performance in the form of a reward. Reinforcement

learning methods resemble how humans and animals learn, the machine carries out numerous activities and gets rewarded whenever it does something well.

Example 1

Let's play a game:



We have an agent, a robot, and a reward (diamond here) with many hurdles (fires) in between.

The goal of the robot is to get the reward (diamond) and to avoid the hurdles (fire). The robot learns by trying all the possible paths and then chooses the path which reaches the reward while encountering the least hurdles. Each correct step will bring the robot closer to the diamond while accumulating some points and each wrong step will push the robot away from the diamond and will take away some of the accumulated points. The reward (diamond) will be assigned to the robot when it reaches the final stage of the game.

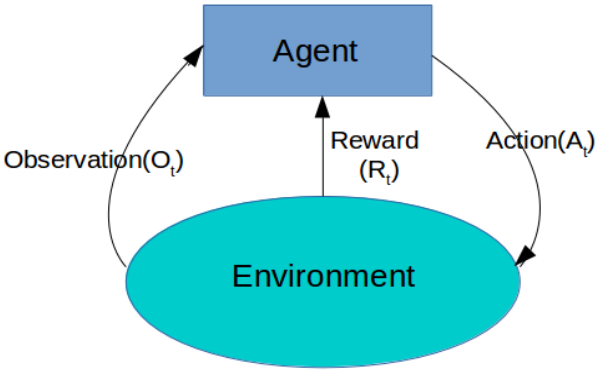
Example 2

Imagine a small kid is given access to a laptop at home (environment). In simple terms, the baby (agent) will first observe and try to understand the laptop environment (state). Then the curious kid will take certain actions like hitting some random buttons (action) and observe how the laptop would respond (next state).

As the non-responding laptop screen goes dull, the kid dislikes it (receiving a negative reward) and probably won't like to repeat the actions that led to such a result (updating the policy) and vice versa. The kid will repeat the process until he/she finds a button which turns the laptop screen bright (rewards) and will be happy maximizing the total rewards.

This is how reinforcement learning works!

In reinforcement learning, artificial intelligence faces a game-like situation. The computer employs trial and error to come up with a solution to the problem. To get the machine to do what the programmer wants, the artificial intelligence gets either rewards or penalties for the actions it performs. Its goal is to maximize the total reward.



Activity 1

Question -1: Can you please find two real world applications of Supervised Learning?

Question -2: Can you write down two real world applications of Unsupervised Learning?

Question-3: What kind of learning algorithm do you think works behind the Computer chess engine?

5.3 Deep Learning and Neural Networks

Deep Learning is inspired from human brain and the neurons in the human brain. Therefore, in order to understand Deep Learning, we will first need to know about 'neurons'.

A small child learns to distinguish between a school bus and a regular transit bus. How?

How do we unconsciously perform complex pattern recognition tasks?

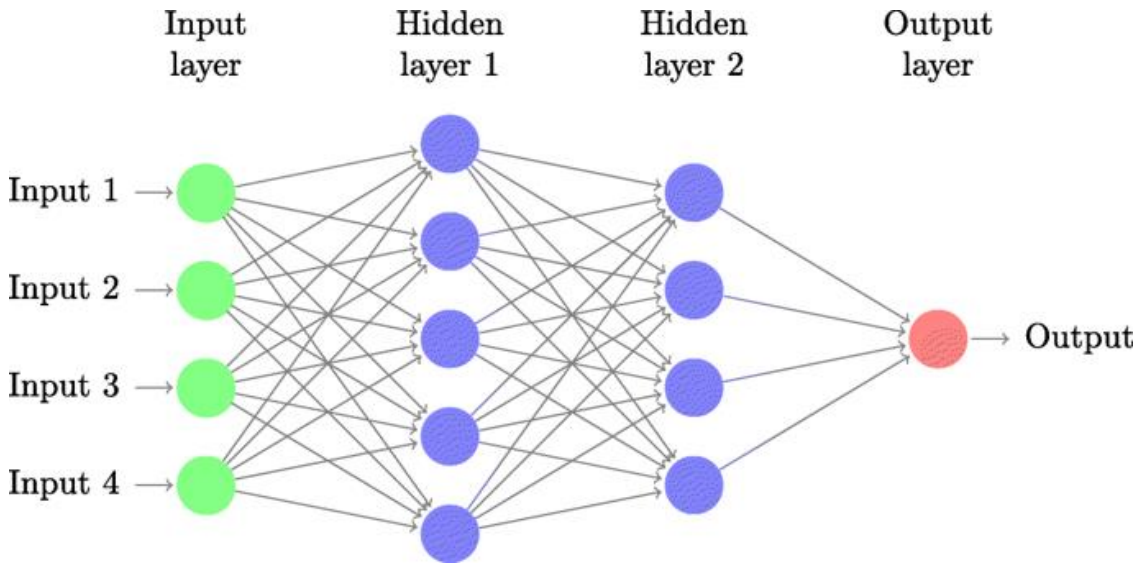
How do we easily differentiate between our pet dog and a street dog?

The answer is we have a vast biological neural network that connects the neurons to our nervous systems. Our brain is a very complex network comprising of about 10 billion neurons each connected to 10 thousand other neurons.

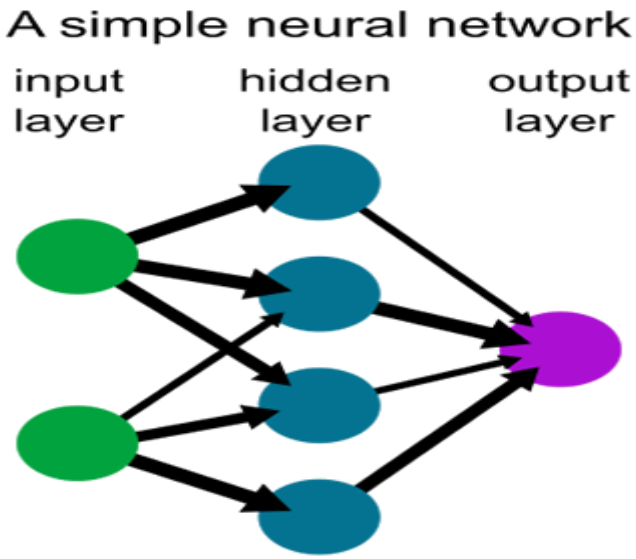
So, before we try to understand Deep Learning, let us understand Neural Network (Artificial Neural Network i.e. ANN). In short, Deep Learning consists of artificial neural networks designed on similar networks present in the human brain. The idea of ANN in Deep Learning is based on the belief that human brain works by making the right connections, and this pattern can be imitated using silicon and wires in place of living **neurons.**

5.3.1. Artificial Neural Network

'Artificial Neural Networks (ANN) can be described as layers of software units called neurons (also called node), connected with different neurons in a layered manner. These networks transform data from one neuron to another neuron until they can classify it as an output. Neural network is again a technique to build a computer program that learns from data.'



The most common structure for a neural network consists of three separate nodes known as input, hidden and output.



- **Input Node:** This is the layer where information or initial data from the real world gets introduced into the neural network. The information is then passed onto the hidden node where computations can begin.
- **Hidden Node**: There is no connection to the real world at this stage. This is the point where the machine uses the information received from the input node, it carries out computation and processing on it. There can be more than one hidden layer.
- **Output Node**: This is the final stage where the computations conclude, and data is made available to the output layer from where it gets transferred back into the real-world environment.

Example

Let me share an example to further explain Artificial Neural Networks…

A school has to select students for their upcoming sports meet. The school principal forms a group of three teachers (a selection jury) and entrusts them with the responsibility of selection of students based on the following criteria:

- Students' Marks (in Grade X)
- Students' Gender
- Students' Age
- Students' Emotional stability

The school has a history of fair selection procedure and therefore only talented and bonafide students are able to secure a place in the sports team. In order to continue the same standard and selection procedure, the principal decides to share (with the jury) data of about 50 previous students' (who were selected) cases to study. The principal feels this will give the jury an opportunity to practice, which will eventually help them make a fair selection.

The process that will be followed for this exercise is as below:

(I would like to remind that this whole exercise is being performed on the previous batch of students and the purpose of this exercise is to sharpen the decision making accuracy of the jury for the upcoming selection)

- Every jury member is given a maximum of 10 points (weight) on which they rate a student. They need to distribute the 10 points across the four criteria of marks, gender, age and emotional stability.
- The cut-off average required for a student to qualify is fixed at '6'. So, a student needs to have an average score of ≥ 6 to reserve his/her spot in the sports team.
- After the jury gives their verdict on a particular student (using the above four criteria), the principal will reveal whether their verdict of "Selected" or "Not Selected" matches the original selection outcome.

Once the ground rules have been set, the jury enters a room to deliberate on the candidates and start the decision making process. Here is a peak into the jury conversation:

- **Teacher 1:** For me 'Grade X Marks' is most important and I am assigning this criterion the most weight and other criteria are not important. Accordingly, I'm giving a score of '7 points' to Student#1.
- **Teacher 2:** I think differently…'Marks' are important, however I am also considering 'Gender' and 'Age' and I'm assigning each of the three criteria equal weight. So I'm scoring Student # 1 '2 points for Marks', '2 points for Gender' and '2 points for Age'.
- **Teacher 3:** For me only 'Gender' and 'Emotional Stability' count and I'm assigning equal weightage to both these criteria. Accordingly, I will score Student # 1 with '5 points for Gender' and '5 points for Emotional Stability'.

Based on the above deliberation, let us take a look at how the jury members have scored Student # 1:

Criteria	**Teacher 1**	**Teacher 2**	**Teacher 3**
Grade X Marks	7	2	0
Gender	0	2	5

Age	0	2	0
Emotional Stability	0	0	5

Average score for Student # 1: (7 + 6 + 10)/ 3 = 7.6

As per the selection rule (cut-off ≥ 6), Student # 1 should have ideally qualified, but the principal reveals that this student actually did not make the team as per the original decision.

Let us take a look at Student # 2 now… Please see below the jury discussion and deliberation for this candidate and how they now begin to adjust their scoring based on learning from Student # 1.

- **Teacher 1:** It seems I'm attaching too much weight to just 'Marks', so I'm leaning towards giving some weightage to 'Age' as well.
- **Teacher 2:** I feel I'm assigning too much weight to 'Gender', I'm going to consider splitting it between 'Gender' and 'Emotional Stability'.
- **Teacher 3:** I now feel in addition to 'Gender' and 'Emotional Stability' some weightage needs to be given to 'Age' as well.

Based on the above deliberations, let us take a look at the score table for Student # 2:

	Teacher 1	**Teacher 2**	**Teacher 3**
Grade X Marks	3	2	0
Gender	0	1	1
Age	3	2	3
Emotional Stability	0	1	1

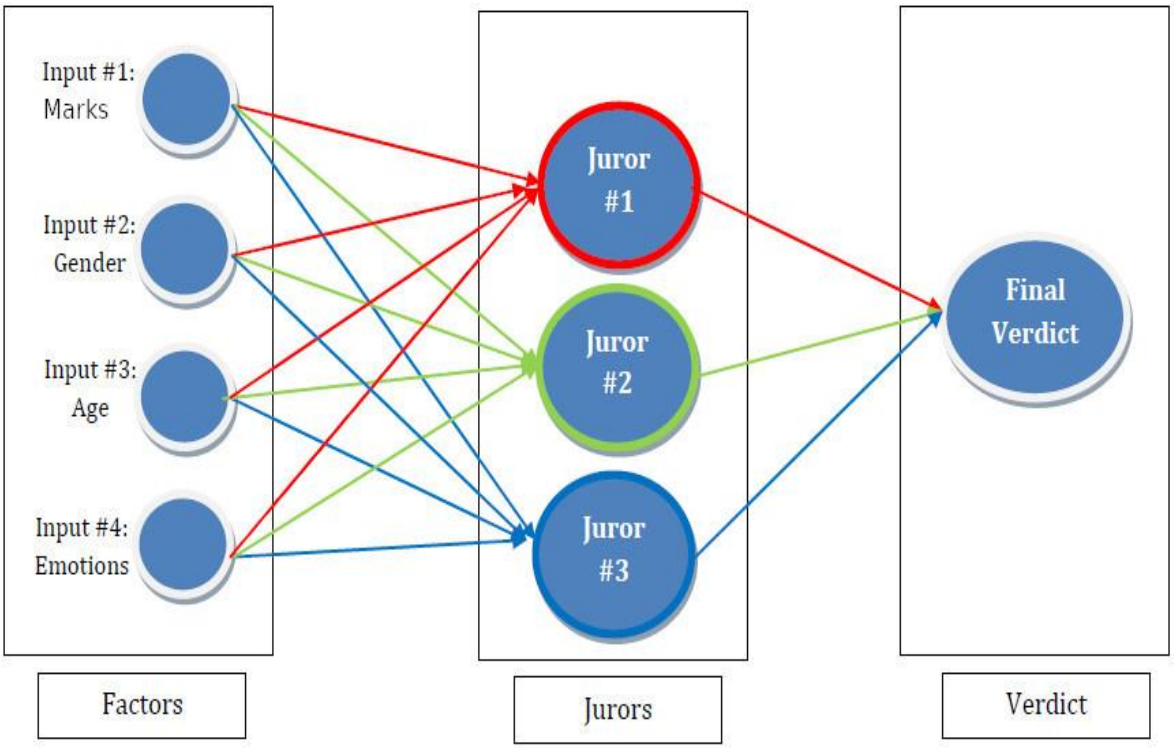
Average score for Student # 2: (6 + 6 + 5) /3 = 5. 6

As per the selection rule (cut-off ≥ 6), Student # 2 will not qualify and the principal reveals that indeed this student did not make the team as per the original decision as well.

So in this case the jury decision matches the original verdict!

In the above fashion the jury proceeds to evaluate student after student and in doing so a pattern emerges for the right 'weightage' for each criteria (per jury member) that yields the highest number of correct predictions.

And this whole process of learning and developing an accuracy is nothing but Artificial Neural Networks (ANN).

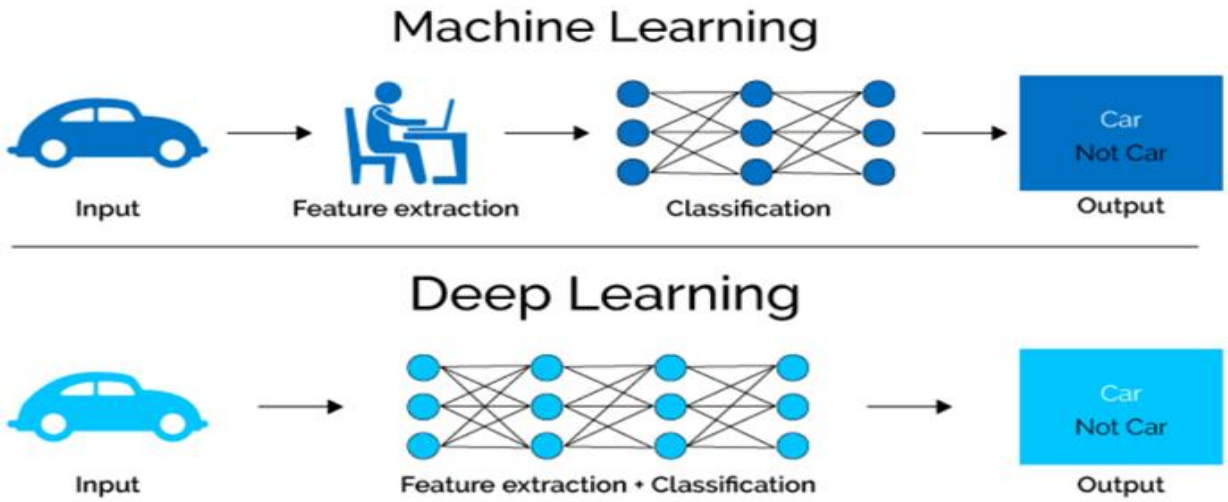


To explain the above illustration:

- The selection criteria (marks, age, gender and emotional stability), is what we call the **'Input Layer'** in a neural network – the input to the network, which will be assigned weightage and eventually decide an outcome
- The decision/prediction is what we call the **'Output Layer'** in a neural network. In this case, 'Selected' and 'Not Selected' is the output layer. It should be noted that it can either be a continuous outcome (regression, as in a number like 3.14 or 42) or categorical outcome (true/false, yes/no, selected/not selected etc.)
- The jurors (group of teachers) form the **'Hidden Layer'**. It's called 'hidden' because no one besides them know how much weightage they are attaching to each criteria (or input). To the input and output neuron, the hidden layer is a 'black box' that simply listens and jointly decides an outcome.

5.3.2. Deep Learning

Deep learning is a branch of machine learning which is completely based on artificial neural networks, as neural network mimics the human brain so deep learning is also a kind of imitation of the human brain. In deep learning, we don't need to explicitly program everything". It is important to know that in deep learning, we do not need to explicitly program everything.



Let us now understand the difference between Machine Learning and Deep Learning:

MACHINE LEARNING	DEEP LEARNING
Works on small amount of Dataset for accuracy.	Works on Large amount of Dataset.
Dependent on Low-end Machine.	Heavily dependent on High-end Machine.
Divides the tasks into sub-tasks, solves them individually and finally combine the results.	Solves problem end to end.
Takes less time to train.	Takes longer time to train.
Testing time may increase.	Less time to test the data.

Here are a few examples of Deep Learning at Work:

- **Automated Driving:** Automotive researchers are using profound learning to robotically spot entities such as stop lights and traffic signals. In addition, deep learning is also used to detect pedestrians, reducing the incident of accidents.

- **Aerospace and Defence:** Identifying objects from satellites and locate safe and unsafe zones for troops is another area where Deep Learning is playing major role.

- **Medical Research:** Deep Learning is used by cancer researchers to automatically detect cancer cells.

- **Industrial Automation:** Deep learning is helping to improve worker safety around heavy machinery by automatically detecting when people or objects are within an unsafe distance from the machines.

6. What machine learning can and cannot do?

The first thought that arises in one's mind after learning about AI and ML is if they will replace humans. In which case, what are humans for?

Humans as the Commander-In-Chief know 'what to count", whereas computers know "how to count". Smart machines can be put to best use only when we understand what it can do and cannot do.

AI and ML are tools, like a calculator, that help us in solving complex problems which otherwise are complicated for the human brain to solve. For instance, we would not use a calculator to multiply "4 x 2", and would not when we have to multiply "798 x 347".

Here are a few examples of Machine Learning that we use every day:

1. **Virtual Personal Assistant** like Siri, Alexa, Google Home etc.

2. **Predictions while commuting** - like Traffic Forecasts on Google Maps.

3. **Video Surveillance** systems nowadays are powered by AI that makes it possible to detect crime before they happen. They track unusual behaviour of people like standing motionless for a long time, stumbling, or napping on benches etc.

4. Social Media Services

- Facebook Friend Suggestion: Facebook continuously notices the friends that you connect with, the profiles that you visit very often. On the basis of continuous learning, list of Facebook users is suggested that you can become friends with.

- Face Recognition on Facebook: When you upload a picture of yourself with a friend does Facebook instantly recognizes that friend? Facebook checks the poses and projections in the

picture, notices the unique features, and then matches the same with the people in your friends list.

5. Email spam and malware filtering - Emails are arranged according to some standards as per email spam. Mail filtering manages received mails, detects and removes the ones holding malicious codes such as virus, Trojan or malware.

6. Product recommendations - You often receive emails from similar merchandizers after you have shopped online for a product. The products are either similar or matches your taste, it definitely refines the shopping experience. Did you know that it is Machine Learning working its magic in the back?

7. Online Fraud Detection

Machine learning is lending its potential to make cyberspace a secure place by tracking monetary frauds online. Take for example PayPal is using ML for protection against money laundering. Even with the advancements we have made in ML over the years, there are instances where a Grade 2 student has been able to beat a computer by solving a problem faster.

1. Any problems or questions which require social context will take longer for a machine to solve
2. Particularly with respect to text analytics, there are two main challenges. First is “Ambiguity” - this means that the same word can mean many things. Second is “Variability” - indicating the same thing can be said in many different ways.
3. Machine learning can’t solve ethical problem. If a self-driving car kills someone on the road, whose fault is it?

7. Jobs in AI

Can you guess the jobs depicted in the pictures below:

Picture – 1

Picture -2

Picture – 3

Picture -4

The jobs depicted in the pictures above, were professions from not long back, may be 20-30 years ago. There are so many jobs, which used to exist few decades ago but are redundant in today's age. Similarly, there are jobs which were unheard of 30 years ago but are very popular now.

Activity

1. Can you please prepare a list of 10 such jobs which existed in the 80's but no longer relevant now?

---

2. Can you prepare a list of 5 jobs, which were not in 80's but are popular now?

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3. Can you imagine 5 jobs / professions that do not exist now but maybe popular in 2035?

The World Economic Forum predicts that AI and ML will displace 75 million jobs but generate 133 million new ones worldwide by 2022. Another Gartner report claims that in 2020, Artificial Intelligence will create 2.3 million jobs and eliminate 1.8 million jobs.

Job losses due to Artificial Intelligence is a baseless fear as AI will NOT take over the employment market – as simple as that. It will merely introduce a paradigm shift, similar to the one which occurred after the Industrial Revolution. Consequently, while many professions will become obsolete and disappear, some occupations will become much more popular, with new ones emerging on the go. It's important to keep two things in mind:

1. Acquiring basic tech-related skills is not something you will live to regret
2. Understanding what is happening in the field of AI may help you gain a significant career advantage, either by investing time and money into learning a new skill or leveraging your existent knowledge into solving relevant AI-related problems.

Jobs which will grow with the help of AI

1) Creative Jobs

Professionals like artists, doctors, scientists are only a few which can be labelled creative. Such category of jobs is only going to get refined and advance by use of AI.

The number of such professionals required will not increase. But AI will make certain parts of these jobs less complex for humans, so it will become easier in the future to learn the skill in lesser time and flourish.

2) Management Jobs

Management jobs cannot be replaced by artificial managers. Human managers have to manage artificial managers. Managing is a very complex task which involves deep understanding of people and communication. There are already few smart tools which help managers become more effective at their

job. So, if you're interested in this kind of job, you can learn to use them and gain some advantage in the field.

3) Tech Jobs

Programmers, data scientists, people who work on the creation and maintenance of AI systems are the jobs of the future and they will be very important for humanity to make the next large step of its evolution. They too should undergo certain changes. Few of the tech jobs which are in demand today may become less common, while others may become more vital.

Few of the jobs title, which can be expected to appear by 2030:

1. Chief Bias Office
2. Data detective
3. Man – Machine teaming manager
4. AI business development manager
5. AI assisted medical professional (this I am sure, will appear before 2030)
6. AI tutor

I will leave up to you guys to take up as a project and define the roles and responsibilities of these jobs profile.

Happy learning in AI Age!

Activity

***(This activity has been designed by** MIT AI Ethics Education Curriculum. "An Ethics of Artificial Intelligence Curriculum for Middle School Students was created by Blakeley H. Payne with support from the MIT Media Lab Personal Robots Group, directed by Cynthia Breazeal.")*

Let's play a game of 'AI BINGO'!

Learning Objectives:

1. To understand the basic mechanics of AI systems
2. Know that artificial intelligence is a specific type of algorithm and has three specific parts: dataset, learning algorithm, and prediction.
3. Recognize AI systems in everyday life and be able to reason about the prediction an AI system makes and the potential datasets the AI system uses.

Instructions for Teachers

1. Print out all of the materials below these two paragraphs, with each bingo card on a separate paper and the list of Tasks, Data Sets & Predictions on a third.
2. Pass around the bingo cards to the separate teams and keep the list of tasks/dataset/prediction for yourself (It will serve as both the answer key and the bingo calls)
3. Along with every data set and prediction, you will see the task that it corresponds to on the Bingo grids. Read out the data set and prediction pairs at random (but not the task itself!) and have the students fill in the tile they think it belongs to.
4. The first of the two teams to correctly fill out five tiles in a row, diagonal, or column win.


It's time to play AI bingo!
When you flip this page, you'll see two different bingo cards, one for each team.
1 With your friends, form two teams of 1–2 people.
2 Each bingo tile will contain something you do in your life that uses an AI system. Your job is to figure out what data sets the AI would need and what predictions it would make. As an adult reads off the list of data sets and predictions one by one, try your best to work out where they belong.
3 Use a pencil to fill in the tile. The first team to fill in five squares with the correct data set and prediction in a row, diagonal, or column wins.

Print out these 2 images to get started

Search for something on Google DATA SET: PREDICTION:	Send a voice-to-text message DATA SET: PREDICTION:	Have a news app suggest an article DATA SET: PREDICTION:	Get "nudged" to respond to an email on Gmail DATA SET: PREDICTION:	See a recommended product on Facebook DATA SET: PREDICTION:
See a suggested ad on Snapchat DATA SET: PREDICTION:	Use an app like Shazam to identify a song DATA SET: PREDICTION:	Have Google autocomplete your search query DATA SET: PREDICTION:	Communicate with a customer service bot DATA SET: PREDICTION:	Have an email go to your spam folder DATA SET: PREDICTION:
Replace letters, like "lol," with a suggested emoji DATA SET: PREDICTION:	Play a motion-sensitive video game on Nintendo or Wii DATA SET: PREDICTION:		Click on an Instagram ad DATA SET: PREDICTION:	Use your face to unlock a device DATA SET: PREDICTION:
Have your words autocorrected in a text DATA SET: PREDICTION:	Have an email labeled as "important" DATA SET: PREDICTION	Listen to a recommended song on Spotify DATA SET: PREDICTION:	Use a map app to find a path to a destination DATA SET: PREDICTION:	Get a suggested email response on Gmail DATA SET: PREDICTION:
Use "safe search" on Google DATA SET: PREDICTION:	Get a forecast from a weather app DATA SET: PREDICTION:	Use a Snapchat filter DATA SET: PREDICTION:	Receive a product recommendation on Amazon DATA SET: PREDICTION:	Have a writing assignment graded by a computer DATA SET: PREDICTION:

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Data Sets & Predictions – FOR TEACHERSY

***TASK:* Get a forecast from a weather app**
DATA SET: what the weather was like in the past
PREDICTION: what the weather will be like in the future

T: Send a voice-to-text message
D: transcribed audio of people talking
P: transcription of your audio message

T: Search for something on Google
D: past links you've clicked on in Google
P: which search results you'd want to see first

T: Have Google autocomplete your search query
D: past searches of people who share your interests
P: your full search after you type the first word

T: Have a writing assignment graded by a computer
D: examples of graded writing assignments
P: the grade a new assignment deserves

T: Use "safe search" on Google
D: examples of websites that are safe and unsafe
P: new websites that are safe and unsafe

T: Get a suggested email response on Gmail
D: people's responses from past email exchanges
P: a response you might give to a new email

T: Use a Snapchat filter
D: examples of people's faces
P: where to paste glasses on your face

T: Play a motion-sensitive video game on Nintendo or Wii
D: examples of different motions that correspond with actions in a video game
P: the action you're trying to take when you make a motion

T: Replace letters, like "lol," with a suggested emoji
D: what each emoji could mean
P: the best emoji to replace what you've texted

T: Receive a product recommendation on Amazon
D: the products people have bought together in the past
P: a product you might like with what you just bought

T: Have an email go to your spam folder
D: examples of emails that are or aren't spam
P: whether a new email is spam

T: Click on an Instagram ad
D: the Instagram accounts people follow and what they buy
P: what you might buy based on who you follow

T: Have a news app suggest an article
D: the news articles you've read in the past
P: the news articles you may like to read

T: See a suggested ad on Snapchat
D: the Snapchat accounts people follow and what they buy
P: what you might buy based on who you follow

T: Have your words autocorrected in a text
D: examples of how people misspell words
P: the word you're trying to spell

T: Listen to a recommended song on Spotify
D: past songs that you've listened to
P: new songs you may like

T: See a recommended product on Facebook
D: the Facebook posts people engage with and what they buy
P: what you might buy based on posts you engage with

T: Get "nudged" to respond to an email on Gmail
D: how quickly people have responded to emails in the past
P: how quickly you should respond to an email

T: Use your face to unlock a device
D: images of your face
P: whether a face is yours

T: Use a map app to find a path to a destination
D: how long it historically takes to get from point A to B
P: the shortest commute from point A to B

T: Use an app like Shazam to identify a song
D: examples of what songs sound like in noisy environments
P: the name of a song playing in a noisy environment

T: Communicate with a customer service bot
D: the most helpful answers to past customer questions
P: the best answer to your question

T: Have an email labelled as "important"
D: examples of emails that are or aren't important
P: whether a new email is important

Unit 2: AI Applications and Methodologies

Title: AI Applications and Methodologies	**Approach: Interactive/ Discussion, Activities**
Summary: As soon as someone mentions the word "AI", the first picture that comes in our mind is of Terminator or a Robot which can do everything. Thankfully, the present picture is more positive. In this unit, we will explore how AI and its various applications helping our planet and benefiting the humankind. This unit will let you know the applications of AI in the domain of science, automobiles, healthcare, trading and business, weather etc. This unit will also take you through the cognitive computing aspect of AI by introducing you to terms like Computer Vision, speech, reasoning etc. Which otherwise is considered to be the attributes of humans.	
Objectives: 1. Students get familiar with AI applications such as Chatbots, role of AI in weather forecasting, autonomous cars etc. 2. Students start appreciating the fact that AI is here to supplement us and NOT compete with us. 3. Students get a fair understanding of how our society is expected to look like in the age of AI and the skills that students need to acquire in order to keep pace with the changes.	
Learning Outcomes: 1. To develop a fair understanding of AI applications and to know where and how to apply these tools to improve productivity. 2. They should see AI as a tool pretty much like they treat calculator as a tool for simple calculation.	
Pre-requisites: Basic understanding of AI, reasonable fluency in English and computer literacy, comfortable in using the internet	
Key Concepts: AI applications, cognitive computing, Impact of AI on society	

Before we start this unit, let me ask you a few questions:

1. Give me two reasons why you should learn to ride a bicycle?
2. Share two reasons why one should learn how to operate a calculator?
3. Do you know anybody who doesn't know even know the basics of mobile phone operation?

Hope you have noticed, that I did not ask why we should learn how to manufacture bicycles or how to build and program a mobile phone or calculator. Anyone, who can't operate a mobile phone or doesn't know how to use a calculator is probably a misfit in the society that we live in today. Those days are not far away when AI tools and applications will start replacing calculators, bicycles or mobile phones, and many other gadgets that we use in our day-to-day lives.

Artificial Intelligence technologies are widely used by people today, just that they don't realise it or are unaware of it. In the modern times that we live today, we are surrounded by a variety of AI tools that make many aspects of our lives easier. Have you ever thought about the music that we listen to, the products we buy from Amazon or Flipkart, or the news and information that we receive are all made available to us with the help of AI? AI is helping in composing poems, writing stories, helping doctors perform complex surgeries and also prescribing medicines.

