Introduction to Artificial Intelligence

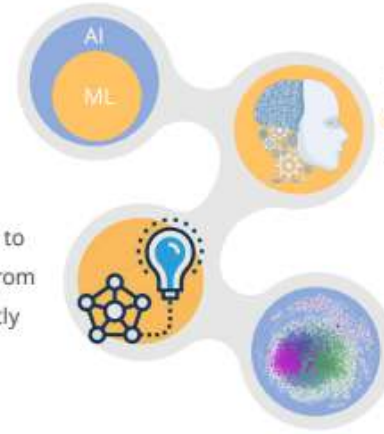
Lesson 2: Fundamentals of Machine Learning and Deep Learning

Fundamentals of Machine Learning and Deep Learning

Topic 1: Meaning of Machine Learning

Meaning of Machine Learning

Machine learning (ML) is an application of artificial intelligence.



It involves teaching a computer to recognize patterns in the data and creating rules rather than programming it in traditional methods.

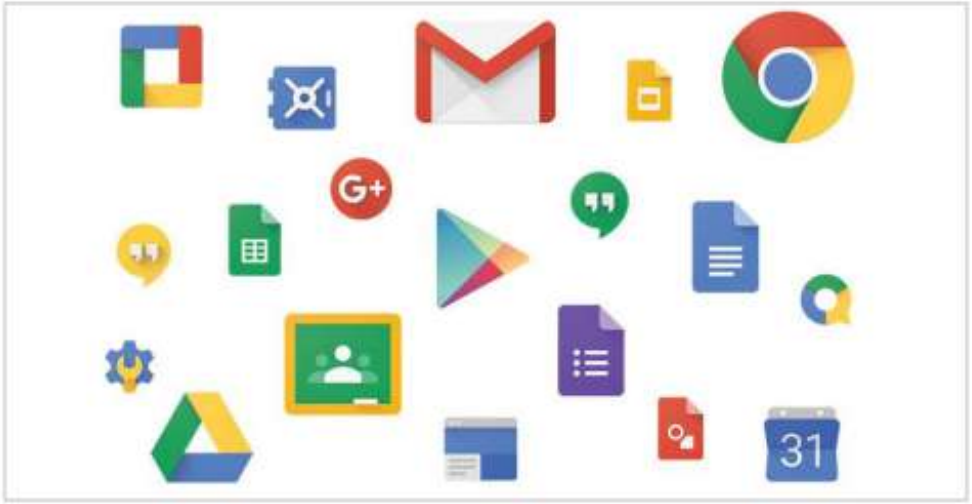
It provides an ability to machines to automatically learn and improve from experience without being explicitly programmed.

The process of learning begins with observations or data, such as direct experience, or instructions to look for patterns in the data.

> Machine learning can be defined as an approach to achieve artificial intelligence through systems or software models that can learn from experience to find patterns in a set of data.

Google Utilizing AI

Google uses artificial intelligence and machine learning in almost all of its applications.



Google Utilizing AI

Google Photos uses machine learning in smart search to display photos related to the keywords you searched for and animate similar photos from your albums into quick videos.

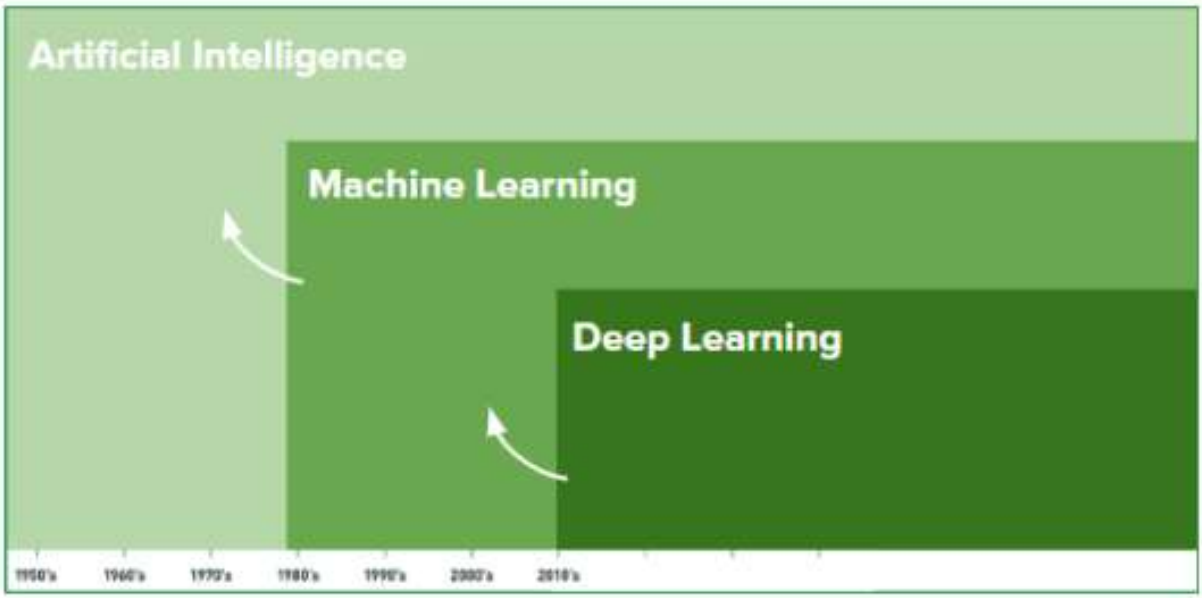
The Smart Compose and Smart Reply features of Gmail uses AI to suggest phrases and complete sentences when you draft an email or a reply. The spam filter uses artificial neural networks to analyze and flag spam messages.

Google Assistant has recently launched a new feature called Google Duplex that lets AI take over some real-world task such as booking a haircut appointment over phone.

The feature Talk to Books lets you make a statement or ask a question and surfaces relevant passages from the books using machine learning.

Relationship Between AI, ML, and DL

- AI gained popularity in 1950, ML in 1980, and DL in 2010.
- Deep learning is a subset of machine learning, which is a subset of artificial intelligence.



Fundamentals of Machine Learning and Deep Learning

Topic 2: Relationship Between Machine Learning and Statistical Analysis

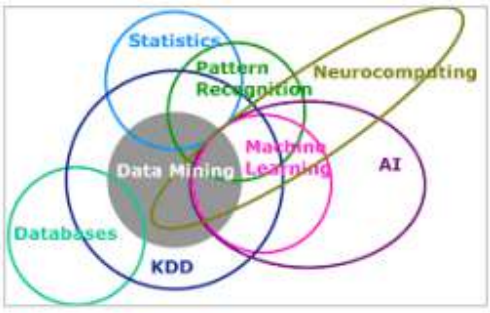
Importance of Data and Statistical Analysis

- Machine learning depends largely on data to study patterns.
- A large amount of data and statistical analysis of this data is required for ML.
- Statistical analysis involves collecting and scrutinizing the data sample to identify trends.
- A statistical model is a formalization of relationships between variables in the form of mathematical equations.

Machine Learning and Statistical Analysis

Machine learning

- Machine learning is a subset of artificial intelligence in the field of computer science.
- Machine learning is associated with high-dimensional data.



Statistical Analysis

- Statistical analysis belongs to the field of mathematics and deals with finding a relationship between variables to predict an outcome.
- Statistical analysis deals with low-dimensional data.

The goals of machine learning and statistical analysis are same, but the formulations are significantly different.

Formulations of ML and Statistical Analysis

Machine learning

It takes away the deterministic function f out of the equation:

Output(Y) -----> Input (X)

Statistical Analysis

It tries to estimate the function f:

Dependent Variable (Y) = f (Independent Variable) + Error Function

Naming Conventions of ML and Statistical Analysis

Machine learning	Statistics
Network, graphs	Model
Weights	Parameters
Learning	Fitting
Generalization	Test set performance
Supervised learning	Regression/classification
Unsupervised learning	Density estimation, clustering
Large grant = $1,000,000	Large grant = $50,000
Nice place to have a meeting: Snowbird, Utah, French, Alps	Nice place to have a meeting: Las Vegas in August

Fundamentals of Machine Learning and Deep Learning

Topic 3: Process of Machine Learning

Approach of Machine Learning

ML leverages on existing data, images, and videos to train algorithms and models.

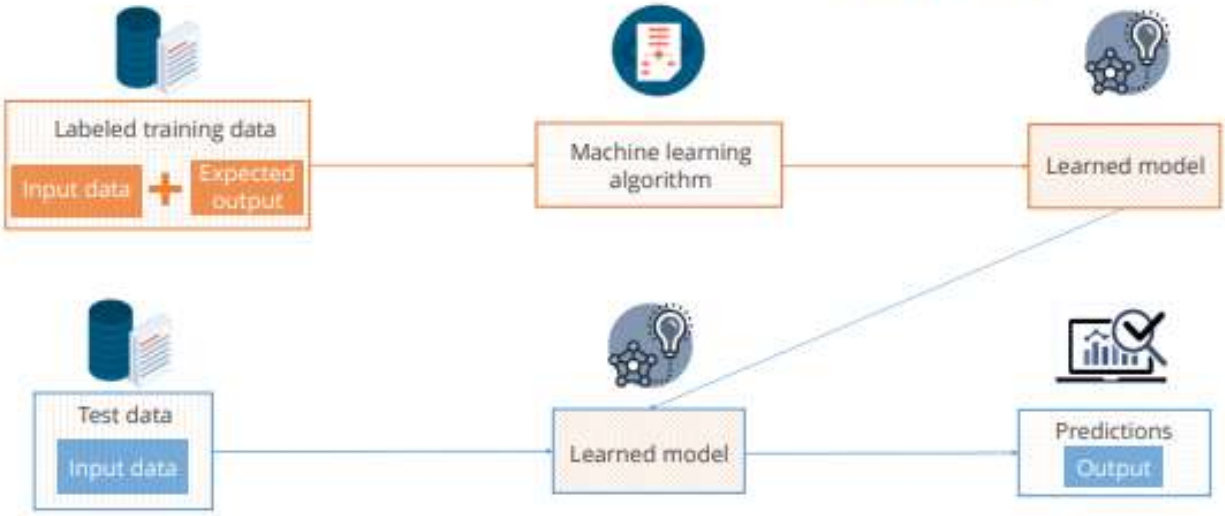
Numerous set of examples are fed into the system and are called training sets.

The larger the training set, the more accurate the AI system would be.

Each item in a training set is labeled either 0 or 1.

