ARTIFICIAL INTELLIGENCE CURRICULUM

Class 10

Facilitator Handbook

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ARTIFICIAL INTELLIGENCE CURRICULUM

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About the Book

In the rapidly evolving landscape of the global digital economy, Artificial Intelligence (AI) stands as the cornerstone of future innovation and growth. Recognizing this, nations worldwide are strategically positioning themselves to harness the transformative potential of AI. India, in particular, views AI not just as a technological advancement but as an opportunity to foster inclusive economic growth and social development.

At the forefront of this vision is the Central Board of Secondary Education (CBSE), which is on a mission to equip the next generation with the skills and mindset necessary to thrive in an AI-driven world. As part of this initiative, CBSE has collaborated with Intel India since 2019, to curate a comprehensive Facilitator Handbook and accompanying AI training resources. The resources aim to empower educators and students alike, fostering a deeper understanding of AI concepts and their practical applications.

This edition of the 'AI Facilitator Handbook' is more than just a curriculum; it's a roadmap for students to navigate the complexities of AI with confidence and creativity. Enriched with updated AI tech and social concepts, real-life examples, and AI project development guides using no-code tools, this book is designed to inspire students to not only understand AI but also to leverage it to drive positive social change.

Key features include:

- Enhanced Content: Concepts are presented with further elaboration and fresh examples to facilitate deeper engagement and comprehension.
- Real-Life Examples: Additional real-world scenarios are integrated to offer clearer explanations, making complex AI concepts accessible to students.
- AI enabled social impact solutions: Students are encouraged to develop AI solutions for social impact in a straightforward manner, fostering understanding and empowerment.
- Use Case Walkthroughs: Practical implementation of AI concepts is demonstrated across various domains, enabling students to grasp their real-world applications.

Grade X Artificial Intelligence

Units	Sessions	Topics	Hours
Unit -1-Revisiting AI Project Cycle & Ethical Frameworks for AI1	1.1 AI Project Cycle	The overview of the six stages of theAI Project Cycle	15
	1.2 Introduction to AIDomains	The three domains of AI and theirapplications	
	1.3 Ethical Frameworks of AI	• Frameworks • Ethical frameworks • Need of Ethical Frameworks for AI • Factors that influence our decision-making • Types of Ethical Frameworks • Bioethics and its principles • A use case of Bioethics	
Unit 2. Advancedconcepts of Modeling in AI	2.1 Revisiting AI, ML and DL	• Differentiate between AI, MLand DL • Common terminologies usedwith data	25
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	2.3 Neural Networks	• What is neural network? • How does AI make a decision?	
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Unit 5: ComputerVision	5.2 Applications of CV	• Facial Recognition • Face Filters • Google Search by Image • Computer Vision in retail • Self-Driving cars • Medical Imaging • Google Translate App	30
	5.3 Computer Vision Tasks	• Classification • Classification + Localisation • Object Detection • Image Segmentation • Basics of Images and Pixels • Resolution & Pixel Value • Grayscale & RGB Images	
	5.4 No-Code AI tools	• Introduction to Lobe • Teachable Machine • Smart Sorter Activity • Orange Data Mining Tool • Use Case Walkthrough • Steps to project development	
	5.5 Image Features	• Introduction to image features • Examples • Conclusion	
	5.6 Convolution	• Convolution • What is Kernel?	
	5.7 Convolution NeuralNetwork	• Introduction • Convolution Layer • Rectified Linear Unit • Pooling Layer • Fully Connected Layer	
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	6.2 Applications of NaturalLanguage Processing	• Voice Assistants • Autogenerated captions • Language translation • Sentiment analysis • Text classification • Keyword extraction	
	6.3 Stages of Natural Language Processing (NLP)	• Lexical Analysis • Syntactic Analysis • Semantic Analysis • Discourse Integration • Pragmatic Analysis	
	6.4 Chatbots	Differences between a Script bot anda Smart bot	
	6.5 Text Processing	• Text Normalisation • Bag of words • TFIDF • Applications of TFIDF	
	6.6 Natural Language Processing: Use Case Walkthrough	• Examples of code and no-code tools • Applications of Sentiment Analysis • Sentiment Analysis using the Orange Data Mining tool.	

Unit–1: Revisiting AI Project Cycle & Ethical Frameworks for AI

Lesson Title: Ethical Frameworks for AI	**Approach:** Session + Activity

Summary: There is a recapitulation of the AI Project Cycle and various domains of AI. Students will be introduced to ethics in AI and they will explore ethical frameworks for AI. They understand the need for such frameworks and the various factors that contribute tocoming up with a framework of their own. They will also learn about different types of ethical frameworks and explore one of these frameworks in detail. The module concludes with a case study on how to apply ethical frameworks to AI solutions to avoid their unintended consequences.

Learning Objectives:

Students are:

1. Briefed on the various stages of the AI Project Cycle.
2. Briefed on the different domains of AI and their applications.
3. Introduced to the ethical frameworks for AI.
4. Introduced to types of ethical frameworks.
5. Introduced to the principles of bioethics.

Learning Outcomes:

Students will be able to:

1. Outline the six stages of the AI Project Cycle.
2. Elucidate the AI domains and their applications.
3. Describe what are frameworks and ethical frameworks.
4. Classify ethical frameworks based on sectors and value addition.
5. Explore the bioethical framework and its principles in detail.
6. Practice the application of an ethical framework for AI.

Pre-requisites:

1. Basic knowledge of AI.
2. Basic understanding of ethics and ethics in AI.

Key-concepts:

1. Introduction to ethical frameworks for AI
2. Types of ethical frameworks
3. Application of ethical frameworks for AI
4. Principles of bioethics

1.1: AI Project Cycle

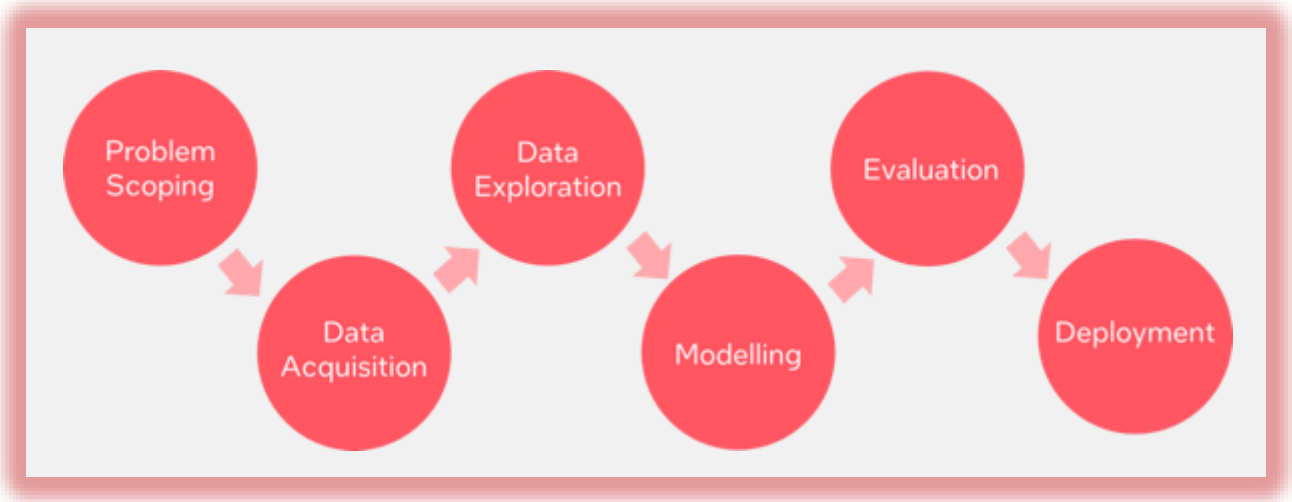
Let's revisit the concept of the AI Project Cycle.

Introduction

Let us assume that you have to make a greeting card for your mother as it is her birthday. You are very excited about it and have thought of many ideas to execute the same. Let us look at some of the steps which you might take to accomplish this task:

1. Look for some cool greeting card ideas from different sources. You might go online and check out some videos or you may ask someone who knows about it.
2. After finalising the design, you would make a list of things that are required to make this card.
3. You will check if you have the material with you or not. If not, you could go and get all the items required, ready for use.
4. Once you have everything with you, you will start making the card.
5. If you make a mistake in the card somewhere which cannot be rectified, you will discard it and start remaking it.
6. Once the greeting card is made, you will gift it to your mother.

These steps show how we plan to execute the tasks around us. Consciously or subconsciously our mind makes up plans for every task which we have to accomplish which is why things become clearer in our mind. Similarly, if we have to develop an AI project, the AI Project Cycle provides us with an appropriate framework which can lead us towards the goal. The AI project cycle is the cyclical process followed to complete an AI project. The AI Project Cycle mainly has 6 stages:



Starting with Problem Scoping, you set the goal for your AI project by stating the problem which you wish to solve with it. Under problem scoping, we look at various parameters which affect the problem we wish to solve so that the picture becomes clearer.
To proceed,

● You need to acquire data which will become the base of your project as it will help you understand what the parameters that are related to problem scoping are.

● You go for data acquisition by collecting data from various reliable and authentic sources. Since the data you collect would be in large quantities, you can try to give it a visual image of different types of representations like graphs, databases, flow charts, maps, etc. This makes it easier for you to interpret the patterns which your acquired data follows.

● After exploring the patterns, you can decide upon the type of model you would build to achieve the goal. For this, you can research online and select various models which give a suitable output.

● You can test the selected models and figure out which is the most efficient one.

● The most efficient model is now the base of your AI project and you can develop your algorithm around it.

● Once the modelling is complete, you now need to test your model on some newly fetched data. The results will help you in evaluating your model and improving it.

● Finally, after evaluation, the deployment stage is crucial for ensuring the successful integration and operation of AI solutions in real-world environments, enabling them to deliver value and impact to users and stakeholders.

1.2: Introduction to AI Domains

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

Statistical Data

Statistical Data is a domain of AI related to data systems and processes, in which the system collects numerous data, maintains data sets and derives meaning/sense out of them.
The information extracted through statistical data can be used to make a decision about it.

Example of Statistical Data

Price Comparison Websites

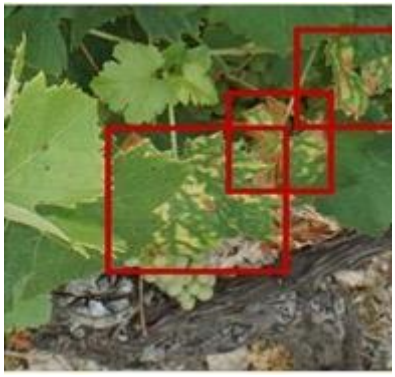
These websites are being driven by lots and lots of data. If you have ever used these websites, you would know, the convenience of comparing the price of a product from multiple vendors in one place. PriceGrabber, PriceRunner, Junglee, Shopzilla, DealTime are some examples of price comparison websites.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

Computer Vision

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

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

Examples of Computer Vision



Agricultural Monitoring

Computer vision is employed in agriculture for crop monitoring, pest detection, and yield estimation. Drones with cameras capture aerial images of farmland, which are then analysed to assess crop health and optimize farming practices.

Surveillance Systems

Computer vision is used in surveillance systems to monitor public spaces, buildings, and borders. It can detect suspicious activities, track individuals or vehicles, and provide real-time alerts to security personnel.

Natural Language Processing

Natural Language Processing, abbreviated as NLP, is a branch of artificial intelligence that deals with the interaction between computers and humans using the natural language. Natural language refers to language that is spoken and written by people, and natural language processing (NLP) attempts to extract information from the spoken and written word using algorithms.
The ultimate objective of NLP is to read, decipher, understand, and make sense of human languages in a valuable manner.

Examples of Natural Language Processing

Email filters

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

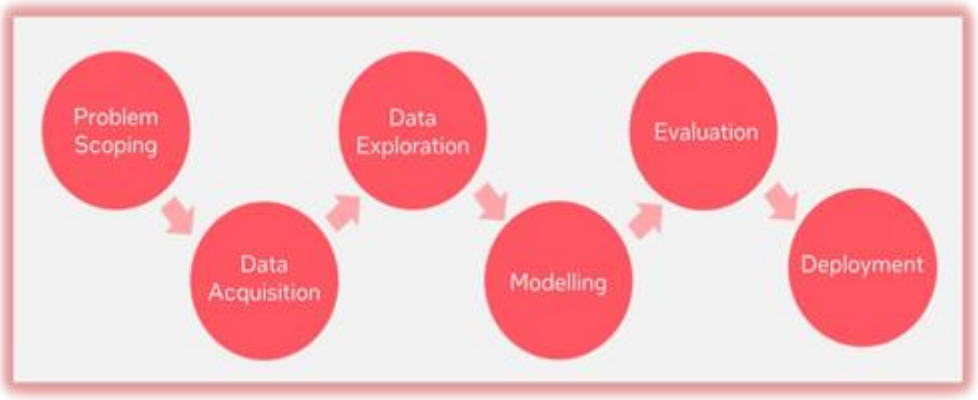
Machine Translation

NLP is used in machine translation systems like Google Translate and Microsoft Translator to automatically translate text from one language to another. These systems analyze the structure and semantics of sentences in the source language and generate equivalent translations in the target language.

1.3: Ethical Frameworks for AI

Frameworks

Frameworks are a set of steps that help us in solving problems. It provides a step-by-step guide for solving problems in an organized manner. Moreover, frameworks offer a structured approach to problem-solving, ensuring that all relevant factors and considerations are taken into account. Additionally, they serve as a common language for communication and collaboration, facilitating the sharing of best practices and promoting consistency in problem- solving methodologies.
You may have used frameworks without knowing it! Can you think of one framework you have come across during your AI journey?



Ethical Frameworks

We know that ethics are a set of values or morals which help us separate right from wrong. Frameworks are step-by-step guidance on solving problems.

Hence, Ethical frameworks are frameworks which help us ensure that the choices we make do not cause unintended harm.
Furthermore, ethical frameworks provide a systematic approach to navigating complex moral dilemmas by considering various ethical principles and perspectives. By utilizing ethical frameworks, individuals and organizations can make well-informed decisions that align with their values and promote positive outcomes for all stakeholders involved.

Why do we need Ethical Frameworks for AI?

As we have seen how bias could result in unwanted outcomes in AI solutions. Think of thehiring algorithm which was biased against women applicants!

AI is essentially being used as a decision-making/ influencing tool. As such we need to ensure that AI makes morally acceptable recommendations

Ethical frameworks ensure that AI makes morally acceptable choices. If we use ethical frameworks while building our AI solutions, we can avoid unintended outcomes, even before they take place!

So far, we have understood why ethical frameworks are needed.Let's

try to guess what such a framework would be made of!

Activity: 1 My Goodness

Purpose: To understand how our decisions get influenced by our personal morals, values and ethics!

Say: "Carefully read the descriptions provided that help you decide on donating. Explore your decision-making ability."

Visit the website – https://www.my-goodness.net/

Take a quick look at the video to learn more about the game!

Players must make 10 decisions on how they would like to make a charitable donation. In most cases, players will receive details about the recipients. They will also be given information on the intended use of the money they are donating. In a few instances, this may be hidden from them, however they can choose to reveal it.

This activity aims to understand an individual's judgment. We are looking to discover potential biases within us!

Data is collected anonymously and with your consent.

If you wish to delve deeper and explore your own decision-making, click on "yes."

After clicking on “yes” you will be taken to a short survey.
After the survey has been filled, you will see interesting insights about your decisions

Did you discover any internal biases in your decisions?

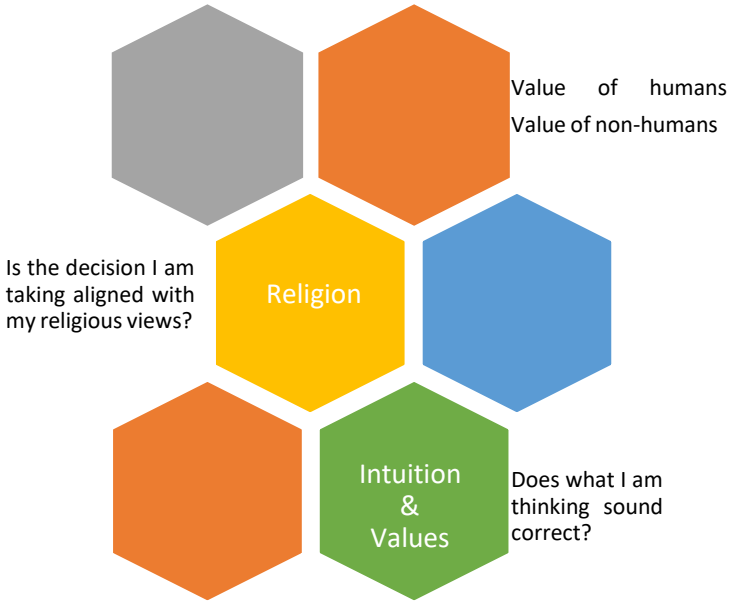
Do you agree with the results shared by thegame?

Factors which could influence your decisions without you realizing it include

- Identity of the charity recipient.
- Location of the recipient.
- Bias towards relatives.
- Uncovering information available.

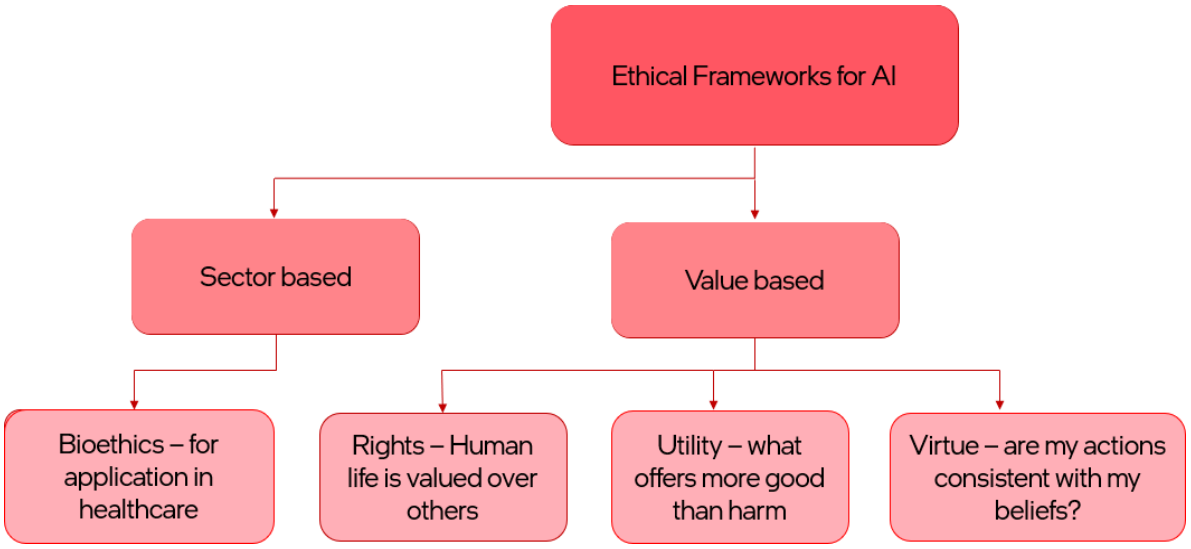
This is just an exercise to uncover our biases and thought processes behind making certain decisions. This will help us in producing a framework which can aid in making decisions which are ethically sounder.

Let’s list at least **3 factors** which knowingly or unknowingly influence our decision-making.



Types of Ethical Frameworks

The various types of ethical frameworks are classified as follows:



Let's delve into the classifications of ethical frameworks.

Ethical frameworks for AI can be categorized into **two main** types: sector-based and value-based frameworks.

1. Sector-based Frameworks:

These are frameworks tailored to specific sectors or industries. In the context of AI, one common sector-based framework is Bioethics, which focuses on ethical considerations in healthcare. It addresses issues such as patient privacy, data security, and the ethical use of AI in medical decision-making. Sector-based ethical frameworks may also apply to domains such as finance, education, transportation, agriculture, governance, and law enforcement.

2. Value-based Frameworks:

Value-based frameworks focus on fundamental ethical principles and values guiding decision-making. It reflects the different moral philosophies that inform ethical reasoning. Value-based frameworks are concerned with assessing the moral worth of actions and guiding ethical behaviour. They can be further classified into three categories:

i. Rights-based: Prioritizes the protection of human rights and dignity, valuing human life over other considerations. It emphasizes the importance of respecting individual autonomy, dignity, and freedoms. In the context of AI, this could involve ensuring that AI systems do not violate human rights or discriminate against certain groups.

ii. Utility-based: Evaluates actions based on the principle of maximizing utility or overall good, aiming to achieve outcomes that offer the greatest benefit and minimize harm. It seeks to

maximize overall utility or benefit for the greatest number of people. In AI, this might involve weighing the potential benefits of AI applications against the risks they pose to society, such as job displacement or privacy concerns.

iii. Virtue-based: This framework focuses on the character and intentions of the individuals involved in decision-making. It asks whether the actions of individuals or organizations align with virtuous principles such as honesty, compassion, and integrity. In the context of AI, virtue ethics could involve considering whether developers, users, and regulators uphold ethical values throughout the AI lifecycle.

These classifications provide a structured approach for addressing ethical concerns in AI development and deployment, ensuring that considerations relevant to specific sectors and fundamental ethical values are adequately addressed.

Let's explore a popular framework which is used in the healthcare industry.

Bioethics

Bioethics is an ethical framework used in healthcare and life sciences. It deals with ethical issues related to health, medicine, and biological sciences, ensuring that AI applications in healthcare adhere to ethical standards and considerations.

Principles of bioethics:

- Respect for Autonomy.
- Do not harm.
- Ensure maximum benefit for all.
- Give justice.

• "**Non-maleficence**" refers to the ethical principle of avoiding causing harm or negative consequences. It emphasizes the obligation to minimize harm as much as possible and prioritize actions that prevent harm to individuals, communities, or the environment.

• "**Maleficence**" refers to the concept of intentionally causing harm or wrongdoing.

• "**Beneficence**" refers to the ethical principle of promoting and maximizing the well-being and welfare of individuals and society. It emphasizes taking actions that produce positive outcomes and contribute to the overall good, ensuring that the greatest benefit is achieved for all stakeholders involved.

Let’s look at a case study and see the impact of the application of an AI ethical framework on the end outcome.

Case Study

A company aimed to support hospitals in optimizing patient care by creating an AI algorithm designed to identify individuals at high risk. The objective was to provide healthcare providers with valuable insights to allocate resources effectively and ensure those most in need receive appropriate attention. However, potential unintended consequences lead to some problems in the model, such as the algorithm inadvertently exacerbating existing biases or inaccuracies in the data, potentially leading to misclassification of patients or overlooking critical cases. Addressing concerns about the algorithm's accuracy and reliability becomes paramount, as any flaws in its designor training data could compromise patient care and outcomes

The problem it caused:

Patients from the Western region of a particular area, who were categorized at the same risk level by the algorithm, generally exhibited more severe health conditions compared to patients from other regions.

Why the problem happened:

- The algorithm utilized was trained on healthcare expense data as a measure for health metrics rather than actual physical illness.
- This algorithm was created in the United States where less money is spent on western region patient healthcare than other ethnic patient healthcare.

This meant the algorithm

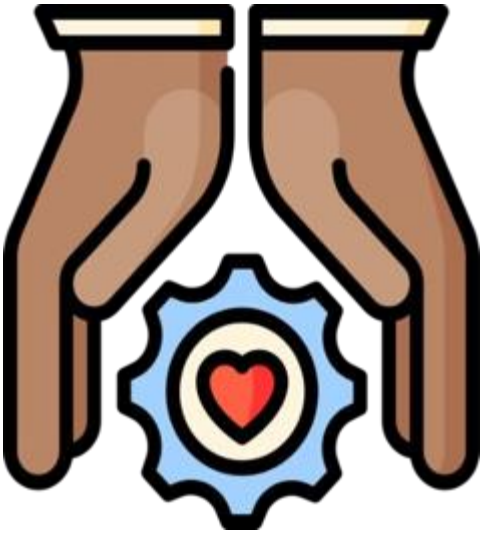
We can use principles of the Bioethics framework to ensure an ethical AI solution.

The **four principles** of bioethics can be used to ensure an ethical AI solution for the healthcare problem.

i. Respect for autonomy: Enabling users to be fully aware of decision-making. E.g., users of an AI algorithm should know how it functions.

- The data that models were trained on, and used to make decisions, should be reproducible and accessible to the patients.
- In the event of performance concerns, model predictions and data labels should be released.

ii. Do not harm: Harm to anyone (be it human or non–human) must be avoided at all costs. If no choice is available path of least harm must be always chosen.



- Promote well-being, minimize harm, and ensure that benefits and harms are distributed among stakeholders in a just manner.
- The AI algorithm must be trained on data sets that equitably reduce harm for all, not just harm for some groups.
- In this instance, patients from other regions excluding western part who were less ill would receive more intensive care from doctors than patients who actuallyrequire help.
- This algorithm, if implemented, would actively harm patients belong to western region by inappropriately recommending healthcare resource allocation.

iii. Maximum benefit: Not only should we avoid harm our actions must focus on providing the maximum benefit possible.

- The solution should be held to clinical practice standards, not merely technological ethics standards.
- It should go beyond nonmaleficence and strive for beneficence.
- Considering the example, we discussed, the AI algorithm should not only avoid causing harm to patients from the western region but also provide benefits to these patients, as well as patients from other regions and of all races.
- Is there a better data set for training that reflects the healthcare needs and outcomes of patients of all races?
- The data we use for training must be unbiased.

iv. Justice: All benefits and burdens of a particular choice must be distributed in a justified manner across people irrespective of their background.

- Solution development requires concerted and in-depth knowledge of social structures at play that result in issues like racism and sexism (a few types of societal biases).
- The solution needs to be aware of social determinants of healthcare and actively work against those structures.

We saw that abiding by bioethical principles could have helped us to avoid the unintended consequences of the AI solution.

Test Yourself:

1. What is the purpose of defining the problem statement during the Problem Scoping stage in an AI project cycle?
A) To collect data
B) To understand the aim and objective of the project
C) To train the model
D) To process data

2. In what ways can AI models be categorized based on the type of data fed into them?
A) Two domains
B) Four domains
C) Three domains
D) Five domains

3. In Statistical Data, what is the primary function of the system in relation to data?
A) Generating large datasets
B) Analyzing data to extract insights
C) Converting data into images
D) Distributing data across networks

4. What is the main goal of Computer Vision projects?
A) Translating audio data into visual descriptions
B) Converting digital data into analogue signals
C) Teaching machines to understand textual information
D) Converting digital visual data into computer-readable language

5. What is the primary focus of NLP?
A) Analyzing computer languages
B) Interacting between computers and humans using artificial language
C) Dealing with the interaction between computers and humans using natural language
D) Enhancing human-to-human communication

6. What do frameworks provide in the context of problem-solving?
A) Random solutions
B) Step-by-step guidance
C) Legal advice
D) Ethical justifications

7. How are Ethical Frameworks for AI categorized?
A) Into legal and illegal frameworks
B) Into sector-based and value-based frameworks
C) Into historical and contemporary frameworks
D) Into theoretical and practical frameworks

8. What is the central focus of virtue-based value-based frameworks?
A) Maximizing utility
B) Protecting human rights
C) Aligning actions with ethical principles and beliefs
D) Ensuring compliance with legal regulations

9. Which of the following best describes rights-based value-based frameworks?
A) Prioritizing human rights and dignity, valuing human life over other considerations
B) Evaluating actions based on maximizing overall good and minimizing harm
C) Centering on the character of the decision-maker and the alignment of actions with personal or societal virtues
D) Focusing on achieving outcomes that offer the greatest benefit

10. What is the primary domain of application for Bioethics?
A) Agriculture
B) Healthcare and life sciences
C) Information technology
D) Environmental conservation

11. Assertion: Ethics provide guidance in distinguishing right from wrong.

Reasoning: Ethics consist of a set of values and morals that aid individuals in making moral judgments and decisions.

A) Both Assertion and Reasoning are true, and Reasoning is the correct explanation of the Assertion.

B) Assertion is true, but Reasoning is false.

C) Both Assertion and Reasoning are true, but Reasoning is not the correct explanation of the Assertion.

D) Assertion is false, but Reasoning is true.

12. Assertion: Value-based frameworks in ethics provide guidance by focusing on fundamental ethical principles and values.

Reasoning: These frameworks reflect different moral philosophies guiding ethical reasoningand are concerned with assessing the moral worth of actions.

A) Both Assertion and Reasoning are true, and Reasoning is the correct explanation of the Assertion.

B) Assertion is true, but Reasoning is false.

C) Both Assertion and Reasoning are true, but Reasoning is not the correct explanation of the Assertion.

D) Assertion is false, but Reasoning is true.

Reflection Time:

1. Outline the main steps in the AI Project Cycle briefly.

2. What roles does computer vision play in agricultural monitoring systems?

3. Mention the factors which knowingly or unknowingly influence our decision-making.

4. What is the necessity for Ethical Frameworks in AI development?

5. Mention the key characteristics of sector-based frameworks.

6. What do you mean by Bioethics?

7. What is Natural Language Processing? Explain any two real-life applications of NLP.

8. How do value-based frameworks contribute to ethical decision-making by emphasizing fundamental principles and values?

Case-Based Questions

1. Case Scenario:

In a corporate setting, a multinational company is facing scrutiny over its environmental practices, particularly regarding the disposal of industrial waste. The company has historically prioritized profit maximization and cost-cutting measures, leading to practices that result in environmental harm and negative impacts on local communities. As public awareness and concern about environmental sustainability grow, stakeholders, including investors, customers, and advocacy groups, are calling for the company to adopt more responsible and sustainable business practices.

Question:

Drawing from the case presented, analyze the ethical considerations surrounding the company's environmental practices through the lens of value-based frameworks in ethics.

2. Case Scenario:
In a rural farming community, a group of small-scale farmers is faced with a dilemma regarding the use of pesticides on their crops. The farmers have traditionally relied on chemical

pesticides to control pests and maximize crop yields. However, concerns have been raised about the potential environmental and health impacts of pesticide use, including soil contamination, water pollution, and adverse effects on human health. Additionally, neighboring communities and environmental advocacy groups have expressed opposition to the widespread use of pesticides, citing ecological damage and risks to biodiversity.

Question:
Using the case provided, examine the ethical considerations surrounding pesticide use in the agricultural sector, applying ethical frameworks to analyze the competing interests and values at stake.

Unit-2: Advanced Concepts of Modeling in AI

Lesson Title: Advanced concepts of Modeling in AI	**Approach:** Session + Activity
Summary: There are two main categories of AI models: Rule based and Learning based. Learning based models can be further classified as: Supervised Learning, where machines are taught using labeled data; Unsupervised Learning, where machines independently uncover patterns from unlabeled data; and Reinforcement Learning, enabling computers to optimize decisions for rewards without direct programming. Neural networks, mimicking the brain's neurons, automatically extract data features through interconnected nodes, making them efficient for processing large datasets like images.	
Learning Objectives: 1. To familiarize students with supervised, unsupervised and reinforcement learning based approach. 2. To Introduce students to the neural network.	
Learning Outcomes: 1. Understand supervised, unsupervised and reinforcement learning based approach. 2. Understand Neural Networks.	
Pre-requisites: Essential understanding of Artificial Intelligence	
Key-concepts: 1. Supervised, unsupervised and reinforcement learning based approach 2. Neural Networks	

2.1 Revisiting AI, ML, DL

To build an AI based project, we need to work around Artificially Intelligent models or algorithms. This could be done either by designing your own model or by using the pre-existing AI models. Before jumping into modelling let us clarify the definitions of Artificial Intelligence (AI), Machine Learning (ML) and Deep Learning (DL).

Differentiate between AI, ML, and DL

Purpose: To differentiate between Artificial Intelligence (AI), Machine Learning (ML) and Deep Learning (DL).

Say: *"As we enter the world of modelling, it is a good time to clarify something many of you may be having doubts about. You may have heard the terms AI, ML and DL when research content online and during this course. They are of course related, but how?*

Artificial Intelligence, or AI for short, refers to any technique that enables computers to mimic human intelligence. An artificially intelligent machine works on algorithms and data fed to it and gives the desired output.

Machine Learning, or ML for short, enables machines to improve at tasks with experience. The machine here learns from the new data fed to it while testing and uses it for the next iteration. It also takes into account the times when it went wrong and considers the exceptions too.

Deep Learning, or DL for short, enables software to train itself to perform tasks with vast amounts of data. Since the system has got huge set of data, it is able to train itself with the help of multiple machine learning algorithms working altogether to perform a specific task.

Artificial Intelligence is the umbrella term which holds both Deep Learning as well as Machine Learning. Deep Learning, on the other hand, is the very specific learning approach which is a subset of Machine Learning as it comprises of multiple Machine Learning algorithms."

As you can see in the Venn Diagram given below, Artificial Intelligence is the umbrella terminology which covers machine and deep learning under it and Deep Learning comes under Machine Learning. It is a funnel type approach where there are a lot of applications of AI out of which few are those which come under ML out of which very few go into DL.

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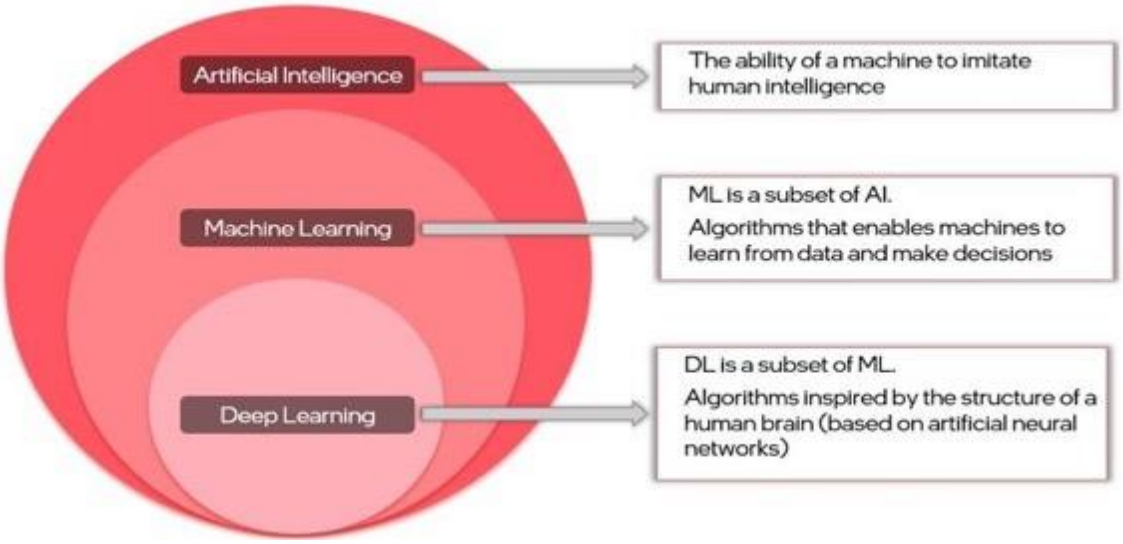
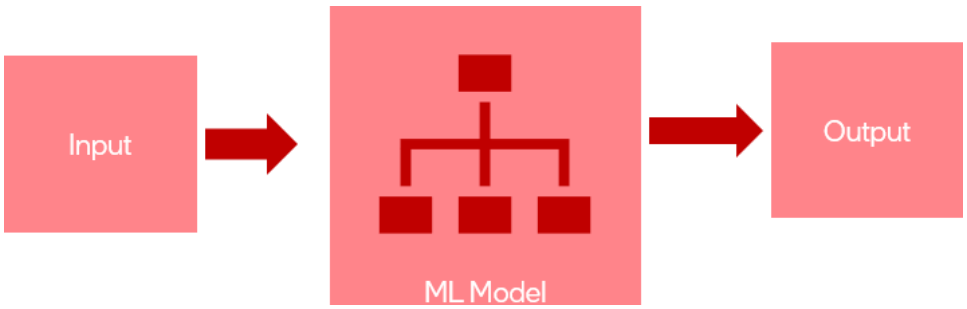


Machine Learning (ML)

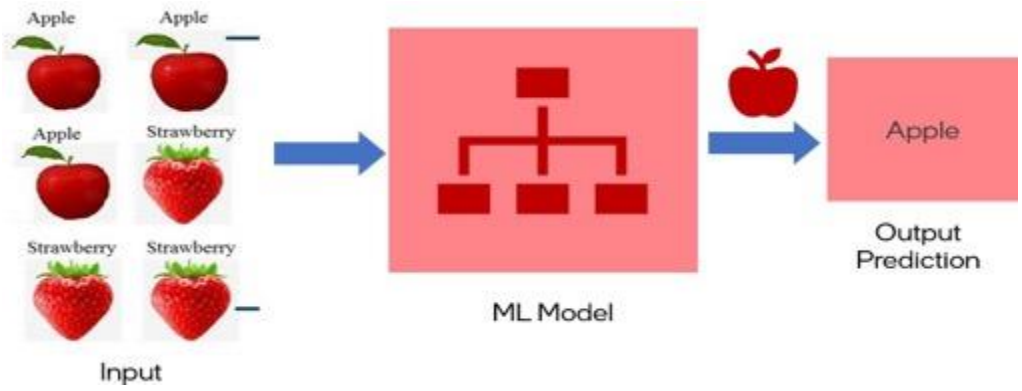
Machine Learning, or ML, enables machines to improve at tasks with experience. The machine learns from its mistakes and takes them into consideration in the next execution. It improvises itself using its own experiences.



Block Representation – Machine Learning (ML)

This is just a broad representation of how a machine learning model works. Input (past or historical data) is given to the ML model and the model generates output by learning from the input data.

Here is an example which shows labelled images (every image is tagged either as apple or strawberry) are given as input to the ML model. ML model learns from the input data to classify between apples and strawberries and predicts the correct output as shown.



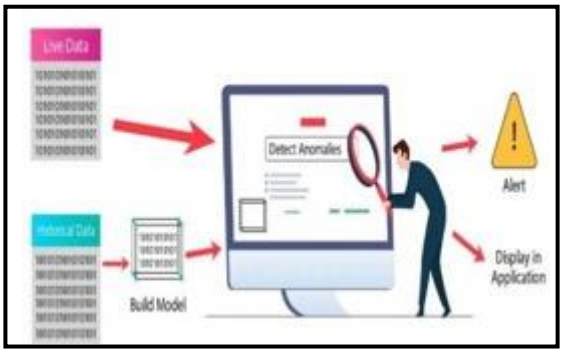
Examples of Machine Learning (ML)

Object Classification

Identifies and labels objects present withinan image or data point. It determines the category an object belongs to.

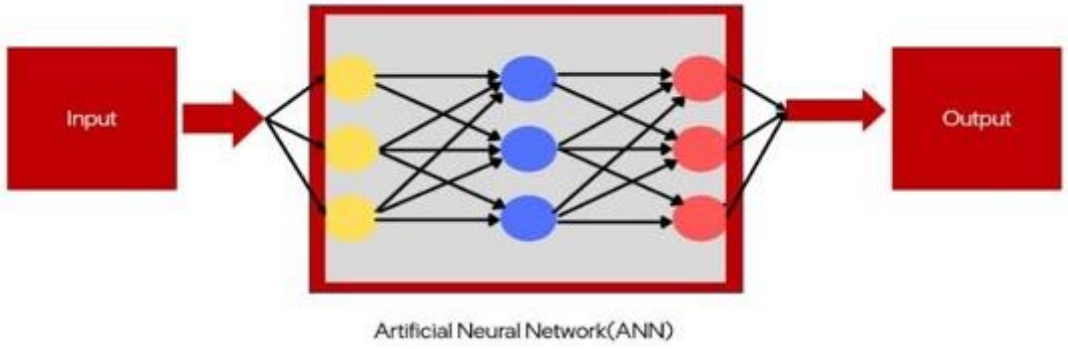
Anomaly Detection

Anomaly detection helps us find the unexpected things hiding in our data. For example, tracking your heart rate, and finding a sudden spike could be an anomaly, flagging a potential issue.



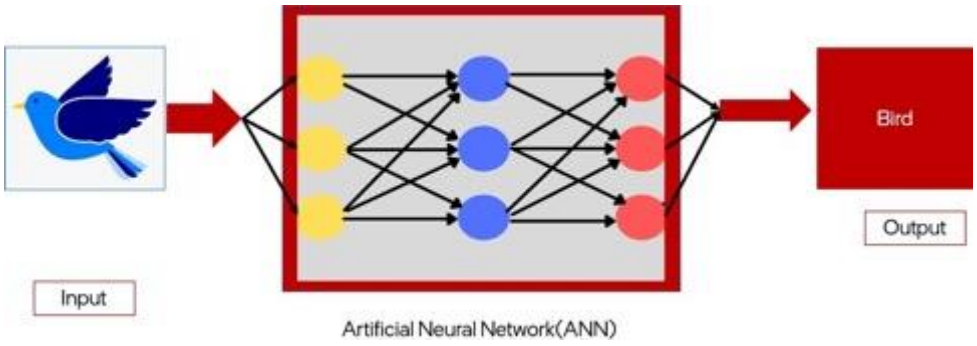
Deep Learning (DL)

Deep Learning, or DL, enables software to train itself to perform tasks with vast amounts of data. In deep learning, the machine is trained with huge amounts of data which helps it into training itself around the data. Such machines are intelligent enough to develop algorithms for themselves. Deep Learning is the most advanced form of Artificial Intelligence out of these three. Following is the block diagram of deep learning:



Block Representation- Deep Learning (DL)

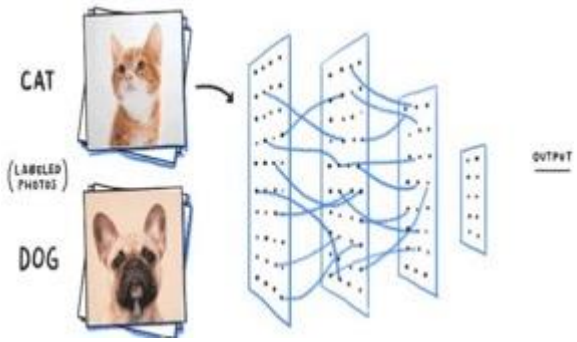
Input is given to an ANN, and after processing, the output is generated by the DL block. Here is an example which shows pixels of a bird image given as input to the DL Model and the model is able to analyze and correctly predict that it is a bird using a deep learning algorithm (ANN).



Examples of Deep Learning (DL)

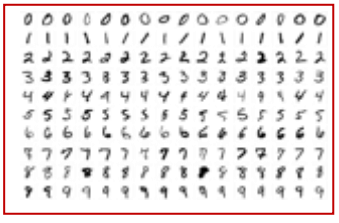
Object Identification

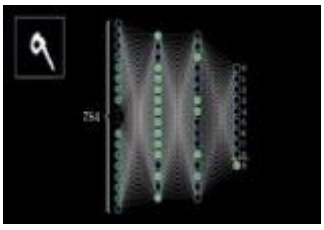
Object classification in deep learning tackles the task of identifying and labeling objects within an image. It essentially uses powerful algorithms to figure out what's ina picture and categorize those things.



Digit Recognition

Digit recognition in deep learning tackles the challenge of training computers to identify handwritten digits (0-9) within images.





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Common terminologies used with data

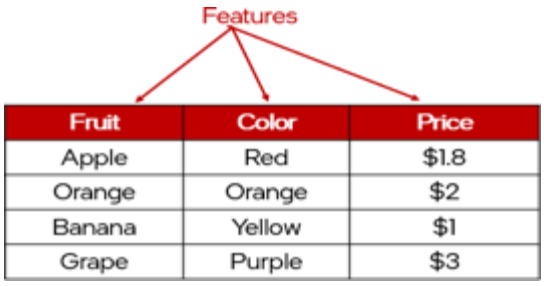
What is Data?

- Data is information in any form
- For e.g. A table with information about fruits is data
- Each row will contain information about different fruits
- Each fruit is described by certain features

Fruit	Color	Price
Apple	Red	$1.8
Orange	Orange	$2
Banana	Yellow	$1
Grape	Purple	$3

What do you mean by Features?

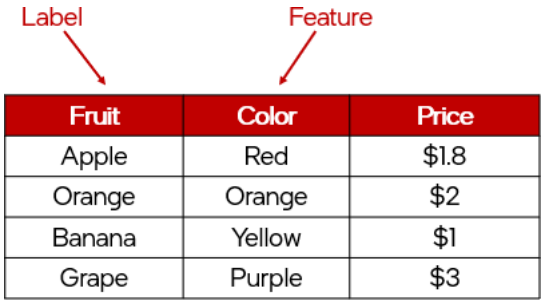
- Columns of the tables are called features
- In the fruit dataset example, features may be name, color, size, etc.
- Some features are special, they are called labels



What are Labels?

Data Labeling is the process of attaching meaning to data

- It depends on the context of the problem we are trying to solve
- For e.g. if we are trying to predict what fruit it is based on the color of the fruit, then color is the feature, and fruit name is the label.
- Data can be of two types – Labeled and Unlabeled

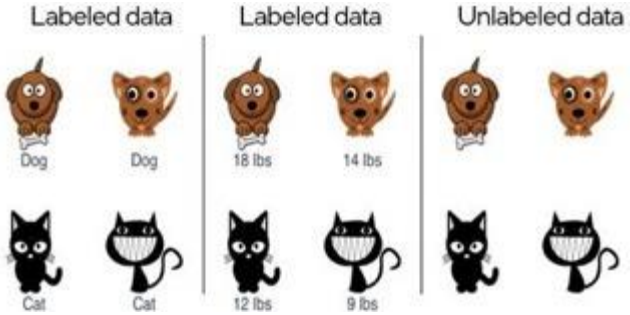


Labeled Data

- Data to which some tag/label is attached.
- For e.g. Name, type, number, etc.

Unlabeled Data

- The raw form of data
- Data to which no tag is attached.



What do you mean by a training data set?

- The training data set is a collection of examples given to the model to analyze and learn.
- Just like how a teacher teaches a topic to the class through a lot of examples and illustrations.
- Similarly, a set of labeled data is used to train the AI model.