You must have watched a number of Sci-Fi movies, but to encounter something like “The Terminator” come to life is not going to happen anytime soon**.**

Activity 1:

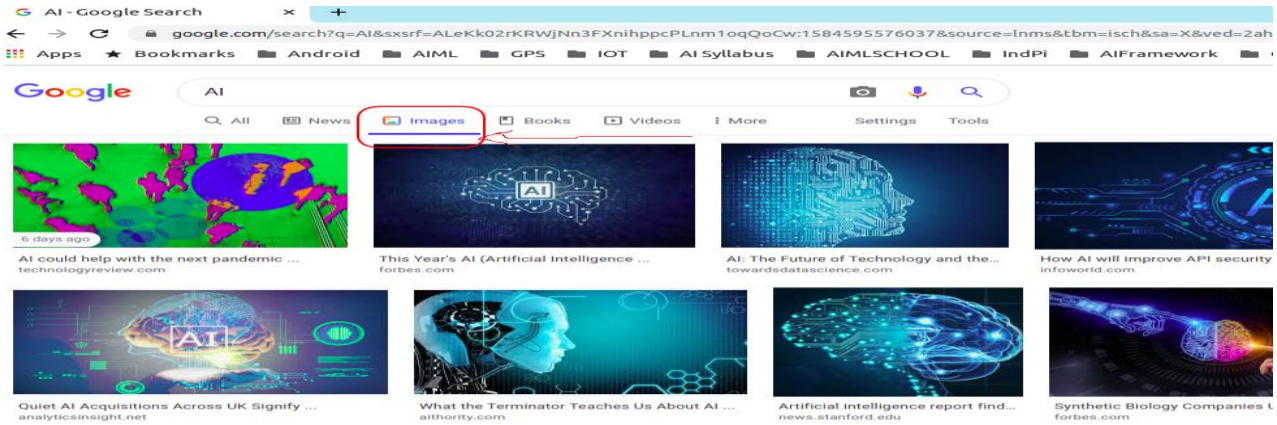
Let us do a small exercise on how AI is perceived by our society.

Do you have any idea what people think about AI? Do an online image search for the term “AI”

The results of your search would help you get an idea about how AI is perceived.

[Note - If you are using Google search, choose "Images" instead of “All” search]

Based on the outcome of your web search, create a short story on “People’s Perception of AI”



Activity 2:

In this activity, let us explore what is being written on the web about AI?

Do you think the articles on the net are anywhere close to reality or are they just complete science fantasies?

Now based on your experience during the online search about ‘AI’, prepare your summary report that answers the following questions:

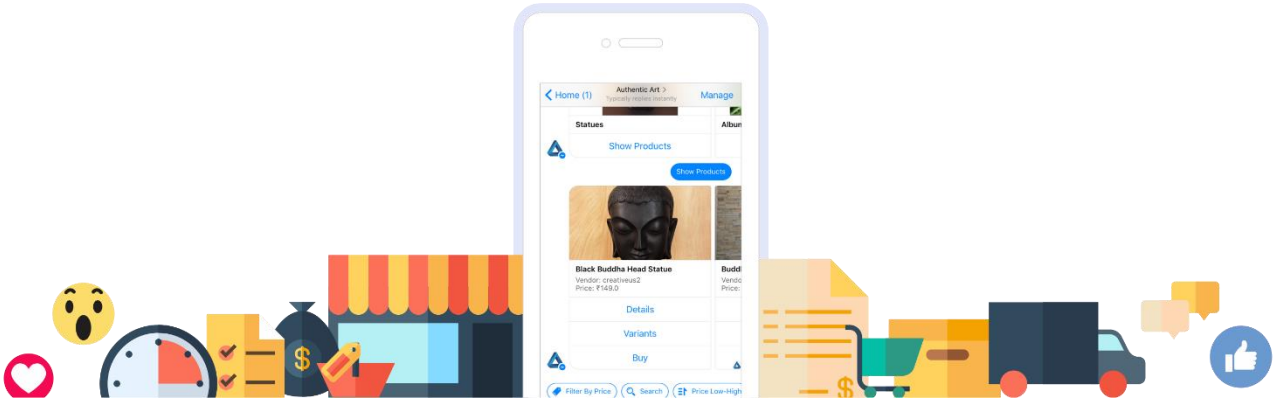
1. What was the name of the article, name of the author and web link where the article was published?
2. What was the main idea of the article? Mention in not more than 5 sentences

1. Key Fields of Application in AI

According to the father of Artificial Intelligence, John McCarthy, “Artificial Intelligence is the science and engineering of making intelligent machines, especially intelligent computer programs”. Artificial Intelligence helps in developing intelligent machines and software that learns, works and responds like the human beings. Today, AI has become an integral part of human lives and has permeated in areas as diverse as science, engineering, business, medicine, video games, etc. Some of the applications are discussed below.

1.1 Chatbots

If you remember from Unit-1, AI tries to mimic human cognitive functions like vision, speech, reasoning etc. Chatbot is one of the applications of AI which simulate conversation with humans either through voice commands or through text chats or both. We can define Chatbot as an AI application that can imitate a real conversation with a user in their natural language. They enable communication via text or audio on websites, messaging applications, mobile apps, or telephones.



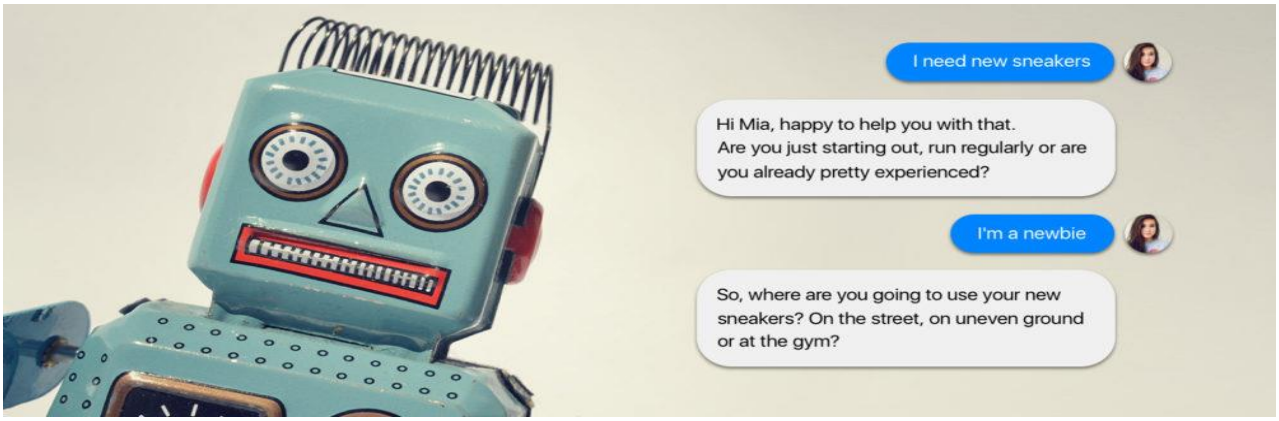
Some interesting applications of Chatbot are Customer services, E-commerce, Sales and Marketing, Schools and Universities etc.

Let us take up some real-life examples. HDFC Bank’s EVA (Electronic Virtual Assistant) is making banking service simple and is available 24x7 for the HDFC bank’s customers.

Please visit the link to get a first-hand experience of banking related conversations with EVA : https://v1.hdfcbank.com/htdocs/common/eva/index.html

You can also visit https://watson-assistant-demo.ng.bluemix.net/ for a completely new experience on the IBM Web based text Chatbot.

Open the link in your web browser, and you will land on the demo page of IBM’s banking virtual assistant. In this demo, you will be engaging with a banking virtual assistant that is capable of simulating a few scenarios, such as making a credit card payment, booking an appointment with a banker or choosing a credit card. Watson can understand your entries and responds accordingly.

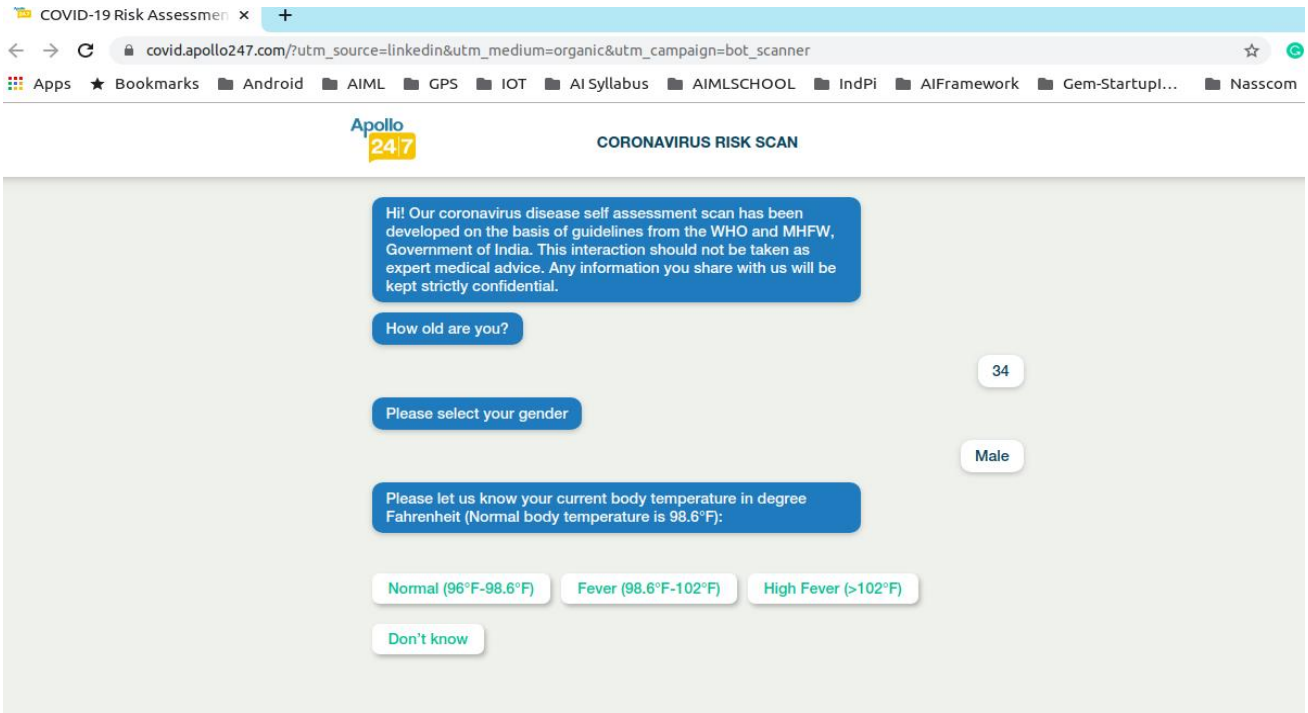


The other online Chatbot platform, where you can get basic hands on experience using your Gmail account is the Google Dialog flow. You can visit the link https://dialogflow.com/ to experience the Chatbot

We all know the threat due to Corona Virus on humanity. Most of us want to calculate our own risk level at this time. But just for the risk assessment, it's not advisable to go out to see a doctor or hospital.

Amidst the current paranoia surrounding COVID 19, Apollo hospitals (and many other hospitals /medical companies also) released a Chatbot to scan one's risk level. Another example of leveraging AI at the time of need.

URL: https://covid.apollo247.com/



Types of Chatbots

Chatbots can broadly be divided into two types:

1. Rule based Chatbot
2. Machine Learning (or AI) based Chatbot risk

1. Rule – based Chatbot

This is the simpler form of Chatbot which follows a set of pre-defined rules in responding to user's questions. For example, a Chatbot installed at a school reception area, can retrieve data from the school's archive to answer queries on school fee structure, course offered, pass percentage, etc.

Rule based Chatbot is used for simple conversations, and cannot be used for complex conversations.

For example, let us create the below rule and train the Chatbot:

```
bot.train ( [
        'How are you?',
        'I am good.',
        'That is good to hear.',
        'Thank you',
        'You are welcome.',
        ])
```

After training, if you ask the Chatbot, "How are you?", you would get a response, "I am good". But if you ask 'What's going on? or What's up? ', the rule based Chatbot won't be able to answer, since it has been trained to take only a certain set of questions.

Quick Question?

Question: Are rule-based bots able to answer questions based on how good the rule is and how extensive the database is?
Answer: We can have a rule-based bot that understands the value that we supply. However, the limitation is that it won't understand the intent and context of the user's conversation with it.

For example: If you are booking a flight to Paris, you might say "Book a flight to Paris" and someone else might say "I need a flight to Paris" while someone from another part of the world may use his/her native language. AI-based or NLP-based bot identifies the language, context and intent and then it reacts accordingly. A rule-based bot only understands a pre-defined set of options.

2. Machine Learning (or AI) based Chatbot

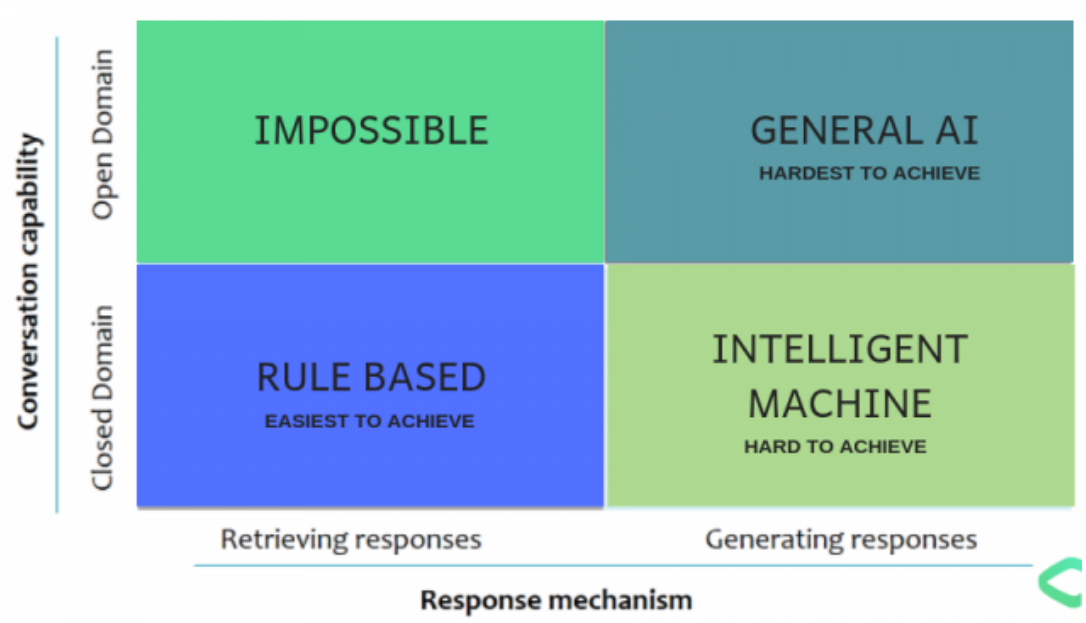
Such Chatbots are advanced forms of chatter-bots capable of holding complex conversations in real-time. They process the questions (using neural network layers) before responding to them. AI based Chatbots also learn from previous experience and reinforced learning and it keeps on evolving.

AI Chatbots are developed and programmed to meet user requests by furnishing suitable and relevant responses. The challenge, nevertheless lies in aligning the requests to the most intelligent and closest response that would satisfy the user.

Had the rule based Chatbot discussed earlier been an AI Chatbot and you had posed 'What's going on? or What's up?' instead of 'How are you?', you would have got a suitable response from the AI Chatbot.

The earlier mentioned IBM Watson Chatbot - https://watson-assistant-mo.ng.bluemix.net/ is in fact an AI Chatbot .

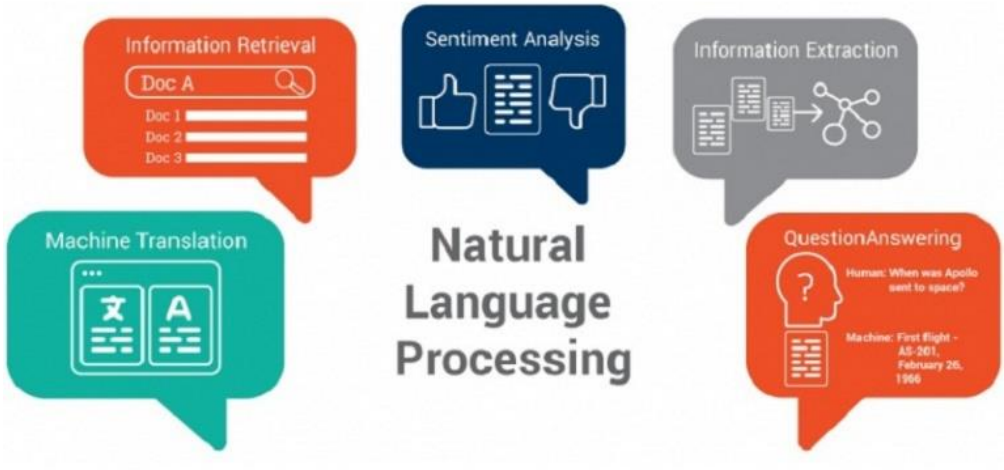
How AI Chatbots Understands User Requests



source: https://dzone.com/articles/how-to-make-a-chatbot-with-artificial-intelligence

1.2 Natural Language processing (NLP)

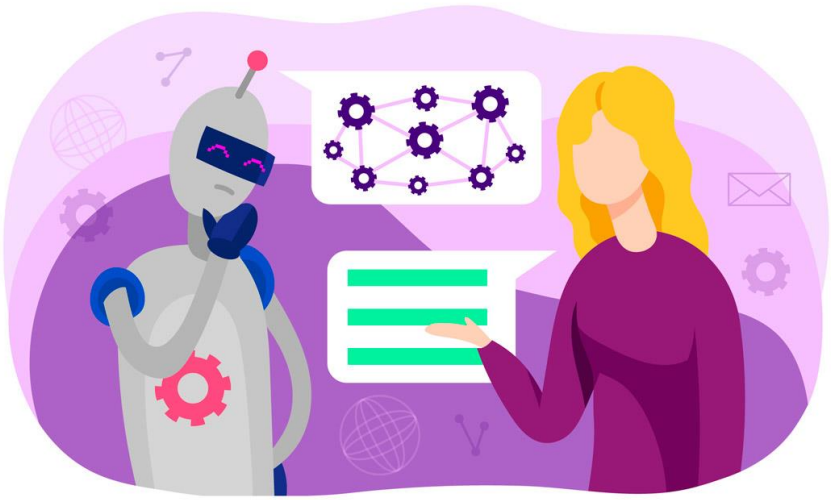
We read about Chatbots in the previous section. But do you understand the technology behind the Chatbots? It is called is NLP, short for Natural Language Processing. Every time you throw a question to Alexa, Siri or Google assistant, they use NLP to answer your question. Now we are faced with the question, what is Natural Language processing (NLP)?



Source: https://www.techsophy.com/chatbots-need-natural-language-processing/

Natural language means the language of humans. It refers to the different forms in which humans communicate with each other – verbal, written or non-verbal or expressions (sentiments such as sad, happy, etc.). The technology which enables the machines (software) to understand and process the natural language (of humans), is called natural language processing (NLP). In other words, it is defined as branch of Artificial Intelligence that deals with the interaction between computers and humans using the natural language. The main objective of NLP is to read, interpret, comprehend, and coherently make sense of the human language such that it creates value for all. Therefore, we can safely conclude that NLP essentially comprises of natural language understanding (human to machine) and natural language generation (machine to human).

NLP is a sub – area of Artificial Intelligence deals with the capability of software to process and analyse human language, both verbal and written language.



Natural language processing has found applications in various fields which are listed as follows

1. Text Recognition (in an image or a video)

You might have seen / heard about cameras that read vehicle's number plate

camera / machine translation

using NLP => KL 85 C 4780

Camera / machine captures the image of number plate, the image is transferred to neural network layer of NLP application, NLP extracts the vehicle's number from the image. However, correct extraction of data also depends on the quality of image.

Quick Question?

Question: Where and how is NLP used?
Answer: NLP is natural language processing and can be used in scenarios where static or predefined answers, options and questions may not work. In fact, if you want to understand the intent and context of the user, then it is advisable to use NLP.

Let's take the example of pizza ordering bot. When it comes to pre-listed pizza topping options, you can consider using the rule-based bot, whereas in case you want to understand the intent of the user where one person is saying "I am hungry" and another person is saying "I am starving", it would make more sense to use NLP, in which case the bot can understand the emotion of the user and what he/she is trying to convey.

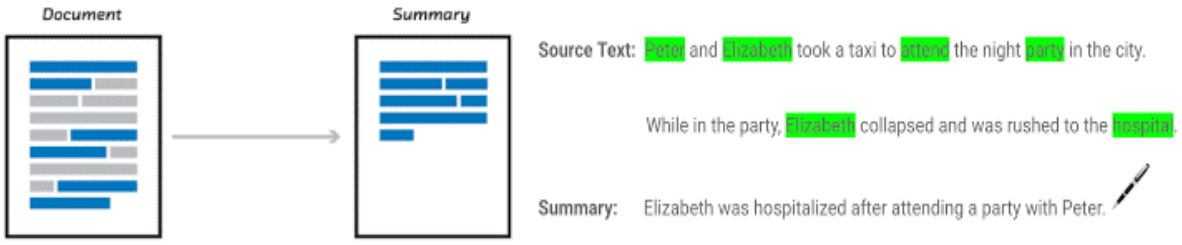
Activity:

Do you think the application of NLP, can completely remove the language barriers? Can you write the algorithm / steps to show how NLP will perform the language translation?

---

2. Summarization by NLP

NLP not only can read and understand the paragraphs or full article but can summarize the article into a shorter narrative without changing the meaning. It can create the abstract of entire article. There are two ways in which summarization takes place – one in which key phrases are extracted from the document and combined to form a summary **(extraction-based summarization)** and the other in which the source document is shortened **(abstraction-based summarization).**



https://techinsight.com.vn/language/en/text-summarization-in-machine-learning/
https://blog.floydhub.com/gentle-introduction-to-text-summarization-in-machine-learning/

Example 1

To understand the summarization process, let us take an example from our real-life, that from our judiciary. The Lawyers and judges have to read through large volumes of documents just to develop an understanding of one case. The NLP can be leveraged here by assigning the task of reading the case files to create a short abstract of every case file. Judges/lawyers will read the summarized files (prepared by NLP AI) saving their precious time, which can be utilized to expedite the pending cases resolution.

Example 2

Let us take one more example:

Source text: **Joseph and Mary** rode on a horse drawn carriage to attend the annual fair in London. In the city, **Mary bought** a **new dress** for herself.

Extractive summary: **Joseph and Mary attend annual fair in London. Mary bought new dress.**

Have you noticed that in this case the extractive summary has been formed by joining the words in bold?

3. Information Extraction

Information extraction is the technology of finding a specific information in a document or searching the document itself. It automatically extracts structured information such as entities, relationships between entities, and attributes describing entities from unstructured sources.

Example

For example, a school's Principal writes an email to all the teachers in his school -

"I have decided to organize a teachers' meet tomorrow. You all are requested to please assemble in my office at 2.30 pm. I will share the agenda just before the meeting."

NLP can extract the meaningful information for teachers:

What: Meeting called by Principal

When: Tomorrow at 2.30 pm

Where: Principal's office

Agenda: Will be shared before the meeting

Another very common example is Search Engines like Google retrieving results using Information Extraction.

4. Speech processing

The ability of a computer to hear human speech and analyse and understand the content is called speech processing. When we talk to our devices like Alexa or Siri, they recognize what we are saying to them. For example:

You: Alexa, what is the date today?

Alexa: It is the 18-March-2020.

What happens when we speak to our device? The microphones of the device hears our audio and plots the graphs of our sound frequencies. As light-wave has a standard frequency for each colour, so does sound. Every sound (phonetics) has a unique frequency graph. This is how NLP recognizes each sound and composes an individual's words and sentences.

Below table shows the step-wise process of how speech recognition works:

Step 1: Voice / Sound is picked up by the microphone	**Step 2:** Waveform vibrates on the microphone's diaphragm which measures amplitude of the sound of our speech
Step 3: Inbuilt algorithm converts amplitude to frequency and then plots a graph	**Step 4:** The plotted graph is converted to equivalent text which is further analysed by NLP

Activity

Have you noticed that virtual assistants like Alexa and Google Assistant work very well when they are connected to the internet, and cannot function when they are offline?

Can you do a web search to find out the reason for the same? Please summarize your findings/understanding below:

Natural Language Processing Tools and Libraries for advance learners

1. NLTK (www.nltk.org) Open source NLP Toolkit

2. Cornel (https://stanfordnlp.github.io/CoreNLP/)

3. Open NLP (https://opennlp.apache.org/) Open Source NLP toolkit for Data Analysis and sentiment Analysis

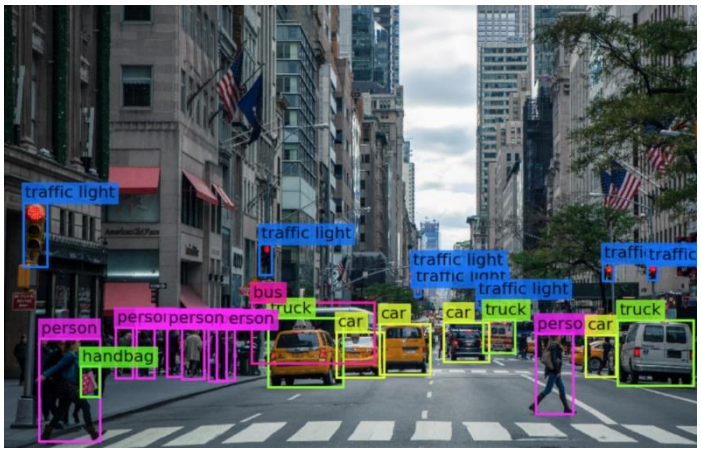
4.SpaCy (https://spacy.io/) for Data Extraction, Data Analysis, Sentiment Analysis, Text Summarization

5. Allen NLP (https://allennlp.org/) for text analysis and Sentiment Analysis

1.3 Computer Vision (CV): Getting started

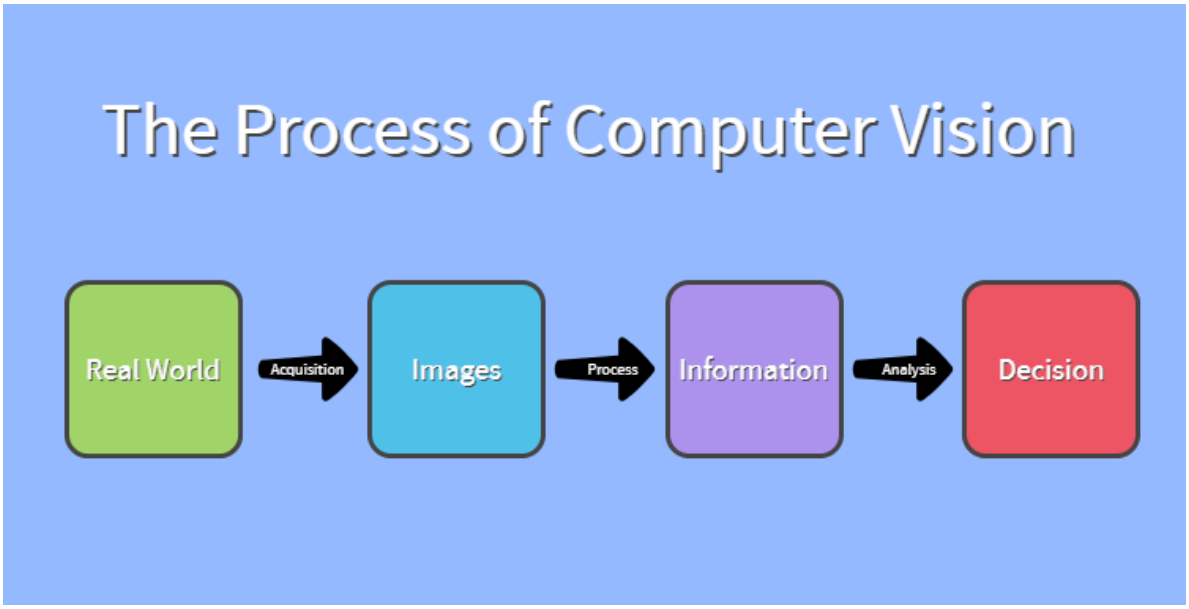
Have you ever heard the term Computer Vision often abbreviated as CV? In very simple terms CV is a field of study that enables the computers to "see". It is a subfield of AI and involves extraction of information from digital images like the videos and photographs, analysing, and understanding the content thereof. CV has been most effective in the following:

- Object detection
- Optical Character Recognition
- Fingerprint Recognition



Source: https://towardsdatascience.com/everything-you-ever-wanted-to-know-about-computer-vision-heres-a-look-why-it-s-so-awesome-e8a58dfb641e & https://nordicapis.com/8-biometrics-apis-at-your-fingertips/

How many of you have seen video surveillance cameras installed in schools, shopping malls or other public places? Do you know what it does? What is the purpose behind installing these cameras? I am sure your answer would be – safety and security.



Quick Question?

Q1: List out three of 3 places/locations (like library, playground etc.) in your school where surveillance cameras have been installed?

Q2: In your opinion, who does the actual surveillance – the camera or the person sitting behind the device? Justify your answer. and why?

Q3: What features you would like to add to the surveillance camera to make it true smart surveillance camera?

From the above exercise you must have understood that although cameras or any device similar to it, have the capability to capture a picture or a particular moment but it can't really analyse or make sense of that. The device (camera in this case) has a limited capacity to just capture the image of the objects but is not able to recognize them. Taking pictures is not same as seeing, recognising or understanding.

Watch Video 1 & 2 for which links have been given below and answer the related questions:

Video 1: https://www.youtube.com/watch?v=GN7RKRFtZiQ

Can you explain what you saw in this video?