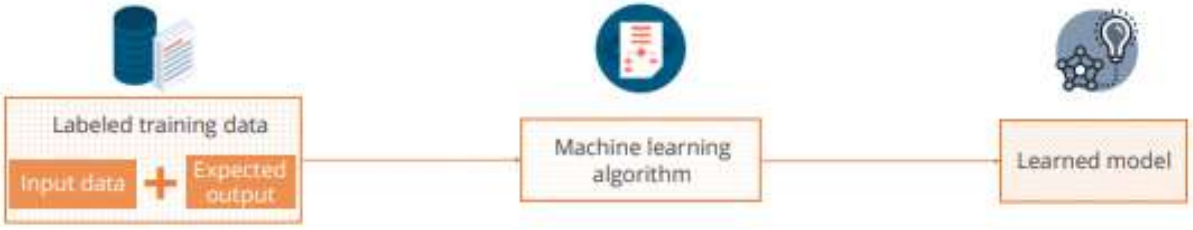
Machine Learning Process

A machine learning process can be divided into two phases: training and testing.



Machine Learning Process

Training Phase



Labeled data is given as input into the algorithm along with the expected output or labels. This is called the training data.

The algorithm studies the patterns in the data and works out a logic based on the training data input and output.

A machine learning model is derived, which can then be used with test dataset.

Machine Learning Process

Testing Phase

The test data contains only the inputs, and the output is generated by the system based on the logic derived from the training data.

The system classifies the test data based on the patterns learned from the training data.

The patterns from the test data and the logic of the learned model are used to make predictions and derive output.

Fundamentals of Machine Learning and Deep Learning

Topic 4: Types of Machine Learning

Types of Machine Learning

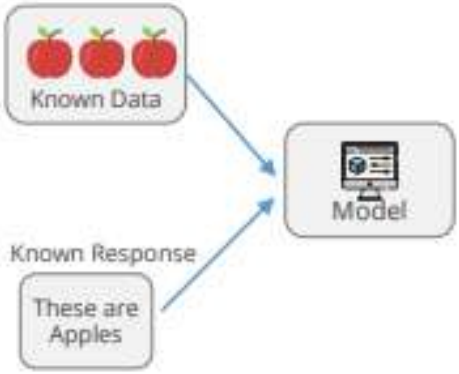
There are four main types of machine learning:

Supervised Learning	Unsupervised Learning	Semi-supervised Learning	Reinforcement Learning

Meaning of Supervised Learning

- In case of supervised learning, the ML program is provided with training data along with the expected output or rules to categorize this data also known as labels.
- The ML system uses this set of inputs and outputs to predict the output for future unseen inputs. It works well in the classification.

Supervised Learning Example



Step one: Train the model

- Provide images of apples along with the expected response to the model. This is called the labeled data.

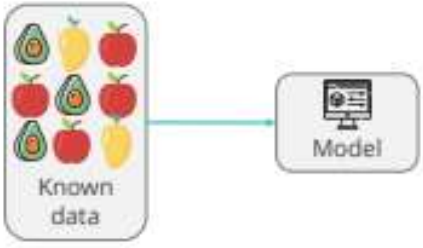
Supervised Learning Example

Predicting house prices based on various features

Number of rooms	Bathrooms	Garage space	Year it was built	Location

Unsupervised Learning Process

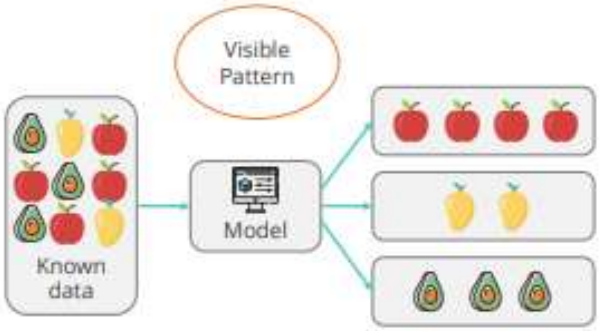
Unsupervised Learning Example: Image Identification



Step one: Input unlabeled data

- We provide the system with a data that contains photos of different kinds of fruits without the expected output. This is called the unlabeled data.
- The goal of unsupervised learning models is to understand the output from given data and notice patterns, trends, and similarities.

Unsupervised Learning Example: Image Identification



Step two: Train the model

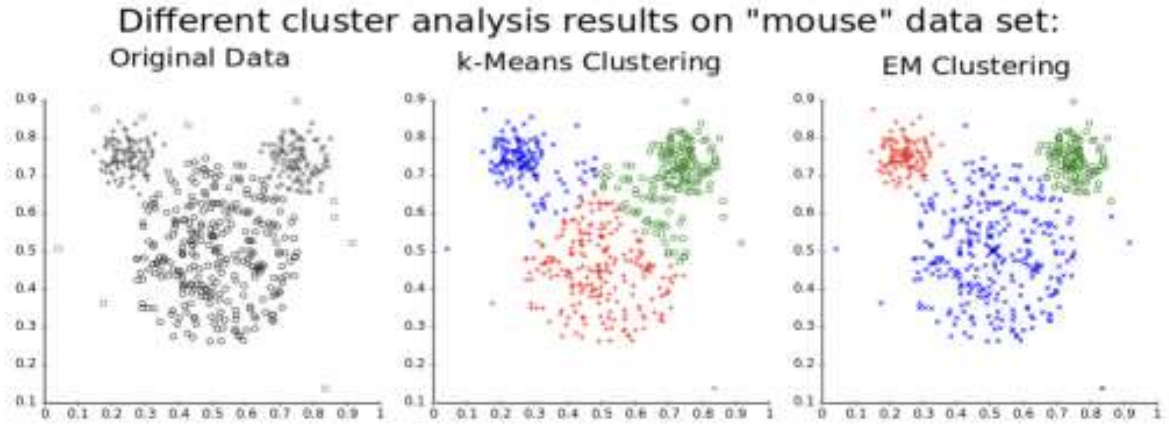
- The model identifies the patterns like shape, color, and size in the data.
- It groups the fruits based on these features, attributes, or qualities.

Unsupervised Learning Example: Litterati

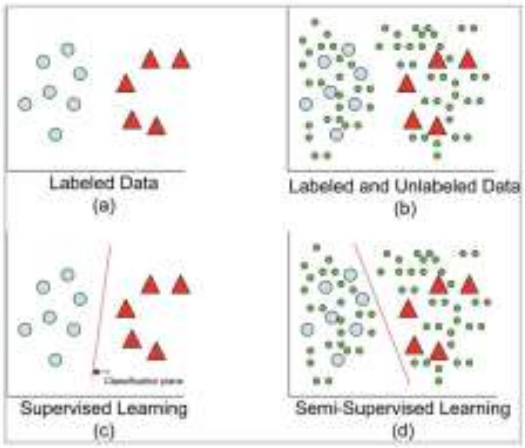
- Litterati, the global database for litter, uses unsupervised learning to organize geographical litter locations using clustering.

Unsupervised Learning Example: Mouse Clicks

- Unsupervised learning is used to understand the users' mouse clicks on a web page or a website.
- It helps companies understand the user browsing patterns.

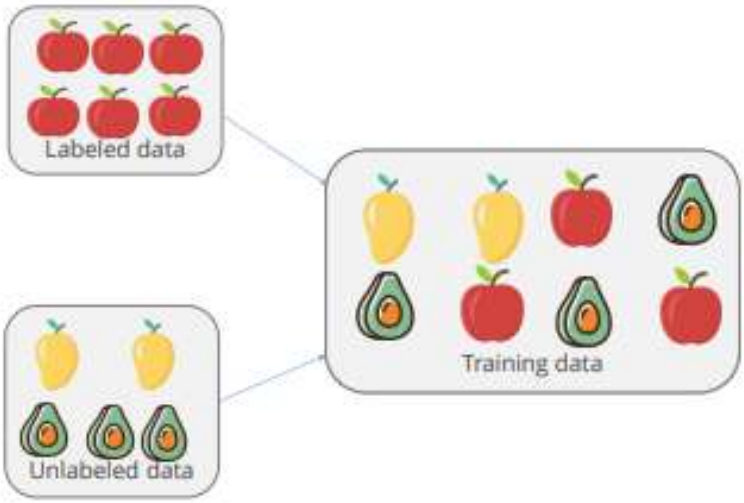


Meaning of Semi-supervised Learning



- Semi-supervised learning is a hybrid approach and is a combination of supervised and unsupervised learning.
- It uses a combination of labeled and unlabeled data.

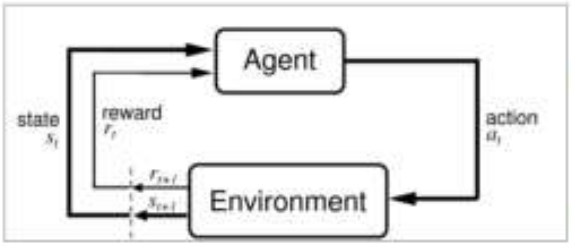
Semi-supervised Learning Example



Step one: Collect and group data

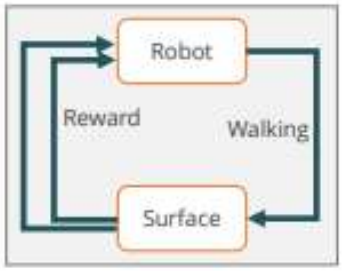
- Collect and group labeled and unlabeled data for training.

Meaning of Reinforcement Learning



- Reinforcement learning is a type of machine learning that allows the learning system to observe the environment and learn the ideal behaviour.
- The learning system (agent) observes the environment, selects and takes certain actions, and gets rewards in return (or penalties in certain cases).
- The feedback is given to the system or agent in a loop.
- The agent learns the strategy or policy (choice of actions) that maximizes its rewards over time and tries to maximize the cumulative reward.

Reinforcement Learning Example: Robot



- Robot is an agent trying to manipulate the environment, which is the surface.
- This happens as the robot walks and tries to go from one state to another.
- It gets a reward for accomplishing a sub module of the task (taking couple of steps).

Reinforcement Learning Example: Robot

- In a manufacturing unit, a robot uses deep reinforcement learning to identify a device from one box and put it in a container.
- The robot learns this by means of a rewards-based learning system, which incentivizes it for the right action.

Selecting the ML Approach

The data modeling approach for machine learning is based on the structure and volume of the data at hand, regardless of the use case. Any of the following approaches can be chosen considering all the factors.

Supervised Learning	Unsupervised Learning	Semi-supervised Learning	Reinforcement Learning

Quiz Time

Guess what ML approach is used by spam detection?

