Python

Python Language

Python is a **high level interpreted**, **interactive**, and **object-oriented** programming language created by Guido Rossum in 1989.

Like Perl, Python programming language used to generate web application and desktops Graphical User Interface.

Python Language

Python is one of the ***scripting languages*** which were ideally, designed for prototyping of complex applications.

Python can interface with many OS systems, libraries and extensible languages like C and C++..

Python Language

The top companies in the world like NASA, Google, YouTube etc works on Python Programming language for their web applications.

Introduction to Python

For anyone serious about pursuing and growing in a career in IT, a basic question that roils the mind is this: which is the best programming language to learn? Most people who want answers to this question tend to get slightly confused, because they would have heard about multiple languages, such as **Java**, **Python**, **PHP**, etc. It is in selecting that one truly apt programming language to learn that the challenge lies.

Even learners who are fully aware of the benefits of most programming languages are in a fix about choosing the one language they should learn, and also about the best ways to learn a programming language.

It is very important for the students to make the right choice from the start as it will take a lot of time and effort to master any given programming language. While selecting any programming language to learn, students need to consider few aspects such as:

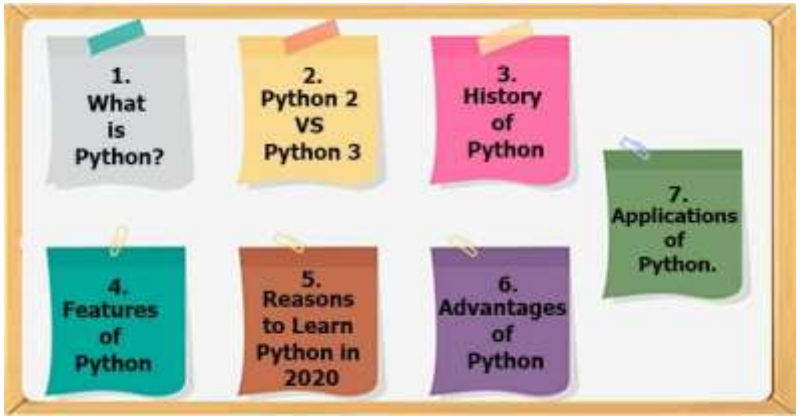
- The difficulty level of a programming language you are willing to learn
- The skills you already know that align with a programming language
- Reasons you want to learn a programming language.

Every programming language has its advantages as well as disadvantages. A language that is perfectly suited for developing a certain types of applications might not fit for developing other types.

So, keeping the debate aside of which programming language is good to learn among all, here in the following discussion we will focus towards understanding what is Python

programming language and what are its benefits. At a later stage of this blog, we will discuss different reasons to learn Python.

In the upcoming discussion we will focus on the following topics:



- What is Python?
- Python 2 VS Python 3
- History of Python
- Features of Python
- Reasons to learn Python in 2020
- Advantages of Python
- Applications of Python.

Initially, let us discuss what is Python

What is Python? This is one of the most asked questions these days in the technology space. The answer is, Python is one of the powerful programming languages that is high-level, open-source, and most commonly used for web development, scientific and mathematical application development, etc.

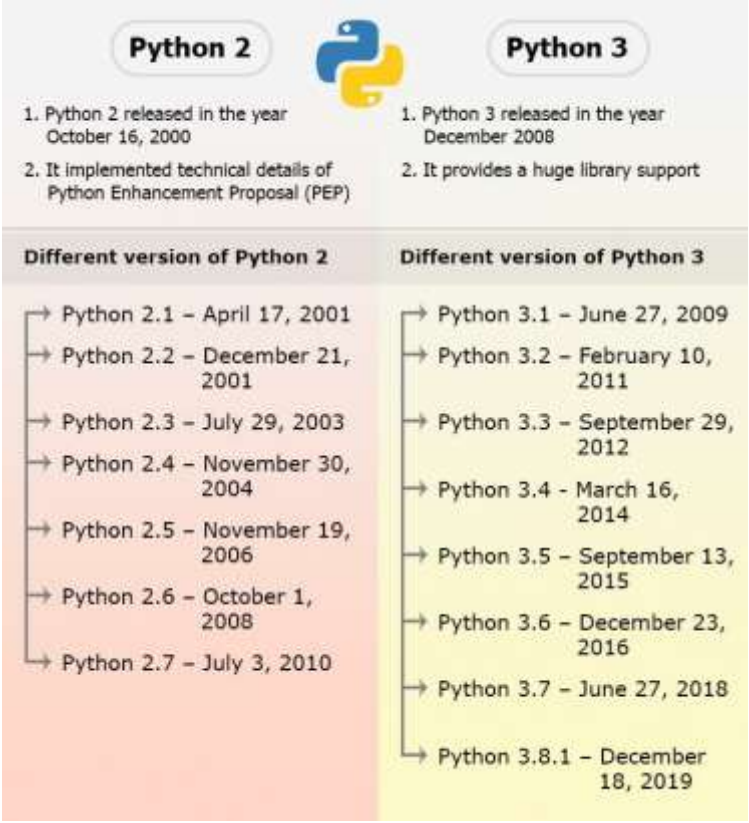
One of the great advantages of this programming language is it provides excellent library support and has a large developer community. It also provides easy integration with web services and GUI-based desktop applications.

- ***"Did You Know? Python is one of the 9 programming languages that influenced the design of JavaScript".***

Python is fast, easy-to-use and the most preferred programming language for developing projects by many companies such as YouTube, Instagram, Pinterest, and Quora, etc. Because of its excellent features, Python is considered an easy to learn programming language for beginners and is also sophisticated enough for experienced professionals to use.

Apart from web development and desktop app development, Python is extensively used in the **Data Science** field and is used for developing **Machine Learning projects**. Because of its huge popularity, many IT professionals are learning this programming language to build their career as a Python developer.

Python 2 v/s Python 3



Having understood what is Python, let us start exploring the different versions of Python, such as Python 2 and Python 3. Later we will look at the major differences between them.

Python 2: Python 2 has been the more popular version. This version released in the year 2000 and made the code development process very easy compared to its earlier versions.

Python 2 is a more transparent and inclusive language development process than its earlier versions.

Python 2 has implemented technical details of Python Enhancement Proposal (PEP). Python 2.7 or Python 2.7.20 is the last version of Python 2 and is no longer under development and in the year 2020, it will be discontinued.

Different versions of Python and their release dates are as follows:

- Python 2.0 – October 16, 2000
- Python 2.1 – April 17, 2001
- Python 2.2 – December 21, 2001
- Python 2.3 – July 29, 2003
- Python 2.4 – November 30, 2004
- Python 2.5 – November 19, 2006
- Python 2.6 – October 1, 2008
- Python 2.7 – July 3, 2010

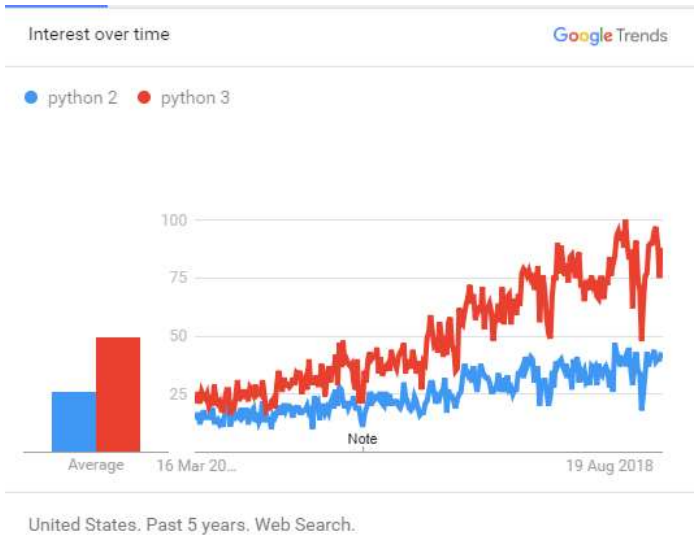
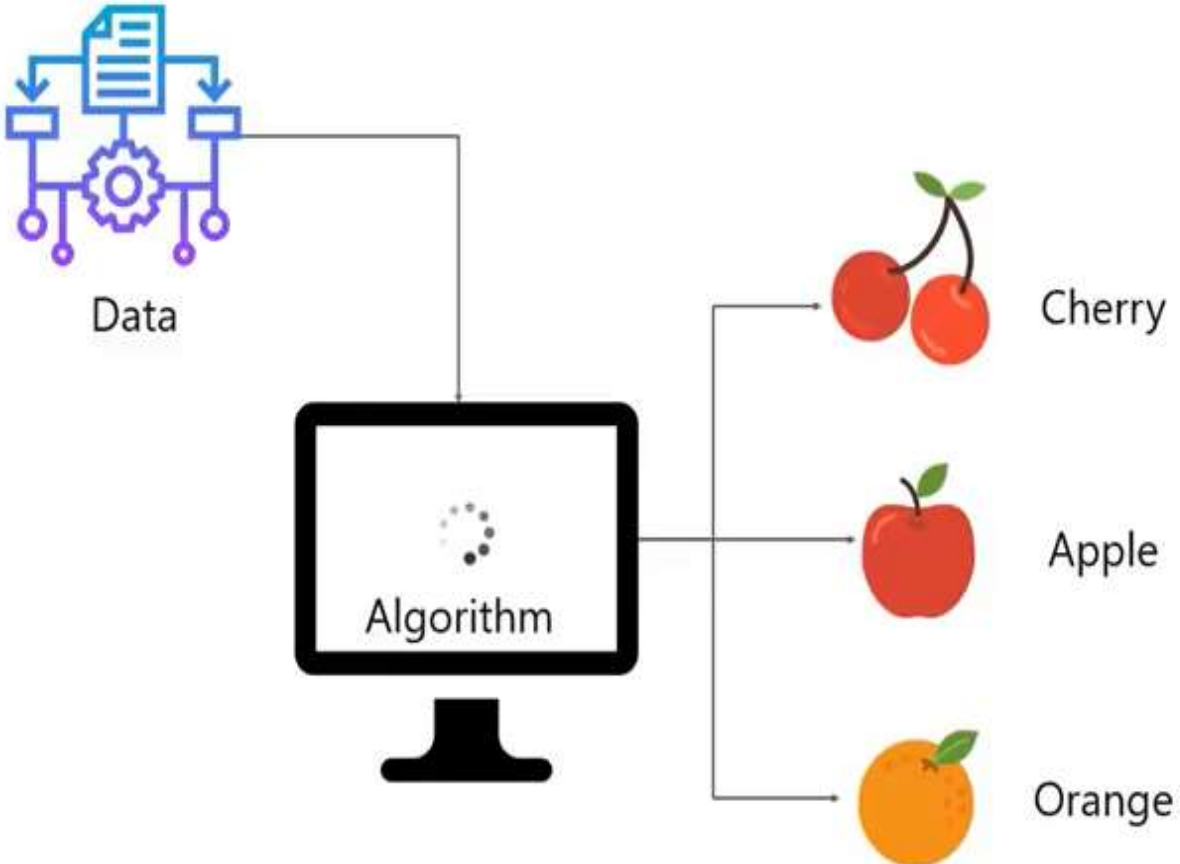


Image source: Guru99

Python 3: Python 3 is an improved version. It was released in the year December 2008. This version was released with the aim of fixing the errors that existed in Python 2. Many companies are switching towards Python 3 version. This version provides huge library support.

What Is Machine Learning?

Machine learning is a subset of artificial intelligence (AI) which provides machines the ability to learn automatically & improve from experience without being explicitly programmed.



