PUSL 3123

AI and Machine Learning.

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- Plymouth Batch 10 [21.1]

04/10/2023.

what is Artificial Intelligence.

- AI definition.
  : Reffer to the simulation of human intelligence in a machine that are programe to think like humans and mimic actions like humans.

slide :

- Artificial Intelligence :

  is the simulation of human intelligence processes by machines, especially computer systems.

- Defination Could be divided as

  * Thinking Humananly
  * Thinking Rationally
  * Acting Humananly
  * Actiag Rationally.

- General Problem Solver → 1st Ai Program.

* Difference Between acting like human and Thinking like human

Slide :

- The difference between "acting humanly" and "Thinking humanly" is that the first is only concerned with the actions, the outcome or product of the human's thinking process; whereas the latter is concerned with modelling human thinking processes.

Note :

- The terms "acting humanly" and "think humanly" are concepts that differentiates two approaches to ~~achei~~ achieving artificial Intelligence (AI), particularly in the Contex of how AI system & can mimic human behavior and ~~conger~~ cognetive process. These concepts are often associated with ~~tar Turning~~ Turing Test, proposed by the British mathematician and Computer scientist Alan turing in his 1950 paper

"Computing Machinery and Intelligence"

Acting Humanly.

- The approach ~~four~~ focuses on making AI system simulate human behaviour or actions. In other words, It is concerned with the external ~~appearance~~ appearance or observable action of an AI system
- When an AI system is said to be "acting humanly". It mean that it can perform tasks or engage in activities in a way that indistinguishable from how a human would perform them.
- The turing test, for example, is often framed in terms of whether an AI can carry on a conversation enough to pass as a human.

Thinking Humanly.

- This approach is concerned with replicating the internal cognitive process and thought patterns of a human beign. It delves into the AI's ability to think, reason, and understand like a human.
- When as AI system is said to be "thinking humanly" it means that it is not just mimicking external behaviours but is also replicating the internal mental processes that lead to those behaviours
- Acheiving "thinking humanlly" AI works would involve understanding and repilicating human thought processes, including problem-solving, learning, memory and reasoning.

modeling out thinking as a logical process → Thinking Rationally.

Acting in a logical way to acheiving a goal is → Acting Rationally.

Core / Components of AI

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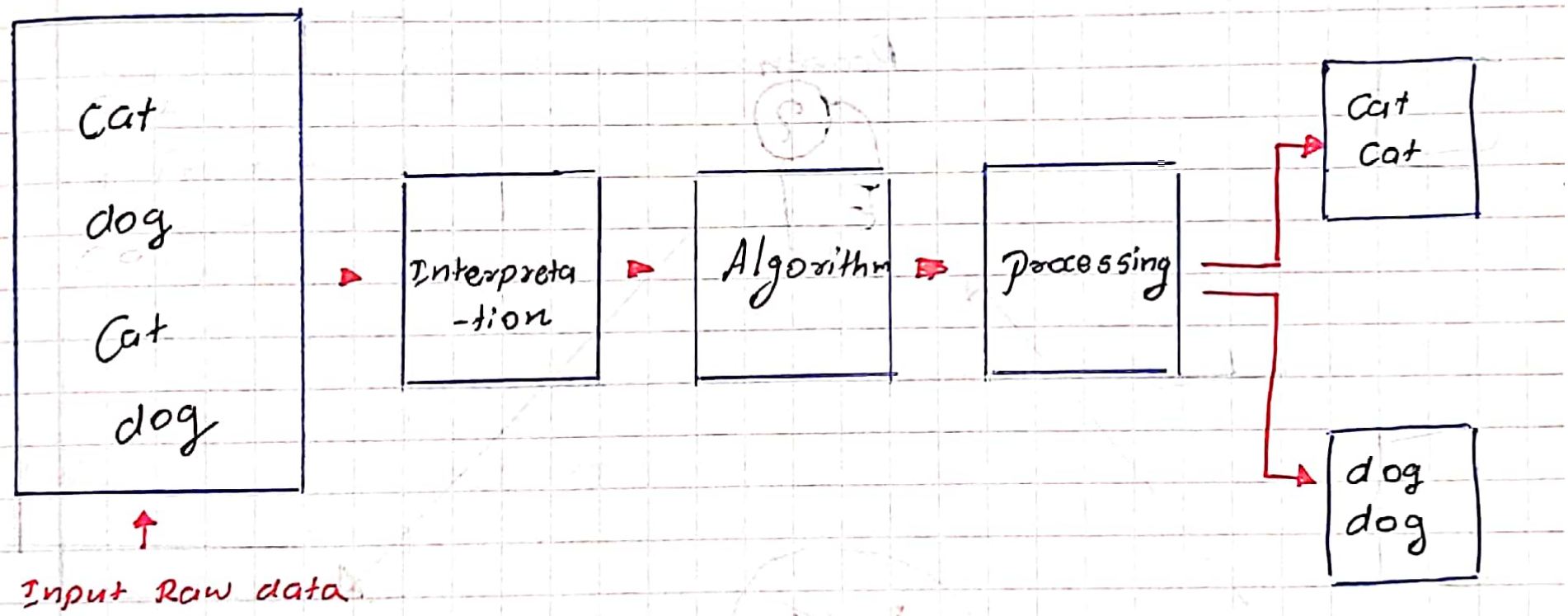
~~Genrat~~

- Generalize learning
- Reasoning
- problem solving

Generalize learning.

- Demonstrate how well is a trained model to classify or forecaset unseen data.



NOTE :

- If the system can recognize have to train the model again
- Important thing is when training use data diversity (when training don't limit the data).

Reasoning.

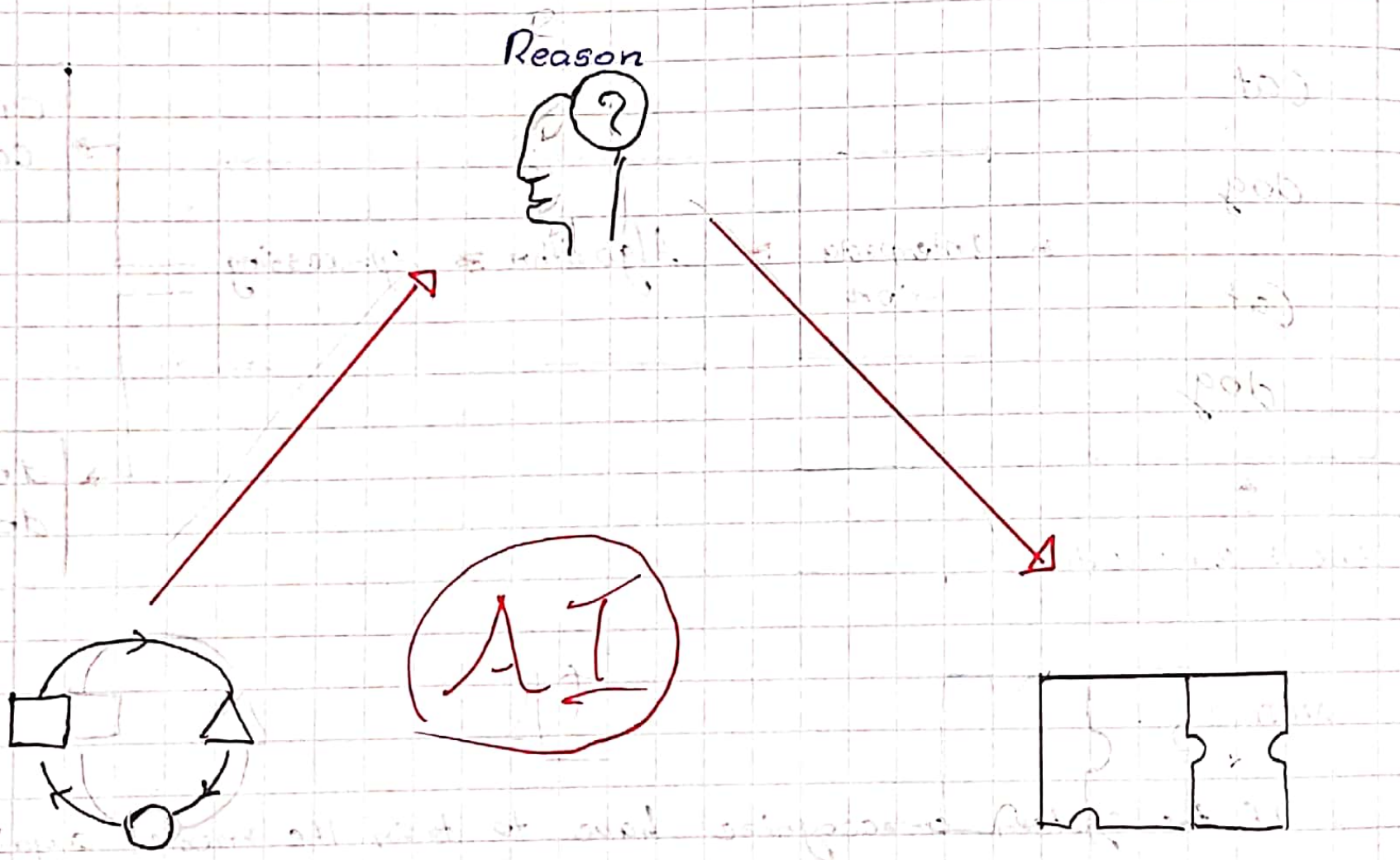
- The logical process of drawing conclusions, making predictions or constructing approaches towards a particular thought with the help of existing knowledge.

Note :

- Mental process
- making prediction on training process using logics This will use existing knowlegde

Problem Solving:

- Reach the desired goal or find a solution to a given situation



Advantages of Artificial Intelligence

- High Accuracy with less errors
- High Speed
- High reliability
- Usefull of risky areas
- Digital Assistance
- Usefull as a public utility.

Disadvantages of Artificial Intelligence

- High cost
- Can't think out of the box
- No feelings and emotions
- Increase dependency on machines
- No Original Creativity.

Applications of Computer vision.

- fraud defection
- Image analyze
- Autonomouse Care
- and etc....

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Strong AI vs weak AI.

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Weak AI

- Application specific / Task limited
- Learn from thousands of labeled ~~data~~ samples.
- Reflexive task with no understanding
- Today's AI
- Example:
  voice activated assistance (Siri)

Strong AI

- perform general (human) intelligent action.
- Self learnings and reasons with its operating environment.
- Learn from few samples and/or ~~under~~ unstructured samples.

full range of human Cognitive abilities
future AI
Example :
Self driving Cars.

Challenges of AI

1. Algorithm.

: Learning Algorithm to be trained and how to determine whethera the algorithm Performing as expected ?

2. Data availability.

labeled Data :

- also known as supervised data, consist of input examples paired with their Corresponding output or forget lables. In other word each data point in labled data has known, predefined category or value that the machine learning model is trying to learn to Predict.

- Labled data is used for supervised learning tasks such as classification and regression. In Classification the model learns to categorize data points into predefine classes while in regression, It learn to predict numerical values.

unlabeled Data

- These data doesn't have Corresponding target lables It consists on Inputs data or features without associated output values or categories. In other words the ML algos works with this type of data to discover patterns

- oftenly used in unsupervised learning tasks, where the goal is to find hidden structures or groupings with in the data. Common u unsupervised learning

techniques include clustering and dimensionallity reduct

Slide :

- Data availability remains as a major challengers to overcome in order to go beyond the pilot stage
- ML and Deep Learning in particular require a very large amounts of (mostly labled) data to achieve proper generlization.
- Labelling raw data is a time counsuming and costly endeavour which this conter frequently requires and domain knowledge.