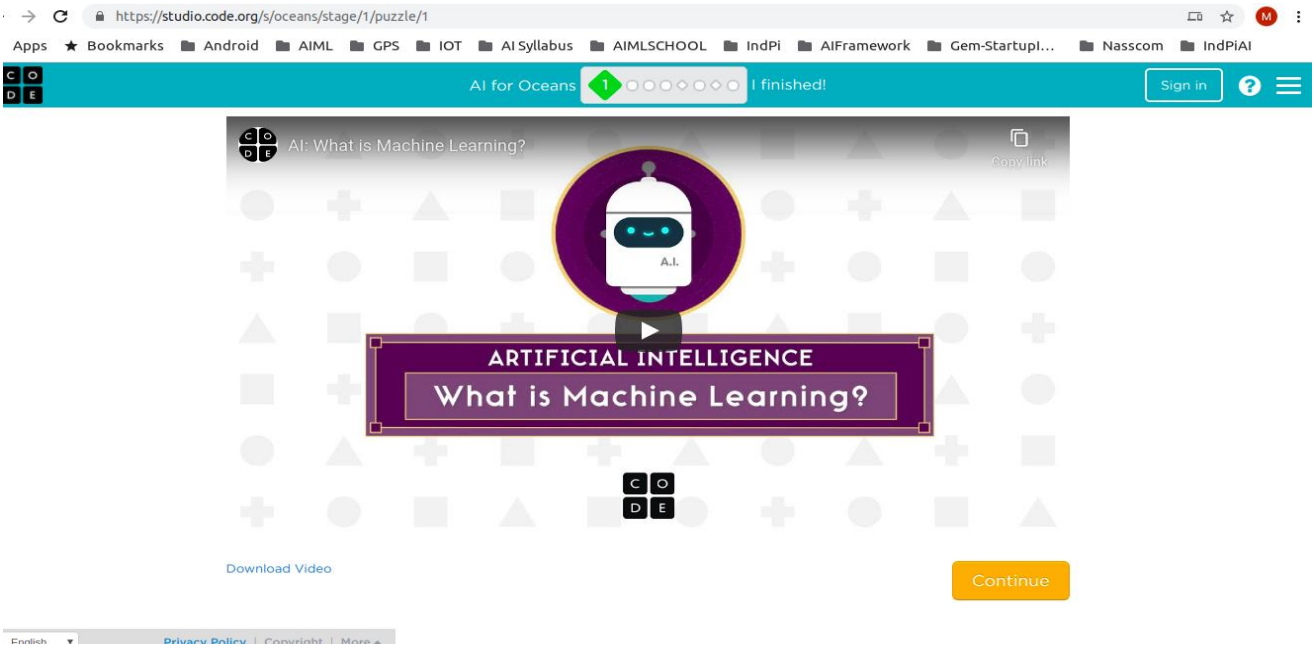
Video 2: https://www.youtube.com/watch?v=1_B44HO_PAI

After watching this video, do you still believe that a device (camera in this case) can only take pictures of objects but can't recognize them?

Before we dive deep into the interesting world of computer vision, let us perform an online activity:

Activity:

Open the URL in your web browser – https://studio.code.org/s/oceans/stage/1/puzzle/1



'AI for Ocean' by Code.org is designed to quickly introduce students to **machine learning**, a branch of **artificial intelligence and is based on the idea that machines can recognise patterns, make sense of data and make decisions with very little human involvement. Over the years machine learning and computer vision have come to work very closely. Machine learning has also improved the effectiveness of computer vision.** Students will explore how **training data** is used to enable a machine to see and classify the objects.

Activity Plan

There are 8 levels and you will be allowed not more than an hour to complete all the eight levels. And it is not mandatory for students to complete all eight levels to understand the concept of computer vision. Although it is recommended that students complete all eight levels).

Activity Outcome

Gaining a basic overview of AI and computer vision.

Activity details

Level 1:

The first level is talking about a branch of AI called Machine Learning (ML). This level is explaining about the example of ML in our daily life like email filters, voice recognition, auto-complete text and computer vision.

Level 2 – 4:

Students can proceed through the first four levels on their own or with a partner. In order to program AI, use the buttons to label an image as either "Fish" or "Not Fish". Each image and its label become part of the data which is used to train the Computer Vision Model. Once the AI model gets properly trained, it will classify an image as 'Fish' and 'Not Fish'. Fish will be allowed to live in the ocean but 'Not-Fish' will be grabbed and stored in the box, to be taken out of ocean/river later.

At the end of Level-4, we should explain to students how AI identifies objects using the training data, in this case fish is our training data. This ability of AI to see and identify an object is called 'Computer Vision'. Similar to the case of humans where they can see an object and recognise it, an AI application (using camera) can also see an object and recognise it.

Advance learners may go ahead with the level 5 and beyond.

Quick Question?

Based on the activity you just did, answer the following questions:

Q1: Can we say 'computer vision' acts as the eye of a machine / robot?
Q2: In the above activity, why did we have to supply many examples of fish before the AI model actually started recognizing the fish?
Q3: Can a regular camera see things?
Q4: Let me check your imagination – You have been tasked to design and develop a prototype of a robot to clean your nearby river/ ponds. Can you use your imagination and write 5 lines about features of this 'future' robot?

With the supporting materials provided in the section above, you must have developed a reasonably good understanding of Computer Vision. Let us reinforce the learning by quickly going over it again in brief.

Computer vision is a sub-set of Artificial Intelligence which enables the machines (robot/ any other device with camera) to see and understand the digital images – photographs or videos. Computer Vision has made it possible to make good use of the critical capabilities of AI by giving machines the power of vision. Computer vision enables machines/ robots to inspect objects and accomplish certain tasks making them useful for both homes and offices.

(Source: https://www.bitbrain.com/sites/default/files/styles/blog_1200x500/public/robot-maquina-inteligencia-artificial-con-emociones-sentimientos.png?itok=S_50rjPm)

1.3.1. Computer Vision: How does computer see an image

Consider the image below:

Looking at the picture, the human eye can easily tell that a train/engine has crashed through the statin wall (https://en.wikipedia.org/wiki/Montparnasse_derailment). Do you think the computer also views the image the same was as humans? No, the computer sees images as a matrix of 2-dimensional array (or three-dimensional array in case of a colour image).

0	3	2	5	4	7	6	9	8
3	0	1	2	3	4	5	6	7
2	1	0	3	2	5	4	7	6
5	2	3	0	1	2	3	4	5
4	3	2	1	0	3	2	5	4
7	4	5	2	3	0	1	2	3
6	5	4	3	2	1	0	3	2
9	6	7	4	5	2	3	0	1
8	7	6	5	4	3	2	1	0

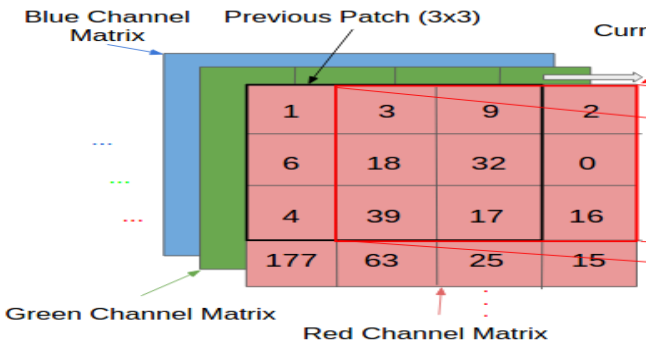
The above image is a grayscale image, which means each value in the 2D matrix represents the brightness of the pixels. The number in the matrix ranges between 0 to 255, wherein 0 represents black and 255 represents white and the values between them is a shade of grey.

For example, the above image has been represented by a 9x9 matrix. It shows 9 pixels horizontally and 9 pixels vertically, making it a total of 81 pixels (this is a very low pixel count for an image captured by a modern camera, just treat this as an example).

In the grayscale image, each pixel represents the brightness or darkness of the pixel, which means the grayscale image is composed of only one channel*. But colour image is the right mix of three primary colours (Red, Green and Blue), so a colour image will have three channels*.

Since colour images have three channels*, computers see the colour image as a matrix of a 3-dimensional array. If we have to represent the above locomotive image in colour, the 3D matrix will be 9x9x3. Each pixel in this colour image has three numbers (ranging from 0 to 255) associated with it. These numbers represent the intensity of red, green and blue colour in that particular pixel.

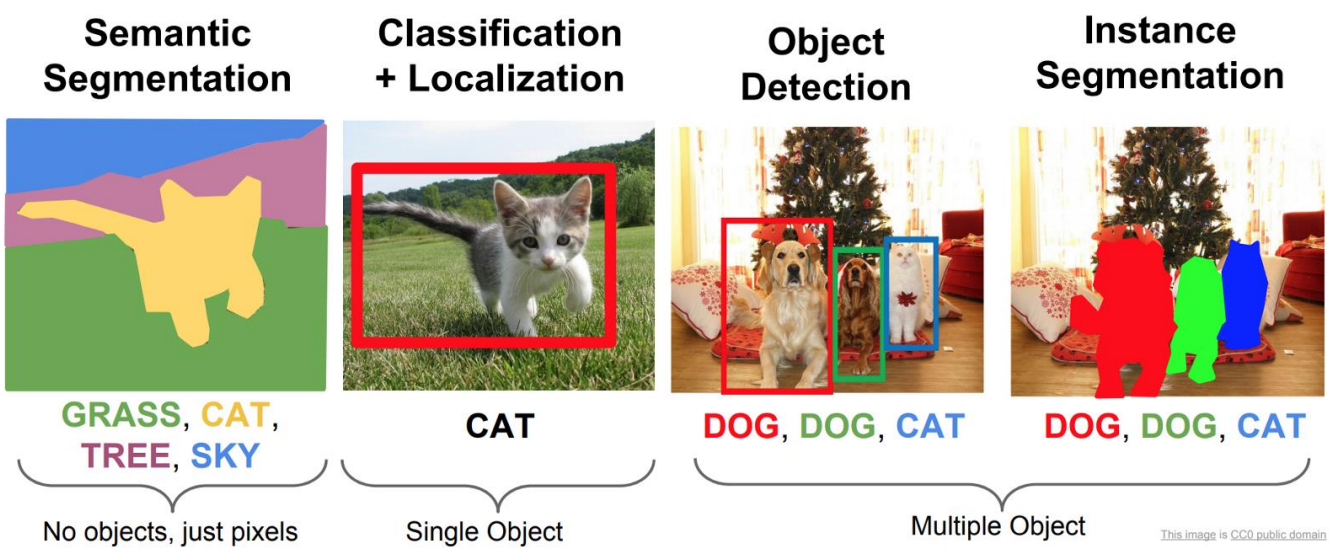
* Channel refers to the number of colours in the digital image. For example, a coloured image has 3 channels – the red channel, the green channel and the blue channel. Image is usually represented as height x width x channels, where channel is 3 for coloured image and channel is for 1 for grayscale image.



1.3.2. Computer Vision: Primary Tasks

There are primarily four tasks that Computer vision accomplishes:

1. Semantic Segmentation (Image Classification)
2. Classification + Localization
3. Object Detection
4. Instance Segmentation



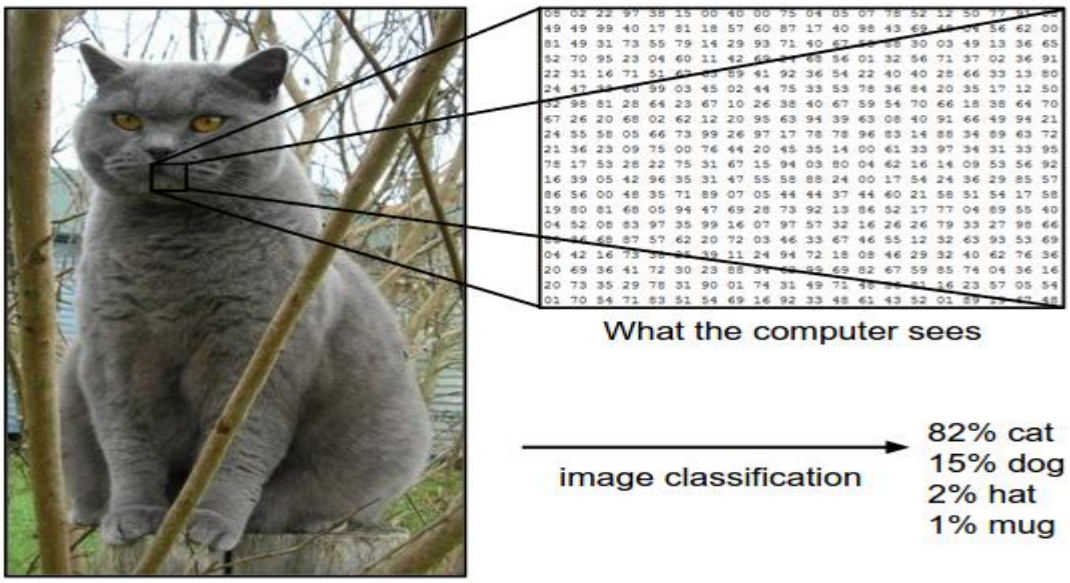
(Source : http://cs231n.stanford.edu/slides/2017/cs231n_2017_lecture11.pdf)

1. Semantic Segmentation

Semantic Segmentation is also called the Image classification. Semantic segmentation is a process in Computer Vision where an image is classified depending on its visual content. Basically, a set of classes (objects to identify in images) are defined and a model is trained to recognize them with the help of labelled example photos. In simple terms it takes an image as an input and outputs a class i.e. a cat, dog etc. or a probability of classes from which one has the highest chance of being correct.

For human, this ability comes naturally and effortlessly but for machines, it's a fairly complicated process.

For example, the cat image shown below is the size of 248x400x3 pixels (297,600 numbers)



(Source : http://cs231n.github.io/assets/classify.png)

Though image classification model takes this image as an input and reports 4 possibilities, we can see that it indicates the highest probability of a cat. Therefore, the classification model has to be refined /trained on further to produce a single label 'cat' as output.

2. Classification and Localization

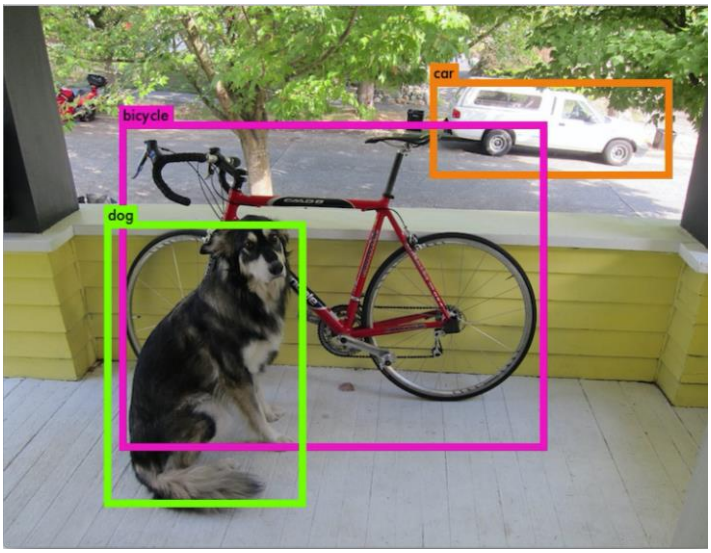
Once the object classified and labelled, the localization task is evoked which puts a bounding box around the object in the picture. The term 'localization' refers to where the object is in the image. Say we have a dog in an image, the algorithm predicts the class and creates a bounding box around the object in the image.

Image Localization

Source: https://medium.com/analytics-vidhya/image-classification-vs-object-detection-vs-image-segmentation-f36db85fe81

3. Object Detection

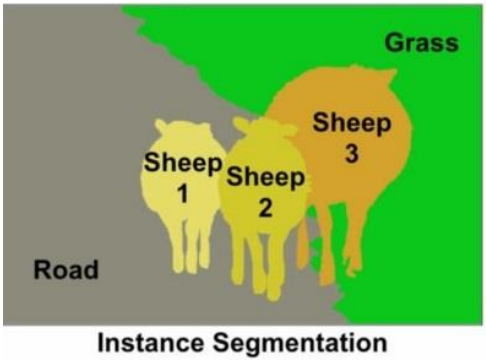
When human beings see a video or an image, they immediately identify the objects present in them. This intelligence can be duplicated using a computer. If we have multiple objects in the image, the algorithm will identify all of them and localise (put a bounding box around) each one of them. You will therefore, have multiple bounding boxes and labels around the objects.



Source: https://pjreddie.com/darknet/yolov1/

4. Instance segmentation

Instance segmentation is that technique of CV which helps in identifying and outlining distinctly each object of interest appearing in an image. This process helps to create a pixel-wise mask for each object in the image and provides us a far more granular understanding of the object(s) in the image. As you can see in the image below, objects belonging to the same class are shown in multiple colours.



Source: https://towardsdatascience.com/detection-and-segmentation-through-convnets-47aa42de27ea

Activity

Let's have some fun now!

Given a grayscale image, one simple way to find edges is to look at two neighbouring pixels and take the difference between their values. If it's big, this means the colours are very different, so it's an edge.

The grids below are filled with numbers that represent a grayscale image. See if you can detect edges the way a computer would do it.

Try it yourself!

Grid 1

If the values of two neighbouring squares on the grid differ by more than 50, draw a thick line between them.

21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
21	21	21	21	21	21	21	103	103	21	21	21	21	21	21	21
21	21	21	21	21	21	21	99	103	21	21	21	21	21	21	21
21	21	21	21	21	21	21	91	103	21	21	21	21	21	21	21
21	21	21	21	21	21	21	103	99	21	21	21	21	21	21	21
21	21	21	21	21	21	91	99	103	99	21	21	21	21	21	21
21	72	93	101	103	105	99	103	91	99	104	102	101	91	103	21
21	21	99	99	91	103	99	99	103	99	99	91	99	88	21	21
21	21	21	99	99	91	91	99	103	99	91	99	103	21	21	21
21	21	21	21	99	99	99	99	99	99	99	103	21	21	21	21
21	21	21	21	21	99	103	103	91	103	103	21	21	21	21	21
21	21	21	21	21	103	91	99	99	103	91	21	21	21	21	21
21	21	21	21	103	91	99	99	103	99	103	99	21	21	21	21
21	21	21	21	91	103	99	21	21	99	91	99	21	21	21	21
21	21	21	103	103	21	21	21	21	21	21	103	99	21	21	21
21	21	21	103	3	21	21	21	21	21	21	7	103	21	21	21

Grid 2

If the values of two neighbouring squares on the grid differ by more than 40, draw a thick line between them.

255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
255	80	80	255	255	255	255	255	255	255	255	255	255	80	80	255
255	90	90	80	255	255	255	255	255	255	255	255	80	85	85	255
255	90	90	80	255	255	255	255	255	255	255	80	80	85	85	255
255	90	90	90	80	255	255	255	255	255	255	80	85	85	80	255
255	90	90	90	80	255	255	255	255	255	80	80	85	85	80	255
255	90	90	90	80	80	20	80	80	20	80	80	85	85	90	255
255	255	90	90	80	80	20	80	80	20	80	80	85	85	255	255
255	255	90	90	80	80	85	80	80	85	80	80	85	90	255	255
255	80	90	20	20	20	90	85	85	90	20	20	20	80	90	255
255	80	80	62	0	62	90	85	85	90	62	0	62	85	90	255
255	90	85	62	0	62	62	85	85	80	62	0	62	85	90	255
255	90	85	85	62	85	85	85	85	80	85	62	85	85	90	255
255	255	85	85	90	90	10	10	10	10	85	85	85	85	90	255
255	255	85	85	85	85	10	40	40	10	85	85	85	85	255	255
255	255	85	85	85	85	85	10	10	85	85	85	85	85	255	255

1.4 Weather Prediction using AI

Story -1: *Fani, a rare summer cyclone in the Bay of Bengal, hit eastern India on May 03,2019. It is one of the strongest cyclones to have hit India in the last 20 years, according to the Indian government's meteorological department. Storm surges and powerful winds reaching 125 mph blew off roofs, damaged power lines, and uprooted countless trees.*
But the worst-affected state, Odisha, has been successful in keeping the loss of life and numbers of affected people to a minimum. This is the result of a very effective strategy of disaster preparation and effective weather forecasting.
(Source: https://qz.com/india/1618717/indias-handling-of-cyclone-fani-has-a-lesson-for-the-us/)

Story-2: *KOLKATA | NEW DELHI: Laxman Vishwanath Wadale, a 40-year-old farmer from Maharashtra's Jalna district, spent nearly Rs 25,000 on fertilisers and seeds for his 60-acre plot after the Indian Meteorological Department (IMD) said in June that it stands by its earlier prediction of normal monsoon.*

Today, like lakhs of farmers, Wadale helplessly stares at parched fields and is furious with the weather office that got it wrong - once again. So far, rainfall has been 22% below normal if you include the torrential rains in the northeast while Punjab and Haryana are being baked in one of the driest summers ever with rainfall 42% below normal.
(Source : https://economictimes.indiatimes.com/news/economy/agriculture/indian-meteorological-departments-high-failure-rate-prompts-states-to-set-up-their-own-systems/articleshow/15133072.cms)

Now watch this video: https://www.youtube.com/watch?v=fdErsR8_NaU

Can you imagine how weather forecasting impacts people's lives? Accurate weather forecasting allows farmers to better plan for harvesting. It allows airlines to fly their passengers with safety. Electricity departments can make decisions about their capacity needs during summer and winters. As we saw in story-1, it allows governments to better prepare their responses to natural disasters that impact the lives of millions.

Mini Research Project

Project 1: Make a report on the tools used for weather forecasting. Your report should not be more than a page long.

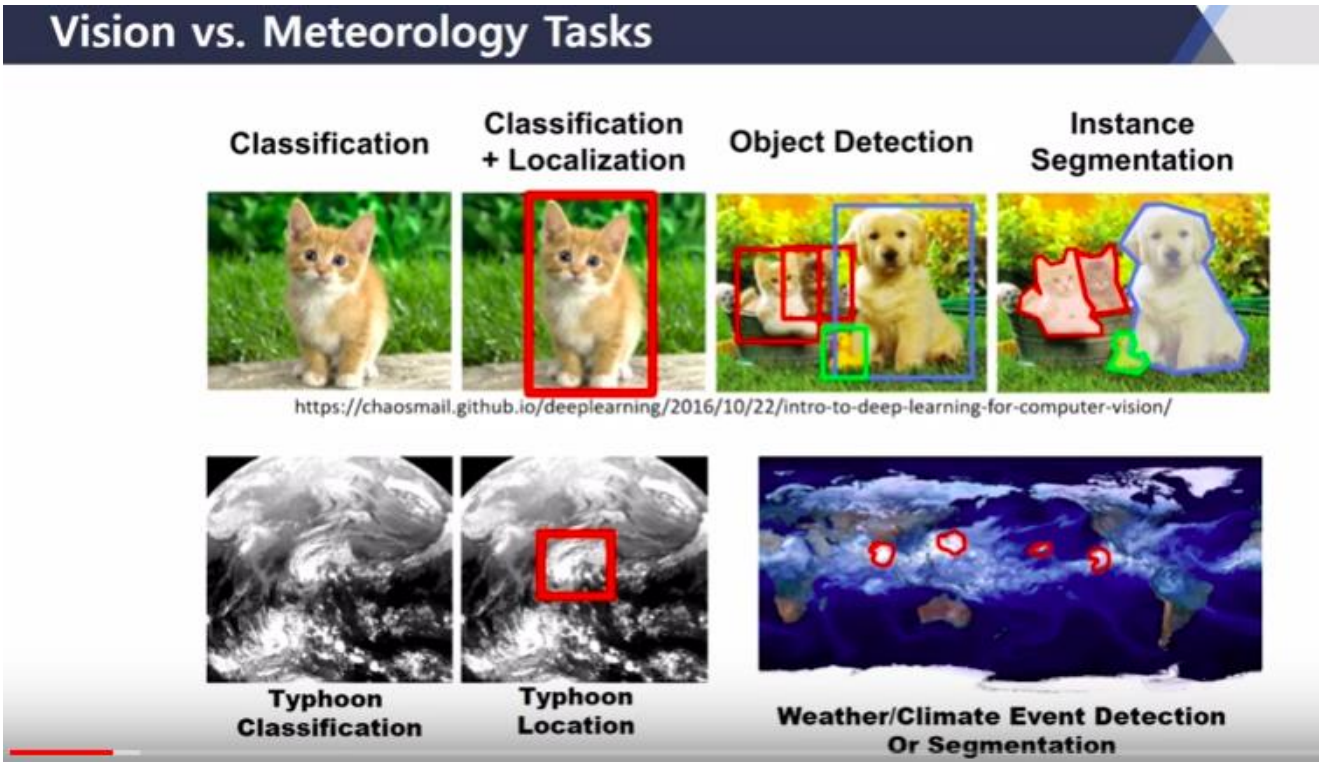
Project 2: What are the different types of weather forecasting techniques?

Weather forecasting deals with gathering the satellites data, identifying patterns in the observations made, and then computing the results to get accurate weather predictions. This is done in real-time to prevent disasters. Artificial Intelligence uses computer-generated mathematical programs and computer vision technology to identify patterns so that relevant weather predictions can be made. Scientists are now using AI for weather forecasting to obtain refined and accurate results, fast!

In the current model of weather forecasting, scientists gather satellite data i.e. temperature, wind, humidity etc. and compare and analyse this data against a mathematical model that is based on past weather patterns and geography of the region in question. This is done in real time to prevent disasters. This model being primarily human dependent (and the mathematical model cannot be adjusted real time) faces many challenges in forecasting.

On the other hand, Artificial Intelligence (AI) uses computer-generated mathematical programs and computer vision technology to identify patterns and make relevant weather predictions. This has resulted in scientists preferring AI for weather forecasting. One of the key advantages of the AI based model is that it adjusts itself with the dynamics of atmospheric changes.

The image below will help you to understand how companies are leveraging Computer vision in weather prediction.



Leading IT companies have been doing their intensive research by leveraging technologies like AI, IoT, and Big Data:

1. IBM Global High-resolution Atmospheric Forecasting System (IBM GRAF) is a high-precision global weather model that updates hourly to provide a clearer picture of weather activity around the globe

(https://www.ibm.com/weather)

2. Panasonic has been working on its weather forecasting model for years. The company makes TAMDAR, a speciality weather sensor installed on commercial airplanes.

1.5. Price forecast for commodities

What is commodity? Commodities are the natural resources and agriculture products that come from the earth. Some examples of these goods are wheat, cattle, soybeans, corn, oranges, various metals, coal, cotton, oil etc.

Question: Is Mobile phone or TV, a commodity?
Answer: No

In commodity market, production is normally local but consumption is global. Therefore, price forecast is beneficial for farmers, policymakers or for industries. Commodities like agricultural products are prone to weather risk, demand and price risk than any other products and because of such vulnerabilities, small farmers often do distress sales. Farmers are in distress under both the situation of crops failures and bumper productions. A reliable price forecast tool will allow producer to make informed decision to manage their price.

There are reliable forecasting techniques (mathematical and statistical models) which are currently being used but they all work at macro level i.e. national or state level. Switching the forecasting technique from classical methods (mathematical) to machine learning model would attract multiple benefits, like machine learning can predict at the micro level i.e. individual market/mandi.

The AI based commodity forecasting system can produce transformative results, such as:

1. The accuracy level would be much higher than the classical forecasting model
2. AI can work on broad range of data and due to which it can reveal new insights
3. AI model is not rigid like classical model therefore its forecasting is always based on the most recent input.

1.6. Self-Driving car

Wikipedia defines the self-driving car as, " A self-driving car, also known as an autonomous vehicle (AV), driverless car, robot car, or robotic car is a vehicle that is capable of sensing its environment and moving safely with little or no human input."

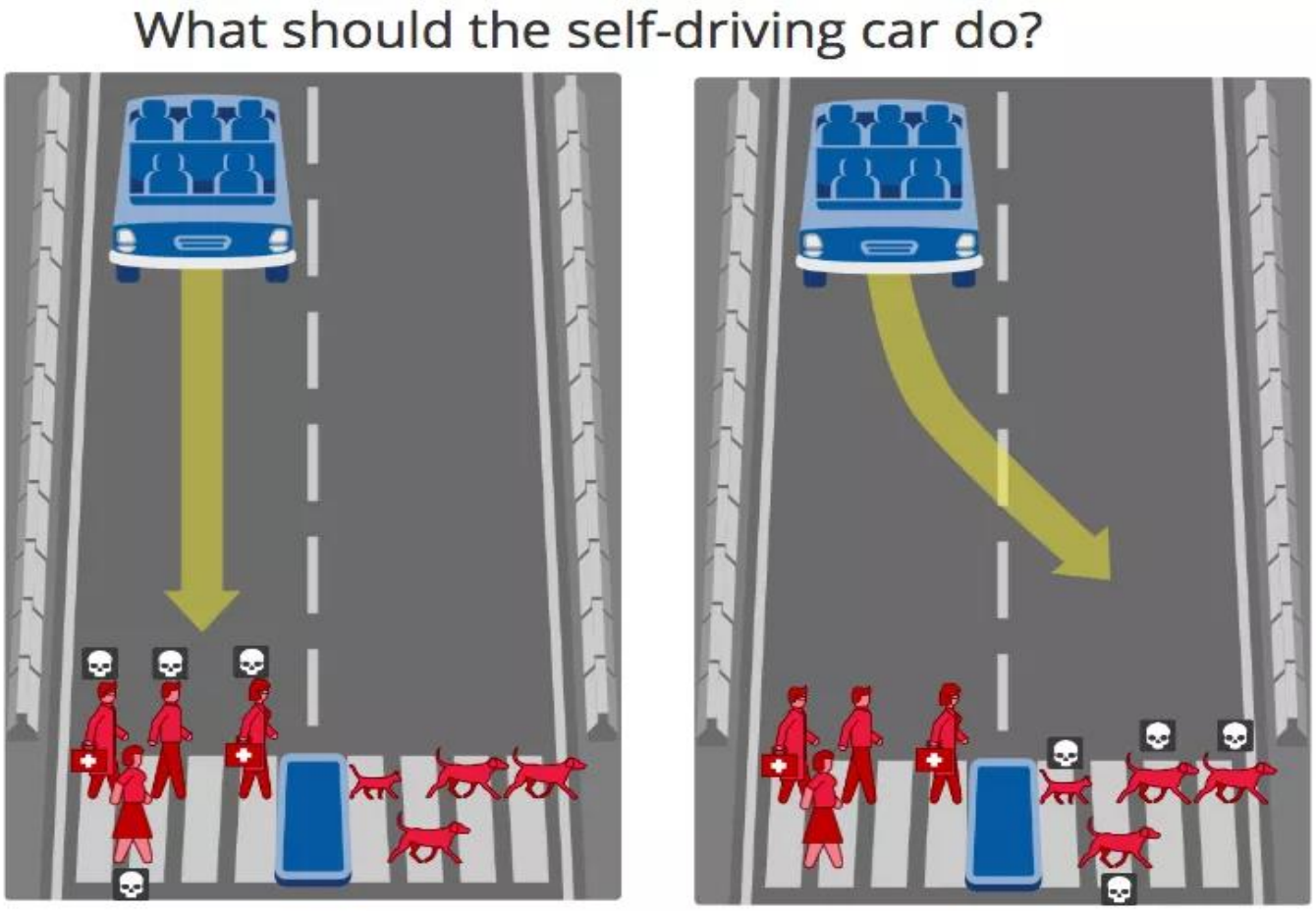
Self-driving cars combine a variety of sensors to perceive their surroundings, such as radar, lidar, sonar, GPS, odometry and inertial measurement units.