Types Of Machine Learning

Supervised Learning

Unsupervised Learning

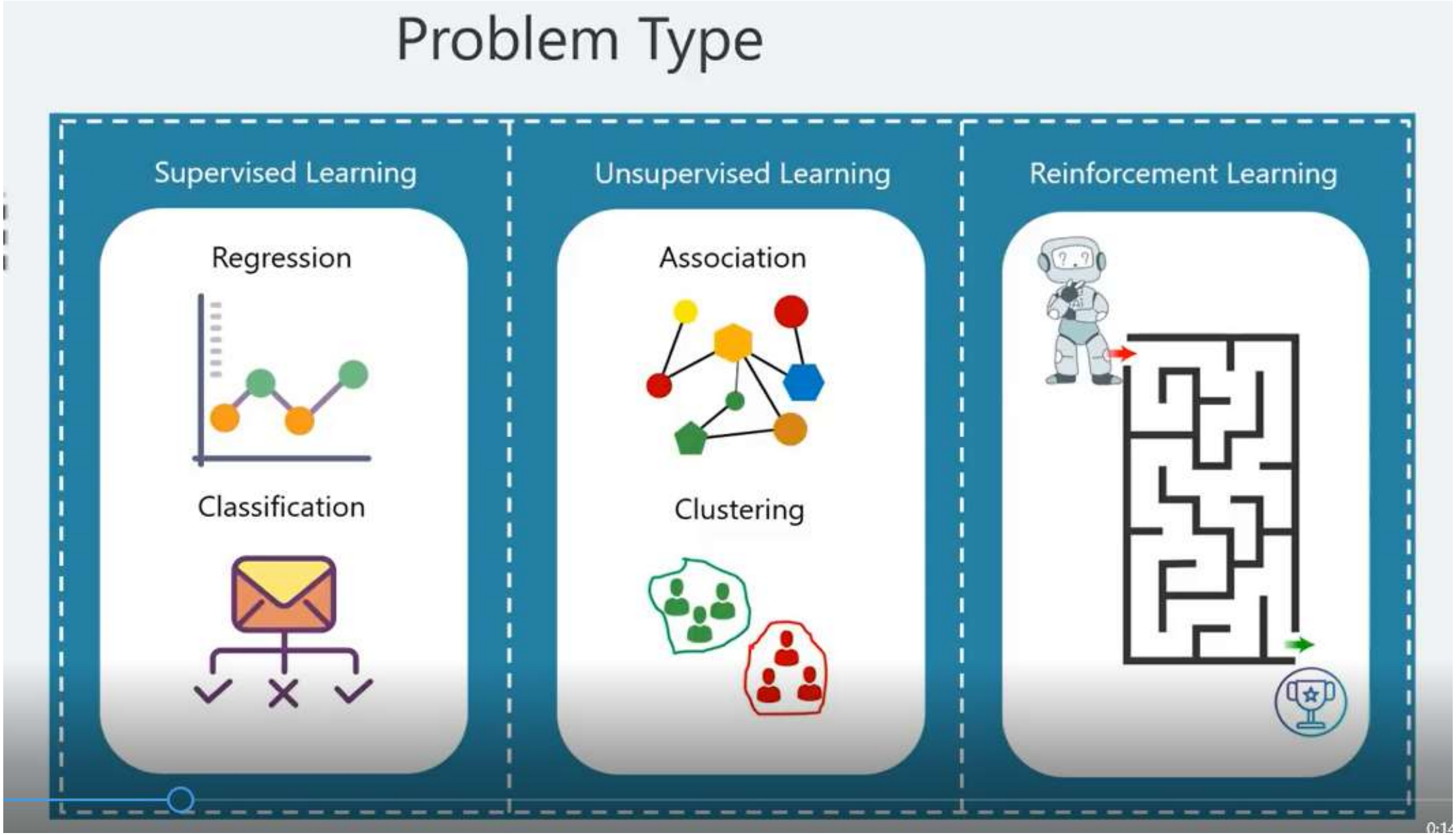
Reinforcement Learning

Supervised learning is a method in which we teach the machine using labelled data

In unsupervised learning the machine is trained on unlabelled data without any guidance

In Reinforcement learning an agent interacts with its environment by producing actions & discovers errors or rewards

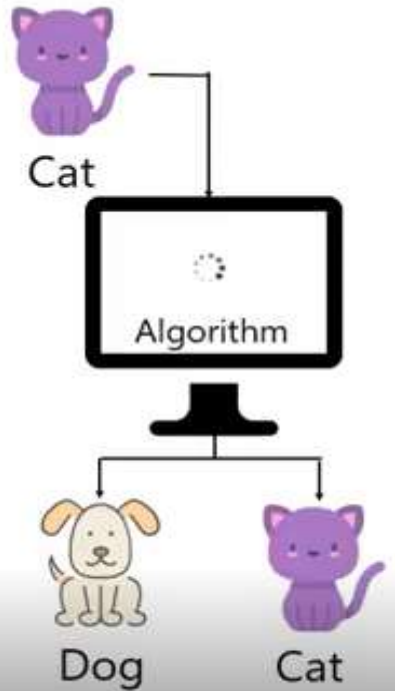
Problem Type



Type of data

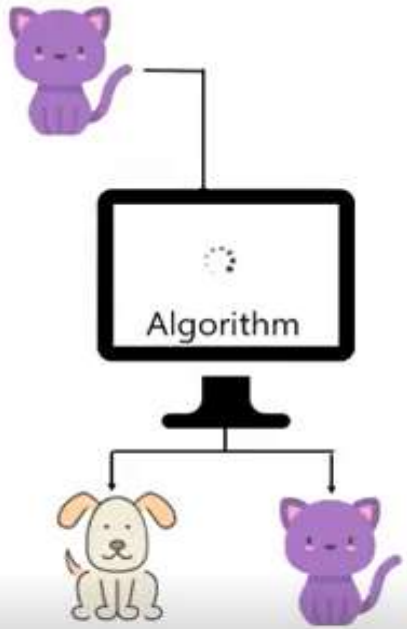
Supervised Learning

Labelled Data



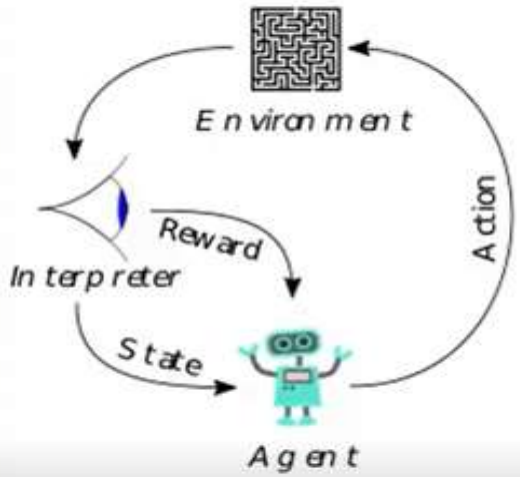
Unsupervised Learning

Unlabelled Data



Reinforcement Learning

No Predefined Data



Training

Supervised Learning

External supervision

Unsupervised Learning

No supervision

Reinforcement Learning

No supervision

Aim

Supervised Learning

Forecast outcomes

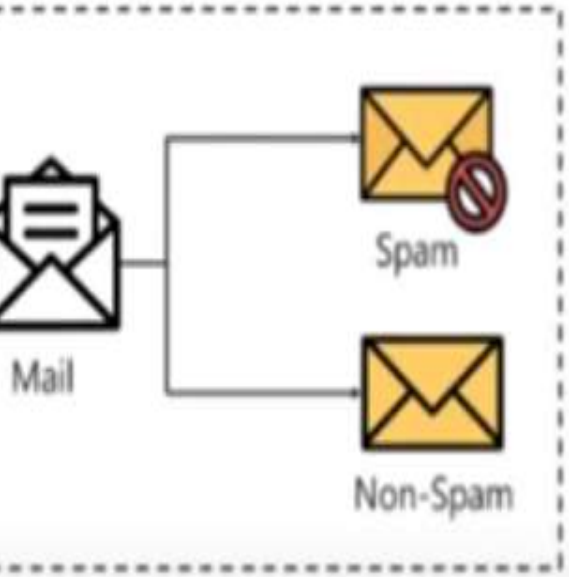
Unsupervised Learning

Discover underlying patterns

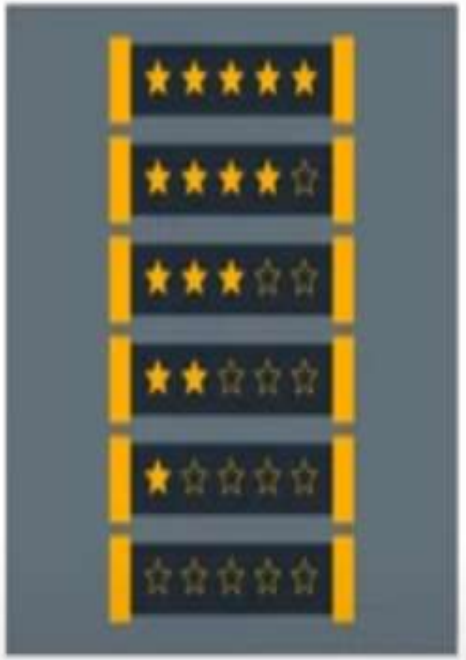
Reinforcement Learning

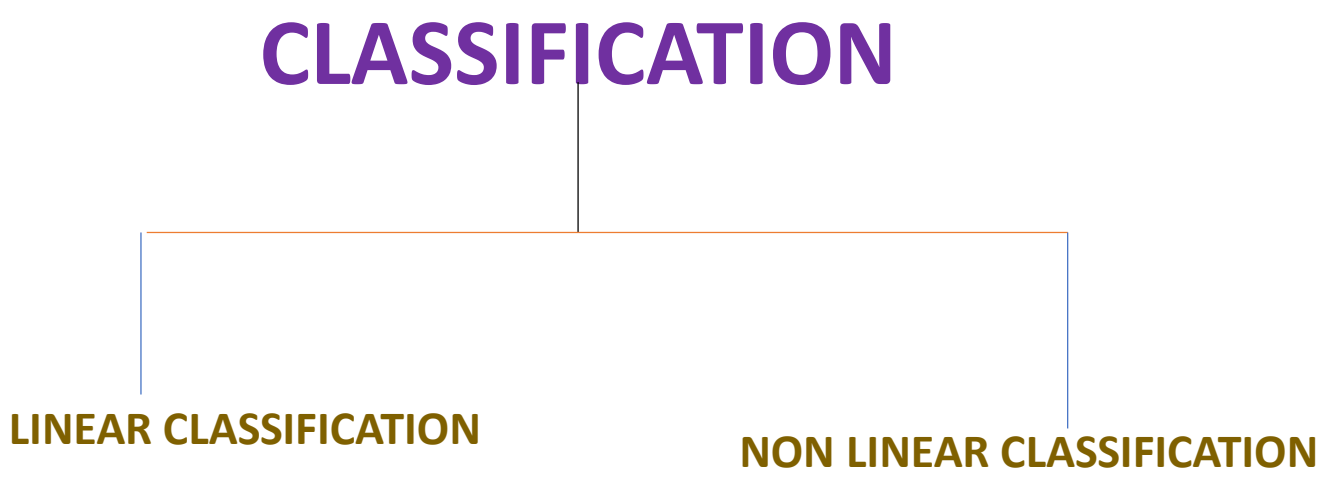
Learn series of action

What is Classification In Machine Learning?

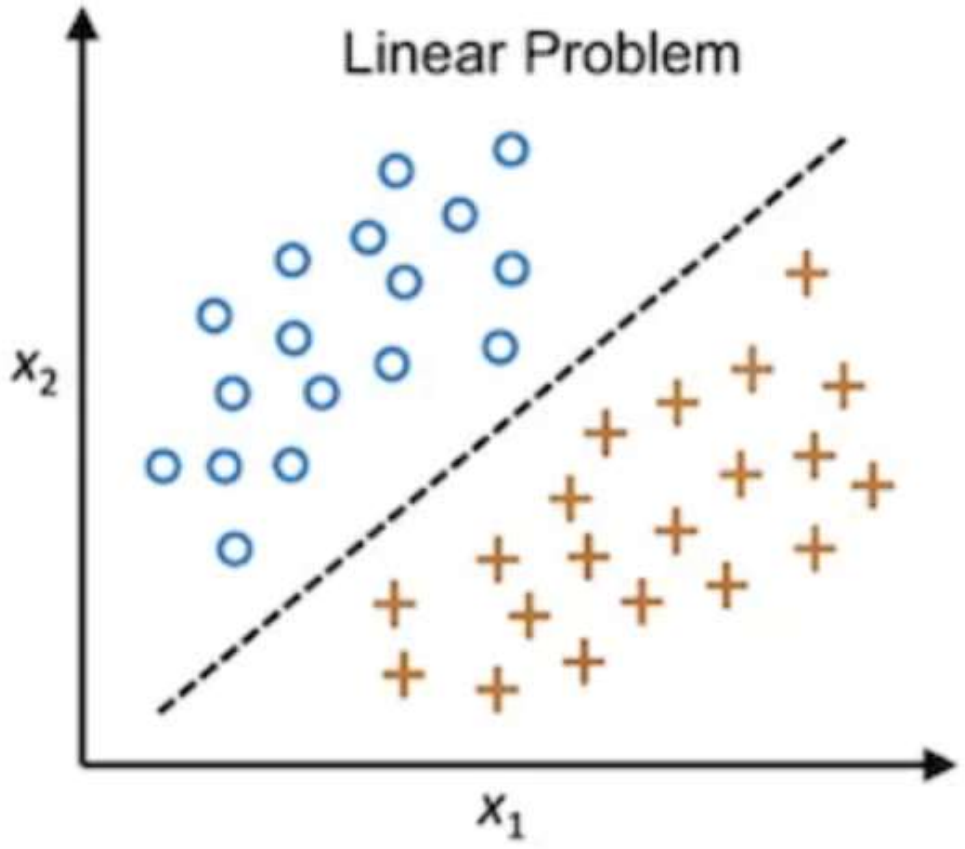


Classification is a process of categorizing a given set of data into classes, It can be performed on both structured or unstructured data. The process starts with predicting the class of given data points. The classes are often referred to as target, label or categories.