What do you mean by a testing data set?

- The testing data set is used to test the accuracy of the model.
- Just like how a teacher takes a class test related to a topic to evaluate the understanding level of students.
- Test is performed without labeled data and then verify results with labels.

2.2 Modelling

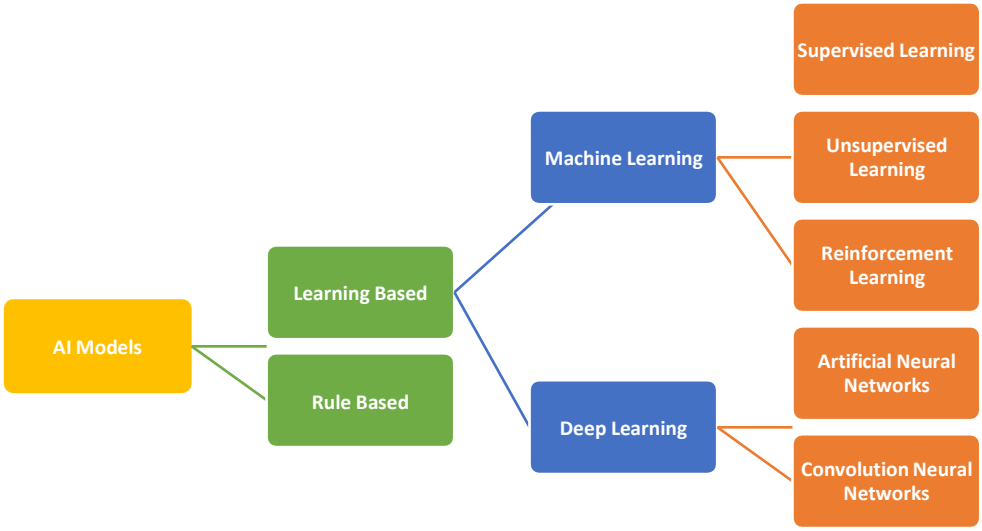
Purpose: Classification of Models into Rule-based approach and Learning approach.

Say: *"In general, there are two approaches taken by researchers when building AI models. They either take a rule-based approach or learning approach. A Rule based approach is generally based on the data and rules fed to the machine, where the machine reacts accordingly to deliver the desired output. Under learning approach, the machine is fed with data and the desired output to which the machine designs its own algorithm (or set of rules) to match the data to the desired output fed into the machine"*

AI Modelling refers to developing algorithms, also called models which can be trained to get intelligent outputs. That is, writing codes to make a machine artificially intelligent.

Types of AI Models

Generally, AI models can be classified as follows:



Rule Based Approach

Rule Based Approach refers to the AI modelling where the relationship or patterns in data are

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defined by the developer. The machine follows the rules or instructions mentioned by the developer, and performs its task accordingly.

Rule-based Chatbots are commonly used on websites to answer frequently asked questions (FAQs) or provide basic customer support. Here's an example:

Scenario: A clothing website has a Chabot to answer questions about order tracking.

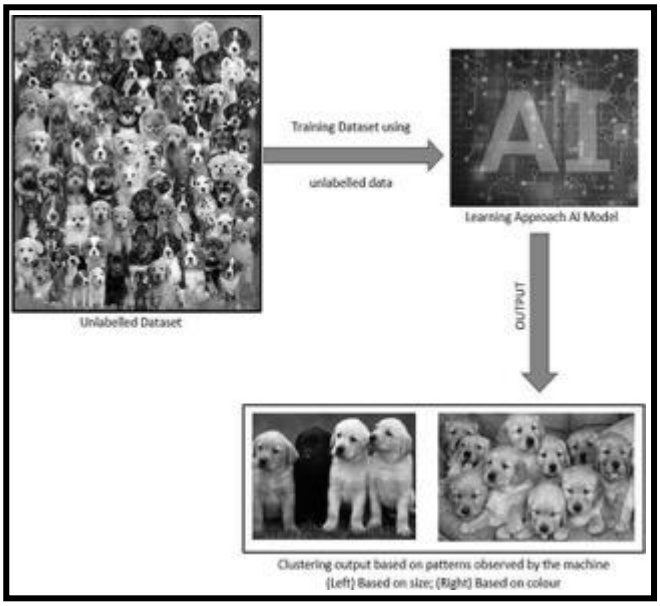
1. **Data:** The Chabot doesn't require a massive dataset for training. It relies on a predefined set of questions and corresponding answers.
2. **Rules:** The Chabot uses a decision tree approach with clearly defined rules to understand user queries and provide responses. Here's a simplified example:
    - **Rule 1:** If the user's message contains keywords like "track order," "shipment status," or "delivery," proceed to order tracking options.
    - **Rule 2:** Under order tracking options:
        - If the user asks for their order number, prompt them to enter it.
        - If the user enters a valid order number, retrieve the tracking information from the database and display it.
        - If the user enters an invalid order number, provide an error message and ask them to re-enter it.
    - **Rule 3:** If the user's message doesn't match any defined rules, offer a message like "Sorry, I can't help you with that. Perhaps you can try searching our FAQs or contact customer support."
3. **Interaction:** When a user chats with the bot, their message is analyzed based on the defined rules. The Chabot responds with a pre-written answer or prompts the user for additional information depending on the scenario.

A drawback/feature for this approach is that the learning is static. The machine once trained, does not take into consideration any changes made in the original training dataset. That is, if you try testing the machine on a dataset which is different from the rules and data you fed it at the training stage, the machine will fail and will not learn from its mistake. Once trained, the model cannot improvise itself on the basis of feedbacks. Thus, machine learning gets introduced as an extension to this as in that case, the machine adapts to change in data and rules and follows the updated path only, while a rule-based model does what it has been taught once.

Learning Based Approach

A learning-based approach is a method where a computer learns how to do something by looking at examples or getting feedback, similar to how we learn from experience. Instead of being explicitly programmed for a task, the computer learns to perform it by analyzing data and finding patterns or rules on its own.

For example, suppose you have a dataset of 1000 images of random stray dogs of your area. Now you do not have any clue as to what trend is being followed in this dataset as you don't know their breed, or colour or any other feature. Thus, you would put this into a learning approach-based AI machine and the machine would come up with various patterns it has observed in the features of these 1000 images. It might cluster the data on the basis of colour, size, fur style, etc. It might also come up with some very unusual clustering algorithm which you might not have even thought of!



Learning Based AI Model

We can say that it refers to the AI modelling where the machine learns by itself. Under the Learning Based approach, the AI model gets trained on the data fed to it and then is able to design a model which is adaptive to the change in data. That is, if the model is trained with X type of data and the machine designs the algorithm around it, the model would modify itself according to the changes which occur in the data so that all the exceptions are handled in this case.

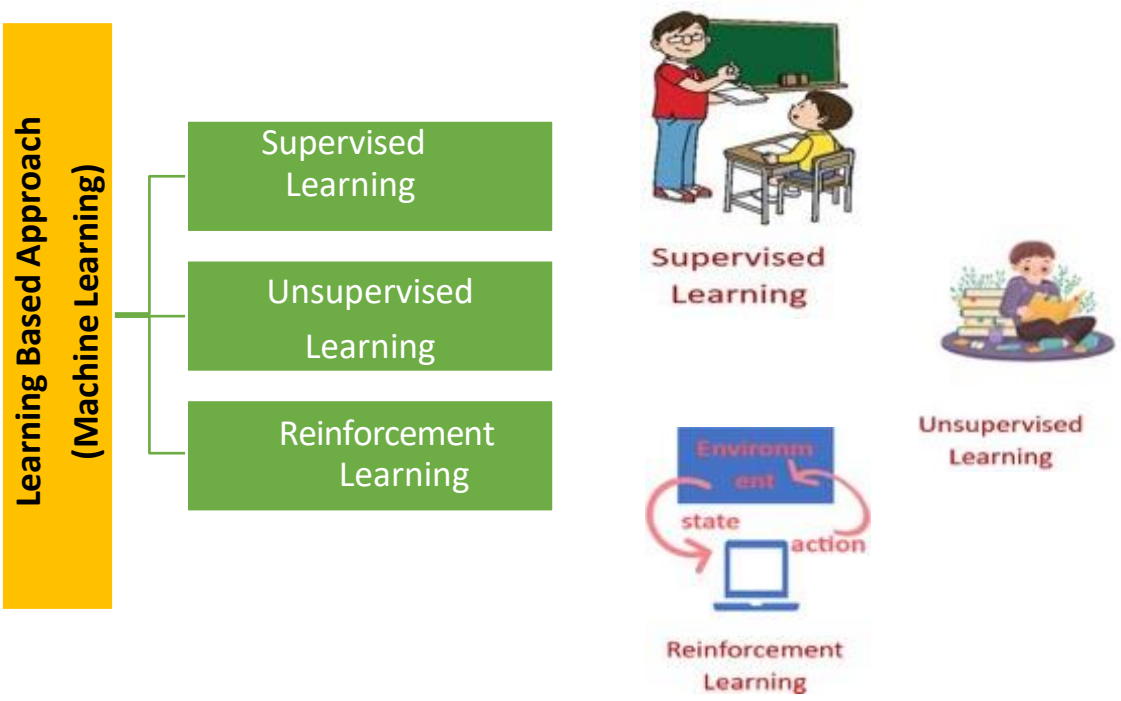
For example, A learning-based spam email filter is a computer program that automatically identifies whether an incoming email is spam or not. Instead of being explicitly programmed with rules for identifying spam, the filter learns from examples of labeled emails during a training phase.

During training, the filter is provided with a large dataset of emails, each labeled as either spam or legitimate (non-spam). The filter analyzes the content and characteristics of these emails, such as words used, sender information, and presence of attachments. Using machine learning algorithms, the filter learns to recognize patterns that distinguish spam from legitimate emails.

Once trained, the filter can classify new incoming emails as spam or not spam based on the patterns it learned. It continuously adapts and improves its accuracy over time as it encounters new examples. This learning-based approach allows the filter to effectively identify and filter out spam emails, helping users manage their email inbox more efficiently.

Categories of Machine learning based models

Learning-based approaches are indeed a broad category that encompass both machine learning and deep learning. Machine learning can further be divided into three parts:



Supervised Learning

In a supervised learning model, the dataset which is fed to the machine is labelled. In other words, we can say that the dataset is known to the person who is training the machine only then he/she is able to label the data. A label is some information which can be used as a tag for data. For example, students get grades according to the marks they secure in examinations. These grades are labels which categorize the students according to their marks.

- Supervised Learning indicates having a supervisor as a teacher
- For e.g. A math teacher teaches the class by making the students learn using a lot of solved examples(training) and then test the knowledge gained by giving the class, problems to solve on their own.

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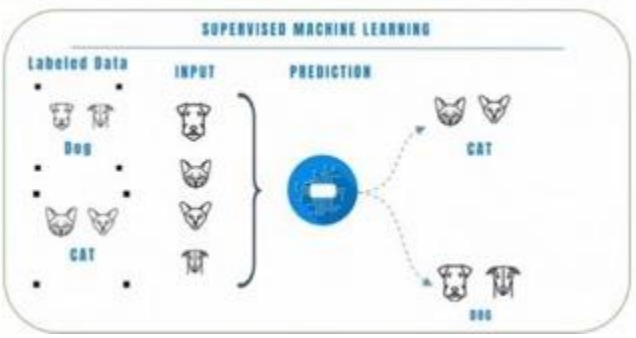
- Similarly, Supervised Learning is when you make the machine learn by teaching or training the machine using labeled data.

Supervised Learning – Example

- Let's consider the example of currency coins.
- Problem Statement: Build a model to predict the coin based on its weight.
- Assume that we have different currency coins (dataset) having different weights.
- 1 Euro weighs 5 grams
- 1 Dirham weighs 7grams
- 1 Dollar weighs 3grams
- 1 Rupee weighs 4 grams and so on
- Feature – Weights
- Label – Currency

So, if a model is trained in tagging the features i.e., the weights of the coin with the targets i.e., currency, the trained model can be further be used to identify a coin based on its weight (since it has already learnt).

- In the example shown in the image, the model has learned from labeled input data and produces output to classify them as dogs and cats.
- Therefore, you can see that the model learns from the training data and then applies the same knowledge to test data.



Unsupervised Learning

An unsupervised learning model works on unlabelled dataset. This means that the data which is fed to the machine is random and there is a possibility that the person who is training the model does not have any information regarding it. The unsupervised learning models are used to identify relationships, patterns and trends out of the data which is fed into it. It helps theuser in understanding what the data is about and whatare the major features identified by the machine in it.

For example, you have a random data of 1000 dog images and you wish to understand some pattern out of it, you would feed this data into the unsupervised learning model and would train the machine on it. After training, the machine would come up with patterns which it was able to identify out of it. The Machine might come up with patternswhich are already known to the user like colour or it might even come up with somethingvery unusual like the size of the dogs.

- Unsupervised Learning is a type of learning without any guidance
- For e.g. A child learning to swim on his own without any supervision. Here, the child is the model trying to discover ways and techniques to swim and the swimming pool is similar to the unknown data fed to the model.
- Here, the machine is responsible to discover patterns, similarities, and differences on its own based on the unlabeled dataset.

Unsupervised Learning - Example

Let's consider the example of a supermarket

Assume that we have a customer database with records of their products bought over a period.

Now you being the marketing manager decides to send a grocery offer message to those customers who buys grocery regularly.

- Note that there was no customer labeled as grocery shoppers and non-grocery shopper.
- Model could discover patterns on its own and could come up with these two clusters/groups.

Customer ID	Total number of grocery items bought	Total number of non-grocery items bought

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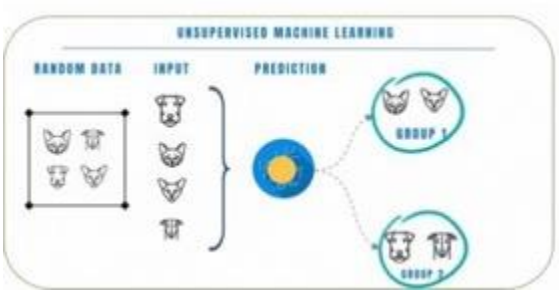
- In the example shown in the image, the model has to process information without any labels.
- It has to analyze and process the data to identify hidden patterns and attributes and then uses that to classify the animals into two categories based on similarities



As you observe in the image, input is not labeled but the model can come up with two clusters by identifying similar patterns and attributes and have grouped them together-

- All Cats have been grouped into cluster 1
- All Dogs have been grouped into cluster 2

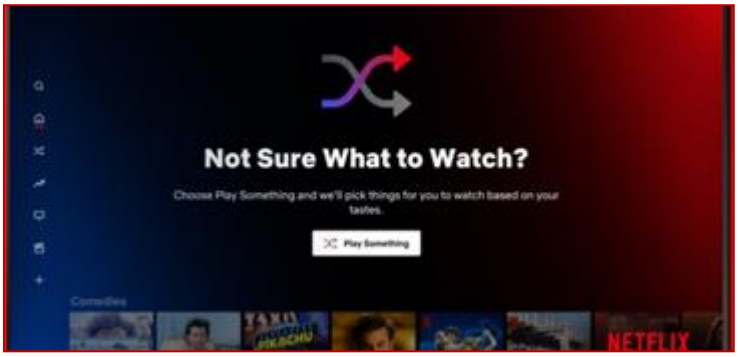
Test Yourself:

Identify the model: Supervised or Unsupervised?

Case 1: Social Media platforms identify your friend in a picture from an album of tagged photographs

It is supervised learning. Here social media platform is using tagged photos to recognize the person. Therefore, the tagged photos become the labels of the pictures and we know that when the machine is learning from labeled data, it is supervised learning.

Case 2: OTT platform Recommendations based on someone's watch history



It is unsupervised learning. This is what OTT platforms like Netflix, Pandora, and Spotify do all the time; they collect the songs/movies that you like already, evaluate the features based on your likes/dislikes and then recommend new movies/songs based on similar features.

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Case 3: Analyze bank data for suspicious-looking transactions and flag the fraud transactions

[Note that suspicious transactions are not defined in this case]

It is unsupervised learning. In this case, the suspicious transactions are not defined, hence there are no labels of "fraud" and "not fraud". The model tries to identify outliers by looking at anomalous transactions and flags them as 'fraud'.

Supervised Vs. Unsupervised Learning

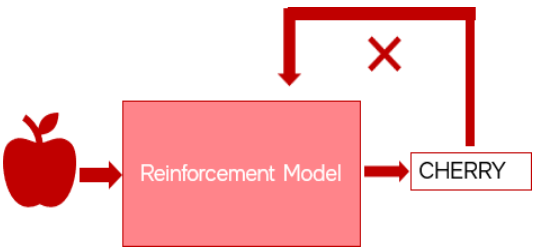
Supervised Learning	Unsupervised Learning
▪ Deals with labelled data	▪ Deals with unlabelled data
▪ Useful in real-world problems-like predicting the prices of an item something based on past trends.	▪ Useful in finding unknown patterns within data-like making sense of a large number of observations from an experimental device.
▪ Computing power required is simpler as clean labelled data is used as input.	▪ The computing power required is more complex as unsorted and messy data is used as input.

Reinforcement Learning

This learning approach enables the computer to make a series of decisions that maximize a reward metric for the task without human intervention and without being explicitly programmed to achieve the task.

Reinforcement Learning – Example

- Reinforcement learning is a type of learning in which a machine learns to perform a task through a repeated trial-and-error method.
- Let's say you provide an image of an apple to the machine and ask the machine to predict it-
- The machine first predicts it as 'cherry' and you give negative feedback that it's incorrect.
- Now, the machine learns that it's not a cherry.



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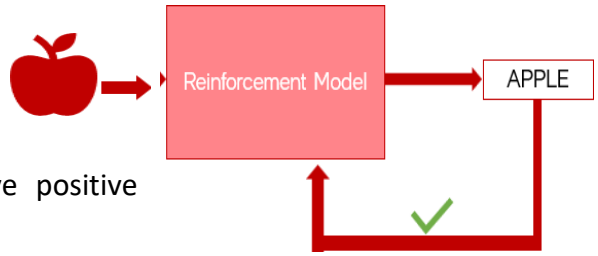
- Then again, you ask the machine to predict the fruit by giving an image of an apple as input;
- Now, it knows it is not a cherry.
- It predicts it as an apple and you give positive feedback that it's correct.
- So, now the machine learns that this is an apple.



What makes it different?

1. For supervised learning and unsupervised learning, you need to have a pretty good idea of the data that you have, what's going on, and how to solve the problem.
2. However, you will frequently encounter situations where you have to deal with large complex problem spaces.
3. You may need to respond to unforeseen environments, and you don't have sufficient data on those specific scenarios.
4. The environment may change. Hence your system needs to be adaptive. Reinforcement Learning will be important because it doesn't require a lot of pre-existing knowledge or data to provide useful solutions.

Examples of Reinforcement Learning

Parking a car

Humanoid walking

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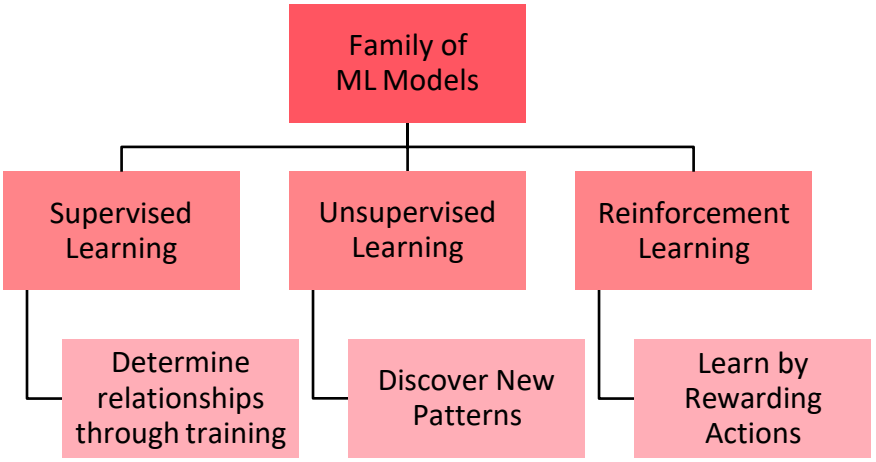
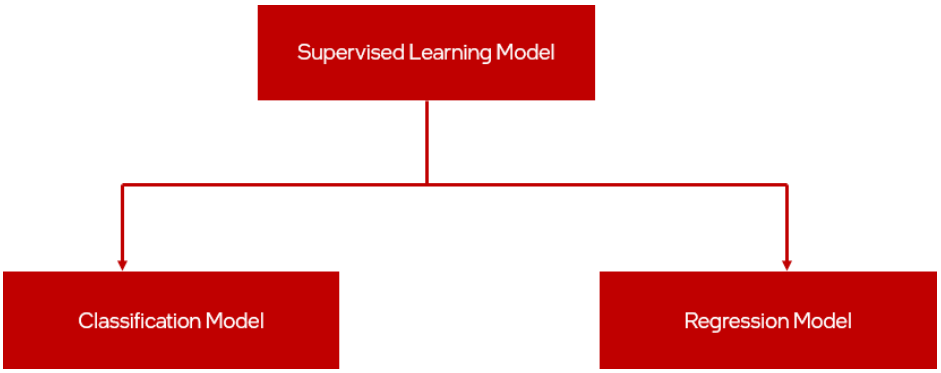
Summary of ML Models

- Supervised learning models are used when we want to determine relationships through training.
- Unsupervised learning models are used when we want to discover new patterns from data.
- Reinforcement learning models are used when we want to implement machine learning through a reward mechanism.



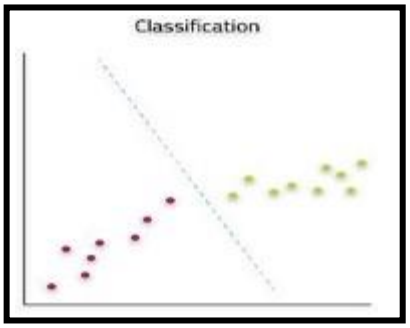
Sub-categories of Supervised Learning Model

There are two types of Supervised Learning models: Classification model and Regression model.



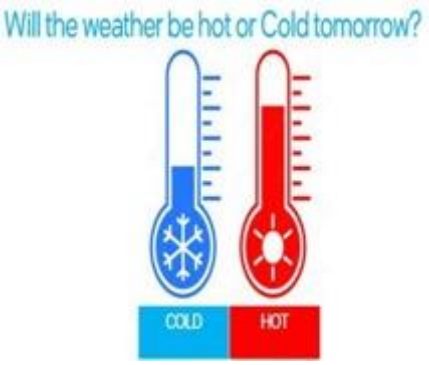
Classification Model

Here the data is classified according to the labels. For example, in the grading system, students are classified on the basis of the grades they obtain with respect to their marks in the examination. This model works on discrete dataset which means the data need not be continuous.



Examples of the Classification Model

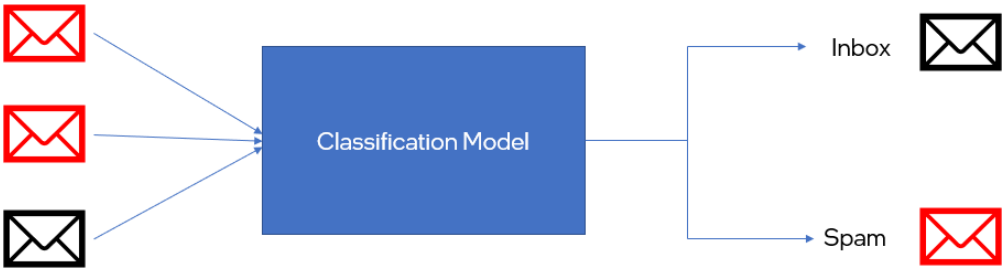
In this case, the model would be trained on historical weather data that includes temperature information labeled as "hot" or "cold". The model would learn the patterns that differentiate hot and cold weather based on factors like:



- Location (average temperatures vary geographically)
- Season (summer vs. winter)
- High and low temperatures
- Humidity

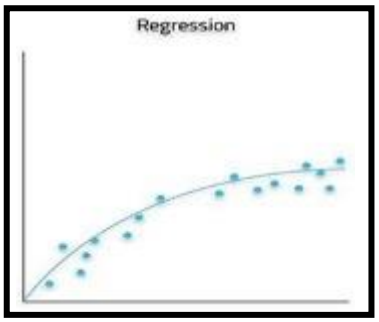
When presented with weather data for tomorrow, the trained classification model would analyze these factors and predict the most likely category - "hot" or "cold" weather tomorrow.

Classifying emails as spam or not: The model is shown tons of emails, both real ones (like from friends or colleagues) and spam. The model learns what makes an email look like spam. Once trained, the model sees a new email. It analyzes the clues in the email and decides: is this spam or not? It assigns a category - "spam" or "not spam" - just like sorting your mail.



In modern-day Email, classifiers identify if the email is spam and have evolved into other categories such as social, advertisement, notifications, etc. Similar models are increasingly being used in messaging applications.

Regression Model



Regression: Such models work on continuous data. For example, if you wish to predict your next salary, then you would put in the data of your previous salary, any increments, etc., and would train the model. Here, the data which has been fed to the machine is continuous.

- Regression algorithms predict a continuous value based on the input variables.
- Continuous values as Temperature, Price, Income, Age, etc.

Examples of the Regression Model

Example 1: Predicting temperature

Temperature is a continuous variable, meaning it can take on any value within a range. Regression models are well-suited for predicting continuous outputs.

Example 2: Predicting the price of the house

Predicting the price of the house based on some parameters:

1. [Features/Independent Variables]
    1. No of bedrooms
    2. Carpet Size
    3. Garage Area
2. [Label/Dependent Variable]
    1. Price [Label/Dependent Variable]

- In the House Price Prediction Problem, we are trying to predict the price (dependent variable) based on certain parameters like the number of bedrooms, carpet size, and garage area (independent variables).

Example 3: Used Car Price Prediction

This model predicts the selling price of the car with the help of a few parameters like

- fuel type,

- years of service,
- the number of previous owners,
- kilometers driven,
- transmission type (manual/automatic)

This type of model will be of type regression since it will predict an approximate price (continuous value) of the car based on the training dataset.

Test Yourself:

Identify the model: Classification or Regression?

Case 1: Predicting whether a customer is eligible for a bank loan or not?

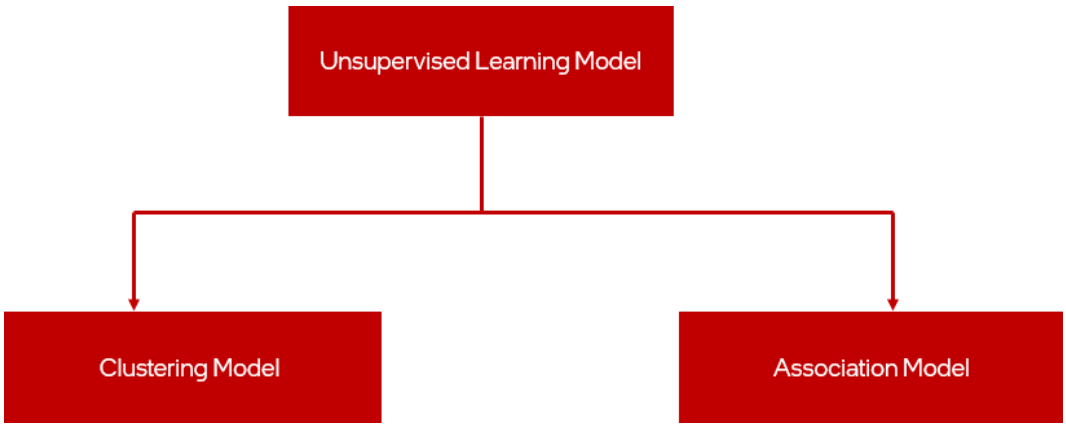
It is Classification. Binary Classification; since the model is going to predict whether or not the customer is eligible for a loan- The output will be either yes or no (discrete values)

Case 2: Predicting weather for next 24 hours

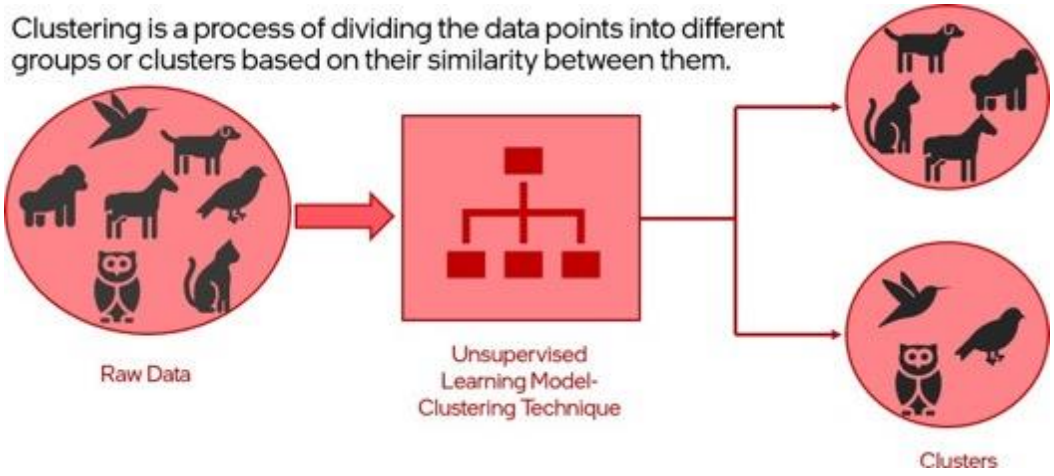
It is Regression because predicting weather for next 24 hours will be a continuous range (it will keep changing over the period of 24 hours)

Sub-categories of Unsupervised Learning Model

Unsupervised learning models can be further divided into two categories: Clustering model and Association model.



What is Clustering?



In this example, we have input data with no class labels (unlabeled data), and this input data comprises of birds and animals. Note that, even though there were no class labels, the unsupervised learning model was able to divide this data into two clusters based on clustering.

The two clusters have been formed based on the similarity of characteristics. The first cluster comprises all the animals, and the second cluster comprises all the birds.

Difference between Clustering and Classification

- Classification uses predefined classes in which objects are assigned.
- Clustering finds similarities between objects and places them in the same cluster and it differentiates them from objects in other clusters.

Clustering – Example

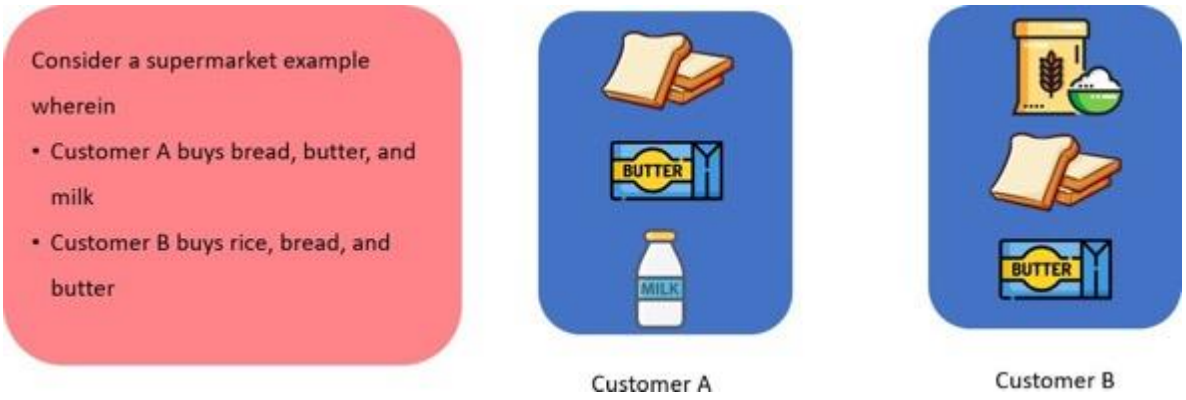
Jim enjoys listening to music. Jim likes to listen to music having slow tempo and soft intensity whereas he dislikes songs having fast tempo and high intensity.

- We have grouped all the songs having slow tempo and soft intensity into 1 cluster that he likes
- While, songs with a fast tempo and high intensity into another cluster
- Now if he listens to a new song X with a slow tempo and soft intensity. Could you predict will he like the song X or not?

This is how clustering techniques work. The clustering model will be able to identify clusters based on some similarities or patterns which are not defined in the input. For example, tempo and intensity are the only features known, but clusters based on likes and dislikes have been grouped together and given as output. Similar techniques are used in OTT platforms like Netflix/Spotify for recommendations.

Association

Association Rule is an unsupervised learning method that is used to find interesting relationships between variables from the database.

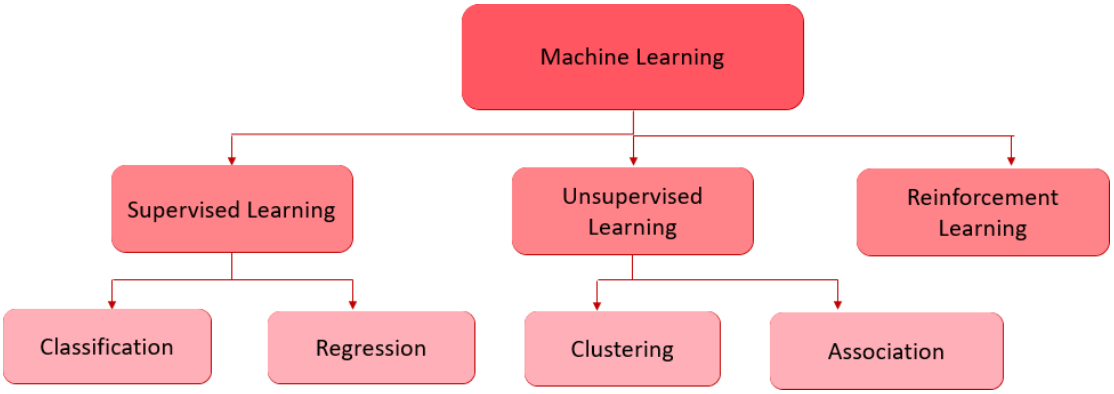


Based on the purchase pattern of customers A and B, can you predict any Customer X who buys bread will most probably buy?

Based on the purchase pattern of other customers, we can predict that there is highprobability that any customer x who buys bread will most probably buy butter.

Therefore, such meaningful associations can be useful to recommend items to customers. Thisis called Association Rule.

Summary of detailed classification of ML models



Test Yourself:

Let's have knowledge check based on learning approaches and its types!

Q1. Which learning approach uses labelled data for training?

Supervised Learning

Reinforcement Learning

Unsupervised Learning

Q2. The target variable is categorical in_____Problem?

Regression

Clustering

Classification

Q3. Which algorithmic model would you use when you have to predict a continuous valued output?

Regression

Clustering

Classification

Q4. Which of the following is false about Reinforcement Learning?

Uses Reward Mechanism

Target is to Maximize the Reward

Predicts a continuous value as output

Q5. Clustering is_____learning and its goal is to_____?

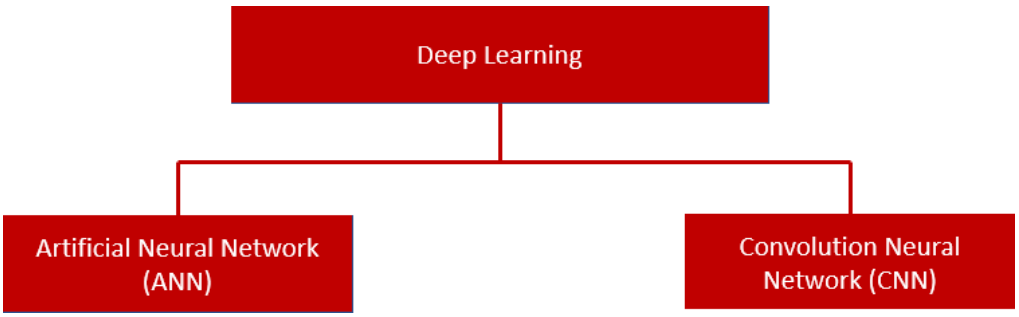
Supervised, Classify data points intodifferent classes

Unsupervised, Divide the data points into different groups

Unsupervised, Predict the output based on input data points

Sub-Categories of Deep Learning

Deep Learning enables software to train itself to perform tasks with vast amounts of data. In deep learning, the machine is trained with huge amounts of data which helps it to train itself around the data. Such machines are intelligent enough to develop algorithms for themselves. There are two types of Deep Learning models: Artificial Neural Networks (ANN) and Convolution Neural Network (CNN).



Artificial Neural networks (ANN) - Artificial Neural networks are modelled on the human brain and nervous system. They are able to automatically extract features without input from the programmer. Every neural network node is essentially a machine learning algorithm. It is useful when solving problems for which the data set is very large.

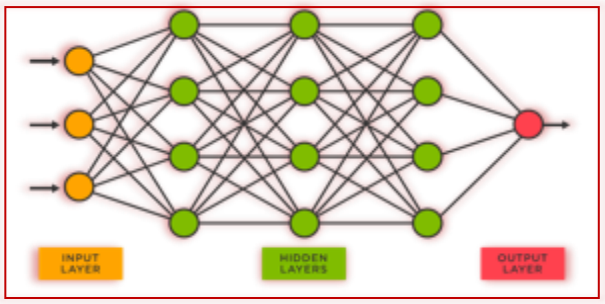
Convolutional Neural Network (CNN) - Convolutional Neural Network is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the o

2.3 Artificial Neural Networks

Purpose: To understand and experience what a neural network is like.

Brief:
Neural networks are loosely modelled after how neurons in the human brain behave. The key advantage of neural networks is that they are able to extract data features automatically without needing the input of the programmer. A neural network is essentially a system of organizing machine learning algorithms to perform certain tasks. It isa fast and efficient way to solve problems for which the data set is very large, such as in images.

What is Neural Network?



Neural networks are loosely modelled after how neurons in the human brain behave. The key advantage of neural networks is that they are able to extract data features automatically without needing the input of the programmer. A neural network is essentially a system of organizing machine learning algorithms to perform certain tasks. It is a fast and efficient way to solve problems for which the dataset is very large, such as in images.

This is a representation of how neural networks work:

- A Neural Network is divided into multiple layers and each layer is further divided into several blocks called nodes. Each node has its own task to accomplish which is then passed to the next layer.
- Neural Network consists of an input layer, hidden layer which performs computation using weights and biases on each node and finally, information is passed through these layers to reach the output layer.
- The first layer of a Neural Network is known as the input layer. The job of an input layer is to acquire data and feed it to the Neural Network. No processing occurs at the input layer.
- Next to it, are the hidden layers. Hidden layers are the layers in which the whole processing occurs. Their name essentially means that these layers are hidden and are not visible to the user. Each node of these hidden layers has its own machine learning algorithm which it executes on the data received from the input layer.

- The hidden layer performs computation by means of weights and biases Information passes from one layer to the other after the value found from this calculation passed through a selected activation function.
- The process of finding the right output begins with trial and error until the network finally learns.
- With each try, the weights are adjusted based on the error found between the desired output and the network output.

There can be multiple hidden layers in a neural network system and their number depends upon the complexity of the function for which the network has been configured. Also, the number of nodes in each layer can vary accordingly. The last hidden layer passes the final processed data to the output layer which then gives it to the user as the final output. Similar to the input layer, output layer too does not process the data which it acquires. It is meant for user-interface.

Real-world applications of neural network are facial recognition, customer support chatbot,vegetable price prediction etc.

How does AI make a Decision?

Let's say you want to go out to the park today. What would be your thought process? What would you consider?

Most of us would want to avoid getting soaked in the rain. These are possible factors that may influence your decision whether to go out. So, the first question that you may ask is, “Should I bring a rain jacket?”

Then, you may also ask, “Should I bring an umbrella?”Or

you may also ask, “What is the weather now?”

And finally, “What will the weather be like, later in the day?”

Do I have a jacket?

Do I have an umbrella?

Is it raining now?

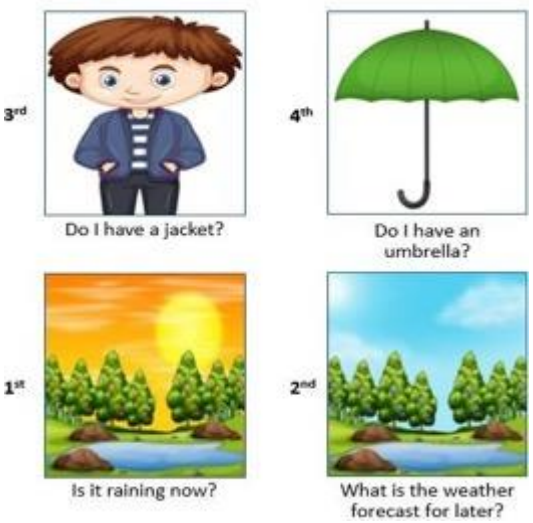
What is the weather forecast for later?

* Images shown here are the property of individual organisations and are used here for reference purpose only.

Now, you have the factors that will influence your decision to go out. But take note, not all factors are equal. Some factors are more important, while some are not.

Let's see which one is more important. Let us rank them from the most important to the least important.

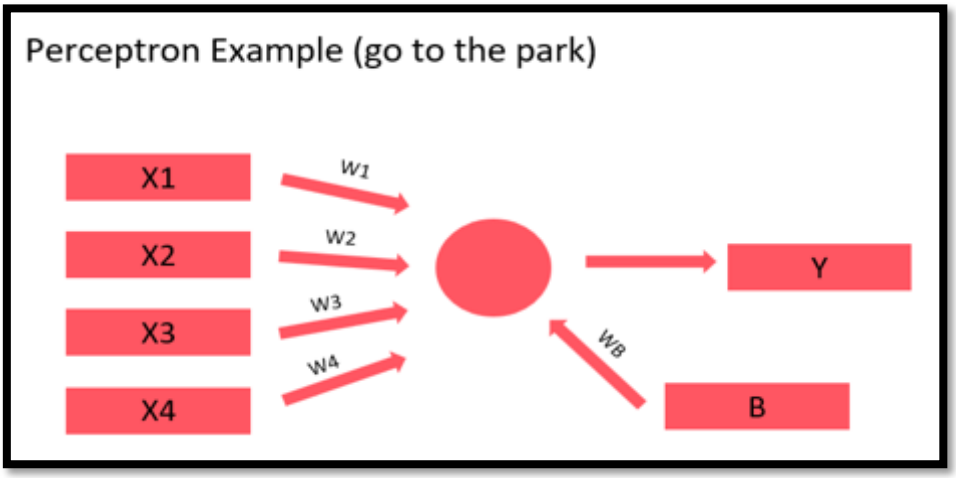
For me, “is it sunny now” is more important than “the weather forecast later”. And “having a jacket” is more important than “having an umbrella. We can put the ranking for this example.



Now let us convert this to perceptron.

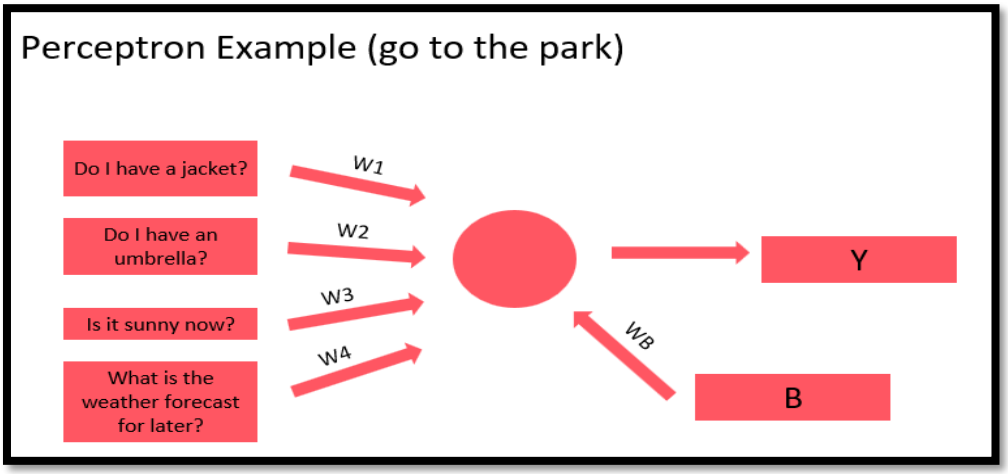
Going back to the earlier example, we have four inputs. So, let’s draw the perceptron with four inputs (from X1 to X4). Next, we have their weights (from W1 to W3). Then, we also have the bias B, with weight WB.

Finally, we sum them all up, compare with threshold, and we will get our output.



Now we will fill in the four inputs with the factors that we have listed out.

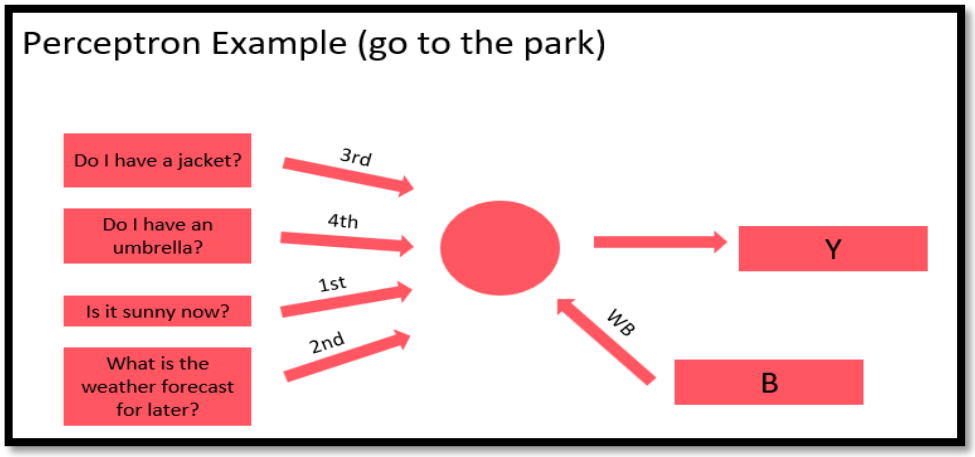
- Do I have a jacket?
- Do I have umbrella?
- Is it sunny now?
- What is the weather forecast for later?