3 : Data quality :

Slide

- "Garbage in, garbage out"
- Data quality is another challange for AI. Even though a huge amount of data is beign generated the quality of the data to be used to develop an AI system is critical
- Industrial AI and ML models rely heavily on accurate clean and often appropriatly labelled.

The key components of Quality Data in AI

- Accuracy :

  Accurate data produce correct and reliable outcome

- Consistancy

  Consistancy ensures that data follows a standard formats and structure, facilitating the efficient processin and analyze of the data.

- Completeness :

  Incomplete data sets can cause AI algorithms to miss essential patterns and correlations

leading to Incomplete or biased results.

- Timeliness :

  Out dated data may not reflect the current environment or trends, resulting in irrelevant or misslead outputs.

- Relevance

  Relevant data helping AI Systems to focus on the most important variable and relationships.

What are the challenges of ensuring data quality in AI.

1. Data collection

   Ensuring that all data points follows the same standards and eliminating duplicate or conflicting data is complex

2 Data labelling

3 Data storage and Security

4 Data governance

Note :

- This is most consume in thing in AI (data quality)
- labelling data time Consuming therefore most of data are Unlabell

Data Security and privacy.

slide :

- AI's need for large amounts of structured and Standardized data with the human rights to privacy.

- Cybersecurity is another challenge ~~in~~ tat that need to be addressed once an AI system has been deployed, particularly in cloud-based environments and on platforms that are connected to the internet such as internet-based services, as well as apps that have AI system embedded.

Ethics in AI.

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- AI ethics is a set of ~~variables~~ values, principles and techniques that employ widely accepted standards of right and wrong to guide moral conduct in the development and use of AI technologies

- Ethical discussions occur around any new technology.

Eg :

Deepfakes : A threat to democracy or just a bit of fun ?

Ethical challenges in AI.

- Biases

  How to eliminate bias from dataset ?

- Control and the Morality of AI

  Does AI in control of the ~~st~~ situation ?

- privacy

  what are the rules around the data collection ?
  what legislation might need to be put in place to protect user's ~~privacy~~ private info.

- Ownership

  who is responsible for some of the things that AI are creating

- Humanity

  ~~Does AI~~
  How does AI make us feel as humans?

Note !

- Bias in AI

  Bias in AI ~~reffer~~ refers to the presence of systematic and unfair discrimination in the results produce by ~~the~~ AI algorithms.

what is Machine Learning.

Slide :

what is 'Learning'?

Dictionary definition : "The process or experience of gaining knowledge or skill through study, experience or being taught.

Can a machine "Learn"? E.g learn from data or learn from past experience?

(Arthur Samuel, 1959) Concluded that " a computer can be programmed so that it will learn to play a better game of checkers that can be played by the person who wrote the program !!

note :

machine Learning is a subset of AI that focuses on the ~~deve~~ development of algorithms and statistical models which enable computer system to improve their performance on a specific task through experience and data . without beign explicity programmed . In other word , machine Learning algorithms learn ~~paterns~~ patterns and make prediction or decisions based on data input.

key components and aspects of Machine Learning.

1 Data :

machine Learning relies on data to train models.

2 Algorithahms :

machine learning ~~algorithms~~ algorithms are mathematical process the data to learn patterns or relationship.

3 Training :

In the training phase , a machine learning model is exposed to a dataset with known outcome (labels or targets)

4 Testing and Evaluation :

After training , the model ~~learns to make predtetion~~ is tested on new , unseen data to assess its performance.

5 feature Engineering.

selecting and transforming relevent features (data - attributes) is crucial in improving model performance.

6 Generalilization :

~~make~~

machine Learning models aim to generalize from the training data to make accurate prediction on new, unseen data.

7 Hyperparameters tuning :

Many machine Learning algorithms have hyperparameters that need to be tuned to optimize model performance

8 Supervised Learning

9 Unsupervised Learning ,

10 Reinfrocement Learning.

- Machine Learning applied in various fields, including in NLP, image recognition, recomendation systems, at autonomus vehicles healthcare, finance and many others. It has potential to make predictions and automate tasks that would be challenging or impossible through traditional rule-based programming.

Slide:

with algorithms.

- Learn from Experince E
- Achieve some task/s T
- Improve their performance P

Ex:

- Collecting emails which have been labled as spams or non-spams - E
- Classifying emails as spam or non-spam and putting the into the right folder - T
- Calculate the precentage of emails correctly as classified as spam or non-spam - P.

~~Machine Learning~~.

- Machine Learning:

  is the study of computer algorithms that improve automatically through experience;

Types of Machine Learning :

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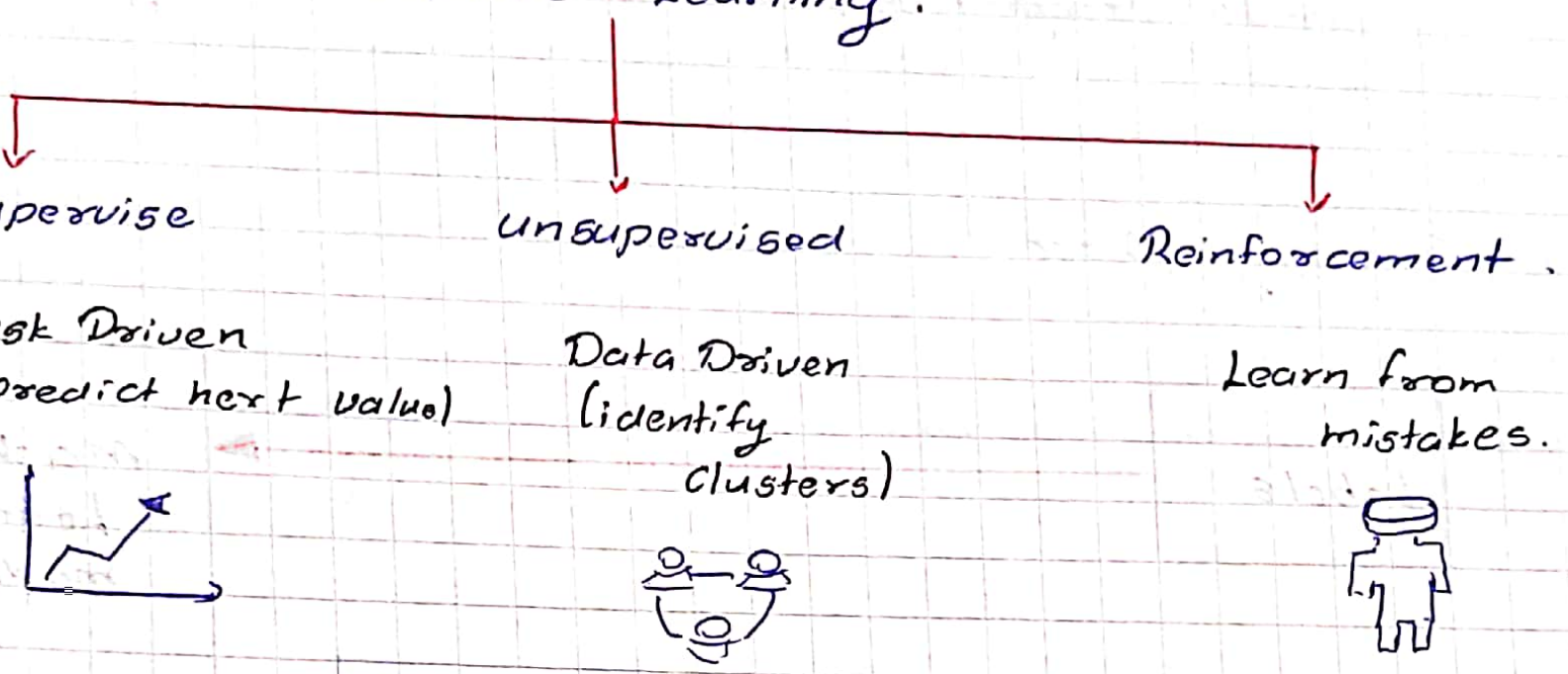
Types of Machine Learning



Supervised Learning

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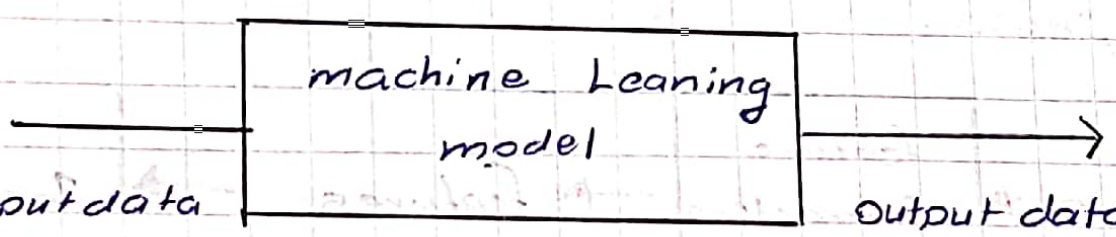
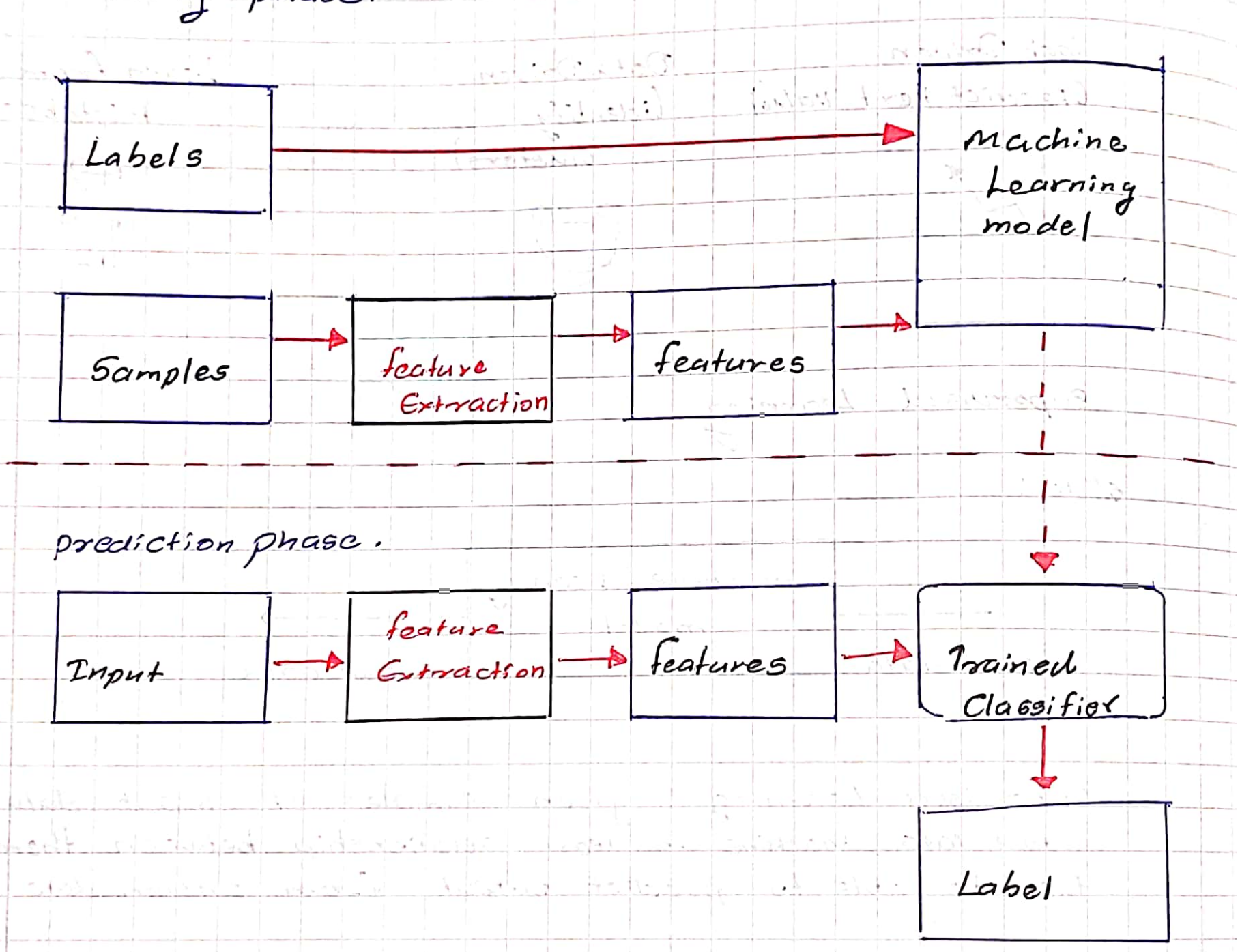


- Supervised Learning : Given samples of input data and output data, machine to learn relationship between them and then be able to predict output from unseen data.
- The machine ~~learn~~ learns under the guidance of labeled data i.e known data
- It is based upon the training dataset, and it improves through iterations.
- Classifying massive data with supervised learning is difficult.