Watch These Videos:

Video 1: Google's Waymo - https://www.youtube.com/watch?v=B8R148hFxPw

Video 2: Tesla's self-parking - https://www.youtube.com/watch?v=0kRArbNfOGA

Having watched the above videos, take a look at the image below and try answering the questions that follow.



Question 1: What should the self-driving car do in the above scenario?

_____

Question 2: In the age of self-driving cars, do we need zebra crossings? After all, self-driving cars can potentially make it safe to cross a road anywhere.

_____

Having attempted the activities let us now understand how self-driving cars work?

Self-driving cars or autonomous cars, work on a combination of technologies. Here is a brief introduction to them:

1. **Computer Vision**: Computer vision allows the car to see / sense the surrounding. Basically, it uses:

    - 'Camera' that captures the picture of its surrounding which then goes to a deep learning model to processing the image. This helps the car to know when the light is red or where there is a zebra crossing etc.

    - 'Radar' – It is a detection system to find out the how far or close the other vehicles on the road are

    - 'Lidar' – It is a surveillance method with which the distance to a target is measured. The lidar (Lidar emits laser rays) is usually placed in a spinning wheel on top of the car so that they can spin around very fast, looking at the environment around them. Here you can see a Lidar placed on top of the Google car

2. **Deep Learning:** This is the brain of the car which takes driving decisions on the information gathered through various sources like computer visions etc.

    - **Robotics:** The self-driven cars have a brain and vision but still its brain needs to connect with other parts of the car to control and navigate effectively. Robotics helps transmit the driving decisions (by deep learning) to steering, breaks, throttle etc.
    - **Navigation:** Using GPS, stored maps etc. the car navigates busy roads and hurdles to reach its destination.

2. Characteristics and Types of AI

- Artificial Intelligence is **autonomous** and can make independent decisions — it does not require human inputs, interference or intervention and works silently in the background without the user's knowledge. These systems do not depend on human programming, instead they learn on their own through data experiencing.
- Has the capacity to **predict and adapt** – Its ability to understand data patterns is being used for future predictions and decision-making.
- It is **continuously learning** – It learns from data patterns.
- AI is **reactive** – It perceives a problem and acts on perception.
- AI is **futuristic** – Its cutting-edge technology is expected to be used in many more fields in future.

There are many applications and tools, being backed by AI, which has a direct impact on our daily life. So, it is important for us to understand what kind of systems can be developed, in a broad sense, using AI.

2.1. Data Driven AI

The recent development in cheap data storage (hard disk etc.), fast processors (CPU, GPU or TPU) and sophisticated deep learning algorithm has made it possible to extract huge value from data and that has led to the rise of data centric AI systems. Such AI systems can predict what will happen next based on what they've experienced so far, very efficiently. At times these systems have managed to outperform humans. Data driven AI systems, get trained with large datasets, before it makes predictions, forecasts or decisions. However, the success of such systems depends largely on the availability of correctly labelled large datasets.
Every AI system we know around, are data driven AI system.

2.2. Autonomous System

Autonomous system is a technology which understands the environment and reacts without human intervention. The autonomous systems are often based on Artificial intelligence. For example, self-driving car, space probe rover like Mars rover or a floor cleaning robot etc. are autonomous system. An IoT device like a smart home system is another example of an autonomous system. Because it does things like gather information about the temperature of a room, then uses that information to determine whether the AC needs to be switched on or not, then executes a task to achieve the desired result.

2.3. Recommendation systems

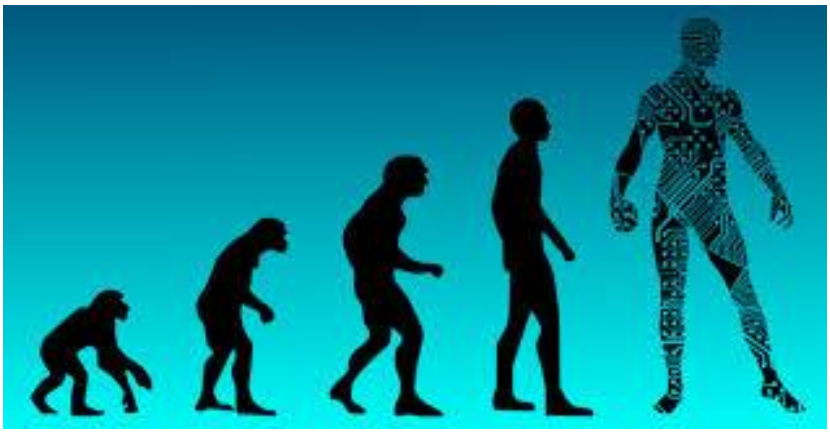
A recommendation system recommends or suggests products, services, information to users based on analysis of data based on a number of factors such as the history, behaviour, preference, and interest of the user, etc. It is a data driven AI which needs data for training. For instance, when you watch a video on YouTube, it suggests many videos that match or suit the videos that you generally search for, prefer, or have been watching in the past. So, in short it gathers data from the history of your activities and behaviour. Let us now take another example. Flipkart recommends the types of products that you normally prefer or buy. All these are classic examples of recommendation, but you must know that Machine Learning (AI) is working behind all this to give you a good user experience.

Activity

You have to design a recommendation system for your school library. What kind of information or data would you would like to collect, that would help you train your recommendation system? Mention 2 such data.

[Hint: The type of books [science fiction, thriller etc.) students borrow, their comments etc.]

2.4. Human Like



(Source:https://cdn0.tnwcdn.com/wp-content/blogs.dir/1/files/2017/11/Screen-Shot-2017-11-24-at-13.17.49-796x399.png)

Activity

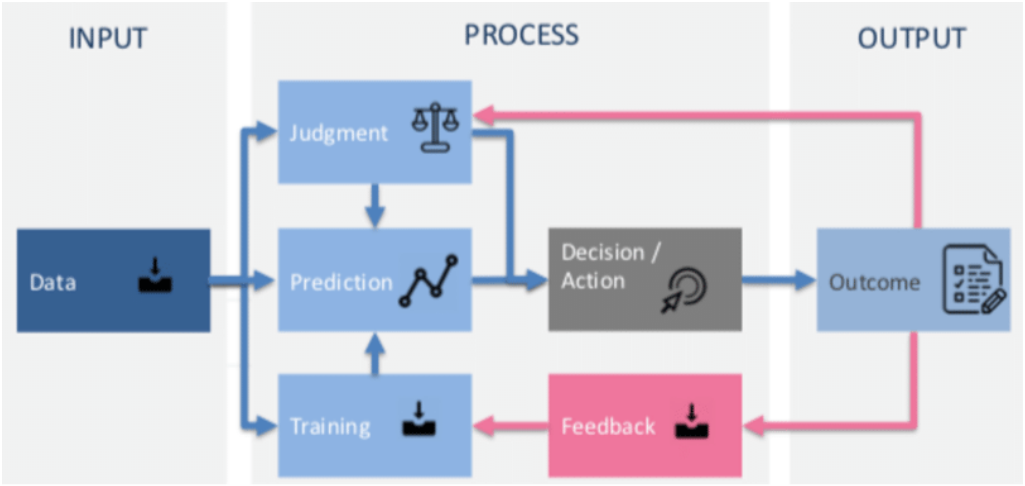
Does this picture remind you of something? Can you please share your thoughts about this image in the context of AI?

The dream of making machines that think and act like humans, is not new. We have long tried to create intelligent machines to ease our work. These machines perform at greater speed, have higher operational ability and accuracy, and are also more capable of undertaking highly tedious and monotonous jobs compared to humans.

Humans do not always depend on pre-fed data as required for AI. Human memory, its computing power, and the human body as an entity may seem insignificant compared to the machine's hardware and software infrastructure. But, the depth and layers present in our brains are far more complex and sophisticated, and which the machines still cannot beat at sin the near future.

These days, the AI machines we see, are not true AI. These machines are super good in delivering a specific type of jobs.

Think of Jarvis in “Iron Man” and you’ll get a sneak peek of Artificial General Intelligence (AGI) and that is nothing but human-like AI. Although we still have a long way to go in attaining human-like AI.



Source: https://www.researchgate.net/figure/AI-and-human-non-automated-decision-Source-Koeszegi-2019-referring-to-Agrawal_fig2_333720228

3. Cognitive Computing (Perception, Learning, Reasoning)

1.This is a platform based on Artificial Intelligence and Signal processing.	**2. The platform (Cognitive computing) uses Machine Learning, Reasoning, Natural Language Processing (NLP) and Computer Vision to compute results.**
3.Cognitive computing improves human decision making	**4.Cognitive computing tries to mimic the human brain**
Examples of cognitive computing software: IBM Watson, Deep mind, Microsoft Cognitive service etc.	

In summary, Cognitive Computing can be defined as a technology platform that is built on AI and signal processing, to mimic the functioning of a human brain (speech, vision, reasoning etc.) and help humans in decision making.

(For additional reference please see: https://www.coursera.org/lecture/introduction-to-ai/cognitive-computing-perception-learning-reasoning-UBtrp)

Now that we have understood what Cognitive Computing is, let us explore the need for the same.

Enormous amounts of unstructured data and information (Facebook pages, twitter posts, WhatsApp data, sensors data, traffic data, traffic signals data, medical reports so on) are available to us in this digital age., We need an advanced technology (traditional computing cannot process this amount of data) to make sense of the data in order to help humans to take better decisions. Because Cognitive Computing generates new knowledge using existing knowledge, it is viewed as platform holding the potential of future computing.

3.1. Applications of Cognitive Computing

In mainstream usage, Cognitive Computing is used to aid humans in their decision-making process. Some examples of Cognitive Computing and its applications include the treatment of disease/' illness by supporting medical doctors. For example, 'The IBM Watson for Oncology' has been used at the 'Memorial Sloan Kettering Cancer Centre' to provide oncologists with evidence-based treatment alternatives for patients having cancer. When medical staff pose questions, Watson generates a list of hypotheses and offers treatment possibilities for doctors.

Watch this video : https://www.coursera.org/lecture/introduction-to-ai/cognitive-computing-perception-learning-reasoning-UBtrp

4. AI and Society

AI is sure changing the world but at the same time there is also a lot of hype and misconceptions about it. In order for citizens, businesses and the government to take full advantages of AI, it is imperative that we have realistic view about the same.

AI will impact almost every walk of society, from health, security, culture, education, jobs and businesses. And as with any change/development, AI also has positive and negative influence on society and this depends on how we leverage the same.

Some of the key social benefits of AI are outlined below:

1. Healthcare

IBM Watson (An AI Tool by IBM) can predict development of a particular form of cancer up to 12 months before its onset with almost a 90% accuracy.
(https://www.beckershospitalreview.com/artificial-intelligence/ibm-ai-predicts-breast-cancer-up-to-a-year-in-advance-using-health-records-mammograms.html)

There are many such developments happening in the field of medical science. To control the outbreak of CORONA virus in China, the country leaned on Artificial Intelligence (AI), Data Science, to track cases and fight the pandemic. Our healthcare sectors are moving towards a future where Robots and AI tools will work alongside doctors.
Though scientists and researchers are working hard to find out the opportunities to apply AI technology in almost all sectors like transportation, education, agriculture etc. But healthcare has been the focal points for AI. Can you please try to find out the two reasons why impact of AI is maximum in healthcare sector?

2. Transportation

Transportation is a field where artificial intelligence along with machine learning has given us major innovations.

Autonomous vehicles like cars, trucks etc. use advanced AI capabilities that offer features like lane-changing systems, automated vehicle guidance, automated braking, use of sensors and cameras for collision avoidance, and analysing information in real time, thus saving human lives by reducing road accidents.

3. Disaster Prediction

AI is considered as one of the best tools for prediction of natural occurrences. There is an AI model that can almost perfectly predict the weather for the next couple of days, which was unimaginable before the advent of AI.

4. Agriculture

Farming is a sector faced is full of multiple challenges such like unpredictable as unpredictable weather, availability of natural resources, growing populations etc. With the help of AI, farmers can now analyse a variety of factors things in real time such as weather conditions, temperature, water usage or soil conditions collected from their farm. Real-time data analytics helps farmers to maximize their crop yields and thus, in turn, their profits too.

Having discussed the advantages of AI, it is important to also understand how AI is negatively affecting our society. With all the AI benefits, there comes some significant disadvantages as well, but that's natural for any technology!

Listed below are some of the challenges posed by AI

1. Integrity of AI

AI systems learn by analysing huge volumes of data. What are the consequences of using biased data (via the training data set)) in favour of a particular class/section of customers or users?

In 2016, the professional networking site LinkedIn was discovered to have a gender bias in its system. When a search was made for the female name 'Andrea', the platform would show recommendations/results of male users with the name 'Andrew' and its variations. However, the site did not show similar recommendations/results for male names. i.e. A search/query for the name 'Andrew' did not result in a prompt asking the users if he/she meant to find 'Andrea'. The company said this was due to a gender bias in their training data which they fixed later.

2. Technological Unemployment

Due to heavy automation, (with the advent of AI and robotics) some sets of people will lose their jobs. These jobs will be replaced by intelligent machines. There will be significant changes in the workforce and the market — there will be creation of some high skilled jobs however some roles and jobs will become obsolete.

3. Disproportionate control over data

Data is the fuel to AI; the more data you have, the more intelligent machine you would be able to develop. Technology giants are investing heavily in AI and data acquisition projects. This gives them an unfair advantage over their smaller competitors.

4. Privacy

In this digitally connected world, privacy will become next to impossible. Numerous consumer products, from smart home appliances to computer applications have features that makes them vulnerable to data exploitation by AI. AI can be utilized to identify, track and monitor individuals across multiple devices, whether they are at work, home, or at a public location. To complicate things further, AI does not forget anything. Once AI knows you, it knows you forever!

5. Non-technical Explanation of Deep Learning

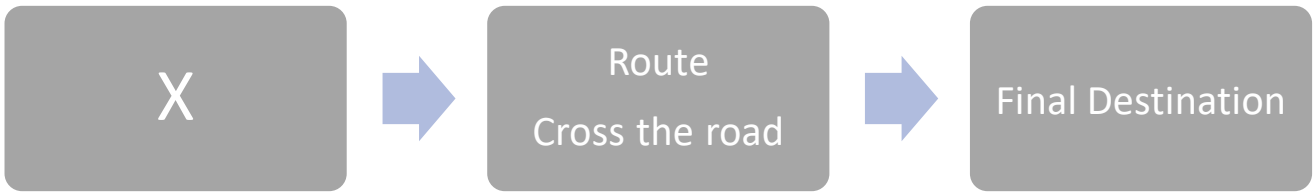
Watch this video: https://www.coursera.org/learn/ai-for-everyone

The excitement behind artificial intelligence and deep learning is at its peak. At the same time there is growing perception that these terms are meant for techies to understand, which is a misconception.

Here is a brief overview of deep learning in simple non-technical terms!

Imagine the below scenario.

A courier delivery person (X) has to deliver a box to a destination, which is right across the road from the courier company. In order to carry out the task, X will pick up the box, cross the road and deliver the same to the concerned person.

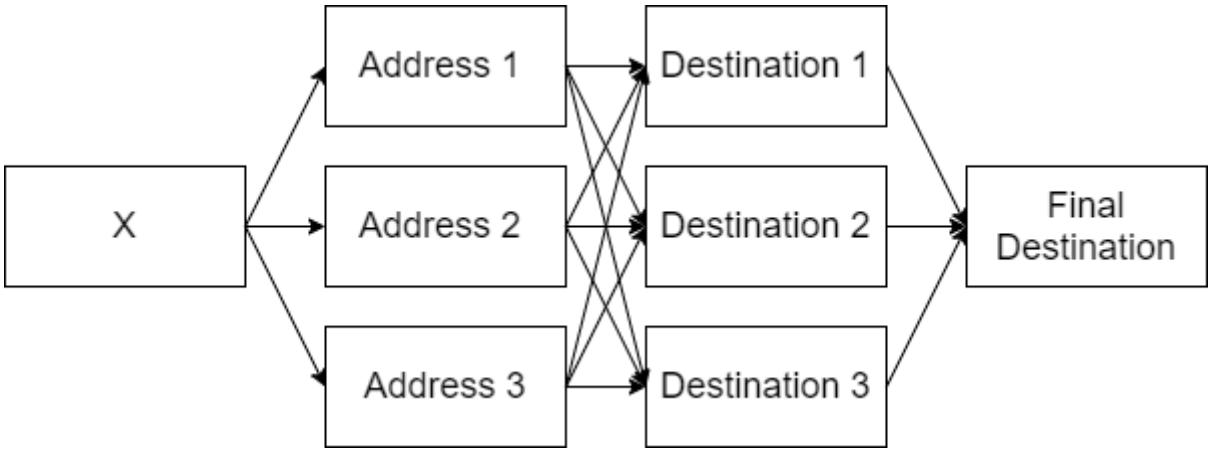


In neural network terminology, the activity of 'crossing the road' is termed as neuron. So, input 'X' goes into a single neuron which is 'Crossing the road' to produce the output/goal which in this case is the 'Final Destination'. In this example the starting and the ending are connected with a straight line. This is an example of a simple neural network.

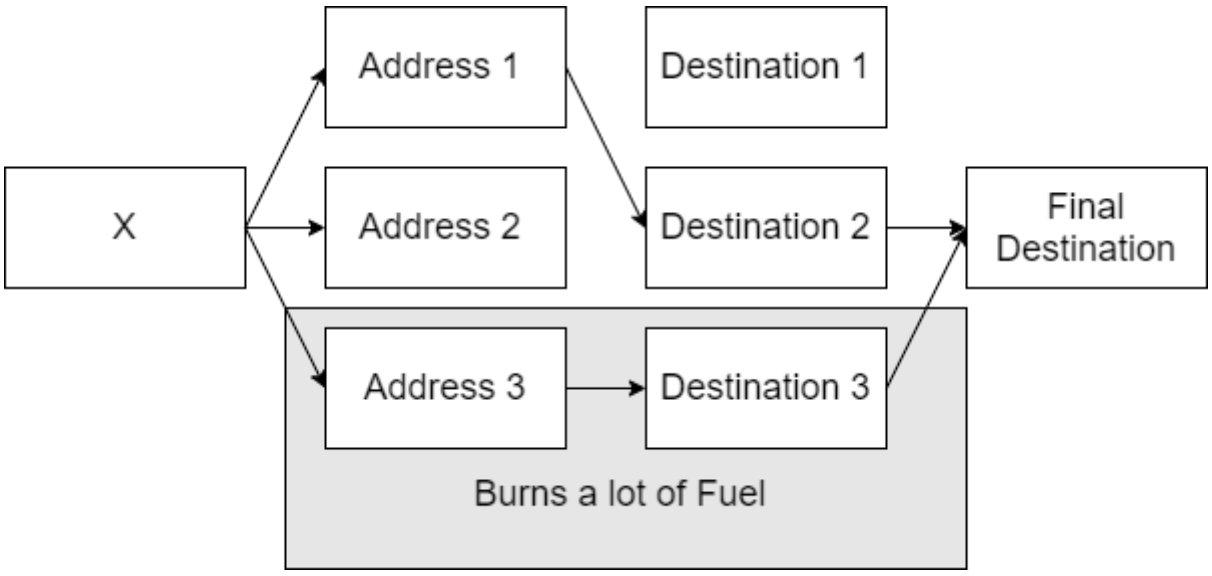
The life of delivery man is not so simple and straightforward in reality. They start from a particular location in the city, and go to different locations across the city. For instance, as shown below, the delivery man could choose multiple paths to fulfil his/her deliveries as shown in the image below:

1. **Option 1:** 'Address 1' to 'Destination 1'and then to the Final Destination'.
2. **Option 2:** 'Address 1' to 'Destination 2' and then to the 'Final Destination'
3. **Option 3: '**Address 3' to 'Destination 3' and then the 'Final Destination'.

All of the above (and more combinations) are valid paths that take the delivery man from 'start' to 'finish'.



However, some routes (or "paths") are better than the rest. Let us assume that all paths take the same time, but some are really bumpy while some are smooth. Maybe the path chosen in 'Option3' is bumpy and the delivery man has to burn a (loss) lot more fuel on the way! Whereas, choosing 'Option 2' is perfectly smooth, so the deliveryman does not lose anything!

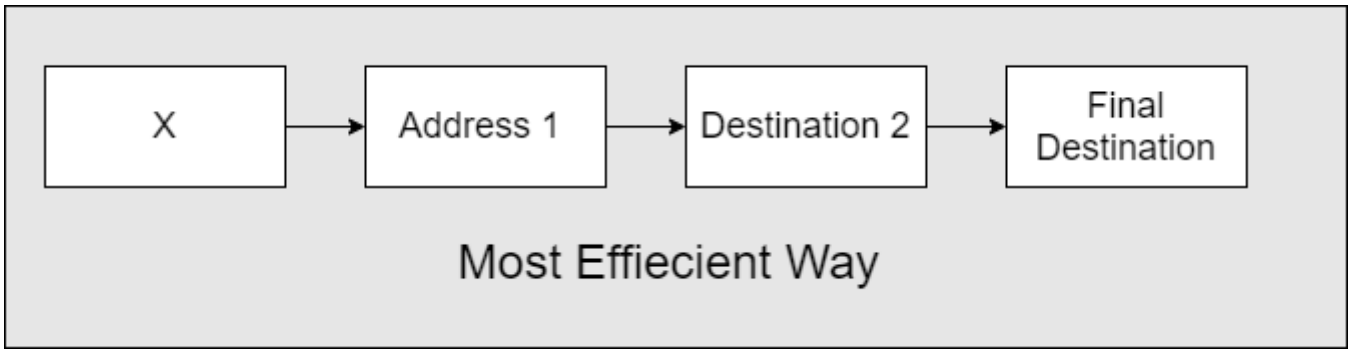


In this case, the deliveryman would definitely prefer 'Option 2' (Address 1 – Destination 2 – Final Destination) as he/she will not want to burn extra fuel! So, the goal of **Deep Learning** then, is to assign 'weights' to each path from address to destination so that delivery man will find the most optimum path.

How does this work?

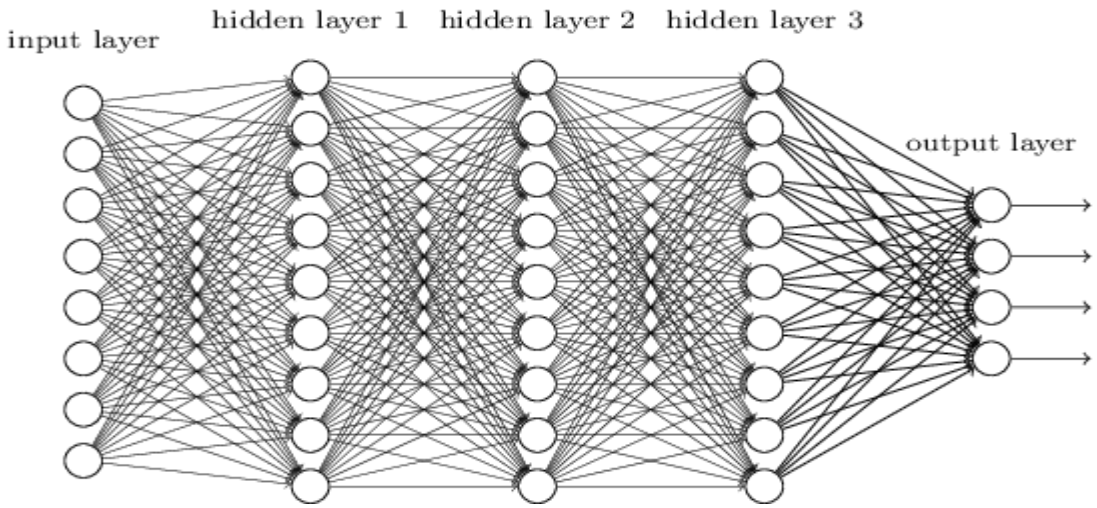
As we discussed, the goal of the deep learning exercise is to assign weights to each path from start to finish (start – address – destination – Final Destination). To do this for the example discussed above, each time a delivery man goes from start to finish, the fuel consumption for every path is computed. Based on this parameter (in reality the number of parameters can go up to 100 or more), cost for each path is calculated and this cost is called the 'Loss Function' in deep learning.

As we saw above in our example, 'Option 3' (Address 3 -- Destination 3 –Final Destination) lost a lot of fuel, so that path had a large loss function. However, 'Option 2' (Address 1 – Destination 2 – Final Destination) cost the deliveryman least fuel cost, thereby having a small loss function as well– thereby making it the most efficient route!



The above picture is a representation of a neural network of the most efficient path to be taken by the deliveryman to reach the goal i.e. to go from starting point 'X' to 'Final Destination' using the best possible route (which is most fuel efficient). This is a very small neural network consisting of 3 neurons and 2 layers (address and destination).

In reality neural networks are not as simple as the above discussed example. They may look like the one shown below!



(Source - http://www.rsipvision.com/exploring-deep-learning/)

The term 'deep' in Deep Learning refers to the various layers you will find in a neural network. This closely relates to how our brains work. The neural network shown above, is a network of 3 layers (hidden layer1, hidden layer 2 and hidden layer 3) with each layer having 9 neurons each.

Let us have a quick quiz now!

Question 1: The size of an image is represented as 600 x 300 x 3. What would be the type of the image?

a) Jpeg Image

b) Grayscale image

c) Colour Image

d) Large image

Question 2: Which of the following have people traditionally done better than computers?

a) Recognizing relative importance

b) Detecting Emotions

c) Resolving Ambiguity

d) All of the above

Question 3: You have been asked to design an AI application which will prepare the 'minutes of the meeting'. Which part of AI will you use to develop your solution -

a) Computer Vision

b) Python Programming

c) Chatbot

d) Natural Language Processing (NLP)

Supervised Machine Learning Activity

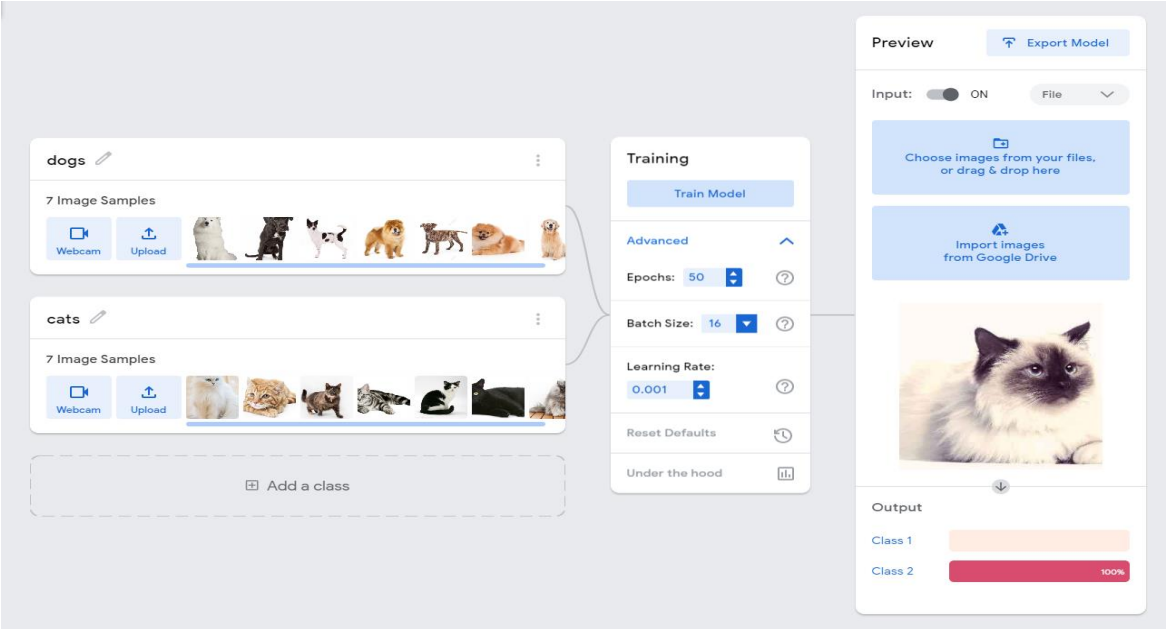
Activity 1

Activity Description

1. In this exercise, you will learn about the three components of an artificial intelligence (AI) system
2. You will then learn about the role of training data in an AI system

Instructions for Teachers/Students

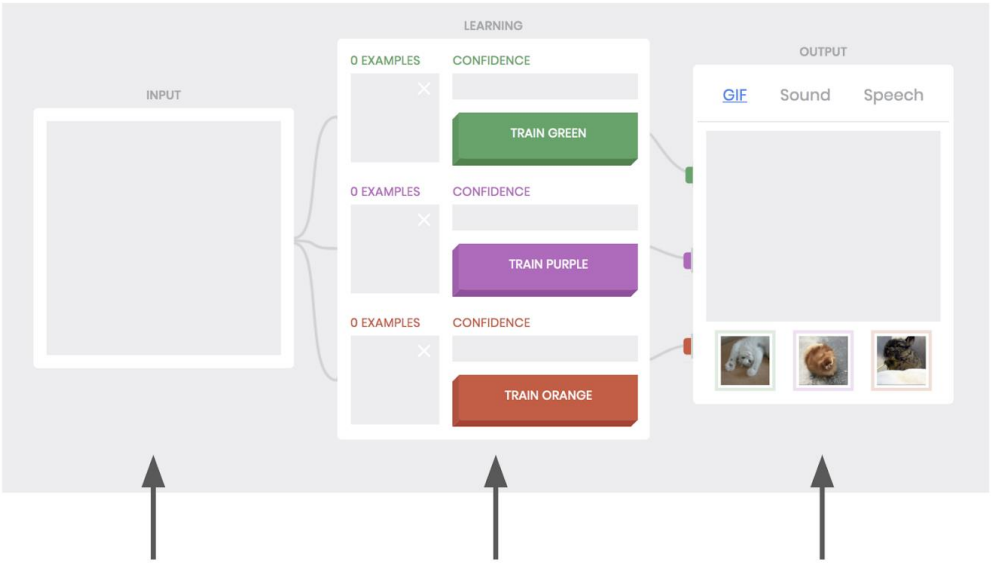
1. Go to: https://teachablemachine.withgoogle.com/
2. Click on 'Get started'
3. Click on 'Image Project'
4. Rename Class 1 to "Dogs" and Class 2 to "Cats"
5. Click on 'Upload' in Class 1/Dogs and select 'Choose images from your files or, drag and drop here' and then upload all the dog images from the dataset from here
6. Repeat the same steps for Class 2/Cats
7. Then click on train model
8. Test your model with a sample image downloaded from the web



Activity 2

Click on https://teachablemachine.withgoogle.com/v1/

1. Identify the three parts of an AI system in the teachable machine – Input, Learning, Output
2. Follow the tutorial



Hit refresh. This time click “skip the tutorial.” Train the same classifier with your face and hands. What happens when:

1. You only train one class?

2.What happens when you increase the number of images in your dataset? Make sure both classes have at least ten images.