Now we will fill in the importance. But the importance is not very useful in mathematical calculations.

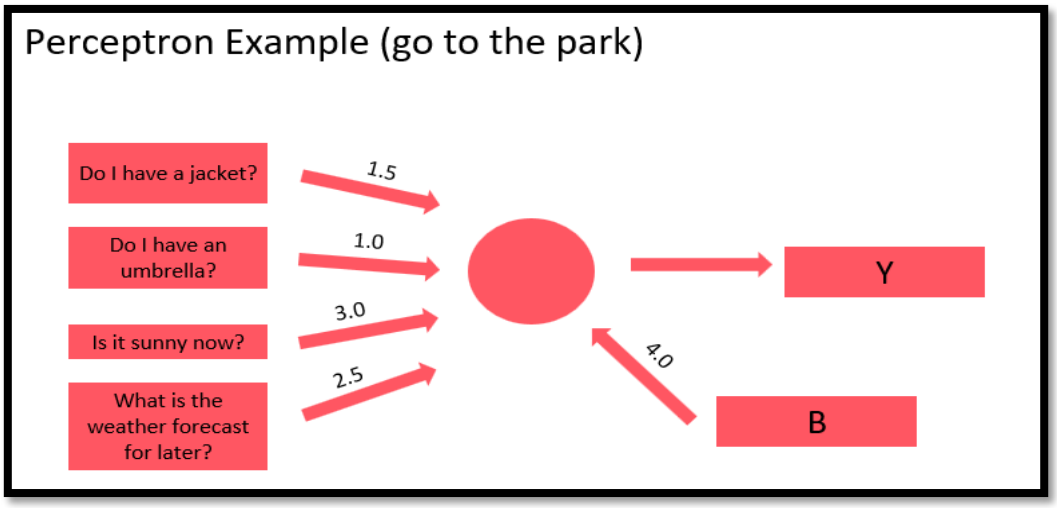
Next, let us assign some numbers to them. At the same time, we will also assign a numberfor the bias weight (WB).

How do we know what should be the actual values for the weights? We will not know whatare the actual weights. However, we can make some assumptions.



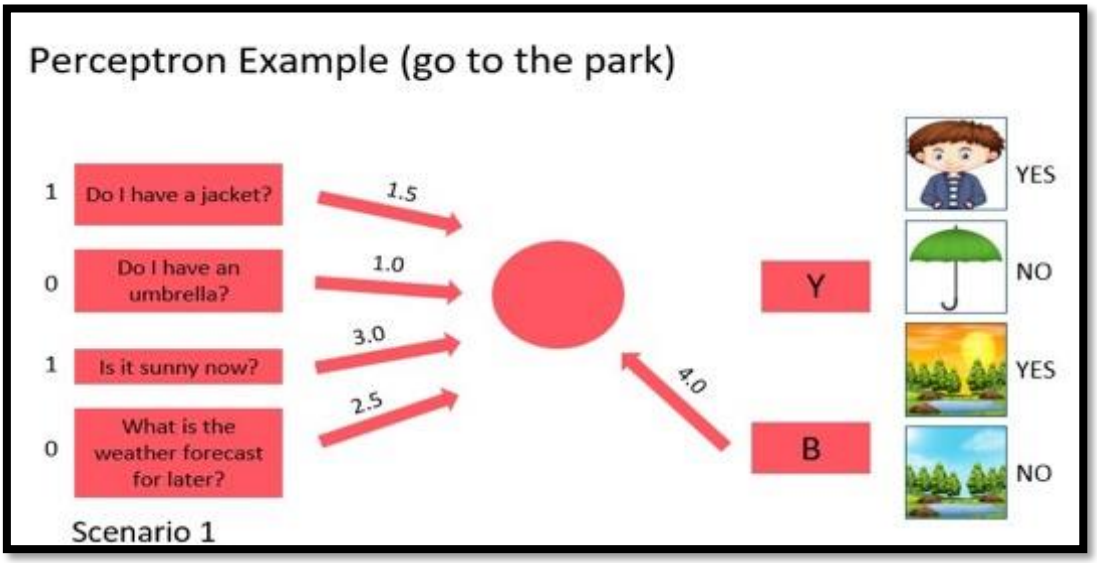
The values for the weights can come from experience. He may have an experience being sunny now would most likely mean a bright day ahead, hence the high importance there. It can also come from personal preference. A person may judge a particular factor more heavily as compared to another person. For example, she may be more concerned with the weather forecast, hence the higher importance there.

The values for WB are also based on personal preference. If a person is more cautious, he may set the value for WB to be higher, hence his decision would gear towards staying indoors unless he is sure that it would not rain. On another hand, a person who is more daring will have a lower WB, hence he is more likely to go out regardless of the current situation. In this example, we choose 4 as we want to be more cautious.



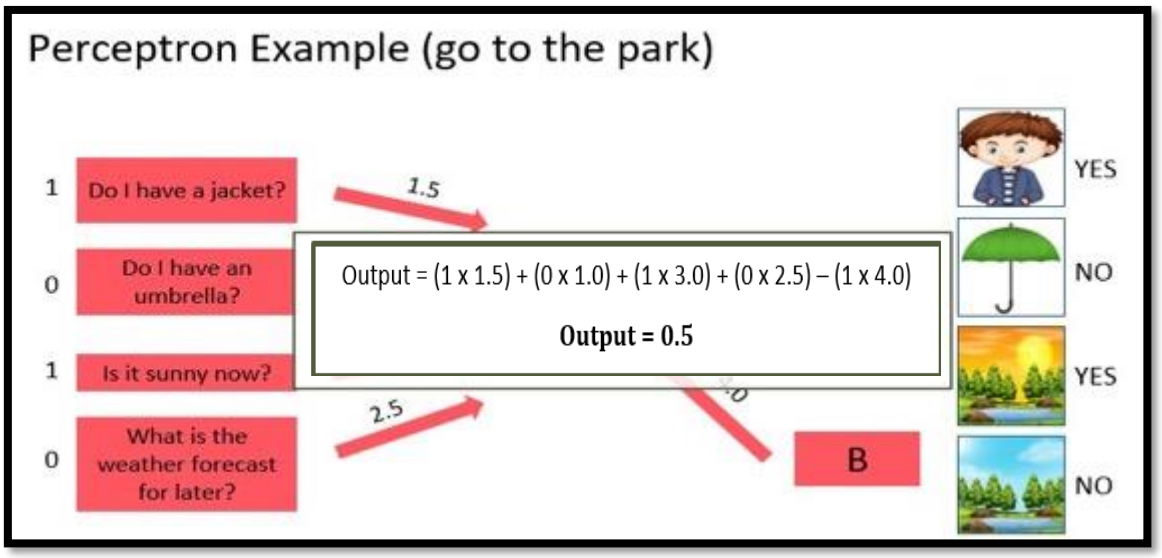
Therefore, there is no right or wrong answers in coming up with the values for the weights. However, the effects of the values will determine the outcome that the person is going to take, whether to go out or not. That is the reason why everyone comes up with a different decision, even though the situation is the same for everyone.

For this example, let's say: I have a jacket, I don't have an umbrella, it is sunny now, and the weather forecast is going to rain. We can convert the yes and no to numbers 1 and 0. For bias, we will always take 1.

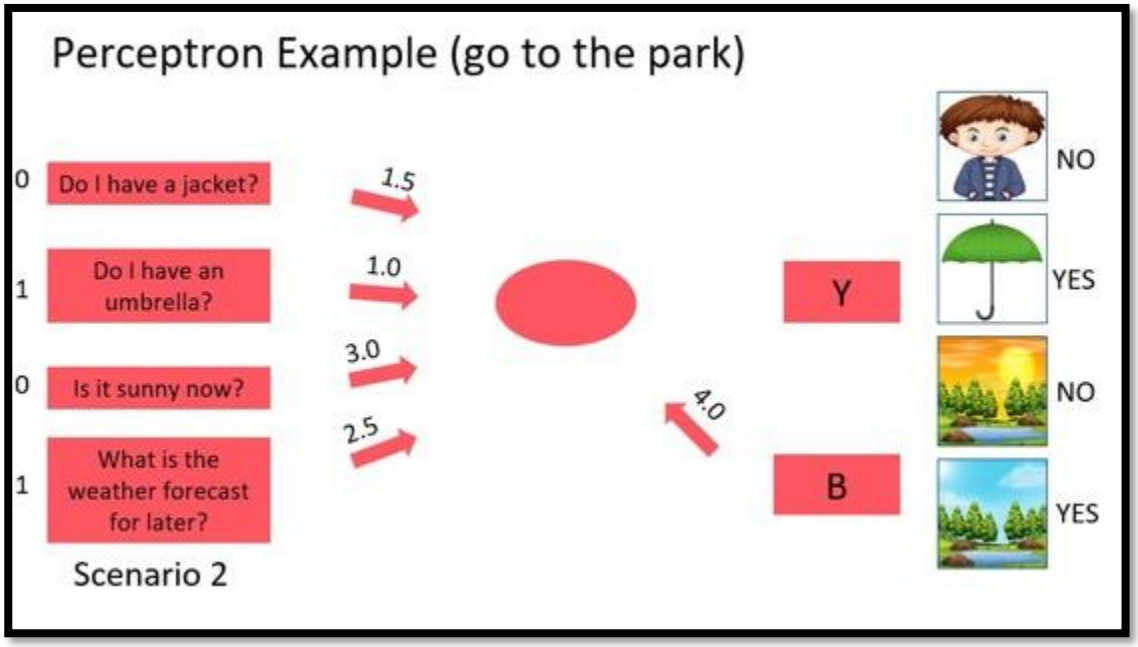


* Images shown here are the property of individual organisations and are used here for reference purpose only.

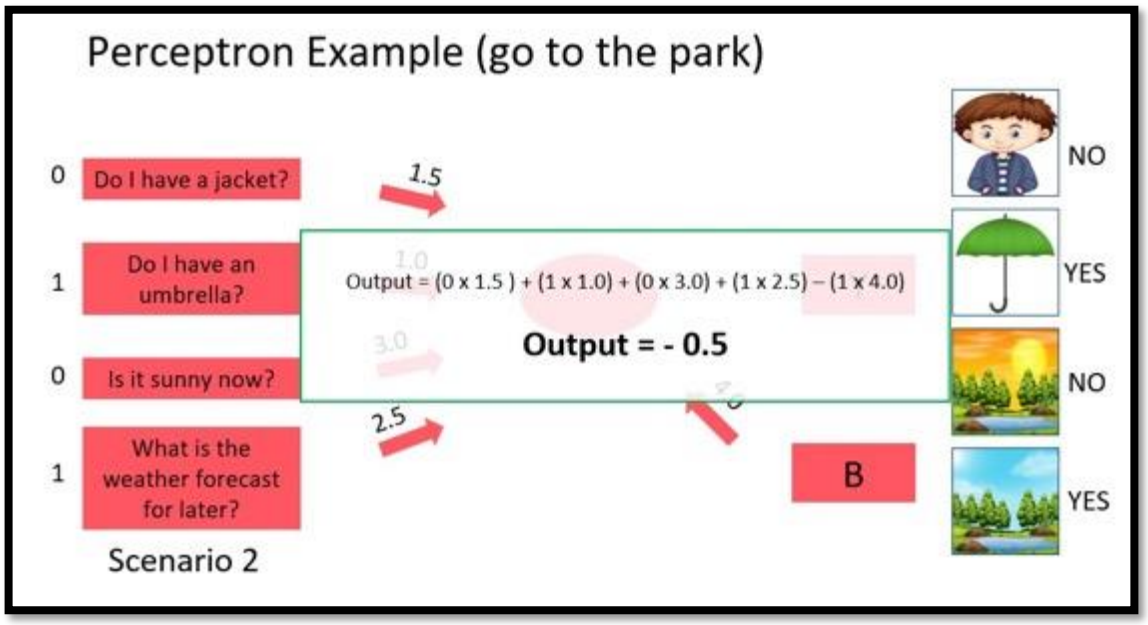
From this calculation, the output is 0.5. Since this is higher than the threshold (which is zero), the result is I will go out to the park.



Now let us change for another example.
let's say: I don't have a jacket, I have an umbrella, it is not sunny now, and the weather forecast is ok. We will convert the yes and no to numbers 1 and 0. And similarly, for bias, we will take1.



From this calculation, the output is -0.5. Since this is lower than the threshold (which is zero), the result is I will not go out to the park.



Activity 1

Human Neural Network – The Game

Session Preparation

Logistics: For a class of 40 students [Individual Activity]

Materials Required:

ITEM	QUANTITY
Images (To be kept with the facilitator)	2
Post-It Notes	80
Sketch-pens	40

* Images shown here are the property of individual organisations and are used here for reference purpose only.

Purpose: To understand and experience what a neural network is like.

Brief:

Students will now experience how Neural networks work with the help of an activity. Each of the students will be considered as the node of either Input Layer,1st Hidden Layer, 2nd Hidden Layer or the Output Layer. The instructions and rules have been mentioned in the Students Handbook.

After arranging the students at their positions and handing them sticky notes to write, show the sample image print-out to the input layer students. Let the students understand and do by themselves after this.

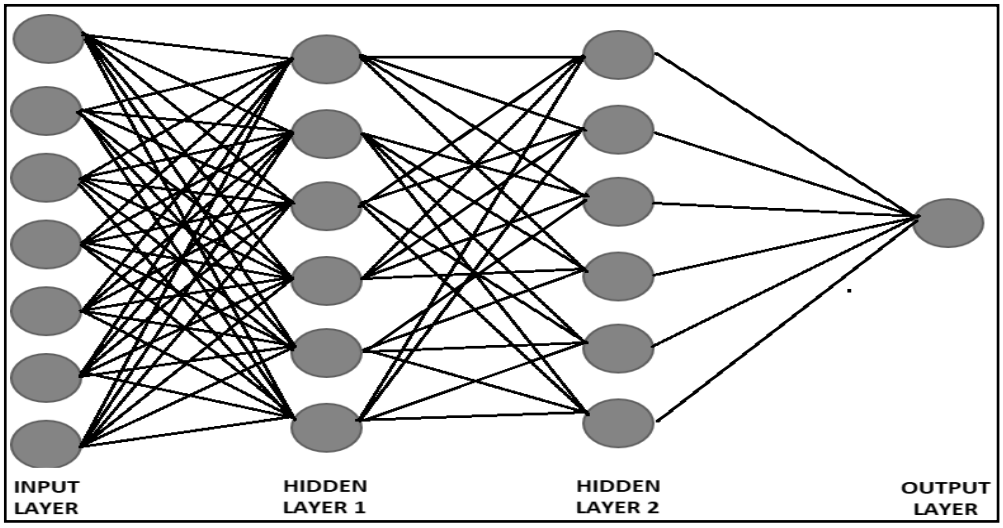
When to intervene?

Ask the students to play the game with honesty. No two nodes can discuss anything. Each one of them has to use their own discretion to understand and play.

Let us develop a better understanding about this concept with the help of a game called ***Human Neural Network.***

Game Structure:

Layers	Number of Students	Number of chits
Input Layer	7	6
Hidden Layer 1	6	4
Hidden Layer 2	6	2
Output Layer	1	-
TOTAL	**20**	**-**



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Ground Rules:

- No one is allowed to talk or discuss till the game ends. Fun of the game lies in playing it honestly.
- Each layer should sit distant to each other.
- The image should only be shown to the Input layer and no one else.
- The game is supposed to be played silently. This means that one has to write a word on the chit and pass on the chit without speaking out aloud.
- One needs to process the data as fast as possible, hence not take much time can be taken to write and pass on the chits.
- Input layer nodes cannot discuss the image shown with each other. Everyone has to use their own discretion.
- No sentences or multiple words are to be written on the chit. Only one word per chit is allowed.
- Once the task of a layer is finished, that layer needs to go and sit aside and not disturb others till the game ends.

Game Instructions:

Input Layer:

7 students will be standing as the nodes of an input layer.
All of them will be shown an image. After looking at it, they need to write 6 different words on 6 different chits. They have to choose the words which describe the image in the best way possible. They can also repeat the words if needed.
After making these chits, they need to pass on one chit to each of the nodes of hidden layer 1. That is, 1 chit will be given to one member.

Hidden Layer 1:

6 students will be standing as the nodes of hidden layer 1.
Each of them will receive 7 chits from 7 different input nodes. Now they have to take a good look at the chits and then write down 4 different words on 4 different chits. For this, they can either use the same words as the input layer did, or they can make their own information (relevant to the context) and write it.
Now these 4 chits are to be given randomly to any 4 nodes of Hidden Layer 2.Out of the 6 nodes of 2nd hidden layer, one can choose any 4 and give once chit to each. (For best results, each node of hidden layer 2 should get almost same number of chits thus the division should be done properly)

Hidden Layer 2:

6 Students will be standing as the nodes of hidden layer 2.
Each one of them will get some number of chits from the previous layer. Now they have to perform the same task as hidden layer 1 and have to write down2 different words on 2 different chits and pass it on to the output layer.

Output Layer:

Finally, the output layer node will get 12 chits. Now s/he has to understand all the words and has to guess which image was shown to the input layer initially.
Output layer will then write a summary out of all the words received to explain his/her deduction. The summary should not be more than 5 lines.

Finally, the output layer presents this summary in-front of everyone and the real image is finally revealed to all.

If the summary is accurate enough, the whole network wins else they lose.

Test Yourself:

Choose the most appropriate answer for each question.

1. In which type of machine learning is the data labeled with the desired output?

a) Supervised Learning

b) Unsupervised Learning

c) Reinforcement Learning

d) Deep Learning

2. An email spam filter that learns to identify spam emails based on labeled examples is an application of:

a) Supervised Learning

b) Unsupervised Learning

c) Reinforcement Learning

d) Transfer Learning

3. A machine learning algorithm that groups similar customer purchases into clusters for recommendation systems uses:

a) Supervised Learning

b) Unsupervised Learning

c) Reinforcement Learning

d) Neural Networks

4. An AI agent playing a game and learning from its rewards and penalties is an example of:

a) Supervised Learning

b) Unsupervised Learning

c) Reinforcement Learning

d) Evolutionary Learning

5. Which of the following statements is NOT true about supervised learning?

a) Requires labeled data for training.

b) Used for classification and regression tasks.

c) Can be less efficient for large datasets.

d) Often used in image recognition applications.

6. In an unsupervised learning scenario, the goal is to:

a) Predict a specific output based on labeled data.

b) Identify patterns and relationships within unlabeled data.

c) Train an AI agent through rewards and penalties.

d) Develop complex neural network architectures.

7. Clustering algorithms are commonly used in unsupervised learning for:

a) Spam filtering

b) Image classification

c) Stock price prediction

d) Grouping similar data points

8. Reinforcement learning is particularly useful for scenarios where:

a) Large amounts of labeled data are available.

b) The desired outcome is clear, but the path to achieve it is unknown.

c) The data is structured and easily categorized.

d) The task requires reasoning and logical deduction.

9. Imagine an AI playing a game and learning to win by trial and error. This is an example of:

a) Supervised Learning

b) Unsupervised Learning

c) Reinforcement Learning

d) Natural Language Processing

10. Artificial neural networks are inspired by the structure and function of:

a) The human brain

b) Quantum computers

c) Complex mathematical models

d) High-speed processors

11. The process of adjusting the weights in a neural network to improve performance is called:

a) Activation

b) Learning

c) Optimization

d) Training

12. A neural network with multiple layers of interconnected neurons is called a:

a) Single-layer network

b) Deep Neural Network

c) Linear network

d) Perceptron

13. Neural networks are particularly well-suited for tasks involving:

a) Simple calculations and mathematical operations

b) Recognizing patterns in complex data like images and text

c) Performing logical deductions and reasoning tasks

d) Storing and retrieving large amounts of information

14. Training a neural network often requires:

a) A small set of labeled data samples

b) A significant amount of data and computational resources

c) A specific set of programming instructions

d) A human expert to guide the learning process

Assertion and reasoning-based questions:

Q1. Assertion: Unsupervised Learning is a type of learning without any guidance.

Reasoning: Unsupervised learning models work on unlabeled datasets, where the data fed into the machine is random and the person training the model may not have any prior information about it.

Options:

(a) Both A and R are true and R is the correct explanation for A

(b) Both A and R are true and R is not the correct explanation for A

(c) A is True but R is False

(d) A is false but R is True

Q2. Assertion (A): Information processing in a neural network relies on weights and biases assigned to nodes.

Reasoning (R): These weights and biases determine how strongly a node is influenced by its inputs and its overall contribution to the next layer.

Reflection Time:

Answer the following questions:

Q1. Give difference between rule based and learning based AI models.

Q2. What is supervised, unsupervised and reinforcement learning? Explain with examples.

Q3. What is clustering and how is it different from classification?

Q4. Explain neural networks. Also give functions of three layers of neural networks.Q5.

Differentiate between classification and regression model.

Q6. What is neural network? Give the functioning of its three layers?

Q7. Identify the type of learning (supervised, unsupervised, reinforcement learning) are the following case studies most likely based on?

a) Case Study 1:
   A company wants to predict customer churn based on past purchasing behavior, demographics, and customer interactions. They have a dataset with labeled examples of customers who churned and those who did not.
b) Case Study 2:
   A social media platform wants to group users based on their interests and behavior to recommend relevant content. They have a large dataset of user interactions but no predefined categories. Which type of learning is this case study most likely based on?
c) Case Study 3:

An autonomous vehicle is learning to navigate through a city environment. It receives feedback in the form of rewards for reaching its destination safely and penalties for traffic violations. Which type of learning is this case study most likely based on?

d) Case Study 4:
A healthcare provider wants to identify patterns in patient data to personalize treatment plans. They have a dataset with various patient attributes but no predefined labels indicating specific treatment plans. Which type of learning is this case study most likely based on?

e) Case Study 5:
A manufacturing company wants to optimize its production process by detecting anomalies in sensor data from machinery. They have a dataset with examples of normal and anomalous behavior. Which type of learning is this case study most likely based on?

Q8. Identify the type of model (classification, regression, clustering, association model) are the following case studies most likely based on?

a) A bank wants to predict whether a loan applicant will "default" or "non-default" on their loan payments. They have a dataset containing information such as income, credit score, loan amount, and employment status.

b) A real estate agency wants to predict the selling price of houses based on various features such as size, location, number of bedrooms, and bathrooms. They have a dataset containing historical sales data.

c) A marketing company wants to segment its customer base into distinct groups based on purchasing behavior for targeted marketing campaigns. They have a dataset containing information such as purchase history, frequency of purchases, and amount spent.

d) A grocery store wants to identify associations between different products purchased by customers to understand which products are commonly bought together. They have a transaction dataset containing records of items purchased together during each transaction.

Q9. A healthcare provider wants to improve patient care by predicting the length of hospital stays for different medical conditions. They have a dataset containing patient demographics, medical history, and treatment details. The task involves:

a) To predict whether a patient will have a short or long hospital stay.
b) To predict the number of days a patient will stay in the hospital.
c) To segment patients into groups with similar characteristics for personalized treatment plans.
d) To identify patterns in patient treatments and outcomes.

Identify the type of model (classification, regression, clustering, and association model) in the above tasks.

Q10. Convert the following scenarios to perceptron:

a) Context: A manager is deciding whether to approve a work-from-home request from an employee.

   Factors:

   - Does the employee perform well when working remotely?

   - Are there any upcoming team meetings or collaborative projects?
   - Does the company's policy support remote work?

   - Is it beneficial for both the employee and the company?

b) Context: A homeowner is deciding whether to invest in solar panels for their house.

   Factors:

   - Do I have a sufficient average amount of sunlight in my area?

   - Are there any available incentives or rebates for installing solar panels?

   - Does installing solar panels impact the value of my home?

   - Does solar energy lead to environmental benefits?

Unit-3: Evaluating Models

Lesson Title: Evaluating Models	**Approach:** Session + Activity
Summary: In this module, students are introduced to the common metrics used to evaluate AI models. They will know how to derive and calculate the evaluation metrics and would also get an idea on how to improve the accuracy/efficiency of an AI Model. They will be introduced to the concept of Train/ Test Split, Common evaluation metrics such as Accuracy, Confusion Matrix, Precision, Recall, F1 Score) Learners will also be able to identify the use of this metrics in use cases encountered in everyday life.	
Learning Objectives: 1. To introduce students to the common metrics used to evaluate AI models 2. To familiarize students with deriving and calculating the evaluation metrics 3. To enable students to recognize the most suitable evaluation metric for a given application.	
Learning Outcomes: 1. Recognise common metrics used to evaluate AI models 2. Derive and calculate the evaluation metrics 3. Recognize the most suitable evaluation metric for a given application.	
Pre-requisites: Essential understanding of Artificial Intelligence	
Key-concepts: 1. Importance of model evaluation 2. Evaluation metrics for classification	

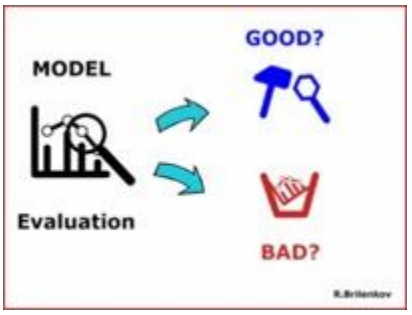
Introduction

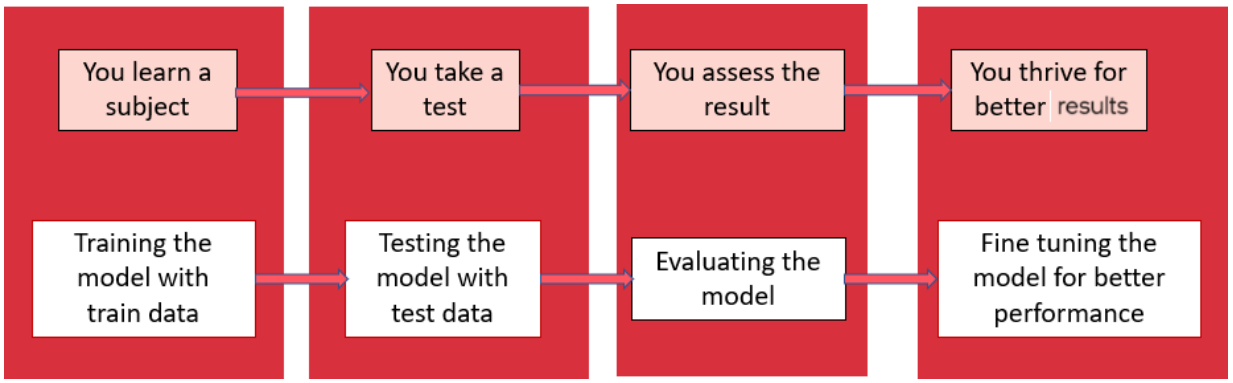
Till now we have learnt about the 4 stages of AI project cycle, viz. Problem scoping, Data acquisition, Data exploration and modelling. While in modelling we can make different types of models, how do we check if one's better than the other? That's where Evaluation comes into play. In the Evaluation stage, we will explore different methods of evaluating an AI model. Model Evaluation is an integral part of the model development process. It helps to find the best model that represents our data and how well the chosen model will work in the future

3.1: Importance of Model Evaluation

What is evaluation?

- Model evaluation is the process of using different evaluation metrics to understand a machine learning model's performance
- An AI model gets better with constructive feedback
- You build a model, get feedback from metrics, make improvements and continue until you achieve a desirable accuracy





- It's like the report card of your school
- There are many parameters like grades, percentage, percentiles, ranks
- Your academic performance gets evaluated and you know where to work more to get better

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Need of model evaluation

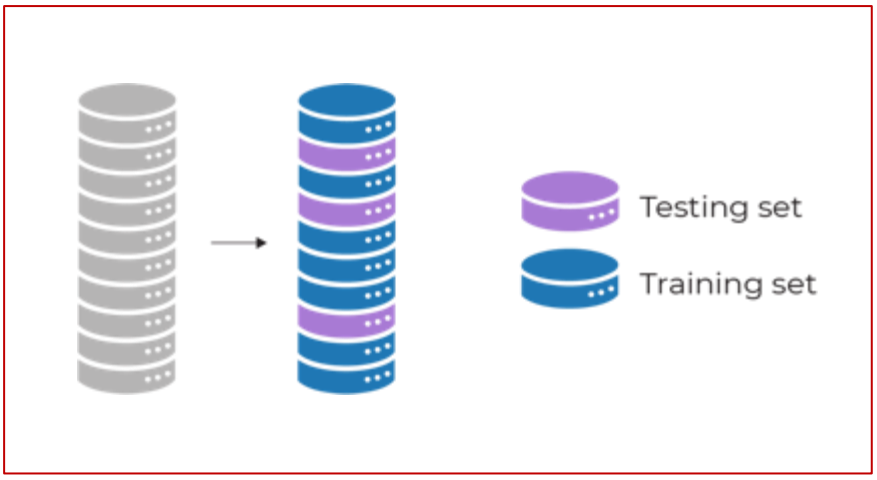
In essence, model evaluation is like giving your AI model a report card. It helps you understand its strengths, weaknesses, and suitability for the task at hand. This feedback loop is essential for building trustworthy and reliable AI systems.

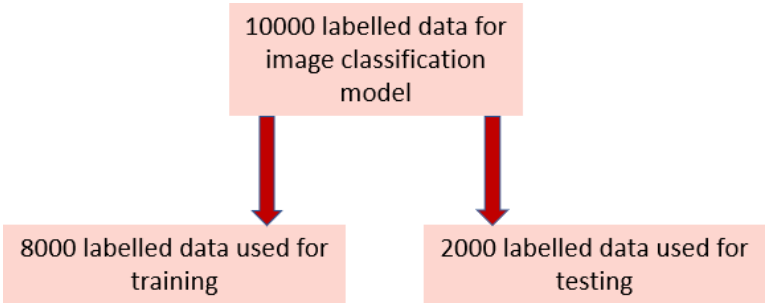
After understanding the need for Model Evaluation, let's know how to begin with the process. There can be different Evaluation techniques, depending of the type and purpose of the model.

3.2: Splitting the training set data for Evaluation

Train-test split

- The train-test split is a technique for evaluating the performance of a machine learning algorithm
- It can be used for any supervised learning algorithm
- The procedure involves taking a dataset and dividing it into two subsets: The training dataset and the testing dataset
- The train-test procedure is appropriate when there is a sufficiently large dataset available





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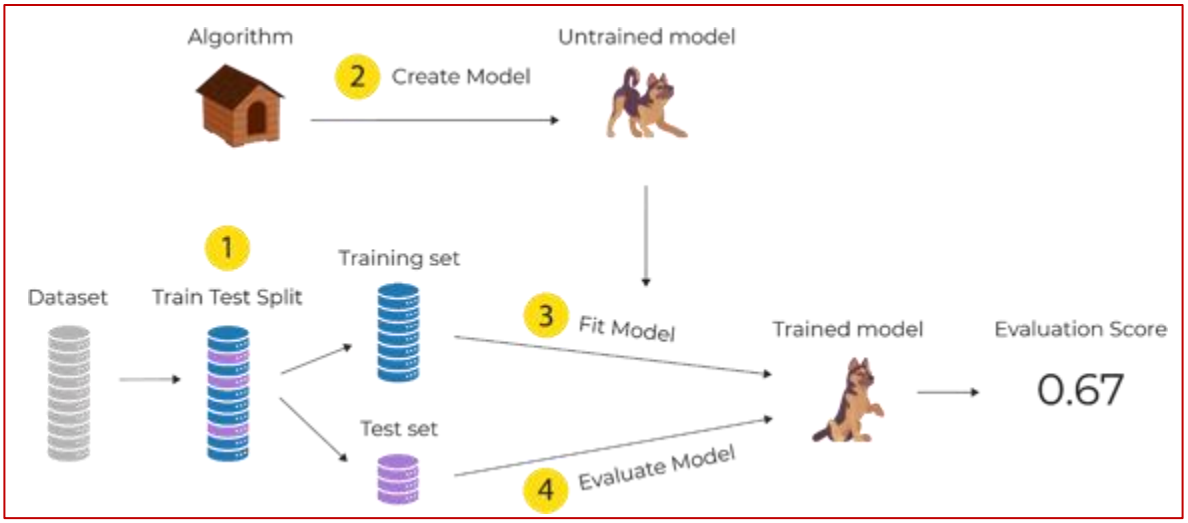
Need of Train-test split

- The train dataset is used to make the model learn
- The input elements of the test dataset are provided to the trained model. The model makes predictions, and the predicted values are compared to the expected values
- The objective is to estimate the performance of the machine learning model on new data: data not used to train the model



This is how we expect to use the model in practice. Namely, to fit it on available data with known inputs and outputs, then make predictions on new examples in the future where we do not have the expected output or target values.

Remember that It's not recommended to use the data we used to build the model to evaluate it. This is because our model will simply remember the whole training set, and will therefore always predict the correct label for any point in the training set. This is known as **overfitting**.

You will learn more about the concepts including train test split and cross validation in higher classes.

3.3: Accuracy and Error

- Bob and Billy went to a concert
- Bob brought Rs 300 and Billy brought Rs 550 as the entry fee for that
- The entry fee per person was Rs 500
- Can you tell:
  - Who is more accurate? Bob or Billy?
  - How much is the error for both Bob and Billy in estimating the concert entry fee?

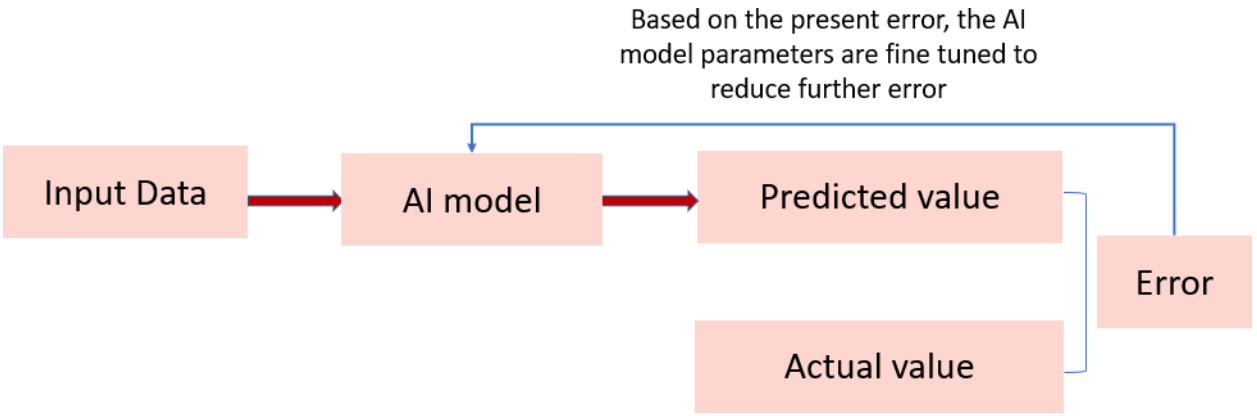
Accuracy

- Accuracy is an evaluation metric that allows you to measure the total number of predictions a model gets right.
- The accuracy of the model and performance of the model is directly proportional, and hence better the performance of the model, the more accurate are the predictions.

Error

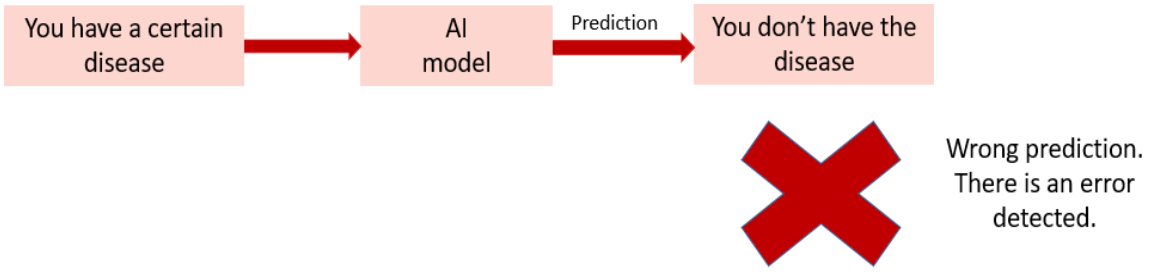
- Error can be described as an action that is inaccurate or wrong.
- In Machine Learning, the error is used to see how accurately our model can predict data it uses to learn new, unseen data.
- Based on our error, we choose the machine learning model which performs best for a particular dataset.

Error refers to the difference between a model's prediction and the actual outcome. It quantifies how often the model makes mistakes.



Imagine you're training a model to predict if you have a certain disease (classification task).

- **Error:** If the model predicts you don't have a disease but you actually have a disease, that's an error. The error quantifies how far off the prediction was from reality.



- **Accuracy:** If the model correctly predicts disease or no disease for a particular period, it has 100% accuracy for that period.

Key Points:

- Here the goal is to minimize error and maximize accuracy.
- Real-world data can be messy, and even the best models make mistakes.
- Sometimes, focusing solely on accuracy might not be ideal. For instance, in medical diagnosis, a model with slightly lower accuracy but a strong focus on avoiding incorrectly identifying a healthy person as sick might be preferable.
- Choosing the right error or accuracy metric depends on the specific task and its requirements.

Understanding both error and accuracy is crucial for effectively evaluating and improving AI models.

Activity 1: Find the accuracy of the AI model

Purpose: To understand how to calculate the error and the accuracy.

Say: "The youth will understand the concept of accuracy and error and practice it mathematically."

Calculate the accuracy of the House Price prediction AI model

- Read the instructions and fill in the blank cells in the table.
- The formula for finding error and accuracy is shown in the table
- Accuracy of the AI model is the mean accuracy of all five samples
- Percentage accuracy can be seen by multiplying the accuracy with 100

Predicted House Price (USD)	Actual House Price (USD)	Error Abs (Actual-Predicted)	Error Rate (Error/Actual)	Accuracy (1-Error rate)	Accuracy% (Accuracy*100)%
391k	402k	Abs (402k-391k)= 11k	11k/402k=0.027	1-0.027= 0.973	0.973*100%= 97.3%
453k	488k				
125k	97k				
871k	907k				
322k	425k				

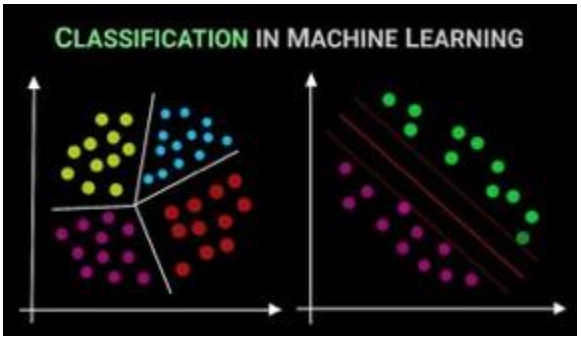
*Abs means the absolute value, which means only the magnitude of the difference without any negative sign (if any)

The Model Evaluation stands on the two pillars of accuracy and error. Let's understand some more metrics standing on these two pillars.

3.4: Evaluation metrics for Classification

What is Classification?

- You go to a supermarket and were given two trolleys
- In one, you have to place the fruits and vegetables; in the other, you must put the grocery items like bread, oil, egg, etc.
- So basically, you are classifying the items of the supermarket into two classes:
    - fruits and vegetables
    - grocery
- Classification usually refers to a problem where a specific type of class label is the result to be predicted from the given input field of data
- For example, here we are working on a vegetable-grocery-classifier model that predicts whether the item in the supermarket is a vegetable or a grocery item



Visualizing the concept of classification: Left 4 Classes; Right 2 classes

Try Yourself:

Which of this is a classification use case example?

House price prediction

Credit card fraud detection

Salary prediction

Classification Metrics

Popular metrics used for classification model

- Confusion matrix
- Classification accuracy
- Precision
- Recall

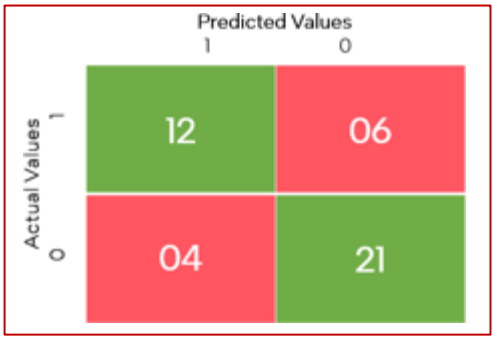
Let's understand these metrics in details:

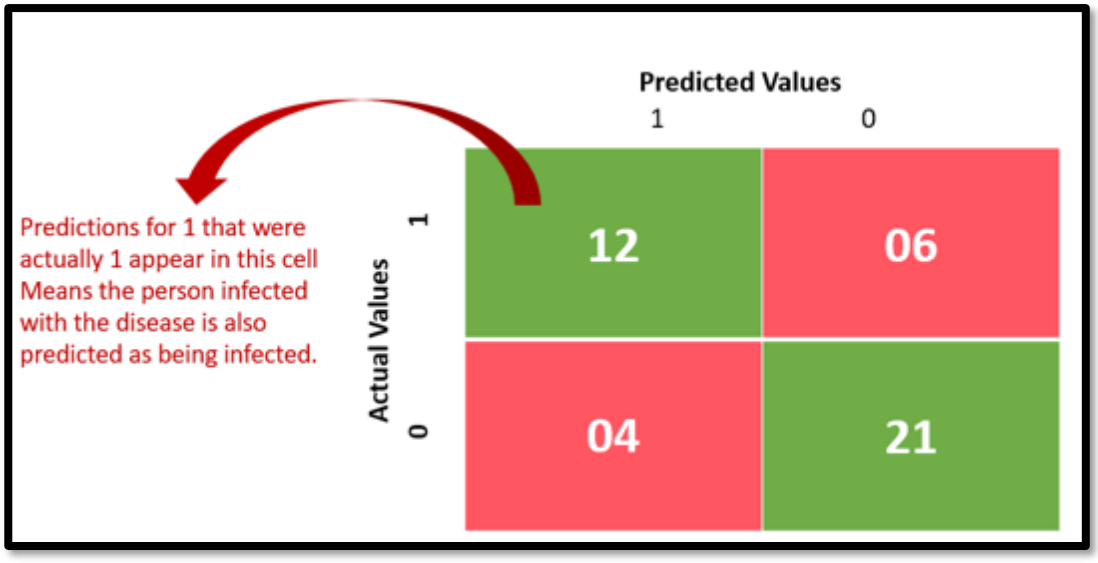
Confusion matrix

Let's say, based on some clinical parameters; you have designed a classifier that predicts whether a person is infected with a certain disease or not.

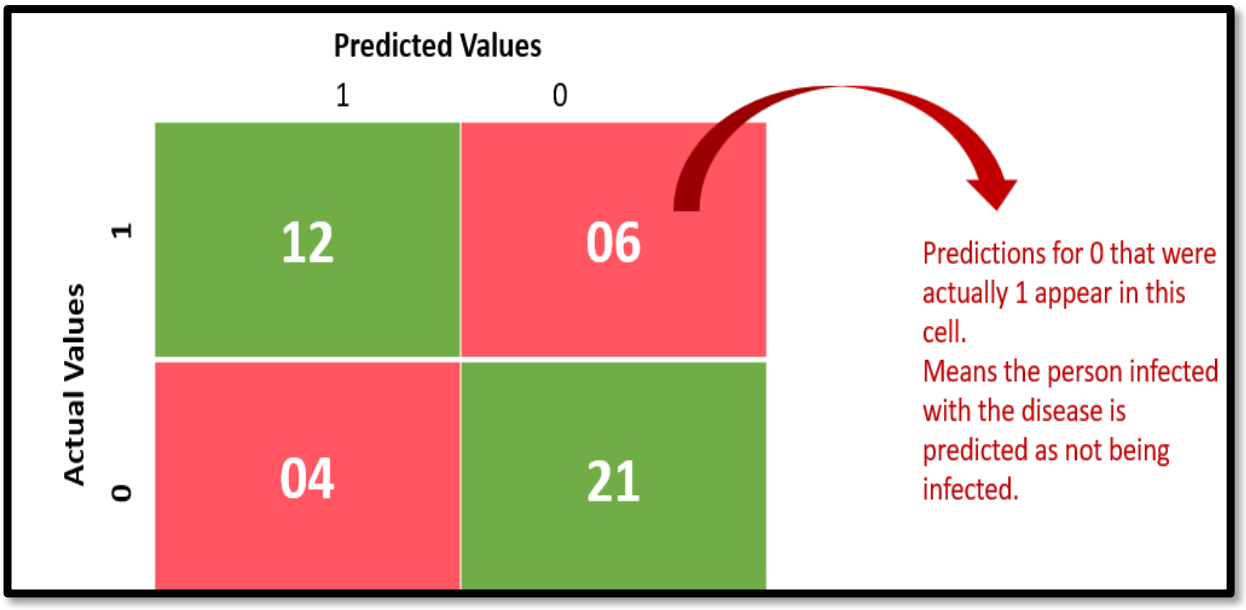
The output is 1 if the person is infected or 0 if the person is not infected. That is, 1 and 0 signify whether a person is infected or not.