- ✓ Supervised Learning
- Unsupervised Learning
- Semi-supervised Learning
- Reinforcement Learning

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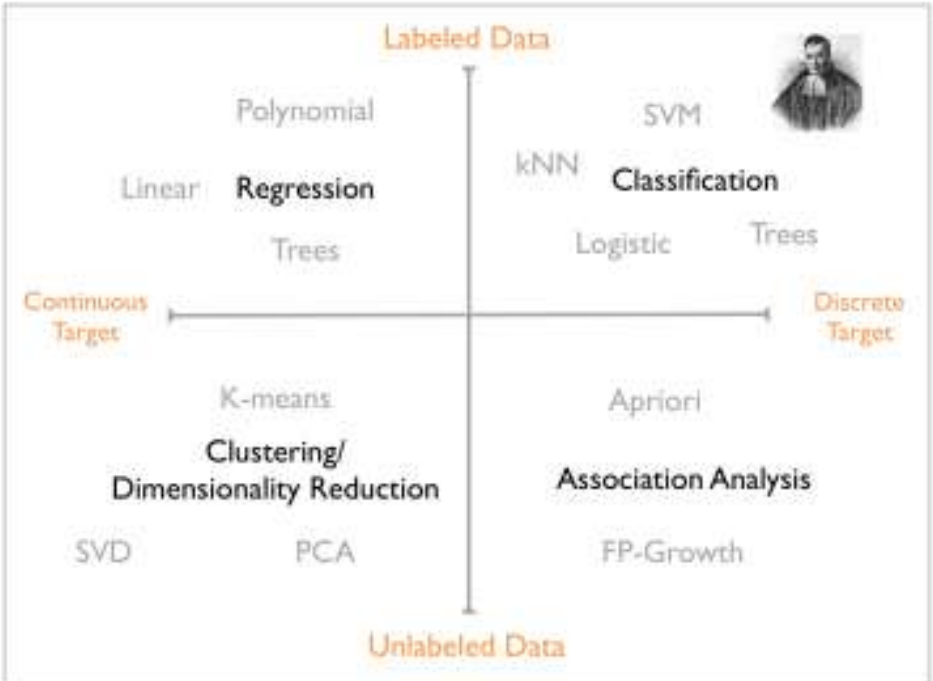
Fundamentals of Machine Learning and Deep Learning

Topic 5: Algorithms of Machine Learning

Machine Learning Algorithms

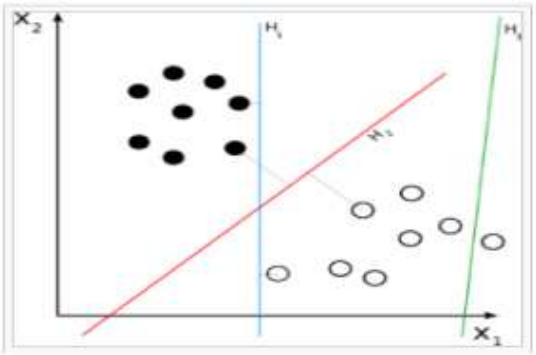
- There are four main types of machine learning algorithms.
- The choice of the algorithm depends on the type of data in the use case.



Types of Supervised Learning

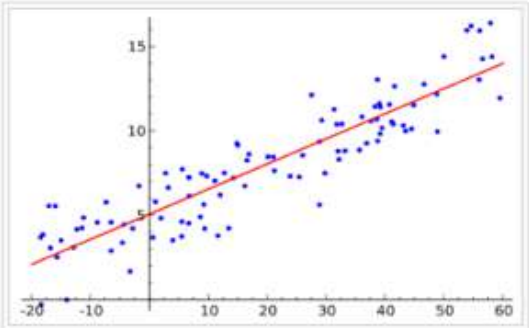
The two main types of supervised learning that use labeled data are regression and classification.

Classification



- Classification is applied when the output has finite and discrete values.
- For example, social media sentiment analysis has three potential outcomes: positive, negative, or neutral.

Regression

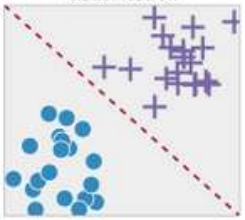


- Regression is applied when the output is a continuous number.
- A simple regression algorithm: y = wx + b. For example, relationship between environmental temperature (y) and humidity levels (x).

Classification vs. Regression

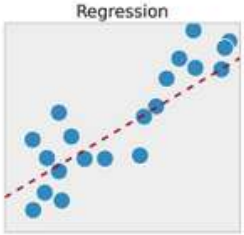
By fitting to the labeled training set, you can find the most optimal model parameters to predict unknown labels on other objects (test set).

Classification



If the label is a real number, we call the task regression. For example, finding actual value of house price based features like location, construction year, etc.

Regression



If the label is from the limited number of unordered values, we call it classification. For example, classifying images of animals into separate groups (labels) of dogs and cats.

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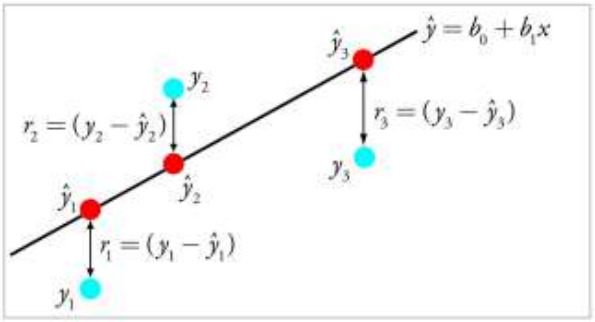
Linear Regression

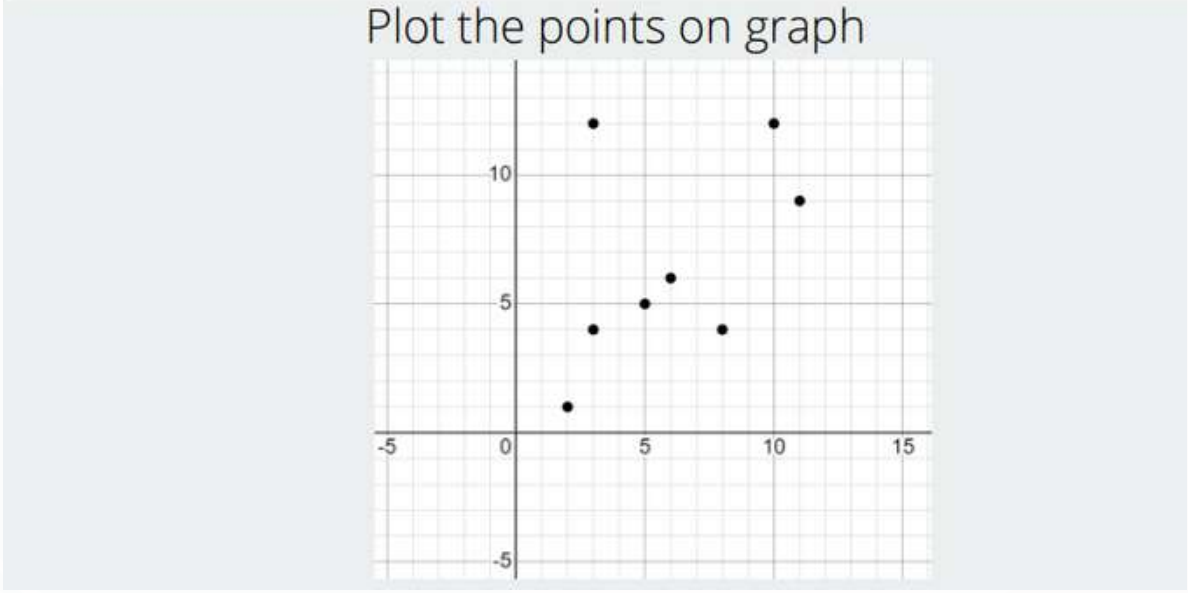


- Linear regression is an equation that describes a line that represents the relationship between the input variables (x) and the output variables (y).
- It does so by finding specific weightings for the input variables called coefficients (B).

Question -1: Consider the time series data given below: **0.5 Marks**

X_i	8	3	2	10	11	3	6	5
Y_i	4	12	1	12	9	4	6	1

i. Use the least square method to determine the equation of line of best fit for the data. Then plot the line.



x	8	3	2	10	11	3	6	5
y	4	12	1	12	9	4	6	1
X(mean)	6							
Y(men)	6.125							

i	xi	yi	xi-X	yi-Y	(xi-X)(yi-Y)	(xi-X)^2
1	8	4	2	-2.125	-4.25	4
2	3	12	-3	5.875	-17.625	9
3	2	1	-4	-5.125	20.5	16
4	10	12	4	5.875	23.5	16
5	11	9	5	2.875	14.375	25
6	3	4	-3	-2.125	6.375	9
7	6	6	0	-0.125	0	0
8	5	1	-1	-5.125	5.125	1
Sum					48	80

Calculate the slope.

$$m = \frac{\sum_{i=1}^{n}(x_i-\overline{X})(y_i-\overline{Y})}{\sum_{i=1}^{n}(x_i-\overline{X})^2} = \frac{48}{80} = 0.6$$

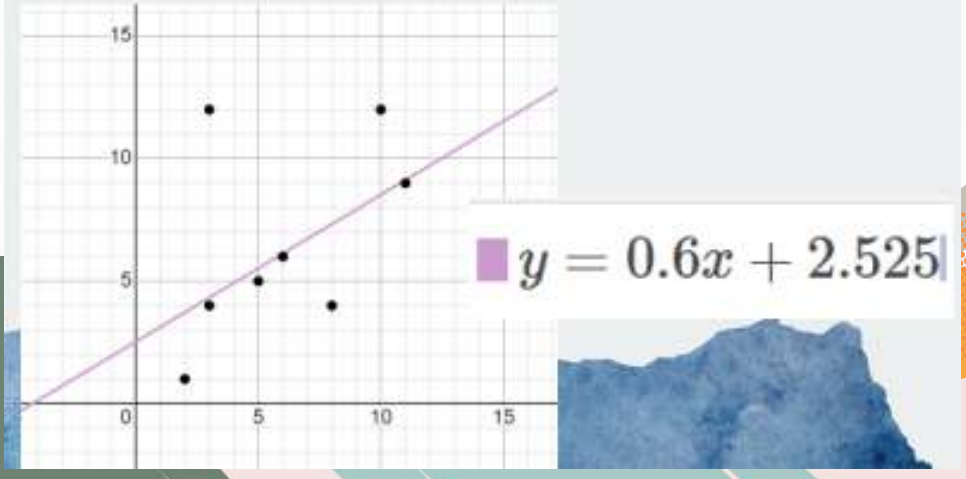
Calculate the y -intercept.

Use the formula to compute the y -intercept.