3. If you’ve mainly been training with one hand up, try using the other hand. What happens when your test dataset is different from your training dataset?

Image Datasets

Three different datasets include:

Dataset	Description
Initial Training Dataset	These are the images students should use to "teach" their machine learning model which image is a cat and which image is a dog. Note that there are many more cats and that the cats are more diverse in appearance than the dogs. This means that the classifier will more accurately classify cats than dogs.
Test Dataset	These are the images that students should use to test their classifier after training. Students should show these images to their model and record if their classifier predicts if the image is of a dog or a cat. Note: Students should not use these images to teach their classifier. If an image is used to train a classifier, the machine will have already recorded the corresponding label for the particular image. Showing this image to the machine during the testing phase will not measure how well the model generalizes.
Recurating dataset	This is a large assortment of images students can use to make their training dataset of cats and dogs larger and more diverse.

The test dataset should be used twice, once for testing students' initial classifier and again for testing their recurated dataset.

Unit 3: Mathematics for AI

Title: Maths For AI	**Approach: Interactive/ Discussion, Problem Solving through examples**
Summary: Artificial Intelligence (AI) and Machine Learning (ML) are built on mathematics like Calculus, Linear Algebra, Probability, Statistics, Algorithms and Complex Optimizations. This unit aims to help students learn the foundation concepts of mathematics which will be utilized in AI and ML.	
Objectives: 1. Learners to appreciate the role of mathematics in Artificial Intelligence and Machine learning 2. Students to get to know the application side of mathematics and to have a basic level of understanding of the mathematical models. 3. Help students learn about the different ways data can be represented and summarized graphically.	
Learning Outcomes: 1. By the end of this unit, students are expected to have foundation level understanding of Linear Algebra, Statistics, various kinds of graphs to visualize data and set theory. 2. Students should be in a position to relate real world problems with these mathematical concepts. 3. Students should be curious enough to explore deeper concepts of the application aspects of mathematics.	
Pre-requisites: Knowledge of Grade X Mathematics	
Key Concepts: Matrices, Statistics, Set theory, Data representations	

1. Introduction to Matrices

We all know that computer understands only numbers (binary / hexadecimal etc.) then how do you think they (computer/mobile phones / digital camera etc.) store the image?

Let us capture the image of a pet dog using the mobile camera

But for your mobile, the above image is like a grid as written below:

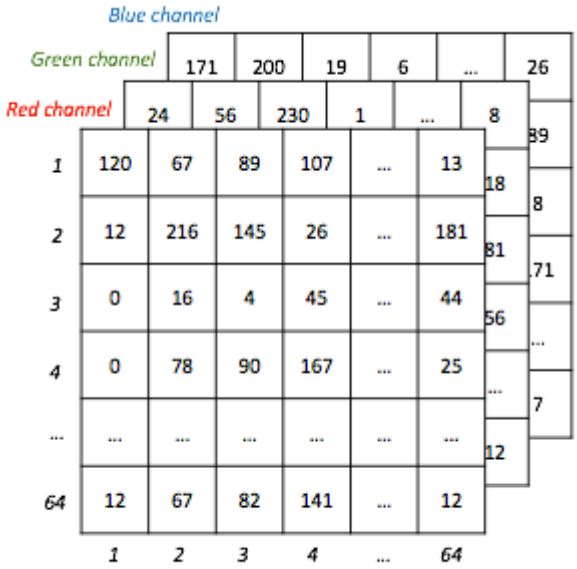


Image array: [64 x 64 x 3]

The grid above is a matrix – which is what we are going to learn about now!

Matrix (or linear algebra) is also called the mathematics of data. It is arguably the pillar of the study of Artificial Intelligence and therefore this topic is advised as a prerequisite prior to getting started with the study of Artificial Intelligence.

Terminology related to Matrices

1. **Order of matrix** – If a matrix has 3 rows and 4 columns, order of the matrix is 3*4 i.e. row*column
2. **Square matrix** – The matrix in which the number of rows is equal to the number of columns
3. **Diagonal matrix** – A matrix in which all the non-diagonal elements equal to 0 is called a diagonal matrix
4. **Upper triangular matrix** – Square matrix where all the elements below the diagonal is equal to 0
5. **Lower triangular matrix** – Square matrix where all the elements above the diagonal equal to 0
6. **Scalar matrix** – Square matrix where all the diagonal elements equal to some constant k
7. **Identity matrix** – Square matrix where all the diagonal elements equal to 1 and all the non-diagonal elements equal to 0
8. **Column matrix** – The matrix which consists of only 1 column. Sometimes, it is used to represent a vector.
9. **Row matrix** – A matrix consisting only of row.
10. **Trace** – It is the sum of all the diagonal elements of a square matrix.

The followings topics will be dealt with under Matrix:

1.1. Types of Matrix

1.2. Matrix Operations

1.3. Vector and Vector Arithmetic

1.4. Matrices and Matrix Arithmetic

1.1 Matrix

How do you define a Matrix?

When we represent a set of numbers in the form of 'M' horizontal line (called rows) and 'N' vertical line (called columns), this arrangement is called m x n (m by n) matrix.

If A = | 1 2 3 |
| 4 5 6 |
| 7 8 9 |

The top row is row 1. The leftmost column is column 1. This matrix is a 3x3 matrix because it has three rows and three columns. In describing matrices, the format is:

rows X columns

Each number that makes up a matrix is called an **element** of the matrix. The elements in a matrix have specific locations.

The upper left corner of the matrix is [row 1 x column 1]. In the above matrix the element at row 1 column 1 is the value 1. The element at [row 2 x column 3] is the value 6.

Quick Question

Question 1: What is the location of value 8?

Question 2: What is the value at location row 3 x column 2?

Activity 1

Can you try to represent the following sum in matrix format:

Mohan purchased 3 Math books, 2 Physics books and 3 Chemistry books. Sohan purchased 8 Math books, 7 Physics books and 4 Chemistry books.

Activity 2

What do you see when you look at the above image? A colorful pattern - easy guess!
Can you think of how to represent it so that computer also can understand this or process this?
I know you are too young to solve this, all I want to know is your approach.

If you thought that matrix representation is the solution, you got it right!

NOTE: You were able to identify the pattern because the human brain has gone through million years of evolution. We have somehow trained our brains to automatically perform this task but making a computer do the same task is not an easy. But before we work on identifying attributes in an image, let us understand - How does a machine stores this image?

You know that computers are designed to process only numbers. So how can an image such as the above with multiple attributes like color, height, width be stored in a computer? This is achieved by storing the pixel intensities in a construct called **Matrix.** Then, this matrix can be processed to identify colors etc.

So any operation which you want to perform on this image would likely use matrices at the back end.

1.1. Types of Matrix

1. **Row Matrix**: Matrix with only one row.

   A = [1 3 -5]

2. **Column Matrix**: Matrix with only one column.

   $$A = \begin{bmatrix} 1 \\ 3 \\ -5 \end{bmatrix}$$

3. **Square Matrix**: A matrix in which number of rows are equal to number of columns.

   A = | 1 2 3 |
   | 4 5 6 |
   | 7 8 9 |

   Rows = 3 and Column = 3, so this is square matrix.

4. **Diagonal Matrix**: A matrix with all elements zero except its leading diagonal.

   A = | 2 0 0 |
   | 0 3 0 |
   | 0 0 4 |

5. **Scalar Matrix**: A matrix in which all the diagonal elements are equal and all other elements are zero.

   A = | 5 0 0 |
       | 0 5 0 |
       | 0 0 5 |

   And if all diagonal element is unity (1) and all other non-diagonal element is equal to zero, this matrix is called Unit matrix.

   A = | 1 0 0 |
       | 0 1 0 |
       | 0 0 1 |

1.2. Matrix Operations

Following are the 3 types of operations, that we perform frequently on matrices

1. Transpose

Transpose of a matrix creates a new matrix with number of rows and columns flipped

This is denoted by the superscript T next to the matrix A^T.

C = AT.

A = | 1 2 |

| 3 4 |

| 5 6 |

A^T = | 1 3 5 |

| 2 4 6 |

Inverse

For matrices, there is no such thing as division. You can add, subtract or multiply but you can't divide them. There is a related concept, which is called "inversion".

Matrix inversion is a process that finds another matrix that when multiplied with the matrix, results in an identity matrix. Given a matrix A, find matrix B, such that

AB = I^n or BA = I^n

AB = BA = I^n

Calculating inverse of matrix is slightly complicated, so let us use Inverse matrix calculator

- https://matrix.reshish.com/inverCalculation.php

2. Determinant

Every square matrix can be expressed using a number which is known as it determinant.

If A = [a_{if}] is a square matrix of order n, then determinant of A is denoted by det A or $|A|$.

To find the value assigned to determinant we can expand it along any row or column.

Explanation: let us take a 2 x 2 matrix -

$$A = \begin{vmatrix} a & b \\ c & d \end{vmatrix}$$

The determinant is: $|A| = ad - bc$

Example 1

If $A = \begin{vmatrix} 2 & 4 \\ 3 & 8 \end{vmatrix}$

$|A| = 2 \times 8 - 4 \times 3$

$= 16 - 12$

$= 4$

Example 2: $A = \begin{vmatrix} 6 & 1 & 1 \\ 4 & -2 & 5 \\ 2 & 8 & 7 \end{vmatrix}$

$|A| = 6\times(-2\times7 - 5\times8) - 1\times(4\times7 - 5\times2) + 1\times(4\times8 - (-2\times2))$

$= 6\times(-54) - 1\times(18) + 1\times(36)$

$= -306$

Similarly, we can expand matrix to calculate its determinant.

There are 2 more matrices operations i.e. Trace and Rank, which students are advised to explore themselves.

1.3. Vector and Vector Arithmetic

Vectors are foundation of linear algebra. Vectors are used throughout the field of machine learning in the description of algorithms and processes such as the target variable (y) when training an algorithm.

In this section we will be covering 3 important topics related to Vectors.

What is Vector?

The two-dimensional array-expression enclosed in brackets is a matrix while the one-dimensional array expression in brackets are column vectors or simply vectors.

We begin by defining a vector, a set of n numbers which we shall write in the form

$$x = \begin{bmatrix} x1 \\ x2 \\ x3 \\ . \\ . \\ xn \end{bmatrix}$$

This object is called a column vector. Vectors are often represented using a lowercase character such as “v”; for example: v = (V1, V2, V3) Where v1, v2, v3 are scalar values, often real values.

For instance, in the popular machine learning example of housing price prediction, we might have features (table columns) including a house's year of construction, number of bedrooms, area (m^2), and size of garage (auto capacity). This would give input vectors such as

$$\begin{bmatrix} xn \end{bmatrix} = [\ 1988 \quad 4 \quad 200 \quad 2]$$
$$[\ 2001 \quad 3 \quad 220 \quad 1]$$

1.3.1. Vector Arithmetic

1. Vector Addition

Vectors of equal length can be added to create a new vector

$$x = y + z$$

The new vector has the same length as the other two.

$$X = (y_1 + z_1, y_2 + z_2, y_3 + z_3)$$

2. Vector Subtraction

Vector of unequal length can be subtracted from another vector of equal length to create a new third vector.

$$x = x - y$$

As with addition, the new vector has the same length as the parent vectors and each element of the new vector is calculated as the subtraction of the elements at the same indices.

$$X = (y_1 - z_1, y_2 - z_2, y_3 - z_3)$$

3.Vector Multiplication

If we perform a scaler multiplication, there is only one type operation – multiply the scaler with a scaler and obtain a scaler result,

$$a \times b = c$$

But vector has a different story, there are two different kinds of multiplication - the one in which the result of the product is scaler and the other where the result of product is vector (there is third one also which gives tensor result, but out of scope for now)

To begin, let's represent vectors as column vectors. We'll define the vectors A and B as the column vectors

$$A = \begin{vmatrix} Ax \\ Ay \\ Az \end{vmatrix} \qquad B = \begin{vmatrix} Box \\ By \\ Bz \end{vmatrix}$$

We'll now see how the two types of vector multiplication are defined in terms of these column vectors and the rules of matrix arithmetic -

Physical quantities are of two types:

Scaler: Which has only magnitude, no direction.

Vector: Which has both in it – magnitude and direction.

This is the first type of vector multiplication, called dot product, written as A.B. The vector dot product, multiplication of one vector by another, gives scaler result.

[Where do we use it in AI – This operation is used in machine learning to calculate weight. Please refer "weight" in the Unit 2: Deep Learning]

If i = unit vector along the direction of x -axis

j = unit vector along the direction of y -axis

k = unit vector along the direction of z -axis

Vector Dot Product

If there are 2 vectors, vector $a = a_1i + a_2j + a_3k$

And vector $b = b_1i + b_2j + b_3k$

Their dot product $a.b = a_1b_1 + a_2b_2 + a_3b_3$

And their cross product,

$$a \times b = \begin{vmatrix} i & j & k \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$$

$$= [(a_2b_3 - a_3b_2)\, i - (a_1b_3 - a_3b_1)\, j - (a_1b_2 - a_2b_1)\, k]$$

Example 1

Calculate the dot product of a= (1,2,3) and b= (4, −5,6).

Using the formula for the dot product of three-dimensional vectors,

$a.\, b = a_1b_1 + a_2b_2 + a_3b_3$,

we calculate the dot product to be

$a \cdot b = 1(4) + 2(-5) + 3(6) = 4 - 10 + 18 = 12$.

Practice Sum -1: Calculate the dot product of **c** = (−4, −9) and d = (−1,2).

1.4. Matrix and Matrix Arithmetic

Matrices are a foundational elements of linear algebra. Matrices are used in machine learning to processes the input data variable when training a model.

1.4.1. Addition of matrices

A and B are two matrices of order m x n (means it has m rows and n columns), then their sum A+B is a matrices of order m x n, is obtained by adding corresponding elements of A and B.

$$A = \begin{vmatrix} 12 & 1 \\ 3 & -5 \end{vmatrix} \qquad B = \begin{vmatrix} 8 & 9 \\ -1 & 4 \end{vmatrix}$$

$$A + B = \begin{vmatrix} 12+8 & 1+9 \\ 3+(-1) & -5+4 \end{vmatrix} = \begin{vmatrix} 20 & 10 \\ 2 & -1 \end{vmatrix}$$

1.4.2. Multiplication of a matrix by a scalar

Let $A = [a_{if}]$ be an m x n matrix and K be any number called a scalar. Then matrix obtained by multiplying scalar K is denote by K A

If $A = \begin{vmatrix} 12 & 1 \\ 3 & -5 \end{vmatrix}$ and $K = 2$

Then $KA = = \begin{vmatrix} 24 & 2 \\ 6 & -10 \end{vmatrix}$

1.4.3. Multiplication of Matrices

Two matrices with the same size can be multiplied together, and this is often called element-wise matrix multiplication

Two matrices A and B can be multiplied (for the product AB) if the number of columns in A (Pre- multiplier) is same as the number of rows in B (Post multiplier).

If $A = [a_{if}]_{mxn}$, $B = [b_{if}]_{nxp}$

Pre multiplier Post multiplier

Then $AB = [c_{if}]_{mxp}$

$$A = \begin{vmatrix} 2 & -3 & 4 \\ 3 & 6 & -1 \end{vmatrix} \quad \text{and} \quad B = \begin{vmatrix} 2 & 5 \\ -1 & 0 \\ 4 & -2 \end{vmatrix}$$

A is 2 x 3 matrix while B is 3 x 2 matrix, No of row of B = No of column of A
They are meet the condition for matrix multiplication.

Now we use to multiply them A and B matrix as

(first row of A) X First column of B

(first Row of A) X second column of B

(second row of A) X (first column of B)

(second row of A) X (second column of B)

For example

AB = | (2x2) + (-3 x -1) + (4 x 4) (2x5) + (-3 x 0) + (4x -2) |
| (3 x 2) + (6 x -1) + (- 1 x 4) (3 x 5) + (6 x 0) + (-1 x -2) |

= | 4+3+16 10+0-8 |
| 6 -6 -4 15 + 0 +2 |

= | 23 2 |
| - 4 17|

Tinker your brain – Real world Math!

Activity 1:

Three people denoted by P1, P2, P3 intend to buy some rolls, buns, cakes and bread. Each of them needs these commodities in different amounts and can buy them in two shops S1, S2. Which shop is the best for each person P1, P2, P3 to pay as little as possible? The individual prices and desired quantities of the commodities are given in the following tables:

Demanded Quantity

	roll	bun	cake	bread
P1	6	5	3	1
P2	3	6	2	2
P3	3	4	3	1

Prices in shops S1 and S2

	S1	S2
roll	1.5	1.00
bun	2.00	2.50
cake	5.00	4.5
Bread	16.00	17.00

Let us solve this matrices way:

These calculations can be written using a product of two matrices

$$P = \begin{vmatrix} 6 & 5 & 3 & 1 \\ 3 & 6 & 2 & 2 \\ 3 & 4 & 3 & 1 \end{vmatrix}$$ (The demand matrix)

and

$$Q = \begin{vmatrix} 1.50 & 1 \\ 2 & 2.50 \\ 5 & 4.50 \\ 16 & 17 \end{vmatrix}$$ (The Price matrix)

For example, the first row of the matrix

$$R = PQ = \begin{vmatrix} 50 & 49 \\ 58.50 & 61 \\ 43.50 & 43.50 \end{vmatrix}$$

expresses the amount spent by the person P1 in the shop S1 (the element r11) and in the shop S2 (the element r12). Hence, it is optimal for the person P1 to buy in the shop S2, for the person P2 in S1 and the person P3 will pay the same price in S1 as in S2.

Activity 2

Share Market Portfolios

A has INR 1000 worth stock of Apple, INR 1000 worth of Google and INR 1000 worth of Microsoft.
B has INR 500 of Apple, INR 2000 of Google and INR 500 of Microsoft.
Suppose a news broke and Apple jumps 20%, Google drops 5%, and Microsoft stays the same.
What is the updated portfolio of A and B and net profit /loss from the event?

The original stock price matrices look like,

apple	1 0 0
google	0 1 0
Microsoft	0 0 1
profit (+/-)	0 0 0

After news broke, updated stock price, |apple | | 1.2 0 0 |
google		0 .95 0
Microsoft		0 0 1
profit (+/-)		+.20 -.05 0

Now let's feed in the portfolios for A (INR 1000, 1000, 1000) and B (INR 500, 2000, 500). We can crunch the numbers by hand.
Input Interpretation -

1.2 0 0		1000 500
0. 95 0	*	1000 2000
0 0 1		1000 500
.2 -.5 0

Results - | 1200 600 |
| 950 1900 |
| 1000 500 |
| 50 0 |

The key is understanding why we're setting up the matrix like this, not blindly crunching numbers. This is the algorithm which plays behind any electronic spreadsheet (i.e. MS EXCEL) when you do what if **analysis.**

2. Set Theory: Introduction to Data Table Joins

Many a times, you might have heard your teachers saying mathematics is the foundation of Computer Science and you must have started thinking – how? Did this question ever cross your mind?

In this module, we will try to explain the confluence of Set theory, which is a branch of mathematics, and relational database (RDBMS), which is the part of the computer science. A lot of things are going to come together today, because we are going to learn how set theory principles are helping in data retrievals from database, which in turn is going to be used by AI model for its training. The important topics which we are going to cover in this strand are as below:

2.1. Context setting – Set theory and Relational Algebra

2.2. Set Operations

2.3. Data Tables Join (SQL Joins)

2.4. Practice Questions

2.1 Context Setting: Set Theory and Relational Algebra

Before we get into the actual relation between Set and Database of sets, we first need to understand what do these terms refer to.

A **Set** is an unordered collection of objects, known as elements or members of the set. An element 'a' belongs to a set A can be written as 'a ∈ A', 'a ∉ A' denotes that a is not an element of the set A. So set is a mathematical concept and the way we relate sets to other sets, is called set theory.

Set of even numbers: {..., -4, -2, 0, 2, 4, ...}
Set of odd numbers: {..., -3, -1, 1, 3, ...}
Set of prime numbers: {2, 3, 5, 7, 11, 13, 17, ...}
Set of names of grade X students: {'A', 'X', 'B', 'H', ...}

We use database (like Oracle, MS SQL server, MySql etc.) to store digital data. Database is made up of several components, of which table is the most important. Database stores the data in the table. Without tables, there would not be must significance of the DBMS.

For example, student database and its 2 tables

Students Table

Student	ID*
John Smith	084
Jane Bloggs	100
John Smith	182
Mark Antony	219

Activities Table

ID*	Activity*	Cost
084	Swimming	$17
084	Tennis	$36
100	Squash	$40
100	Swimming	$17
182	Tennis	$36
219	Golf	$47
219	Swimming	$15
219	Squash	$40

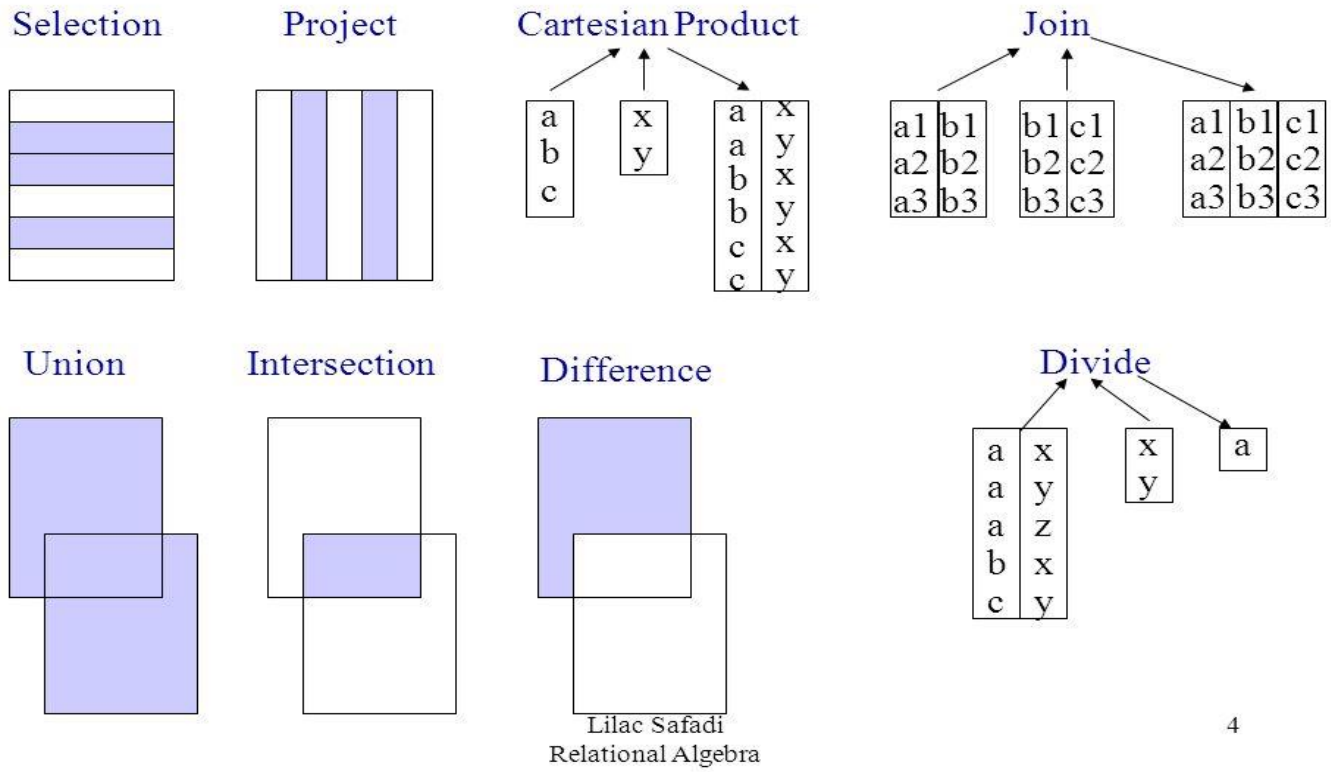
Please see the records in the 'Activity Table', does this information make any meaning - No? But if you combine the information from the 2 tables - 'Students Table' and 'Activities Table', you get a meaning information.

For example, student John Smith, participated in swimming and he must have paid $17.

The data in the table of database are of limited values unless the data from different tables are combined and manipulated to generate useful information. And from here, the role of relational algebra begins.

Relational algebraic is a set of algebraic operators and rules that manipulates the relational tables to yield desired information. Relational algebra takes relation (table) as their operands and returns relation (table) as their results. Relational algebra consists of eight operators:

SELECT, PROJECT, JOIN, INTERSECT, UNION, DIFFERENCE, PRODUCT, AND DIVIDE.



(Image Source : https://images.slideplayer.com/42/11342631/slides/slide_4.jpg)

Here are the simplifies definitions of these eight operators:

1. **SELECT** also known as RESTRICT, yields values for all the rows found in a table that satisfy a given condition. SELECT yields a horizontal subset of a table as shown in the above diagram.

2. **PROJECT** yields all values for selected attributes. PROJECT yields a vertical subset of a table. Please refer the above picture.

3. **PRODUCT** yields all possible pairs of rows from two tables- also known as Cartesian product. Therefore, if one table has three rows and the other table has two, the PRODUCT yields a list composed of 3 x 2= 6 rows as shown in the picture.

4. **JOIN** allows the combination of two or more tables based on common attributes. Please refer the above picture.

5. **UNION** returns a table containing all records that appear in either or both of the specified tables as shown in the diagram.

6. **INTERSECTION** returns only those rows that appears in both tables, see the diagram above.

7. **DIFFERENCE** returns all rows in one table that are not found in the other table, that is, it subtracts one table from the other, a shown in the diagram above.

8. **DIVIDE** is typically required when you want to find out entities that are interacting with **all entities** of a set of different type entities.

Say for example, if want to find out a person who has account in all the bank of a city?

The division operator is used when we have to evaluate queries which contain the keyword 'all'. **Division is not supported by SQL directly. However, it can be represented using other operations (like cross join, Except, In)**

2.2. Set Operations

When two or more sets combined together to form another set under the mathematical principles of sets, the process of combining of sets is called set operations.

To keep the process simple, let us assume two small sets:

A = {2 ,3 ,4} and B = {3,4,5}

Keeping these two sets as our example, let us perform four important set operations:

i) Union of Sets (U)

Union of the sets A and B is the set, whose element are distinct element of set A or Set B or both.

A U B = {2, 3, 4, 5}

ii) Interpretation of Sets

Intersection of set A and set B is the set of elements belongs to both A and B.

A∩B = {3, 4}

iii) Complement of the Sets

Complement of a set A is the set of all elements except A, which means all elements except A.

A^C

= {5}

iv) Set Difference

Difference between sets is denoted by 'A – B', is the set containing elements of set A but not in B. i.e. all elements of A except the element of B.

A – B = {2}

v) Cartesian Product

Remember the term used when plotting a graph, like axes (x-axis, y-axis). For example, (2, 3) depicts that the value on the x-plane (axis) is 2 and that for y is 3 which is not the same as (3, 2).

The way of representation is fixed that the value of the x- coordinate will come first and then that for y (ordered way). Cartesian product means the product of the elements say x and y in an ordered way.

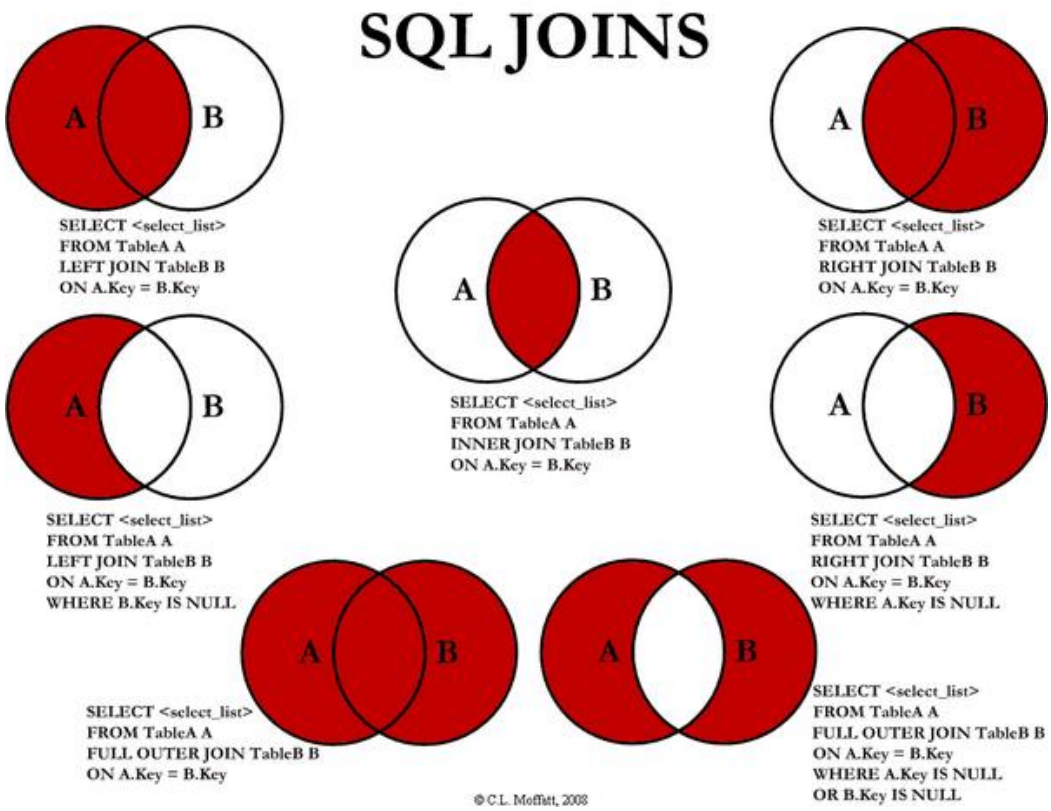
A and B are two non-empty sets, then the Cartesian product of two sets, A and set B is the set of all ordered pairs (a, b) such that a ∈A and b∈B which is denoted as A × B.

A x B = {(2,3) ;(2,4) ;(2,5) ;(3,3) ;(3,4) ;(3,5) ;(4,3) ;(4,4) ;(4,5)}

2.3. Data Tables Join (SQL Joins)

You may have understood by now that relational databases are based almost entirely upon set theory. In fact, if you've ever worked with or SQL queried a database you're probably familiar with the idea of finding records from a database tables. Finding records from a database tables is nothing but some form of set operations.

Look at the diagram below, all possible table join operations have been summarized here for your quick reference:



(http://stackoverflow.com/questions/406294/left-join-vs-left-outer-join-in-sql-server)

In a database, information is stored in various tables. In order to retrieve a meaningful information about an entity, all concerned tables need to be joined.