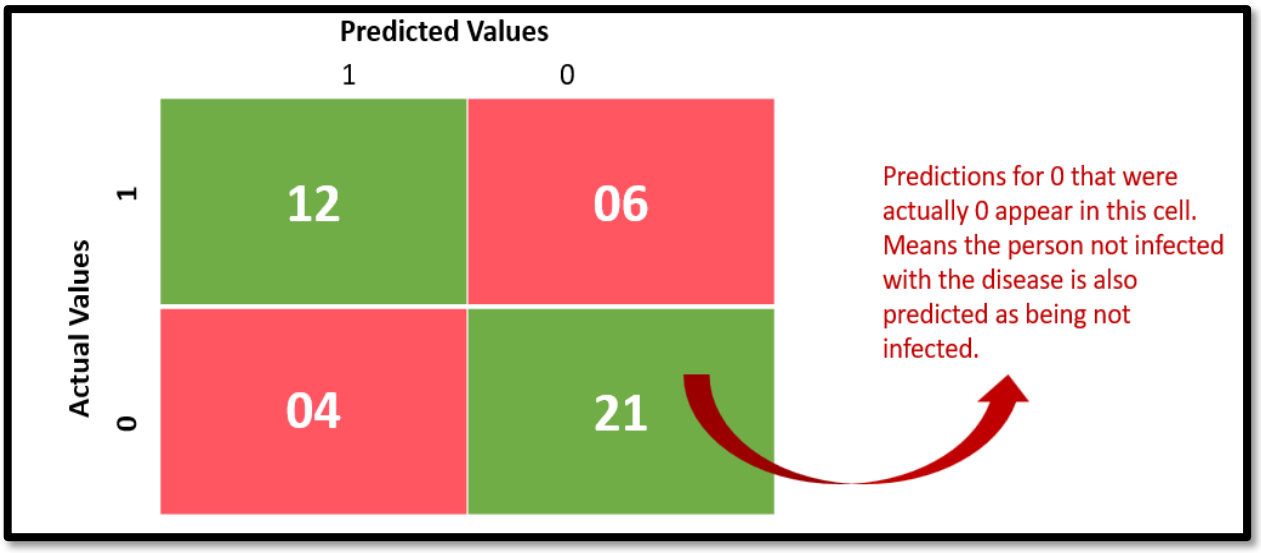
- The confusion matrix is a handy presentation of the accuracy of a model with two or more classes
- The table presents the actual values on the y-axis and predicted values on the x-axis
- The numbers in each cell represents the number of predictions made by a machine learning algorithm that falls into that particular category

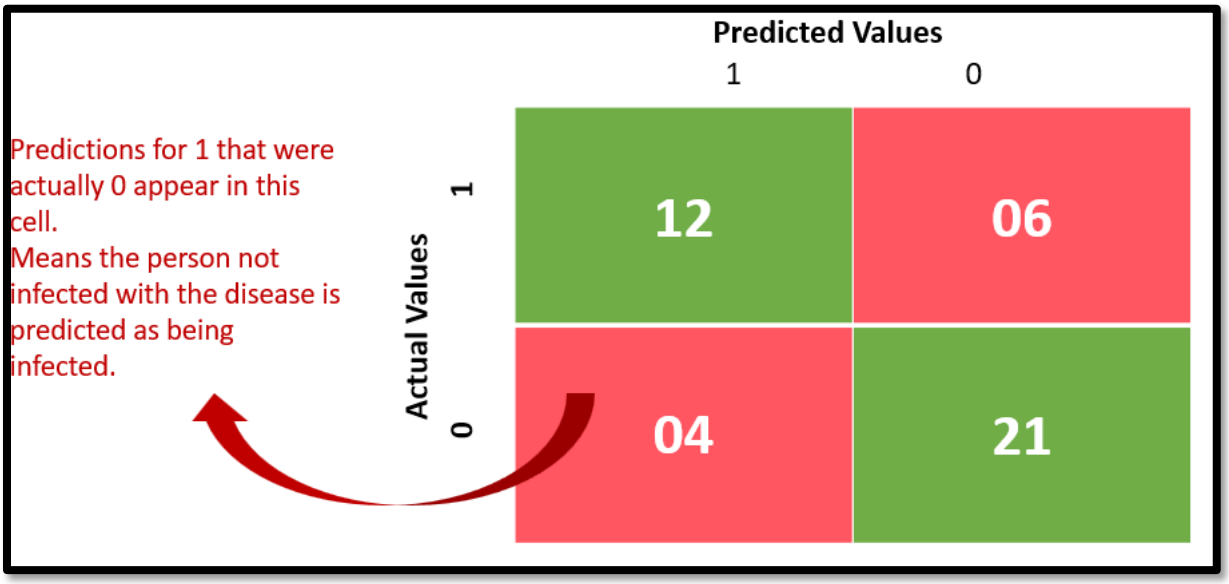




For example, a machine learning algorithm can predict 0 or 1 and each prediction may actually have been a 0 or 1.







Activity 2: Build the confusion matrix from scratch

Duration: 10 minutes

Purpose: Learn how to create confusion matrix from the scratch.

Say: “The youth need to analyze the situation and tabulate a non-numerical information a numerical one.”

Activity Guidelines

- Let’s assume we were predicting the presence of a disease; for example, "yes" would mean they have the disease, and "no" would mean they don't have the disease
- So, the AI model will have output is Yes or No
- The following chart shows the actual values and the predicted values
    - Construct a confusion matrix.
    - Can you tell how many are correct predictions among all predictions?

Actual value	Predicted Value
Yes	Yes
No	No
No	Yes
Yes	No
No	No
Yes	Yes
Yes	No
No	No
No	No
No	No

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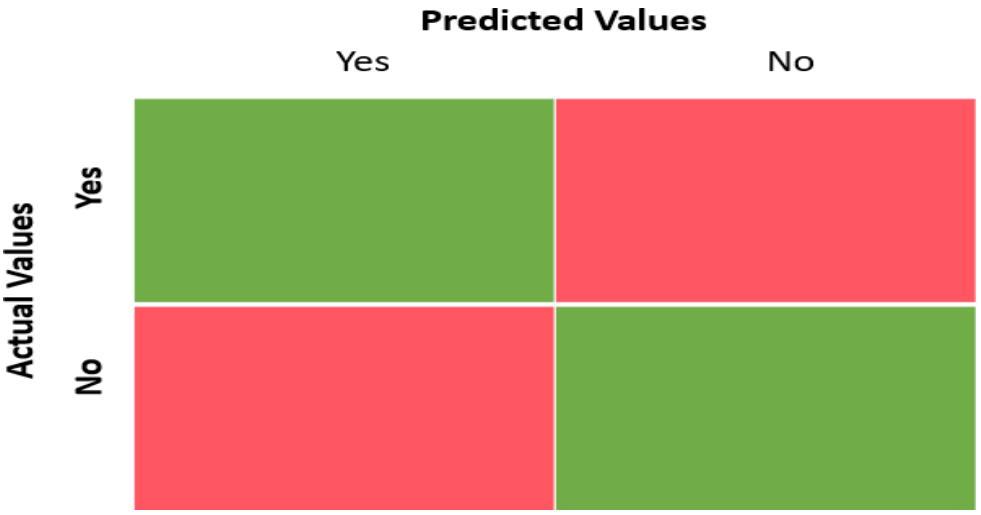
Fill the matrix based on the table given here.



Count the number of rows having YES in both columns of the table and put the count in the first cell. Similarly, number of rows having YES in the first column and NO in the second column will be shown in the top right cell of confusion matrix. Number of rows having NO in the first column and YES in the second column will be shown in the down left cell of confusion matrix. Lastly, number of rows having NO in the first column and YES in the second column will be shown in the downright cell of confusion matrix.

Activity Guidelines – Solution

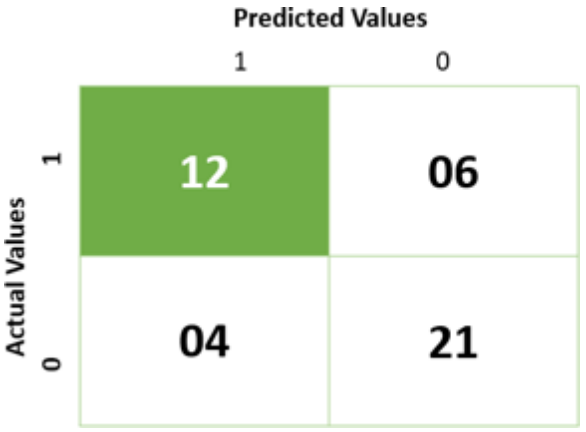
Activity Reflection

- So, there are 07 correct predictions out of 10 predictions.
- What do you think? How good is your model?

Now that you know how to construct a Confusion matrix, let's understand each cell of the matrix in details.

True Positive

- **True Positive** (**TP**) is the outcome of the model correctly predicting the positive class
- Any class can be assumed as a positive class, and the rest can be assumed as negative
- Let's say class 1 is assumed as the positive class
- Can you tell the TP value from this matrix?



Scenario 1:

Consider you are watching football world cup. Scenario 2:

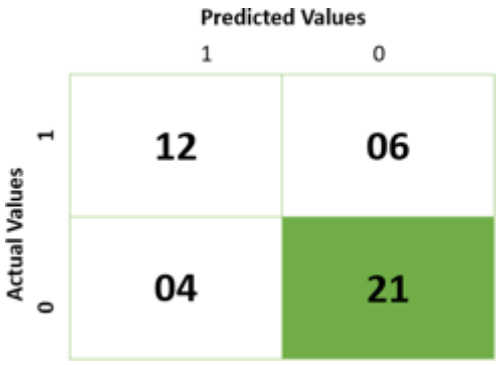
Consider the earlier example of medical diagnosis of an infected disease.

True Positive examples

- You had predicted that France would win the world cup, and it won.
- In the earlier activity, the cases in which we predicted yes (they have the disease), and they do have the disease.

True Negative

- **True Negative** (**TN**) is the outcome of the model correctly predicting the negative class.
- Since in the previous example, class 1 is assumed the positive class, class 0 should be assumed the negative class.
- Can you tell the TN value from this matrix?

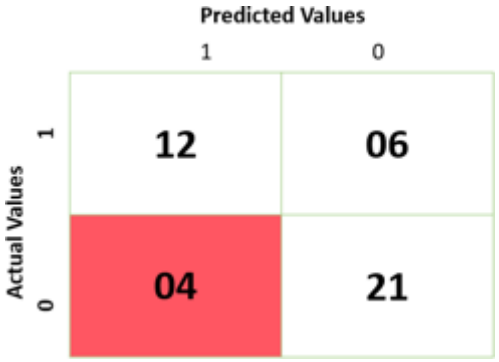


True Negative examples

- You had predicted that Germany would not win, and it lost
- In the earlier activity, the cases in which we predicted No (they don't have the disease), and they don't have the disease

False Positive

- **False Positive (FP)** is the outcome of the model wrongly predicting the negative class as positive class.
- Here, when a class 0 is predicted as class 1, it falls into the FP cell.
- Can you tell the FP value from this matrix?

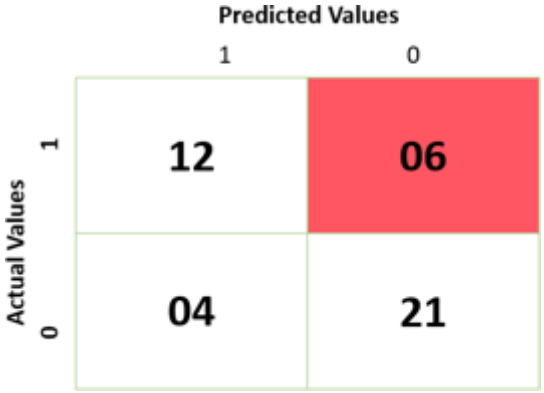


False Positive examples

- You had predicted that Germany would win, but it lost.
- In the earlier activity, the cases in which we predicted Yes (they have the disease), and they don't have the disease.

False Negative

- **False Negative (FN)** is the outcome of the model wrongly predicting the positive class as the negative class.
- Here, when class 1 is predicted as class 0, it falls into the FN cell.
- Can you tell the FN value from this matrix?



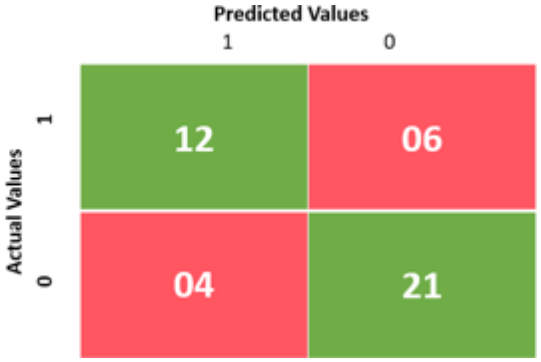
False Negative examples

- You had predicted that France would not win but it won
- In the earlier activity, the cases in which we predicted No (they don't have the disease), and they have the disease

Accuracy from Confusion matrix

Classification accuracy is the number of correct predictions made as a ratio of all predictions made.

Can you spot the correct predictions?



Calculate the Classification accuracy from this confusion matrix.

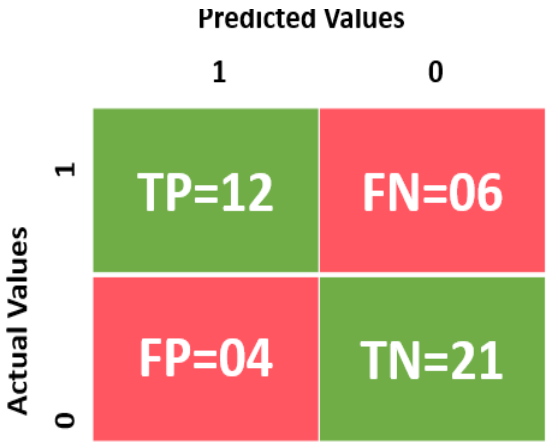
Correct predictions=TP+TN

Total predictions=TP+TN+FP+FN

$$\text{Classification accuracy} = \frac{\text{Correct predictions}}{\text{Total predictions}}$$

$$= \frac{TP+TN}{TP+TN+FP+FN}$$

$$= \frac{12+21}{12+21+04+06} = 0.767$$



Can we use Accuracy all the time?

- It is only suitable when there are an equal number of observations in each class, i.e., a balanced dataset (which is rarely the case), and that all predictions and prediction errors are equally important, which is often not the case.
- But why is that so? Let's understand it better from the next activity

Activity 3: Calculate the accuracy of the classifier model

Duration: 20 minutes

Purpose: To design an AI model that predicts whether a student will pass a test (Yes) or not pass a test (No).

Say: It classifies the input into two classes Yes and No. Also, calculate the accuracy of the classifier model and construct the confusion matrix for the model.

Activity Guidelines

- Let's assume you are testing your model on 1000 total test data.
- Out of which the actual values are 900 Yes and only 100 No (Unbalanced dataset).
- Let's assume that you have built a faulty model which, irrespective of any input, will give a prediction as Yes.
- Can you tell the classification accuracy of this model?

Step 1: Construct the Actual value vs Predicted value table

Actual value	Predicted Value

Consider '*Yes* 'as the positive class and '*No* 'as the negative class.

Step 2: Construct the confusion matrix.

Activity solution: Accuracy from Confusion matrix

So, the faulty model will predict all the 1000 input data as Yes.

Actual value	Predicted Value
Yes=900	Yes=1000
No=100	No=0

Consider '*Yes* ' as the positive class and '*No* ' as the negative class.

Construct the confusion matrix from the Actual vs Predicted table.

Activity solution: Accuracy from Confusion matrix

Step 3: Now calculate the accuracy from this matrix.

$$\text{Classification accuracy} = \frac{\text{Correct predictions}}{\text{Total predictions}}$$

$$= \frac{\mathbf{TP+TN}}{\mathbf{TP+TN+FP+FN}}$$

Step 4: Converting the accuracy to percentage: = %

$$\text{Classification accuracy} = \frac{\text{Correct predictions}}{\text{Total predictions}}$$

$$= \frac{\mathbf{TP+TN}}{\mathbf{TP+TN+FP+FN}}$$

$$= \frac{900}{\mathbf{900+0+100+0}} = 0.9$$

Converting the accuracy to percentage: 0.9x100 % = 90%

So, the faulty model you made is showing an accuracy of 90%. Does this make sense?

So, ***in cases of unbalanced data, we should use other metrics such as Precision, Recall or F1 score***. Let's understand them one by one…

Precision from Confusion matrix

- **Precision** is the ratio of the total number of correctly classified positive examples and the total number of predicted positive examples.
- Precision = 0.843 means that when our model predicts a patient has heart disease, it is correct around 84% of the time.

$$\textbf{Precision} = \frac{\textbf{Correct positive predictions}}{\textbf{Total positive predictions}}$$

$$= \frac{\textbf{TP}}{\textbf{TP+FP}}$$

Precision: where should we use it?

The metrics Precision is generally used for unbalanced datasets when dealing with the False Positives become important, and the model needs to reduce the FPs as much as possible.

Precision use case example

- For example, take the case of predicting a good day based on weather conditions to launch satellite.
- Let's assume a day with favorable weather condition is considered Positive class and a day with non-favorable weather condition is considered as Negative class.
- Missing out on predicting a good weather day is okay (low recall) but predicting the bad weather day (Negative class) as a good weather day (Positive class) to launch the satellite can be disastrous.
- So, in this case, the FPs need to be reduced as much as possible.

Recall from Confusion matrix

- The recall is the measure of our model correctly identifying True Positives
- Thus, for all the patients who actually have heart disease, recall tells us how many we correctly identified as having a heart disease. Recall = 0.86 tells us that out of the total patients who have heart disease 86% have been correctly identified.

$$\text{Recall} = \frac{\text{Correct positive predictions}}{\text{Total actual positive values}}$$

$$= \frac{TP}{TP+FN}$$

Do you know Recall is also called as Sensitivity or True Positive Rate?

Recall: Where we should we use it?

The metrics Recall is generally used for unbalanced dataset when dealing with the False Negatives become important and the model needs to reduce the FNs as much as possible.

Recall use case example

For example, for a covid-19 prediction classifier, let's consider detection of a covid-19 affected case as positive class and detection of covid-19 non-affected case as negative class.

- Imagine if a covid-19 affected person (Positive) is falsely predicted as non-affected of Covid-19 (Negative), the person if rely solely on the AI would not get any treatment and also may end up infecting many other persons.
- So, in this case, the FNs needs to be reduced as much as possible.
- Hence, Precision is a go-to metrics for this kind of use case.

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F1 Score

- F1-Score provides a way to combine both precisions and recall into a single measure that captures both properties
- In those use cases, where the dataset is unbalanced, and we are unable to decide whether FP is more important or FN, we should use the F1 score as the suitable metric.

$$\text{F1 Score} = \frac{2 \times \text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}$$

Activity 4: Decide the appropriate metric to evaluate the AI model

Duration: 30 minutes

Purpose: To work with the given scenario and choose the most appropriate evaluation metric to evaluate their model.

Say: "Different evaluation metrics are used for evaluation in different scenarios and it is important that we realize how to choose the correct one."

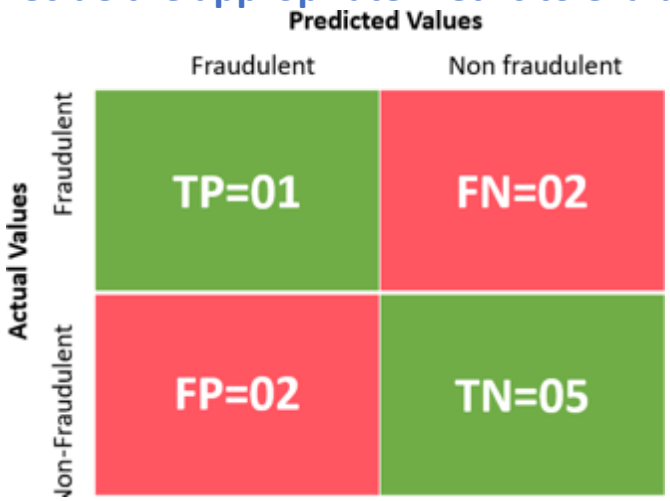
Scenario: Flagging fraudulent transactions

- You have designed a model to detect any fraudulent transactions with credit card.
- You are testing your model with highly unbalanced dataset.
- What is the metric to be considered in this case?
- It is okay to classify a legit transaction as fraudulent — it can always be re-verified by passing through additional checks.
- But it is definitely not okay to classify a fraudulent transaction as legit (false negative).
- So here false negatives should be reduced as much as possible.
- Hence in this case, Recall is more important.
- For the given data, construct the confusion matrix.
- Calculate the recall from the confusion matrix.

Transaction ID	Actual value	Predicted Value
1	Non-Fraudulent	Non-Fraudulent
2	Non-Fraudulent	Fraudulent
3	Non-Fraudulent	Non-Fraudulent
4	Fraudulent	Non-Fraudulent
5	Fraudulent	Fraudulent
6	Non-Fraudulent	Non-Fraudulent
7	Fraudulent	Non-Fraudulent
8	Non-Fraudulent	Fraudulent
9	Non-Fraudulent	Non-Fraudulent
10	Non-Fraudulent	Non-Fraudulent

Fill the matrix based on the table given above.

Activity solution: Decide the appropriate metric to evaluate the AI model



Calculate the recall from the confusion matrix based on.

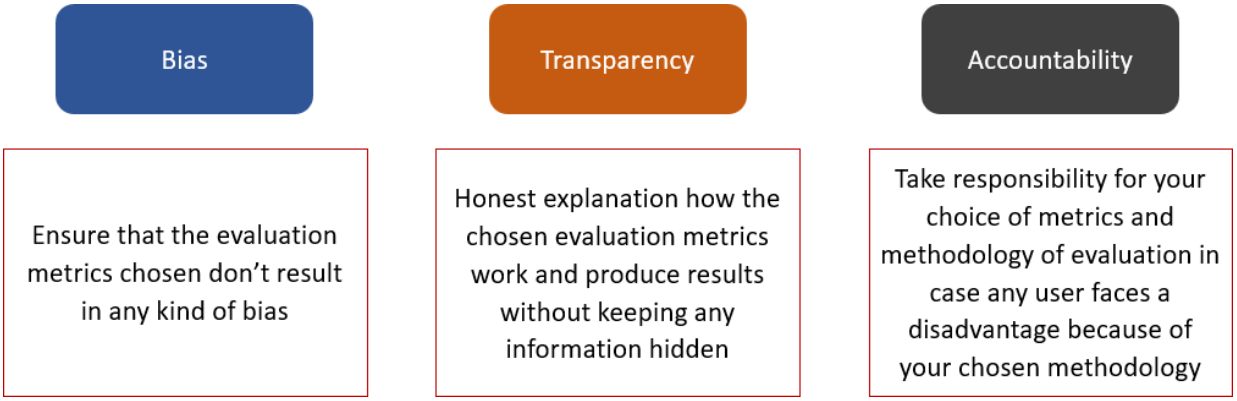
Write the formula for recall:

Calculate recall from the formula:

Are there any ethical concerns we need to keep in mind when performing model evaluation?

3.2 Ethical concerns around model evaluation

While evaluating an AI model, the following ethical concerns need to be kept in mind



Test Yourself

Choose the most appropriate answer for each question.

1. In a medical test for a rare disease, out of 1000 people tested, 50 actually have the disease while 950 do not. The test correctly identifies 40 out of the 50 people with the disease as positive, but it also wrongly identifies 30 of the healthy individuals as positive. What is the accuracy of the test?

   A) 97%

   B) 90%

   C) 85%

   D) 70%

2. A student solved 90 out of 100 questions correctly in a multiple-choice exam. What is the error rate of the student's answers?

   A) 10%

   B) 9%

   C) 8%

D) 11%

3. In a spam email detection system, out of 1000 emails received, 300 are spam. The system correctly identifies 240 spam emails as spam, but it also marks 60 legitimate emails as spam. What is the precision of the system?

   A) 80%

   B) 70%

   C) 75%

   D) 90%

4. In a binary classification problem, a model predicts 70 instances as positive out of which 50 are actually positive. What is the recall of the model?

   A) 50%

   B) 70%

   C) 80%

   D) 100%

5. In a sentiment analysis task, a model correctly predicts 120 positive sentiments out of 200 positive instances. However, it also incorrectly predicts 40 negative sentiments as positive. What is the F1 score of the model?

   A) 0.8

   B) 0.75

   C) 0.72

   D) 0.82

6. A medical diagnostic test is designed to detect a certain disease. Out of 1000 people tested, 100 have the disease, and the test identifies 90 of them correctly. However, it also wrongly identifies 50 healthy people as having the disease. What is the precision of the test?

   A) 90%

   B) 80%

   C) 70%

   D) 60%

7. A teacher's marks prediction system predicts the marks of a student as 75, but the actual marks obtained by the student are 80. What is the absolute error in the prediction?

   A) 5

   B) 10

   C) 15

   D) 20

8. The goal when evaluating an AI model is to:

A) Maximize error and minimize accuracy

B) Minimize error and maximize accuracy

C) Focus solely on the number of data points used

D) Prioritize the complexity of the model

9. A high F1 score generally suggests:

A) A significant imbalance between precision and recall

B) A good balance between precision and recall

C) A model that only performs well on specific data points

D) The need for more training data

10. How is the relationship between model performance and accuracy described?

A) Inversely proportional

B) Not related

C) Directly proportional

D) Randomly fluctuating

Reflection Time:

Q1. What will happen if you deploy an AI model without evaluating it with known test set data? Q2.

Do you think evaluating an AI model is that essential in an AI project cycle?

Q3. Explain train-test split with an example.

Q4. "Understanding both error and accuracy is crucial for effectively evaluating and improving AI models." Justify this statement.

Q5. What is classification accuracy? Can it be used all times for evaluating AI models?

Assertion and reasoning-based questions:

Q1. Assertion: Accuracy is an evaluation metric that allows you to measure the total number of predictions a model gets right.
Reasoning: The accuracy of the model and performance of the model is directly proportional, and hence better the performance of the model, the more accurate are the predictions.

Choose the correct option:
(a) Both A and R are true and R is the correct explanation for A
(b) Both A and R are true and R is not the correct explanation for A
(c) A is True but R is False
(d) A is false but R is True

Q2. Assertion: The sum of the values in a confusion matrix's row represents the total number of instances for a given actual class.
Reasoning: This enables the calculation of class-specific metrics such as precision and recall, which are essential for evaluating a model's performance across different classes.
Choose the correct option:
(a) Both A and R are true and R is the correct explanation for A
(b) Both A and R are true and R is not the correct explanation for A
(c) A is True but R is False
(d) A is false but R is True

Case study-based questions:

Q1. Identify which metric (Precision or Recall) is to be used in the following cases and why?

a) Email Spam Detection
b) Cancer Diagnosis
c) Legal Cases (Innocent until proven guilty)
d) Fraud Detection
e) Safe Content Filtering (like Kids YouTube)

Q2. Examine the following case studies. Draw the confusion matrix and calculate metrics such as accuracy, precision, recall, and F1-score for each one of them.

a. Case Study 1:

A spam email detection system is used to classify emails as either spam (1) or not spam (0). Out of 1000 emails:

- True Positives (TP): 150 emails were correctly classified as spam.

- False Positives (FP): 50 emails were incorrectly classified as spam.

- True Negatives (TN): 750 emails were correctly classified as not spam.

- False Negatives (FN): 50 emails were incorrectly classified as not spam.

-

b. Case Study 2:

A credit scoring model is used to predict whether an applicant is likely to default on a loan (1) or not (0). Out of 1000 loan applicants:

- True Positives (TP): 90 applicants were correctly predicted to default on the loan.

- False Positives (FP): 40 applicants were incorrectly predicted to default on the loan.

- True Negatives (TN): 820 applicants were correctly predicted not to default on the loan.

- False Negatives (FN): 50 applicants were incorrectly predicted not to default on the loan.

Calculate metrics such as accuracy, precision, recall, and F1-score.

c. Case Study 3:

A fraud detection system is used to identify fraudulent transactions (1) from legitimate ones (0). Out of 1000 transactions:

- True Positives (TP): 80 transactions were correctly identified as fraudulent.
- False Positives (FP): 30 transactions were incorrectly identified as fraudulent.
- True Negatives (TN): 850 transactions were correctly identified as legitimate.
- False Negatives (FN): 40 transactions were incorrectly identified as legitimate.

d. Case Study 4:

A medical diagnosis system is used to classify patients as having a certain disease (1) or not having it (0). Out of 1000 patients:

- True Positives (TP): 120 patients were correctly diagnosed with the disease.
- False Positives (FP): 20 patients were incorrectly diagnosed with the disease.
- True Negatives (TN): 800 patients were correctly diagnosed as not having the disease.
- False Negatives (FN): 60 patients were incorrectly diagnosed as not having the disease.

e. Case Study 5:

An inventory management system is used to predict whether a product will be out of stock (1) or not (0) in the next month. Out of 1000 products:

- True Positives (TP): 100 products were correctly predicted to be out of stock.
- False Positives (FP): 50 products were incorrectly predicted to be out of stock.True Negatives (TN): 800 products were correctly predicted not to be out of stock.
- True Negatives (TN): 800 products were correctly predicted not to be out of stock.
-
- False Negatives (FN): 50 products were incorrectly predicted not to be out of stock.

UNIT 4: Statistical Data

4.1: No-Code AI for Statistical Data

Lesson Title: No-Code AI for Statistical Data	**Approach:** Session + Activity
Summary: Understanding the importance and need of No-Code AI for Statistical Data, advantages, and disadvantages of using No-Code AI for Statistical Data, how to use No-Code AI tools for Statistical Data.	
Learning Objectives: • Understand the meaning of No-Code AI and the need of it. • Understand the difference between No-Code and Low-Code. • What are some no-code tools used for the statistical dataset? • How is the AI project cycle different for No-Code AI?	
Learning Outcomes: • Define No-Code and Low-Code AI. • Identify the differences between Code and No-Code AI concerning Statistical Data. • Relate AI project stages to the stages of No-Code AI projects.	
Pre-requisites: Basic knowledge of AI project cycle.	
Key-concepts: • No code tools for AI projects • Understanding different types of approaches like code, low code and No-Code for statistical data. • Identifying and recognizing various tools and platforms for low code and No-Code approaches	

Data science is a journey of exploration and discovery. Artificial Intelligence is a technology which completely depends on data, which is fed into the machine which makes it intelligent. And depending upon the type of data we have; AI can be classified into three broad domains: Data science, Computer Vision and Natural language processing.

Data Sciences is a concept to unify statistics, data analysis, machine learning and their related methods in order to understand and analyze actual phenomena with data. It employs techniques andtheories drawn from many fields within the context of Mathematics, Statistics, Computer Science, and Information Science.

Applications of Data Science:

Internet Search: All the search engines (including Google) make use of data science algorithms to deliver the best result for our searched query in the fraction of a second. Considering the fact that Google processes more than 20 petabytes of data every day, had there been no data science, Google wouldn't have been the 'Google' we know today.

Targeted Advertising: If you thought Search would have been the biggest of all data science applications, here is a challenger – the entire digital marketing spectrum. Starting from the display banners on various websites to the digital billboards at the airports – almost all of them are decided by using data science algorithms. This is the reason why digital ads have been able to get a much higher CTR (Call-Through Rate) than traditional advertisements. They can be targeted based on a user's past behaviour.

Website Recommendations: Aren't we all used to the suggestions about similar products on Amazon? They not only help us find relevant products from billions of products available with thembut also add a lot to the user experience. A lot of companies have fervidly used this engine to promote their products in accordance with the user's interest and relevance of information. Internet giants like Amazon, Twitter, Google Play, Netflix, LinkedIn, IMDB and many more use this system to improve the user experience. The recommendations are made based on previous search results for auser.

Genetics & Genomics:

Data Science applications also enable an advanced level of treatment personalization through research in genetics and genomics. Data science techniques allow integration of different kinds of data with genomic data in disease research, which provides a deeper understanding of genetic issues in reactions to particular drugs and diseases. As soon as we acquire reliable personal genome data, we will achieve a deeper understanding of human DNA. The advanced genetic risk prediction will be a major step towards more individual care.

Activity: Word Scramble the terms related to AI applications.

Purpose: Recall of AI terms

VANAGTOINI APP _____

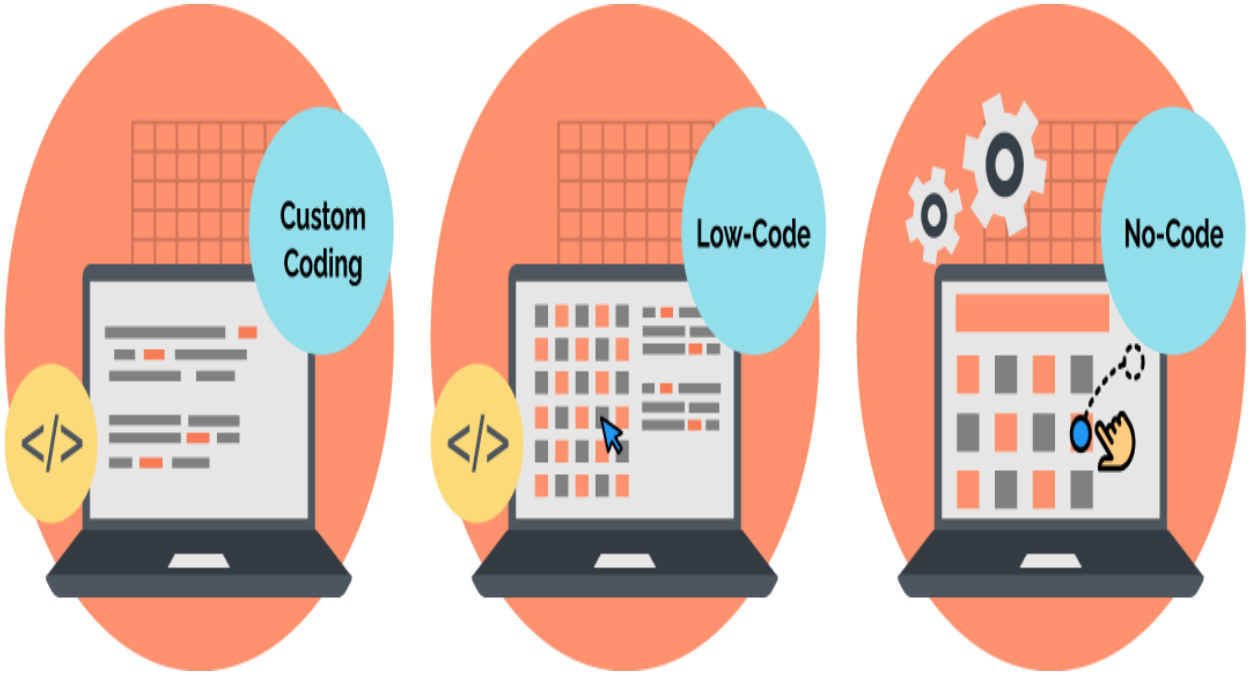
UALTIRV SSISATANT _____

AGEGUALAN TIONSLATRAN _____

Introduction to Low/No-Code AI approach for Statistical Data

Let's say you want to build a product, food delivery application. How do you go about starting it?

Building a food delivery application involves several steps, from conceptualization to development, testing, and deployment. The 3 most popular approaches to code are given below.



Custom code is also known as high code.

How do we choose? Which of these 3 is the most suitable for our app?

High code	Low code	No code
High code development refers to traditional software development where programmers write code manually using programming languages like Java, Python, C#, etc.	Low code development involves using platforms or tools that provide visual interfaces and pre-built components to streamline the application development process.	No code development takes low code principles further by allowing users to create applications without any coding or scripting knowledge.
A team of software coders need to write all the code manually.	Programmers need to write some code manually.	Coding knowledge is not required; hence anyone can make the product.
It is expensive.	It is less expensive compared to high code.	It is less expensive compared low code.
The company can own the product they create. You can create anything and customise your product in any way.	You can customise your product to an extent only using code. For example, custom chatbot.	Lack of customisable options as No-Code AI tools are limited to functions in the tool. Simple to use as it uses drag-and-drop features instead of coding.

Now that we have seen the differences,
which approach do you think is the most suitable one for our Food Delivery app? Discuss!

Can you think of an invention that has made life easier in terms of saving time/cost for you?

Some inventions that have made life today easier are smartphones, credit cards, internet, onlinestreaming services, Refrigeration technology, GPS navigation, medical innovations etc.

Similar to those inventions, let's look at how No-Code AI makes our lives easier!

More code to test out different algorithms…And

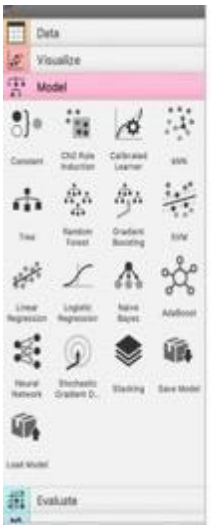
more code to pick the best algorithm…

```
# evaluate each model in turn
results = []
names = []
for name, model in models:
    kfold = StratifiedKFold(n_splits=10, random_state=1, shuffle=True)
    cv_results = cross_val_score(model, X_train, Y_train, cv=kfold, scoring='accuracy')
    results.append(cv_results)
    names.append(name)
    print('%s: %f (%f)' % (name, cv_results.mean(), cv_results.std()))
# Compare Algorithms
pyplot.boxplot(results, labels=names)
pyplot.title('Algorithm Comparison')
pyplot.show()
```

That's a lot of code, right? And that's why we have No-Code AI.

No-Code

- In No-Code AI, we can drag and drop, these models in few seconds.
- No coding knowledge is required to implement complex ML algorithms
- Drag and drop feature of a No-Code tool makes it easier.



Why do we need No-Code AI?

- We tend to run into many types of errors when we are coding, and it can be very troublesome at times.
- In No-Code AI since we do not need to code, we won't have any code errors!
- No-Code AI helps to save cost for businesses as it is costly to implement completely coded AI systems.
- Companies can implement AI with less stress and without the need to hire an AI staff with No-Code AI.
- No-Code AI is easy to use – even middle school students can create AI using No-Code tools
- Since it has visual & drag-and-drop features, anyone can see what they are building in real-time

Who can use No-Code AI?

- No-Code AI makes AI more accessible to the general public.
- Non-technical people such as doctors, architects, musicians may quickly construct accurate AI models with no coding involved.

Let's look at a scenario to understand who can use No-Code AI

- No-Code AI makes AI more accessible to the general public.
- Non-technical people such as doctors, architects, musicians may quickly construct accurate AI models with no coding involved.

Thus No-Code AI can empower individuals and organizations across various industries and skill levels to harness the potential of artificial intelligence for their specific needs.

Let's look at a scenario to understand who can use No-Code AI.

Problem: Kayla is a wildlife animal's dietitian manager at the zoo. She takes care of the cost of buying meat and vegetables for animals. With the prices of food increasing rapidly, it will become more expensive for the zoo to buy healthy and nutritious foods for its animals. Therefore, the zoo's accounts team wants to know the increase in the price of food so that they can ask the government or sponsors to fund for the food. Thus, Kayla requires the help of AI to predict the price.

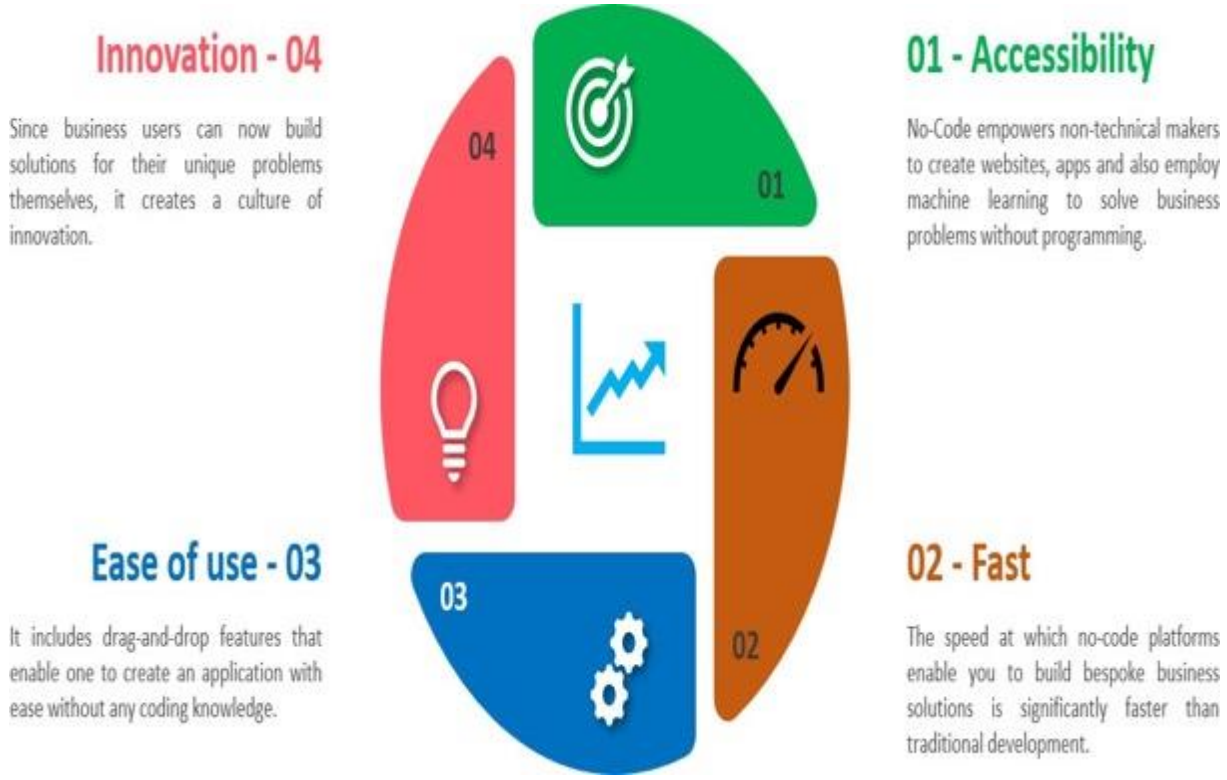
However, Kayla does not know how to code to build an AI model as she has not learnt AI before.

Solution:

She finds a No-Code AI tool online that can help her build an AI model to predict the prices of meatand vegetables without any code!

Kayla can also use any popular No-Code Tool like Orange Data Mining to build a price prediction model. We will look at how to build a simple price prediction model in a short while. From this scenario you can infer that: You do not need to know coding to build an AI model and anyone canmake use of No-Code AI to build an AI model.

Benefits of No-Code Tools



Now that we have discussed the advantages of No-Code tools, let us discuss the disadvantages too…

Disadvantages of No-Code Tools

Lack of Flexibility

Drag-and-drop elements can be very convenient. On the other hand, you are limited to those fixed elements. Hence, you have a limitation in customizing your application in no-code platforms, and it does not give you all the authority and flexibility you might need.

Automation Bias

Automation bias is the tendency for humans to favor suggestions from automated decision-making systems and to ignore contradictory information made without automation, even if it is correct.

Security Issues

No code platforms do not essentially force you to think of security first or even evaluate security best practices. Therefore, these applications are only best suited for companies that don't deal with sensitive data, as these platforms usually offer limited control over it.

Popular No-Code Tools

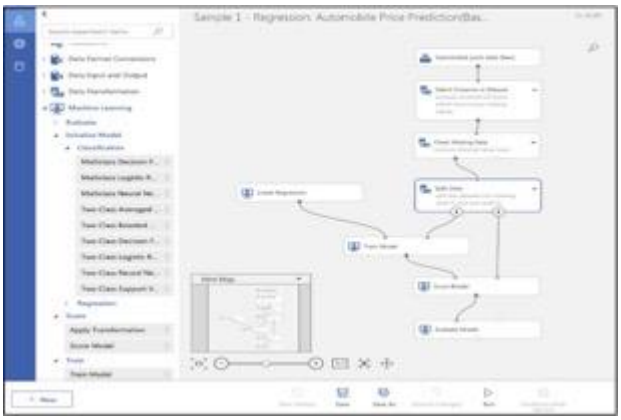
Here are some of the top No-Code AI tools where we can build our AI models in.

No-Code tool	Details	Released
Azure Machine Learning	Cloud-based service provided by Microsoft	July 2014
Google Cloud AutoML	Cloud-based service provided by Google	January 2018
Orange Data Mining	An open-source data visualization, machine learning and data mining toolkit. Developer: University of Ljubljana	October 1996
Lobe AI	Lobe AI is a machine learning platform that enables to create custom machine learning models using a visual interface	2015
Teachable Machine	Teachable Machine is a web-based tool that makes creating machine learning models fast, easy, and accessible to everyone.	November 2017

Azure Machine Learning

Microsoft's Azure Machine Learning aims to simplify ML processes.

- It allows users to build ML models without having to touch any code,
- and provides an easy interface for cleaning up your data, training models, evaluating them and, finally, putting them into production.



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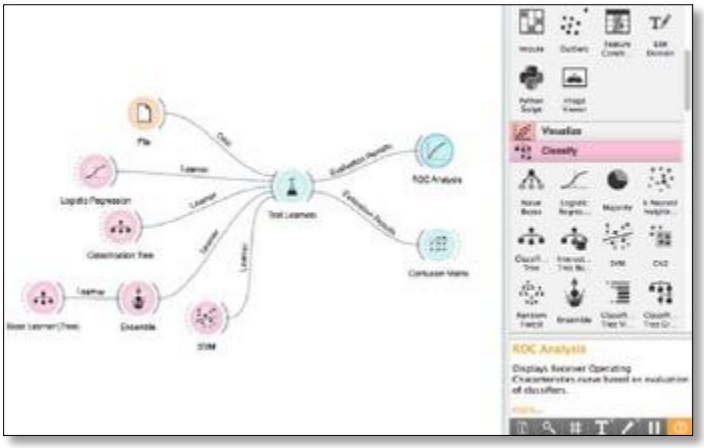
Google Cloud AutoML

- Users with limited ML knowledge can train high-quality models specific to their business needs with minimal effort.
- They can build their own custom machine learning model in minutes and then use the models in their applications and web sites.

  Click on Introducing Cloud AutoML to watch a video on it.

Orange Data Mining

- Orange enables you to visualize data and perform data mining and machine learning.
- You can use this tool without writing a single code.
- This platform can be used for analysis, is relatively easy, and has beautiful visuals.



Now, let us get back to building a simple prediction model using Orange Data Mining for Kayla!