CLASSIFICATION
LINEAR CLASSIFICATION
NON LINEAR CLASSIFICATION

LINEAR CLASSIFICATION

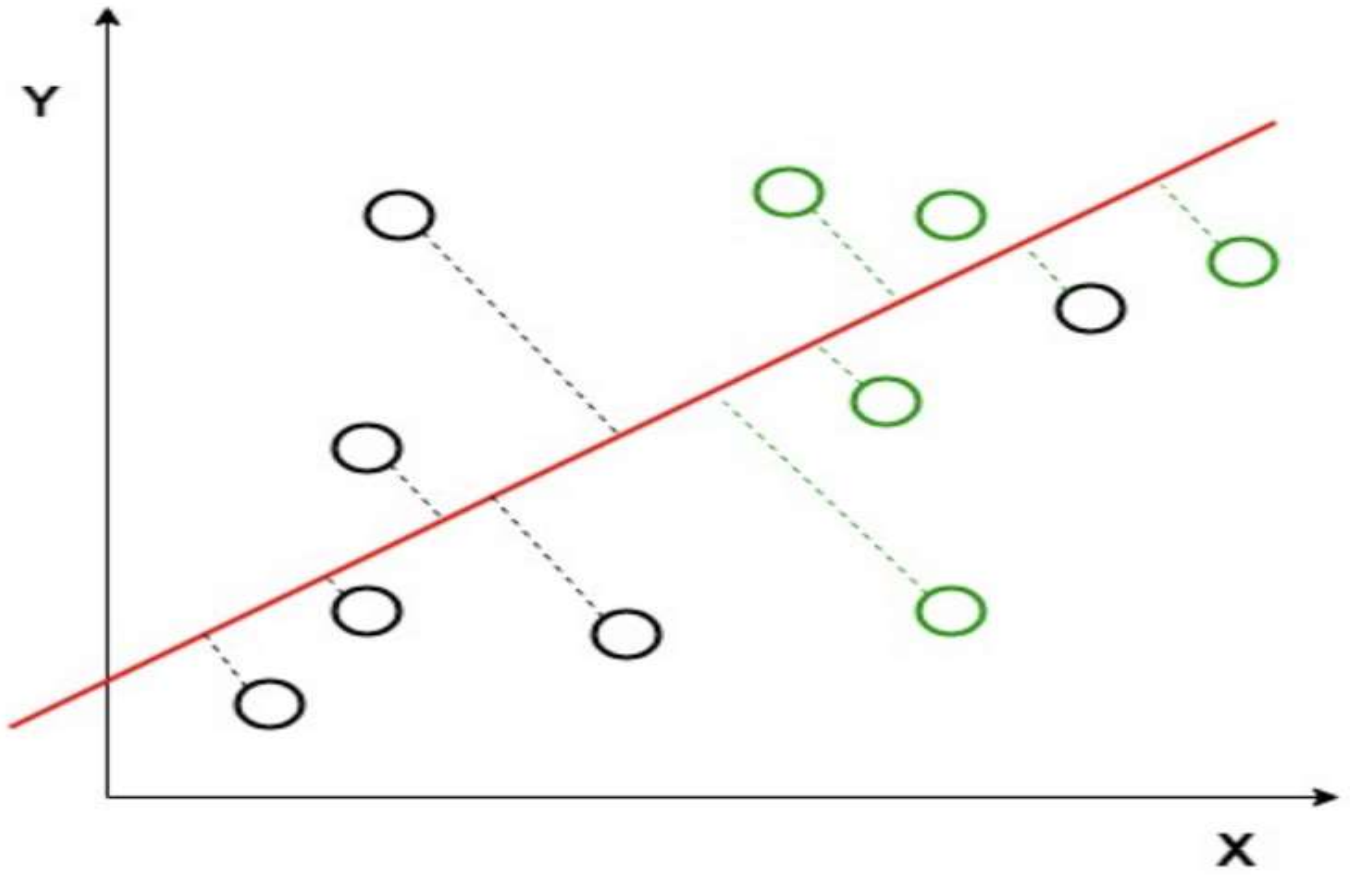


LINEAR CLASSIFICATION ALGORITHMS

- **Linear Discriminant Classifier**
- **Naive Bayes**
- **Logistic Regression**

Linear Discriminant Classifier

Linear Discriminant Analysis (LDA) is used, which reduced the 2D graph into a 1D graph by creating a new axis. This helps to maximize the distance between the two classes for differentiation.



Naive Bayes:

- It is based on the Bayes Theorem and lies in the domain of Supervised Machine Learning.
- Every feature is considered equal and independent of the others during Classification.
- Naive Bayes indicates the likelihood of occurrence of an event. It is also known as conditional probability.

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

The Naive Bayes classifier is based on two essential assumptions:

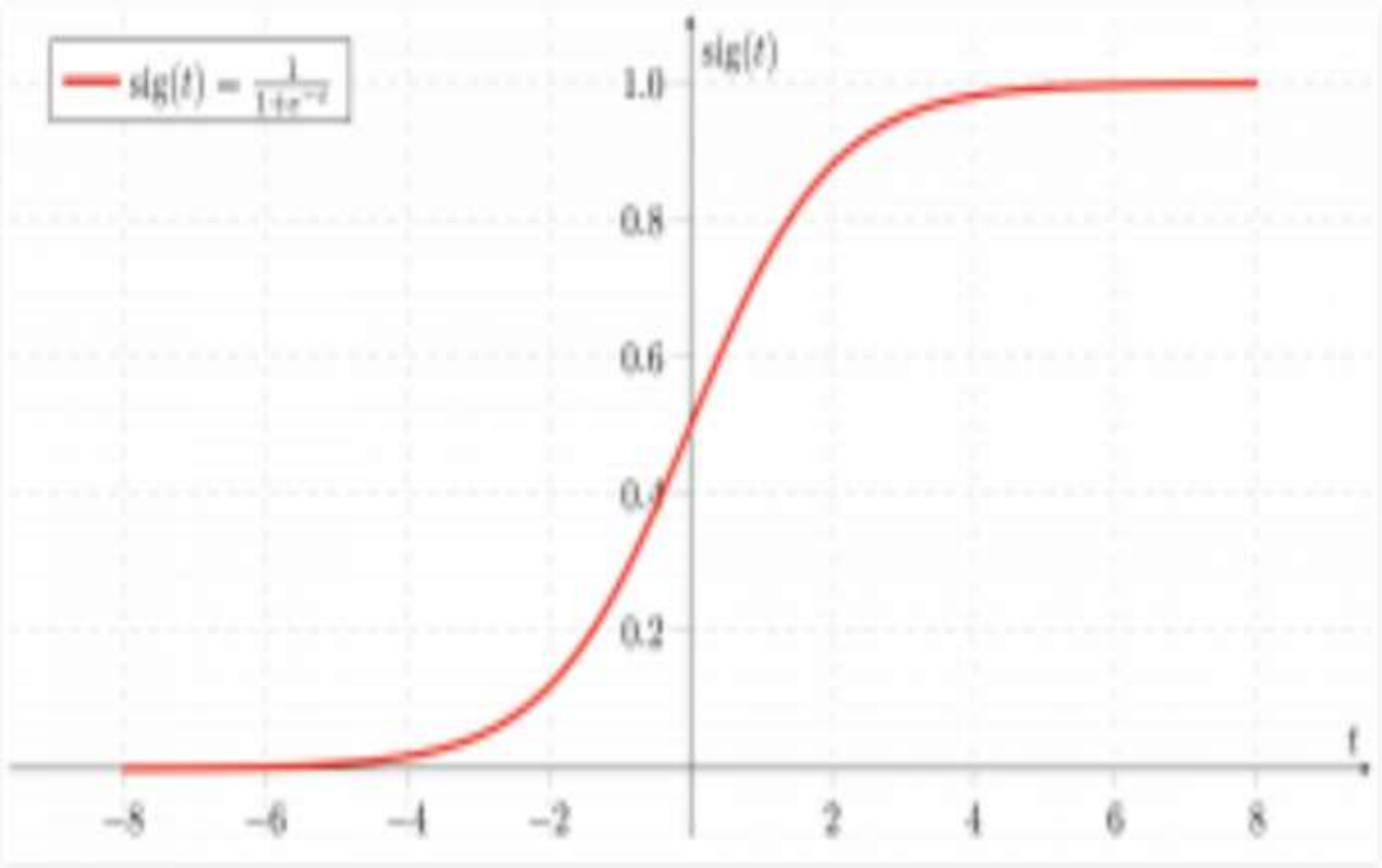
(i) **Conditional Independence -** All features are independent of each other. This implies that one feature does not affect the performance of the other. This is the sole reason behind the ‘Naive’ in ‘Naive Bayes.’

(ii) **Feature Importance -** All features are equally important. It is essential to know all the features to make good predictions and get the most accurate results.

Logistic Regression :

→ The model builds a regression model to predict the probability of a given data entry.
→ Similar to linear regression, logistic regression uses a linear function and, in addition, makes use of the 'sigmoid' function.

$$g(z) = \frac{1}{1+e^{-z}}$$

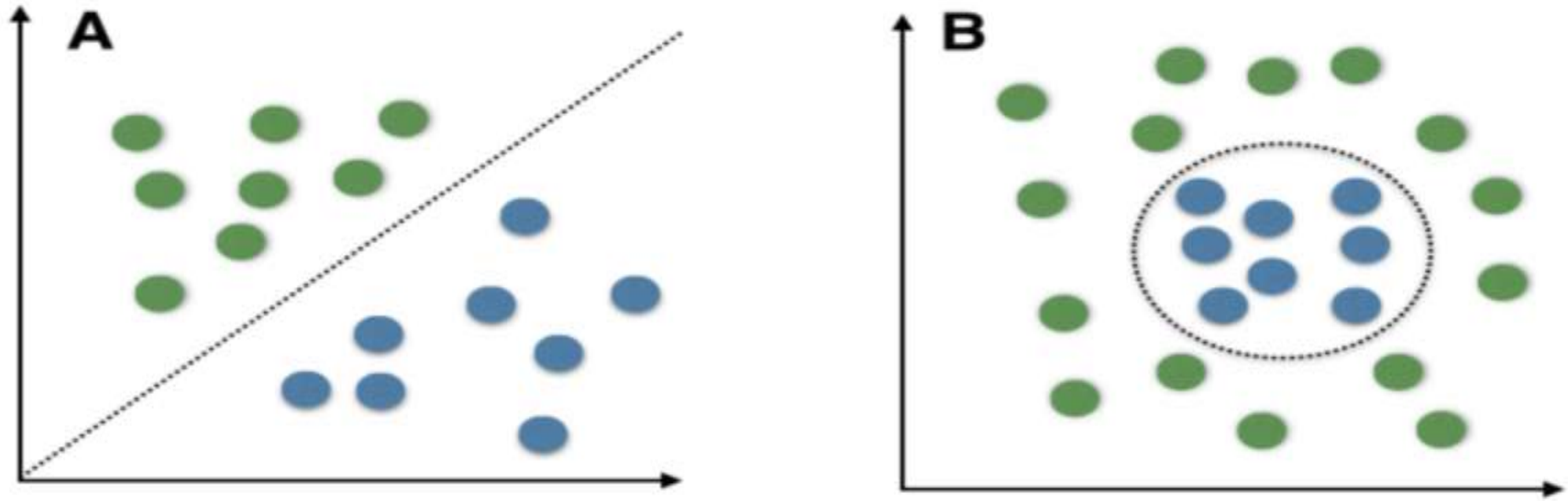


Support Vector Machine (linear kernel)

→ It is a straightforward supervised machine learning algorithm used for regression/classification.

→ In the case of SVM, the classifier with the highest score is chosen as the output of the SVM.

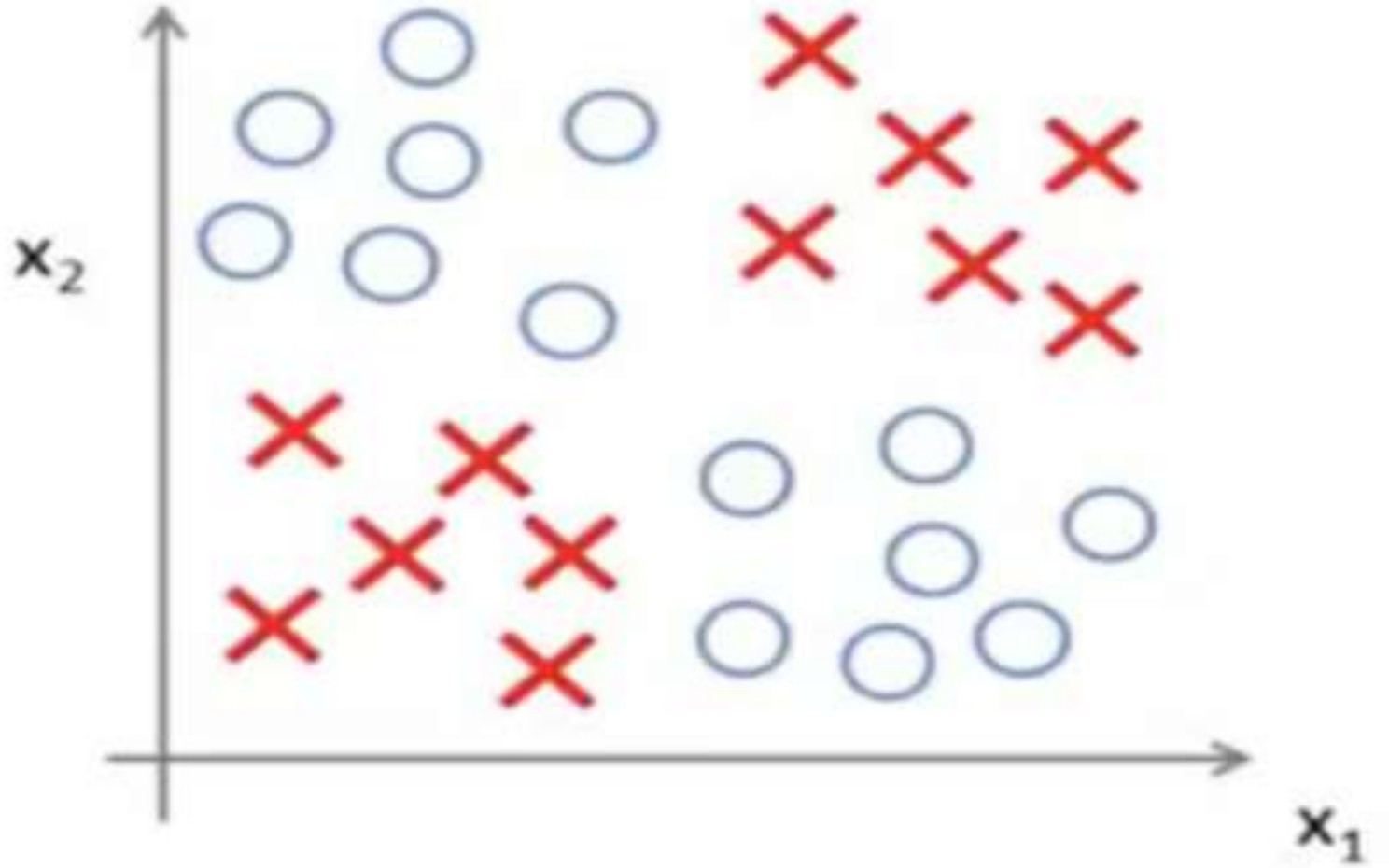
→ SVM works very well with linearly separable data but can work for non-linearly separable data as well.