Note:

- Supervised learning is a type of machine learning where algorithms are trained on labeled data learning to make predictions of classifications based on input features and their corresponding known outputs. It's widely used in tasks like image recognition, Speach recognition, and recommendation systems.



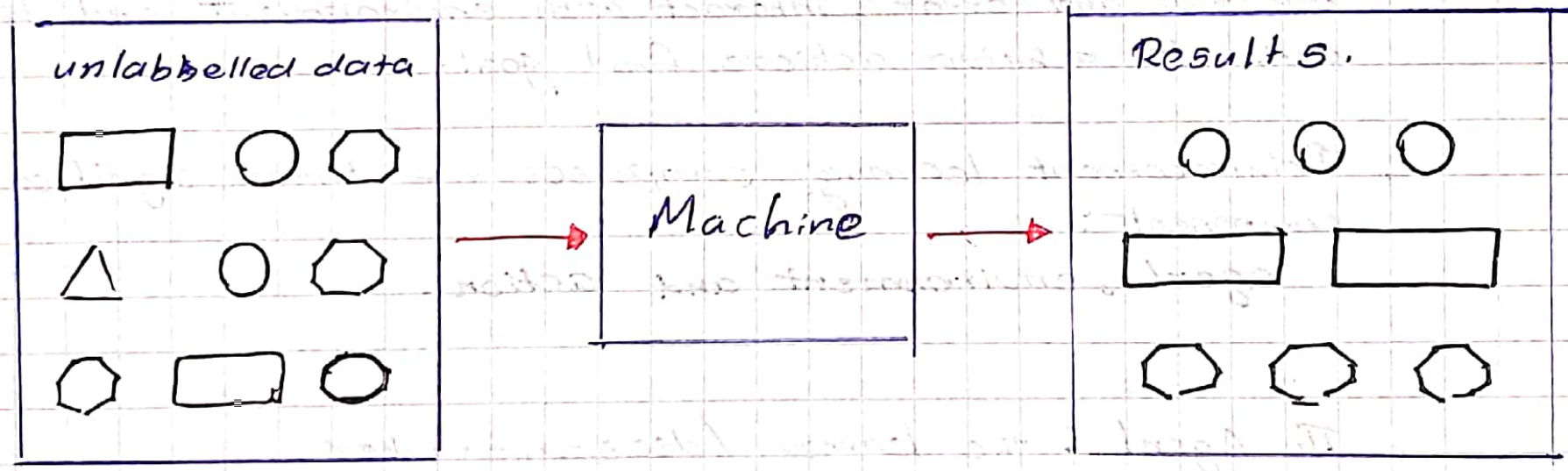
unsupervised Machine Learning.

Slide :

- Unsupervised Learning: Only given input data without known output data, machine to learn latent / hidden relationship within the data and make decisions
- It's a self-Organized learning algorithms (no labelled data is required).
- Algorithms would be fed a lot of data and given the tools to understand the properties of the data.
- Unsupervised Learning an interesting area is that an ~~over~~ overwhelming majority of data in this world is unlabled.

Note :

- unsupervised learning is a type of machine learning where algorithms analyze data without labled outputs it's primary goal is to discover hidden patterns group data or reduce dimentionally. Applications include Clustering, dimentionality reduction and anomaly detection.

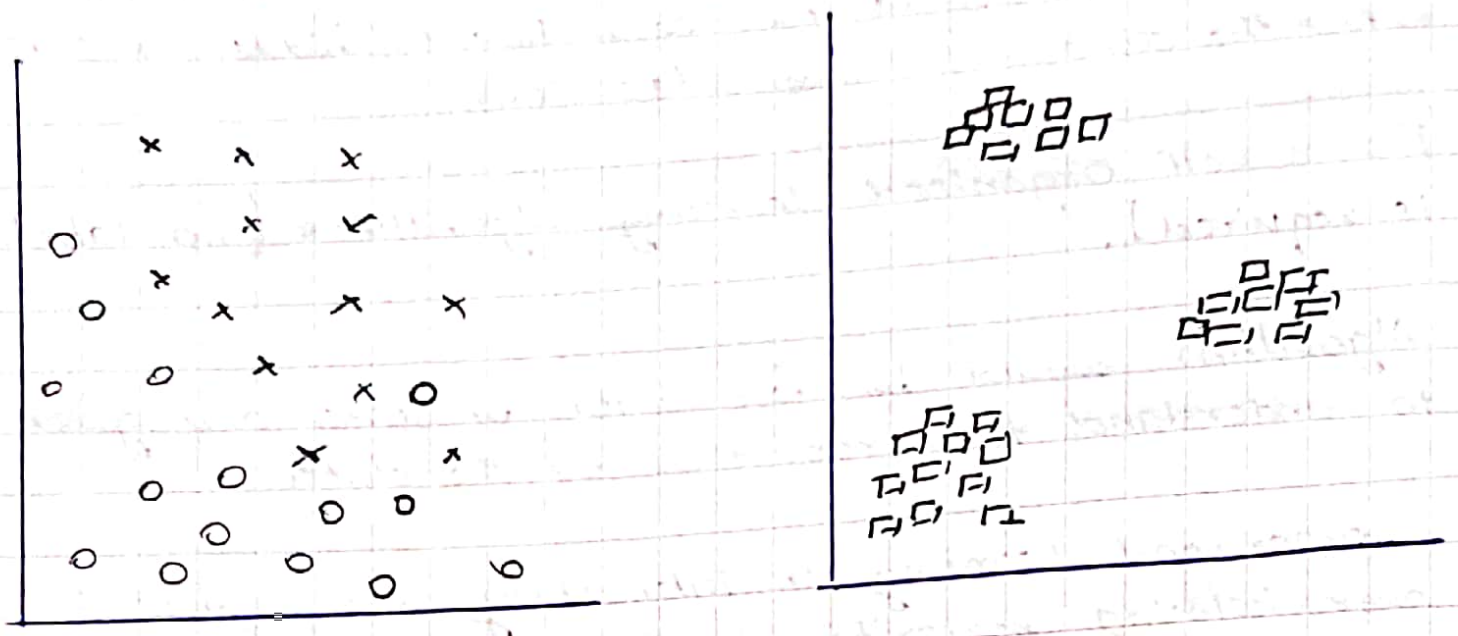


Slide :

use of unsupervised Machine Learning.

- Outlier detection - to detect outlier in noisy ~~database~~ dataset
- Detect fraud, find anomalies in the Credit card usage

- Detect abnormal behaviour (malicious or unintentional) in systems/networks
- Detect tumour from medical imaging data.



Supervised

unsupervised.

Reinforcement Learning

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Slide:

- Reinforcement Learning : get machine to learn by itself via trail and error, interact with environment, and take action to ~~achieve~~ achieve final goal.
- Reinforcement learning comprises ~~the~~ three significant components:
  agent, environment and action.
- The Agent : the learner/decision-maker
- The Environment : anything the agent interact with
- The Action : what the agent does.

How does Machine Learning work.

1 : Chose and Prepare a Training Data set

- Training data is also known as training dataset, learning set, and training set
- Traing data is the initial data used to train machine learning models
- Without high-quality training data, even the most efficient machine learning algorithms will faild to perform.
- Training data can be classified in to two categories:
  labeled data
  unlabeled data.

2 : Select an Algorithm to Apply to the Training Data set.

- The selection process of machine learning algorithm depend on a few aspects.
  - Whether the use case is prediction or Clustering.
  - How much data is in the training set.
  - The nature of the Problem the model seek to solve

3 : Train the Algorithm to Build the model.

- Setting model variables and Parameters to more -
  - accurately predict the appropriate results.
- using a variety of optimization methods depending upon the Chosen model.

4 : Use and Improve the model.

- feed new data to the model as a means of improving it's ~~effi~~ effectiveness and accuracy over time.
- feature Engineering which create new features from the existing ones.

- feature selection that helps to identify the most usefull features in the dataset.

- Try multiple Algorithms to identify which ones work best for ~~$~~ data and then use that information to improve the accuracy of models.

- Adjusting Hyperparameters such as numbers of layers in a deep neural network.

- If the prediction and results don't mach, re-train the algorithms multiple times until getting the desired outcom

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Neural Network.

Slide :

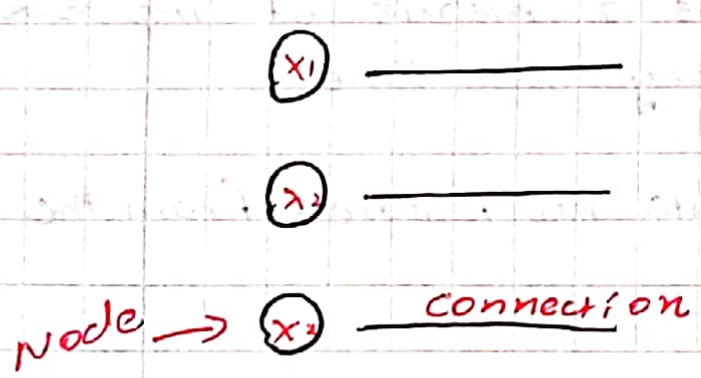
- Neural Network ~~refl~~ reflect the behaviour of the human brain, allowing computer programs to recognize patterns and solve common Problems in the field of AI, machine learning and deep learning.

- Neural Network can be expressed by many layers. ie input ~~and~~, output and hidden layers.