FAO food price index

		Food Price Index [1]	Meat [2]	Dairy [3]	Cereals [4]	Vegetables Oils [5]	Sugar [6]
2004		65.6	67.6	69.8	64.0	69.6	44.3
2005		67.4	71.8	77.2	60.8	64.4	61.2
2006		72.6	70.5	73.1	71.2	70.5	91.4
2007		94.3	76.9	122.4	100.9	107.3	62.4
2008		117.5	90.2	132.3	137.6	141.1	79.2
2009		91.7	81.2	91.4	97.2	94.4	112.2
2010		106.7	91.0	111.9	107.5	122.0	131.7
2011		131.9	105.3	129.9	142.2	156.5	160.9
2012		122.8	105.0	111.7	137.4	138.3	133.3
2013		120.1	106.2	140.9	129.1	119.5	109.5
2014		115.0	112.2	130.2	115.8	110.6	105.2
2015		93.0	96.7	87.1	95.9	89.9	83.2
2016		91.9	91.0	82.6	88.3	99.4	111.6
2017		98.0	97.7	108.0	91.0	101.9	99.1
2018		95.9	94.9	107.3	100.8	87.8	77.4
2019		95.1	100.0	102.8	96.6	83.2	78.6
2020		98.1	95.5	101.8	103.1	99.4	79.5
2021		125.7	107.7	119.1	131.2	164.9	109.3
2021	September	129.2	112.7	118.1	132.8	168.6	121.2
	October	133.2	112.0	121.5	137.1	184.8	119.1
	November	135.3	112.5	126.0	141.4	184.6	120.2
	December	133.7	111.0	129.0	140.5	178.5	116.4
2022	January	135.6	112.1	132.6	140.6	185.9	112.7
	February	141.2	113.9	141.5	145.3	201.7	110.5
	March	159.7	119.3	145.8	170.1	251.8	117.9
	April	158.4	121.9	146.7	169.7	237.5	121.5
	May	158.1	122.9	144.2	173.5	229.2	120.4
	June	154.7	125.9	150.2	166.3	211.8	117.3
	July	140.6	124.1	146.5	147.3	168.8	112.8
	August	137.9	122.0	143.4	145.6	163.3	110.5
	September	136.3	121.4	142.5	147.8	152.6	109.7

Purpose: To build an AI model to predict price using Orange Data mining AI tool

Steps for building a simple priceprediction model:
Step 1: Download the datasetfrom

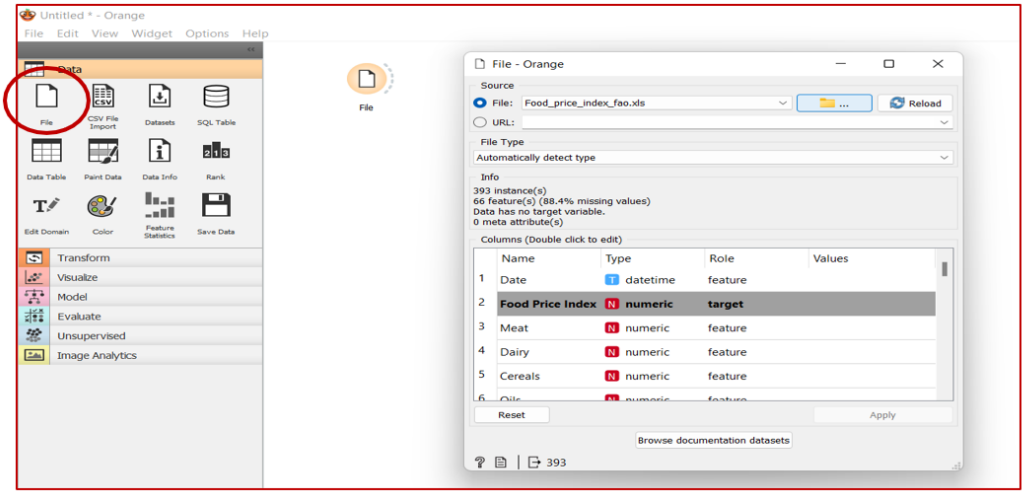
https://www.fao.org/worldfoodsituation/foodpricesindex/en/

Step 2: Open Orange Data Mining

- Double Click on Orange Icon
- Open the tool

Step 3: Upload the Dataset

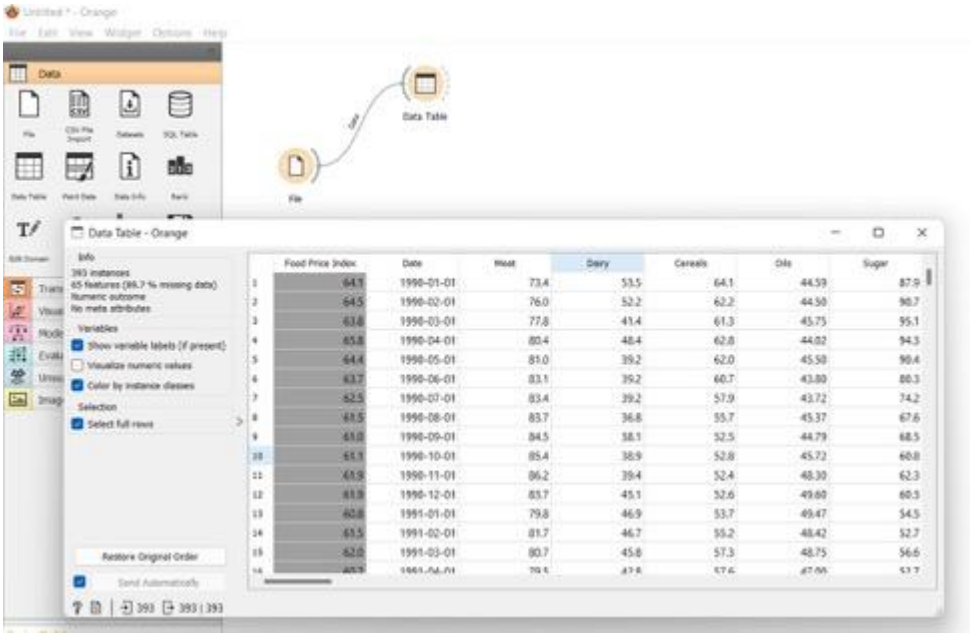
- Click on the File widget under Data Menu
- File widget will appear on the canvas
- Click on it and browse to the folder to upload the dataset
- Select the target variable as Food Price Index, as we are trying to predict the price index.



Step 4: View the Dataset

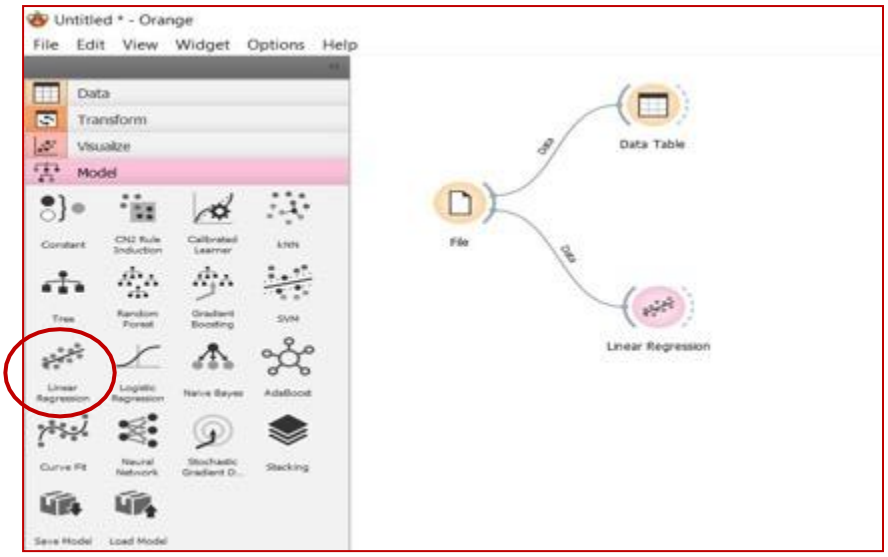
- Click on the Data Table widget under Data Menu
- Data Table widget will appear on the canvas
- Connect File to Data Table

- Click on Data Table to view the dataset using the tool.



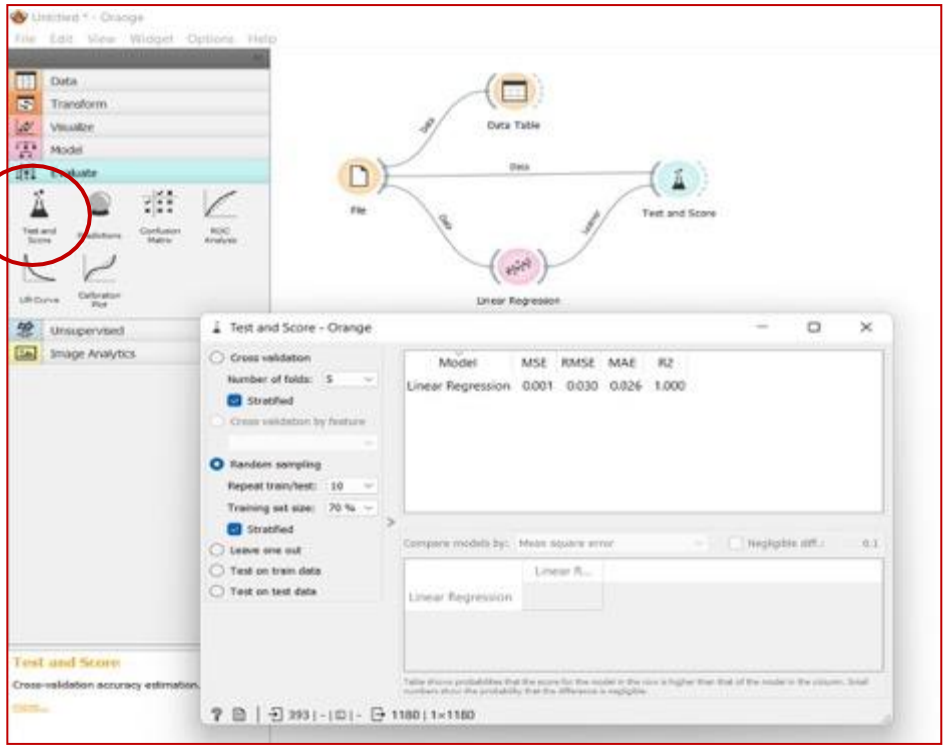
Step 5: Select the Model for Prediction

- Click on the Linear Regression widget under Model Menu
- Linear Regression widget will appear on the canvas
- Connect File to Linear Regression
- Linear Regression is an algorithm used for Regression Model



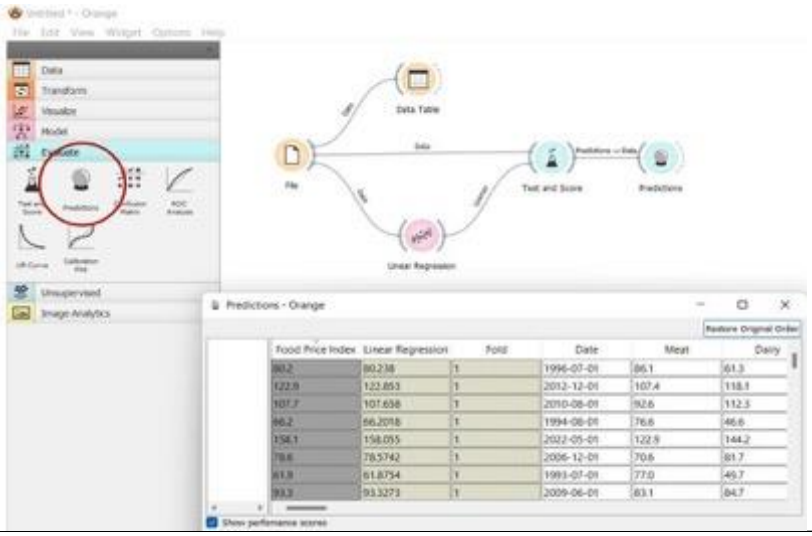
Step 6: Evaluate the Model

- Click on the Test and Score widget under Evaluate Menu
- Test and Score widget will appear on the canvas
- Connect File and Linear Regression to Test and Score to check the performance parameters.
- Click on Test and Score to view the parameters.



Step 7: Model Prediction

- Click on the Prediction widget under Evaluate Menu
- Prediction widget will appear on the canvas
- Connect the Test and Score to the Prediction to check the prediction made by Logistic Regression Model.
- Click on Prediction to view the price prediction.



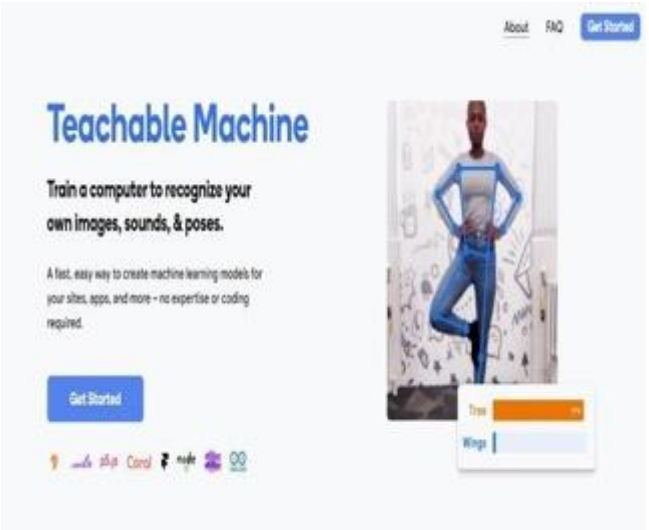
Kayla could use such a model to make the price prediction for animal feed and make a systematic fund-raising plan for the Zoo.

Other No code AI tools

Lobe

- Machine Learning has been made easy using Lobe.
- It has everything that you need to bring your machine-learning ideas to life.
- Lobe helps you, train models with a free and easy-to-use tool.
- It automatically trains a custom machine-learning model that can be shipped in your app.

Teachable Machine



- Teachable Machine is a web-based tool that makes creating machine learning models fast, easy and accessible to everyone.
- It can be used to train a computer to recognize your own images, sounds and poses.
- No specific expertise or coding is required to use this tool.

Test Yourself:

1. Orange data mining is an example of

a) Custom coding c) No code

b) Low code d) None of these.

2.Select Which is not the feature of No code approach.

a) visual c) code free

b) Highly expensive d) drag and drop

3. _____ assembly relies on developers to write and deploy code.

a) High code c) No code

b) Low code d) None of these

c) 4.Flexibility is often limited in _____

a) High code c) No code

b) High code and Low code d) High code and No code.

5. The organisation is heavily dependent on developer resources. This statement is true for

a) High code approach c) No code approach

b) Low code approach d) All of the above.

Answer the following briefly:

1. Name any two-cloud based No-code AI tools?
2. How accessible are no-code AI tools for non-technical users?
3. What types of tasks can be accomplished with no-code AI tools?
4. Can no-code AI tools be used for advanced projects? Justify.
5. Do no-code AI tools require prior programming knowledge? Justify.

Answer the following in detail:

1. What are the benefits of using No-code AI tools?
2. What are the challenges faced in using the No-code AI tools?
3. Differentiate low code and No-code AI tools with examples.
4. As the CEO of a small e-commerce startup, you're eager to leverage artificial intelligence to enhance your platform's user experience and drive sales. However, your team lacks the technical expertise to develop and deploy AI-powered solutions. What would be your recommendations for the CEO?
5. Samarth attended a seminar on Artificial Intelligence and has now been asked to write a report on his learnings from the seminar. Being a non-technical person, he understood that the AI enabled machine uses data of different formats in many of the daily based applicationsbut failed to sync it with the right terminologies and express the details. Help Samarth define Artificial Intelligence, list the three domains of AI and the data that is used in these domains.

Reflection Time:

1. Would you like to explore the tools specified here to build No-Code AI projects? How?

2. Are you aware of any other tools or platforms used for low code or No-Code AI Projects? List them.

4.2: Statistical Data: Use Case Walkthrough

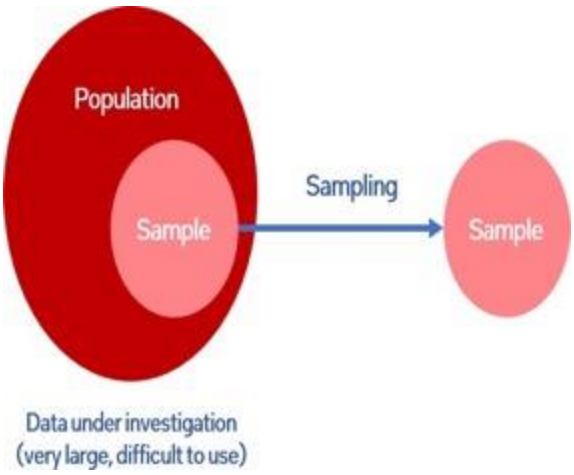
Lesson Title: Statistical Data: Use Case Walkthrough	**Approach:** Session + Activity
Summary: Introduction to a No-code AI tool for Statistical Data (Orange Data mining tool) through some practical use cases. Mapping AI Project cycle with use cases and perform data exploration, modelling and evaluation with Orange data mining.	
Learning Objectives: • Understand what is Orange Data Mining? What are its features? • To perform Data Acquisition, Data Exploration, and Modelling on a No-Code tool. • How to map the AI project cycle to develop an AI solution with a No-Code tool. • Build the AI project using no code tool Orange Data Mining.	
Learning Outcomes: • Learner will be able to use no-code tool Orange Data mining. • Learner will be able to map AI Project cycle with use cases. • Learner will be able to perform data exploration, modelling and evaluation with Orange data mining.	
Pre-requisites: Basic knowledge of AI project cycle.	
Key-concepts: • Orange Data Mining is a machine learning tool for data analysis where we can perform operations through simple drag-and-drop steps. • A sample of the entire population is taken to perform computations. • Descriptive statistics – Mean, Median, Mode – help us to describe the data and its underlying characteristics. • Distributions display the frequency of each value that appears in a data set. • Probability is the likelihood of an event occurring. • Variance measures how far each value in the data set is from the mean.	

Before we start with Orange data mining, let's discuss some important concepts of Statistical Analysis

Important concepts in statistics

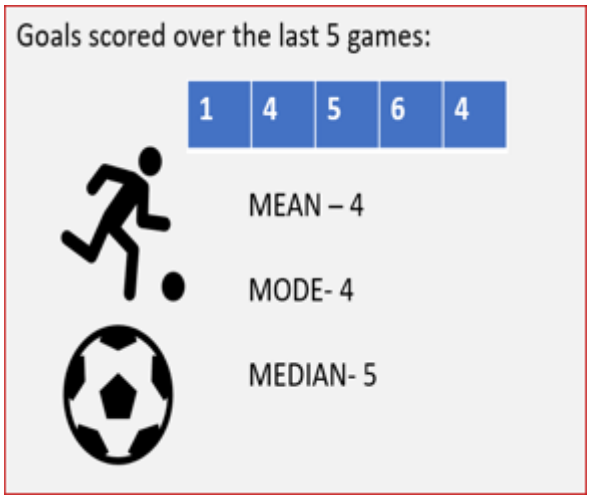
Statistical sampling

- The entire set of raw data that you may have available for a test or experiment is known as the population.
- You cannot necessarily measure the patterns and trends across the entire population.
- Take a sample, or portion of the population, perform some computations.

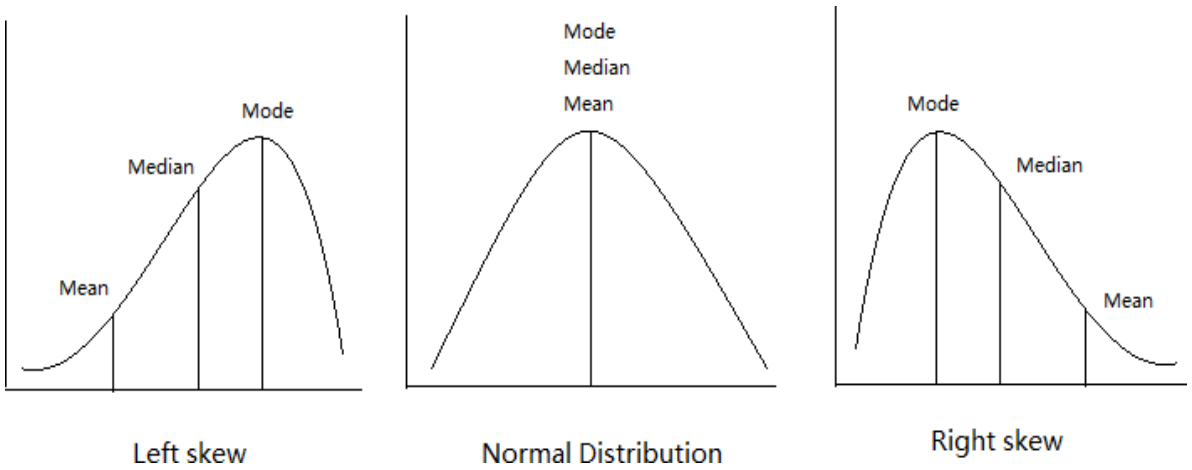


Descriptive statistics

- Helps us to describe the data and enables us to understand the underlying characteristics.
- Mean — the central value, commonly called the average.
- Median — the middle value if we ordered the data from low to high and divided it exactly in half.
- Mode – the value which occurs most often.



Distributions



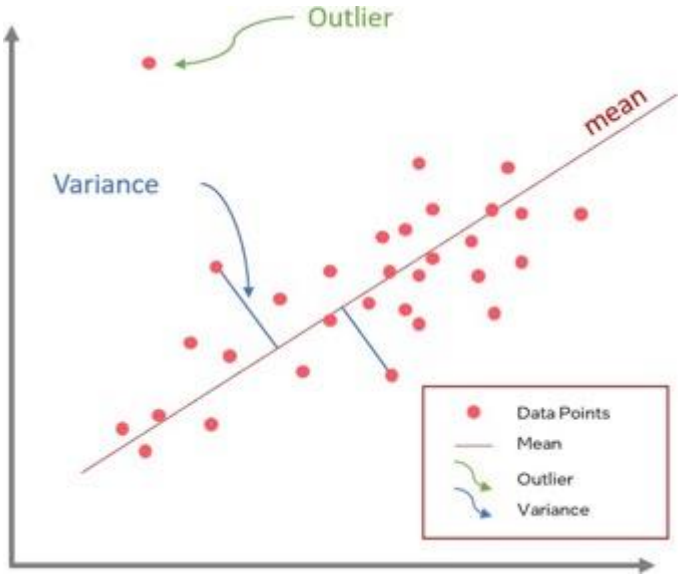
- These are charts or graphs that display the frequency of each value that appears in a data set.
- Some distributions contain some numbers much larger than others, causing the distributions to become skewed.
- Normal distribution – A distribution that is symmetrical in shape with most values around the central peak.

Probability

- In simple terms, is the likelihood of an event occurring.
- An event is the outcome of an experiment.
- Events can be either independent or dependent.

Variance

- Variance measures how far each value in the data set is from the mean (a measurement of the spread of numbers in a data set)
- Standard deviation – a calculation that gives a value to represent how widely distributed the values are.
- Outlier – A data point that lies at an abnormal distance from other values.



Activity: Mind map making

Purpose: Reinforce the need of Descriptive statistics

Say: Use any mind map tool offline/online to Craft a mind map in detailing the various contexts where mean, mode, and median are applied in real life.

MS Excel for Statistical Data

Activity: Excel for Statistical Analysis

Purpose: To use Excel tool for Simple linear regression of cars speed and distance

Say: Download the template and follow the instructions

Activity template-MS Excel for Statistical Analysis: https://bit.ly/43SIq6K
Long Link: https://docs.google.com/spreadsheets/d/1f5G-JXyP7EV2fy1hax47YVaH5gyq8KZy/edit?usp=drive_link&ouid=109928090180926267402&rtpof=true&sd=true

Guidelines to Activity:

Use the Activity template Link to access the file:_____

Step 1: Get the Add-in

- Go to File
- Click on Options
- Click on Add-ins
  - Click on Analysis Tool Pak under Inactive Application Add-ins
  - In the bottom, you will find Manage-> Select Excel Add-ins-> Click on Go
  - Click Ok
- Add-in pop-up window will appear
  - Check on Analysis Tool Pak (Put a tick)
  - Click on Ok
- Once all the steps have been performed successfully, the Data Analysis option will appear inside Data Menu

Step 2: View the Speed Vs Distance Data available in the excel sheet

- Identify the Independent and Dependent Features – X and Y

Step 3: Visualize the Data using Scatter Plot

- Select both columns- Speed and Distance

- Go to Insert -> Charts -> Scatter
- Scatter Plot will appear
- Go to Chart Elements -> Edit Chart Title -> Distance Versus Speed

Step 4: Plot the Regression Line

- Click on the Scatter Plot
- Click on Chart Design
    - Add Chart Element
- Go to Trendline
- Click on More Trendline Options
- Click on Linear
- Put a tick on
- Display Equation on chart
- Display R-squared value on chart

Step 5: Verify the Linear Regression equation coefficients

- Click on Data
- Click on Data Analysis
    - Data Analysis option window will pop-up
    - Choose Regression
    - Click on Ok
    - Regression window will appear
- Select Y Range -> Select the Distance column data along with columnname Distance
- Select X Range -> Select the Speed column data along with columnname Speed
- Put a tick on the check box for Labels as we have selected the columndata along with column names
- Select output range and click on any cell where you want the output tobe displayed
- Summary output for regression statistics will appear on the sheet

Step 6: Find the distance using the generated linear equation as per y = mx + c

- For the value of Speed(X) = 6, What will be the distance covered by thevehicle?

Orange Data Mining

What is Orange Data Mining (ODM)?

- A machine learning tool for data analysis through Python and visual programming
- We can perform operations on data through simple drag and drop steps.
- Orange enables you to visualize data and perform data mining and machine learning.
- You can use this tool without writing a single code.
- This platform can be used for analysis, is relatively easy, and has beautiful visuals.

Orange Data Mining:

Orange is an open-source data mining and machine learning software suite designed for data analysis, visualization, and exploration. It offers a graphical user interface (GUI) that allows users tointeractively build data analysis workflows using various components called widgets. Each widget serves a specific purpose in the data analysis process. Here's a brief description of some commonly used Orange data mining widgets.

Data Loading Widgets: These widgets help you bring your data into Orange from files or online sources.

File: Allows you to load data from files in various formats such as CSV, Excel, and SQL.URL:

Loads data from a URL.

Data Table: Displays loaded data in a tabular format.

Data Exploration Widgets: These widgets allow you to look at your data in different ways, like scatter plots or histograms, to see patterns or trends.
Scatter Plot: Visualizes the relationship between two variables in the data.

Data Table: Allows for manual inspection and exploration of data.

Distributions: Displays histograms and other statistical distributions of variables.

Preprocessing Widgets: These widgets help you clean up your data, like filling in missing values or making sure all your data is on the same scale.
Impute: Handles missing values in the dataset. Normalize: Normalizes the data to a common scale.
Select Columns: Allows you to select specific columns from the dataset.

Feature Selection Widgets: These widgets help you choose which parts of your data are most important for your analysis.

Select Columns: Allows you to choose relevant columns/features from the dataset.

Select Best Features: Automatically selects the best features based on certain criteria like mutual information or correlation.

Modelling Widgets: These widgets build models from your data, like decision trees or clustering algorithms, to help you understand it better.

Classification Tree: Constructs a decision tree classifier.

k-Means: Performs k-means clustering on the data.

Support Vector Machine: Trains a support vector machine classifier.

Logistic Regression: Constructs a logistic regression model.

Evaluation Widgets: These widgets help you see how well your models are performing, so you can make adjustments if needed.

Test & Score: Evaluates the performance of a predictive model on a test dataset.

Cross Validation: Performs cross-validation to assess model performance.

ROC Curve: Plots the receiver operating characteristic curve for binary classifiers.

Visualization Widgets: These widgets help you turn your data into visual representations, like charts or graphs, to make it easier to understand.

Bar Chart: Displays data in a bar chart format.

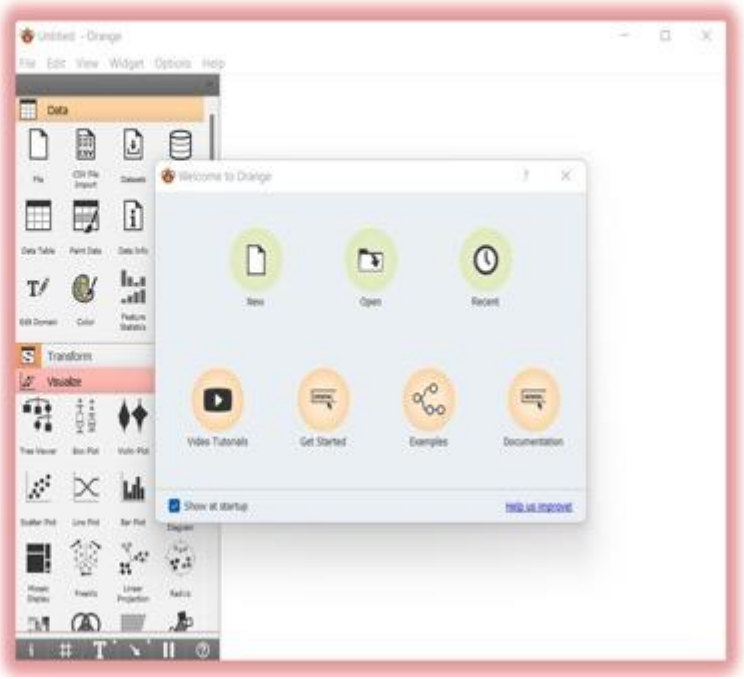
Heat Map: Visualizes data using a heatmap.

Scatter Plot: Visualizes the relationship between two variables.

These are just a few examples of the wide range of widgets available in Orange. Users can combine these widgets to create custom workflows for tasks such as data preprocessing, modelling, evaluation, and visualization, making it a powerful tool for data analysis and mining tasks.

Getting started with Orange Data Mining

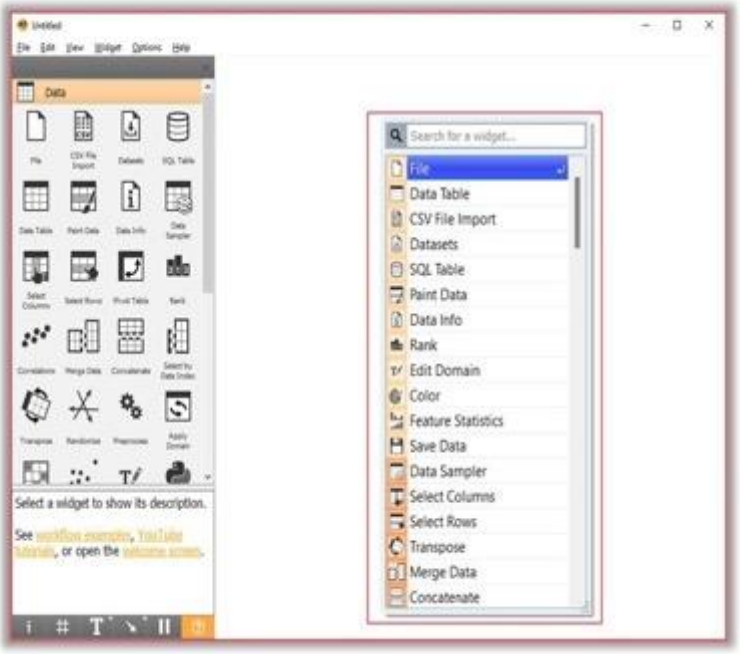
- Open the software, and this is what you will see!

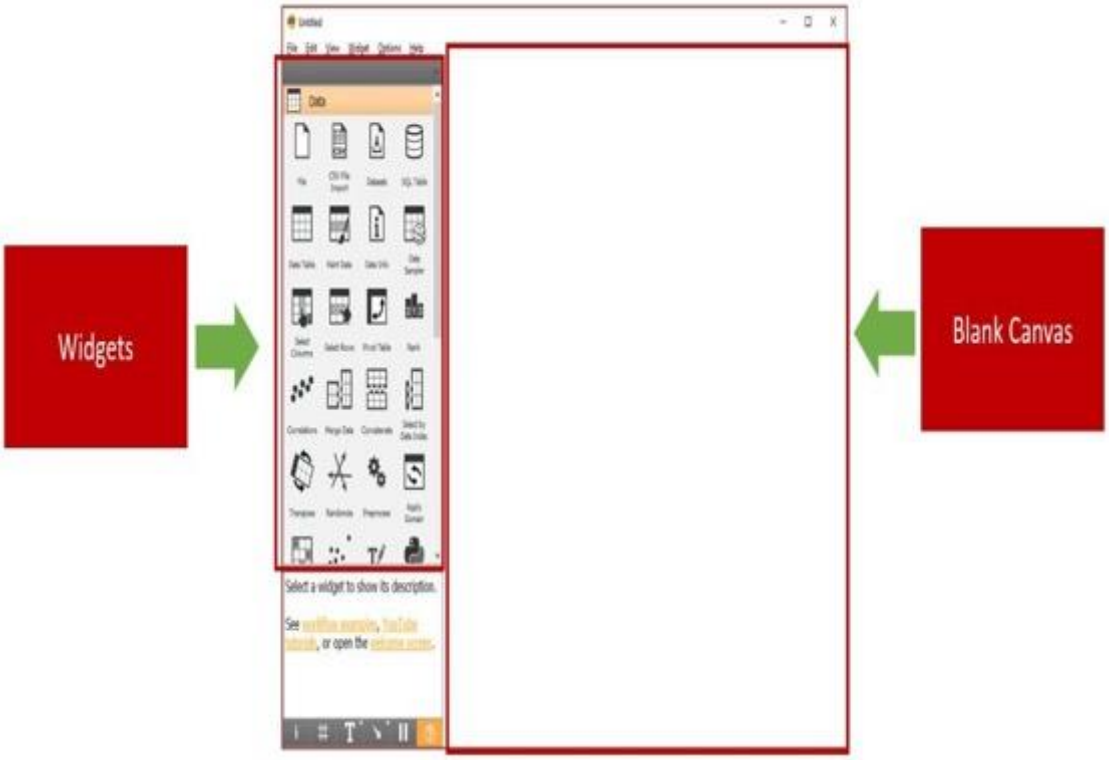


When you open Orange you will see a welcome screen. We can start a new project here or open a project that has already been made. We can explore.

Exploring the Canvas

Right click on the canvas to get this prompt





Orange comes with a lot of widgets to work with.
File widget, lets us load a file into our Workspace/canvas.

Exploring the Canvas

Data Acquisition

Data Widgets

These widgets help perform different operations on data

Examples:

- File Widget: To read data from an input file
- CSV File Import Widget: To read data from an input file
- Datasets Widget: To load a dataset from an online repository
- Data Info Widget: To display information on a selected dataset

Data Table widget, lets us observe what the data in the file looks like. Let's drag these two into our blank canvas (can also be done by clicking the widget)

Exploring the Canvas

Data Exploration

Transform Widgets

These widgets help perform different operations on data

Examples:

- **Data Sampler Widget:** To create a subset of data points
- **Select Columns Widget:** To manually select data attributes
- **Impute Widget:** To replace unknown values in the data
- **Discretize Widget:** To discretize continuous attributes

Exploring the Canvas

Data Exploration

Visualize Widgets

These widgets help us visualize the data in different ways

For Example:

- **Tree Viewer Widget:** A visualization of classification and regression trees
- **Box Plot Widget:** shows the distributions of attribute values
- **Scatter Plot Widget:** The data is displayed as a collection of points
- **Bar Plot Widget:** Visualizes comparisons among categories

Exploring the Canvas

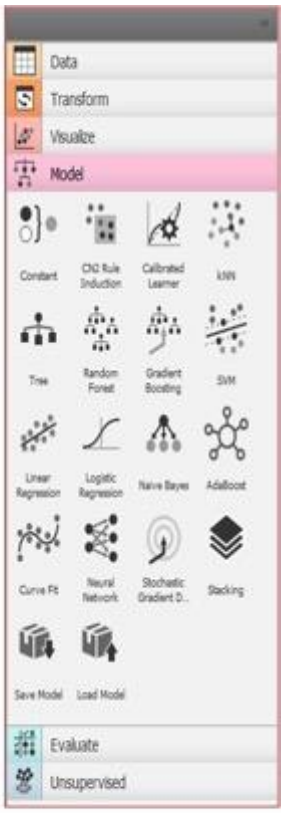
Modeling

Model Widgets

These widgets help apply various models to the input data and use in our projects

For Example:

- Tree Widget: A simple algorithm that splits the data into nodes by class purity
- Random Forest Widget: An ensemble learning method used for classification, regression, and other tasks
- Linear Regression Widget: A linear regression algorithm
- Logistic Regression Widget: The logistic regression classification algorithm



Exploring the Canvas

Modeling

Unsupervised Widgets

These widgets help us apply unsupervised learning models to our data and visualize it

For Example:

- Distance Matrix Widget: Visualizes distance measures in a distance matrix
- t-SNE Widget: Two-dimensional data projection with t-SNE
- Correlations Widget: Compute all pairwise attribute correlations
- k-Means Widget: Groups items using the k-Means clustering algorithm

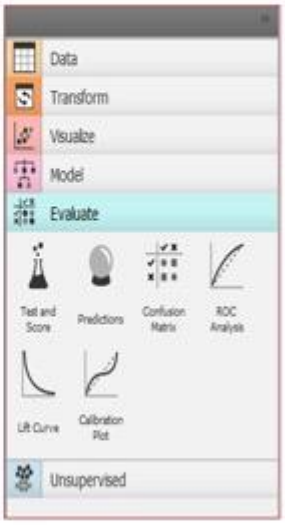
Exploring the Canvas

Evaluation

Evaluate Widgets

These widgets help us evaluate the models we have used in our project

For Example:



- **Test and Score Widget:** Tests learning algorithms on data
- **Predictions Widget:** Shows models' predictions on the data
- **Confusion Matrix Widget:** Shows proportions between the predicted and actual class
- **ROC Analysis Widget:** Plots a true positive rate against a false positive rate of a test

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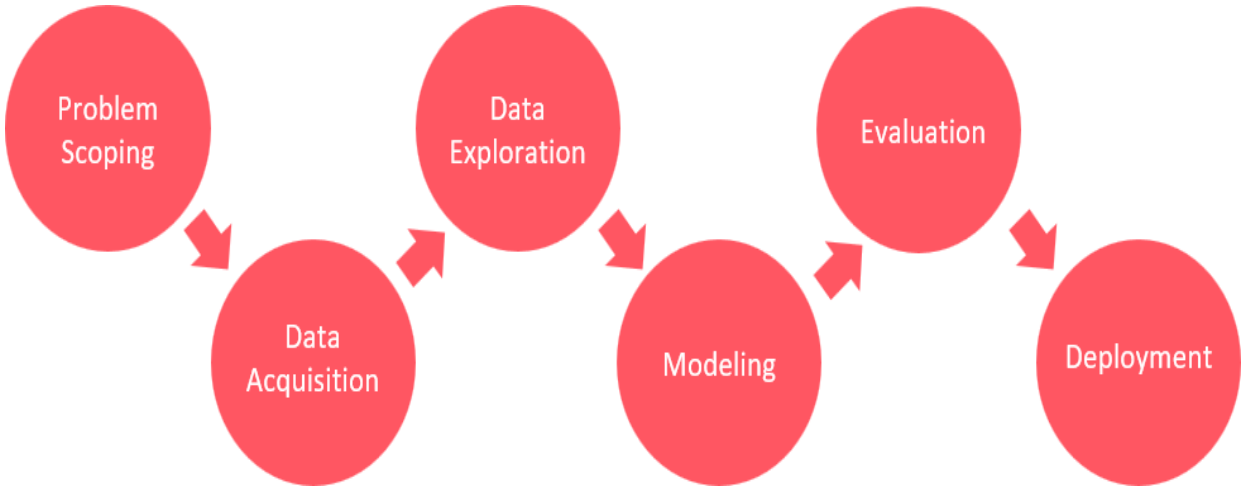
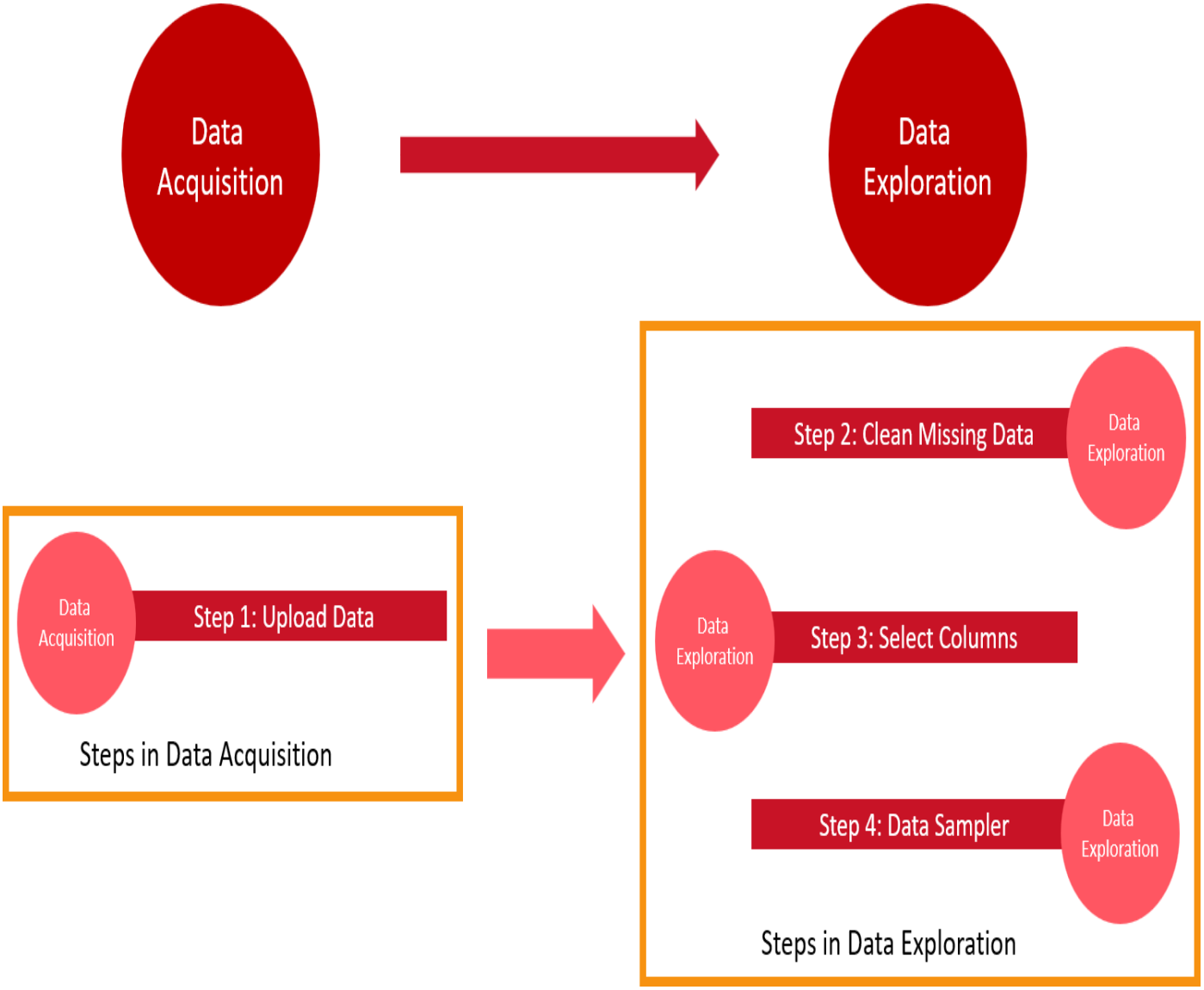
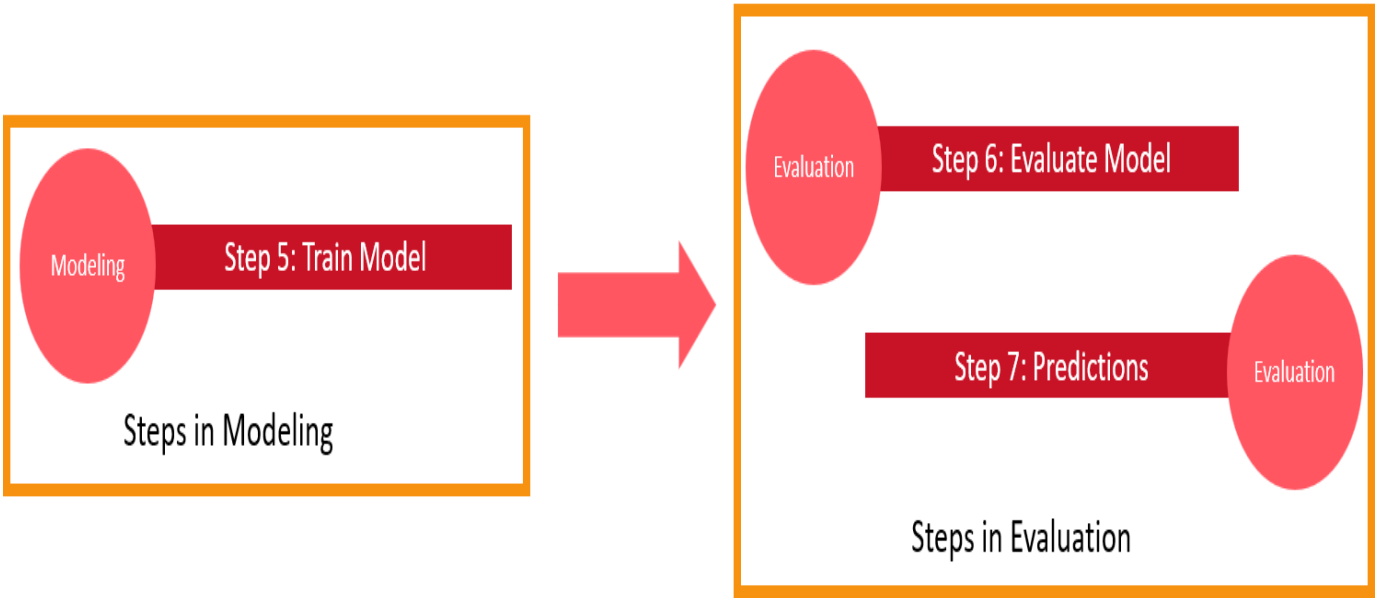
Recall the AI Project Cycle



Let’s understand how we can apply the AI Project Cycle in Orange Data Mining.