A: Linearly Separable Data B: Non-Linearly Separable Data

Non-Linear Classification:

→ Non-Linear Classification refers to categorizing those instances that are not linearly separable.



Non-Linear Classification Algorithms

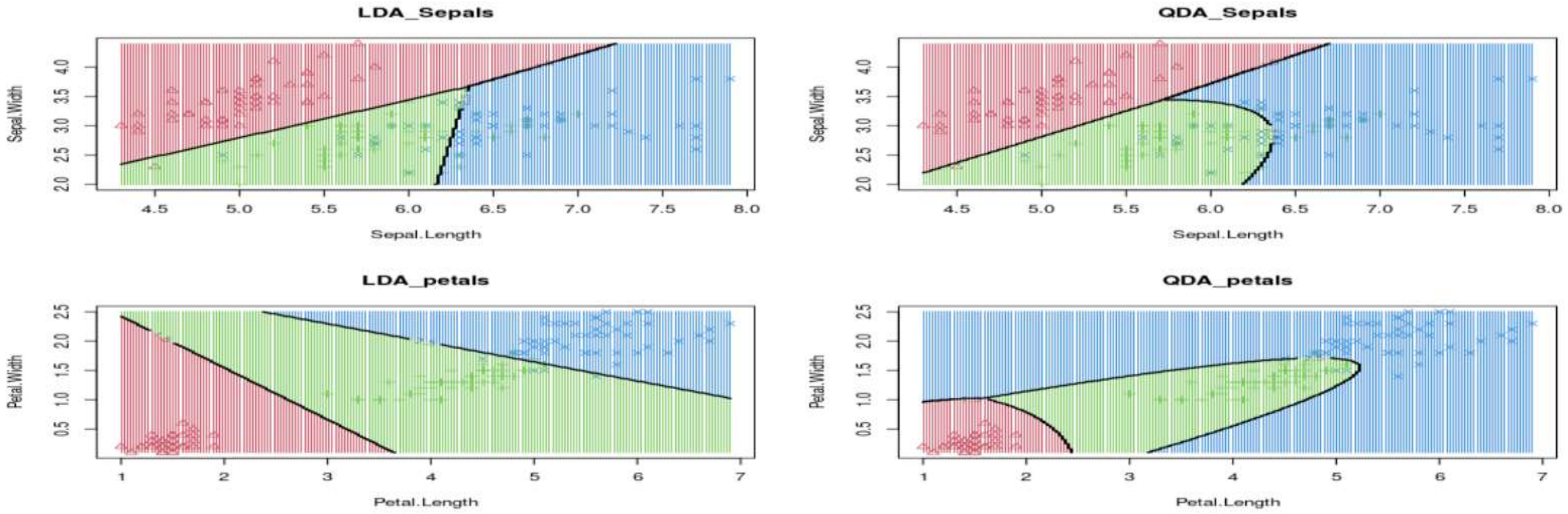
- **Quadratic Discriminant Classifier**
- **Multi-Layer Perceptron (MLP):**
- **Decision Tree:**
- **K-Nearest Neighbours:**
- **Random Forest Algorithm:**

Quadratic Discriminant Classifier

→ This technique is similar to LDA(Linear Discriminant Analysis) discussed above.

→ The only difference is that here, we do not assume that the mean and covariance of all classes are the same.

$$\delta_k(x) = \log \pi_k - \frac{1}{2}\mu_k^T \Sigma_k^{-1} \mu_k + x^T \Sigma_k^{-1} \mu_k - \frac{1}{2} x^T \Sigma_k^{-1} x - \frac{1}{2} \log |\Sigma_k|$$

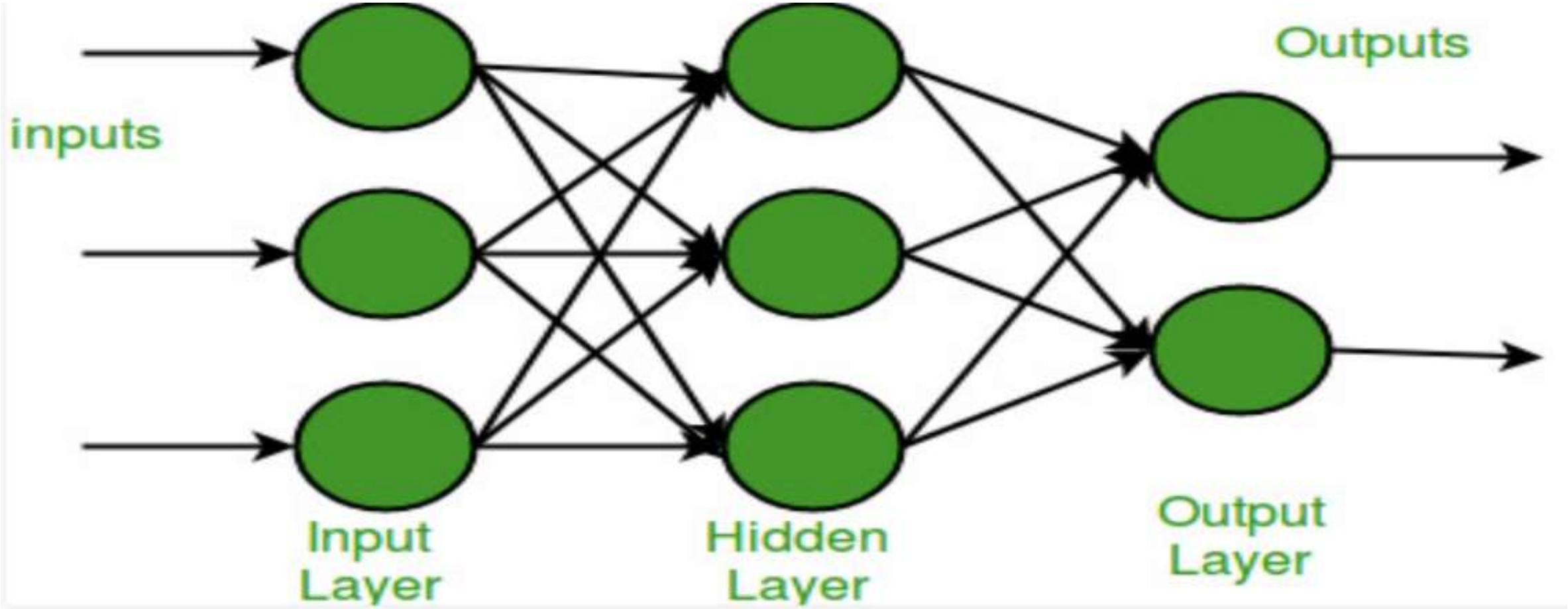


LDA and QDA visualization

Multi-Layer Perceptron (MLP):

→ This is nothing but a collection of fully connected dense layers. These help transform any given input dimension into the desired dimension.

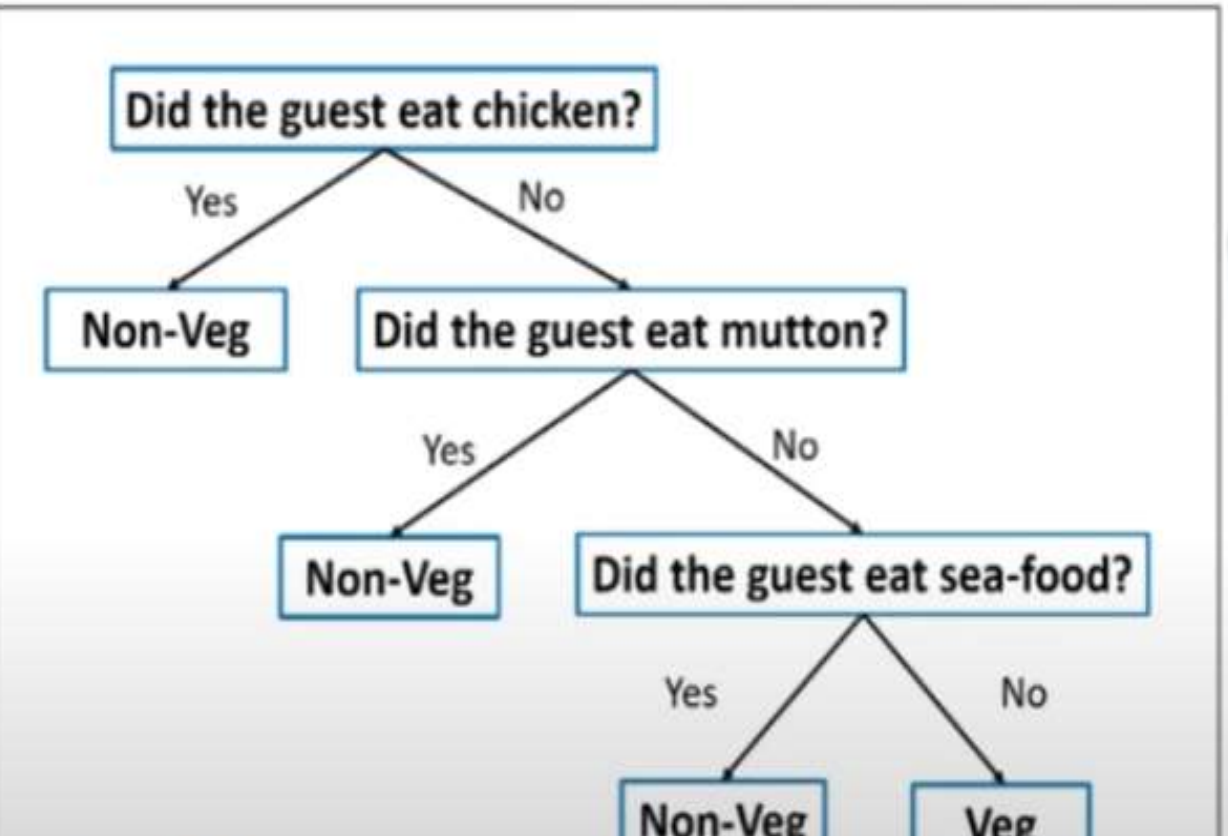
→ It is nothing but simply a neural network.



→ It is considered to be one of the most valuable and robust models.

→ Instances are classified by sorting them down from the root to some leaf node

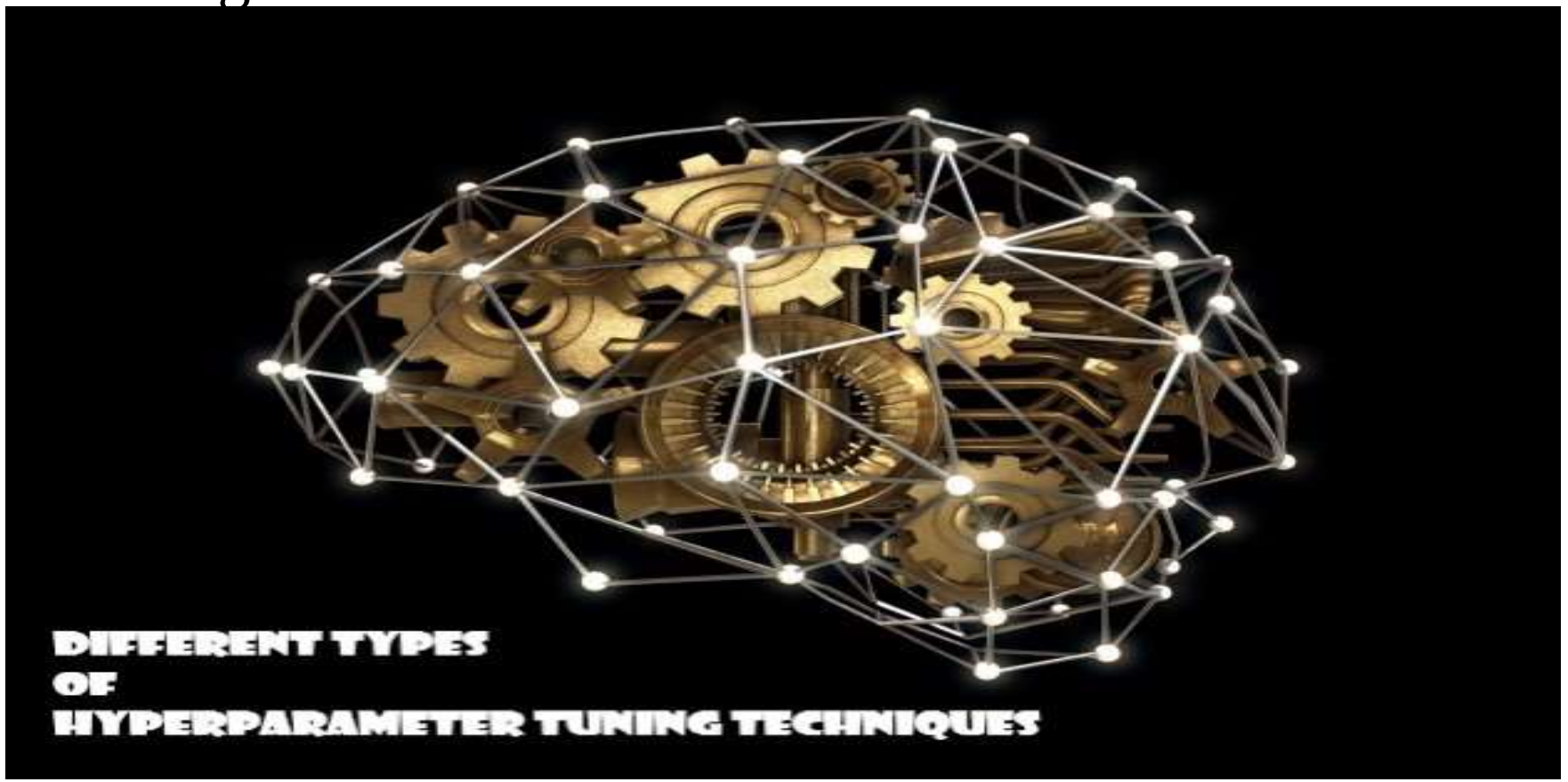
Decision Tree



The decision tree algorithm builds the classification model in the form of a tree structure. It utilizes the if-then rules which are equally exhaustive and mutually exclusive in classification.