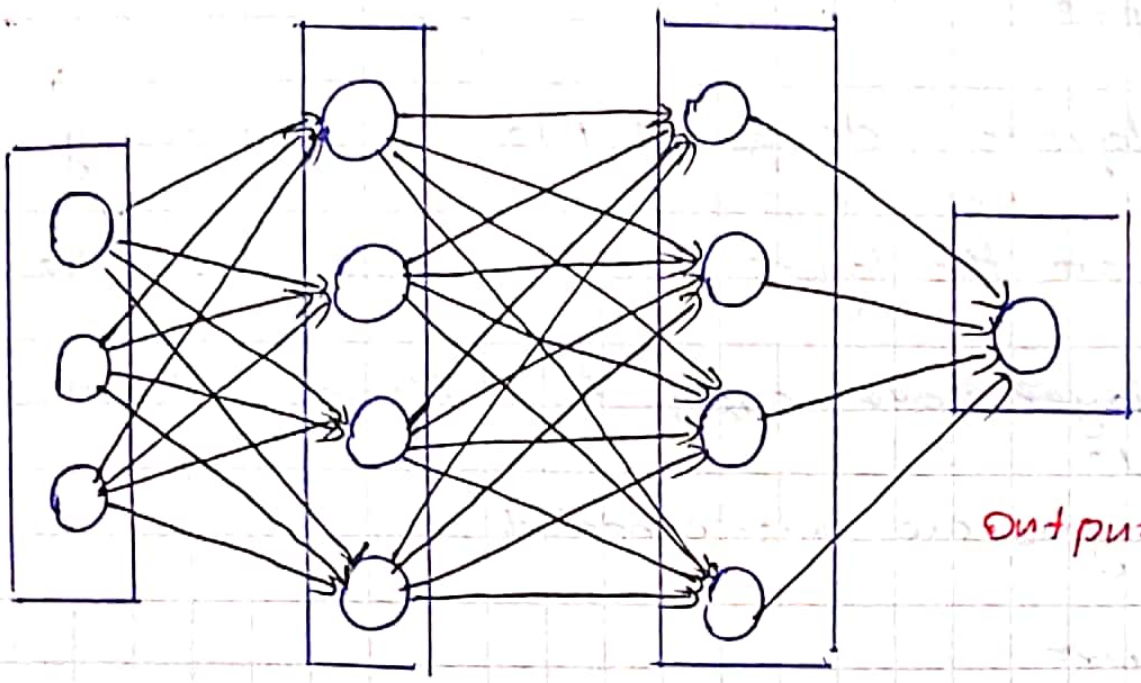
- NNs can be used for supervised and unsupervised learning.

Note :

- functionality unit of Dheep Learning.
- Design mimic function of human brain.
- Supervised and Unsupervised.



key components of the Neural Network.



input layer Hidden layer1 hidden layer2

Slide.

- Input layer :

  It is the set of features that are fed into the model for the learning process.

- Hidden layers

  They are intermeadiate layers that do all the computationals and extract the features from the data.

- Output layer

  The Output layer take input from precending hidden layer and comes to a final prediction based on the model's learning.

Note :

* Input layer :

  There is no processing it just pass the data to

hidden layers
This is the only visible (B) layer.

* Hidden layers :

- These layers doing all the Preprocessing Node are Not exposes
- These are the layers between input and the output -layers
- Each layer node apply to difference transformation method.
- These layers are interconnected

* Output layer:

- This is the last layer
- This gives the output based on the information taken from hidden layers.

Slide :

- Connection :

It connects one neuron in one layer to another neuron in other layer or the same layer.

- weight :

Its main function is to give importance to those features that Contribute more towards the learning A weight represent the Strength of the Connection between units.

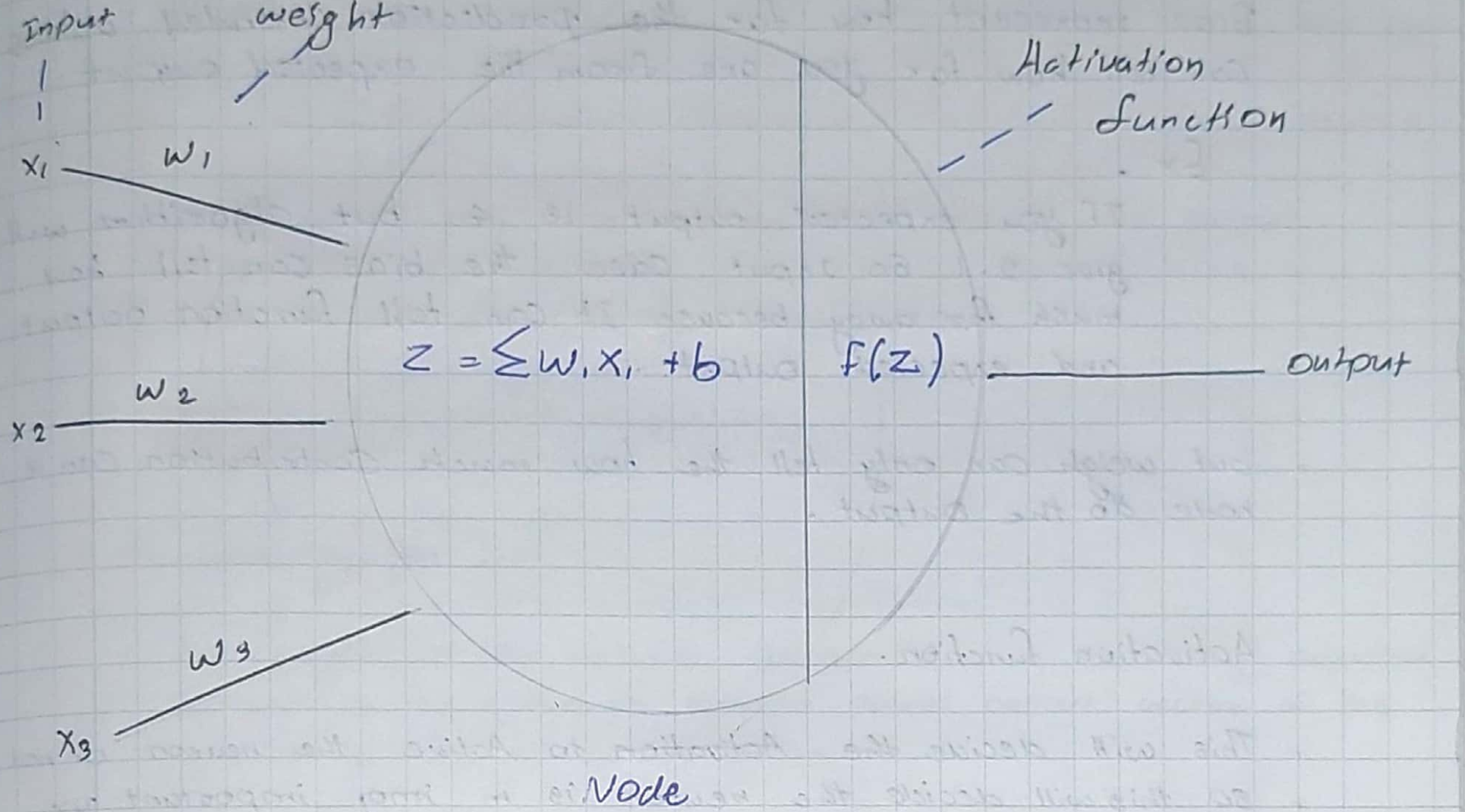
- Bias :

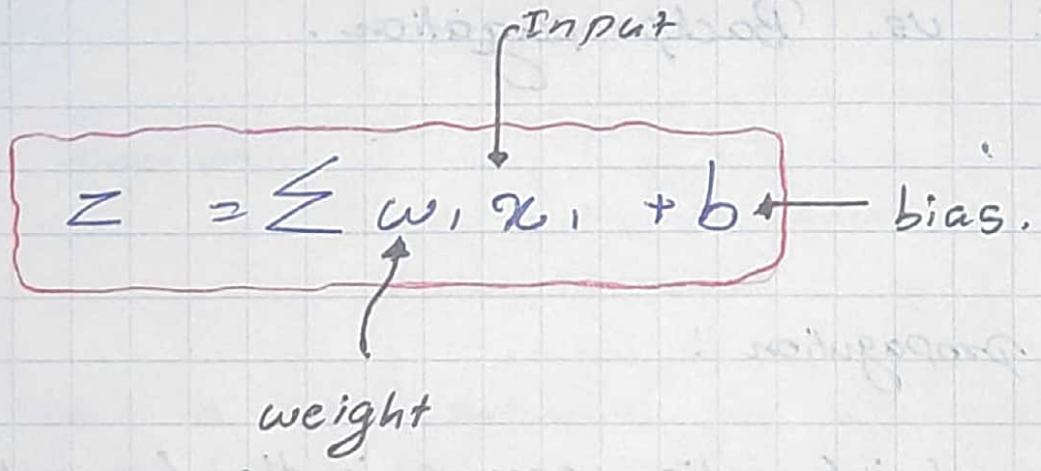
The role of the bias is shift the values produced by the activation function.

- Activation function :

decides whether a neuron should be activated or not - not - such as sigmoid, Hyperbolic Tanget (Tanh),

Rectified Linear unit [ReLU]





Difference between bias and weight.

- Both are teachable parameters
- Bias represent how far the prediction intended values can tell how far you are from the expected output.

  Ex.

  If you expected output is 4 but algorithm will give 2.1 so Input case the bias can tell how much for away because It can tell function output and expected output.

- but weigh can only tell the how much contribution can a node do the output.

Activation function.

- This will decide ~~the~~ ~~Activation~~ to Active the neuron or not
- So this will decide the neuron is ~~a~~ ~~imp~~ important or not to the Prediction.
- If the value get after applying to the equation. If lesser than ~~threeshold~~ value ~~?~~ it ~~is~~ ~~a~~ will not activated.

feedforward vs. Backpropagation.

Slide:

- feedforward propagation:
  - The flow of information occurs in the forward direction. the input is used to calculate some intermediate function in the hidden layer, which is then used to calculate an output

Take the input and multiply by the neuron's weight → Add bias → feed the result x to the activation function : f(x) → Take the output and transmit to the next layer of neuron -

Note :

- Data moves in one direction between input and output
- This is using for simple classification tasks.
- This is suitable for binary classifikon.

Eg :- fingerprint. recogintion

* Backpropagation :

- The weight of the network connection are repeatedly adjusted to minimize the difference between actual output vector of the net and the desired output vector.

The aim of the activation function is to prevent the linearity that is it add non linearity to the neural network.

Error function.

Slide :

- To train a neural network you ~~have~~ must identify a set of weights (and NN structure ?) that minize the and error function.

- Given a set of targets $\{t_n\}_{n=1}^{N}$ and model outputs $\{y_n\}_{n=1}^{N}$ compute -

Mean Absolute error

$$MAE = \frac{\sum_{n=1}^{N} |t_n - y_n|}{N}$$

Root mean Square Error

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N} (predicted_i - Actual_i)^2}{N}}$$

- **predicted:**
  The predicted value for ~~Hh~~ ith observation.
- **Actual;**
  The observed (actual) value for the ith observation.
- **N:**
  Total numbers of observation.