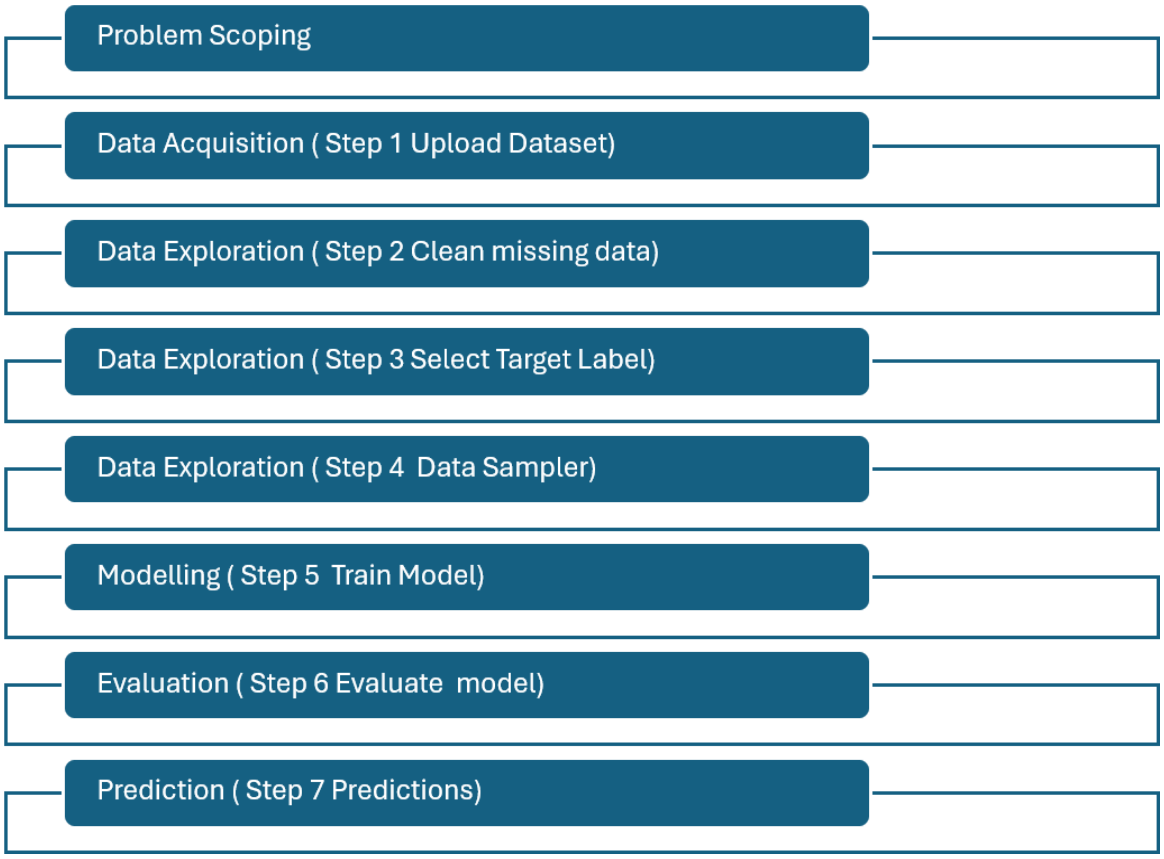


Thus, all the stages of AI project cycle can be mapped in Orange data mining tool.

CASE STUDY:

Palmer Penguins: Palmer Penguins are a species of penguin found in the Antarctic Peninsula region. Studies about penguins, including Palmer Penguins, often focus on their behaviour, habitat, population dynamics, and the effects of climate change on their ecosystems. Palmer Penguins dataset can be accessed from https://www.kaggle.com/code/parulpandey/penguin-dataset-the-new-iris/data

Palmer Penguins Model Index

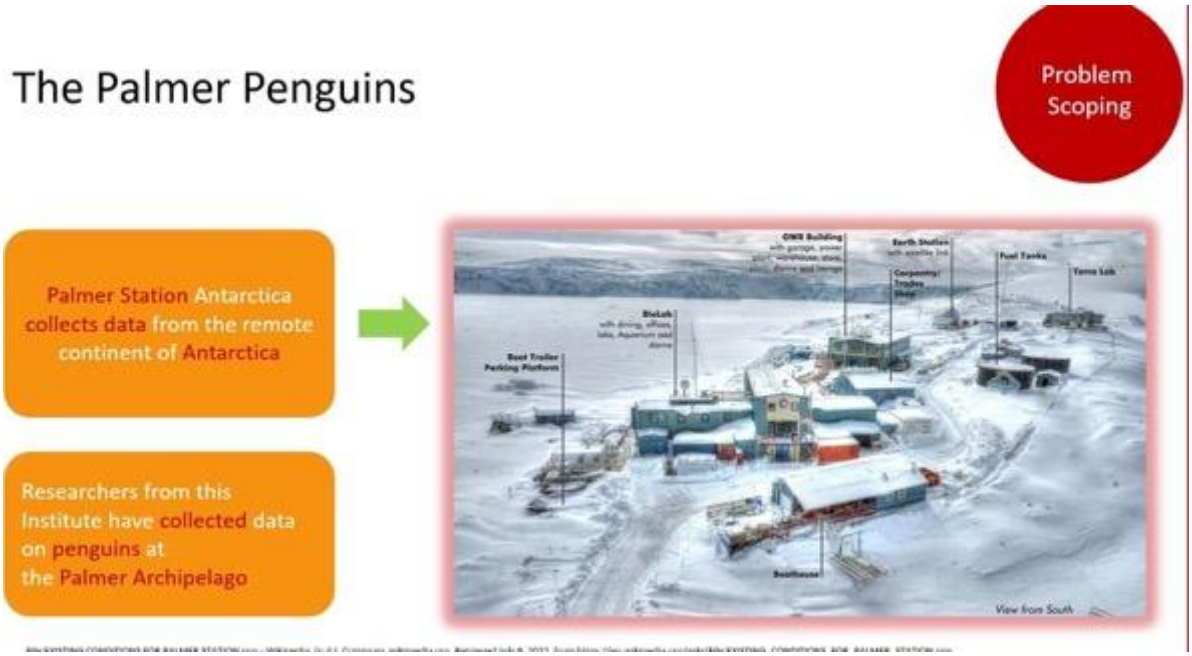


The above image shows the index of this case study.

Scan the QR code for all files of PALMER PENGUINS.

Short link: https://bit.ly/4atlCN7

Long Link : https://drive.google.com/drive/folders/1fmcRVb-ilTyUhmUv4DWT1BFsaCoQ2BmF?usp=drive_link



Problem scoping

Our	Research community	Who
has a problem that	it is difficult to identify the species of some Palmer Penguins	What
when / while	collecting data from the remote continent of Antarctica	Where
An ideal solution would	predict the species of Palmer Penguins from the collected data	Why

The researchers want to predict the species of Palmer Penguins based on the collected data.Can you help them? How?

Let us look at the dataset!
Look out for any differences in the physical features of the penguins!

The three species of penguins

Island feature

Island feature

	A	B	C	D	E	F
1	species	island	culmen_length_mm	culmen_depth_mm	flipper_length_mm	body_mass_g
2	Adelie	Torgersen	39.1	18.7	181	3750
3	Adelie	Torgersen	39.5	17.4	186	3800
4	Adelie	Torgersen	40.3	18	195	3250
5	Adelie	Torgersen	NA	NA	NA	NA
6	Adelie	Torgersen	36.7	19.3	193	3450
7	Adelie	Torgersen	39.3	20.6	190	3650
8	Adelie	Torgersen	38.9	17.8	181	3625
9	Adelie	Torgersen	39.2	19.6	195	4675
10	Adelie	Torgersen	34.1	18.1	193	3475
11	Adelie	Torgersen	42	20.2	190	4250
12	Adelie	Torgersen	37.8	17.1	186	3300
13	Adelie	Torgersen	37.8	17.3	180	3700
14	Adelie	Torgersen	41.1	17.6	182	3200
15	Adelie	Torgersen	38.6	21.2	191	3800
16	Adelie	Torgersen	34.6	21.1	198	4400
17	Adelie	Torgersen	36.6	17.8	185	3700
18	Adelie	Torgersen	38.7	19	195	3450
19	Adelie	Torgersen	42.5	20.7	197	4500

penguins_train

Species feature

	A	B	C	D	E	F
1	species	island	culmen_length_mm	culmen_depth_mm	flipper_length_mm	body_mass_g
2	Adelie	Torgersen	39.1	18.7	181	3750
3	Adelie	Torgersen	39.5	17.4	186	3800
4	Adelie	Torgersen	40.3	18	195	3250
5	Adelie	Torgersen	NA	NA	NA	NA
6	Adelie	Torgersen	36.7	19.3	193	3450
7	Adelie	Torgersen	39.3	20.6	190	3650
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13	Adelie	Torgersen	37.8	17.3	180	3700
14	Adelie	Torgersen	41.1	17.6	182	3200
15	Adelie	Torgersen	38.6	21.2	191	3800
16	Adelie	Torgersen	34.6	21.1	198	4400
17	Adelie	Torgersen	36.6	17.8	185	3700
18	Adelie	Torgersen	38.7	19	195	3450
19	Adelie	Torgersen	42.5	20.7	197	4500

penguins_train

Culmen length and depth features

	A	B	C	D	E	F
1	species	island	culmen_length_mm	culmen_depth_mm	flipper_length_mm	body_mass_g
2	Adelie	Torgersen	39.1	18.7	181	3750
3	Adelie	Torgersen	39.5	17.4	186	3800
4	Adelie	Torgersen	40.3	18	195	3250
5	Adelie	Torgersen	NA	NA	NA	NA
6	Adelie	Torgersen	36.7	19.3	193	3450
7	Adelie	Torgersen	39.3	20.6	190	3650
8	Adelie	Torgersen	38.9	17.8	181	3625
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11	Adelie	Torgersen	42	20.2	190	4250
12	Adelie	Torgersen	37.8	17.1	186	3300
13	Adelie	Torgersen	37.8	17.3	180	3700
14	Adelie	Torgersen	41.1	17.6	182	3200
15	Adelie	Torgersen	38.6	21.2	191	3800
16	Adelie	Torgersen	34.6	21.1	198	4400
17	Adelie	Torgersen	36.6	17.8	185	3700
18	Adelie	Torgersen	38.7	19	195	3450
19	Adelie	Torgersen	42.5	20.7	197	4500

penguins_train

Flipper Length and Body Mass feature

	A	B	C	D	E	F
1	species	island	culmen_length_mm	culmen_depth_mm	flipper_length_mm	body_mass_g
2	Adelie	Torgersen	39.1	18.7	181	3750
3	Adelie	Torgersen	39.5	17.4	186	3800
4	Adelie	Torgersen	40.3	18	195	3250
5	Adelie	Torgersen	NA	NA	NA	NA
6	Adelie	Torgersen	36.7	19.3	193	3450
7	Adelie	Torgersen	39.3	20.6	190	3650
8	Adelie	Torgersen	38.9	17.8	181	3625
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11	Adelie	Torgersen	42	20.2	190	4250
12	Adelie	Torgersen	37.8	17.1	186	3300
13	Adelie	Torgersen	37.8	17.3	180	3700
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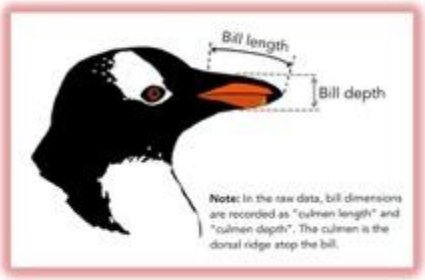
15	Adelie	Torgersen	38.6	21.2	191	3800
16	Adelie	Torgersen	34.6	21.1	198	4400
17	Adelie	Torgersen	36.6	17.8	185	3700
18	Adelie	Torgersen	38.7	19	195	3450
19	Adelie	Torgersen	42.5	20.7	197	4500

penguins_train

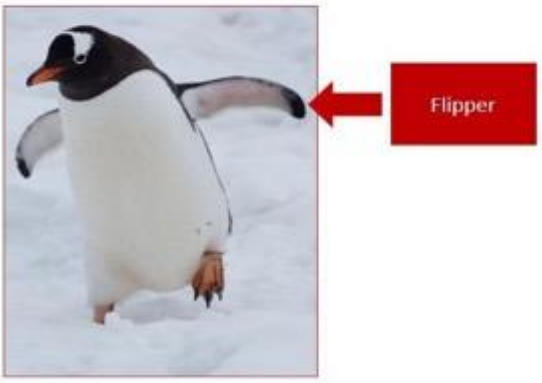
Culmen length and depth features

- Culmen Length = length of the bill
- Culmen Depth = depth of the bill



Flipper Length and Body Mass feature

- Flipper Length is the length of the flippers of a penguin
- Body Mass is the weight of the penguin
- In picture: Gentoo penguin flippers are the shortest in comparison to Adelie and Chinstrap



Let's teach an AI model to predict the penguin species in Orange Data Mining now!

Based on features like their sizes, how long their beaks are, and the colors of their feathers. Now, youwant to figure out which species of penguin is which. ODM is a smart tool that can analyze all the penguin data you collected and learn to recognize patterns.

The link for steps creating the AI model can be accessed in the file

Orange datamining.pdf

Reflection

Are there any limitations of using No-Code AI tools? Share your thoughts with the class?

Test Yourself:

1.What type of tool is Orange?

a) Open-source b) Closed-source

c) Paid software d) Hardware

2. Which of the following tasks can be performed using Orange?

a) Classification b) Regression

c) Clustering d) All of the above

3. What type of data can be imported into Orange?

a) CSV b) Excel

c) SQL databases d) All of the above

4. What does the Data Table widget in Orange primarily facilitate?

a) Loading and viewing datasets b) Performing clustering analysis

c) Running machine learning algorithms d) Evaluating

5. Which component in Orange enables users to evaluate the performance of machine learning models?

a) Test & Score b) Data Table

c) Data Projection d) Data Exploration

Reflection Time:

1. Define No-Code and Low-Code AI.
2. Identify the differences between Code and No-Code AI concerning Statistical Data.
3. Relate AI project stages to the stages of No-Code AI projects.
4. Orange Data Mining is a machine learning tool for data analysis where we can perform operations through simple drag-and-drop steps.
5. Descriptive statistics – Mean, Median, Mode – help us to describe the data and its underlying characteristics.
6. No code tools for AI projects.

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Unit 5: Computer Vision

Title: Computer Vision	**Approach:** Practical Implementation
Summary: Computer Vision is a branch of artificial intelligence that enables machines to interpret and understand visual information from the real world. This unit provides an in-depth exploration of various methodologies, and applications in computer vision, equipping students with the skills necessary to analyze and process visual data.	
Objectives: 1. To introduce students to the basic principles and techniques of computer vision. 2. To familiarize students with common algorithms and tools used in image processing and analysis. 3. To enable students to apply computer vision techniques to solve real-world problems. 4. To foster critical thinking and problem-solving skills in the domain of computer vision.	
Learning Outcomes: 1. Understand the fundamental concepts and theories underlying computer vision. 2. Implement basic and advanced image processing techniques using programminglanguages such as Python. 3. Apply computer vision techniques to tasks such as object detection, image segmentation, and feature extraction. 4. Develop ideas to solve real-world problems leveraging computer vision technologies.	
Pre-requisites: Essential understanding of Artificial Intelligence	
Key-concepts: Image processing, feature extraction, object detection & recognition.	

5.1: Introduction

In the previous chapter, you studied the concepts of Artificial Intelligence for Data Sciences. It is a concept to unify statistics, data analysis, machine learning and their related methods to understand and analyse actual phenomena with data.

As we all know, artificial intelligence is a technique that enables computers to m1m1c human intelligence. As humans, we can see things, analyse them and then do the required action based on what we see.

But can machines do the same? Can machines have the eyes that humans have? If you answered yes, then you are right. The Computer Vision domain of Artificial Intelligence, enables machines to see• through images or visual data, process and analyse them on the basis of algorithms and methods to analyse actual phenomena with images.

Now before we get into the concepts of Computer Vision, let us experience this domain with the help of the following game:

* Emoji Scavenger Hunt: https://emojiscavengerhunt.withgoogle.com/

Go to the link and try to play the game Emoji Scavenger Hunt. The challenge here is to find 8 items within the time limit to pass. Did you manage to win?

_____

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What was the strategy that you applied to win this game?

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Was the computer able to identify all the items you brought in front of it?

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Did the lighting of the room affect the identifying of items by the machine?

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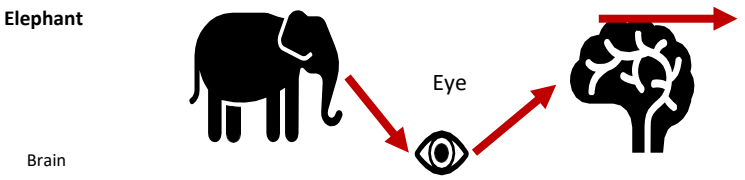
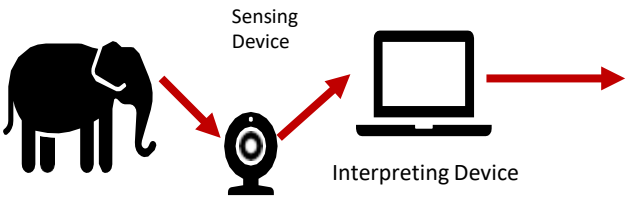
A Quick Overview of Computer Vision!

Computer vision is the process of extraction of information from images, text, videos, etc.

A system that can process, analyze and make sense of visual data in the same way as humans do.

Human Vision System

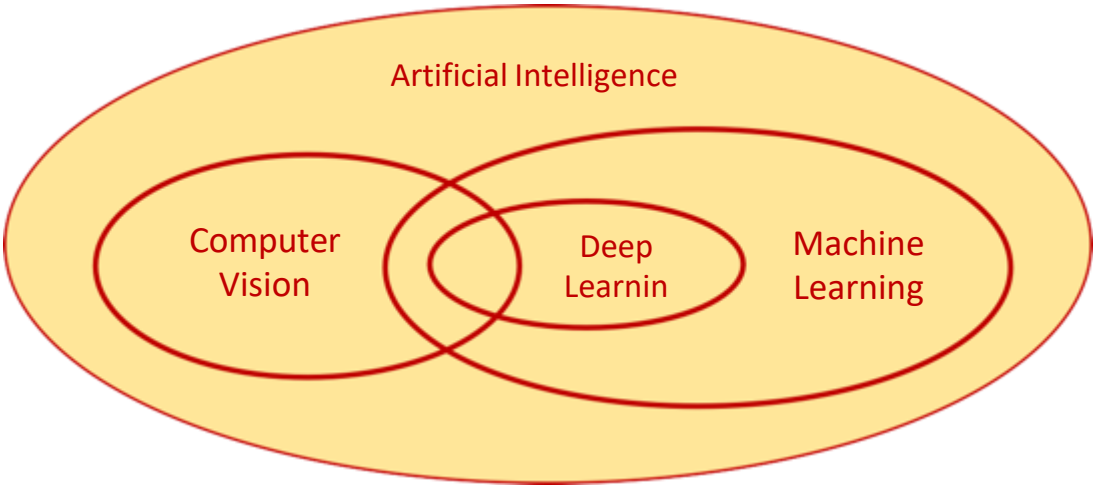




Computer Vision and Artificial Intelligence

Computer vision is a field of artificial intelligence (AI).

AI enables computers to think, and computer vision enables AI to see, observe and make sense of visual data(like images & videos).

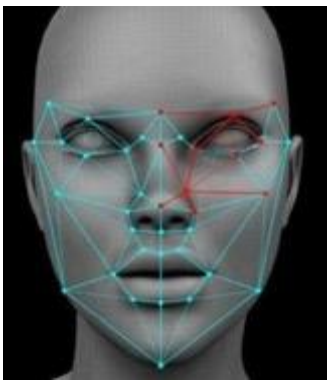


Computer Vision Vs. Image Processing

Computer Vision	Image Processing
• Computer vision deals with extracting information from the input images or videos toinfer meaningful information and understanding them to predict the visual input • Computer Vision is a superset of ImageProcessing. • Examples - Object detection, Handwritingrecognition, etc.	• Image processing is mainly focused on processing the raw input images to enhance them or preparing them to do other tasks • Image Processing is a subset of ComputerVision. • Examples - Rescaling image, Correcting brightness, Changing tones, etc.

5.1 Applications of Computer Vision

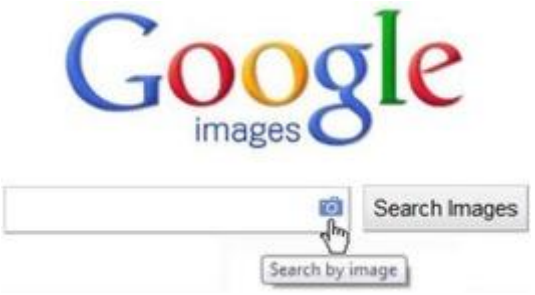
The concept of computer vision was first introduced in the 1970s. All these new applications of computer vision excited everyone. Having said that, computer vision technology advanced enough to make these applications available to everyone at ease today. However, in recent years the world witnessed a significant leap in technology that has put computer vision on the priority list of many industries. Let us look at some of them:



Facial Recognition*: With the advent of smart cities and smart homes, Computer Vision plays a vital role in making the home smarter. Security being the most important application involves the use of Computer Vision for facial recognition. It can be either guest recognition or log maintenance of the visitors. It also finds its application in schools for an attendance system based on facial recognition of students.

Face Filters*: Modern-day apps like Instagram and Snapchat have a lot of features based on the

usage of computer vision. The application of face filters is one among them. Through the camera, the machine or the algorithm is able to identify the facial dynamics of the person and applies the facial filter selected.



Google's Search by Image*: The maximum amount of searching for data on Google's search engine comesfrom textual data, but at the same time it has an interesting feature of getting search results through an image. This uses Computer Vision as it compares different features of the input image to the database of images and gives us the search result while at the same time analysing various features of the image.

Computer Vision in Retail*: The retail field has been one of the fastest-growing fields and at the same time is using Computer Vision for making the user experience more fruitful. Retailers can use Computer Vision techniques to track customers' movements through stores, analyse navigational routes and detect walking patterns.

Inventory Management is another such application. Through security camera image analysis, a Computer Vision algorithm can generate a very accurate estimate of the items available in the store. Also, it can analyse the use of shelf space to identify suboptimal configurations and suggest better item placement.

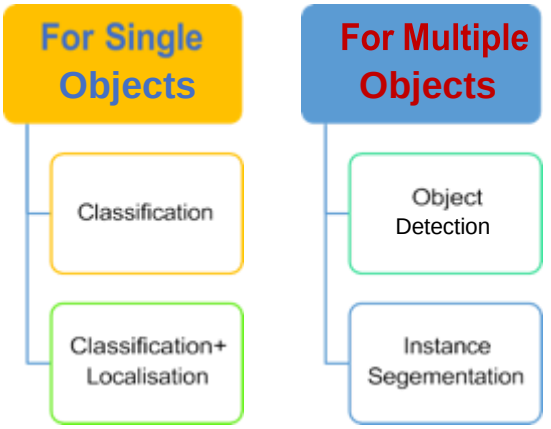
Self-Driving Cars: Computer Vision is the fundamental technology behind the development of autonomous vehicles. Most leading car manufacturers in the world are reaping the benefits of investing in artificial intelligence for developing on-road versions of hands-free technology. This involves the process of identifying the objects, getting navigational routes and also at the same time environment monitoring.

Medical Imaging*: For the last decades, computer supported medical imaging application has been a trustworthy help for physicians. It doesn't only create and analyse images, but also becomes an assistant and helps doctors with their interpretation. The application is used to read and convert 20 scan images into interactive 30 models that enable medical professionals to gain a detailed understanding of a patient's health condition.

Google Translate App*: All you need to do to read signs in a foreign language is to point your phone's camera at the words and let the Google Translate app tell you what it means in your preferredlanguage almost instantly. By using optical character recognition to see the image and augmented reality to overlay an accurate translation, this is a convenient tool that uses Computer Vision

5.2 Computer Vision Tasks

The various applications of Computer Vision are based on a certain number of tasks that are performed to get certain information from the input image which can be directly used for predictionor forms the base for further analysis. The tasks used in a computer vision application are:



Classification

The image Classification problem is the task of **assigning an input image one label from a fixed set ofcategories.** This is one of the core problems in CV that, despite its simplicity, has a large variety of practical applications.

Classification+ Localisation

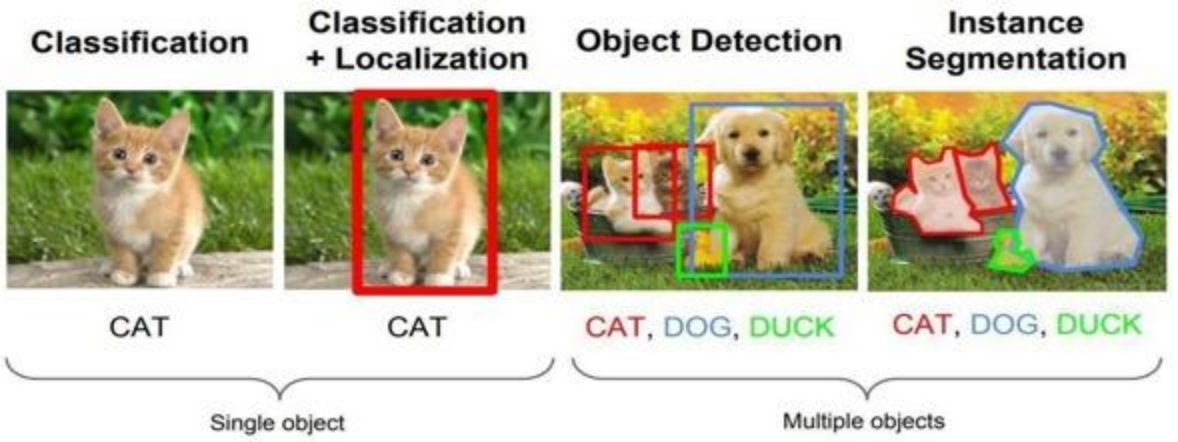
This is the task that involves both processes of **identifying what object is present** in the image and at the same time **identifying at what location** that object is present in that image. It is used only for single objects.

Object Detection

Object detection is the process of **finding instances of real-world objects such as faces, bicycles, and buildings in images or videos.** Object detection algorithms typically use extracted features andlearning algorithms to recognize instances of an object category. It is commonly used in applications such as image retrieval and automated vehicle parking systems.

Instance Segmentation

Instance Segmentation is the process of detecting instances of the objects, giving them a category, andthen giving each pixel a label based on that. A segmentation algorithm takes an image as input and outputs a collection of regions (or segments).



Basics of Images

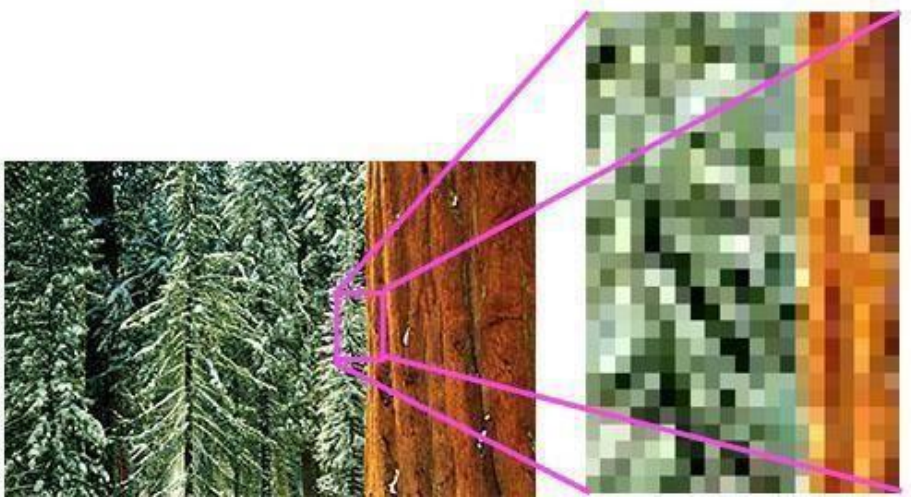
We all see a lot of images around us and use them daily either through our mobile phones or computer system. But do we ask some basic questions to ourselves while we use them on regular basis?

Don't know the answer yet? Don't worry, in this section, we will study the basics of an image:

Basics of Pixels

The word "pixel" means a picture element. Every photograph, in digital form, is made up of pixels. They are the smallest unit of information that make up a picture. Usually round or square, they are typically arranged in a 2-dimensional grid.

In the image below, one portion has been magnified many times over so that you can see its composition in pixels. As you can see, the pixels approximate the actual image. The more pixels you have, the more closely the image resembles the original.



Resolution

The number of pixels in an image is sometimes called the *resolution.* When the term is used to describepixel count, one convention is to express resolution as the width by the height, for example, a monitor resolution of 1280x1024. This means there are 1280 pixels from one side to the other, and 1024 from top to bottom.

Another convention is to express the number of pixels as a single number, like a 5 mega pixel camera (a megapixel is a million pixels). This means the pixels along the width multiplied by the pixels along the height of the image taken by the camera equals 5 million pixels. In the case of our 1280x1024 monitors, it could also be expressed as 1280 x 1024 = 1,310,720, or 1.31 mega pixels.

Pixel value

Each of the pixels that represent an image stored inside a computer has a *pixel value* that describes how bright that pixel is, and/or what colour it should be. The most common *pixel format* is the *byte image,* where this number is stored as an 8-bit integer giving a range of possible values from Oto 255.Typically, zero is to be taken as no colour or black and 255 is taken to be full colour or white. Why do we have a value of 255?
In computer systems, computer data is in the form of ones and zeros, which we call the binary system. Each bit in a computer system can have either a zero or a one. Since each pixel uses 1 byte of an image, which is equivalent to 8 bits of data. Since each bit can have two possible values which tell us that the 8 bits can have 255 possibilities of values that starts from 0 and ends at 255.

Number of bits	Different patterns	No. of patterns	No. of patterns
1	0 1	2^1	2
2	00 01 10 11	2^2	4
3	000 001 010 100 011 101 110 111	2^3	8

$2^8 = 256$

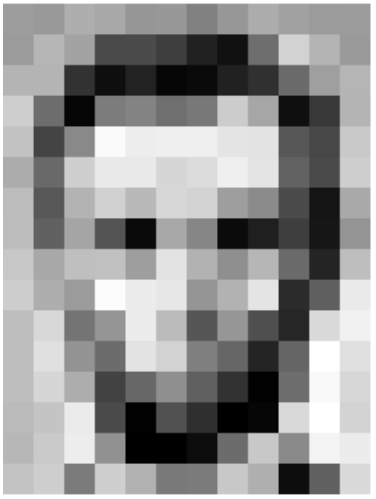
Here ^, represents exponent (2 raised to the power 8)

Grayscale Images

Grayscale images are images that have a range of shades of gray without apparent colour. The darkest possible shade is black, which is the total absence of colour or zero value of pixel. The lightest possible shade is white, which is the total presence of colour or 255 value of a pixel. Intermediate shades of gray are represented by equal brightness levels of the three primary colours.

A grayscale has each pixel of size 1 byte having a single plane of 2d array of pixels. The size of a grayscale image is defined as the Height x Width of that image.

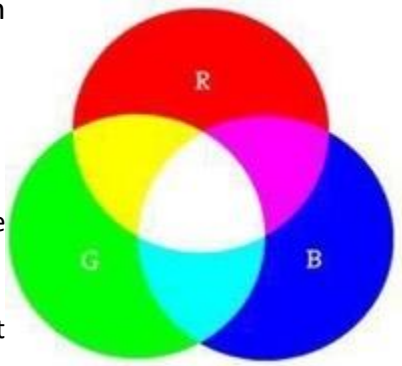
Let us look at an image to understand grayscale images.



157	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	86	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

157	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	86	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

Here is an example of a grayscale image. As you check, the value of pixels is within the range of 0-255.The computers store the images we see in the form of these numbers.



RGB Images

All the images that we see around us are coloured images. These images are made up of three primary colours Red, Green, and Blue.

All the colours that are present can be made by combining different intensities of red, green, and blue.

Let us experience!

Go to this online link https://www.w3schools.com/colors/colors_rgb.asp. On the basis of this online tool,try and answer all the below mentioned questions.

1) What is the output colour when you put R=G=B=255?

_____

2) What is the output colour when you put R=G=B=0?

_____

3) How does the colour vary when you put either of the three as 0 and then keep on varying theother two?

_____

_____

_____

4) How does the output colour change when all the three colours are varied in same proportion?

_____
_____
_____
_____

5) What is the RGB value of your favourite colour from the colour palette?

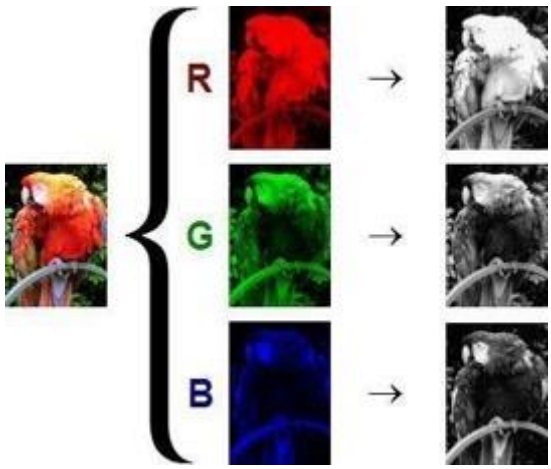
_____

Were you able to answer all the questions? If yes, then you would have understood how every colour we see around is made.

Now the question arises, how do computers store RGB images? Every RGB image is stored in the form of three different channels called the R channel, G channel, and the B channel.

Each plane separately has many pixels with each pixel value varying from Oto 255. All the three planeswhen combined form a colour image. This means that in an RGB image, each pixel has a set of three different values which together give colour to that particular pixel.

For Example,



As you can see, each colour image is stored in the form of three different channels, each having different intensity. All three channels combine to form a colour we see.

In the above given image, if we split the image into three different channels, namely Red (R), Green {G) and Blue (B), the individual layers will have the following intensity of colours of the individual pixels. These individual layers when stored in the memory looks like the image on the extreme right. The images look in the grayscale image because each pixel has a value intensity of O to 255 and as studied earlier, 0 is considered as black or no presence of colour and 255 means white or full presenceof colour. These three individual RGB values when combined form the colour of each pixel.

Therefore, each pixel in the RGB image has three values to form the complete colour.

Task:

Go to the following link www.piskelapp.com and create your pixel art. Try and make a GIF using the online app for your pixel art.

5.3 No-Code AI Tools:

Introduction to Lobe

- Lobe.ai is an Auto-ML tool, which means that it is a no-code AI tool
- It works with image classification and allows a set of images with labels and will

automatically find the most optimal model to classify the images

Introduction to Teachable Machine

- Teachable Machine is an AI, Machine Learning, and Deep Learning tool that was developed by Google in 2017
- It runs on top of tensorflow.js which was also developed by the same company
- It is a web-based tool that allows training of a model based on different images, audio, orposes given as input through webcam or pictures

Activity Time: Build a Smart Sorter
Purpose: Using CV is to automate and enhance sorting processes through computer vision technology.

- Form groups of 4 members
- Find images of Bottles, Cans and Paper online or from around.
- Visit the No-code AI tool
- Ensure to build 3 different classes [Bottles, Cans and Paper].
- Train the model
- Finally, test the classifier!

Orange Data Mining Tool:

Let's work on a real-world Classification Model: Coral Bleaching (Use Case Walkthrough)

Activity Time: Build a classification model
Purpose: Developing a classification model for early identification of coral bleaching to safeguard marine ecosystems.

What Are Coral Reefs?

- Coral can be found in tropical ocean waters around the world.
- Coral reefs are large underwater structures composed of the skeletons of marine invertebrates called coral.
- Corals are an integral part of aquatic life.

What causes Coral Bleaching?

Coral bleaching has caused unbalanced scenarios in aquatic life. So, detecting bleached corals at early stages prevents aquatic life from disaster

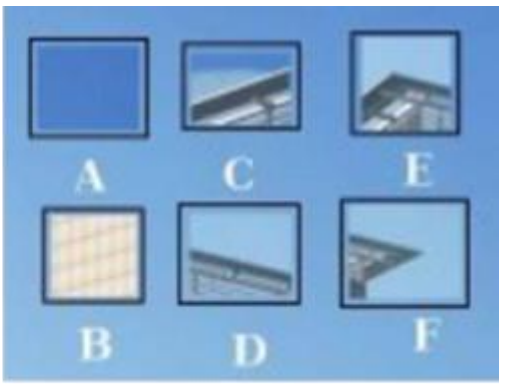
Use Case Walkthrough - Steps involved in project development & required dataset can be checked using the links and QR code given below:

Short link: https://bit.ly/orange_computer_vision
Long Link: https://drive.google.com/drive/folders/1ppJ4d-8yOFJ2G22rHHpjNrK0ejdIAe5Q?usp=sharing
or scan the QR code below

5.4 Image Features

In computer vision and image processing, a **feature** is a piece of information that is relevant for solving the computational task related to a certain application. Features may be specific structures in the image such as points, edges, or objects.

For example:
Imagine that your security camera is capturing an image. At the top of the image, we are given six smallpatches of images. Our task is to find the exact location of those image patches in the image.
Take a pencil and mark the exact location of those patches in the image.



Were you able to find the exact location of all the patches?

_____

Which one was the most difficult to find?

_____

_____

Which one was the easiest to find?

_____

_____

Let's Reflect:

Let us take individual patches into account at once and then check the exact location of those patches. **For Patch A and B:** The patch A and Bare flat surfaces in the image and are spread over a lot of area. They can be present at any location in a given area in the image.
For Patch C and D: The patches C and D are simpler as compared to A and B. They are edges of a building and we can find an approximate location of these patches but finding the

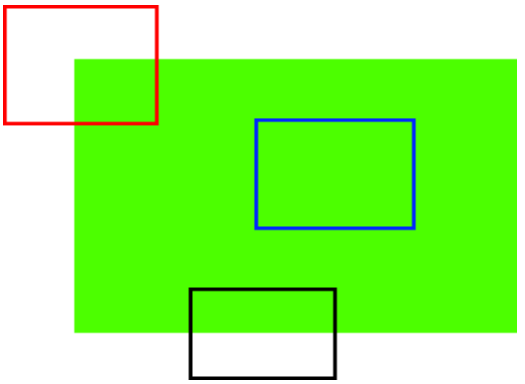
exact location isstill difficult. This is because the pattern is the same everywhere along the edge.

For Patch E and F: The patches E and Fare the easiest to find in the image. The reason is that E and F are some corners of the building. This is because at the corners, wherever we move this patch it will look different.

Conclusion

In image processing, we can get a lot of features from the image. It can be either a blob, an edge, or a corner. These features help us to perform various tasks and then get the analysis done based on the application. Now the question that arises is which of the following are good features to be used? As you saw in the previous activity, the features having the corners are easy to find as they can be found only at a particular location in the image, whereas the edges are spread over a line or an edge look the same all along. This tells us that the corners are always good features to extract from an image followed by the edges.

Let's look at another example to understand this. Consider the images given below and apply the concept of good features for the following.



In the above image how would we determine the exact location of each patch?

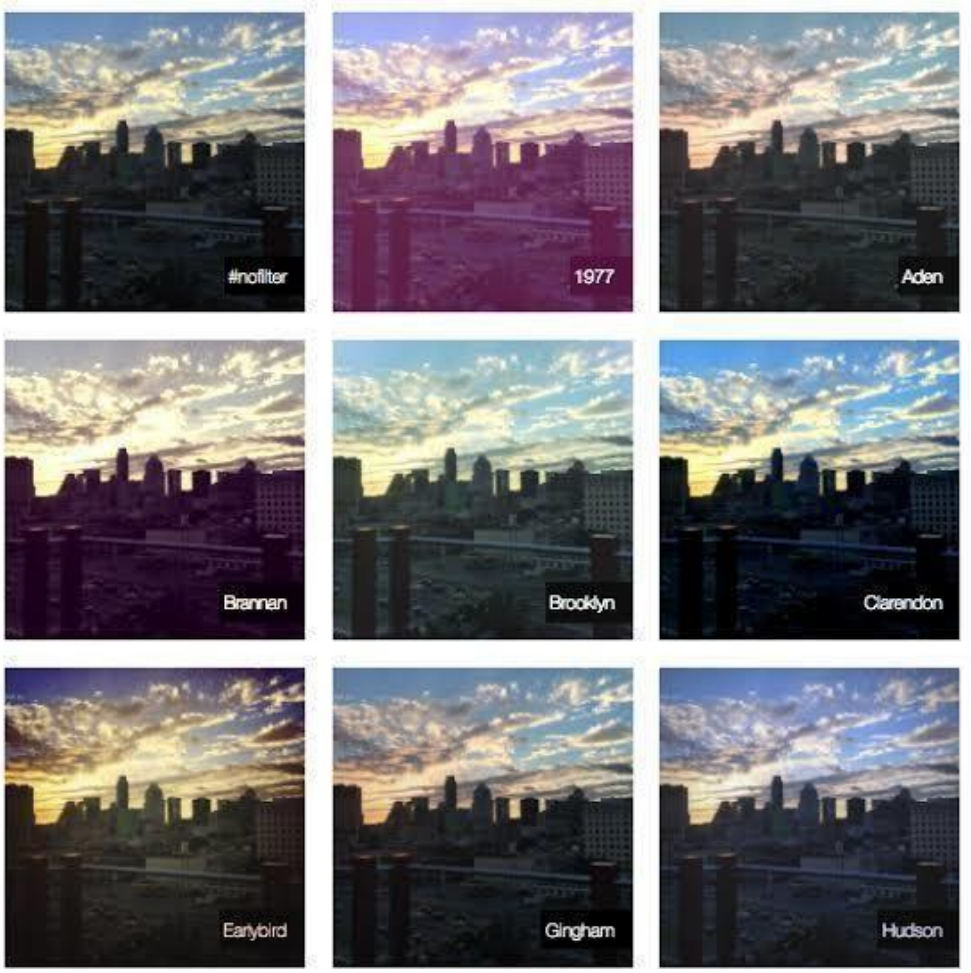
The blue patch is a flat area and difficult to find and track. Wherever you move the blue patch it looks the same. The black patch has an edge. Moved along the edge (parallel to edge), it looks the same. The red patch is a corner. Wherever you move the patch, it looks different, therefore it is unique. Hence, corners are considered to be good features in an image.

5.5 Convolution

We have learnt that computers store images in numbers and that pixels are arranged in a particular manner to create the picture we can recognize. These pixels have values varying from Oto 255 and the value of the pixel determines the color of that pixel.

But what if we edit these numbers, will it bring a change to the image? The answer is yes. As we change the values of these pixels, the image changes. This process of changing pixel values is the base of image editing.

We all use a lot of images editing software like photoshop and at the same time use apps like Instagram and Snapchat, which apply filters to the image to enhance the quality of that image.



As you can see, different filters applied to an image change the pixel values evenly throughout the image. How does this happen? This is done with the help of the process of convolution and the convolution operator which is commonly used to create these effects.

Before we understand how the convolution operation works, let us try and create a theory for the convolution operator by experiencing it using an online application.

Task

Go to the link https://setosa.io/ev/image-kernels/and scroll down to check the convolution matrix applied on the image.

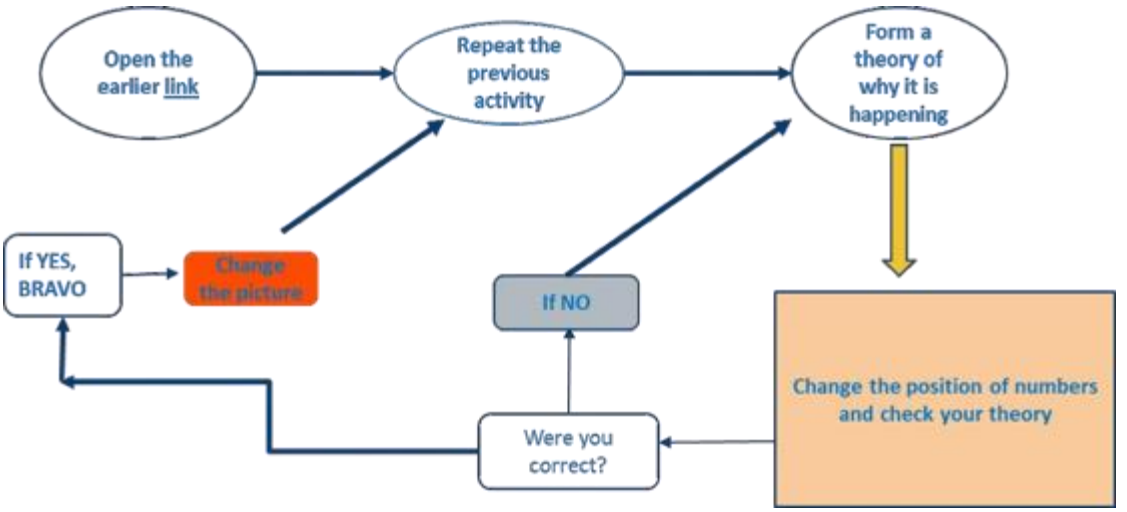
Try changing the values in the convolution operator and observe the modifications in the outputimage. Try these steps

5.6.1 Change all to positive values

5.6.2 Change all to negative values

5.6.3 Have a mixture of negative and positive values

Let us follow the following steps to understand how a convolution operator works. The steps to befollowed are:



Try experimenting with the following values to come up with a theory:

5.6.3.1 Make 4 numbers negative. Keep the rest as 0.5.6.3.2Now make one of them positive.

5.6.3.3 Observe what happens.

5.6.3.4 Now make the second positive.

What theory do you propose for convolution based on the observation?

_____

_____

It is time to test the theory. Change the location of the four numbers and follow the above mentioned steps. Does your theory hold true?

If yes, change the picture and try whether the theory holds true or not. If it does not hold true, modify your theory and keep trying until it satisfies all the conditions.

Let's Discuss

What effect did you apply?

How did different kernels affect the image?