Hyperparameter

Hyperparameters are the tunable parameters adjusted before running the training process. These parameters directly affect model performance and help you achieve faster global minima.



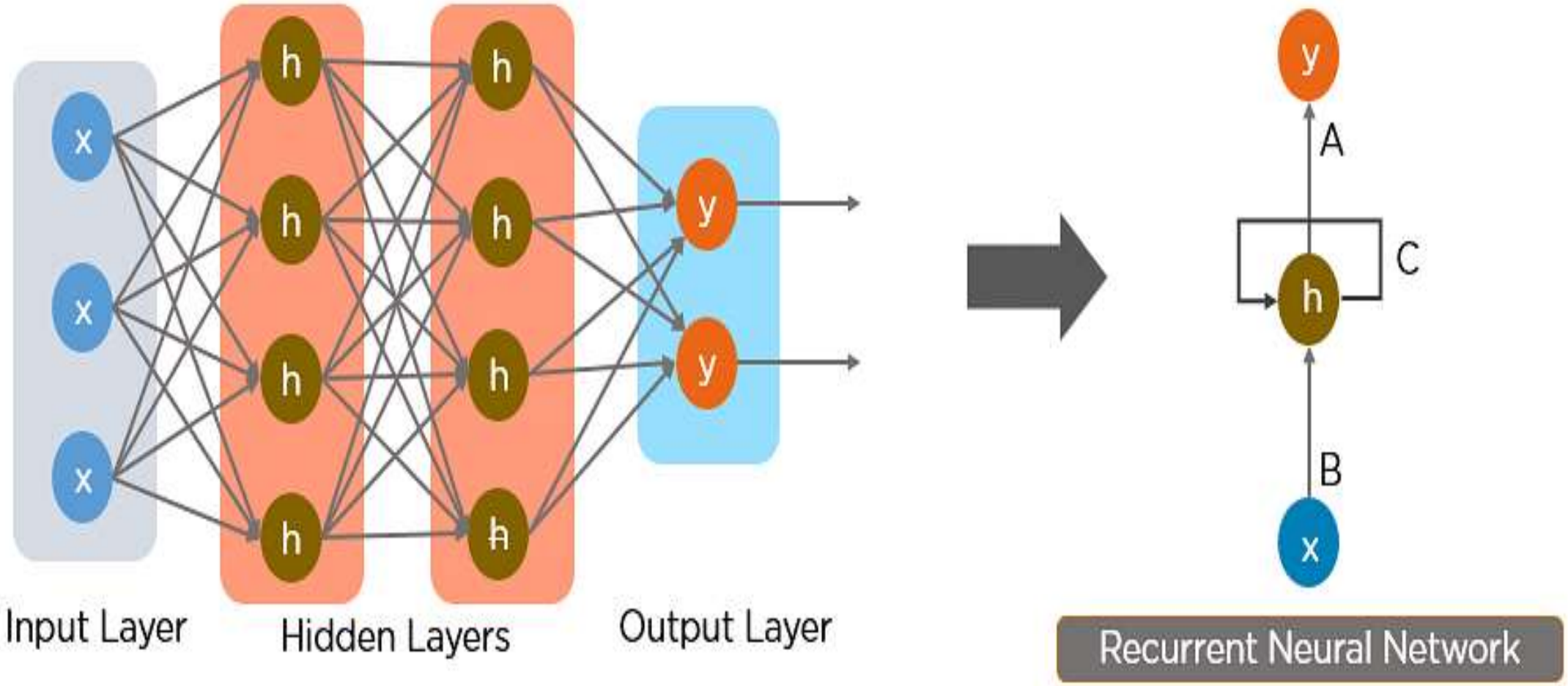
List of most used hyperparameters:

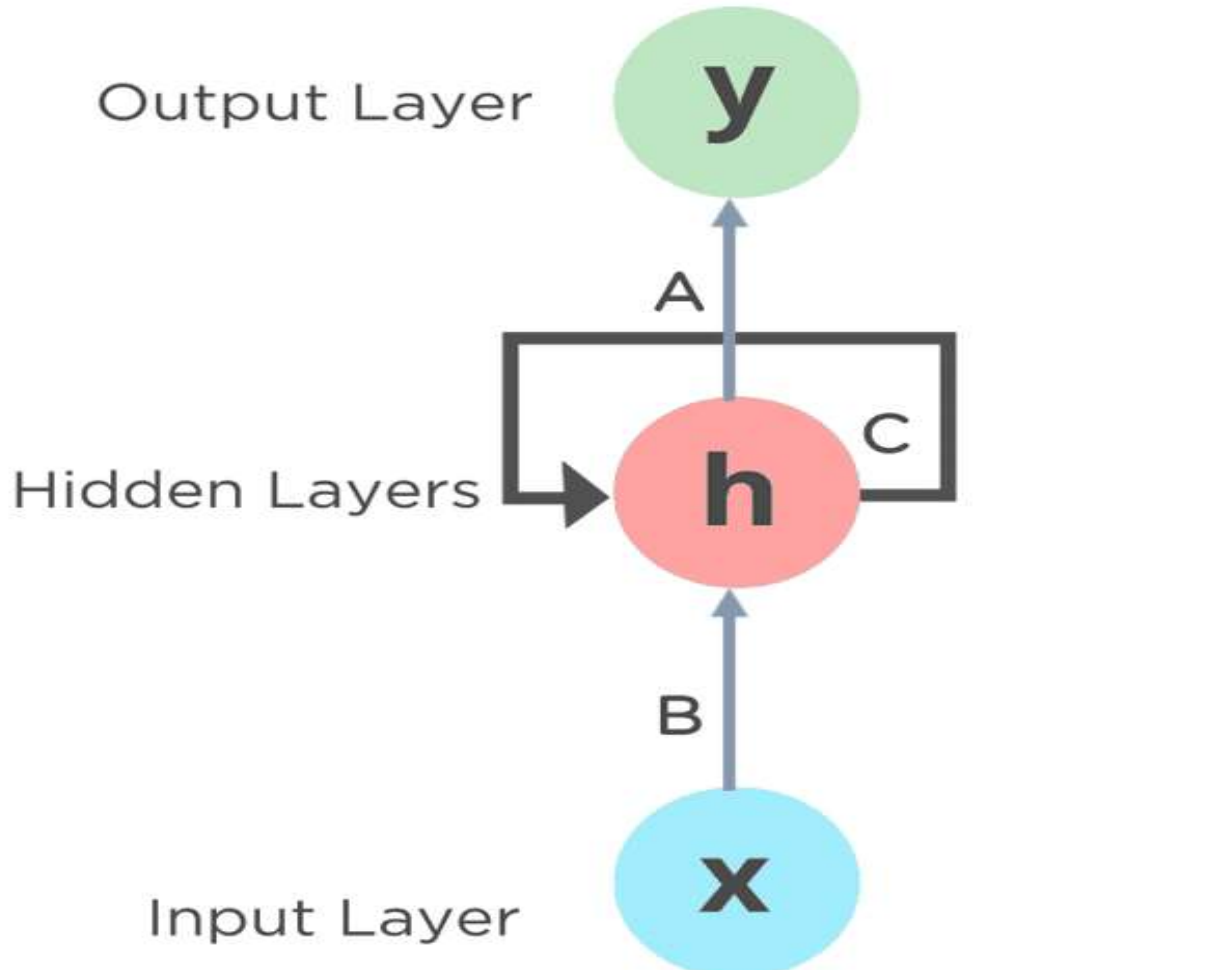
- **Learning rate**: step size of each iteration and can be set from 0.1 to 0.0001. In short, it determines the speed at which the model learns.
- **Batch size**: number of samples passed through a neural network at a time.
- **Number of epochs**: an iteration of how many times the model changes weights. Too many epochs can cause models to overfit and too few can cause models to underfit, so we have to choose a medium number.

Different Hyperparameter Tuning Methods:

1. *GridSearch*
2. *RandomSearch*
3. *Successive Halving*
4. *Bayesian Optimizers*
5. *Manual Search*

Recurrent Neural Network (RNN)





A, B and C are the parameters

Applications of Recurrent Neural Networks:

Image Captioning:

RNNs are used to caption an image by analyzing the activities present

"A Dog catching a ball in mid air"

Time Series Prediction:

Any time series problem, like predicting the prices of stocks in a particular month, can be solved using an RNN.

Natural Language Processing:

Text mining and Sentiment analysis can be carried out using an RNN for Natural Language Processing (NLP).

Machine Translation:

Given an input in one language, RNNs can be used to translate the input into different languages as output.

Types of Recurrent Neural Networks:

There are four types of Recurrent Neural Networks:

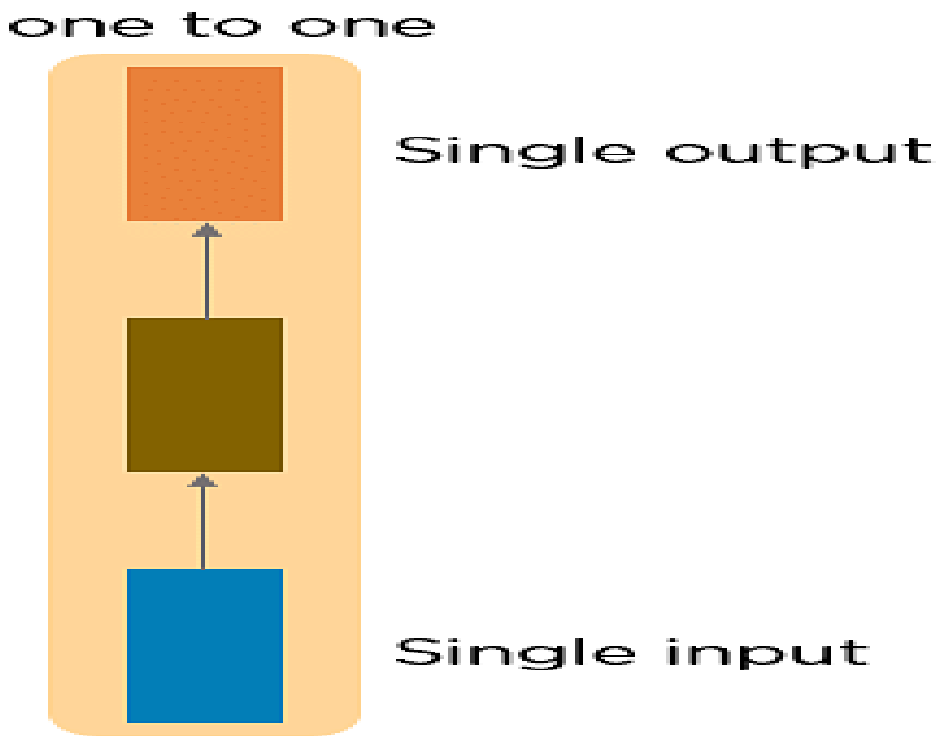
One to One

One to Many

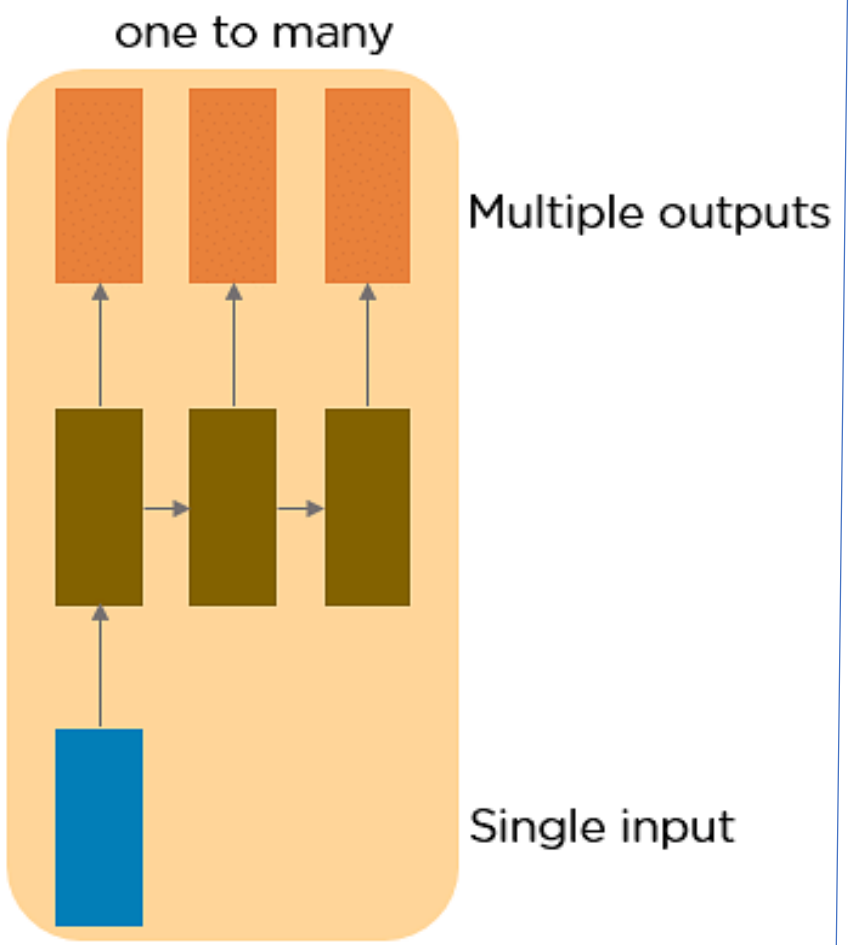
Many to One

Many to Many

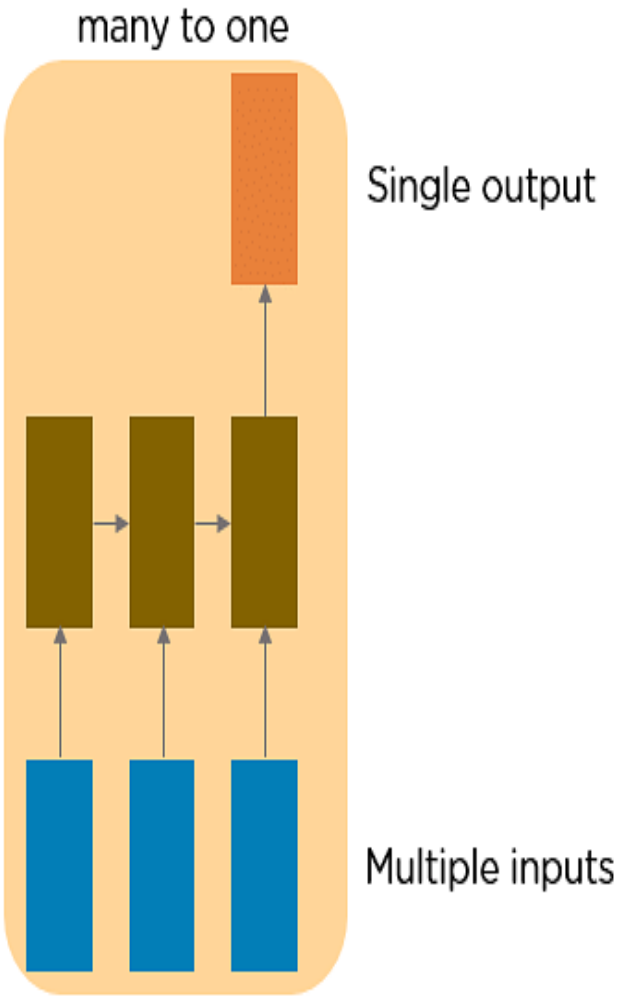
One to One RNN



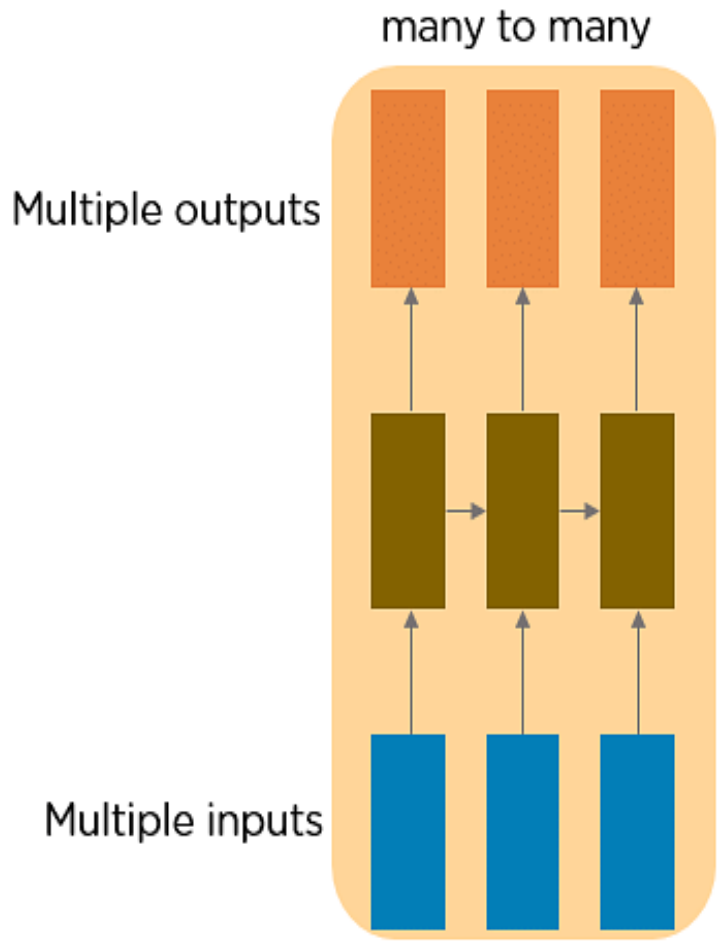
One to Many RNN



Many to One RNN



Many to Many RNN



Loss function

- **Loss functions** are used to estimate and understand how well a particular algorithm performs.
- The **loss function** is the function that **computes the distance between the current output of the algorithm and the expected output**.
- It's a method to evaluate how your algorithm models the data. It can be categorized into two groups. One for **classification** (discrete values, 0,1,2…) and the other for **regression** (continuous values).

The most common losses used in Machine learning and Deep learning is:

Categorical Crossentropy

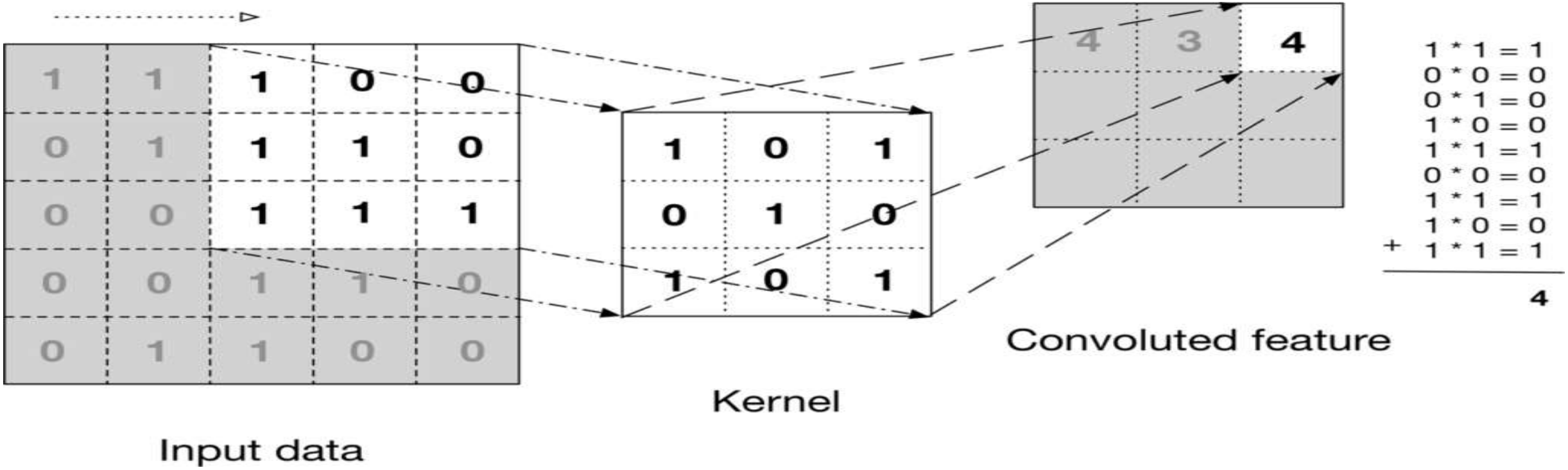
Binary Crossentropy

Mean Absolute Error

Mean Squared Error

What is Convolution Neural Network?

Convolutional Neural Network (CNN) or ConvNets for short is a class of deep neural networks popularly used for visual data analysis. This visual data can be in the form of images or videos. CNNs are inspired by the mammalian visual cortex. They were developed as a computational model for natural visual perception, similar to the human visual system. The applications of CNN include image classification, object detection, semantic segmentation, medical image analysis, and many more



The basic architecture of a convolutional neural network (CNN) consists of the following layers:

Convolutional layer — CONV

Activation layer — ACT

Pooling layer — POOL

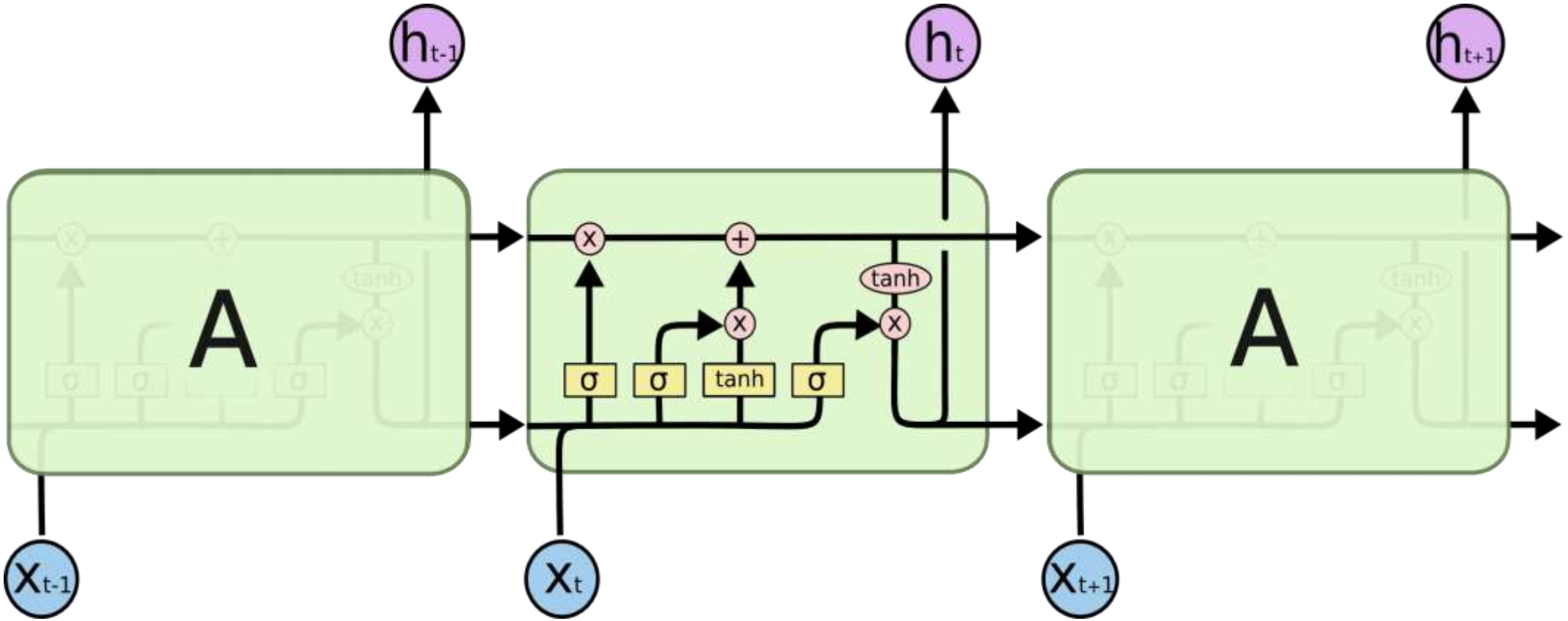
Fully-connected layer — FC

Long Short Term Memory (LSTM):

LSTMs are a special kind of **RNN**, capable of learning long-term dependencies which make **RNN** smart at remembering things that have happened in the past and finding patterns across time to make its next guesses make sense. **LSTMs** broke records for improved Machine Translation, Language Modeling and Multilingual Language Processing.