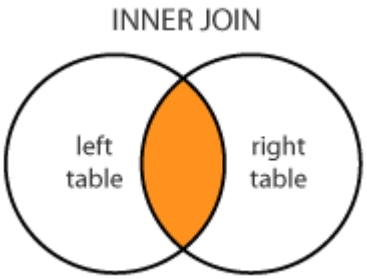
What do we mean in fact by joining tables? Joining tables is essentially a Cartesian product followed by a selection criterion (did you notice, set theory operation. JOIN operation also allows joining variously related records from different relations (tables).

Different types of JOINs

(All INNER and OUTER keywords are optional)

1. **(INNER) JOIN**

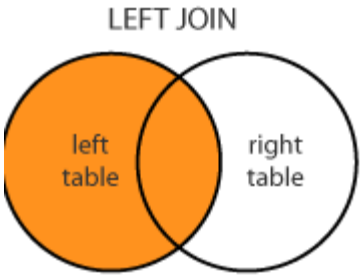
   Select records that have matching values in both tables.



   In an inner join, only those tuples that satisfy the matching criteria are included, while the rest are excluded. Let's study various types of Inner Joins.

2. **LEFT (OUTER) JOIN**

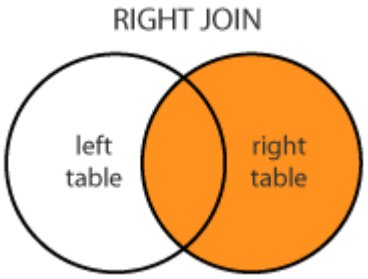
   Select records from the first (left-most) table with matching right table records.



In the left outer join, operation allows keeping all tuple in the left relation. However, if there is no matching tuple is found in right relation, then the attributes of right relation in the join result are filled with null values.

3. **RIGHT (OUTER) JOIN**

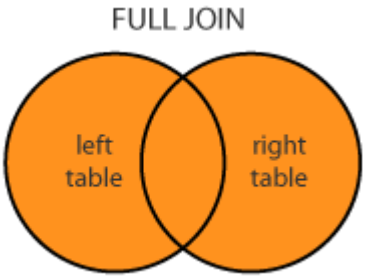
Select records from the second (right-most) table with matching left table records.



In the right outer join, operation allows keeping all tuple in the right relation. However, if there is no matching tuple is found in the left relation, then the attributes of the left relation in the join result are filled with null values.

4. **FULL (OUTER) JOIN**

Selects all records that match either left or right table records.



In a full outer join, all tuples from both relations are included in the result, irrespective of the matching condition.

2.4. Practice Questions

Question 1: Which operation of relational algebra is equivalent to Set Union operation?

_____

Question 2: Which operation of set theory is equivalent to the 'Product' operation of relational algebra?

_____

Question 3: Specify if below statement is true or false:

i) A SQL query that calls for a `FULL OUTER JOIN` is merely returning the *union* of two sets.

_____

ii) Finding the `LEFT JOIN` of two tables is nothing more than finding the *set difference* or the *relative complement* of the two tables.

_____

iii) A SQL `INNER JOIN` is just the *intersection* of two sets.

_____

Question 4: Can you think of an entity like students, employee, sports - create 3 tables of any one of the entities, you want?

For example

Entity: Students

Students Table (name, roll number, age, class, address)

Marks Table (roll number, subject, marks obtained)

Bus Route table (roll number, bus number, boarding point)

3. Simple Statistical Concepts

I won't be wrong if I say, Artificial Intelligence (Machine Learning / Deep Learning) is an engine that needs data as fuel, so data is the primary building block of AI. And to understand data, statistics is the key.

The purpose of this module is not to replace the statistics that you will study as a part of Mathematics in your school, but to introduce you to statistics for the perspective of the Artificial Intelligence and Machine learning.

This module on statistics, is divided into the following parts:

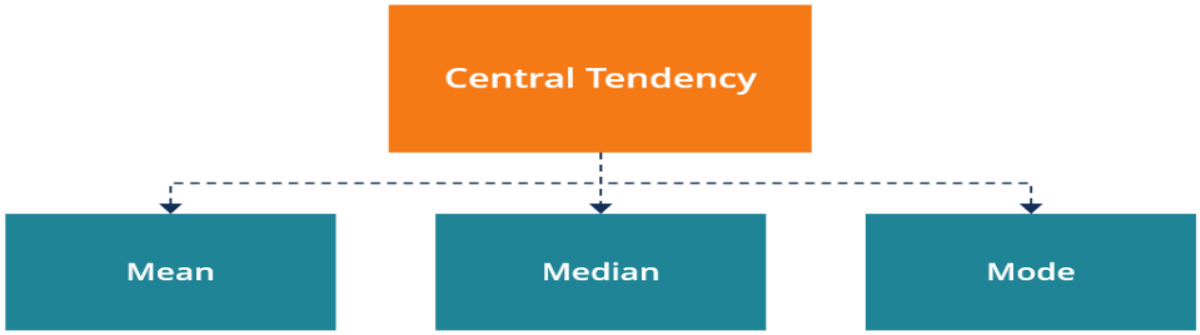
3.1. Measure of Central Tendency
3.2. Variance and Standard Deviation
3.3. Activities

3.1. Measure of Central Tendency

Statistics is the science of data, which is in fact a collection of mathematical techniques that helps to extract information from data. For the AI perspective, statistics transforms observations into information that you can understand and share. You will learn more about statistics and statistical methods in your next level i.e. Level-2.

Usually, Statistics deals with large dataset (population of a country, country wise number of infected people from CORONA virus and similar datasets). For the understanding and analysis purpose, we need a data point, be it a number or set of numbers, which can represent the whole domain of data and this data point is called the central tendency.

"Central tendency" is stated as the summary of a data set in a single value that represents the entire distribution of data domain (or data set). The one important point that I would like to highlight here that central tendency does not talk about individual values in the datasets but it gives a comprehensive summary of whole data domain.



3.1.1. Mean

In statistics, the mean (more technically the arithmetic mean or sample mean) can be estimated from a sample of examples drawn from the domain. It is a quotient obtained by dividing the total of the values of a variable by the total number of their observations or items.

If we have n values in a data set and they have values $x_1, x_2, x_3 \ldots$, the sample mean,

$M = (x_1 + x_2 + x_3 \ldots x_n) / n$

And if we need to calculate the mean of a grouped data,

$M = \sum fx / n$

Where M = Mean

$\sum$ = Sum total of the scores

f = Frequency of the distribution

x = Scores

n = Total number of cases

Example 1

The set S = { 5,10,15,20,30},

Mean of set S = 5+10+15+20+30/5 = 80/5 = 16

Example 2

Calculate the mean of the following grouped data

Class	**Frequency**
2 - 4	3
4 - 6	4
6 – 8	2
8 – 10	1

Solution

Class	**Frequency (*f*)**	**Mid value (*x*)**	***f*·*x***
2 -4	3	3	9
4 - 6	4	5	20
6 – 8	2	7	14
8 – 10	1	9	9
	n=10		∑*f*·*x*=52

Mean (M) = $\sum fxn \;/\; n$

=52 / 10

= 5.2

When to use Mean?

1. Mean is more stable than the median and mode. So that when the measure of central tendency having the greatest stability is wanted mean is used.

2. When you want to includes all the scores of a distribution

3. When you want your result should not be affected by sampling data.

When not to use the mean

1. The mean has one main disadvantage: it is particularly susceptible to the influence of outliers. These are values that are unusual compared to the rest of the data set by being especially small or large in numerical value.

For example, consider the wages of staff at a factory below:

Staff	1	2	3	4	5	6	7	8	9	10
Salary	15k	18k	16k	14k	15k	15k	12k	17k	90k	95k

Mean = Total Salary / Number of Staffs

= 307 / 10

= 30.7 K

The mean salary for these ten staff is INR 30.7k. However, inspecting the raw data suggests that this mean value might not be the best way to accurately reflect the typical salary of a worker, as most workers have salaries in the INR 12k to INR 18k range. The mean is being skewed by the two large salaries. Therefore, in this situation, we would like to have a better measure of central tendency. As we will find out later, taking the median would be a better measure of central tendency in this situation.

2. Sometimes it gives absurd values. For example, there are 41, 44 and 42 students in class VIII, IX and X of a school. So the average students per class are 42.33. It is never possible.

Brain Teaser Question:

Why 6ft tall man drowned while crossing a swimming pool which was on an average 5ft deep?

3.1.2. Median

The median is another measure of central tendency. It is positional value of the variables which divides the group into two equal parts one part comprising all values greater than median and other part smaller than median.

Following series shows marks in mathematics of students learning AI

17	32	35	15	21	41	32	11	10	20	27	28	30

We arrange this data in an ascending or descending order.

10, 11, 15, 17, 20, 21, 27, 28, 30, 32, 32, 35, 40

As 27 is in the middle of this data position wise, therefore Median = 27

How to find median values?

Use Case 1

In case of ungrouped data, the scores are arranged in order of size. Then the midpoint is found out, which is the median. In this process two situations arise in computation of median, (a) N is odd (b) N is even First we shall discuss how to compute median (Mdn) when N is odd.

Step by Step Process for Finding the Median -

Step 1: Put the numbers in numerical order from smallest to largest.

Step 2: If there is an odd number of numbers, locate the middle number so that there is an equal number of values to the left and to the right. If there is an even number of numbers locate the two middle numbers so that there is an equal number of values to the left and to the right of these two numbers.

Step 3: If there is an odd number of numbers, this middle number is the median. If there is an even number of numbers add the two middles and divide by 2. The result will be the median.

Example 2

In your class, 5 students scored following marks in the unit test mathematics, find median value

18, 10, 13, 10, 17, 11, 9

Solution:

Arrange them in order - 9 , 10 , 10 , 11 , 13 , 17 , 18

Total count is odd, so median value is – 11.

Example 2

In your class, 5 students scored following marks in the unit test mathematics, find median value: 11, 11, 14, 18, 20, 22

Solution

They are already in order - 11, 11, 14, 18, 20, 22

Total count is in even number, so median is the average of the two-middle number

(14 + 18) / 2 = 16.

Use Case 2: Calculating median from grouped data

Calculation of a median in continuous series involves the following steps:

(i) The data arranged in ascending order of their class interval.

(ii) Frequencies are converted into commutative frequencies

(iii) Median class of the series is identified

(iv) Formula used to find actual median value

And the formula is : Median $= l_1 + \frac{\frac{N}{2} - c.f}{f} \times i$

l1= Lower limit of median class

c.f= Cumulative frequency of the class preceding the median class

f= Frequency of the median class

i= Class size

Example -1:

Following distribution table is given as

Wage	0-10	10-20	20-30	30-40	40-50
Number of workers	22	38	46	35	20

To find median (M) make table as

Wage	Frequency	Cumulative Frequency
0-10	22	22
10-20	38	60
20-30	46	106
30-40	35	141
40-50	20	161
	N=161	

Median class = size of item $\frac{161+1}{2}$= 81

Median class = 20-30

(as 81 is right before 106 in cumulative frequency table, median group is 20-30 group)

Now, l1=20, c.f=60 , f=46 , n=161 , i=10

$$M = 20 + \frac{\frac{161}{2}-60}{46} \times 10$$

$$= 20 + \frac{80.5-60}{46} \times 10$$

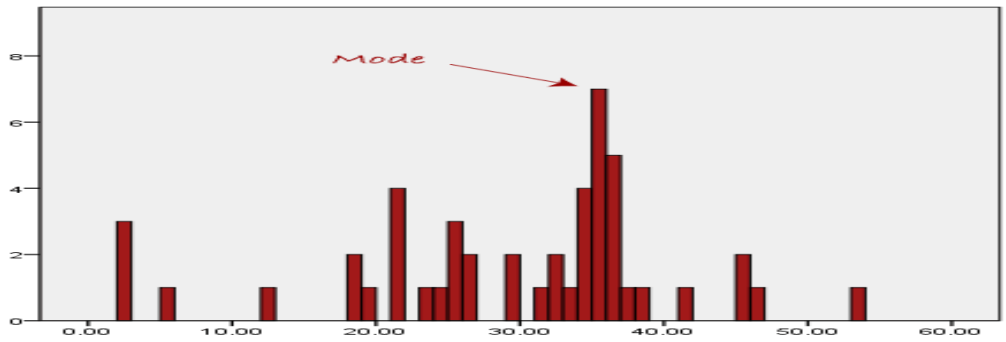
$$= 20 + \frac{20.5}{46} \times 10$$

$$= 20 + 4.46$$

Median = 24.46

3.1.3. Mode

Mode is another important measure of central tendency of statistical series. It is the value which occurs most frequently in the data series. On a histogram it represents the highest bar in a bar chart or histogram. You can, therefore, sometimes consider the mode as being the most popular option. An example of a mode is presented below:



To Calculate the mode, different methods are described below -

(i) Inspection Method

In this method mode is determined just by observation. We use mode by inspection method in the individual series with method involves just an inspection of the series. One is simply identifying the value that occurs most frequently in the series such a value is called a mode.

Example 1: Age of 15 students of a class

Age (years) 22, 24, 17, 18, 17, 19, 18, 21, 20, 21, 20, 23, 22, 22, 22,22,21,24

We arrange this series in ascending order as

17,17,18,18,19,20,20,21,21,22,22,22,

An inspection of the series shows that 22 occurs most frequently

Mode=22

(ii) Mode for Frequency Distribution

For frequency distribution, the method for mode calculation is somewhat different. Here we have to find a modal class. The modal class is the one with the highest frequency value. The class just before the modal class is called the pre-modal class. Whereas, the class just after the modal class is known as the post-modal class. Lastly, the following formula is applied for calculation of mode:

$$\textbf{Mode} = l + h\,[(f1-f0)/(2f1-f0-f2)]$$

Here, l= The lower limit of the modal class

f1 = Frequency corresponding to the modal class,

f2 = Frequency corresponding to the post-modal class,

and f0 = Frequency corresponding to the pre-modal class

Example – 2: Calculate mode for the following data:

Class Interval	10-20	20-30	30-40	40-50	50-60
Frequency	3	10	15	10	2

Answer: As the frequency for class 30-40 is maximum, this class is the modal class. Classes 20-30 and 40-50 are pre-modal and post-modal classes respectively. The mode is:

Mode= 30 + 10× [(15-10)/ (2×15-10-10)] = 30+ 5= 35

There are two methods for calculation of mode in discrete frequency series:

(i) By inspection method - Same as above example.

(ii) Grouping method:

More than one value may command the highest frequency in the series.

In such cases grouping method of calculation is used.

In summary, when do we use mean, median and mode:

Mean	**Median**	**Mode**
The mean is a good measure of the central tendency when a data set contains values that are relatively evenly spread with no exceptionally high or low values.	The median is a good measure of the central value when the data include exceptionally high or low values. The median is the most suitable measure of average for data classified on an ordinal scale.	Mode is used when you need to find the distribution peak and peak may be many. For example, it is important to print more of the most popular books; because printing different books in equal numbers would cause a shortage of some books and an oversupply of others.

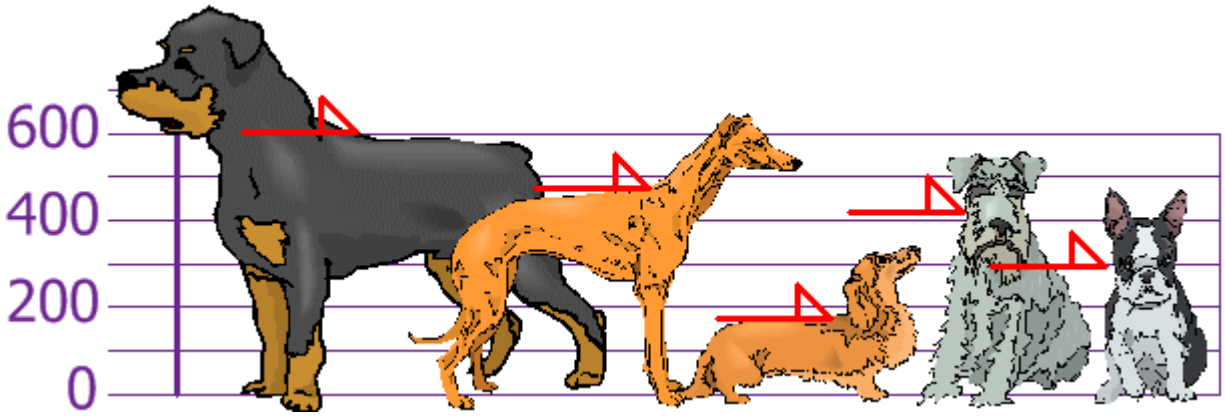
3.2. Variance and Standard Deviation

Measures of central tendency (mean, median and mode) provide the central value of the data set. Variance and standard deviation are the measures of dispersion (quartiles, percentiles, ranges), they provide information on the spread of the data around the centre.

In this section we will look at two more measures of dispersion: Variance and standard deviation.

Let us understand these two using a diagram:

Let us measure the height (at the shoulder) of 5 dogs (in millimetres)



As you can see, their heights are: 600mm, 470mm, 170mm, 430mm and 300mm.

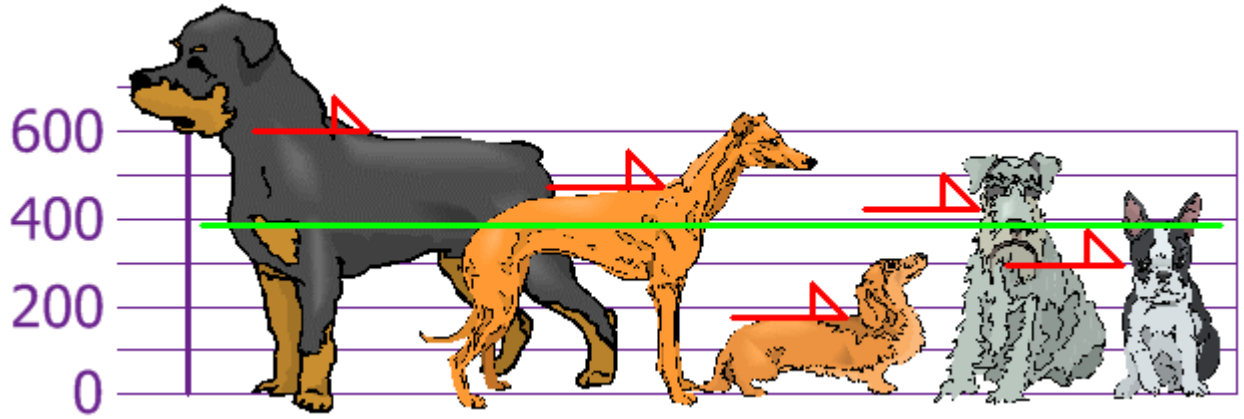
Let us calculate their mean,

Mean = (600 + 470 + 170 + 430 + 300) / 5

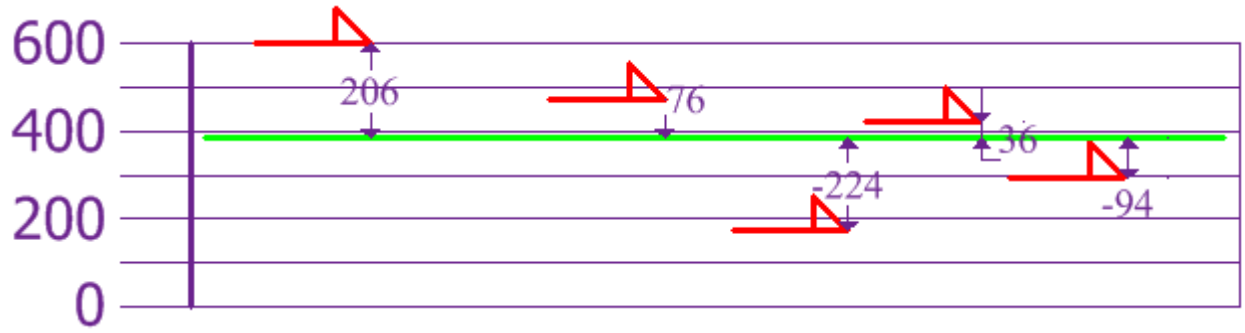
= 1970 / 5

= 394 mm

Now let us plot again after taking mean height (The green Line)



Now, let us find the deviation of dogs height from the mean height



Calculate the difference (from mean height), square them , and find the average. This average is the value of the variance.

Variance = [$(206)^2 + (76)^2 + (-224)^2 + (36)^2 + (-94)^{2]}$ / 5

= 108520 / 5

= 21704

And standard deviation is the square root of the variance.

Standard deviation = √21704 = 147.32

I am assuming that the example above, must have given you a clear idea about the variance and standard deviation.

So just to summarize, Variance is the sum of squares of differences between all numbers and means.
In order to calculate variance , first, calculate the deviations of each data point from the mean, and square the result of each .

Say, there is a data range: 2 ,4 ,4,4,5,5,7,9

Calculate the variance:

Find the mean first: (2 + 4 + 4 + 4+ 5 + 5 + 7 + 9) / 8

= 5

Then sum of square of differences between all numbers and mean =

$(2-5)^2 + (4-5)^2 + (4-5)^2 + (4-5)^2 + (5-5)^2 + (5-5)^2 + (7-5)^2 + (9-5)^2$

= 9 + 1 +1 + 1+ 0 +0 + 4 + 16

= 32

$$Formula : \sigma^2 = \frac{\sum_{i=1}^{N}(x_i-\mu)^2}{N}$$

[Where μ is Mean, N is the total number of elements or frequency of distribution] Variance = Average of sum of square of differences between all numbers and mean

= 32 / 8

= 4

Standard Deviation is square root of variance. It is a measure of the extent to which data varies from the mean.

Standard Deviation (for above data) = $\sqrt{4}$ = 2

Some important facts about variance and standard deviation

- A small variance indicates that the data points tend to be very close to the mean, and to each other.
- A high variance indicates that the data points are very spread out from the mean, and from one another.
- A low standard deviation indicates that the data points tend to be very close to the mean
- A high standard deviation indicates that the data points are spread out over a large range of values.

3.3. Activities

Activity 1

Refer to the website https://www.worldometers.info/coronavirus/
Can you extract 5 statistical data from this global corona tracker?

_____

_____

Activity 2

Can you please perform a statistical research on “The time students spend on social media”?
Condition 1: You will collect the data outside of your school
Condition 2: You can work in a group of 5 students
Condition 3: Your group need to capture data from a minimum 10 students

Once you have data ready with you, do your statistical analysis (central deviation, variance and standard deviation) and present your story.

_____

_____

3. Visual representation of data

This module will provide an introduction about the purpose, importance and various methods of data representation using graphs. Statistics is a science of data, so we deal with large data volume in statistics or Artificial Intelligence. Whenever volume of data increases rapidly, an efficient and convenient technique for representing data is needed. For a complex and large quantity, human brain is more comfortable in dealing if represented through visual format. And that is how the need arise for the graphical representation of data.

The important topics that we are going to cover in this module is:

3.1. Why do we need to represent data graphically?

3.2. What is a Graph?

3.3. Types of Graphs

3.1 Why do we need to represent data graphically?

There could be various reasons of representing data on graphs, few of them have been outlined below

- The purpose of a graph is to present data that are huge in volume or complicated to be described in the text / tables.
- Graphs only represent the data but also reveals relations between variables and shows the trends in data sets.
- Graphical representation helps us in analysing the data.

3.2. What is a Graph?

Graph is a chart of diagram through with data are represented in the form of lines or curve drawn on the coordinated points and its shows the relation between variable quantities.

The are some algebraic and coordinate geometry principle which apply in drawing the graphs of any kind.

Graphs have two axis, the vertical one is called Y-axis and the horizontal one is called X-Axis. X and Y axis are perpendicular to each other. The intersection of these two axis is called '0' or the Origin. On the X axis the distances right to the origin have positive value (see fig. 7.1) and distances left to the origin have negative value. On the Y axis distances above the origin have a positive value and below the origin have a negative value.

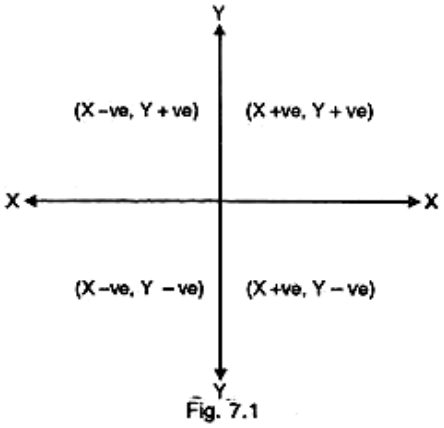


Fig. 7.1

3.3. Types of Graphs

3.3.1 Bar Graphs

As per Wikipedia "A bar chart or bar graph is a chart or graph that presents categorical data with rectangular bars with heights or lengths proportional to the values that they represent ". It is a really good way to show relative sizes of different variables.

There are many characteristics of bar graphs that make them useful. Some of these are that:

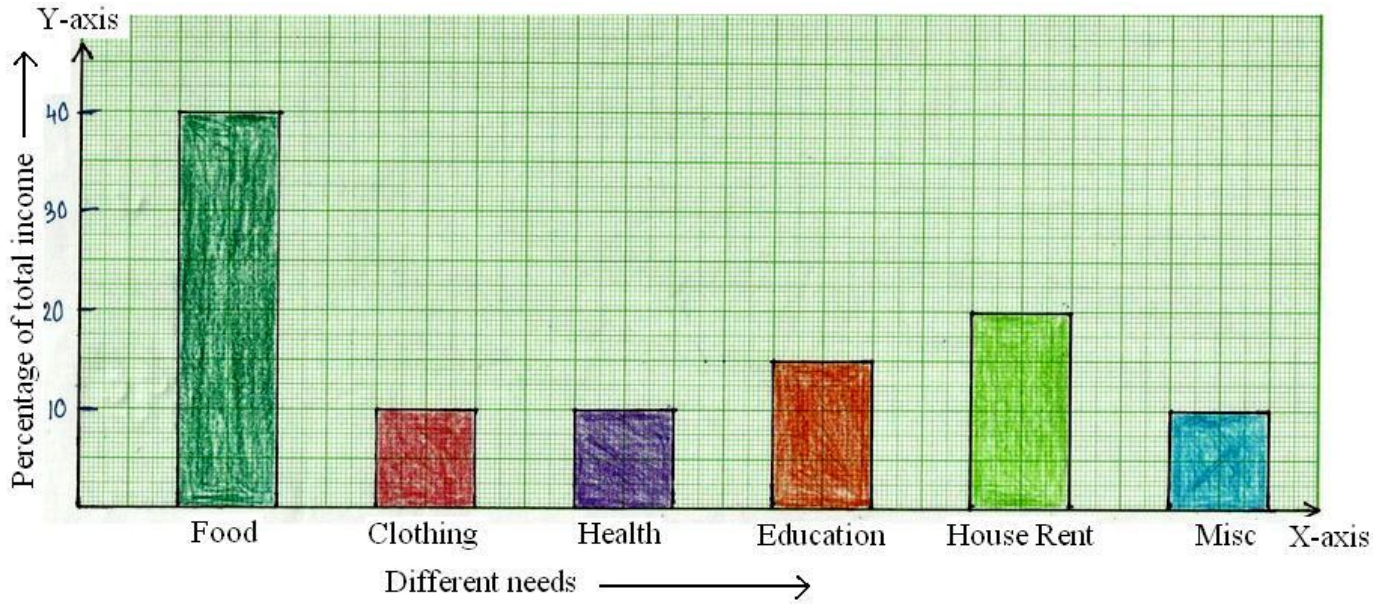
- They make comparisons between different variables very easy to see.
- They clearly show trends in data, meaning that they show how one variable is affected as the other rises or falls.
- Given one variable, the value of the other can be easily determined.

Example 1

The percentage of total income spent under various heads by a family is given below.

Different Heads	Food	Clothing	Health	Education	House Rent	Miscellaneous
% Age of Total Number	40%	10%	10%	15%	20%	5%

Represent the above data in the form of bar graph.



3.3.2 Histogram

Histogram is drawn on a natural scale in which the representative frequencies of the different class of values are represented through vertical rectangles drawn closed to each other. Measure of central tendency, mode can be easily determined with the help of this graph.

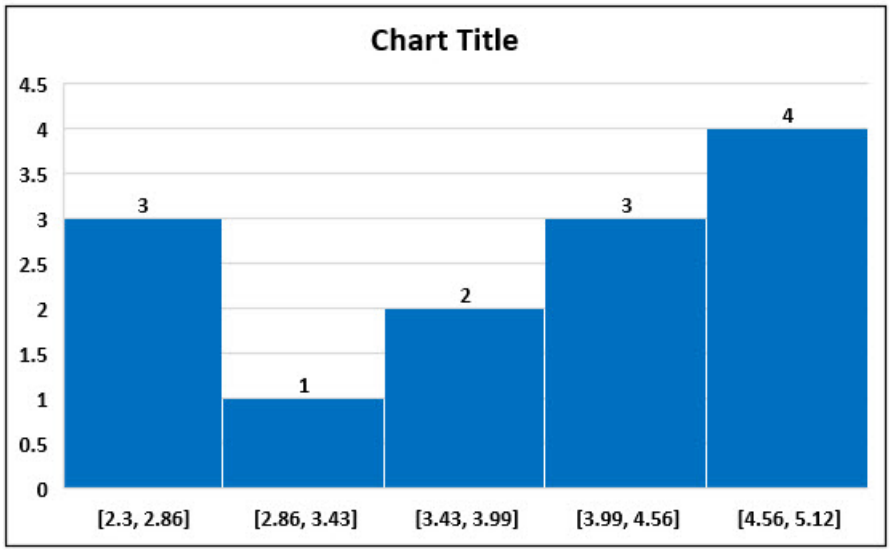
Histogram is easy to draw and simple to understand but it has one limitation that we cannot plot more than one data distribution on the same axis as histogram.

Example 1

Below is the waiting time of the customer at the cash counter of a bank branch during peak hours. You are required to create a histogram based on the below data.

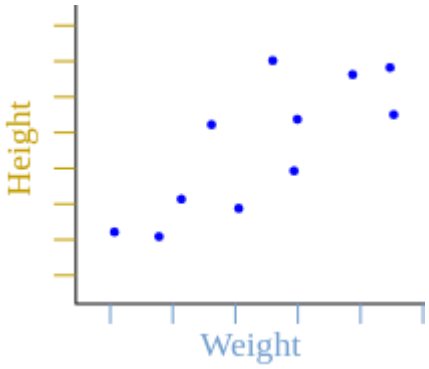
Customer Waiting Time (in mins)
2.30
5.00
3.55
2.50
5.10
4.21
3.33
4.10
2.55
5.07
3.45
4.10
5.12

Represent the above data in the form of a histogram



3.3.3. Scatter Plot

Scatter plots is way to represent the data on the graph which is similar to line graphs. A line graph uses a line on an X-Y axis, while a scatter plot uses **dots** to represent individual pieces of data. In statistics, these plots are useful to see if two variables are related to each other. For example, a scatter chart can suggest a linear relationship (i.e. a straight line).