input	Target	Actual	Δ
0 0	0	0.2	0.2
0 1	1	0.3	0.7
1 0	1	0.4	0.6
1 1	0	0.5	0.5

$$MAE \quad 0.5$$

$$MAE = \frac{\sum_{n=1}^{N} |t_n - y_n|}{N}$$

$$= \frac{|0-0.2 + 1-0.3 + 1-0.4 + 0-0.5}{4}$$

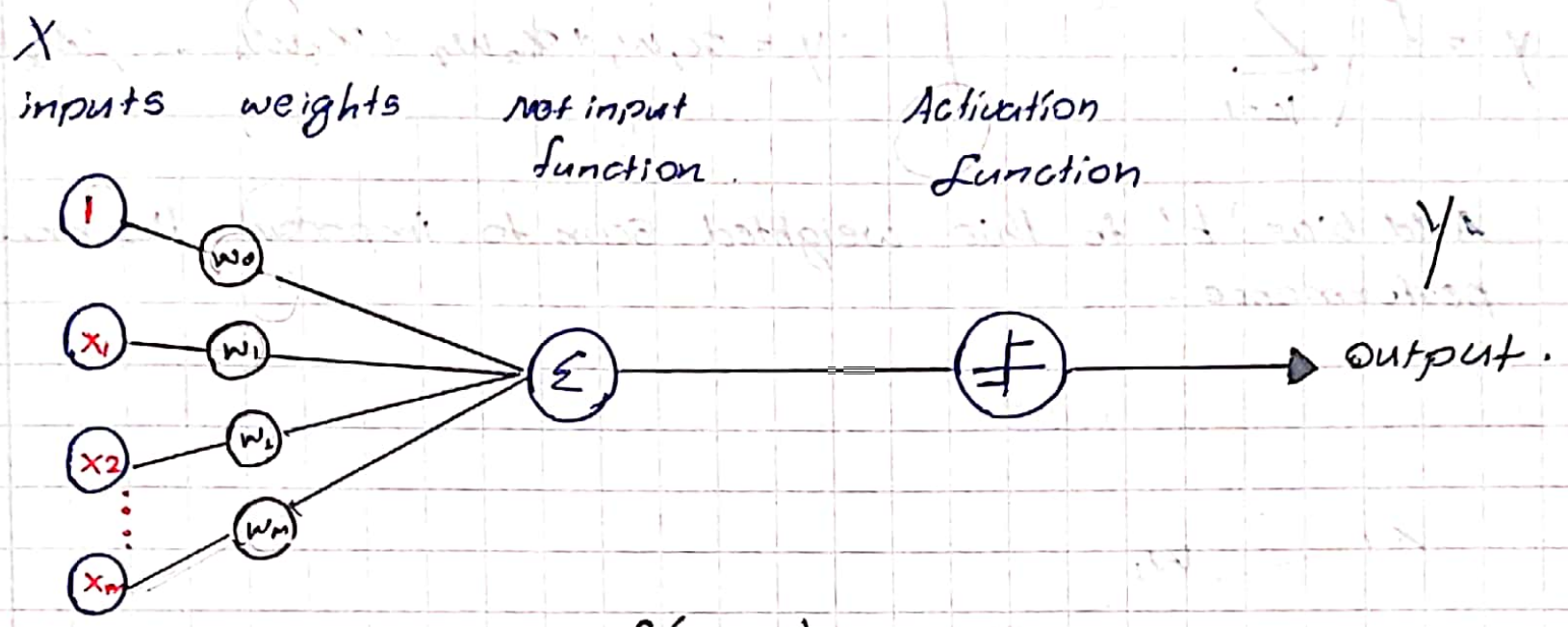
$$= \frac{0.2 + 0.7 + 0.6 + 0.9}{4}$$

$$= \frac{2}{4} = 0.5 //$$

~~The~~

The perceptron.

Slide :



- The model input is the x variable
- The model has a single unit (shown (Y))
- Input is connected to the unit by a weight
- Output is a function of the weighted sum of the input
- A perception is supervised learning of binary ~~classification~~.
- classifier
- It enable neurons to learn and processes elements in the training
- set one at a time.
- Single layer and Multilayer are types of perception.

Slide :

~~How Does Perception~~

- How Does Perceptron work ?

- Single-layer networks.

Step 1 :

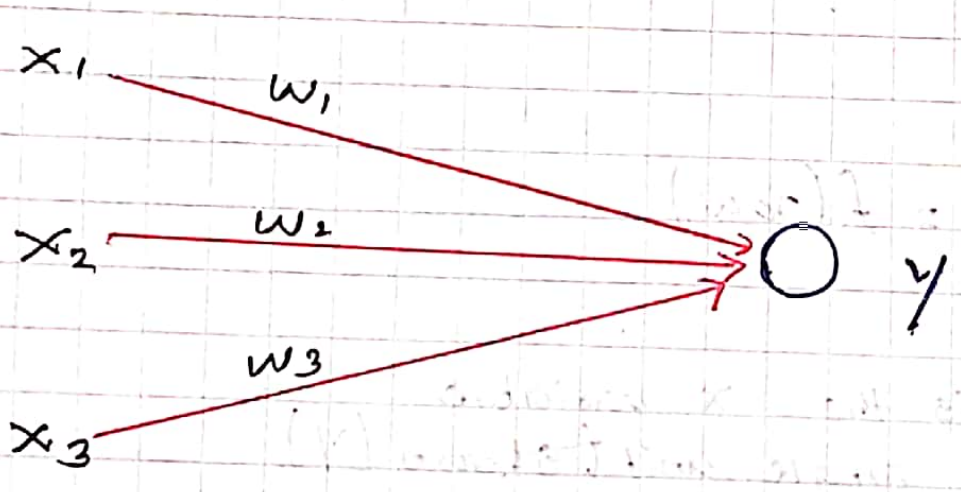
Multiply all input values with corresponding weight values and then add to calculate the weighted sum.

$$y = f\left(\sum_{k=1}^{k} x_k w_k\right)$$

k stands for the number of inputs

$$y = x_1 w_1 + x_2 w_2 + x_3 w_3 \dots x_k w_k$$

Add bias 'b' to this weighted sum to improve the model's performance.



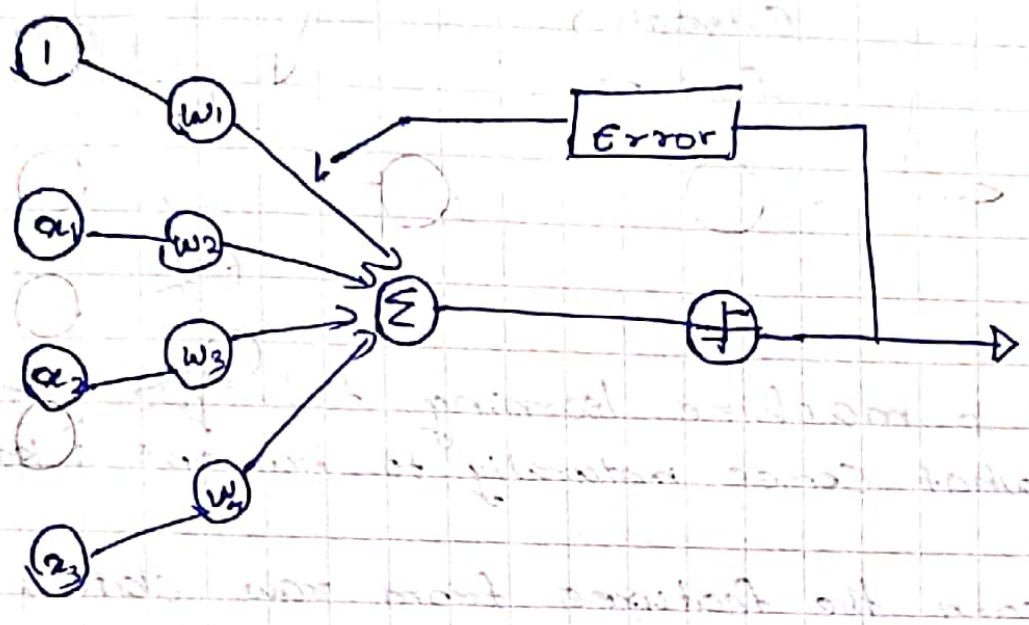
Step 2 :

An activation function (f) is applied with the above-mentioned weighted sum ~~given~~ giving us an output either in binary form or a ~~Continou~~ Continuous value as follows :

$$y = f(\Sigma w_i \times x_1 + b)$$

Multi-Layer Perceptron.

- Multi-Layered Perception has more hidden layers
  It can solve complex non-linear problems
  It works well with both small and large input data
  Time consuming.
  The model functioning depend on the quality of training.



12/10/2023.

Deep Learning.

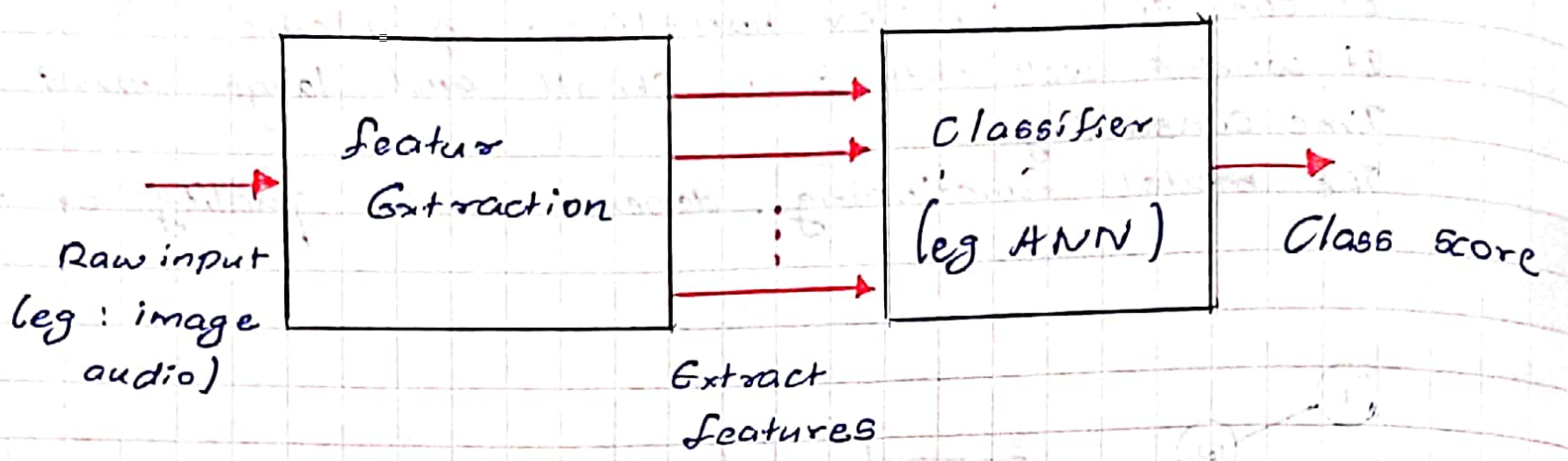
Introduction to deeplearning.

Slide:

Traditional pattern Recognition.

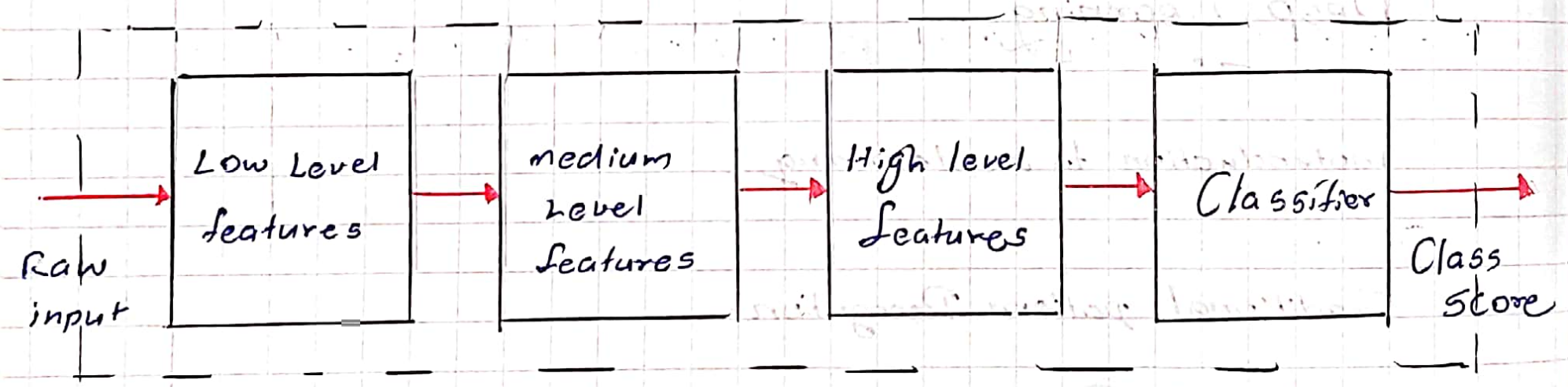
- Traditional Pattern Recognition Consist of two Parts
  - feature extraction.
  - Classifier (eg ANN)
- feature extraction : need Strong domain lonowlagdedge
- Traditional classifiers were limited to low-dimensional space
  - Classification perfomance is also affected by our ~~undorst~~

understanding of features.