The LSTM networks are popular nowadays. The LSTM network are called cells and these cells take the input from the previous state *ht-1* and current input *xt*. The main function of the cells is to decide what to keep in mind and what to omit from the memory. The past state, the current memory and the present input work together to predict the next output

Architecture of LSTM network:



There are various gates in the **LSTM** process

Sigmoid

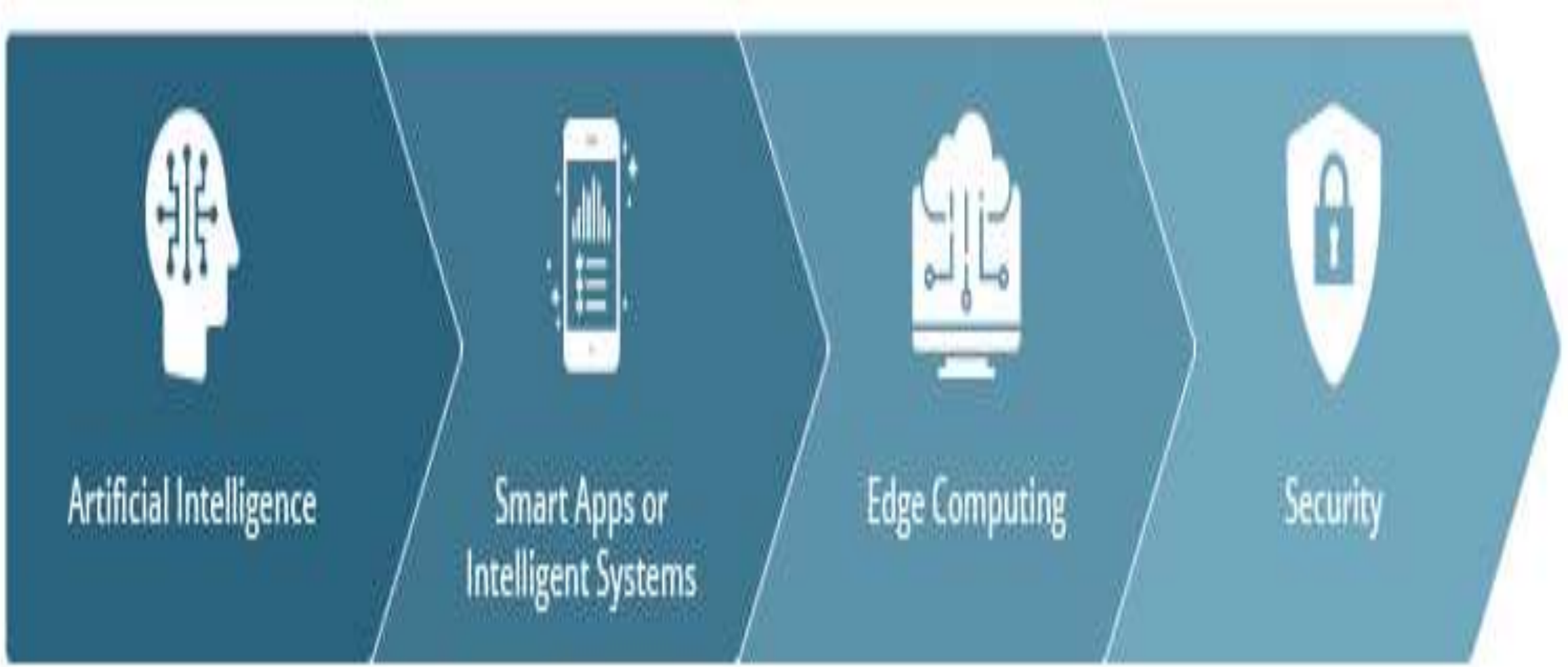
Forget Gate

Input Gate

Cell State

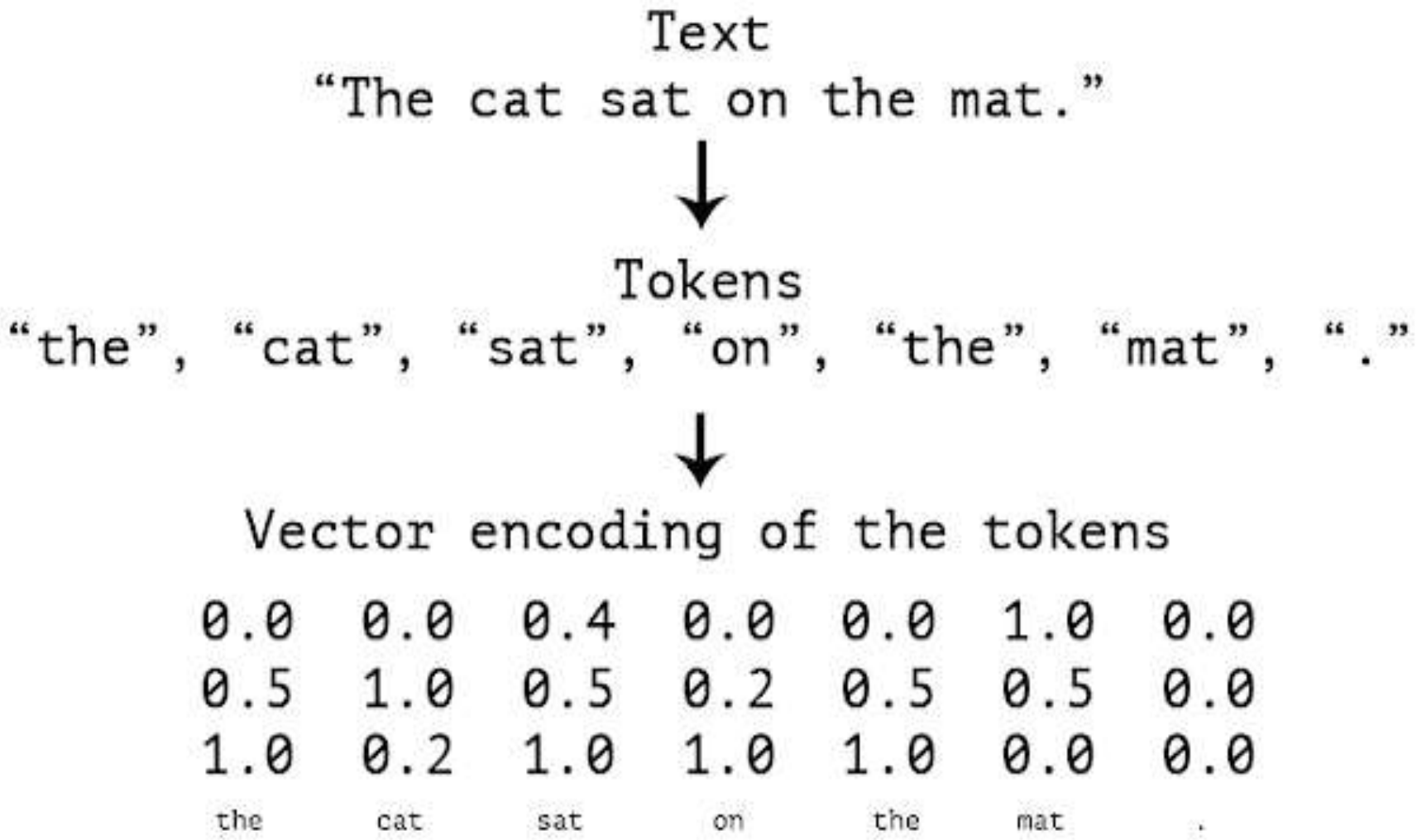
Output Gate

Data Science Models



Applications of Data Science:

Applications to text in Deep Learnig



Applications to image in Data Science:

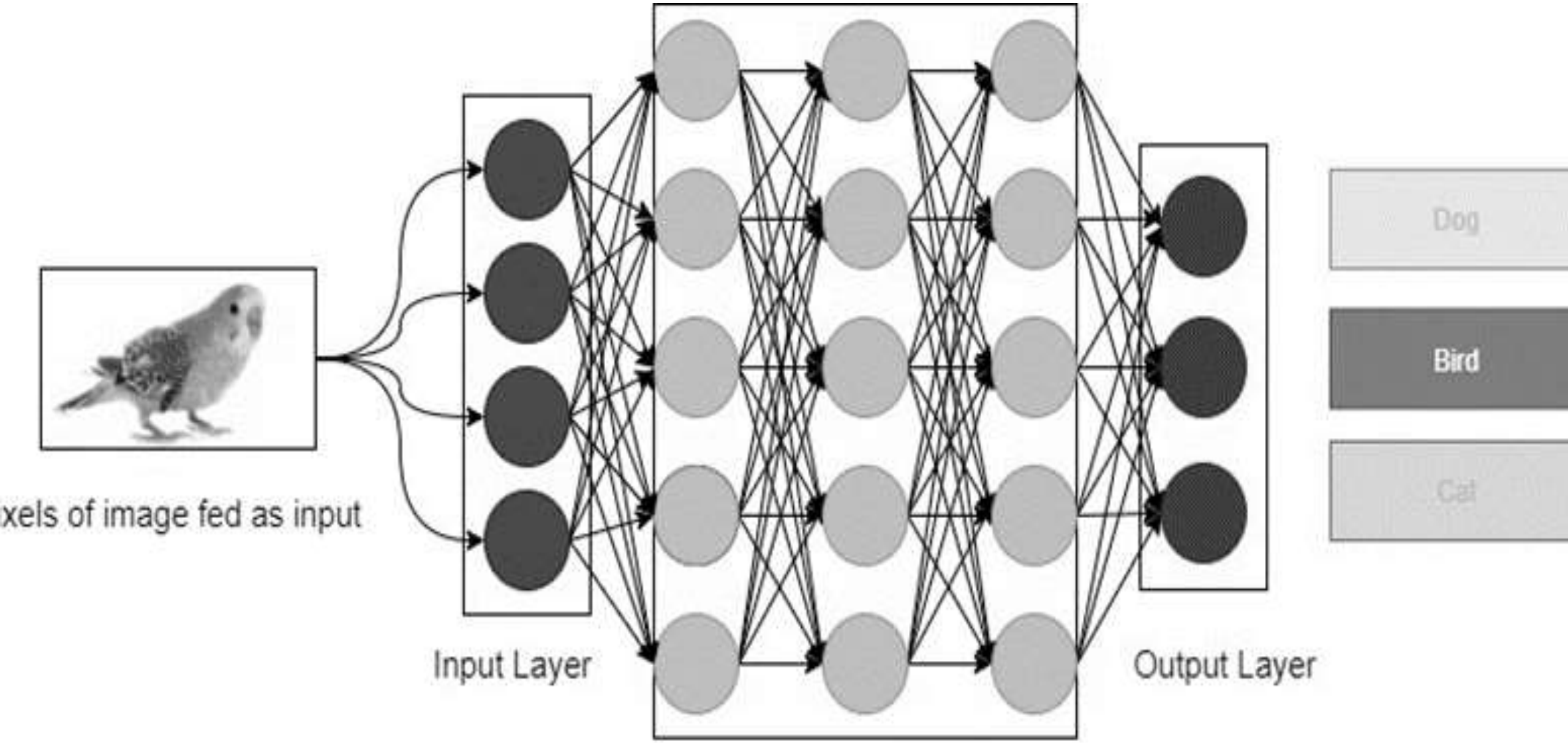


Image Processing Applications:

This section will describe two commonly used image processing applications.

YOLO

It is an algorithm that has been widely used in recent years for computer recognition of objects. Its most important feature is real-time object recognition. The general average accuracy (MAP) values used in object recognition are widely used because they are better than others.

SSD

SSD algorithm is used for real-time object detection. However, it uses optimization methods such as multiscaling and standard boxes to improve the accuracy drop. With these improvements, SSD tries to match the accuracy of Faster R-CNN on low resolution images and further increase the speed.

Applications video in Deep Learning

There are two basic approaches for video-based AI tasks

1. Single Stream Network:

a. Single frame: a single architecture is used to fuse information from all the frames at the last stage.

b. Late fusion: two nets with shared params are used. The nets are spaced 15 frams apart, and combine predictions at the end of the configuration.