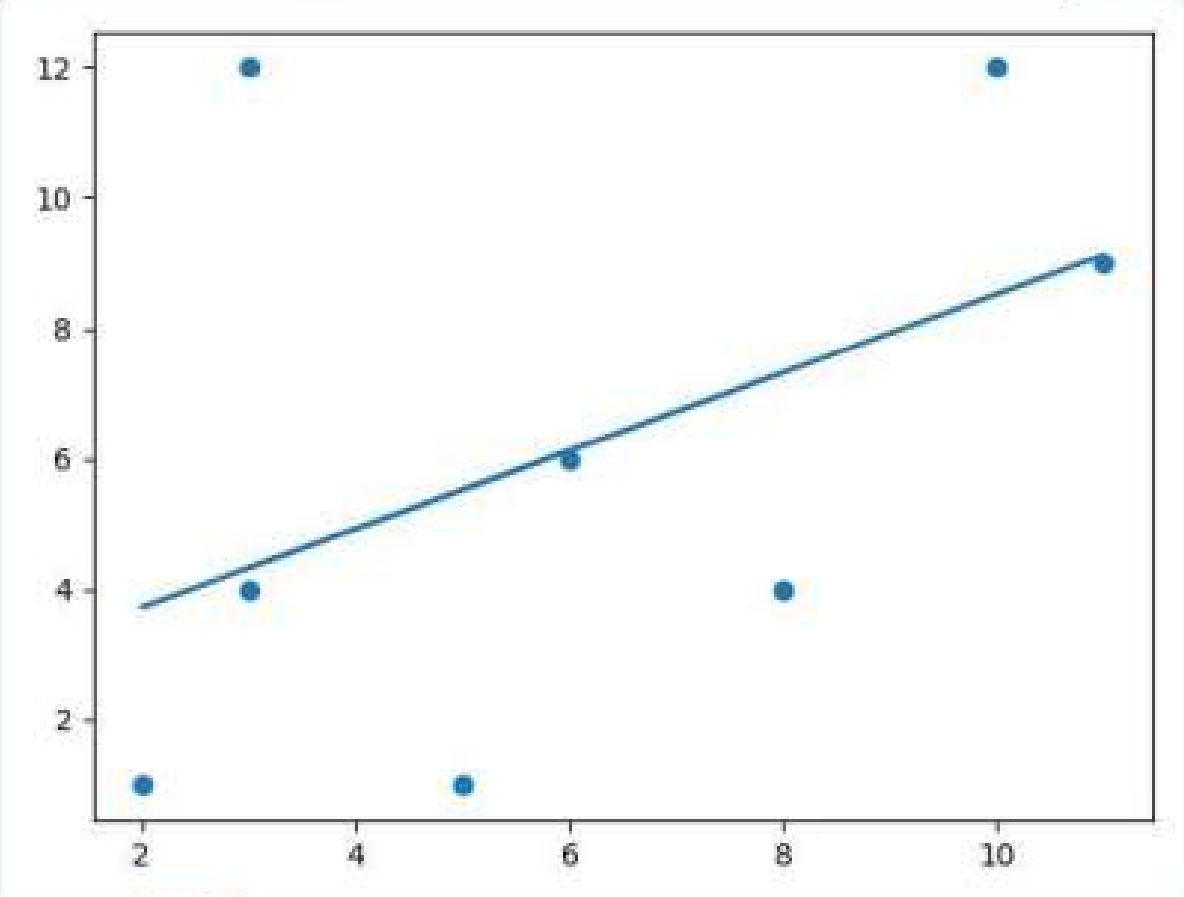
$$b = \overline{Y} - m\overline{X}$$

$$= (6.125-0.6*6)$$

$$=2.525$$



```python
import numpy as np
import matplotlib.pyplot as plt
x=np.array([8,3,2,10,11,3,6,5])
y=np.array([4,12,1,12,9,4,6,1])
m,c=np.polyfit(x,y,1)
plt.scatter(x,y)
plt.plot(x,x*m+c)
plt.show()
```



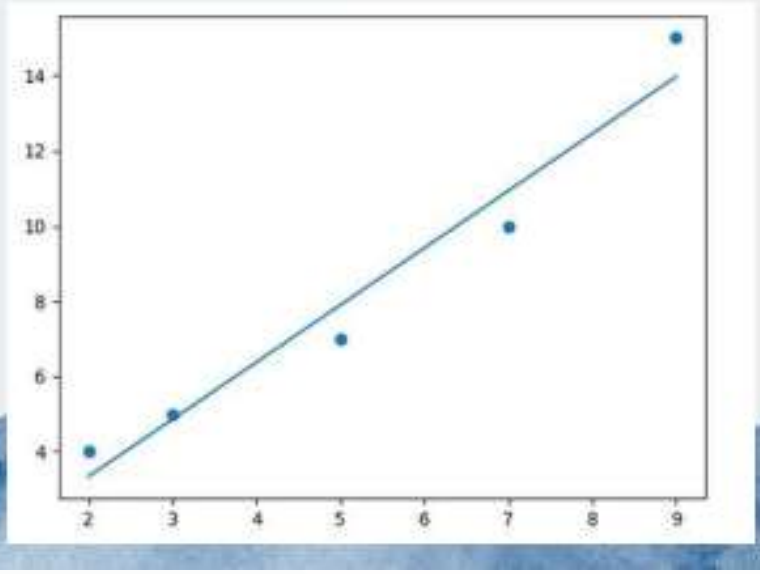
Question -2: Consider the example below where someone named Sam found how many hours of sunshine vs how many ice creams were sold at his shop from Monday to Friday: 0.5 Marks

Hours of sunshine	2	3	5	7	9
Ice cream sold	4	5	7	10	15

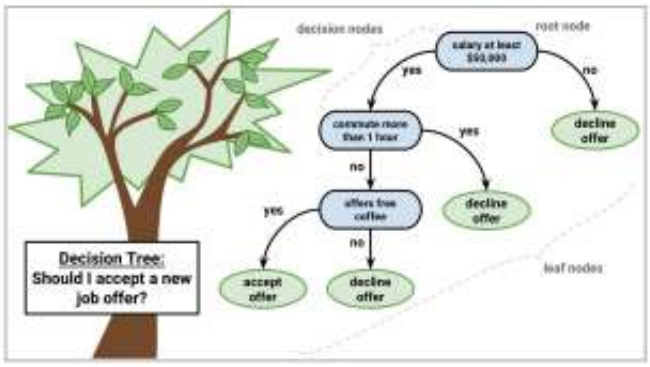
i. Use the least square method to determine the equation of line of best fit for the data.
ii. Plot the best fit line. and estimate if there is a 8 hours of sunshine how many ice cream would be sold tomorrow.

```
from array import array
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
a=np.array([2,3,5,7,9])
b=np.array([4,5,7,10,15])
x = np.mean(a)
y = np.mean(b)
n= len(a)
numer = 0
denom = 0
```

```
for i in range(n):
    numer += (a[i] - x) * (b[i] - y)
    denom += (a[i] - x) ** 2
m = numer / denom
c = b - (m * x)
print(m)
c,d = np.polyfit(a,b,1)
plt.scatter(a,b)
plt.plot(a,a*c+d)
plt.show()
```

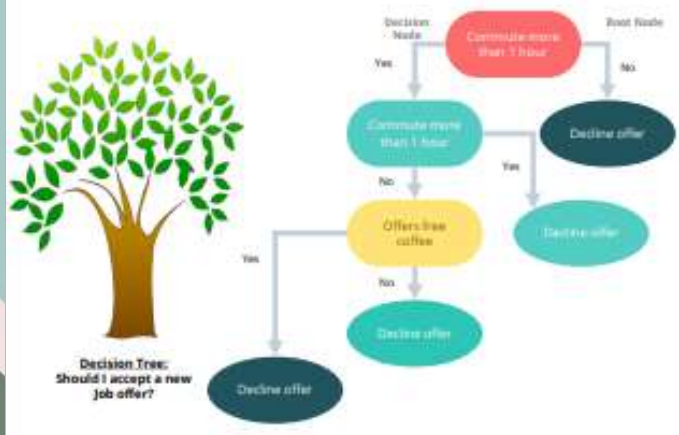


Meaning of Decision Tree



- A decision tree is a graphical representation of all the possible solutions to a decision based on a few conditions.
- It uses predictive models to achieve results.
- A decision tree is drawn upside down with its root at the top.

Classification and Regression Trees



- The tree splits into branches based on a condition or internal node.
- The end of the branch that doesn't split anymore is the decision/leaf.
- In this case, the condition whether the employee accepts or rejects the job offer is represented as green oval shaped boxes.
- This tree is called as classification tree as the target is to classify whether the job is accepted by the employee or not.
- Regression trees are represented in the same manner, but they predict continuous values like price of a house.
- Decision tree algorithms are referred to as CART or Classification and Regression Trees.
- Each node represents a single input variable (x) and a split point on that variable, assuming the variable is numeric.

Naive Bayes

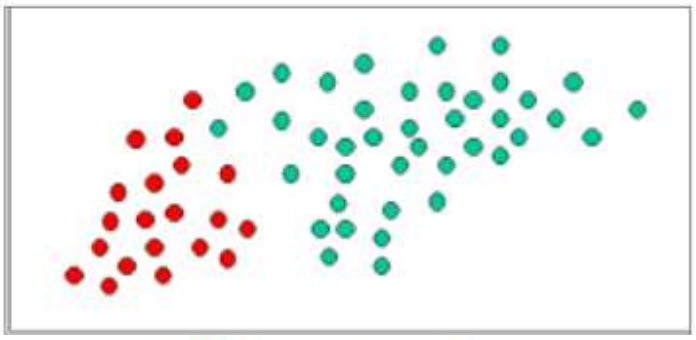
- Naive Bayes is a simple but surprisingly powerful algorithm for predictive modeling.
- The model comprises of two types of probabilities: the probability of each class and the conditional probability of each class based on the value of x.
- Once calculated, this probability model can be used to make predictions for new data using Bayes theorem.
- The probabilities can be easily estimated as bell curve when your data is real valued.

Naive Bayes Example

How does an email client classify between valid and spam emails?

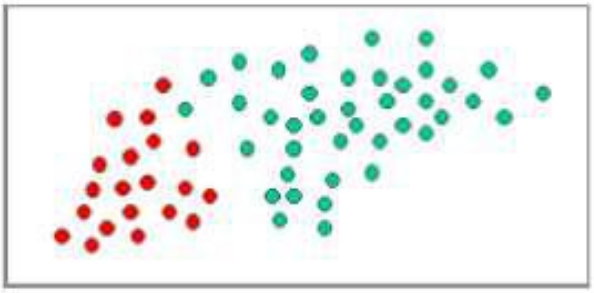
Naive Bayes Classification

- The objects can be classified as either green or red. The task is to classify new cases as they arrive.
- For Example, using Naive Bayes, you can classify the class labels based on the current objects.
- Since there are twice as many green objects as red, it is reasonable to believe that a new case (which has not been observed yet) has same ratio.