There is no line but dots are representation the value of variables on the graph.

Example 1

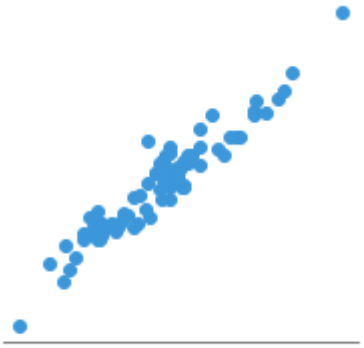
Here price of 1460 apartments and their ground living area. This dataset comes from a kaggle (https://www.kaggle.com/c/house-prices-advanced-regression-techniques/data) machine learning competition. You can read more about this example here

(Sourec : https://www.data-to-viz.com/story/TwoNum.html)

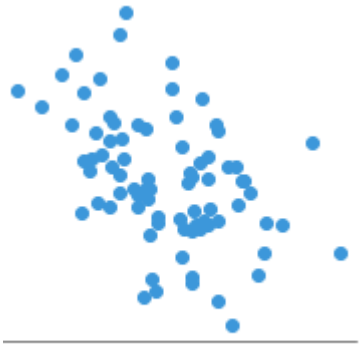
Scatter plot is most frequently used data plotting technique in machine learning.

When should we use scatter plot:

- It is used to observe relationship between two numeric variables. The dots on the plot not only denotes value of variable but also the patterns, when data taken as whole.
- Scatter plot is a useful tool for the correlation. Relationships between variables can be described in many ways: positive or negative, strong or weak, linear or nonlinear.



strong, positive, linear



moderate, negative, linear

4. Introduction to Dimensionality of Data

4.1. Data Dimensionality

Dimensionality in statistics refers to **how many attributes a dataset has**. There is a sample students dataset with four attributes (columns) , so this student dataset is of 4 dimensions.

Students Dataset

Name	Age	Class	Address
X	16	XII	New Delhi

So if you have a data-set having n observations (or rows) and m columns (or features), then your data is m-dimensional.

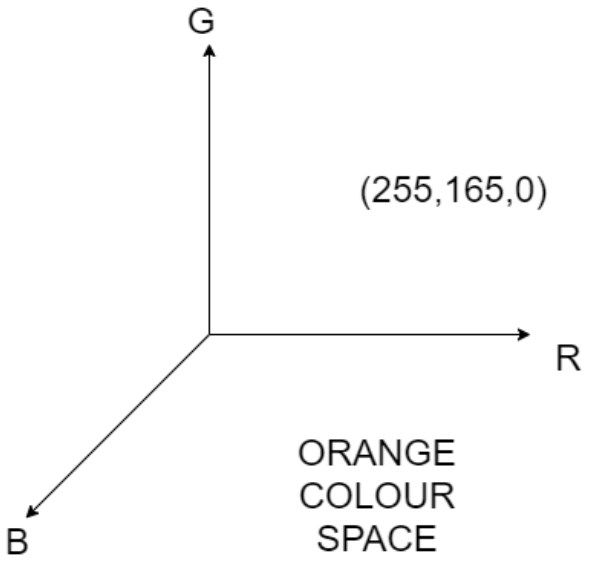
The dimension of dataset can change without forcing change in another dimension. We can change the age of students without changing class or address, for example.

Let us take one more to understand the dimensionality of data

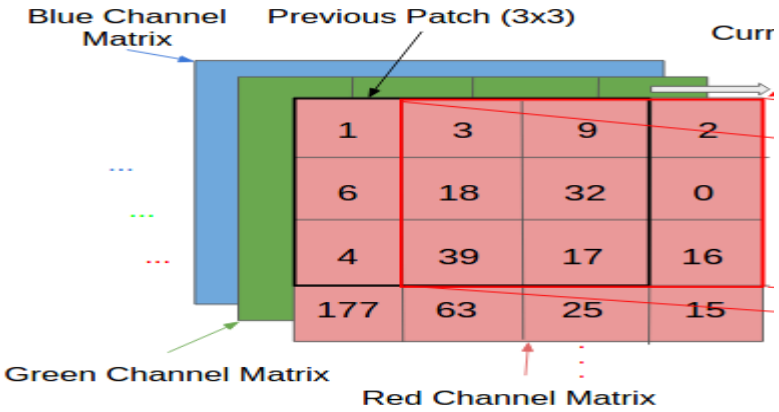
If you remember the 'colour channel' topic of computer vision in Unit-2. The colour image is expressed by three colour (or by three numbers) - Red, Green and Blue.

For example, Orange colour has Red value – 255, Green value – 165 and Blue value – 0. Orange would not be the result if one of these value was different.

We can say, Orange colour space is three dimensional because there are three directions in which colour can vary



Combination of these three colours (numbers: 0 – 255) ultimately decides the colour, hence we say that colour space is three-dimensional because there are three “directions” in which a colour can vary.



Example of Data dimensionality for AI

We know recognizing face or an object is one of the major AI function. The image is stored in the form of pixels. If we consider, each pixel as a variable, then n images can reside in 2D space i.e. y x z space. And then we give computer a set images (residing in y x z plane) for training, using which AI software recognize new objects. Having said that, using dimensionality of data, AI software differentiate between human face to animal face or something like that.

For Advance learners

Let us take, dog an example. Dog is a 3-dimensional object, so

Let us assume, length of dog is – x

Width (dog’s body) dog - dy / dx [y is a function of x here]

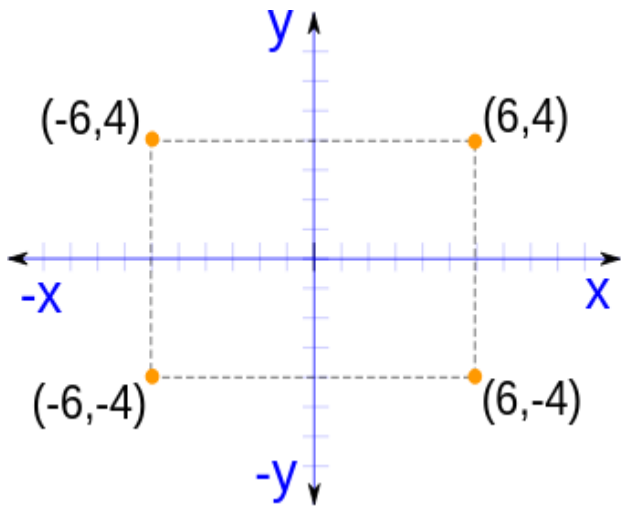
Height - dz / dx [z is a function of x]

We can plot really huge number of dog’s parameter (length, width and height) in terms of x, y and z variable, which further can be used by AI model for its training purpose.

NOTE: Advance learners can further explore it and try to relate with central tendency and variance.

4.2. Data Representation on Graph

Before we move further, let us understand the basics of data representation on the graph



Quadrants - I

Quadrants - IV

Co-ordinates on the graphs:

- Move forward on the X-axis for positive value
- Move backward on the X-axis for negative axis
- Move up on the Y-axis for positive value
- Move down on the X – axis for the negative value

Please look at the above diagram of the graph and try to reason out why

i) (6, 4) is in first quadrant

ii) (-6, 4) is in second quadrant

iii) (-6, -4) is in third quadrant

iv) (6, -4) is in the fourth quadrant

4.3. Multi-Dimensional Data and Graph

Use Case 1

Let us assume a data set of 1-Dimension

Students Dataset

Age
16
15
14

The graphical line will a straight line

Use Case 2

Let us take 2-Dimensional data

Students Dataset

Age	Marks
16	91
15	85
14	93

Cartesian coordinates can go:

- left-right, and
- up-down

So any position needs two numbers.

Use Case 3

Let us take 3-Dimensional data

Students Dataset

Age	Maths Marks	Science Marks
16	91	92
15	85	90
14	93	72

How do we locate a spot in the real world (such as the tip of your nose)? We need to know:

- left-right,
- up-down, and
- forward-backward

that is three numbers, or 3 dimensions!

5. Simple Linear Equation and Regression

Linear regression is perhaps one of the most well-known and well understood algorithms in statistics and machine learning.

Use Case 1

Have you ever come across such situations like?

- Impact of 12th score on college admission
- Impact of product price on number of sales
- Impact of rainfall on farming
- Impact of time of allocated by you on study to your exam performance
- Time spend in front of TV to your monthly electricity bill

What kind of situation are these? College admission (one variable) depends on other variable i.e. 12^{th} score. Number of sales (one variable) depends on other variable i.e. product price.

In all the situations, there are two variables – one is input variable (12^{th} score, product price etc.) and other one is the outcome (college admission, sales, farming etc.)

We know these two variables i.e. input and outcome are related but what is the equation of the relation is unknown.

Example 1

The general formula of linear equation is:

$$Ax + By = C$$

In terms of slope, this formula can be written, $y = -(A / B) x + C$

[We know slope $m = -A / B$, for a straight line]

Now let us take an example from real life to understand how linear equation behaves (slope of the graph) with changing data point.

Suppose, the cab fare in Mumbai is: Fixed amount (x) + INR y per KM.

For a journey of 1 KM, Cab fare = x + y

Slope of straight line = -1

Cab fare revised, new fare is = Fixed amount(x) + twice the number of Km travelled

For a journey of 1 KM, cab fare = x + 2y

Slope of straight line in this case = -2

Thereby, if data points change, the slop of linear equation also changes.

We need to know that linear equation changes its path only when condition of variable changes.

Example 2

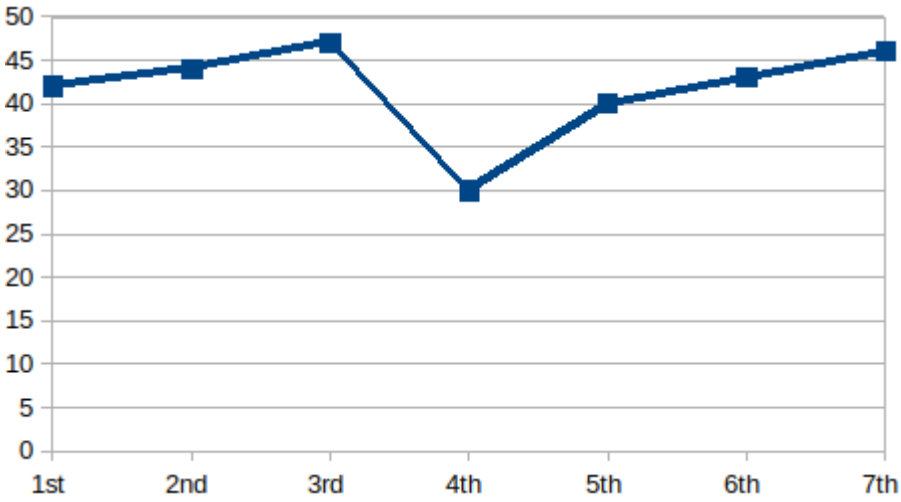
When we collect data, sometimes there are values that are "far away" from the main group of data, how does that 'far away' value (called outlier) impacts the equation? What do we do with them?

Below is the Delhi daily temperature data, recorded for a week:

Temperature recorded (degree C): 1st Week of June

Day	1st	2nd	3rd	4th	5th	6th	7th
Temp.	42	44	47	30	40	43	46

The mean temperature is: 42 + 44 + 47 + 30 + 40 + 43 + 46) / 7 = 41.71



- 4th of June, it rained in Delhi and therefore temperature dipped
- The temperature on 4th, is called outlier for this dataset
- Now, let us take the outlier out, and calculate the mean

  Mean (without outlier) = 43.66

Because data range is very small, even though we notice visible difference in the mean. When we remove outliers we are changing the data, it is no longer "pure", so we shouldn't just get rid of the outliers without a good reason! **And when we do get rid of them, we should explain what we are doing and why.**

Use Case 2

Let us consider another simple example:

Your physical education teacher given you an offer – If you take two rounds of school ground, he will offer you 4 chocolates.

Based on the above offer, students come up with the following tables

Number of Rounds (x)	**Number of chocolates (y)**
2	4
4	8
6	12

So, you can find a relationship between these variables,

Number of chocolates = 2 x Number of rounds [y = 2x]

There you find a linear relationship between these two variables i.e. Input and Outcome.

And congratulation, this is linear regression.

Activity 1

From the case-I, can you prepare some hypothetical data set (of any one event) and try to establish the relationship between input variable and outcome?

What is Linear Regression?

Regression is the process of determining the relationship between two (or more) variables. In the above example of 'number of rounds and chocolates', x (number of rounds) is termed as the independent variable and y (number of chocolate) is termed as dependent variable.

And if there is only one dependent variable, then regression is called simple linear regression.

Question 1

Is Neural network a simple linear equation?

It is called "**simple**" because we take only two variables in this case and try to establish a relationship between them. It is called "**linear**" because both the variables vary linearly (can be described with a straight line) with respect to each other.

A simple straight line can be represented by an equation -

y = mx + c

y = dependent variable

x = independent variable

m = a co-efficient indicating how a unit change in x brings a change in y

c = a constant, which determines where line will cut the x-axis when y = 0

Let us solve a real life problem

Problem:

ABC has shifted to Mumbai recently. The cab prices in Mumbai from ABCs apartment to the office varies every month. ABC wants to understand the cause of the price variation. Also, ABC would like to know how he/she can predict the cost for the cab in the upcoming month.

What will you do??

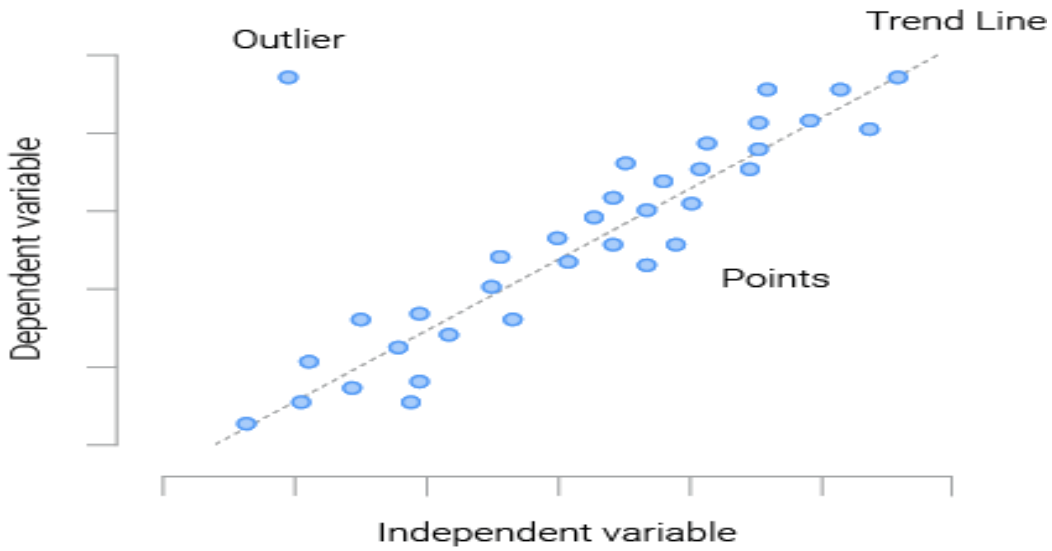
Solution

Independent variable, x = months

Dependent variable, y = cab price

[Remember that your dependent variable is the one which you are trying to predict (cab price) and your independent variable (months) is the one which you will supply as input]

Using the historical data, let us plot the scatter graph



We can describe the above plot as

Cab price (dependent variable) = m * months (independent variable) + C

In linear regression, our aim is to find a straight line which will cover most of the points in the points in the above graph.

[Note: You can easily find the values for **m and c** with the help of free statistical software, online linear regression calculators or Excel. All you need are the values for the independent (x) and dependent (y) variables (as those in the above table). Also, we will discuss more about this in our next level]

For the data points, m = 4.914 and c = 72.752

So, equation becomes,

Cab price = 4.914 + months * 72.752

Now we can predict, cab price for any coming month say the 14th month from the point one has arrived in the city, by just replacing the month variable with 14 in the above equation.

Cab price = 4.914 + 14 * 72.752

= 146.82 INR

Seems like we now have an estimate on how much cab price needs to be paid 2 months from now!

Least Square Method

The "least square" method is a form of mathematical regression analysis used to determine the line of best fit for a set of data, providing a visual demonstration of the relationship between the data points. Each point of data represents the relationship between a known independent variable and an unknown dependent variable.

Linear regression is basically a mathematical analysis method which considers the relationship between all the data points in a simulation. All these points are based upon two unknown variables; one independent and one dependent. The dependent variable will be plotted on the y-axis and the independent variable will be plotted to the x-axis on the graph of regression analysis. In literal manner, least square method of regression minimizes the sum of squares of errors that could be made based upon the relevant equation.

We know the straight line formula

$y = mx + c$

Y (dependent variable) and x (independent variable) are known value, but m and c, we need to calculate.

Steps to calculate the m and c -

Step 1: For each (x,y) point calculate x^2 and xy

Step 2: Sum all x, y, x^2 and xy, which gives us Σx, Σy, Σx^2 and Σxy

Step 3: Calculate Slope **m**:

$$\mathbf{m} = \boxed{N \Sigma(xy) - \Sigma x \Sigma y \quad /} \; \mathbf{N \Sigma(x^2) - (\Sigma x)^2}$$

(N is the number of points.)

Step 4: Calculate Intercept **b**:

$$\mathbf{b} = \boxed{\Sigma y - m \Sigma x \;/} \; \mathbf{N}$$

Step 5: Assemble the equation of a line

$$y = mx + C$$

we are done!

Example 1:

Let us collect a data how many hours of sunshine vs how many ice creams were sold at the shop from Monday to Friday:

X (hours of sunshine)	Y (Ice cream sold)
2	4
3	5
5	7
7	10
9	15

Step -1: For each (x,y) calculate x^2 and xy:

X (hours of sunshine)	Y (Ice cream sold)	x^2	Xy
2	4	4	8
3	5	9	15
5	7	25	35
7	10	49	70
9	15	81	135

Step 2: Sum x, y, x^2 and xy (gives us Σx, Σy, Σx^2 and Σxy):

X (hours of sunshine)	Y (Ice cream sold)	x^2	Xy
2	4	4	8
3	5	9	15
5	7	25	35

7	10	49	70
9	15	81	135
$\Sigma x = 26$	$\Sigma y = 41$	$\Sigma x^2 = 168$	$\Sigma xy = 263$

Also **N** (number of data values) = **5**

Step 3: Calculate slope m:

$$\mathbf{m} = \frac{N\,\Sigma(xy) - \Sigma x\,\Sigma y}{N\,\Sigma(x^2) - (\Sigma x)^2}$$

$$= \frac{5 \times 263 - 26 \times 41}{\mathbf{5 \times 168 - 26^2}}$$

$$= \frac{1315 - 1066}{\mathbf{840 - 676}}$$

$$= \frac{249}{\mathbf{164}}$$

$$= 1.5183.$$

Step 4: Calculate Intercept b:

$$\mathbf{c} = \frac{\Sigma y - m\,\Sigma x}{\mathbf{N}}$$

$$= 41 \frac{- 1.5183 \times 26}{\mathbf{5}}$$

$$= 0.3049...$$

Step 5: Assemble the equation of a line:

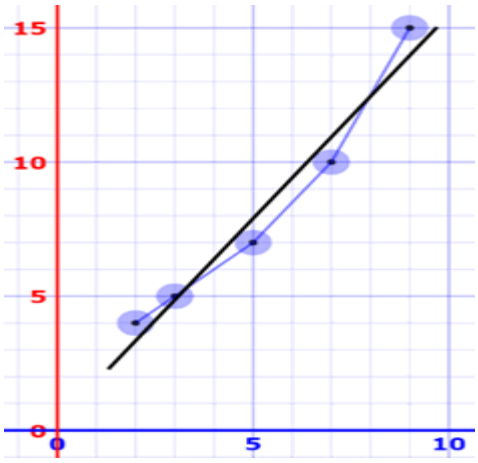
$$y = mx + c$$

$$y = 1.518\,x + 0.305$$

Let's see how it works:

X (hours of sunshine)	**Y (Ice cream sold)**	**y = 1.518 x + 0.305**	**Error**
2	4	3.34	- 0.66
3	5	4.86	- 0.14
5	7	7.89	0.89
7	10	10.93	0.93
9	15	13.97	-1.03

Here are the (x,y) points and the line y = 1.518x + 0.305 on a graph:



Once you hear the weather forecast which says "we expect 8 hours of sun tomorrow", so you use the above equation to estimate that you will sell

y = 1.518 x 8 + 0.305 = 12.45 Ice Creams

Unit 4: AI Values (Ethical Decision Making)

Title: AI Values (Ethical Decision Making)	**Approach: Interactive/Discussion, Reading, Un-plugged Activities**
Summary: "The rise of powerful AI will be either the best or the worst thing to happen to humanity. We do not know which" - By Stephen Hawking AI is just a tool, just an algorithm but an extremely powerful one. It can be used in ways that can affect the society – positively or negatively. Like electricity or nuclear energy, a lot depends on us - how we utilize AI for the humanity. The current advances in research and development in the space of AI have given rise also to challenges of various kinds - ethical challenges, jobs being taken by robots, value system of robots, privacy in the age of AI etc.	
Objectives: 1. As an educator or a parent, it's our responsibility to prepare our next generation for the future The objective of this unit is to give a glimpse of the society of the future 2. Deepen the understanding of students about the technological basis of AI 3. Analyse machine bias and other ethical risks	
Learning Outcomes: 1. To develop a fair understanding of AI bias, how the society is to be impacted with the advent of AI 2. Students should be in position to discuss AI and individual responsibility.	
Pre-requisites: Basic understanding of AI, reasonable fluency in English and computer literacy, comfortable in using the internet	
Key Concepts: AI applications, Ethics , Bias , Jobs in AI age	

1. AI: Issues, Concerns and Ethical Considerations

Recent progress in computing, robotics and AI may create a unique opportunity in human society. Days are not too far, when we will entrust the management of the environment, economy, public security, healthcare or agriculture to artificially intelligent robots and computer systems. And this is where the discussion on 'AI Ethics and values' is born. Countries all over the world are in a race to evolve their AI skills and technologies. The topic of AI is very popular but what are the ethical and practical issue should we be considering before embracing AI?

Question Time!

Let me describe a few scenarios and then pose some associated questions. Do keep in mind that that there are no 'Right/Wrong' answers for ethical questions. Read the scenario carefully and try to answer to the best of your understanding.

Q.1: You are a doctor at a well-renowned hospital. You have six ill patients, five of whom are in urgent need of organ transplant. However, you can't help them as there are no available organs that can be used to save their lives. The sixth patient, however, will die without a particular medicine. If s/he dies, you will be able to save the other five patients by using the organs of patient#6, who is an organ donor. What will you do in this scenario?

(https://listverse.com/2011/04/18/10-more-moral-dilemmas/

_____

Q.2: An AI music software has composed a song which has become a worldwide hit. Who will own the rights to this song? The team who developed the AI software or the music company?

_____

Q.3: A farmer is headed somewhere sitting on his horse cart. A pedestrian makes some noise which upsets the horse who injures the pedestrian in reaction. The pedestrian makes a police complaint. Who do you think is at fault? Who should be penalized?

_____

Q.4: A medical equipment manufacturing company has developed an AI robot to perform complex surgeries. The trained robot has saved many lives by operating on very critical cases. Due to some algorithm issue, the robot makes an error which costs a patients' life. Who is the culprit here? The hospital or the robot or the company who developed this robot?

_____

Q.5: Should AI robot be given citizenship to a country?

_____

1.1. Issues and Concerns around AI

Activity 1

Let us begin with a YouTube video: Humans Need Not Apply

Watch the video in groups of five. After watching this, each student of the group should write a short note on their understanding of the video and present your write up to the teacher.

As Artificial Intelligence evolves, so do the issues and concerns around it. Let us review some of the issues and concerns around AI here:

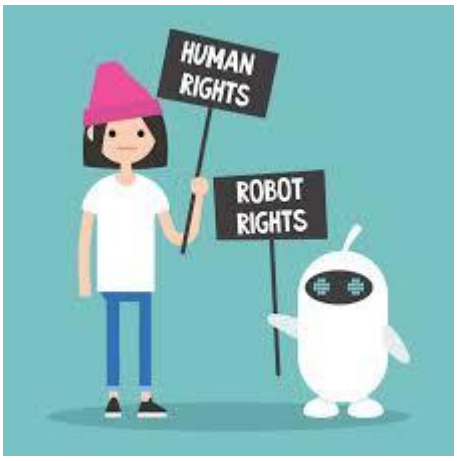
- **Personal Privacy:** Human behaviour and activities can be tracked in in ways that were unimaginable earlier. AI systems need huge amounts of data in order to be trained. In many cases data involves individual faces, medical records, financial data, location information etc.
- **Job Loss:** One of the primary concerns around AI is the future loss of jobs. According to a research by McKinsey, 800 million people will lose their jobs (https://www.theverge.com/2017/11/30/16719092/automation-robots-jobs-global-800-million-forecast). At the same time another point to keep in mind is that AI may also create more jobs, after all, people will be tasked with creating these robots to begin with and then manage them in the future.
- **What if AI makes a mistake:** Microsoft's AI Chatbot – 'Tay' was released on Twitter in 2016. In less than one day, due to the information it was receiving and learning from other Twitter users, the robot learned to spew racist slurs and Nazi propaganda. Another similar example, again from Microsoft Surface device. The device allows the user to login using your face. However, the device has difficulty recognising faces of people from certain demographics. Microsoft identified this issue and fixed it later.

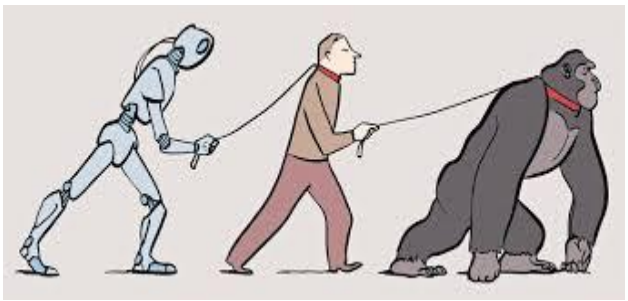
Yes, AI makes mistakes. If Humans make a mistake there are laws that can be enforced, what do we do in the case of AI? Do we have such laws for AI?

How should we treat AI Robot? Should robots be granted Human rights or citizenship? If robots evolve to the point that they are capable of "feeling" does that entitle them to rights similar to humans or animals? If robots are granted rights, then how do we rank their social status?

Activity 2

Look at the four pictures below. Can you write a short story based on these four pictures?





1.2. AI and Ethical Concerns

Ethics is defined as the discipline dealing with moral obligations and duties of humans. It is a set of moral principles which govern the behaviour and actions of individuals or groups.

"The ethics of AI is the part of the ethics technology specific to robots and other artificially intelligent beings. It can be divided into roboethics, a concern with the moral behaviour of humans as they design, construct, use and treat artificially intelligent beings, and machine ethics, which is concerned with the moral behaviour of artificial moral agents (AMAs). With regard to artificial general intelligence (AGIs), preliminary work has been conducted on approaches to integrating AGIs which are full ethical agents with existing legal and social frameworks " .

The bigger concerns are:

- If AI generates human-like output, can it also make human-like decision?
- If AI makes human-like decisions, are the decision human-like also?
- If AI takes decision as to whether a bank loan should be disbursed or not, is AI algorithm fair?
- If AI decides whether college admission can be provided to particular candidate or not, is there guarantee that algorithm is not biased?
- If AI makes human-like decision, is it human-like trustworthy also?
- AI is basically data + mathematical model + training based on data + predictions. What if the data provided for the training is unintentionally wrong/biased?

Such questions and concerns are endless and therefore 'Ethics of AI' is important. As a citizen of the AI society, we must know how AI works and the framework of AI ethics.

Activity 1

***(This activity has been designed by** MIT AI Ethics Education Curriculum. "An Ethics of Artificial Intelligence Curriculum for Middle School Students was created by Blakeley H. Payne with support from the MIT Media Lab Personal Robots Group, directed by Cynthia Breazeal.")*

Activity Description

In this exercise, you will learn to think about the kind of world we make when we build new technology, and the unintended consequences that can occur when we build that technology.

Instructions

1. Go to: https://talktotransformer.com/
2. Explore with the tool for al little bit!
3. Then, answer the following prompts:

Write a brief description of your technology:

_____

Which stakeholders might be interested in this technology?

_____

Who might be affected by this technology most? Brainstorm at least 10 stakeholders.

_____

If this technology was used for evil, how might that be done?

_____

If this technology was used to help other people, who might it help?

_____

In 50 years this technology could do the most good by…

_____

In 50 years this technology could do the most harm by…

_____

1.3. AI and Bias

Brain teaser Questions!

Question. 1: Why are most images that show up when you do an image search for “doctor” are white men?

Question 2: Why is it that most times AI tools associate ‘Doctor’ to a man and ‘Nurse’ to a woman?

Question 3: Why are the virtual assistants (Alexa, Siri, Google assistant etc.) all female?

Question 4: Computer vision systems report high error rates while recognizing people of colour, why?

You can do further search on the web and add more to this list. It's not the case that the developers did this intentionally. This is what we call AI bias!

"AI bias, is a phenomenon that occurs when an algorithm produces results that are systematically prejudiced towards certain gender, language, race, wealth etc. and therefore produces skewed or leaned output. Algorithms can have built-in biases because they are created by individuals who have conscious or unconscious preferences that may go undiscovered until the algorithms are used publically"

What are the sources of AI bias?

There could be many sources, but let's outline three sources of for AI bias

1. Data

AI system are as good as the data we put into them. And putting biased/skewed data into the system is the reason for AI bias. AI system don't have understanding of whether their training data is right or wrong and have enough representation from a broader base.

Amazon developed an AI tool for recruitment, but the company realized its new system was not rating candidates for software developer jobs and other technical posts in a gender-neutral way.

This is because Amazon's computer models were trained to vet applicants by observing patterns in resumes submitted to the company over a 10-year period. Most resumes came from men, a reflection of male dominance across the tech industry (https://in.reuters.com/article/amazon-com-jobs-automation/insight-amazon-scraps-secret-ai-recruiting-tool-that-showed-bias-against-women-idINKCN1MK0AH)

Another example is that of voice assistants like Siri or Alexa that are trained on huge databases of recorded speech that are unfortunately dominated by speech samples from white, upper-middle class Americans, making it challenging for the technology to understand commands from people outside this category.

Activity

Can you think of more examples of AI biases due to data?

2. Algorithm

While algorithm, in itself doesn't inject bias but can amplify the biases caused by data.