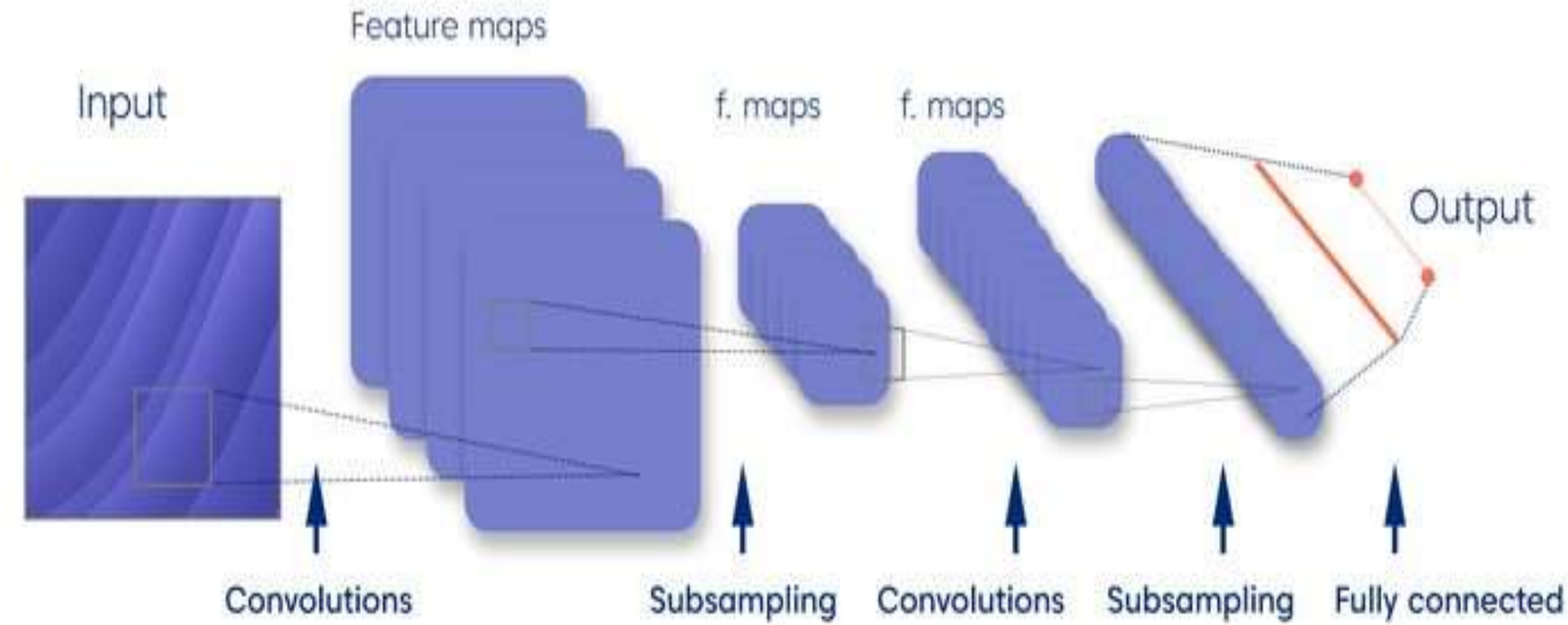
c. Early fusion: the combination is performed in the first layer by convolving over 10 frames.

d. Slow fusion: fusion is performed at multiple stages, as a balance between early and late fusion. Multiple clips are sampled from the entire video and prediction scores are averaged from the sampled clips in order to perform the final predictions

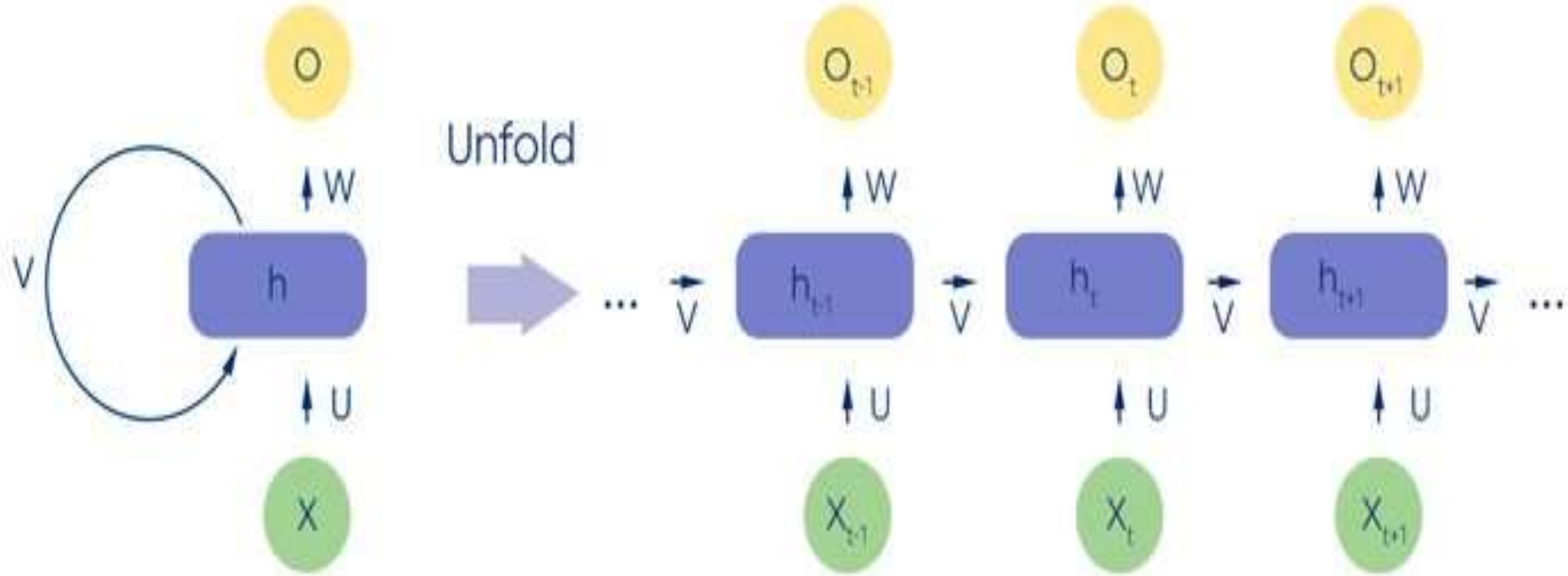
2. Two Stream Networks

Deep learning-based recommender systems

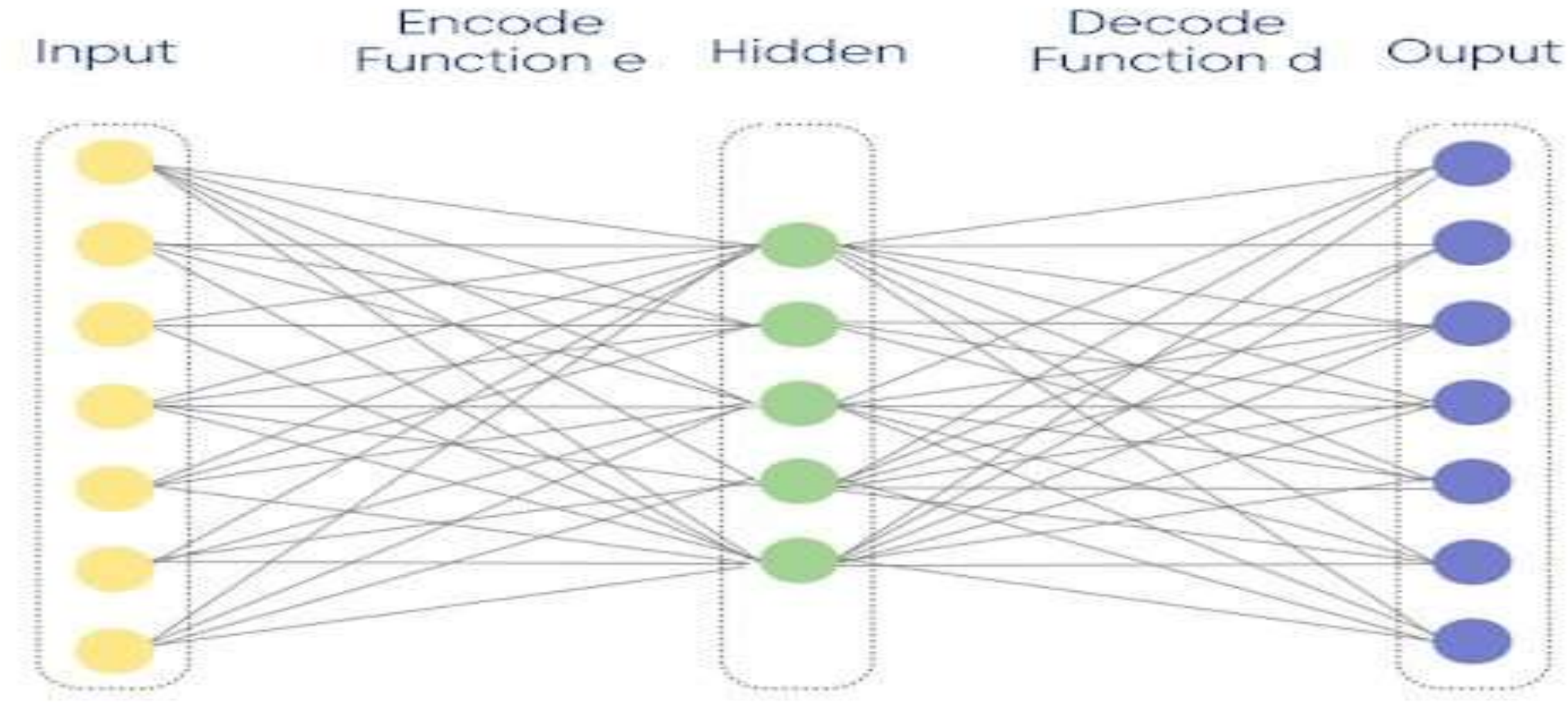
Convolutional neural networks based recommender systems



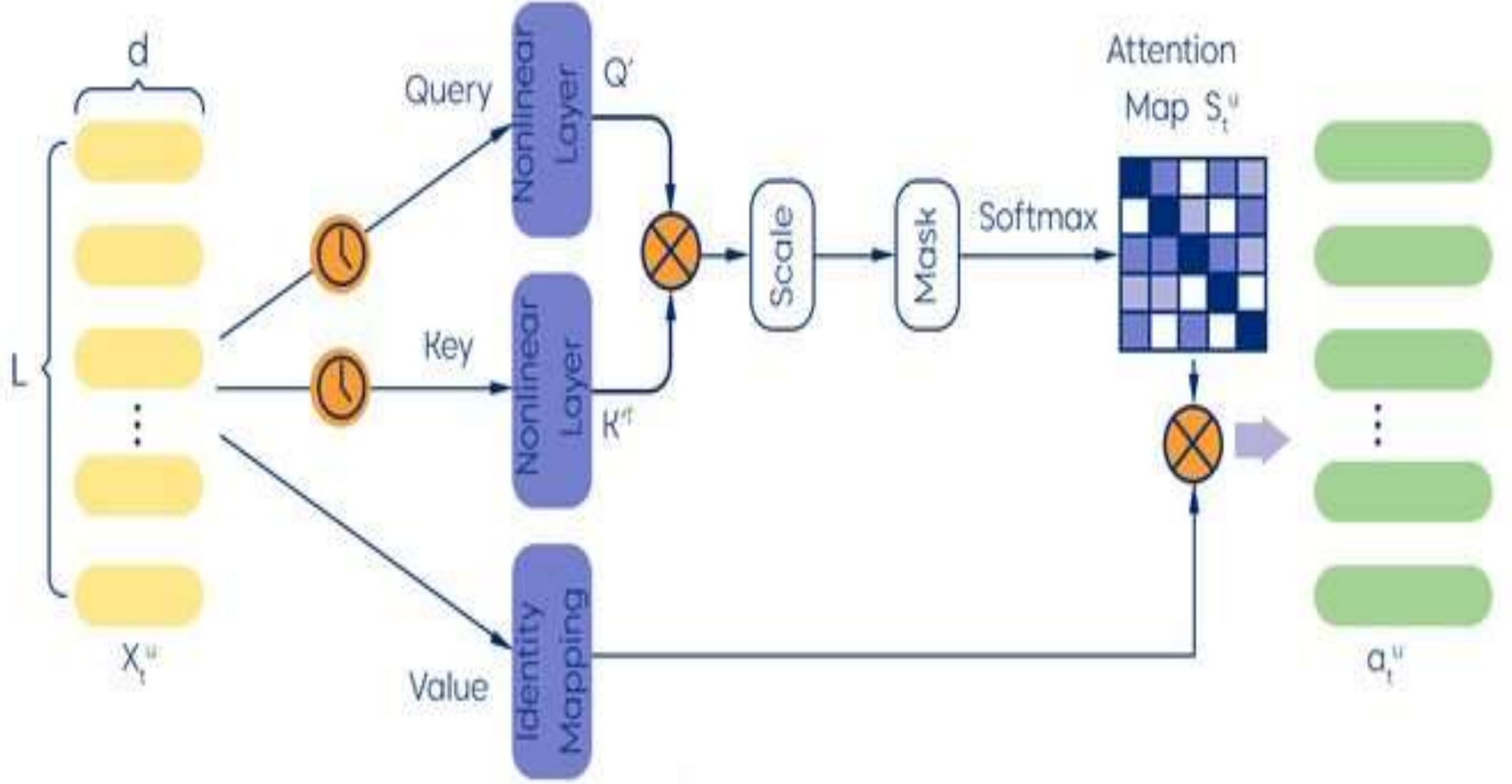
Recurrent neural networks based recommender systems:

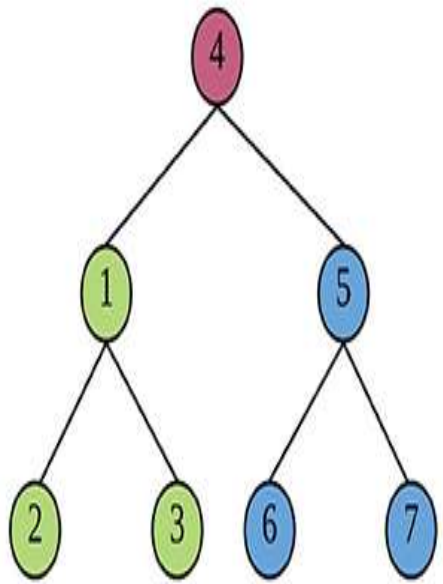


Autoencoder based recommender systems:



Neural attention based recommender systems:





Input Network

1	0.2	0.4	...	0.7
2	0.1	0.5	...	0.6
3	0.2	0.3	...	0.7
4	0.5	0.6	...	0.1
5	0.7	0.9	...	0.1
6	0.8	0.8	...	0.2
7	0.8	0.7	...	0.4

Nodel embedding

V_{S1}	0.1	0.2	...	0.5
V_{S2}	0.6	0.3	...	0.8
V_{S3}	0.8	0.5	...	0.7

Sub-network embedding