Naive Bayes Classification

- In Bayesian analysis, this belief is known as prior probability.
- Prior probabilities are based on previous experience.
- Prior probability of green: number of green objects/total number of objects
- Prior probability of red: number of red objects/total number of objects



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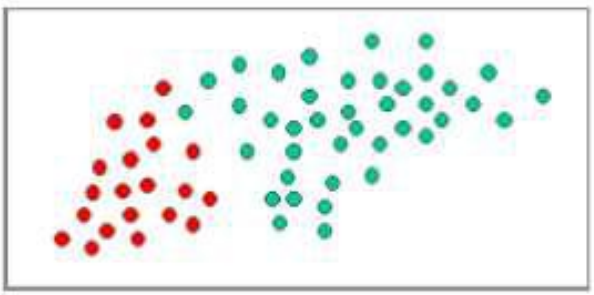
Naive Bayes Classification

Since there is a total of 60 objects, 40 of which are green and 20 are red, prior probabilities for class membership are:

- Prior probability for green: 40/60
- Prior probability for red: 20/60 (number of red objects/total number of objects)



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Naive Bayes Classification

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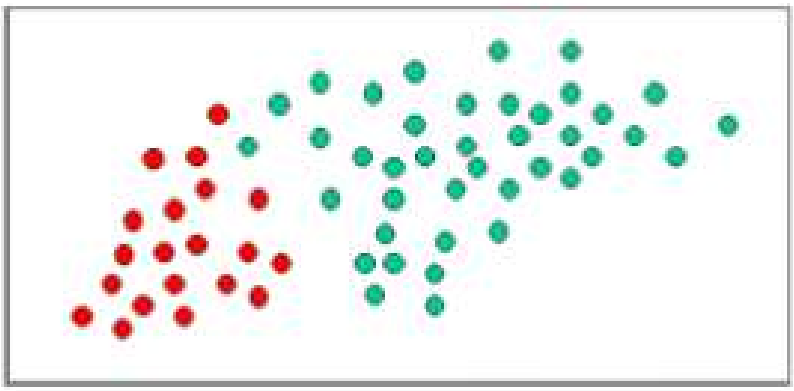

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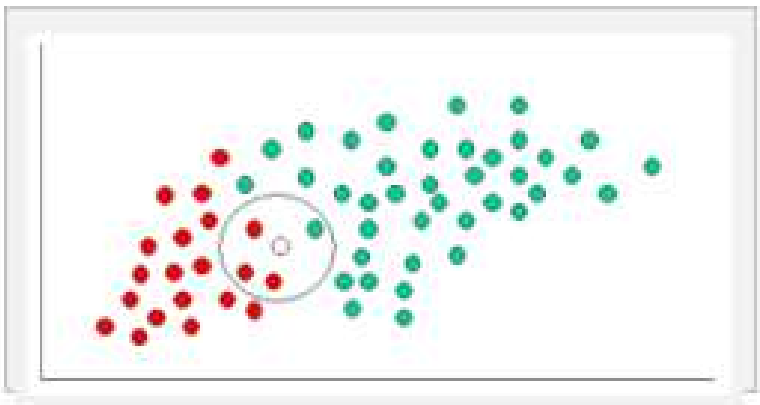
Naive Bayes Classification

- The more green (or red) objects there are in the vicinity of X, the more likely that the new cases will belong to that particular color.
- To measure the likelihood, draw a circle around X which encompasses a number of points irrespective of their class labels.
- Then, calculate the number of points in the circle that belong to each class label.



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WHAT IS BAYES THEOREM?

- Further, the probability of event Y with known event X:

- P(X ? Y)= P(Y|X) P(X) (2)

✓ Mathematically, Bayes theorem can be expressed by combining both equations on right hand side. We will get:

$$P(X|Y) = \frac{P(Y|X).P(X)}{P(Y)}$$

Bayes' Theorem Formula

The formula to calculate a posterior probability of A occurring given that B occurred:

$$P(A \mid B) = \frac{P(A \cap B)}{P(B)} = \frac{P(A) \times P(B \mid A)}{P(B)}$$

where:

A, B = Events

$P(B \mid A)$ = The probability of B occurring given that A is true

$P(A)$ and $P(B)$ = The probabilities of A occurring and B occurring independently of each other

BAYES THEOREM

- Hence, Bayes Theorem can be written as:
- **posterior = (likelihood * prior) / evidence**

WHERE

- P(X|Y) is called as **posterior**, which we need to calculate. It is defined as updated probability after considering the evidence.
- P(Y|X) is called the **likelihood**. It is the probability of evidence when hypothesis is true.
- P(X) is called the **prior probability**, probability of hypothesis before considering the evidence
- P(Y) is called **marginal probability**. It is defined as the probability of evidence under any consideration.

Lab 4 Set 1 – (Bayes theorem and Bayesian Classifier)

Objective: Finding probability by applying Bayes theorem and applying Bayesian Classifier on dataset for finding probability of an event and accuracy of model.

Question-1: (20 Minutes) **1 Mark**

A patient goes to see a doctor. The doctor performs a test with 99 percent reliability--that is, 99 percent of people who are sick test positive and 99 percent of the healthy people test negative. The doctor knows that only 1 percent of the people in the country are sick.

(a) If the patient tests positive, what are the chances the patient is sick?

The intuitive answer is 99 percent, but the correct answer is 50 percent...."

posterior = (likelihood * prior) / evidence

Considering the hypothetical probablity of	10000 people			
	Diseased	**Not Diseased**		
Test +	99	99	198	P(B)
Test -	1	9,801	9,802	
	100	9,900	10,000	
	P(A)			
A - event of disease	P(A)	100/10000	0.01	
B - event of +ve test	P(B)	198/10000	0.0198	
B/A - event of observing event +ve if diseased is true	P(B/A)=P(A^B)/P(A)	(99/10000)*(0.01)	0.99	
A/B - event of observing event diseased if +ve is true	P(A/B)			

$$P(A \mid B) = (0.99 \times 0.01) / 0.0198 = 0.50 = 50\%.$$

```
TESTpos =  99
TESTneg = 99
TESTndandneg = 1
totalcase = 10000
#totalp = 100
TESTndandneg = totalcase - (TESTpos + TESTneg+TESTndandneg)
A = TESTpos/totalcase
B = (TESTpos+TESTneg)/totalcase
prob_b_a = (TESTpos/totalcase)/A
prob_a_b = (prob_b_a*A)/B
print(prob_a_b*100,"%")
```

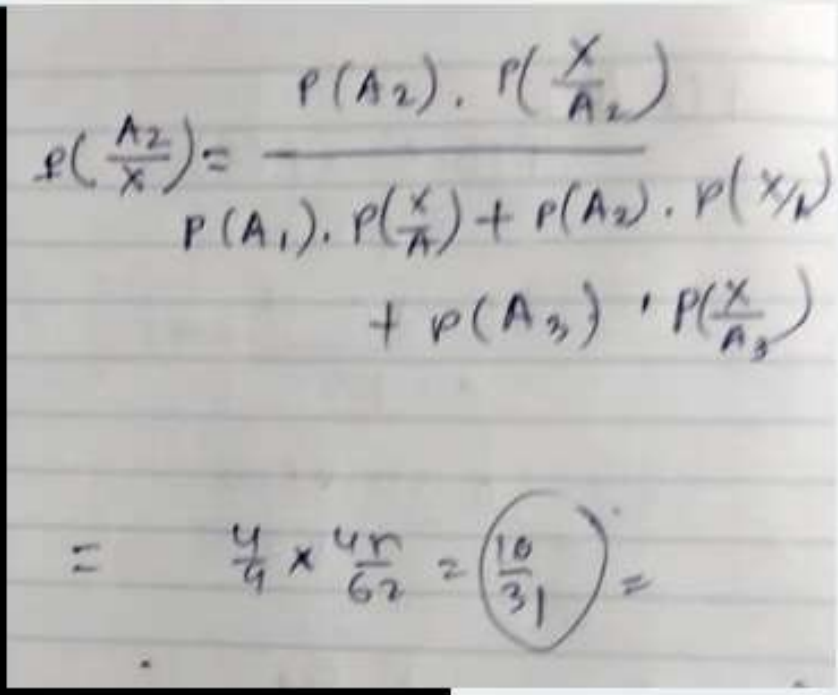
```
50.0 %
```

Question-2: (20 Minutes) **1 Mark**

Three identical boxes contain red and white balls. The first box contains 3 red and 2 white balls, the second box has 4 red and 5 white balls, and the third box has 2 red and 4 white balls. A box is chosen very randomly and a ball is drawn from it. If the ball that is drawn out is red.

(a) What will be the probability that the second box is chosen?

```
#fist box
a = 3 # 3red balls
b = 2 # 2white balls
#second box
c = 4 # 4red balls
d = 5 # 5white balls
#third box
e = 2 # 2red balls
f = 4 # 4white balls
b1 = 1/3
b2 = 1/3
b3 = 1/3
# red/total
x_b1 = a/(a+b)
x_b2 = c/(c+d)
x_b3 = e/(e+f)
s = b2*x_b2
ss = (b1*(x_b1))+(b2*(x_b2))+(b3*(x_b3))
pa2_x = s/ss
print(pa2_x)
```

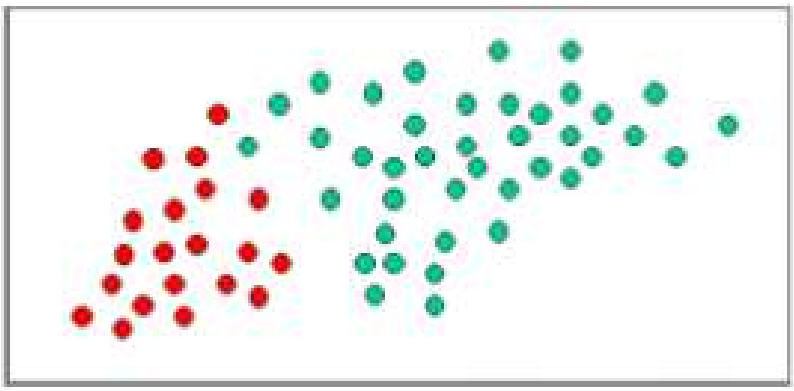



```
0.32258064516129037
```

Naive Bayes Classification

Since there is a total of 60 objects, 40 of which are green and 20 are red, prior probabilities for class membership are:

- Prior probability for green: 40/60
- Prior probability for red: 20/60 (number of red objects/total number of objects)



CALCULATION OF LIKELIHOOD

In this illustration, it is clear that likelihood of X given GREEN is smaller than Likelihood of X given RED, since the circle encompasses 1 GREEN object and 3 RED ones.

$$Likelihood\ of\ X\ given\ GREEN \propto \frac{Number\ of\ GREEN\ in\ the\ vicinity\ of\ X}{Total\ number\ of\ GREEN\ cases}$$

$$Likelihood\ of\ X\ given\ RED \propto \frac{Number\ of\ RED\ in\ the\ vicinity\ of\ X}{Total\ number\ of\ RED\ cases}$$

$$Probability\ of\ X\ given\ GREEN \propto \frac{1}{40} \quad Probability\ of\ X\ given\ RED \propto \frac{3}{20}$$