Deep learning.

- Deep learning is a machine learning technique that teaches Computers to do what Comes naturally to humans : learn by ex
- Let machine to learn the features from raw data, ~~e.g~~ e.g. directly from pixel images, audio signal, ECG signal.
- Through many layers to extract different levels of features from raw data and the classify objects from these features.



Deep learning.

Note :

- In deep learning we give raw data and it will extract the features but in Traditional Pattern ~~recogin~~ recognition we extract features manually.

  Eg :- In deep learning CNN

- If we take model Complexity : In traditional Pattern. R are usuall less complexity because Traditional models have fixed architecture and designed for specific task.
  In the other hand DL have NN it is very complex.

(31/10/2023 chatgpt Chat)

Slide :

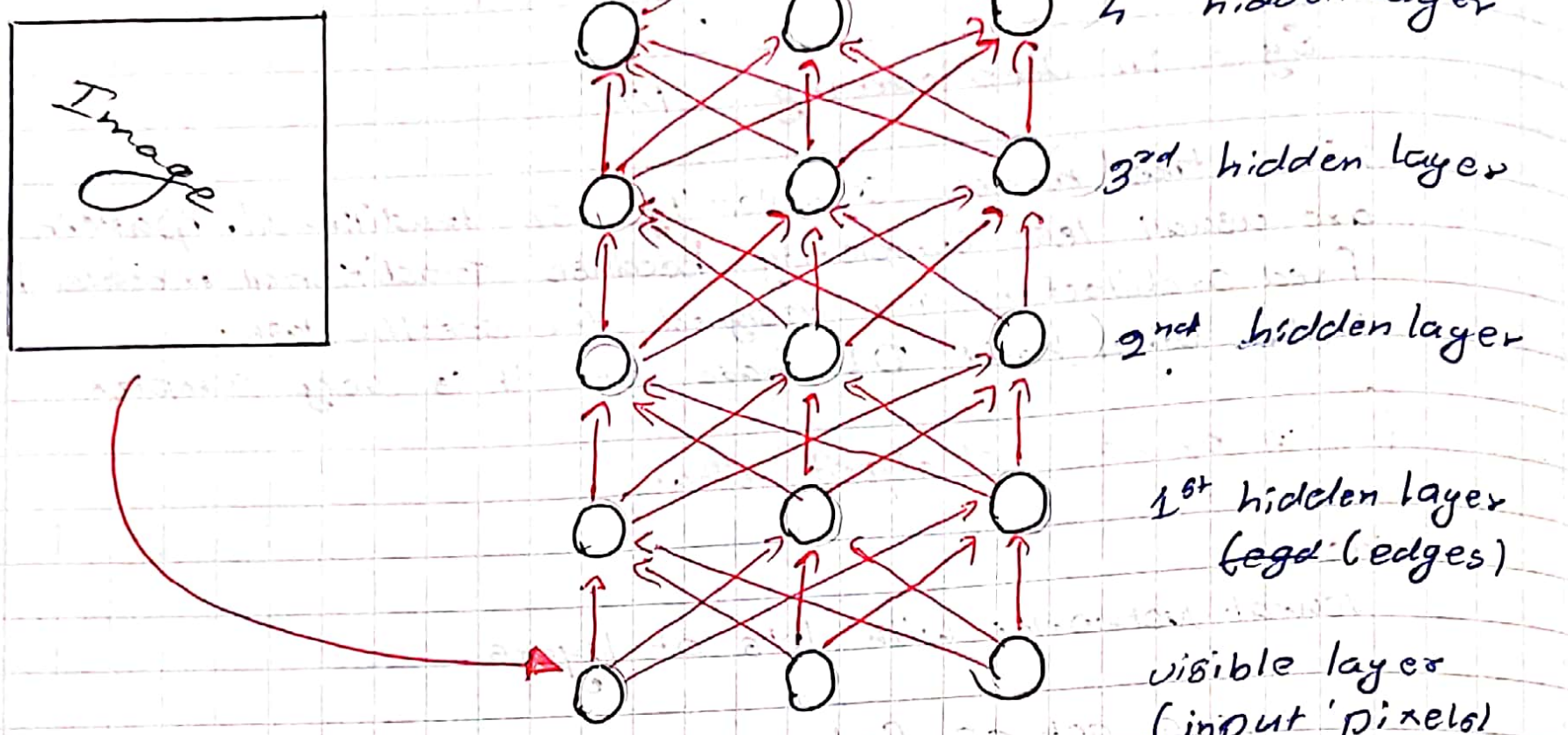
Neural Networks with lots of layers.

- Layers act as feature extractors.
- features are passed onto the next layers
- Raw input data is repeatedly processed befor it reaches the output layer
- Result is black-box - so part of the drive behind explainable AI.
- ANN are prone to overfitting - so are deep learing models

Overfiting :

feeding more dat is ~~uto~~ useful but not always.

Deeplearning for pattern Recognition



How

How deep learning work.

- Most deep learning methods use neural network
- In comparision to the traditional NN (which contain 2-3 hidden layers), deep learning network can have as many as 150
- Deep learning models are trained by using large sets of labeled data and neural network architecture that learn features directly from the data without the need for manual feature extraction.

The Growth of deep learning.

- Increase dataset sizes
- Increase machine learning model sizes
- Availability of computational resources, especially GPU, which can handle high-dimentional inputs.
- Availability of sufficient frameworks/platforms, such as Tensorflow framework (opensource) to coordinate the GPUs to work on complex ML tasks.

Deep learning applications.

* Recognise things : based on CNN (Convolutional Neural Network)

Note :

This is Deeplearning algorithim.
Automaticall extract features
Can be use for complextask
Image recognition, voice recognition.

Benifits:

No manuall feature extraction
Can Automatically select the best features.

used by capturing millions of Images used in Cars.

* Creating things / Creating ones based on GAN (Generative Adversiatrial Network)

Eg : Data augmentation.
Eg : medical data augmentation for diagnosis of certain diseases

- How does deep learn attain such impresive results?

- Deeplearning requires large amount of labelled data
  Ex driveless car.

- Deep learning requires substantial Computering Power. High performance GPUs have a parallel architecture that is

efficient for deep learning. When combined with Clusters or cloud computing, this enables development teams to reduce training time for a deep learning network from weeks to hours or less.

How to Create and Train Deep Learning models.

1) Training from Scratch.

Gather a very large labeled data set
Design a network

2) feature Extraction.

3) Transfer Learning.

It is deep learning approach in which a model that has been trained for one task is used as a straigh point for a model that performs a similar tasks

Benifits :

It trainods model with less labelled data by ~~reducing~~ reusing popular model that have already be trained on large datasets.

It can reduce training time and Computing resources where the weights are not learned from Scax scratch.

Note :

- It is a deep learning approach with the model train to do one task. Is used as a Starting point for the model to perform a simillar tasks.
- updating and retraining a network with in transfer learning is easier and fast

- Difficulties are on the Slides reffer those

13/10/2023

Clustering

Slide :

- In everyday terms, clustering refers to the grouping together of objects with similar characteristics in other words, the aim is to segregate groups with similar traits and assign them into clusters.
- When it comes to data and data mining, the method to identify similar groups of data set is called clustering.
- It is unsupervised learning method.

Note :

- we have data points and based on the similarity we cluster them.
- This is some how related to the classification but in classification we used labled data but in this we used are using unlabeled data therefore this is unsupervised learning.

Slide :

Common uses of clustering.

- Recomendation engines
- market segmentation
- Statistical data analysis
- Social network analysis
- Image segmentation
- Anomal detection

k-mean Clustering

- O'd technique, still very popular in use.
- Main goal is to group similar data point into one cluster
- Number of clusters are represented by k

Strengths

- Simple iterative method
- It can also scale to large datasets.

Weakness

- poor performance (local optimum)
- Difficult to guess the correct "k"

Note :

k → is a instance.

1) This is not complicated simple to implement

2) Can also use larger dataset in this limitation are happened

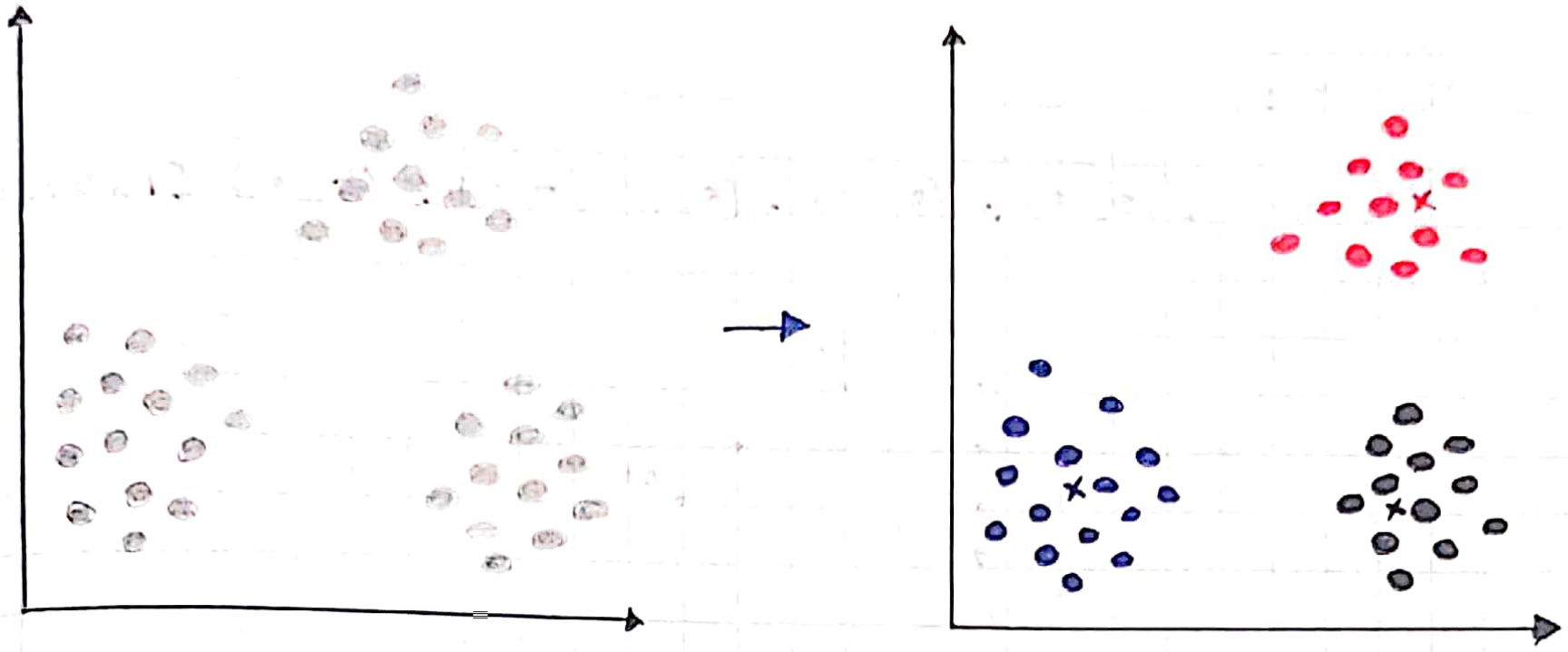
1 Accuracy
2 ~~It is~~ It is difficult to select k value (selection process of the optimal value is hard)

How does k-Means Clustering work ?