For example, an image classifier trained on the images available in public domain - which happens to show more women in the kitchen as opposed to men. AI algorithms are designed to maximize accuracy. So an AI algorithm may decide that all people in the kitchen are women, despite the fact the training data has some images of men in the kitchen. It thereby incorporates a gender bias in the AI system.

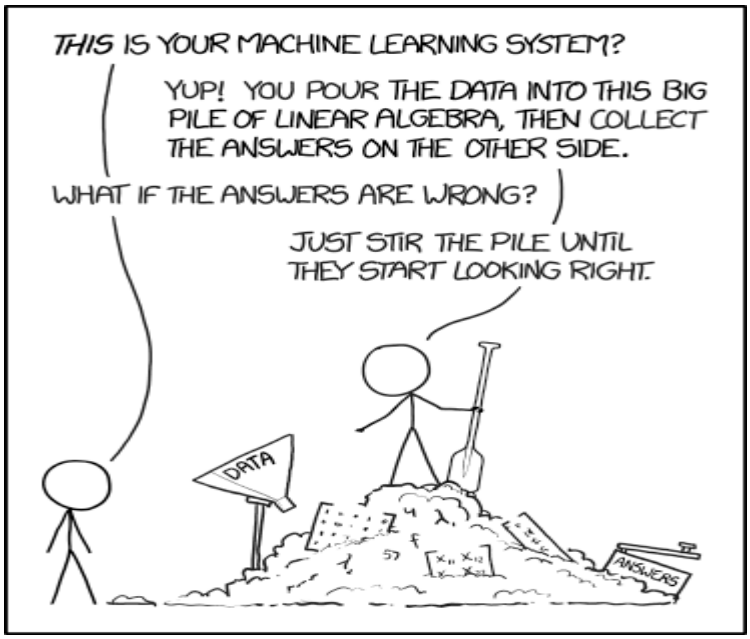
Activity

Can you prepare a list of events where bias appears in the AI system due to the algorithm?

3. People

The last issue is with the people who are developing the AI system i.e. engineers, scientists, developers etc. They aim to get the most accurate results with the available data. They are often lesser focused on the broader context. It is rightly said that ethics and bias are not the problem of the machine but that of the humans behind the machine.

1.4. AI: Ethics, Bias and Trust



(Source :https://xkcd.com/1838/)

Adoption of AI by companies is increasing and they are seeing AI as critical to the future of their business and sustainability. However, there are concerns regarding the possible misuse of the technology, which lead to a trust and confidence issues.

Currently, AI can automate data entry tasks, can take attendance of students in a classroom or can beat Gary Kasparov at chess. However, more complicated usage of algorithms like machine learning or neural networks, makes it less likely for human beings to understand how AI arrived at a conclusion. It is essentially a 'black box' to humans. If a system is so complicated that a user doesn't understand how it works, how can we trust the decisions it makes?

While there is no easy solution to this problem, the way forward is for governments, industry and regulatory bodies to join hands in addressing the challenge of 'AI trust' by doing the following:

1. Minimize bias in training data

2. Share the algorithm with the government/public/users, if possible

- One of the most famous algorithms right now in the world is the 'Google Search'. Sunder Pichai, the Google CEO, had to describe the algorithm to lawmakers, explaining that the search algorithm uses over 200 signals, including relevance and popularity, to determine a page rank. A bipartisan bill was recently proposed by the US lawmakers that would require internet giants such as Google, Facebook, Yahoo and AOL to disclose their search algorithms

  (https://sensecorp.com/ethical-ai/)

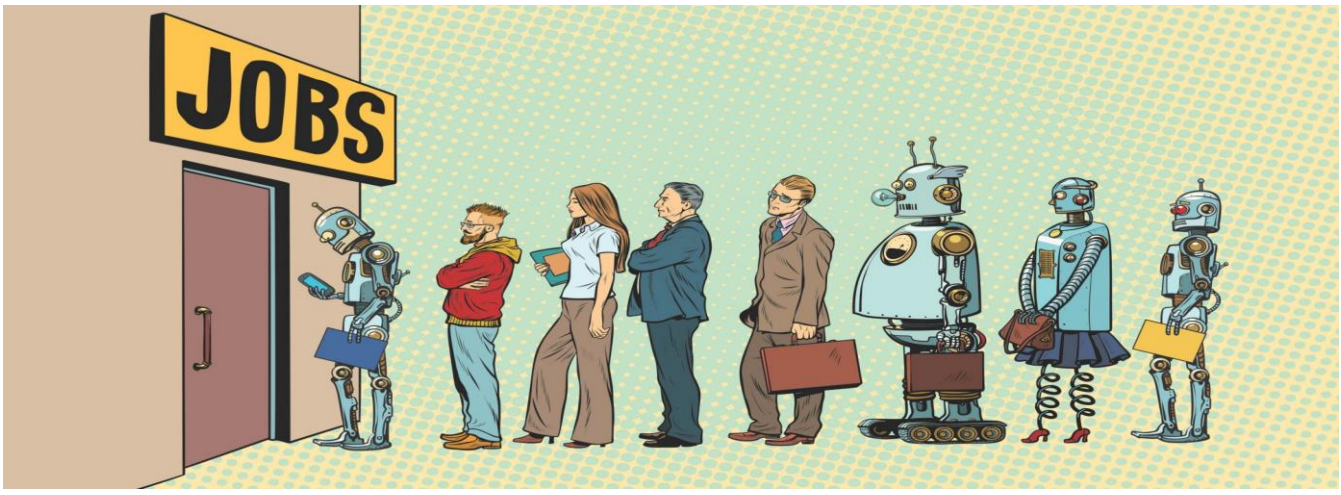
3. AI developers should be representative/inclusive of diverse backgrounds – gender, religion, skin colour, language and so on

4. There should be an international monitoring body that designs and monitors and AI ethics and algorithm policy

1.5. Employment and AI

Activity

Does this picture tell you something? Can you describe this picture in your own words?



Although **Artificial Intelligence** has dramatically improved our world in many ways, there are notable concerns regarding the forthcoming **impact of AI on employment and the workforce**.

Roles and Jobs at Risk:

Jobs that are monotonous and repetitive, can be easily automated; this can gradually lead to certain jobs becoming obsolete.

Activities related to customer care operation, document classification, content moderation, production line in factories etc., are at risk of being taken away by smart robots and software.

- Self-driving cars and trucks will soon be a reality; transportation will see a transportation.
- More traditional professions, such as **legal professions** and accounting will be significantly impacted. In these sectors we will start to see different kinds of roles emerging, which require higher order skills.
- **Financial Services**, **Insurance** and any other sector requiring significant amounts of data processing and content handling will also be impacted to a certain extent. **AI can have a significant role in eliminating bureaucracy**, improving the service to citizens.
- The healthcare sector and imaging services will also have some degree of impact.

It is a fact that AI will create millions of more jobs than the ones that it will affect. These new jobs will require higher order thinking skills.

- Advent of Internet and computers made a few jobs and roles obsolete, but, we know the number of opportunities and new jobs it has created.
- ATMs definitely reduced the number of cashier positions in the banks, but it has had a positive impact on the banking business. ATMs have lowered the cost associated with running brick and motor branches, and as a response banks have responded by opening more ATMs – leading to hiring more bank personnel's for the ATMs.
- AI is becoming adept at language translation i.e. Natural Language Processing (NLP). If the cost of basic translation drops to nearly zero, the cost of doing business with those who speak other languages falls. Thus, it motivates companies to do more business overseas, creating more work for human translators. AI may do the simple translations, but humans are needed for the complicated ones.

Having discussed the above, just as with the internet, the real gains in jobs will come from places where our imagination cannot yet take us.

I would cite here another example from the automobile sector. There used to be two dominant auto makers in India during 70s and 80s –

- Ambassador (https://en.wikipedia.org/wiki/Hindustan_Ambassador)
- Fiat (https://en.wikipedia.org/wiki/Premier_Padmini)

What happened to these models? Do we see them on the roads now? Nobody pushed them out of business, however, their inertia and resistance to change with the changing times and technology, made them run out of business.

Advent of electricity and mechanical engine changed the world. Each of them bettered our lives, created jobs, and raised wages. AI will be bigger than electricity, bigger than mechanization, bigger than anything that has come before it.

We don’t need to fear AI but prepare to reap the benefits of AI!

Let us conclude this unit by enagaging in this activity

Activity

Form groups of 5 students each, and ask the students to prepare a list of

i) 5 jobs or professions that AI will disrupt

ii) 5 job segment that will be immune to AI

iv) 10 new jobs or businesses that will be created by AI

Unit 5: Introduction to Storytelling

Title: Introduction to Storytelling	**Approach: Interactive/ Discussion, Activities**
Summary: Students get to learn about the significance of storytelling which has been used as a medium to pass on knowledge, experience, and information since ages. It also builds intercultural understanding and commonalities thereof. This session will also equip students with a vital skill to tell back their stories with numbers or proof points by blending the two worlds of hard data and human communication. Data visualisation is now a key to interpret and tell an impactful story.	
Objectives: 1. **Students develop an understanding of benefits of powerful storytelling and its need.** 2. **Students appreciate the importance of knowing the audience of their story.** 3. **Students learn to create and deliver effective stories blended with numbers to engage the audience.** 4. **Students demonstrate ability to gain insights from data storytelling.**	
Learning Outcomes: 1. **To get introduced to storytelling.** 2. **Building an impactful story using data for a set of audience.**	
Pre-requisites: Understanding of data and reasonable fluency in English language.	
Key Concepts: Data visualisation and storytelling.	

Purpose: Introduce the importance of storytelling and its effectiveness in passing on knowledge, values, facts and events from one generation to another.

Say: "This unit intends to create value for storytelling. Although storytelling comes naturally to everyone, keeping a few things in mind not only enriches the said art but also makes it more impactful. This unit also dwells on the art of storytelling and how blending stories with numbers/ data can make storytelling forceful."

After having briefed the students about storytelling, ask them to answer the questions that follow and gauge their understanding of the subject. Engage the students in a discussion and ask them about their expectations from this unit.

1. Storytelling: Communication across the ages

Stories have been central to human cognition and it has proved to be the most effective way of communication since time immemorial. There is a bio-chemical reason why people love stories. It's the mode of communication our brains biologically prefer. **When a good story is told the brain comes alive because storytelling literally has a chemical effect on the brain that wakes it up in order to absorb, digest and store information.** Stories have the power to inspire, motivate, and change people's opinions. In short stories are the best possible way to deliver complex information (data).

Storytelling is defined as the art of narrating stories to engage an audience. It originated in the ancient times with visual stories, such as cave drawings, and then shifted to oral traditions, in which stories were passed down from generation to generation by word of mouth. **Later,** words formed into narratives, that included written, printed and typed stories. Written language, as it is seen now, was arguably the first technological innovation, that gave us as a species the power to convey story in a physical format, and thus visualize, archive and share that data with community members and future generations. It encourages people to make use of their imagination and inventiveness (creativity) to express themselves (verbal skills) which makes it **a lot more than just a recitation of facts and events.**

What do you understand by storytelling?

_____
_____
_____

What are the three forms of storytelling?

_____
_____
_____

Expected Responses: Visual, Oral and Written.

What skills do storytelling help develop?

_____
_____
_____

Expected Responses: Imagination, inventiveness, creativity and articulation.

Energiser: Ask the students to watch the video https://www.youtube.com/watch?v=GxcGVCEEdcU and change the end of the story using their imaginativeness and creativity.

1.1. Learn why storytelling is so powerful and cross-cultural, and what this means for data storytelling

Stories create engaging experiences that transport the audience to another space and time. They establish a sense of community belongingness and identity. For these reasons, storytelling is considered a powerful element that enhances global networking by increasing the awareness about the cultural differences and enhancing cross-cultural understanding. Storytelling is an integral part of indigenous cultures.

Some of the factors that make storytelling powerful are its attribute to make information more compelling, the ability to present a window in order to take a peek at the past, and finally to draw lessons and to reimagine the future by affecting necessary changes. Storytelling also shapes, empowers and connects people by doing away with judgement or critic and facilitates openness for embracing differences.

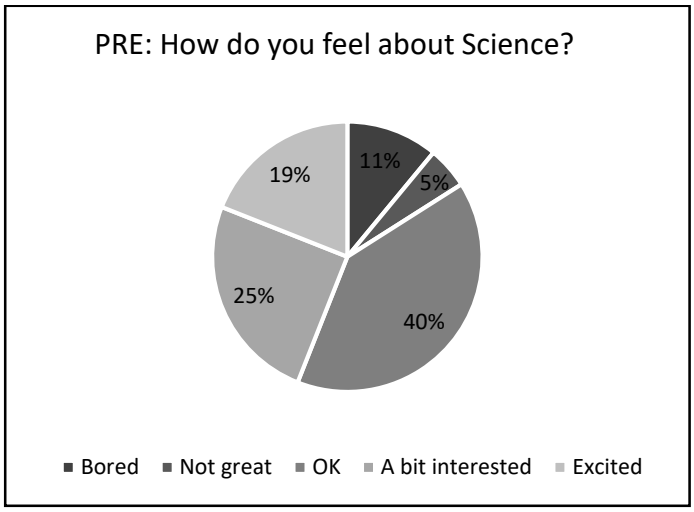
A well-told story is an inspirational narrative that is crafted to engage the audience across boundaries and cultures, as they have the impact that isn't possible with data alone. Data can be persuasive, but stories are much more. They change the way that we interact with data, transforming it from a dry collection of "facts" to something that can be entertaining, engaging, thought provoking, and inspiring change.

Each data point holds some information which maybe unclear and contextually deficient on its own. The visualizations of such data are therefore, subject to interpretation (and misinterpretation). However, stories are more likely to drive action than are statistics and numbers. Therefore, when told in the form of a narrative, it reduces ambiguity, connects data with context, and describes a specific interpretation – communicating the important messages in most effective ways. The steps involved in telling an effective data story are given below:

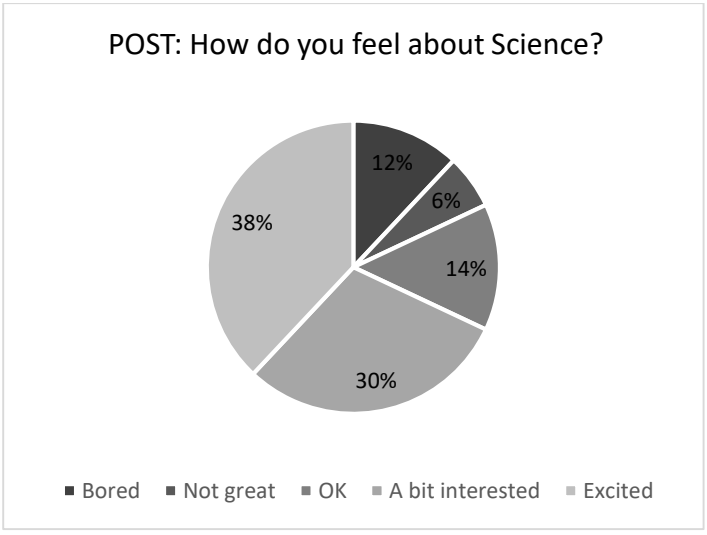
- Understanding the audience
- Choosing the right data and visualisations
- Drawing attention to key information
- Developing a narrative
- Engaging your audience

Activity

A new teacher joined the ABC Higher Secondary School, Ambapalli to teach Science to the students of Class XI. In his first class itself, he could make out that not everyone understood what was being taught in class. So, he decided to take a poll to assess the level of students. The following graph shows the level of interest of the students in the class.



Depending on the result obtained, he changed his method of teaching. After a month, he repeated the same poll once again to ascertain if there was any change. The results of poll are shown in the chart below.



With the help of the information provided create a good data story setting a strong narrative around the data, making it is easier to understand the pre and post data, existing problem, action taken by the teacher, and the resolution of the problem. Distribute A4 sheets and pens to the students for this activity.

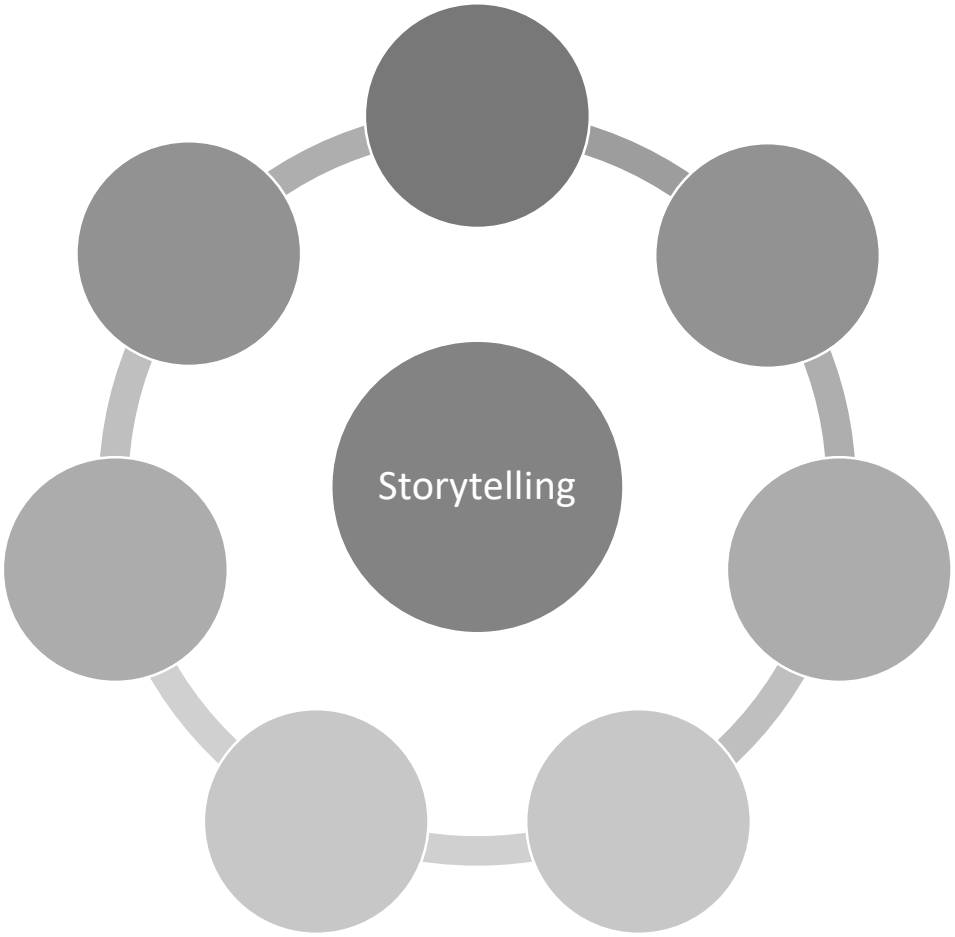
2. The Need for Storytelling

The need for storytelling is gaining importance like never before, as more and more people are becoming aware of its potential to achieve multipurpose objectives.

Purpose: To familiarize students with the need for storytelling and how it proves beneficial.

Say: “Now that you have learnt about storytelling and its power, we will introduce you to the need of storytelling.”

Guide the students to think of the many needs that storytelling satisfies and enter in the blank circles in the figure below:



Expected Responses:

- *Storytelling acts as an emotional glue to connect a diverse audience* – It is an important way to tap into the heart of the audience also conveying a deeper message based on emotion.
- *Information presented in a structured manner* – Organising information into a definite format with a beginning (setting the stage), middle (the challenge), and ending (solution to the problem and a new beginning) works for many topics.
- *Storytelling reshapes knowledge and helps communicate something meaningful* – Stories have been used to pass on knowledge. When the knowledge gets embedded in the context of a story, it is transferred or communicated to the listener in a unique way.
- *Storytelling is persuasive and influential* – It can persuade people to execute plans towards a certain future or objective.
- *Helps transcend one's current envir*onment – Good storytelling can transport people into another world.
- *Storytelling achieves adding meaning to data* - Many people perceive data as meaningless numbers when data is disconnected to anything important. But when the data is placed in the context of a story, it comes alive.
- *Storytelling can be motivating for the audience* – Inspire people to buy into a mission or cause.

3. Storytelling with Data

Session Preparation

Logistics: For a class of ____ students. [Group Activity]

Materials Required

Purpose: To provide insight into data storytelling and how it can bring a story to life.

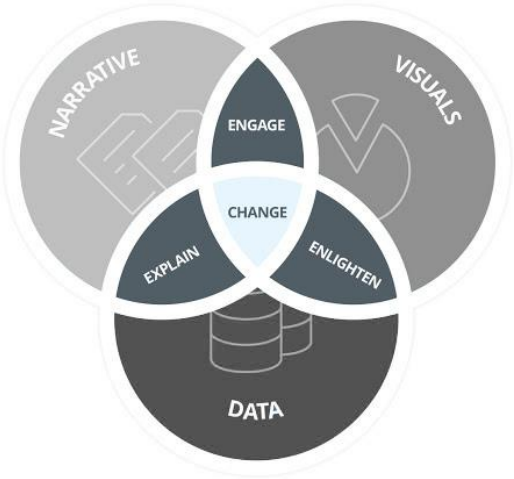
Say: "Now that you have understood what storytelling is and why it is needed, let us learn about a storytelling of a different kind - the art of data storytelling and in the form of a narrative or story."

ITEM	QUANTITY
A4 sheets	Xx
Pens	Xx

Data storytelling is a structured approach for communicating insights drawn from data, and invariably involves a combination of three key elements: ***data***, ***visuals***, and ***narrative***. When the narrative is accompanied with data, it helps to ***explain*** the audience what's happening in the data and why a particular insight has been generated. When visuals are applied to data, they

can ***enlighten*** the audience to the insights that they wouldn't perceive without the charts or graphs.

Finally, when narrative and visuals are merged together, they can ***engage*** or even entertain an audience. When you combine the right visuals and narrative with the right data, you have a data story that can influence and drive ***change***.



3.1. By the numbers: How to tell a great story with your data?

Presenting the data as a series of disjointed charts and graphs could result in the audience struggling to understand it – or worse, come to the wrong conclusions entirely. Thus, the importance of a narrative comes from the fact that it explains what is going on within the data set. It offers a context and meaning, relevance and clarity. A narrative shows the audience where to look and what not to miss and also keeps the audience engaged.

Good stories don't just emerge from data itself; they need to be unravelled from data relationships. Closer scrutiny helps uncover how each data point relates with other. Some easy steps that can assist in finding compelling stories in the data sets are as follows:

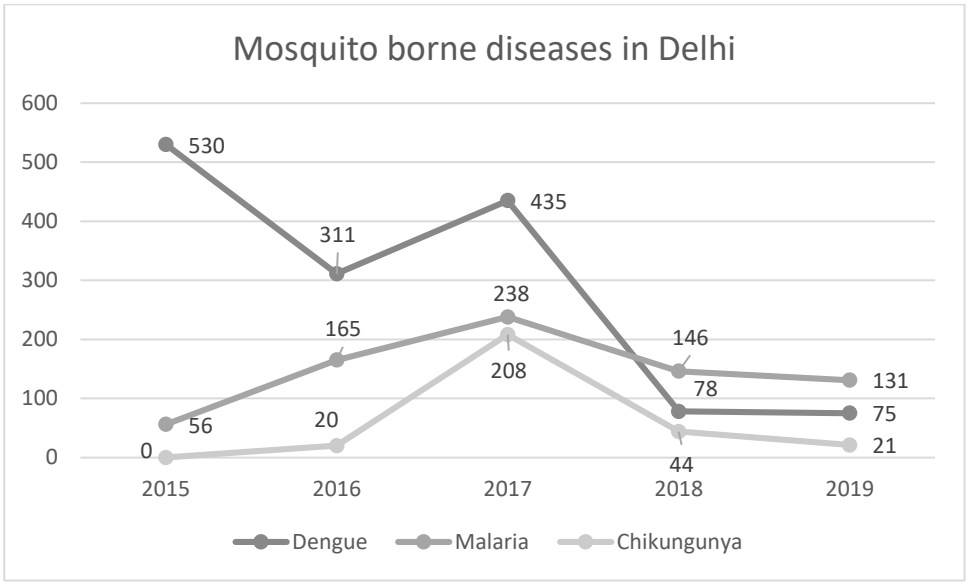
Step 1: Get the data and organise it.

Step 2: Visualize the data.

Step 3: Examine data relationships.

Step 4: Create a simple narrative embedded with conflict.

Activity: Try creating a data story with the information given below and use your imagination to reason as to why some cases have spiked while others have seen a fall.

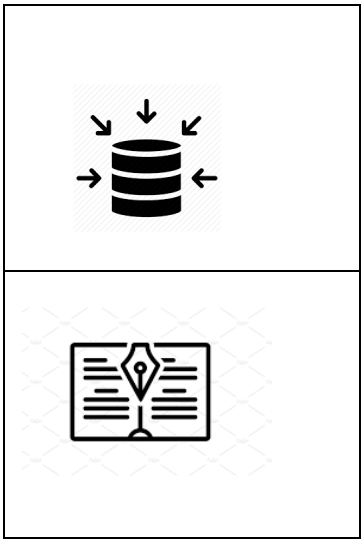


Data storytelling has acquired a place of importance because:

- It is an effective tool to transmit human experience. Narrative is the way we simplify and make sense of a complex world. It supplies context, insight, interpretation—all the things that make data meaningful, more relevant and interesting.
- No matter how impressive an analysis, or how high-quality the data, it is not going to compel change unless the people involved understand what is explained through a story.
- Stories that incorporate data and analytics are more convincing than those based entirely on anecdotes or personal experience.
- It helps to standardize communications and spread results.
- It makes information memorable and easier to retain in the long run.

Data Story elements challenge –

Identify the elements that make a compelling data story and name them



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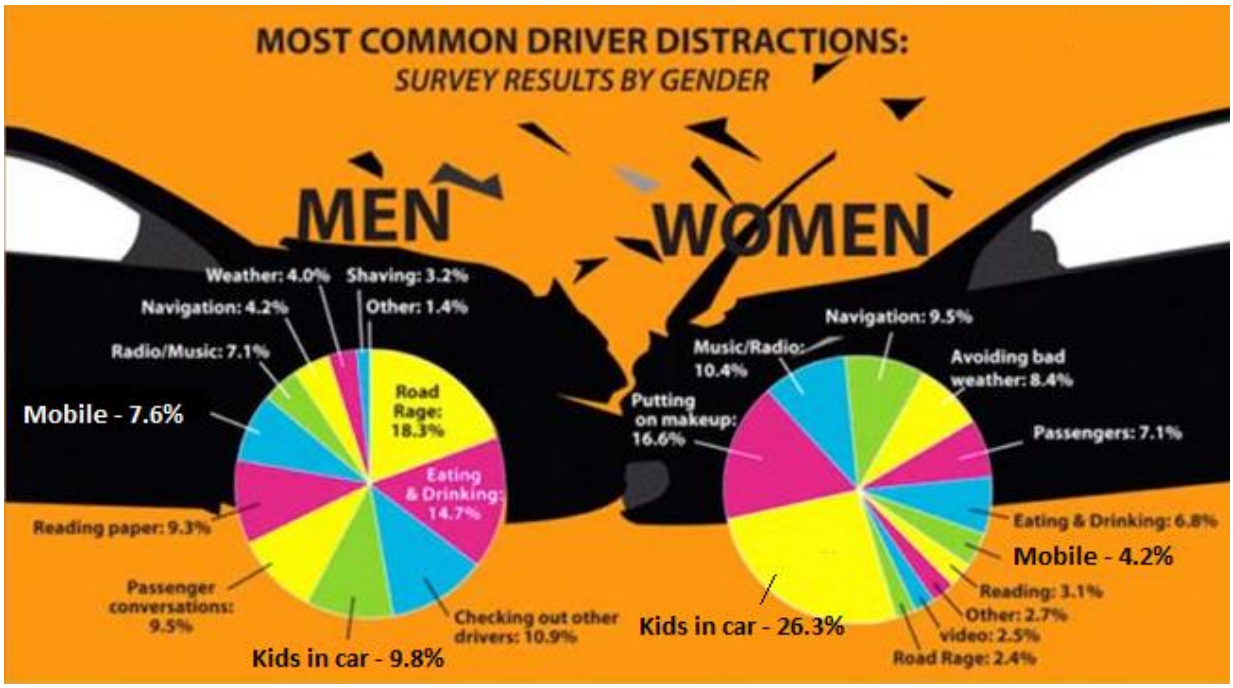
Activity:

First present the statistics as shown below. Ask the students to read it and say if they have understood information presented well.

1. **7.6% of men** believe mobiles are a distraction as compared to **4.2% of the women**.
2. Kids in the car cause **9.8% of the men** to be distracted as compared to **26.3% of the women**.

Another way to recreate the same statistics is the visual shown below:



Ask the students which one tells a better story and list out why?

(**Expected Response:** The former way of presenting story is far more detailed and easier to comprehend.)

4.Conflict and Resolution

Conflict is the most exciting and engaging drive in any story. Every story or plot is centred on its conflict and the ways in which the characters of the story attempt to resolve the problem. Conflict in a story is a struggle between two or more opposing forces. Conflict in a story drives the plot forward towards a resolution.

What is Data storytelling, conflict and resolution?

In a business or our daily life, the users or audience are trying to resolve a conflict always. All decisions have to be made after resolving the conflict. Every question answered in data storytelling is by the means of finding evidence to a conflict.

SKILLS THAT RESOLVE CONFLICT IN A DATA STORYTELLING:

1. Communication
2. Teamwork
3. Problem Solving
4. Stress management
5. Emotional agility

Activity

A school has planned its annual meet for the for the year. 15 students can participate in a drama for which 28 students showed interest to participate. The teacher co-ordinator decides to leave the decision on the 28 students to unanimously select 15 students who will participate in the drama.

Recognise the conflict and way to resolve it.

5.Storytelling for Audience

Here we have seven pointers to become an engaging storyteller

1. Engross the audience in your story
2. Link up with your personal story
3. Create suspense till end
4. Bring characters to life
5. Show, don't tell
6. Build up a peek moment
7. Climax should have a positive takeaway

Data storytelling has few elements without which storytelling is impossible. Let us have a look at them:

1. Character-who populates the story
2. Plot-what takes place in the story
3. Setting-where the story takes place
4. Point of view-participation of narrator and audience
5. Style-skills attained for storytelling
6. Literacy devices-knowledge of technology

Let's do an activity

Create a data story to highlight changes you see in yourself after the outbreak of COVID 19 followed by lockdown in the country.

Extra Resources for further Reference:

Link for storytelling: https://www.khanacademy.org/humanities/hass-storytelling/storytelling-pixar-in-a-box/ah-piab-we-are-all-storytellers/v/storytelling-introb

Link for storytelling: https://www.youtube.com/watch?v=uAG8c-sapUE

Link for storytelling: http://storywards.com/en/what-is-storytelling/