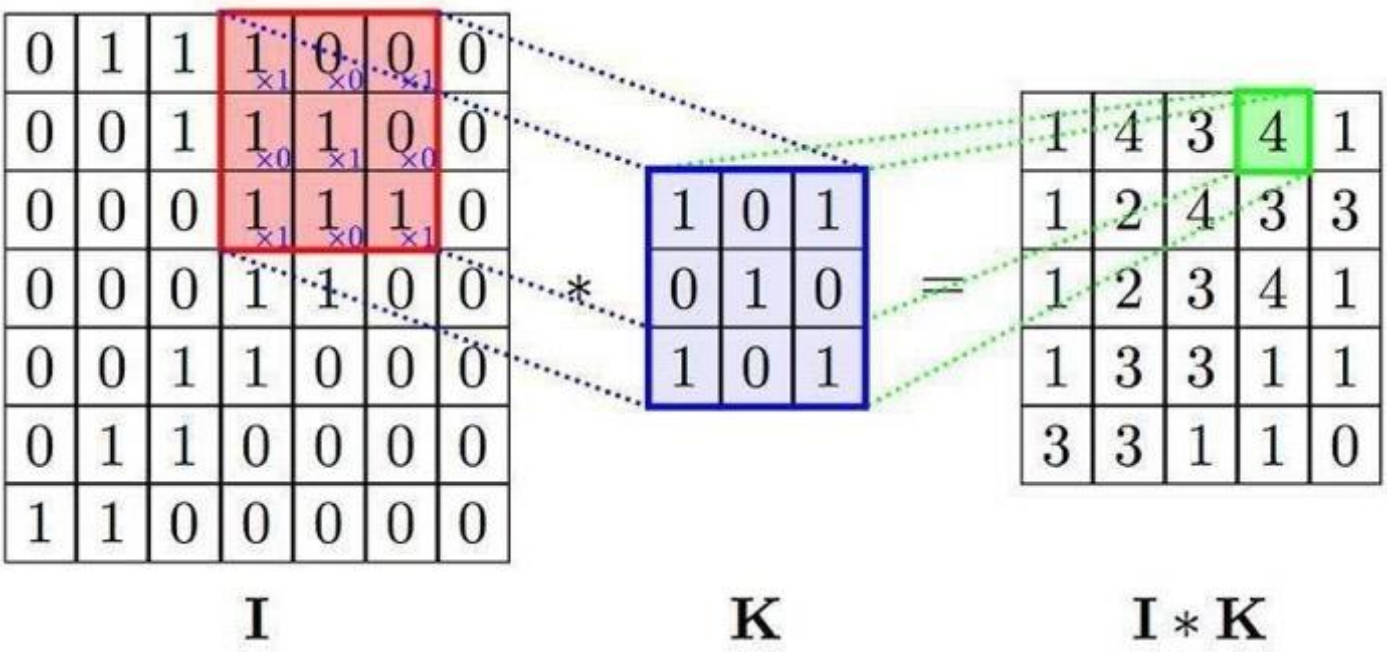
Why do you think we apply these effects?

How do you think the convolution operator works?

Convolution: Explained

Convolution is a simple mathematical operation that is fundamental to many common image processing operators. Convolution provides a way of multiplying together two arrays of numbers, generally of different sizes, but of the same dimensionality, to produce a third array of numbers of the same dimensionality.

An (image) convolution is simply an element-wise multiplication of image arrays and another array called the kernel followed by sum.



As you can see here,

I= Image Array

K = Kernel Array

I * K = Resulting array after performing the convolution operator

Note: The Kernel is passed over the whole image to get the resulting array after convolution.

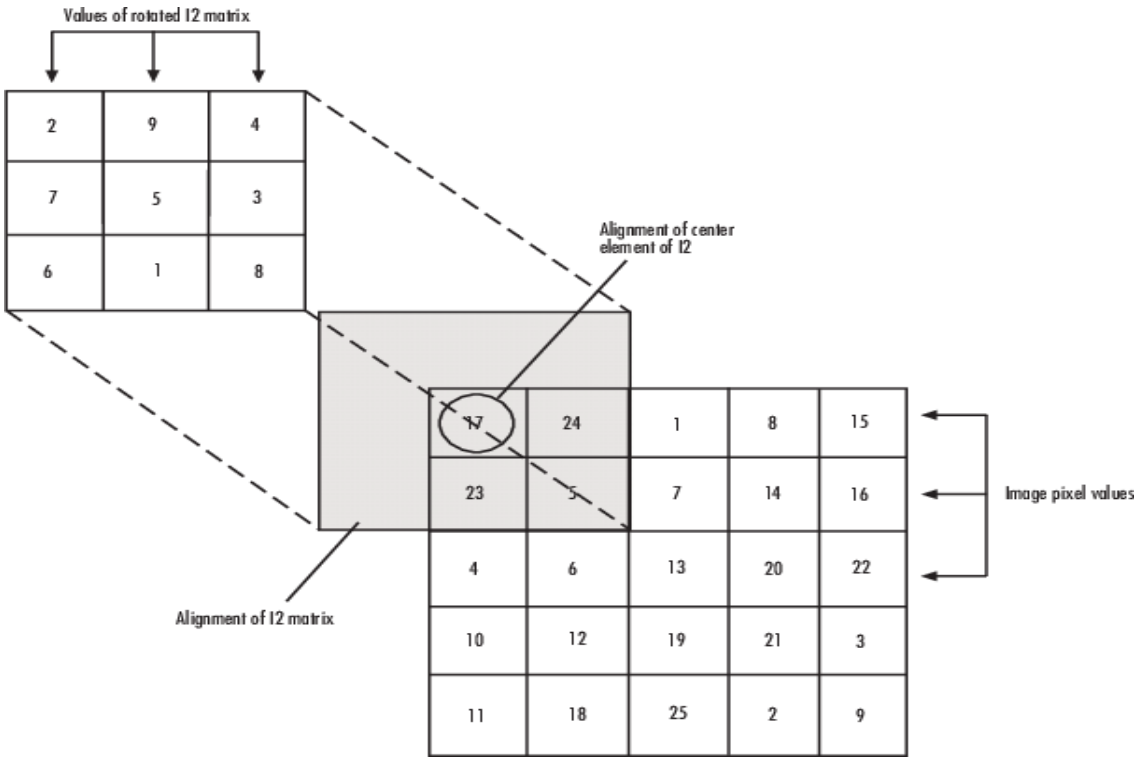
What is a Kernel?

A Kernel is a matrix, which is slid across the image and multiplied with the input such that the outputis enhanced in a certain desirable manner. Each kernel has a different value for different kinds of effectsthat we want to apply to an image.

In Image processing, we use the convolution operation to extract the features from the images which can le later used for further processing especially in Convolution Neural Network (CNN), which we will study later in the chapter.

In this process, we overlap the centre of the image with the centre of the kernel to obtain the convolution output. In the process of doing it, the output image becomes smaller as the overlapping is done at the edge row and column of the image. What if we want the output image to be of the exact size of the input image, how can we achieve this?

To achieve this, we need to extend the edge values out by one in the original image while overlapping the centres and performing the convolution. This will help us keep the input and output image of the same size. While extending the edges, the pixel values are considered zero.



Let's try

In this section we will try performing the convolution operator on paper to understand how it works.
Fill the blank places of the output images by performing the convolution operation.

150	0	255	240	190	25	89	255
100	179	25	0	200	255	67	100
155	146	13	20	0	12	45	0
100	175	0	25	25	15	0	0
120	156	255	0	78	56	23	0
115	113	25	90	0	80	56	155
135	190	115	116	178	0	145	165
123	255	255	0	255	255	255	0

-1	0	-1
0	-1	0
-1	0	-1

Write Your Output Here:

Summary

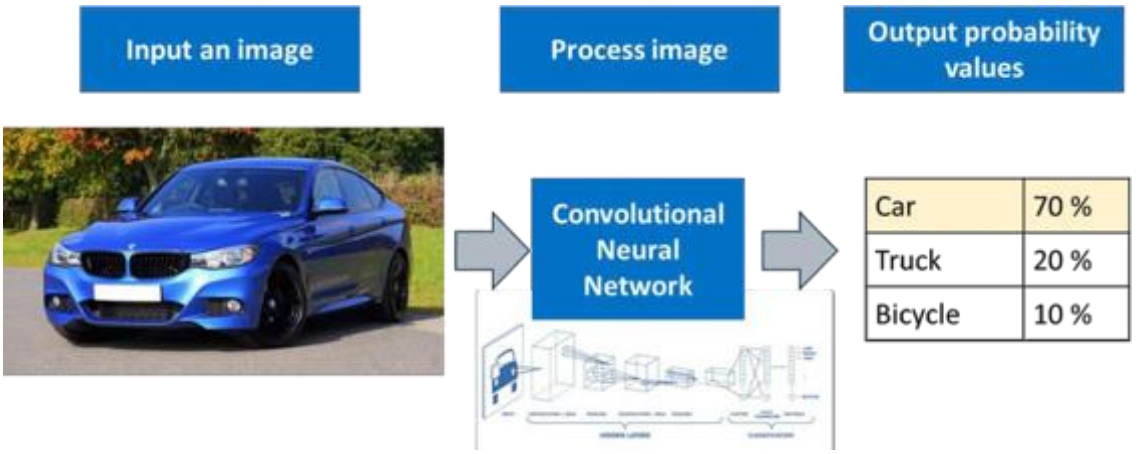
1. Convolution is a common tool used for image editing.
2. It is an element-wise multiplication of an image and a kernel to get the desired output.
3. In computer vision applications, it is used in Convolutional Neural Network (CNN) to extractimage features.

5.6 Convolution Neural Networks (CNN)

Introduction

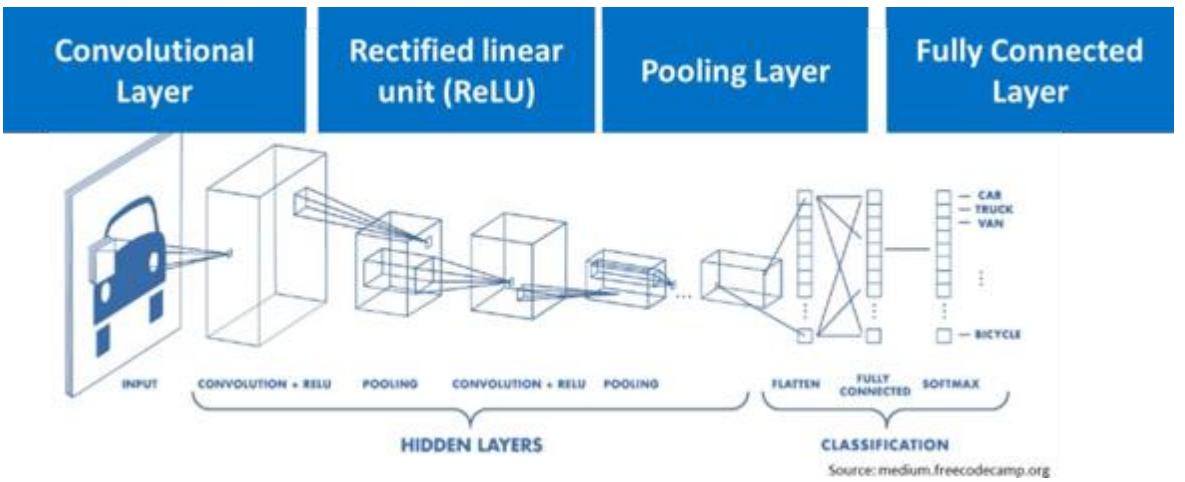
A **Convolutional Neural Network (CNN)** is a Deep Learning algorithm that can take in an input image,assign importance (learnable weights and biases) to various aspects/objects in the image, and be able to differentiate one from the other.

The process of deploying a CNN is as follows:



In the above diagram, we give an input image, which is then processed through a CNN and then gives prediction based on the label given in the particular dataset.

The different layers of a Convolutional Neural Network (CNN) are as follows:



A convolutional neural network consists of the following layers:

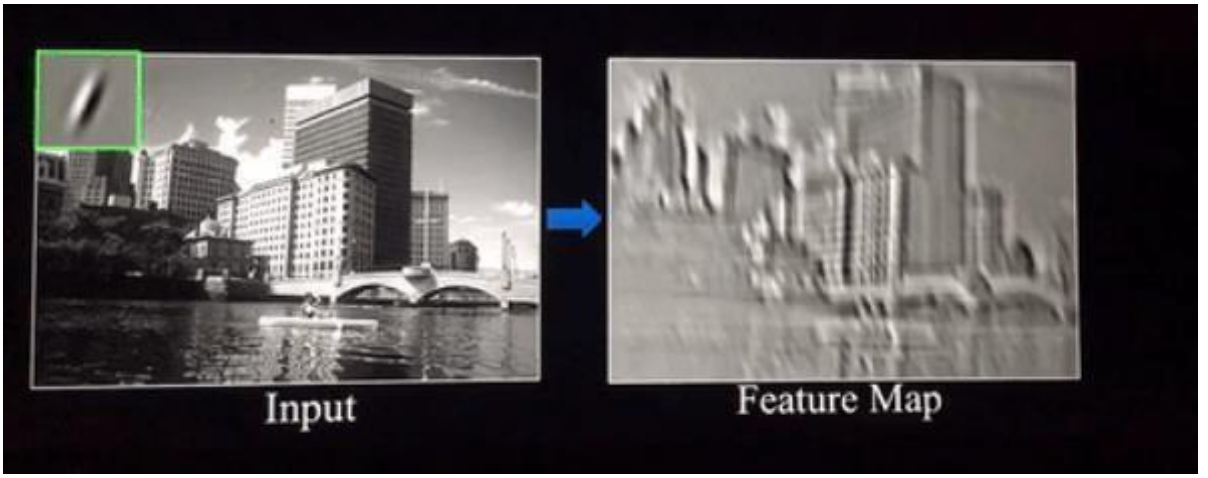
5.7.1 Convolution Layer
5.7.2 Rectified linear unit (ReLU)
5.7.3 Pooling Layer
5.7.4 Fully Connected Layer

5.7.1 Convolution Layer

It is the first layer of a CNN. The objective of the Convolution Operation is to extract the **high-level features** such as edges, from the input image. CNN need not be limited to only one Convolutional Layer. Conventionally, the first Convolution Layer is responsible for capturing the Low-Level features such as edges, colour, gradient orientation, etc. With added layers, the architecture adapts to the High-Level features as well, giving us a network that has a wholesome understanding of images inthe dataset.

It uses convolution operation on the images. In the convolution layer, several kernels are used to produce several features. The output of this layer is called the feature map. A feature map is also called an activation map. We can use these terms interchangeably.
There are several uses we derive from the feature map:

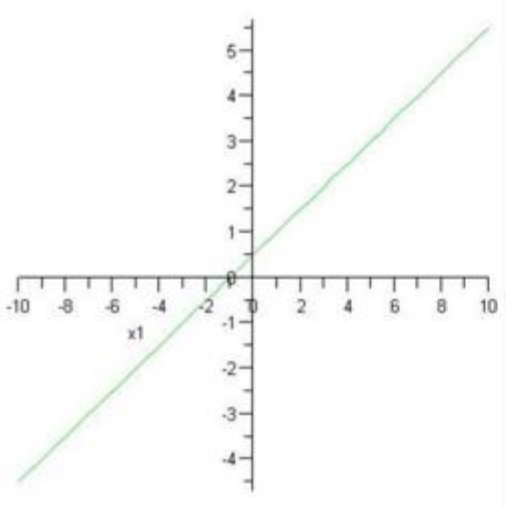
- We **reduce the image size** so that it can be processed more efficiently.
- We only focus on the features of the image that can help us in processing the image further. For example, you might only need to recognize someone's eyes, nose, and mouth to recognize the person. You might not need to see the whole face.

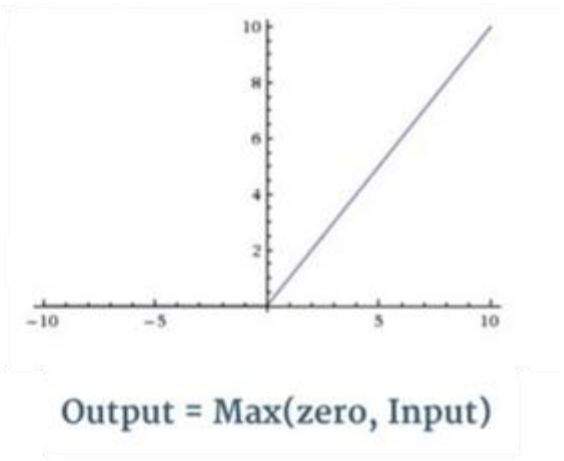


5.7.2 Rectified Linear Unit Function

The next layer in the Convolution Neural Network is the Rectified Linear Unit function or the ReLU layer. After we get the feature map, it is then passed onto the ReLU layer. This layer simply gets rid of all the negative numbers in the feature map and lets the positive number stay as it is.

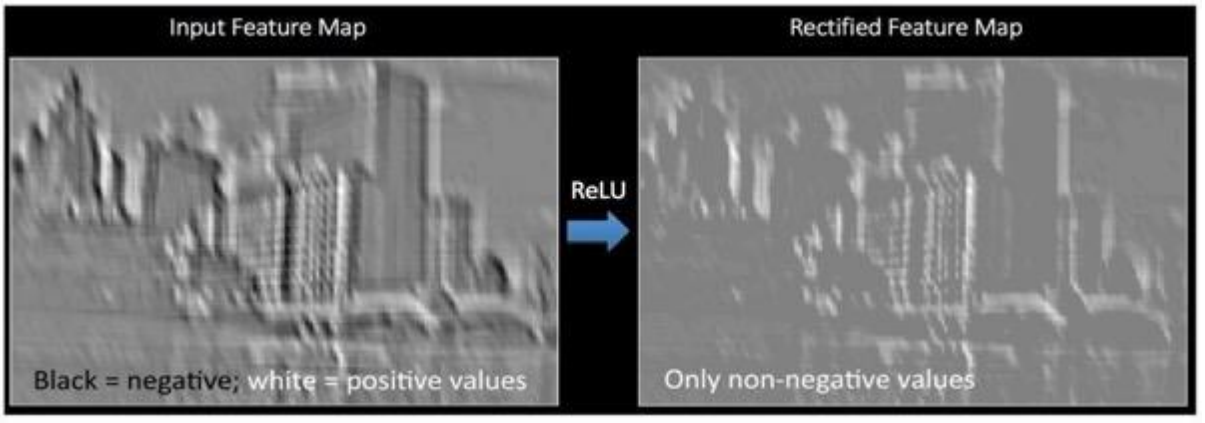
The process of passing it to the ReLU layer introduces non - linearity in the feature map. Let us see it through a graph.





If we see the two graphs side by side, the one on the left is a linear graph. This graph when passed through the ReLU layer gives the one on the right. The ReLU graph starts with a horizontal straight line and then increases linearly as it reaches a positive number.

Now the question arises, why do we pass the feature map to the ReLU layer? It is to make the colour change more obvious and more abrupt?



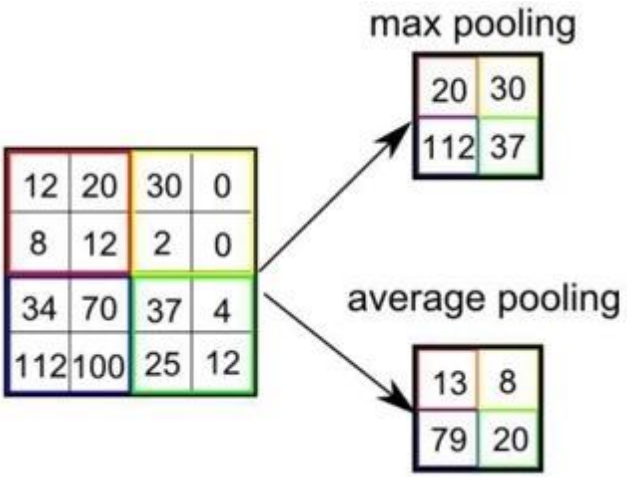
As shown in the above-convolved image, there is a smooth grey gradient change from black to white. After applying the ReLu function, we can see a more abrupt color change which makes the edges more obvious and acts as a better feature for the further layers in a CNN as it enhances the activation layer.

5.7.3 Pooling Layer

Similar to the Convolutional Layer, the Pooling layer is responsible for reducing the spatial size of the Convolved Feature while still retaining the important features.

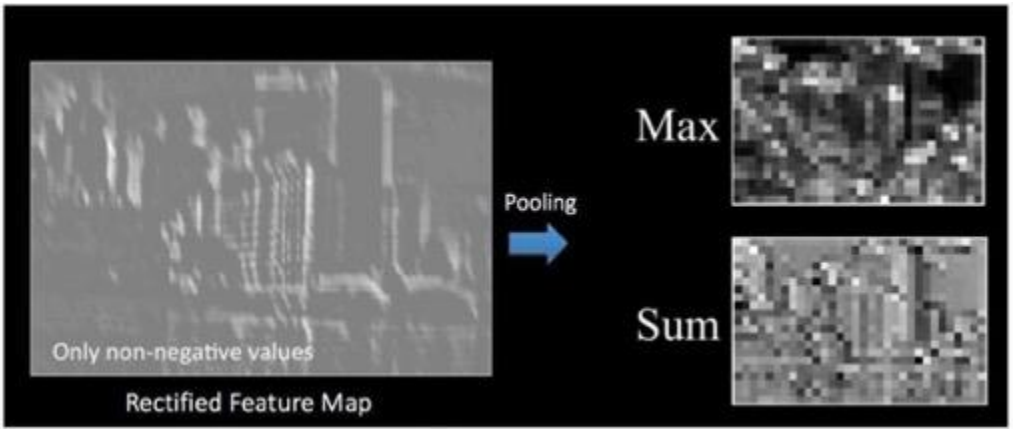
Two types of pooling can be performed on an image.

1. Max Pooling: Max Pooling returns the maximum value from the portion of the image covered by the Kernel.
2. Average Pooling: Max Pooling returns the maximum value from the portion of the imagecovered by the Kernel.



The pooling layer is important in the CNN as it performs a series of tasks which are as follows:

1. Makes the image smaller and more manageable
2. Makes the image more resistant to small transformations, distortions, and translations in theinput image.

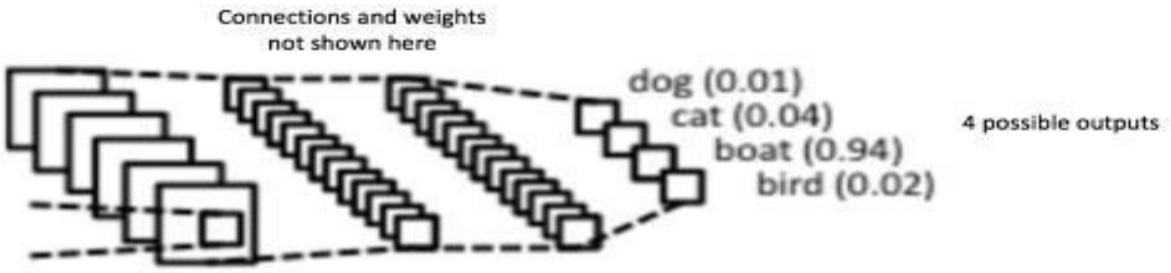


A small difference in the input image will create a very similar pooled image.

5.7.4 Fully Connected Layer

The final layer in the CNN is the Fully Connected Layer (FC layer). The objective of a fully connected layer is to take the results of the convolution/pooling process and use them to classify the image into a label (in a simple classification example).

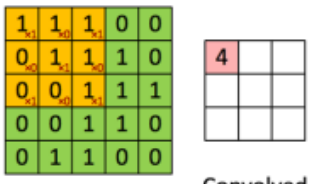
The output of convolution/pooling is flattened into a single vector of values, each representing a probability that a certain feature belongs to a label. For example, if the image is of a cat, features representing things like whiskers or fur should have high probabilities for the label "cat".

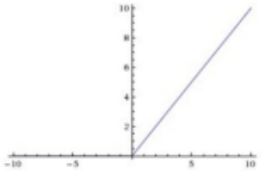


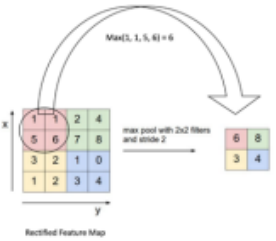
Let's Summarize:

Convolutional Neural Network

Convolutional Layer	Rectified linear unit (ReLU)	Pooling Layer	Fully Connected Layer







Car	70 %
Truck	20 %
Bicycle	10 %

Reduce size, improve feature, give probability value

Write the whole process of how a CNN works on the basis of the above diagram.

Test Yourself:

1. What is the primary objective of the Convolution Layer in a Convolutional Neural Network (CNN)?
   A) To flatten the input image
   B) To assign importance to various aspects/objects in the image
   C) To reduce the spatial size of the input image
   D) To perform element-wise multiplication of image arrays

2. Which of the following tasks is an example of computer vision?
   A) Rescaling an image
   B) Correcting brightness levels in an image
   C) Object detection in images or videos
   D) Changing tones of an image

3. How is resolution typically expressed?
   A) By the number of pixels along the width and height, such as 1280x1024
   B) By the brightness level of each pixel, ranging from 0 to 255
   C) By the total number of pixels, such as 5 megapixels
   D) By the arrangement of pixels in a 2-dimensional grid

4. What is the core task of image classification?
   A) Identifying objects and their locations in images
   B) Segmenting objects into individual pixels
   C) Assigning an input image one label from a fixed set of categories
   D) Detecting instances of real-world objects in images

5. What is the function of the Rectified Linear Unit (ReLU) layer in a CNN?
   A) To reduce the image size for more efficient processing
   B) To assign importance to various aspects/objects in the input image
   C) To get rid of negative numbers in the feature map and retain positive numbers
   D) To perform the convolution operation on the input image

6. Object detection and handwriting recognition are examples of tasks commonly associated with:
   A) Computer vision
   B) Image processing
   C) Both computer vision and image processing
   D) Neither computer vision nor image processing

7. What does the pixel value represent in an image?
   A) Width of the pixel
   B) Brightness or color of the pixel
   C) Height of the pixel
   D) Resolution of the pixel

8. In the byte image format, what is the range of possible pixel values?
   A) 0 to 10
   B) 0 to 100
   C) 0 to 1000
   D) 0 to 255

9. In a grayscale image, what does the darkest shade represent?
   A) Total presence of color
   B) Zero value of pixel
   C) Lightest shade of gray
   D) Maximum pixel value

10. In an RGB image, what does a pixel with an intensity value of 0 represent?
    A) Full presence of color
    B) No presence of color
    C) Maximum brightness level
    D) Minimum brightness level

11. **Assertion:** Object detection is a more complex task than image classification because it involvesidentifying both the presence and location of objects in an image.

    Reasoning: Object detection algorithms need to not only classify the objects present in an imagebut also accurately localize them by determining their spatial extent.

    Select the appropriate option for the statements given above:
    A) Both A and R are true and R is the correct explanation of A
    B) Both A and R are true and R is not the correct explanation of A
    C) A is true but R is false
    D) A is False but R is true

12. **Assertion:** Grayscale images consist of shades of gray ranging from black to white, where each pixel is represented by a single byte, and the size of the image is determined by its height multipliedby its width.

    Reasoning: Grayscale images are represented using a three intensities per pixel, typically rangingfrom 0 to 255.

    Select the appropriate option for the statements given above:
    A) Both A and R are true and R is the correct explanation of A
    B) Both A and R are true and R is not the correct explanation of A
    C) A is true but R is false
    D) A is False but R is true

Reflection Time:

1. Imagine you have a smartphone camera app that can recognize objects. When you point your camera at a dog, the app identifies it as a dog, analyzing patterns and features in the image. Behind the scenes, the app's software processes the image, detecting edges, shapes, and colors, then compares these features to a vast database to make accurate identifications."
   Identify the technology used in the above scenario and explain the way it works.

2. Enlist two smartphone apps that utilize computer vision technology? How have these apps improved your efficiency or convenience in daily tasks?

3. How an RGB image is different from a grayscale image?

4. Determine the color of a pixel based on its RGB values mentioned below: (i) R=0, B=0, G=0
   (ii) R=255, B=255, G=255
   (iii) R=0, B=0, G=255 (iv) R=0, B=255, G=0

5. Briefly describe the purpose of the convolution operator in image processing.

6. What are the different layers in Convolutional Neural Network? What features are likely to be detected by the initial layers of a neural network and how is it different from what is detected by the later layers?

7. "Imagine you're a researcher tasked with improving workplace safety in a manufacturing environment. You decide to employ computer vision technology to enhance safety measures."

8. How would you utilize computer vision in two distinct applications to promote safety within the manufacturing plant, ensuring both the physical well-being of employees and the efficiency of operations?
   Provide detailed explanations for each application, including the specific computer vision techniques or algorithms you would employ, and how they would contribute to achieving your safety goals.

9. Explain the distinctions between image classification, classification with localization, object detection, and instance segmentation in computer vision tasks. Provide examples for each to support your answer.

10. “Agriculture is an industry where precision and efficiency are crucial for sustainable production. Traditional farming methods often rely on manual labor and visual inspection, which can be time- consuming and error-prone. However, advancements in computer vision technology offer promising solutions to optimize various agricultural processes.

Agricultural drones equipped with high-resolution cameras and computer vision algorithms are increasingly being used to monitor crop health, detect diseases, and assess crop yields.”

Answer the following questions based on the case study mentioned above:
How does the integration of computer vision technology with drones improve efficiency in agricultural practices compared to traditional methods?
What are some key indicators or parameters that computer vision algorithms can analyze to assess crop health and detect diseases?

11. You are tasked with developing a computer vision system for a self-driving car company. The system needs to accurately detect and classify various objects on the road to ensure safe navigation. Imagine you're working on improving the object detection algorithm for the self-driving car's computer vision system. During testing, you notice that the system occasionally misclassifies pedestrians as cyclists, especially in low-light conditions.
How would you approach addressing this issue? What steps would you take to enhance the accuracy of pedestrian detection while ensuring the system's overall performance and reliability on the road?

Unit 6: Natural Language Processing

Lesson Title: Natural Language Processing	**Approach:** Session + Activity

Summary: Students will be introduced to the NLP and its importance. They will receive an overview of the various stages of NLP and test processing techniques used in Natural Language Processing (NLP). They will undertake activities to appreciate the distinction between the Code vs No-code NLP. They will understand the Bag of Words algorithm andthe concept of TFIDF.

Learning Objectives:

Students are introduced to

1. NLP and its importance.
2. Various applications of NLP.
3. Different stages of NLP.
4. Various text processing techniques used in NLP.
5. Different No-Code NLP tools.
6. The Bag of Words model.
7. The concept of TFIDF.
8. No code Orange Data Mining Tool

Learning Outcomes:

Students will be able to:

1. Describe the importance of pre-processing NLP data.
2. Recognize the different steps of NLP data pre-processing.
3. Learners will be able to list several applications of NLP which can be implemented without code.
4. Enlist different No-Code NLP tools.
5. Outline the concept of the Bag of Words algorithm.
6. Explain the process of TFIDF.
7. Explain Sentiment Analysis

Pre-requisites: None

Key-concepts:

1. Natural Language Processing
2. Applications of NLP
3. Different stages of NLP
4. Text Processing techniques used in NLP
5. Bag of Word
6. TFIDF
7. No code – Orange Data Mining Tool

6.1 Introduction

A natural language is a human language, such as French, Spanish, English, Japanese, etc.

Features of Natural Languages

- They are governed by set rules that include syntax, lexicon, and semantics.
- All natural languages are redundant, i.e., the information can be conveyed in multiple ways.
- All natural languages change over time.

Test Yourself:

Choose the right word:

1. I am so tired; I want to take a_____?

2. Let's_____her a letter.

Do you see how same-sounding words can have totally different meanings?

- **Different meanings in different contexts.**

Let's consider these three sentences:

His face turned red after he found out that he took the wrong bag.

What does this mean? Is he feeling ashamed because he took another person's bag insteadof his? Is he feeling angry because he did not manage to steal the bag that he has been targeting?

The red car zoomed past his nose.

Probably talking about the colour of the car

His face turns red after consuming the medicine.

Is he having an allergic reaction? Or was he ashamed because he lost a bet ("I will not fall sick because of this")? Or was he taking a medicine that dilates the artery?

Here we can see that context is important. We understand a sentence almost intuitively, depending on our history of using the language, and the memories that have been built within. In all three sentences, the word red has been used in three different ways which according to the context of the statement changes its meaning completely. Thus, in natural language, it is important to understand that a word can have multiple meanings and the meanings fit into the statement according to the context of it.

Think of some other words which can have multiple meanings and use them in sentences.

_____

_____

_____

_____

_____

Computer Language

Computer languages are languages used to interact with a computer, such as Python, C++, Java, HTML, etc.

Can computers understand our language?

Computers require a specific set of instructions to understand human input called programs. To talk toa computer, we convert natural language into a language that a computer understands. We need Natural Language Processing to help computers understand natural language.

Why is NLP important?

Computers can only process electronic signals in the form of binary language. Natural Language Processing facilitates this conversion to digital form from the natural form. Thus, the whole purpose of NLP is to make communication between computer systems and humans possible. This includes creating different tools and techniques that facilitate better communication of intent and context.

Demystify Natural Language Processing (NLP)

Natural Language Processing, or NLP, is the sub-field of AI that is focused on enabling computers to analyse, understand and process human languages to derive meaningful information from human language.

6.2 Applications of Natural Language Processing

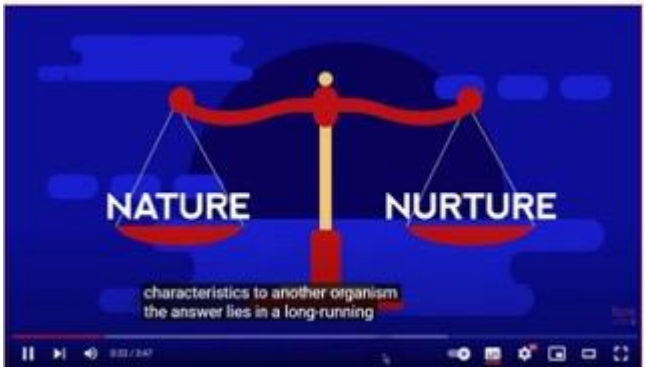
Since Artificial Intelligence nowadays is becoming an integral part of our lives, its applications are very commonly used by the majority of people in their daily lives. Here are some of the applications of Natural Language Processing which are used in the real-life scenario:

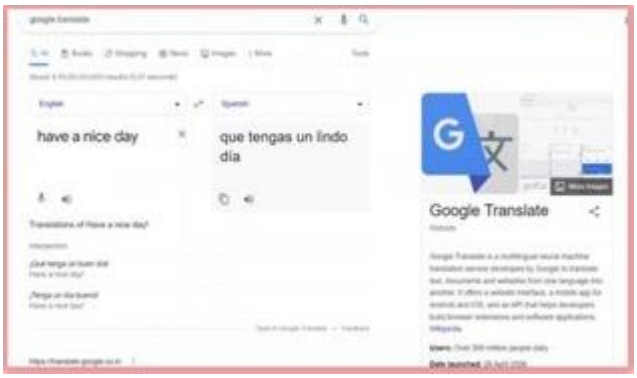
Voice assistants: Voice assistants take our natural speech, process it, and give us an output. These assistants leverage NLP to understand natural language and execute tasks efficiently.

For example:
Hey Google, set an alarm at 3.30 pm
Hey Alexa, play some music
Hey Siri, what's the weather today

Autogenerated captions: Captions are generated by turning natural speech into text in real-time. It is a valuable feature for enhancing the accessibility of video content.

For example:
Auto-generated captions on YouTube and Google Meet.

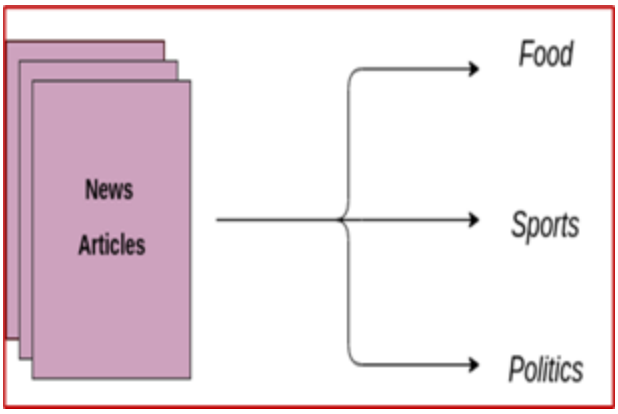




Language Translation: It incorporates the generation of translation from another language. This involves the conversion of text or speech from one language to another, facilitating cross-linguistic communication and fostering global connectivity.

For example:
Google Translate

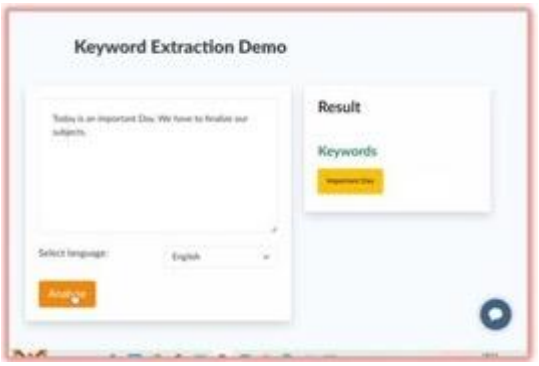
Sentiment Analysis: Sentiment Analysis is a tool to express an opinion, whether the underlying sentiment is positive, negative, or neutral. Customer sentiment analysis helps in the automatic detection of emotions when customers interact with the products, services, or brand



Text Classification: Text classification is a tool which classifies a sentence or document category-wise.

In the example, we can observe news articles containing information on various sectors, including Food, Sports, and Politics, being categorized through the text classification process. This process classifies the raw texts into predefined groups or categories.

Keyword Extraction: Keyword extraction is a tool that automatically extracts the most used, important words and expressions from a text. It can give valuable insights into people's opinions about any business on social media. Customer Service can be improved by using a Keyword extraction tool.

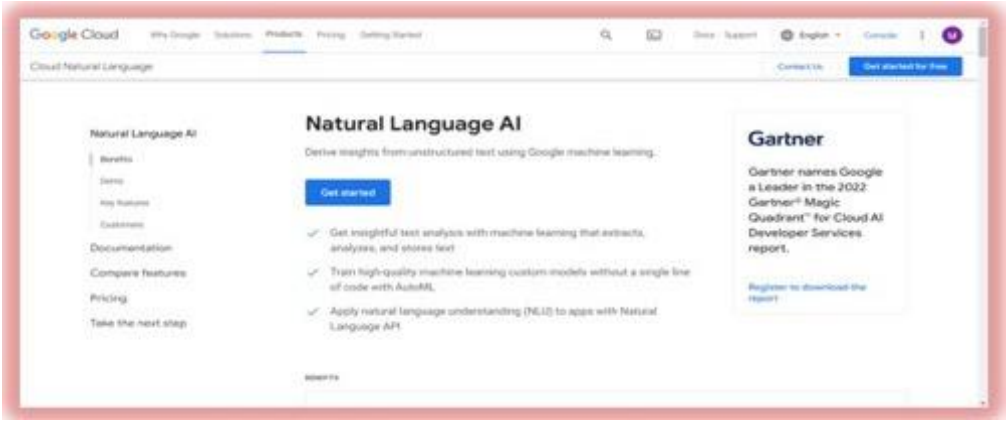


Activity 1: Keyword Extraction

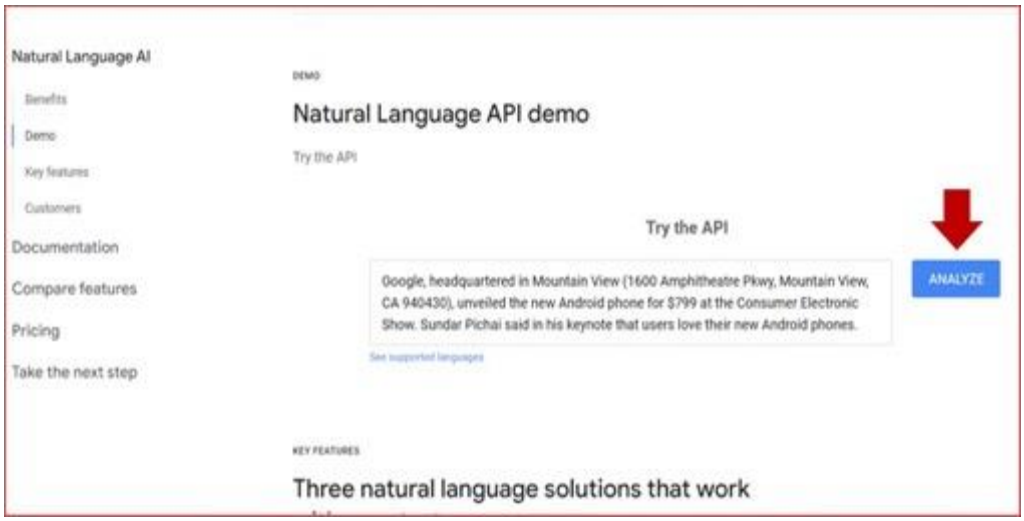
Purpose: To learn how to utilize an API for performing keyword extraction from a website.

Say: "Keyword extraction in NLP involves automatically identifying and extracting the most important words or phrases from a piece of text. These keywords represent the main topics or themes within the text and are useful for tasks like document summarization, information retrieval, and contentanalysis."

STEP – 1: Go to the given website: https://cloud.google.com/natural-language



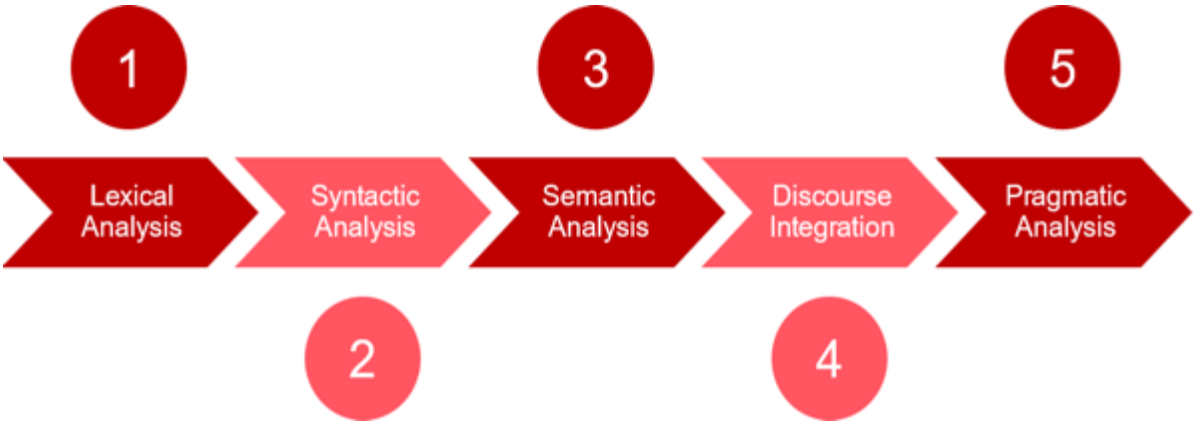
STEP – 2: Click on 'Analyze' and check the results.



- The keywords from the paragraph in the textbox have been highlighted in different colours e.g., Google, Mountain View, etc.
- Click on other options to check the output.
- Use your own text in the text box and observe the results.

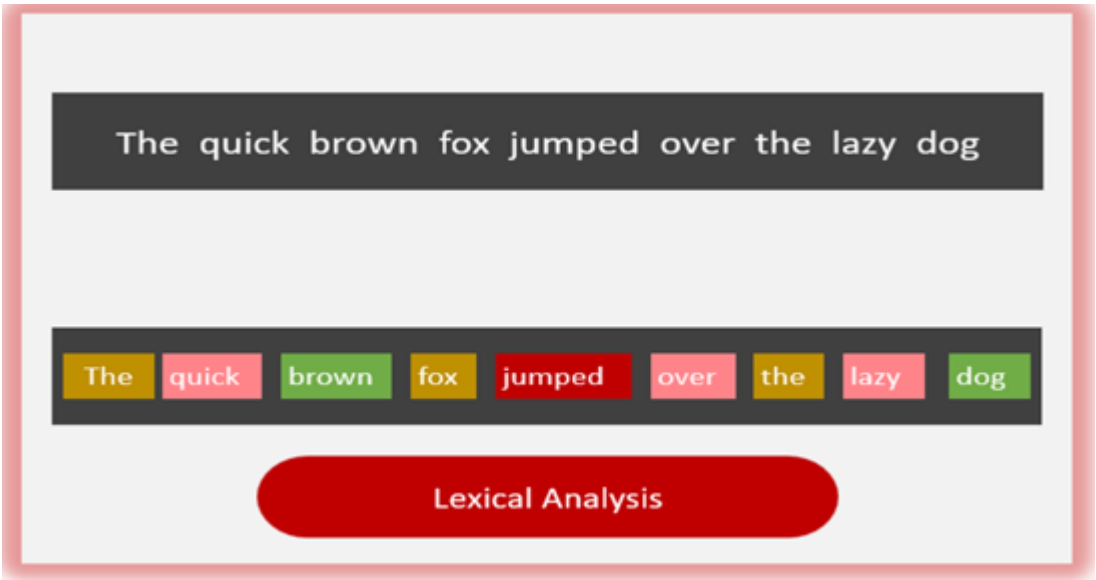
6.3 Stages of Natural Language Processing (NLP)

The different stages of Natural Language Processing (NLP) serve various purposes in theoverall task of understanding and processing human language. The stages of Natural Language Processing (NLP) typically involve the following:



Lexical Analysis:

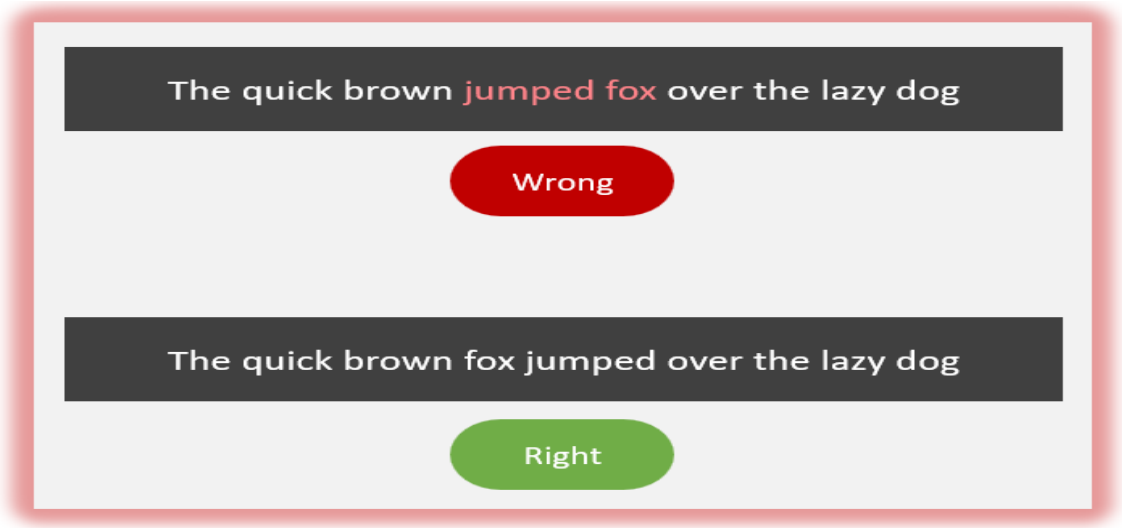
NLP starts with identifying the structure of input words. It is the process of dividing a large chunk of words into structural paragraphs, sentences, and words. Lexicon stands for a collection of the various words and phrases used in a language.