Slide :

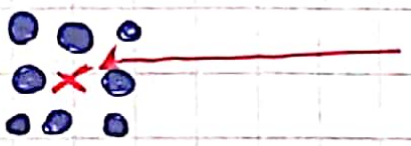
- Define number of clusters
- Randomly set cluster Centers (i.e., cluster centroid)
- Assign points to clusters
- Re-Calculate center of each cluster.
- Assign points to the new cluster.

Refer Slide.



Note :

- we can selected any random Centroid



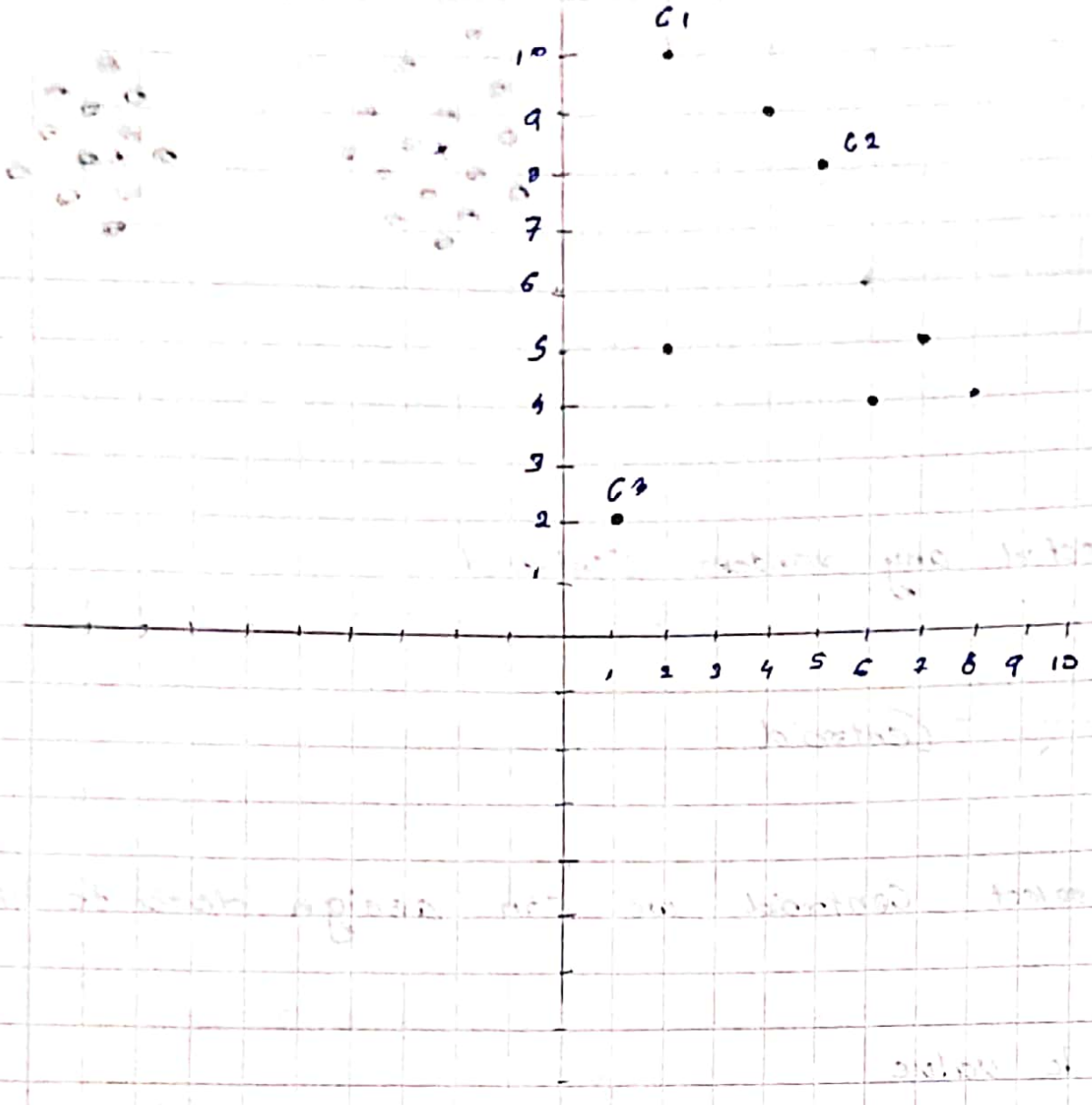
- After we select Centroid we can assign data to the cluster.

1 Select Ic value
2 Select randomly Centroid
3 we need to ~~your~~ see each data points belong to group
4 we recalculated Centroid assign the data points.

point	C1 (2,10)	C2 (5,8)	C3 (1,2)	Cluster
2, 10	(0)	5	9	1
2, 5	5	6	(4)	3
8, 4	12	(7)	9	2
5, 8	5	(0)	10	2
7, 5	10	(5)	9	2
6, 4	10	(5)	7	2
1, 2	9	10	(0)	3
4, 9	3	(2)	10	2

Points :

(2, 10) , (2, 5) , (8, 4) , (5, 8) (7, 8) , (6, 4) (1, 2), (4, 9)



point	C_1 (2, 10)	C_2 (5, 8)	C_3 (1, 2)	Cluster
(2, 10)	0	5	9	1
(2, 5)	5	6	4	3
(8, 4)	12	7	9	2
(5, 8)	3	0	10	2
(7, 5)	10	5	9	2
(6, 4)	10	5	7	2
(1, 2)	9	10	0	3
(4, 9)	3	2	10	2

Cluster 1 | Cluster 2 | Cluster 3

(2, 10) | (8, 4), (9, 8), (7, 6), (6, 4) | (2, 5), (1, 2).

New cluster.

Cluster 1 (2, 10) | Cluster 2 (6, 6) | Cluster 3 (1.8, 3.5)

add the values of data points in each cluster seperatly and divid the value/ sum of the point from number of points of each Cluster.

$$m_1 = \frac{1}{N_i} \sum_{i=1}^{N} x_1$$

point	C_1 (2, 10)	C_2 (6, 6)	C_3 (1.8, 3.5)	Cluster
(2, 10)	0	8	7	1
(2, 5)	5	5	2	3
(8, 4)	12	4	7	2
(5, 8)	5	4	8	2
(7, 5)	10	2	7	2
(6, 4)	10	2	5	2
(1, 2)	9	9	2	3
(4, 9)	3	5	8	1

we will do this again and again untill the centroid not change.

Negative value mean Performing bad near to 1 mean perfoomance is good.

k = Number of clusters

Slide:

Euclidean Distance.

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

(distance between two data points (x_2, y_2) and (x_1, y_1)

Assume two centroid with mean of m_1 and m_2 select a node $x_i \in (x_1, x_2 \ldots x_n)$ where n is the total number of observation

Calculate distance (Euclidean distance)

$$d_{i1} = \sqrt{(x_i - m_1)^T (x_i - m_1)}$$

$$d_{i2} = \sqrt{(x_i - m_2)^T \cdot (x_i - m_2)}$$

If $d_{i1} \leq d_{i2}$, assign x_i to m_1, otherwise to m_2

(All steps are on slides)

16/10/2023

K - Nearest Neighbours

—.

Slide :

k-nearesh neighbours (K-NN)

- Ic-NN is a Supervised learning algorithm that can be used to Predict what class should be put into.
- It requires some training examples (reference vector) with the correct class indicated.
- K-NN tries to predict the correct class for the test data by calculating the distance between the test data and all the training points.
- User sets the value for k. (must be Positive).

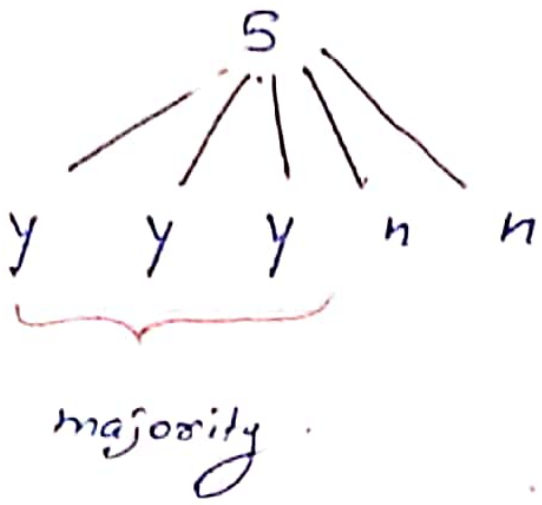
Note :

- Supervised learning
- Does require labbled data
- Use to do binary classification -
- Predict class depending on the calculating distance between datapoints.

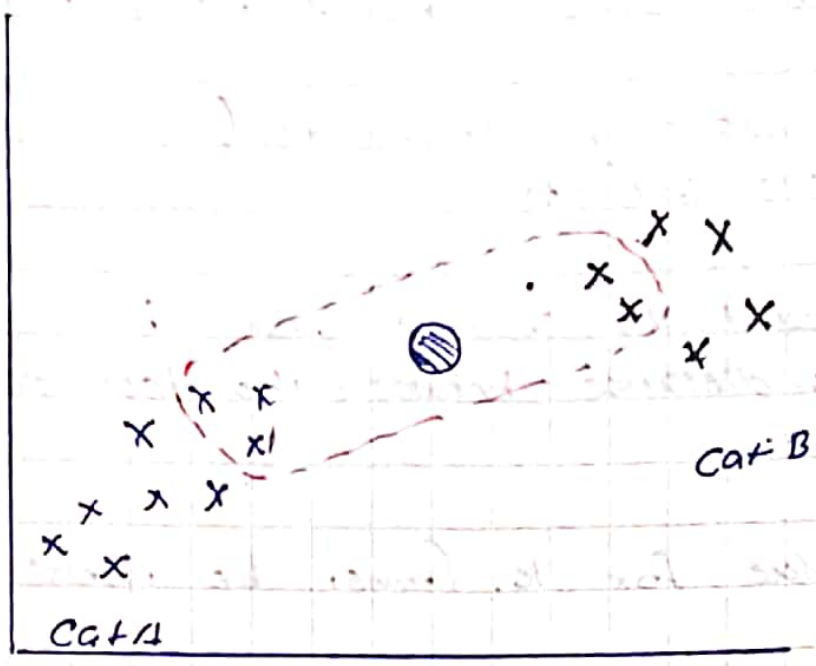
* Difference between k-mean and k-NN

- k-mean = unsupervised
  k-NN = Supervised
- k-mean Clustering the data
  k-NN use for predicting

  k
- Meaning of k is same in the both.
- we take oda value for the k because we can say k value belong to what class because If we take odd value we can take majority votes.