CALCULATION OF PRIOR PROBABILITY

Posterior probability of X being GREEN ∝

Prior probability of GREEN × *Likelihood of X given GREEN*

$$= \frac{4}{6} \times \frac{1}{40} = \frac{1}{60}$$

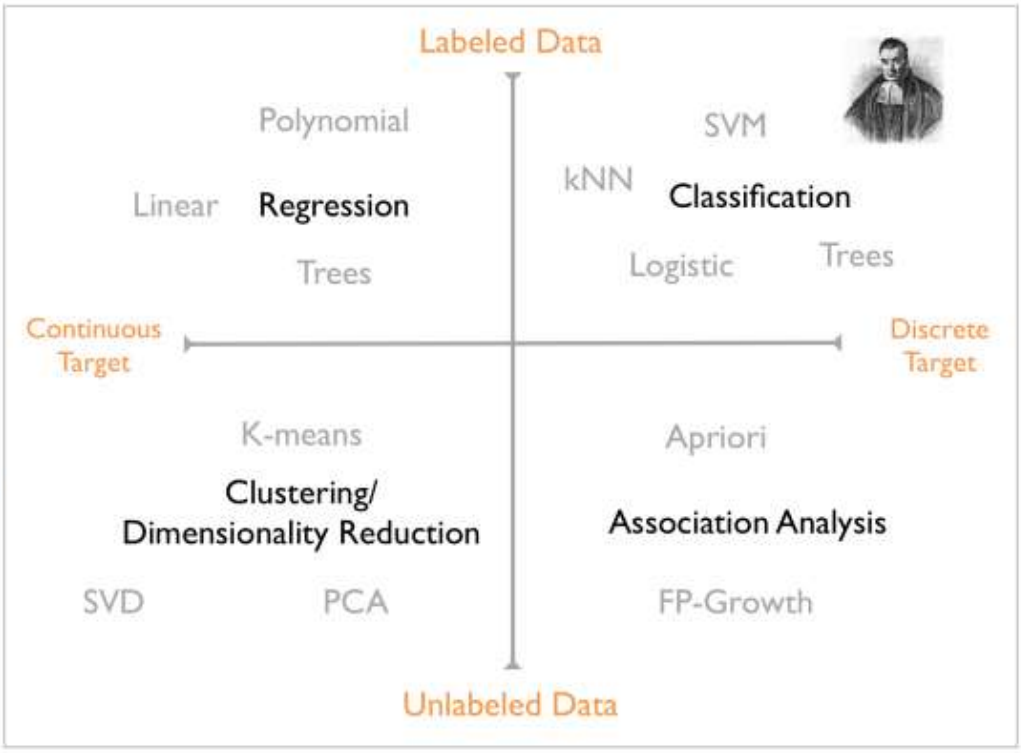
Posterior probability of X being RED ∝

Prior probability of RED × *Likelihood of X given RED*

$$= \frac{2}{6} \times \frac{3}{20} = \frac{1}{20}$$

Machine Learning Algorithms

The next algorithm is K-Means clustering.



served.

K-Means Clustering

- K-Means clustering is an algorithm that can be used for any type of grouping.
- Examples of K-Means clustering:
  - Group images
  - Detect activity types in motion sensors
  - Separate bots from anomalies
  - Segment by purchasing history
- Meaningful changes in data can be detected by monitoring to see if a tracked data point switches groups over time.

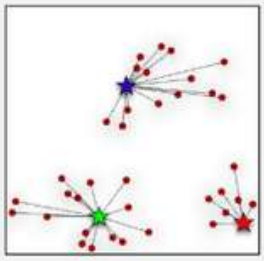
K-Means Clustering: Use Cases

Behavioral segmentation	Inventory categorization	Sorting sensor measurements	Detecting bots or anomalies
Segment by purchase history	Group inventory by sales activity	Detect activity types in motion sensors	Separate valid activity groups from bots
Segment by activities on application, website, or platform	Group inventory by manufacturing metrics	Group images	Group valid activity to clean up outlier detection
Define personas based on interests		Separate audio	
Create profiles based on activity monitoring		Identify groups in health monitoring	

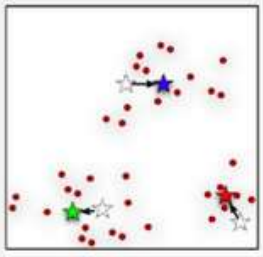
K-Means Clustering for Unsupervised Learning

- To run a K-Means algorithm, randomly initialize three points called the cluster centroids.
- There are three cluster centroids in the image given below since data is grouped into three clusters.

K-Means is an iterative algorithm and it involves two steps:



Step 1: Cluster assignment



Step 2: Move centroid step

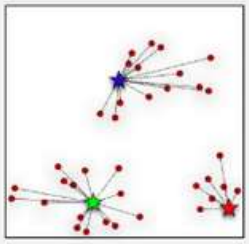
K-Means Clustering for Unsupervised Learning

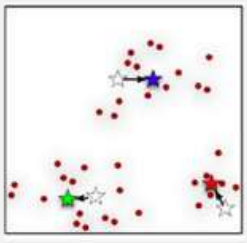
Step 1:

Algorithm travels through data points, depending on which cluster is closer. It assigns it to red, blue, or green cluster.

Step 2:

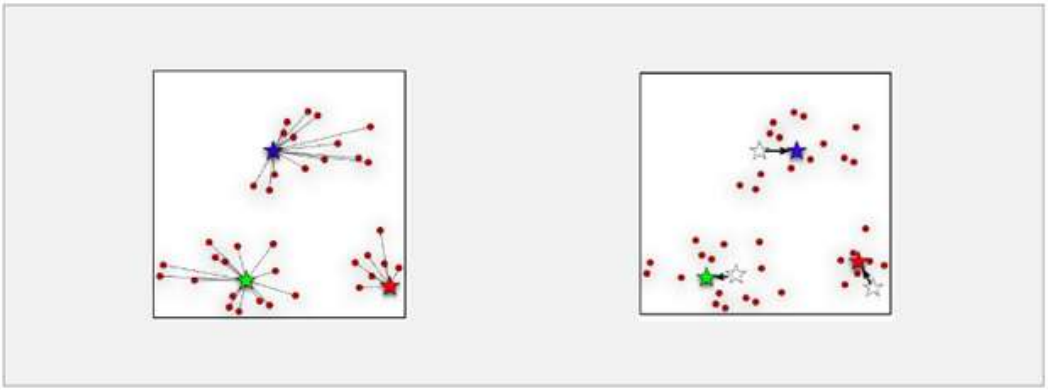
Algorithm calculates average of all points in cluster and moves centroid to the average location.





K-Means Clustering for Unsupervised Learning

- Steps 1 and 2 are repeated until there are no changes in clusters or when the specified condition is met.
- K is chosen randomly, or elbow plot/silhouette score helps decide it.

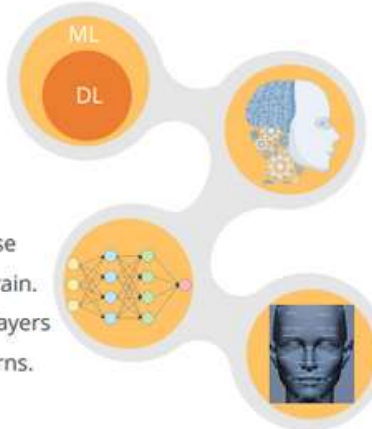


Fundamentals of Machine Learning and Deep Learning

Topic 6: Deep Learning

Introduction to Deep Learning

Deep learning (DL) is a subset of machine learning.



The term deep learning refers to deep artificial neural networks, and less frequently to deep reinforcement learning.

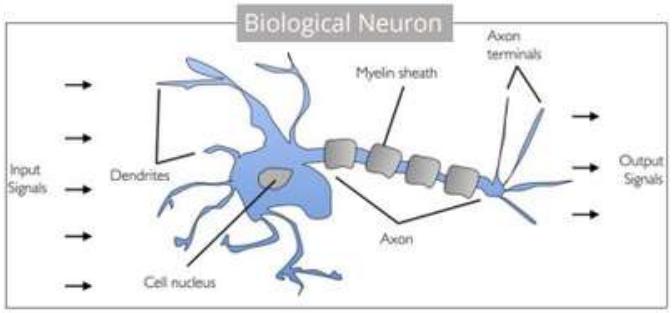
Deep Neural Networks or DNNs use techniques that mimic the human brain. The DNN algorithms are arranged in layers and they learn patterns of the patterns.

DNNs have set new records in accuracy for many problems such as image recognition and recommender system.

Definition of Deep Learning

> Deep learning is a specialized form of machine learning that uses supervised, unsupervised, or semi-supervised learning to learn from data representations. It is similar to the structure and function of the human nervous system, where a complex network of interconnected computation units work in a coordinated fashion to process complex information.

Neural Networks of Human Brain



- Our brain consists of approximately 86 billion interconnected neurons.
- Neurons are interconnected nerve cells in the human brain that are involved in processing and transmitting chemical and electrical signals.
- They take input and pass along outputs.
- Each neuron responds to certain stimuli and passes output to another.

Neural Networks of Human Brain

- A human brain can learn how to identify objects from photos.
- For example, the brain could use several neurons to understand and interpret that the animal seen is a dog (with details such as fur, eyes, tail, etc).
- Each of these neurons may have a different weightage (governed by how important the feature is) to the overall image.
- If all these neurons fire in the same direction, our brain tells us that we saw a dog.
- Furthermore, neurons also fire up to tell us that what kind of dog it is (Doberman, German shepherd etc).

Neural Networks of Human Brain

- Babies, from the time they are born until they grow up to be toddlers, learn to recognize and distinguish multiple objects like trees, dogs, cats, bottles etc.
- The more data you feed or teach them, the better their recognition capabilities become.
- Imagine the number of "training" examples of each they must have seen to be able to distinguish these things.
- The same goes for machine learning and deep learning applications like facial recognition, image/object recognition, etc. The more data we feed the model, the better it becomes.

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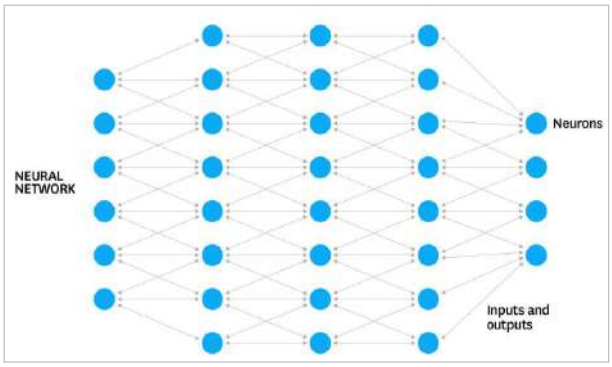
Artificial Neural Networks



- Neural networks are a set of algorithms that are modeled loosely after the human brain and are designed to recognize patterns.
- The multiple layers of training are called Artificial Neural Networks (ANN).
- Each input is separately weighted, and the sum is passed through a non-linear function known as an activation function or transfer function.