Lengthy text is broken down into chunks.

Syntactic Analysis / Parsing

It is the process of checking the grammar of sentences and phrases. It forms a relationship among words and eliminates logically incorrect sentences.



The grammar is correct!

Semantic Analysis

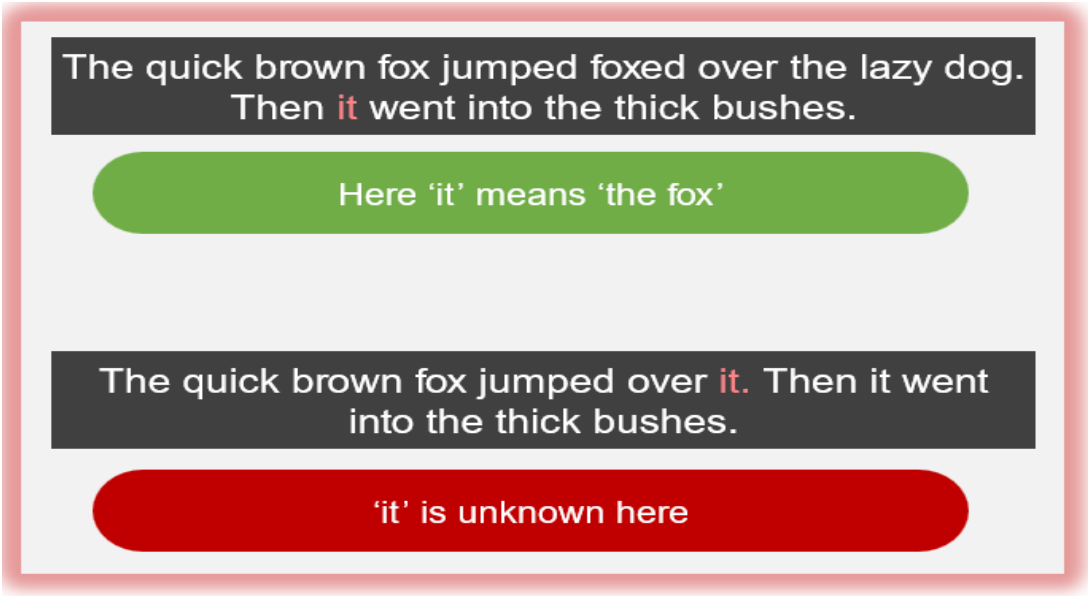
In this stage, the input text is now checked for meaning, and every word and phrase ischecked for meaningfulness.

For example:
It will reject a sentence that contains ‘hot ice cream’ in it.The
fox jumped into the dog.

Sentences make actual sense!

Discourse Integration

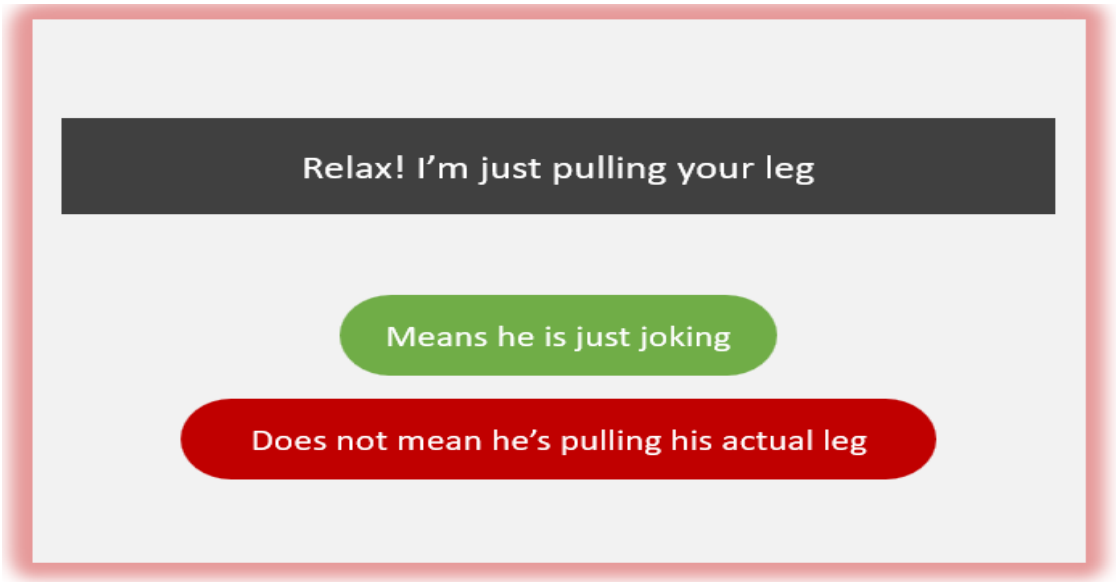
It is the process of forming the story of the sentence. Every sentence should have a relationship with its preceding and succeeding sentences.



The flow of words makes sense!

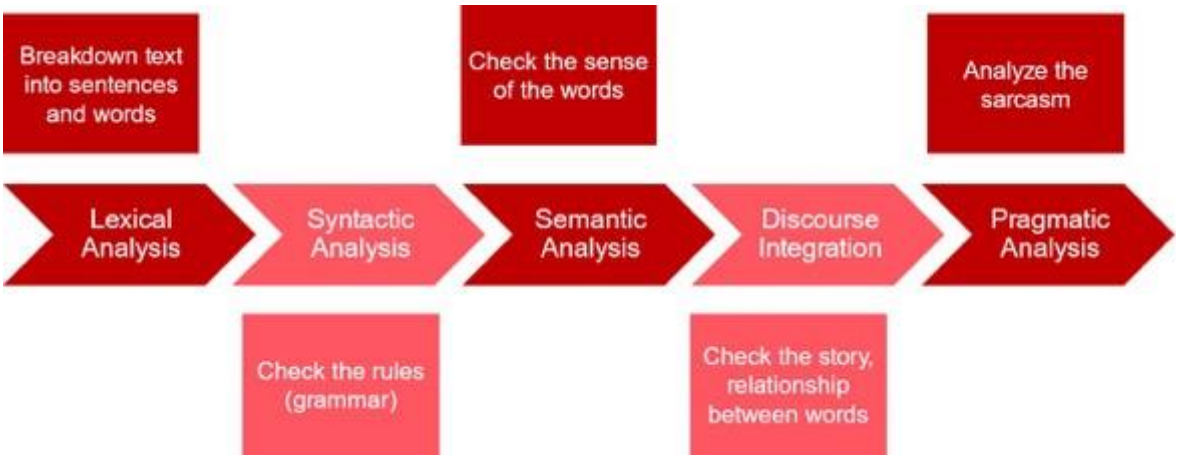
Pragmatic Analysis

In this stage, sentences are checked for their relevance in the real world. Pragmatic means practical or logical, i.e., this step requires knowledge of the intent in a sentence. It also means to discard the actual word meaning taken after semantic analysis and take theintended meaning.



The intended meaning has been achieved!

In summary,



Test Yourself:

Choose the right word:

1. Syntax refers to the grammatical structure of a sentence.

YES

NO

2. Which technique is used to assess the meaningfulness of the input text?

Pragmatic Analysis

Lexical Analysis

Semantic Analysis

Discourse Integration

6.4 Chatbots

Activity 2: Play with chatbots

Purpose: Identify and interact with different chatbots.

Say: “Have you ever wondered why chatbots are created? They are meant to make it feel as if we are talking to a real human as this is the way we are comfortable with. There are several chatbots here. I will split you into groups. Spend some time interacting with the chatbot, and then we will review our experience.”

One of the most common applications of Natural Language Processing is a chatbot. A chatbot is a computer program that's designed to simulate human conversation through voice commands or text chats or both. It can learn over time how to best interact with humans. It can answer questions and troubleshoot customer problems, evaluate and qualify prospects, generate sales leads and increase sales on an ecommerce site. There are a lot of chatbots available. Let us try some of the chatbots and see how they work.

ELIZA

Mitsuku

Cleverbot

Singtel

Elizabot - https://www.masswerk.at/elizabot/

Mitsuki - https://www.kuki.ai/

Cleverbot - https://www.cleverbot.com/

Singtel - https://www.singtel.com/personal/support

Let us discuss it!

• Which chatbot did you try? Name anyone.

• What is the purpose of this chatbot?

• How was the interaction with the chatbot?

• Did the chat feel like talking to a human or a robot? Why do you think so?

• Do you feel that the chatbot has a certain personality?

As you interact with more and more chatbots, you would realise that some of them are scripted or in other words are traditional chatbots while others are AI-powered and have more knowledge. With the help of this experience, we can understand that there are 2 types of chatbots around us: Script-bot and Smart-bot. Let us understand what each of them means in detail.

Script bot

- Script bots are easy to make.
- Script bots work around a script which is programmed in them.
- Mostly they are free and are easy to integrate to a messaging platform.
- No or little language processing skills.
- Limited functionality.

Smart bot

- Smart-bots are flexible and powerful.
- Smart bots work on bigger databases and other resources directly.
- Smart bots learn with more data.
- Coding is required to take this up on board.
- Wide functionality.

Quiz Time

1. Natural Language Processing majorly deals with_____ processing.

a. Numeric data

b. Textual data

c. Image data

d. Visual data

2. _____is an NLP tool to express an opinion, whether the underlying sentiment is positive, negative, or neutral.

a. Text Classification

b. Machine Translation

c. Sentiment Analysis

d. Automatic Text Summarization

3. What is the first stage of Natural Language Processing (NLP)?

a. Semantic Analysis

b. Pragmatic Analysis

c. Lexical Analysis

d. Syntactic Analysis

4. Words that we want to filter out before doing any analysis of the text are called_____.

a. Rare words

b. Stop words

c. Frequent words

d. Filter words

5. What does discourse integration involve in the context of sentence formation?

a. Identifying individual words in a sentence

b. Forming a coherent story within a sentence

c. Establishing relationships between preceding and succeeding sentences

d. Applying punctuation and grammar rules to a sentence

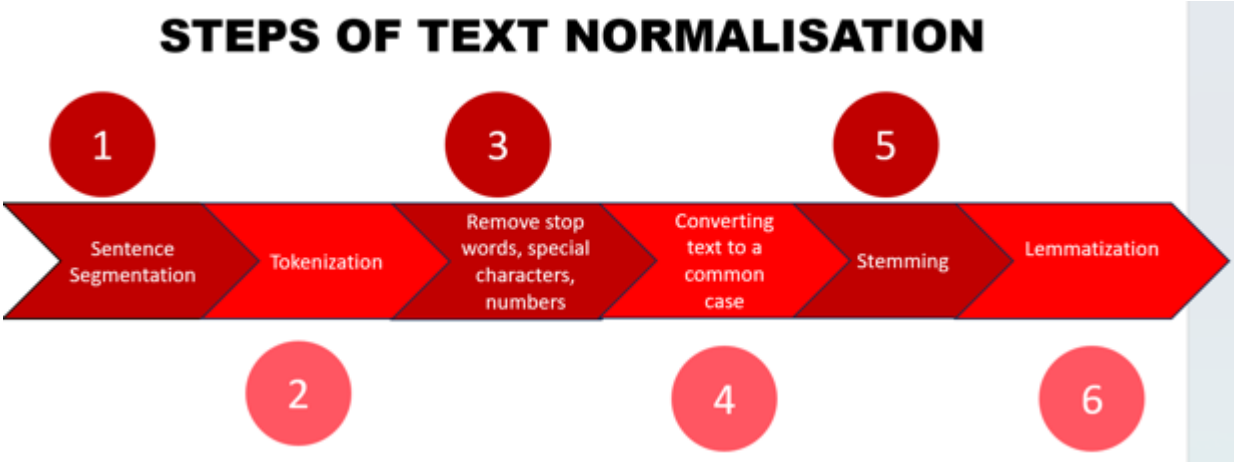
6.5 Text Processing

Humans interact with each other very easily. For us, the natural languages that we use are so convenient that we speak them easily and understand them well too. But for computers, our languages are very complex. As you have already gone through some of the complications in human languages above, now it is time to see how Natural Language Processing makes it possible for machines to understand and speak in Natural Languages just like humans.

Since we all know that the language of computers is Numerical, the very first step that comes to our mind is to convert our language to numbers. This conversion takes a few steps to happen. The first step to it is Text Normalisation. Since human languages are complex, we need to first of all simplify them in order to make sure that understanding becomes possible. Text Normalisation helps in cleaning up the textual data in such a way that it comes down to a level where its complexity is lower than the actual data. Let us go through Text Normalisation in detail.

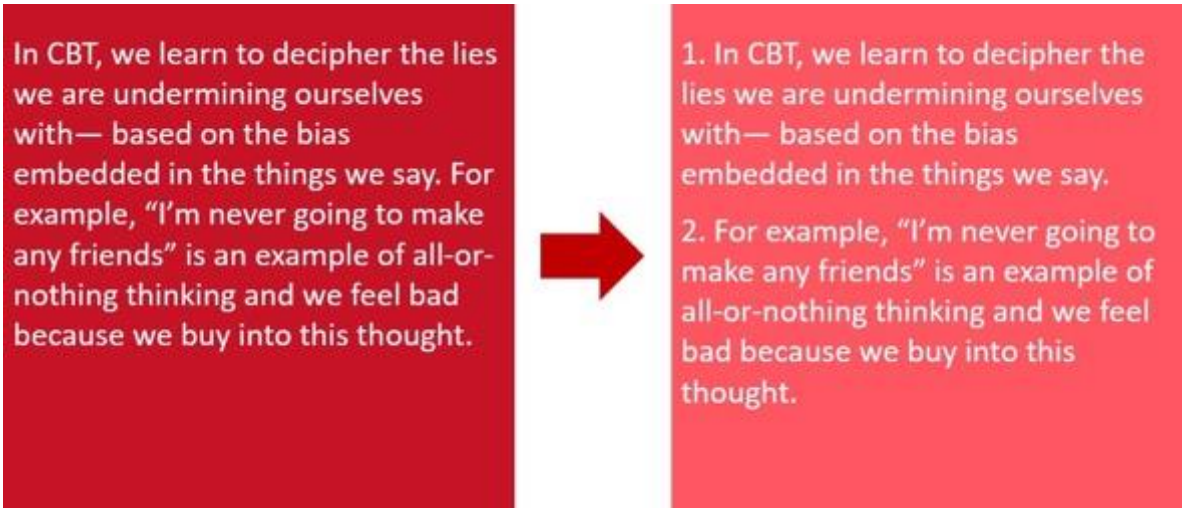
Text Normalisation

In Text Normalisation, we undergo several steps to normalise the text to a lower level. Before we begin, we need to understand that in this section, we will be working on a collection of written text. That is, we will be working on text from multiple documents andthe term used for the whole textual data from all the documents altogether is known as corpus. Not only would we go through all the steps of Text Normalisation, we would also work them out on a corpus. Let us take a look at the steps:



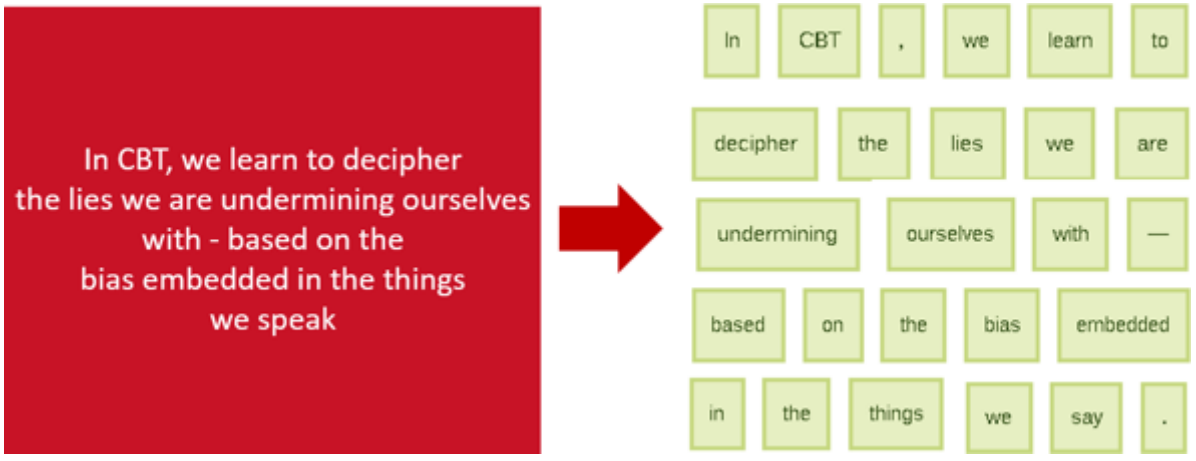
Sentence Segmentation

Under sentence segmentation, the whole corpus is divided into sentences. Each sentence is taken as a different data so now the whole corpus gets reduced to sentences.



Tokenization

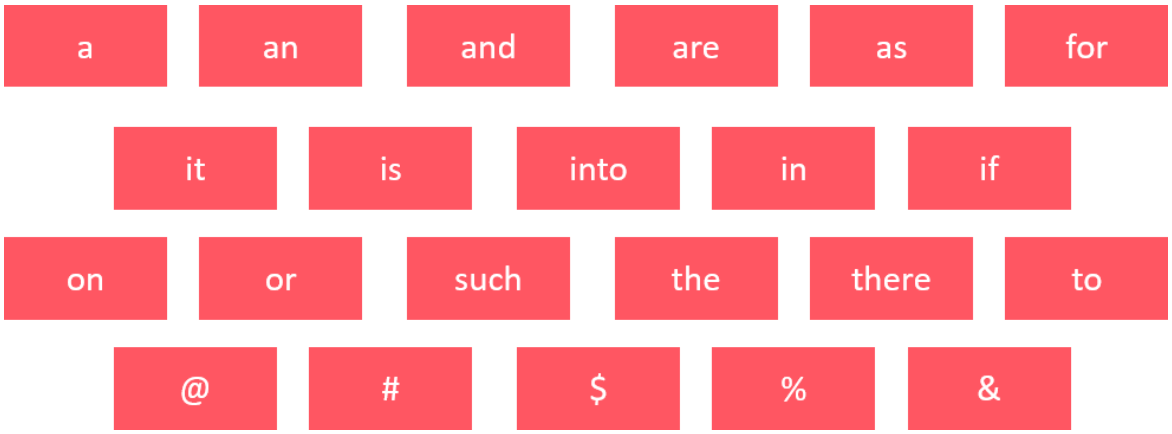
After segmenting the sentences, each sentence is then further divided into tokens. Tokens is a term used for any word or number or special character occurring in a sentence. Under tokenisation, every word, number and special character is considered separately and each of them is now a separate token.



Removing Stop words, Special Characters and Numbers

In this step, the tokens which are not necessary are removed from the token list. What arethe possible words which we might not require?

Stop words are the words which occur very frequently in the corpus but do not add any value to it. Humans use grammar to make their sentences meaningful for the other person to understand. But grammatical words do not add any essence to the information which is tobe transmitted through the statement hence they come under stop words. Some examples of stop words are:

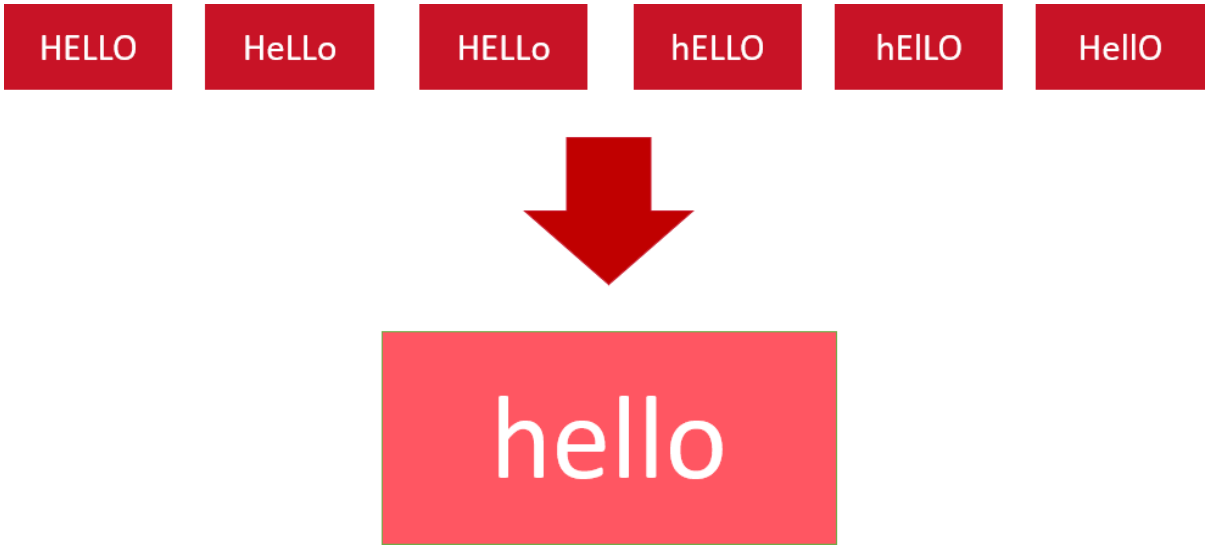


These words occur the most in any given corpus but talk very little or nothing about the context or the meaning of it. Hence, to make it easier for the computer to focus on meaningful terms, these words are removed.

Along with these words, a lot of times our corpus might have special characters and/or numbers. Now it depends on the type of corpus that we are working on whether we should keep them in it or not. For example, if you are working on a document containing email IDs, then you might not want to remove the special characters and numbers whereas in some other textual data if these characters do not make sense, then you can remove them along with the stop words.

Converting Text to a Common Case

After the stop words removal, we convert the whole text into a similar case, preferably lowercase. This ensures that the case sensitivity of the machine does not consider the same words as different just because of different cases.



Here in this example, all the 6 forms of hello would be converted to lowercase and hence would be treated as the same word by the machine.

Stemming

In this step, the remaining words are reduced to their root words. In other words, stemmingis the process in which the affixes of words are removed and the words are converted to their base form.

Word	Affixes	Stem
healed	-ed	heal
healing	-ing	heal
healer	-er	heal
studies	-es	studi
studying	-ing	study

Note that in stemming, the stemmed words (words that we get after removing the affixes) might not be meaningful. Here in this example as you can see: healed, healing and healer all were reduced to heal but studies was reduced to studi after the affix removal which is not a meaningful word. Stemming does not take into account whether the stemmed word is meaningful or not. It just removes the affixes hence it is faster.

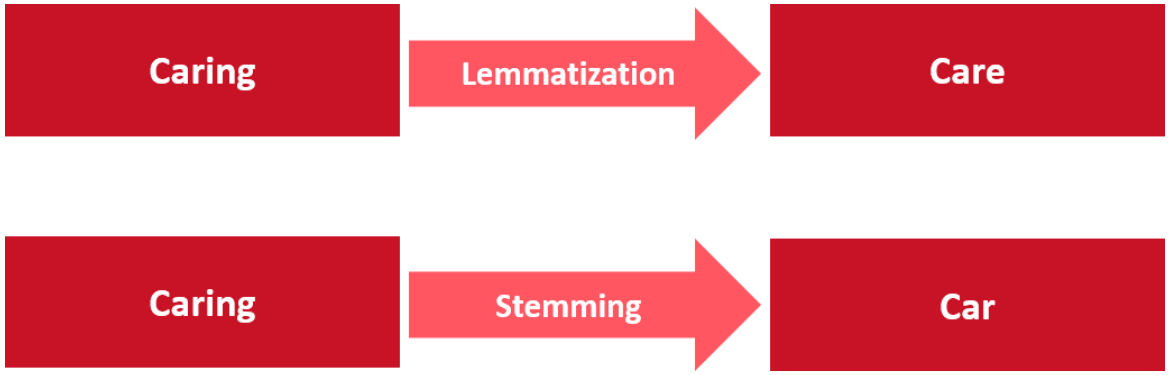
Lemmatization

Stemming and lemmatization both are alternative processes to each other as the role of both the processes is same – removal of affixes. But the difference between both of them isthat in lemmatization, the word we get after affix removal (also known as lemma) is a meaningful one. Lemmatization makes sure that a lemma is a word with meaning and hence it takes a longer time to execute than stemming.

Word	Affixes	Stem
healed	-ed	heal
healing	-ing	heal
healer	-er	heal
studies	-es	**study**
studying	-ing	study

As you can see in the same example, the output for studies after affix removal has become study instead of studi.

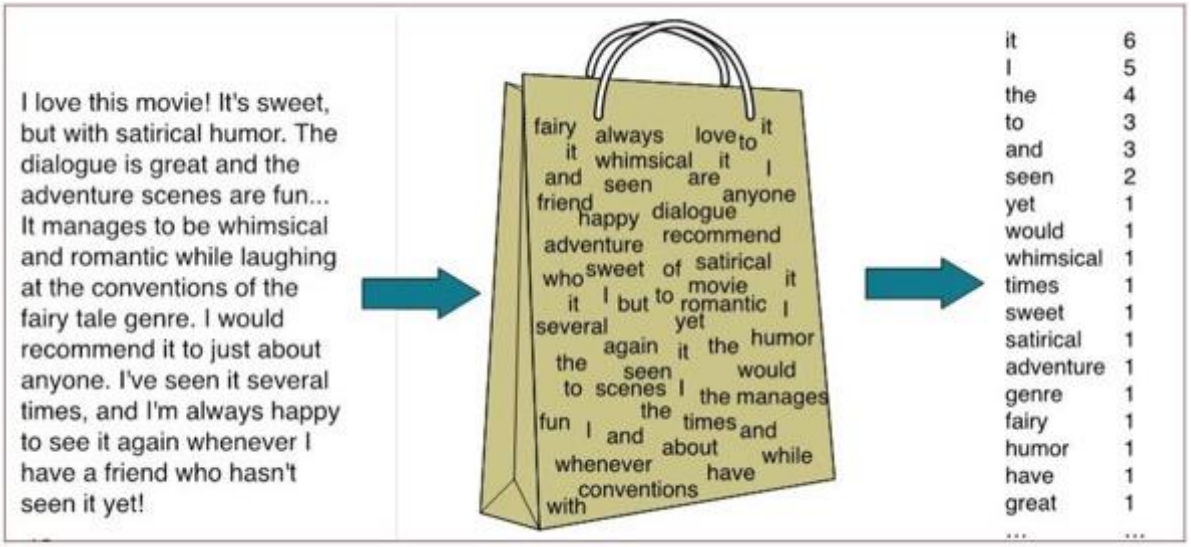
The difference between stemming and lemmatization can be summarized by this example:



With this, we have normalised our text to tokens which are the simplest form of words present in the corpus. Now it is time to convert the tokens into numbers. For this, we would use the Bag of Words algorithm

Bag of Words

Bag of Words is a Natural Language Processing model which helps in extracting features out of the text which can be helpful in machine learning algorithms. In the bag of words, we get the occurrences of each word and construct the vocabulary for the corpus.



This image gives us a brief overview of how the bag of words works. Let us assume that the text on the left in this image is the normalised corpus which we have got after going through all the steps of text processing. Now, as we put this text into the bag of words algorithm, the algorithm returns to us the unique words out of the corpus and their occurrences in it. As you can see on the right, it shows us a list of words appearing in the corpus and the numbers corresponding to it show how many times the word has occurred in the text body. Thus, we can say that the bag of words gives us two things:

1. A vocabulary of words for the corpus
2. The frequency of these words (number of times it has occurred in the whole corpus).

Here calling this algorithm a “bag” of words symbolises that the sequence of sentences or tokens does not matter. In this case, all we need are the unique words and their frequency.

Here is the step-by-step approach to implementing the bag of words algorithm:

1. Text Processing: Collect data and pre-process it

2. Create a Dictionary: Make a list of all the unique words occurring in the corpus. (Vocabulary)

3. Create document vectors: For each document in the corpus, find out how many times the word from the unique list of words has occurred.

4. Create document vectors for all the documents.

Let us go through all the steps with an example:

Step 1: Collecting data and pre-processing it.

Document 1: Aman and Avni are stressed

Document 2: Aman went to a therapist

Document 3: Avni went to download a health chatbot

Here are three documents having one sentence each. After text normalisation, the text becomes:

Document 1: [aman, and, avni, are, stressed]

Document 2: [aman, went, to, a, therapist]

Document 3: [avni, went, to, download, a, health, chatbot]

Step 2: Create a Dictionary

Go through all the steps and create a dictionary i.e., list down all the words which occur in all three documents:

Dictionary:

aman	and	avni	are	stressed	went
download	health	chatbot	therapist	a	to

Note that even though some words are repeated in different documents, they are all written just once as while creating the dictionary, we create the list of unique words.

Step 3: Create a document vector

In this step, the vocabulary is written in the top row. Now, for each word in the document, ifit matches the vocabulary, put a 1 under it. If the same word appears again, increment the previous value by 1. And if the word does not occur in that document, put a 0 under it.

aman	and	avni	are	stressed	went	to	a	therapist	download	health	chatbot
`1	1	1	1	1	0	0	0	0	0	0	0

Since, in the first document, we have words: aman, and, avni, are, stressed. So, all thesewords get a value of 1 and the rest of the words get a 0 value.

Step 4: Create document vectors for all the documents.

The same exercise has to be done for all the documents. Hence, the table becomes:

aman	and	avni	are	stressed	went	to	a	therapist	download	health	chatbot
`1	1	1	1	1	0	0	0	0	0	0	0
1	0	0	0	0	1	1	1	1	0	0	0
0	0	1	0	0	1	1	1	0	1	1	1

In this table, the header row contains the vocabulary of the corpus and three rows correspond to three different documents. Take a look at this table and analyse the positioning of 0s and 1s in it.

Finally, this gives us the **document vector table** for our corpus. However, the tokens havestill not been converted to numbers. This leads us to the final step of our algorithm: TFIDF.

TFIDF: Term Frequency & Inverse Document Frequency

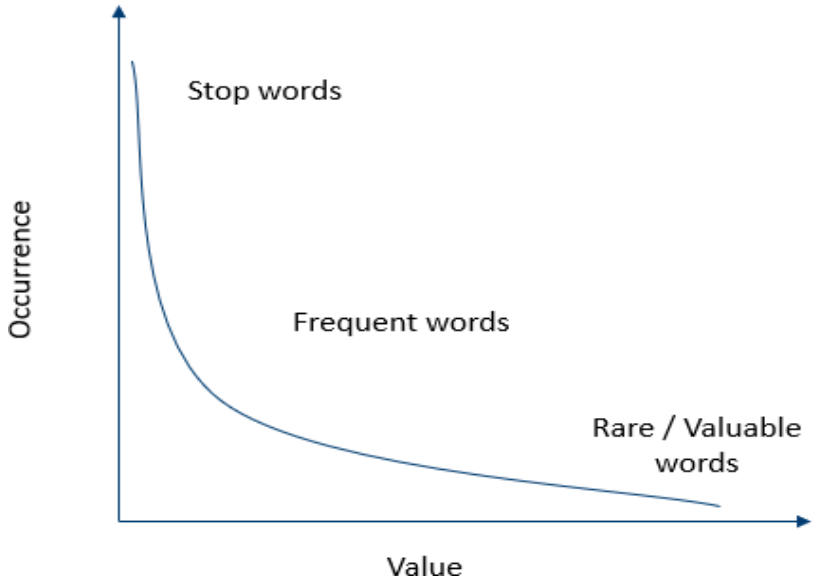
Suppose you have a book. Which characters or words do you think would occur the most init?

_____

_____

The bag of words algorithm gives us the frequency of words in each document we have in our corpus. It gives us an idea that if the word is occurring more in a document, its value is more for that document. For example, if I have a document on air pollution, air and pollutionwould be the words which occur many times in it. And these words are valuable too as they give us some context around the document. But let us suppose we have 10 documents and all of them talk about different issues. One is on women's empowerment; the other is on unemployment and so on. Do you think air and pollution would still be one of the most occurring words in the whole corpus? If not, then which words do you think would have the highest frequency in all of them?

And, this, is, the, etc. are the words which occur the most in almost all the documents. But these words do not talk about the corpus at all. Though they are important for humans as they make the statements understandable to us, for the machine they are a complete waste as they do not provide us with any information regarding the corpus. Hence, these are termed as stop words and are mostly removed at the pre-processing stage only.



Take a look at this graph. It is a plot of the occurrence of words versus their value. As you can see, if the words have the highest occurrence in all the documents of the corpus, they are said to have negligible value hence they are termed as stop words. These words are mostly removed at the pre-processing stage only. Now as we move ahead from the stop words, the occurrence level drops drastically and the words which have adequate occurrence in the corpus are said to have some amount of value and are termed as frequent words. These words mostly talk about the document's subject and their occurrence is adequate in the corpus. Then as the occurrence of words drops further, the value of such words rises. These words are termed as rare or valuable words. These words occur the least but add the most value to the corpus. Hence, when we look at the text, we consider frequent and rare words.

Let us now demystify TFIDF. TFIDF stands for Term Frequency and Inverse Document Frequency. TFIDF helps us identify the value of each word. Let us understand each term one by one.

Term Frequency

Term frequency is the frequency of a word in one document. Term frequency can easily be found in the document vector table as in that table we mention the frequency of each word of the vocabulary in each document.

aman	and	avni	are	stressed	went	to	a	therapist	download	health	chatbot
`1	1	1	1	1	0	0	0	0	0	0	0
1	0	0	0	0	1	1	1	1	0	0	0
0	0	1	0	0	1	1	1	0	1	1	1

Here, you can see that the frequency of each word for each document has been recorded in the table. These numbers are nothing but the Term Frequencies!

Inverse Document Frequency

Now, let us look at the other half of TFIDF which is Inverse Document Frequency. For this, let us first understand what document frequency means. Document Frequency is the number of documents in which the word occurs irrespective of how many times it has occurred in those documents. The document frequency for the exemplar vocabulary would be:

aman	and	avni	are	stressed	went	to	a	therapist	download	health	chatbot
`2	1	2	1	1	2	2	2	1	1	1	1

Here, you can see that the document frequency of ‘aman’, ‘avni’, ‘went’, ‘to’ and ‘a’ is 2 asthey have occurred in two documents. The rest of them occurred in just one document hence the document frequency for them is one.

Talking about inverse document frequency, we need to put the document frequency in the denominator while the total number of documents is the numerator. Here, the total number of documents is 3, hence inverse document frequency becomes:

aman	and	avni	are	stressed	went	to	a	therapist	download	health	chatbot
`3/2	3/1	3/2	3/1	3/1	3/2	3/2	3/2	3/1	3/1	3/1	3/1

Finally, the formula of TFIDF for any word W becomes:

TFIDF(W) = TF(W) * log(IDF(W))

Here, log is to the base of 10. Don’t worry! You don’t need to calculate the log values by yourself. Simply use the log function in the calculator and find out!

Now, let’s multiply the IDF values by the TF values. Note that the TF values are for each document while the IDF values are for the whole corpus. Hence, we need to multiply the IDF values to each row of the document vector table.

aman	and	avni	are	stressed	went	to	a	therapist	download	health	chatbot
`1*log(3/2)	1*log(3)	1*log(3/2)	1*log(3)	1*log(3)	0*log(3/2)	0*log(3/2)	0*log(3/2)	0*log(3)	0*log(3)	0*log(3)	0*log(3)
1*log(3/2)	0*log(3)	0*log(3/2)	0*log(3)	0*log(3)	1*log(3/2)	1*log(3/2)	1*log(3/2)	1*log(3)	0*log(3)	0*log(3)	0*log(3)
0*log(3/2)	0*log(3)	1*log(3/2)	0*log(3)	0*log(3)	1*log(3/2)	1*log(3/2)	1*log(3/2)	0*log(3)	1*log(3)	1*log(3)	1*log(3)

Here, you can see that the IDF values for Aman in each row are the same and a similar pattern is followed for all the words of the vocabulary. After calculating all the values, weget:

aman	and	avni	are	stressed	went	to	a	therapist	download	health	chatbot
`0.176	0.477	0.176	0.477	0.477	0	0	0	0	0	0	0
0.176	0	0	0	0	0.176	0.176	0.176	0.477	0	0	0
0	0	0.176	0	0	0.176	0.176	0.176	0	0.477	0.477	0.477

Finally, the words have been converted to numbers. These numbers are the values of each for each document. Here, you can see that since we have less amount of data, words like ‘are’ and ‘and’ also have a high value. But as the IDF value increases, the value of that word decreases. That is, for example:

Total Number of documents: 10

Number of documents in which ‘and’ occurs: 10

Therefore, IDF(and) = 10/10 = 1

Which means: log(1) = 0. Hence, the value of ‘and’ becomes 0.

On the other hand, the number of documents in which ‘pollution’ occurs: 3 IDF(pollution) = 10/3 = 3.3333…

This means log(3.3333) = 0.522; which shows that the word ‘pollution’ has considerablevalue in the corpus.

Summarising the concept, we can say that:

1. Words that occur in all the documents with high term frequencies have the lowest values and are considered to be the stop words.

2. For a word to have a high TFIDF value, the word needs to have a high term frequency but less document frequency which shows that the word is important for one document but is not a common word for all documents.

3. These values help the computer understand which words are to be considered while processing the natural language. The higher the value, the more important the word is for a given corpus.

Applications of TFIDF

TFIDF is commonly used in the Natural Language Processing domain. Some of itsapplications are:

Document Classification	Topic Modelling	Information Retrieval System	Stop word filtering
Helps in classifying the type and genre of a document.	**It helps in predicting the topic for a corpus.**	**To extract the important information out of a corpus.**	**Helps in removing unnecessary words from a text body.**

6.6 Natural Language Processing: Use Case Walkthrough

Purpose: Students are introduced to the No-code tools for Natural Language Processing.

They will learn about Sentiment Analysis, one of the applications of NLP with the No-code tool Orange Data Mining. Learners will be able to understand this application with use cases

Examples of Code and No-code NLP Tools

Code NLP	No-Code NLP
NLTK package: Natural Language Tool Kit or NLTK is a package readily available for text processing in Python. The package contains functions and modules which can be used for Natural Language Processing.	**Orange Data Mining:** It is a machine learning tool for data analysis through Python and visual programming. We can perform operations on data through simple drag-and-drop steps.
SpaCy: SpaCy is an open-source natural language processing (NLP) library designed to build NLP applications. It offers various features such as tokenization, part-of-speech tagging, named entity recognition, dependency parsing, and more.	**MonkeyLearn:** MonkeyLearn is a text analysis platform that offers NLP tools and machine learning models for text analysis, supporting tasks such as classification, sentiment analysis, and entity recognition. Users can create custom models or use pre-trained ones for tasks like social media monitoring and customer feedback analysis.

Applications of NLP

Introduction to Sentiment Analysis

Sentiment (opinion)

Analysis

Sentiment analysis is a natural language processing (NLP) technique used to analyzewhether a given textual data is positive, negative, or neutral.

Applications of Sentiment Analysis-Customer Service

Collecting customer data through live chat

Customer feedback about service

Customer sentiment analysis helps in the automatic detection of emotions when customers interact with products, services, or brands.

Applications of Sentiment Analysis –Voice of the Customer

- Voice of the customer analysis helps to analyze customer feedback and gain actionable insights from it.
- It measures the gap between what customers expect and what they actually experience when they use the products or services,

Now, let's understand Sentiment Analysis in detail using the Orange Data Mining tool.

Follow the given link to understand the technique.

Case Walkthrough – Steps involved in project development

Short Link - https://bit.ly/OrangeNLP

Long Link - https://drive.google.com/drive/u/2/folders/1geFLXxV5890kfcakMfEg_KsH1LPcS_Iz

Or Scan the QR code provided below.

Test Yourself:

1. What is the primary challenge faced by computers in understanding human languages?

A) Complexity of human languages

B) Lack of computational power

C) Incompatibility with numerical data

D) Limited vocabulary

2. How do voice assistants utilize NLP?

A) To analyze visual data

B) To process numerical data

C) To understand natural language

D) To execute tasks based on computer code

3. Which of the following is NOT a step in Text Normalisation?

A) Tokenization

B) Lemmatization

C) Punctuation removal

D) Document summarization

4. In the context of text processing, what is the purpose of tokenisation?

A) To convert text into numerical data

B) To segment sentences into smaller units

C) To translate text into multiple languages

D) To summarize documents for analysis

5. What distinguishes lemmatization from stemming?

A) Lemmatization produces meaningful words after affix removal, while stemming does not.

B) Lemmatization is faster than stemming.

C) Stemming ensures the accuracy of the final word.

D) Stemming generates shorter words compared to lemmatization.

6. What is the primary purpose of the Bag of Words model in Natural Language Processing?

A) To translate text into multiple languages

B) To extract features from text for machine learning algorithms

C) To summarize documents for analysis

D) To remove punctuation marks from text

7. In the context of text processing, what are stop words?

A) Words with the frequent occurrence in the corpus

B) Words with negligible value that are often removed during preprocessing

C) Words with the lowest occurrence in the corpus

D) Words with the most value added to the corpus

8. What is the characteristic of rare or valuable words in the described plot?

A) They have the highest occurrence in the corpus

B) They are often considered stop words

C) They occur the least but add the most value to the corpus

D) They are typically removed during preprocessing

9. What information does the document vector table provide?

A) The frequency of each word across all documents

B) The frequency of each word in a single document

C) The total number of words in the entire corpus

D) The average word length in the entire corpus

10. What is the primary purpose of TFIDF in text processing?

A) To identify the presence of stop words in documents

B) To remove punctuation marks from text

C) To identify the value of each word in a document

D) To translate text into multiple languages

11. Assertion: Pragmatic analysis in natural language processing (NLP) involves assessing sentences for their practical applicability in real-world scenarios.

Reasoning: Pragmatic analysis requires understanding the intended meaning behind sentences and considering their practical or logical implications, rather than solely relying on literal word meanings obtained from semantic analysis.

A) Both Assertion and Reasoning are true, and Reasoning is the correct explanation of the Assertion.

B) Assertion is true, but Reasoning is false.

C) Both Assertion and Reasoning are true, but Reasoning is not the correct explanation of the Assertion.

D) Assertion is false, but Reasoning is true.

12. Assertion: Converting the entire text into lowercase following stop word removal is a crucial preprocessing step in natural language processing.

Reasoning: This process ensures uniformity in word representation, preventing the machine from treating words with different cases as distinct entities, thereby enhancing the accuracy of subsequent text analysis.

A) Both Assertion and Reasoning are true, and Reasoning is the correct explanation of the Assertion.

B) Assertion is true, but Reasoning is false.

C) Both Assertion and Reasoning are true, but Reasoning is not the correct explanation of the Assertion.

D) Assertion is false, but Reasoning is true.

Reflection Time:

1. Mention a few features of natural languages.

2. What is the significance of NLP?

3. What do you mean by lexical analysis in NLP?

4. What do you mean by a chatbot?

5. What does the term "Bag of Words" refer to in Natural Language Processing (NLP)?

6. Describe two practical uses of Natural Language Processing in real-world scenarios.

7. Explain the process of stemming and lemmatization in text processing, supported by an example.

8. Describe any four applications of TFIDF.

9. Samiksha, a student of class X was exploring the Natural Language Processing domain. She

got stuck while performing the text normalisation. Help her to normalise the text on the segmented sentences given below:

Document 1: Akash and Ajay are best friends.

Document 2: Akash likes to play football but Ajay prefers to play online games.

10. Through a step-by-step process, calculate TFIDF for the given corpus

Document 1: Johny Johny Yes Papa,

Document 2: Eating sugar? No Papa

Document 3: Telling lies? No Papa

Document 4: Open your mouth, Ha! Ha! Ha!

CLASS – X ANSWER KEY (Unit-End Exercise)

UNIT – 1: Ethical Frameworks for AI

TEST YOURSELF

1. B 2. C 3. B 4. D 5. C 6. B 7. B 8. C 9. A 10. B 11. A 12. A

UNIT – 2: Advanced Concepts of Modelling in AI

TEST YOURSELF

1. A 2.A 3. B 4. C 5. C 6. B 7. D 8. B 9. C 10. A 11. B 12. B

UNIT – 3: Evaluating Models

TEST YOURSELF

1. B 2.A 3. A 4. B 5. A 6. B 7. A 8. B 9. B 10. C

UNIT – 4.1: Statistical Data

TEST YOURSELF

1. A 2. D 3. D 4. A 5. A

UNIT – 4.2: Statistical Data

TEST YOURSELF

1. B 2. B 3. A 4. C 5. A

UNIT – 5: Computer Vision

TEST YOURSELF

1. B 2. C 3. A 4. C 5. C 6. A 7. B 8. D 9. B 10. B 11. A 12. C

UNIT – 6: Natural Language Processing

Test Yourself

1. A 2. C 3. D 4. B 5. A 6. B 7. B 8. C 9. A 10. C 11. A 12. A