Ex



If the distance of the ~~one~~ clusters to the centroid and

- If we take the distance of the centroid to the data points of the clusters and The ~~Cluster belong to the~~ The centroid belong to the magority vote cluster

- In the above example centroid belong to cluster A because of the majority votes (3)

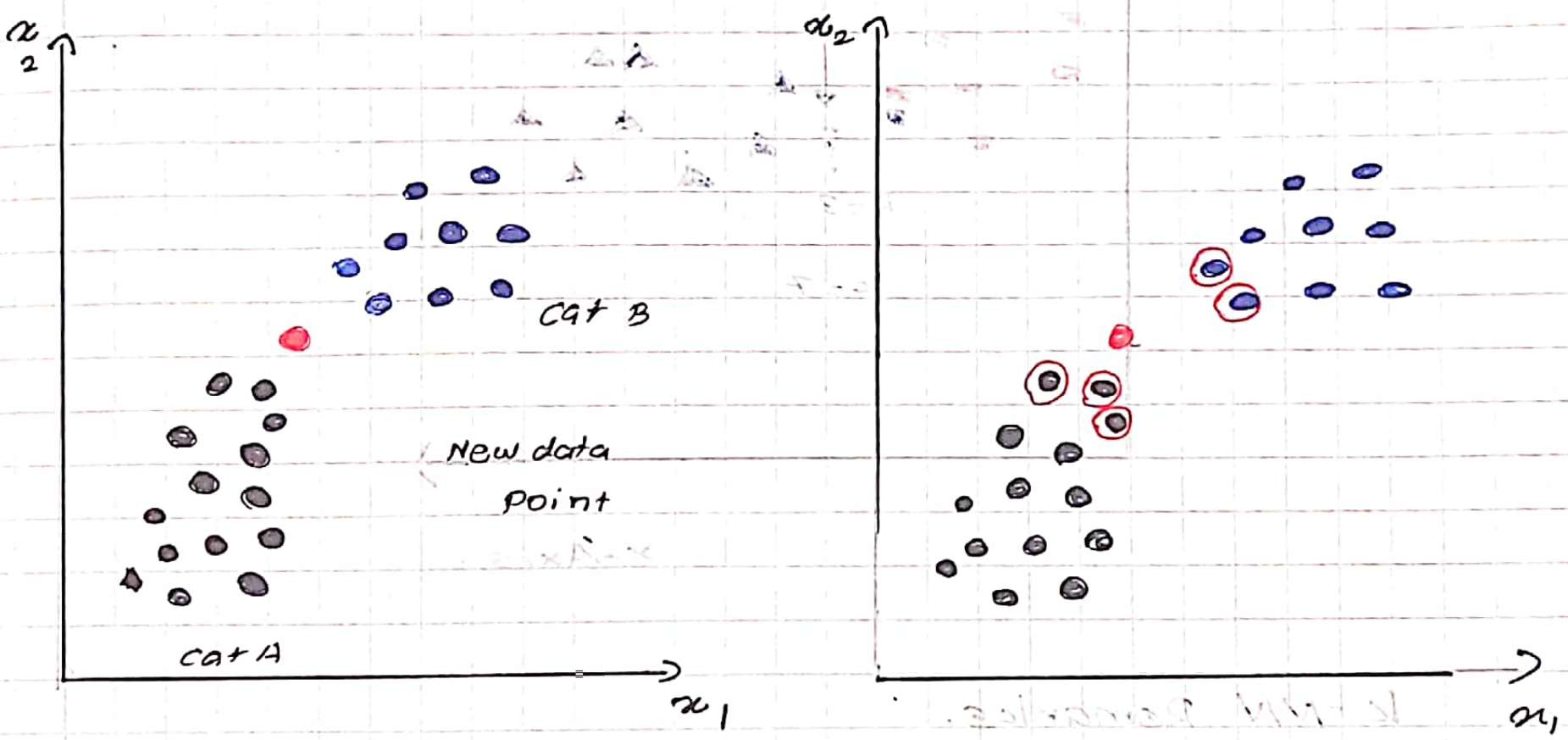
- k-NN ⇒ Not rather than the number of neighbours
  k-mean ⇒ number of classes.

Slide :

How does k-NN. work ?

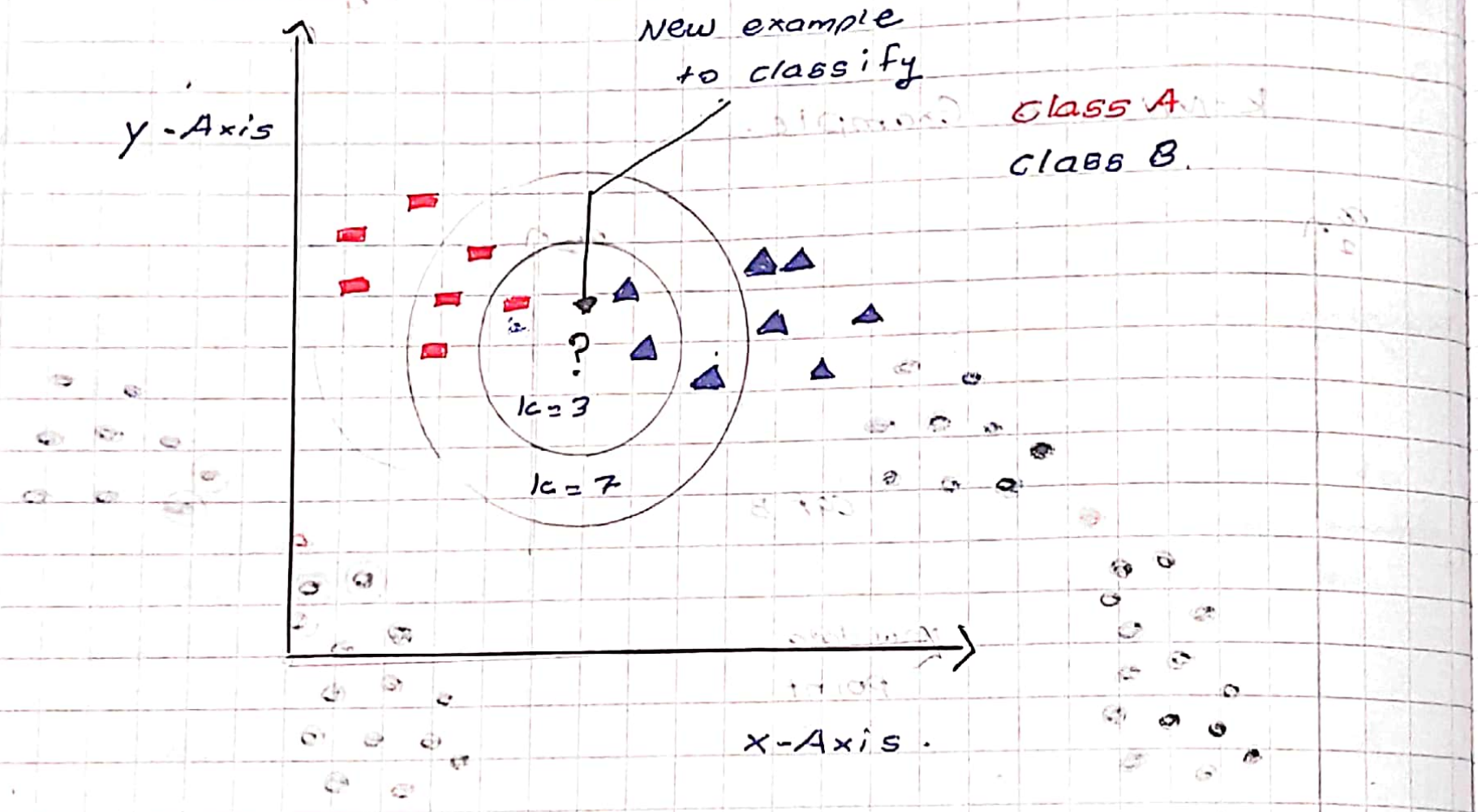
- Step - 1 : Select the number k of the No neighbours
- Step - 2 : Calculate the Euclidean distance of k numbers of neighbours
- Step - 3 : Take the ~~nearest~~ k nearest neighbours as per the calculated Euclidean distance
- Step - 4 : Among these k neighbours, count the number of the data points in each category.
- Step - 5 : Assign the new data points to that category for which the number of neighbours

K-NN with Example.



How to select optimal k value ?

- No pre-defined statistical methods to find the optimal k value.
- Random Initialization of k
- Choosing a small value for k leds to unstable decision boundaries.
- Invesly, as we increase the value of k. our ~~per~~ Predictions become more stable due to majority vote.
- In case where we are taking a majority vote (eg: picking the mode in a classification problem) among labels, we usually make k an odd number to have a tiebraker



k-NN Remarks.

1 - Select an odd k value for a 2 classes problem; this is because if we set

k = 2 for a binary classification problem, we can have a tie what would be the class?

2 - The make drawback of k-NN is the complexity in

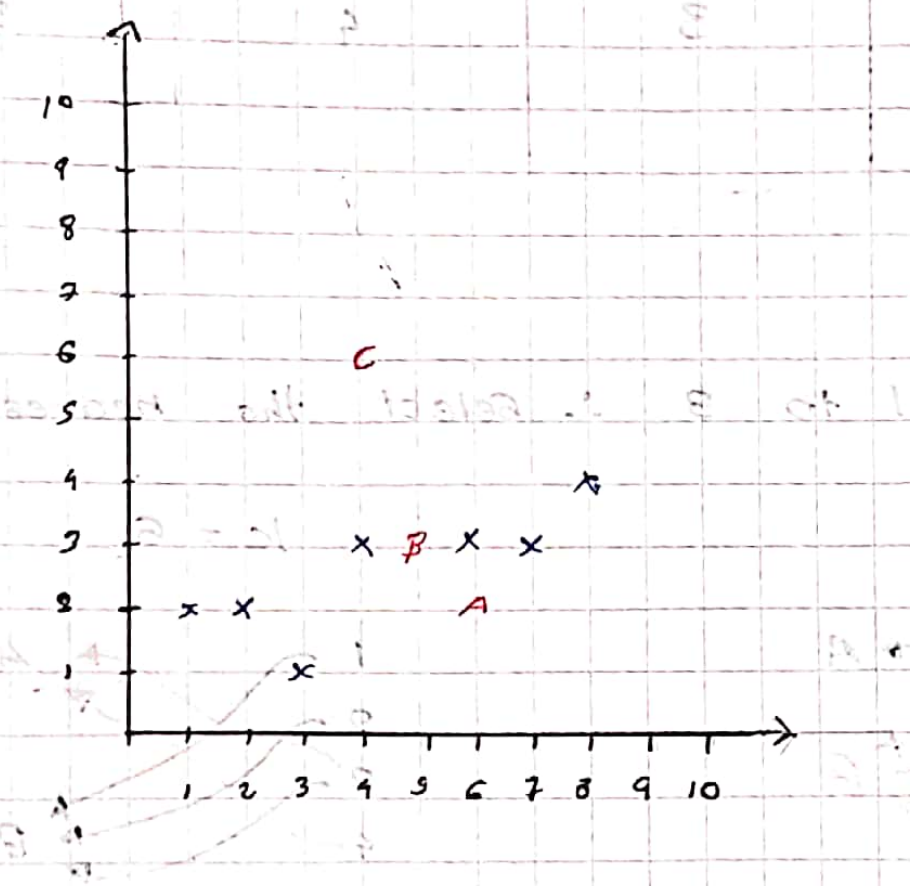
searching the nearest neighbours for each sample in case of a big dataset. Therefore, this would require expensive computation overhead and more memory space.

3 - kNN makes prediction just-in-time by ~~Calcu~~ ~~Calcul~~ calculating the between an input sample and each training instance.

Note :

$k = 3$

(2,2), (3,1), (4,3), (1,2), (6,3), (2,4), (7,3), (8,4)

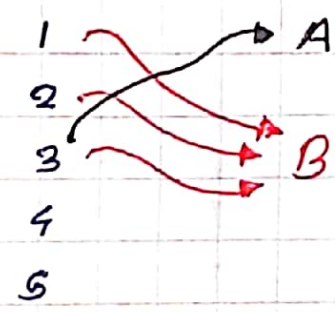


Test (6,2)
Test (5,3)
Test (4,6)

Data point	distance 1	distance 2	distance 3
(2, 2) A	4	4	4
(3, 1) A	4	4	4
(4, 3) A	3	1	1
(1, 2) A	5	5	5
(6, 3) B	1	1	3
(2, 4) A	6	4	2
(7, 3) B	2	2	4
(8, 4) B	3	4	3

k is equal to 3 ∴ select the nearest 3 value

k = 3



k = 5