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Artificial Neural Network: Definition

> "Artificial Neural Network (ANN) is a computing system made up of a number of simple, highly interconnected processing elements which process information by their dynamic state response to external inputs."
>
> - Robert Hecht-Nielsen

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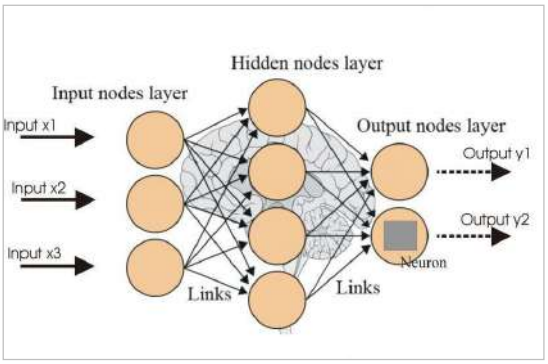
Features of Artificial Neuron



- Artificial neurons interpret sensory data through machine perception, labeling, or clustering raw input.
- They recognize numerical patterns contained in vectors. These vectors contain real world data such as images, sound, text, or time series.
- Neural networks help to cluster and classify the raw input.
- They can be considered a clustering and classification layer on top of the data stored and managed.
- They classify labeled dataset based on expected results.
- They group unlabeled dataset based on the similarities in the inputs.

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Definition of Perceptron

> A perceptron is a neural network unit (an artificial neuron) that does certain computations to detect features or business intelligence in the input data.

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Meaning of Multilayer Perceptron

- The field of artificial neural networks is often called neural networks or multilayer perceptron.
- A perceptron is a single neuron model that is a precursor to larger neural networks.
- It investigates how simple models of biological brains can be used to solve difficult computational tasks like the predictive modeling in machine learning.
- The goal is to develop robust algorithms and data structures that can be used to model difficult problems.

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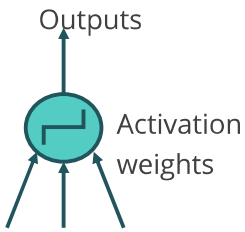
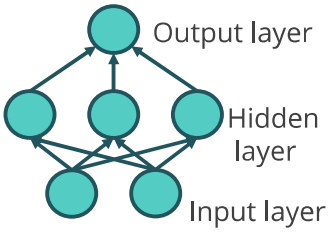
Structure of Multilayer Perceptron



Model of a simple neuron



Model of a simple network

- A row of neurons is called a layer, and one network can have multiple layers.
- The architecture of the neurons in the network is often called the network topology.
- Layers after the input layer are called hidden layers because they are not directly exposed to the input.
- The simplest network structure is to have a single neuron in the hidden layer that directly outputs the value.
- The final hidden layer is called the output layer.

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Online and Batch Learning

- Once configured, the neural network needs to be trained on the dataset.

Online learning

The weights in the network are updated from the errors calculated for each training example. This is called online learning.

Batch learning

The errors can be saved up across all of the training examples, and the network can be updated at the end. This is called batch learning.

- Once a neural network has been trained, it can be used to make predictions.

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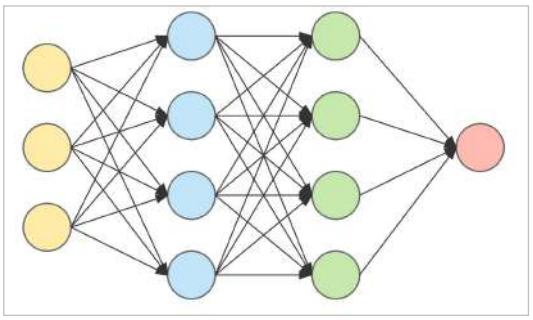
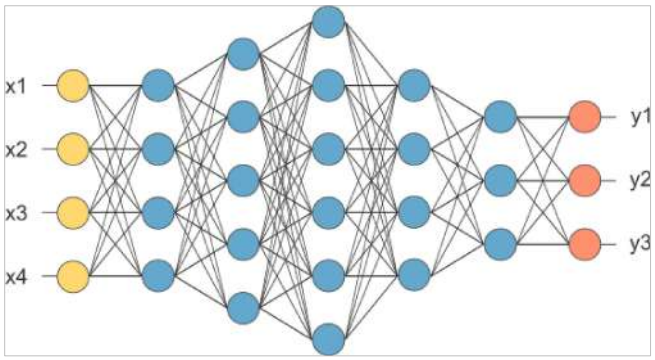
Deep Neural Networks



- Artificial Neural Networks (ANN) are multi-layer fully-connected neural nets.



- Deep Neural Networks (DNN) are layers that have more than one hidden layer between input and output layers.

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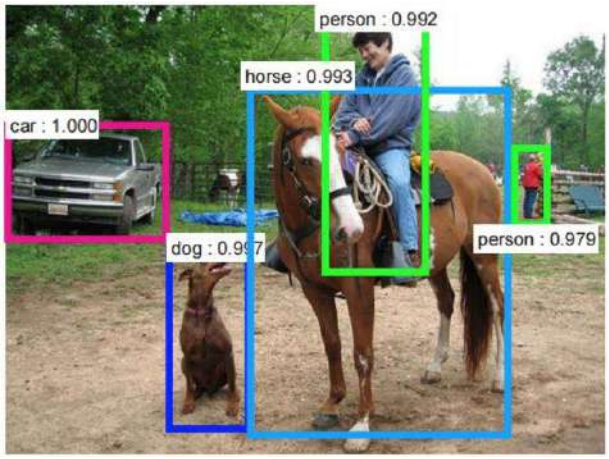
Convolutional Neural Networks (CNN)



Convolutional Neural Networks

- Convolutional Neural Networks (CNN) are neural networks mainly used for image processing and classification.

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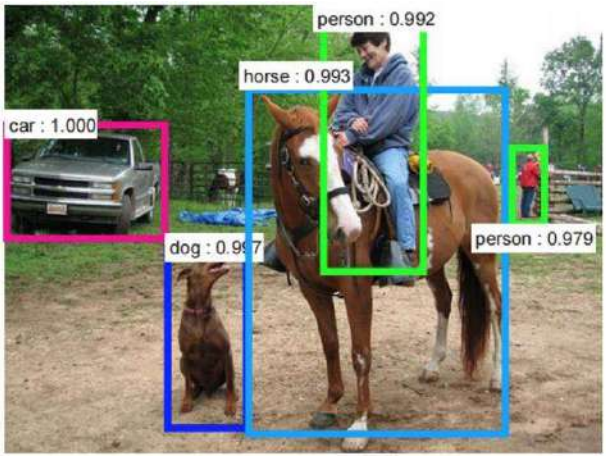
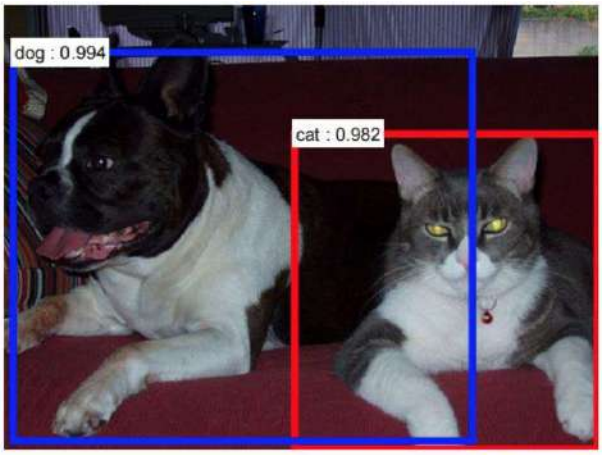
Convolutional Neural Network (CNN)





Until quite recently, computers were not good at tasks like recognizing a puppy in a picture or recognizing spoken words, which humans excel at.

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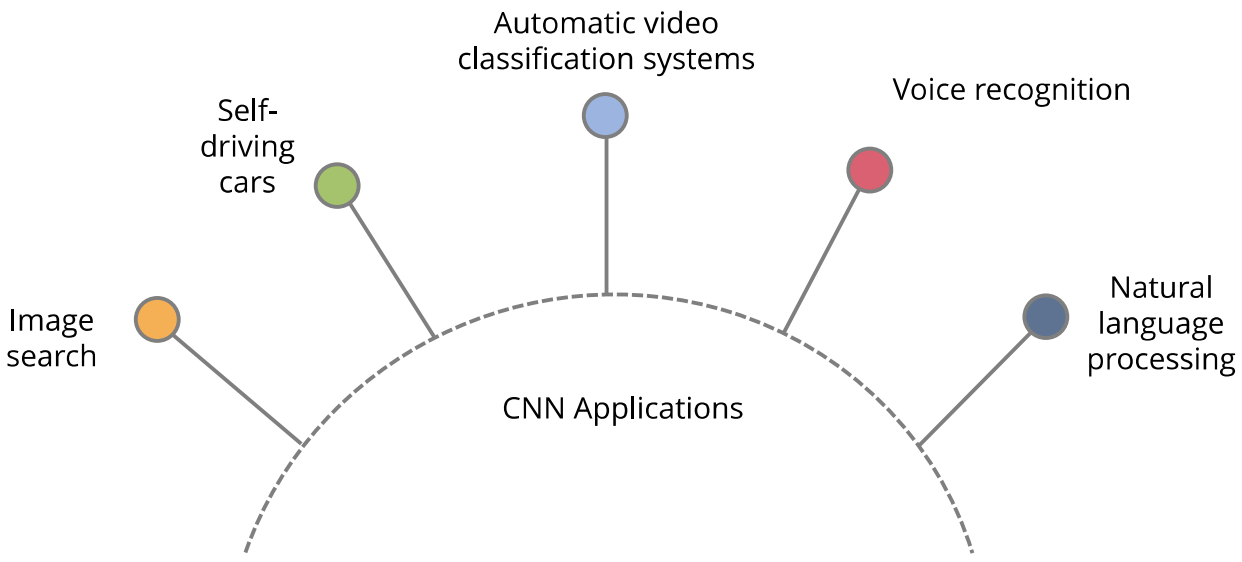
Uses of CNN

CNN is trained and used in the following ways:



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Quiz Time

Do you think artificial intelligence would surpass human intelligence?

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Predicted Future: AI in News

Google develops artificial intelligence algorithm that predicts your death with 95% accuracy.

Singularity is predicted to be achieved by 2045 when computers will have the same level of intelligence as that of humans.

Forbes estimates that 85% of customer interactions will be managed by AI by 2020.

The world's leading car manufacturers predict driverless cars will be on the streets by 2020–2030.

Doomsday AI machines could lead to nuclear war, think tank paper warns.

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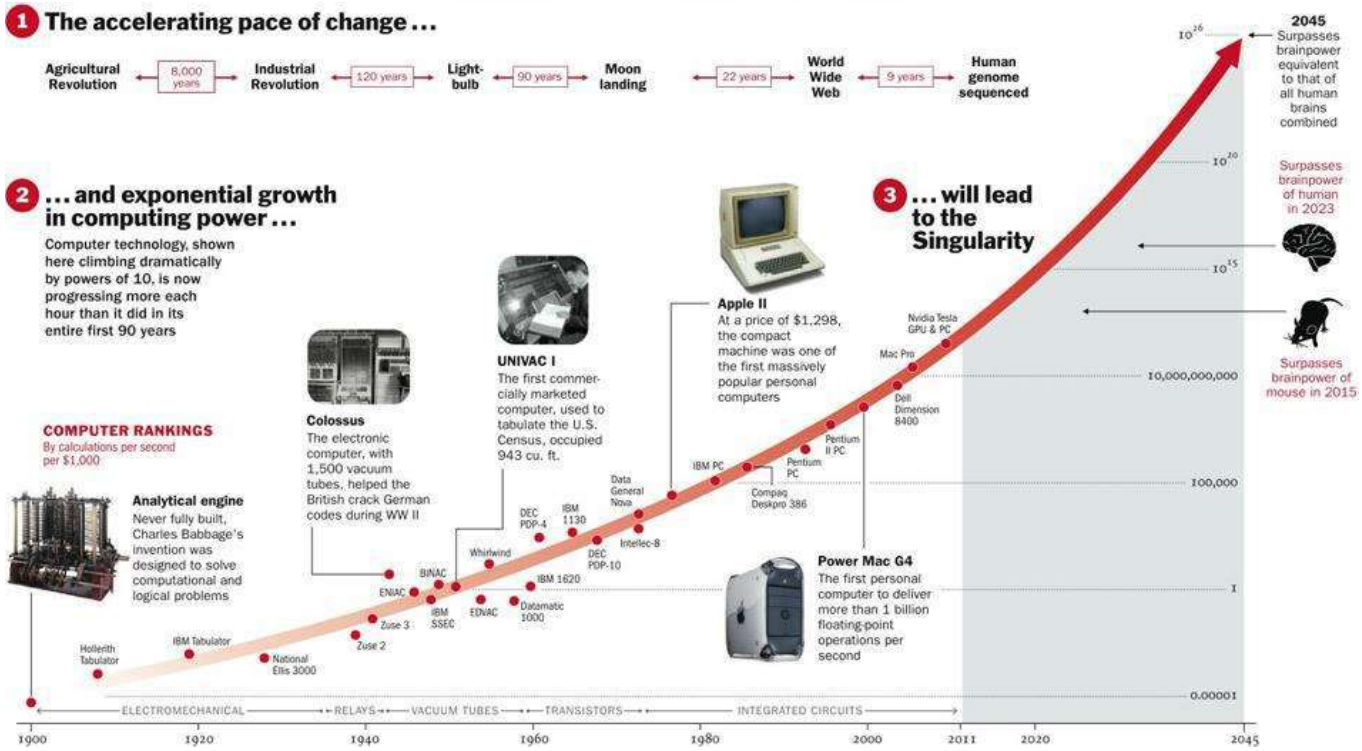
Predicted Future of AI



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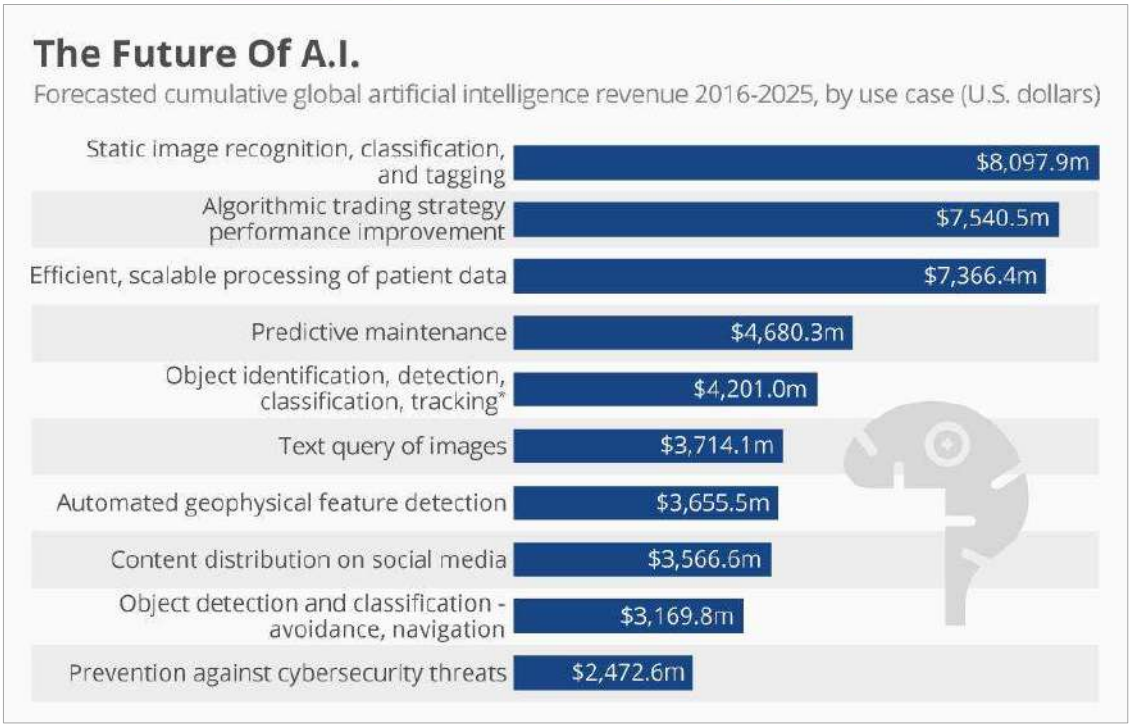
Source: https://www.Time.com/

Future Forecasted Revenue of AI



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Source: https://www.statista.com/

QUIZ 1	What are the different ways in which a machine can learn?

a. Supervised and unsupervised

b. Supervised, unsupervised, and semi-supervised

c. Unsupervised and semi-supervised

d. Supervised and semi-supervised

QUIZ 1

What are the different ways in which a machine can learn?

a. Supervised and unsupervised

b. Supervised, unsupervised, and semi-supervised

c. Unsupervised and semi-supervised

d. Supervised and semi-supervised

The correct answer is **b**

Supervised, unsupervised, and semi-supervised

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QUIZ 2

Give applications of each type of machine learning.

a. Supervised: clustering, unsupervised: airplane booking, semi-supervised: Image recognition

b. Supervised: web page classification, unsupervised: spam detection, semi-supervised: mapping or clustering

c. Supervised and unsupervised: bioinformatics, semi-supervised: mapping or clustering

d. Supervised: bioinformatics, unsupervised: supply chain carrier analysis, mapping/clustering, semi-supervised: web page classification

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d. Supervised: bioinformatics, unsupervised: supply chain carrier analysis, mapping/clustering, semi-supervised: web page classification

The correct answer is **d**

Supervised: bioinformatics, unsupervised: supply chain carrier analysis, mapping/clustering, semi-supervised: web page classification

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QUIZ 3

What are some of the machine learning Algorithms?

a. Decision trees, XGboost, Google Vision API

b. Random forests, regression (linear and logistic) but not KNN

c. Regression, decision trees, Naive Bayes, K-Means clustering

d. XGboost, Adaboost, regression except Naive Bayes

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c. Regression, decision trees, Naive Bayes, K-Means clustering

d. XGboost, Adaboost, regression except Naive Bayes

The correct answer is **C**

Regression, decision trees, Naive Bayes, K-Means clustering

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QUIZ 4

What is the basic concept of deep learning?

a. Deep learning is a subset of machine learning in Artificial Intelligence (AI) with networks capable of learning unsupervised from data that is unstructured or unlabeled.

b. Machine learning is a subset of deep learning in Artificial Intelligence (AI) that has human brain networks capable of learning unsupervised from data that is unstructured or unlabeled.

c. Deep learning is a set of algorithms that are arranged one after another in tandem (like regression, KNN, Naive Bayes, decision trees), to enable maximum accuracy.

d. None of the above

QUIZ 4

What is the basic concept of deep learning?

a. Deep learning is a subset of machine learning in Artificial Intelligence (AI) with networks capable of learning unsupervised from data that is unstructured or unlabeled.

b. Machine learning is a subset of deep learning in Artificial Intelligence (AI) that has human brain networks capable of learning unsupervised from data that is unstructured or unlabeled.

c. Deep learning is a set of algorithms that are arranged one after another in tandem (like Regression, KNN, Naive Bayes, decision trees), to enable maximum accuracy.

d. None of the above

The correct answer is **a**

Deep learning is a subset of machine learning in Artificial Intelligence (AI) that has networks capable of learning unsupervised from data that is unstructured or unlabeled. Also known as Deep Neural Learning or Deep Neural Network.

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Key Takeaways

- Machine learning algorithm learns from data, whereas statistical model is a formalization of relationships between variables.
- Supervised learning, unsupervised learning, and semi-supervised learning are the three types of machine learning.
- Reinforcement learning is an area of machine learning which is used when the training data has a feedback loop.
- A decision tree is a tree-like graph that uses the branching method to demonstrate every possible outcome of a decision.
- Naive Bayes' is a classification technique which assumes that the presence of a particular feature in a class is unrelated to the presence of any other feature.
- K-means clustering is a type of unsupervised learning, which is used to solve clustering problem.
- Neural networks are set of algorithms that are modeled loosely after the human brain and are designed to recognize patterns.

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1 Robots are an example of this type of machine learning. Identify the type.

SELECT THE CORRECT ANSWER

- A. Supervised learning
- B. Semi-supervised learning
- C. Reinforcement ✓
- D. Unsupervised Learning

Correct Option: C

EXPLANATION

In a manufacturing unit, a robot uses deep reinforcement learning to identify a device from one box and put it in a container. The robot learns by means of a rewards-based learning system, which incentivizes it for the right action.

2 What are some of the Machine Learning algorithms?

SELECT THE CORRECT ANSWER

- A. Decision trees, XGboost, Google Vision API
- B. Random forests, regression (linear and logistic) but not KNN
- C. Regression, decision trees, Naive Bayes, K-Means clustering ✓
- D. XGboost, Adaboost, regression except Naive Bayes

Correct Option: C

EXPLANATION

Regression, decision trees, Naive Bayes, and K-Means clustering are some of the machine learning algorithms used.