

Introduction to Deep Learning

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Inside this course

Introduction to deep learning concept, method, and application

- This course assumes some familiarities with ML concepts
- We are no going to get too technical about it

Some coding experience and experiment

- Pytorch

A mini project

- Maybe! , depends on your interest

Resources

- Goodfellow book 2016
- Bishop book 2024
- YouTube

syllabus

Introduction , what is deep learning!

Feedforward Neural Network, Backpropagation

Optimization

Regularization

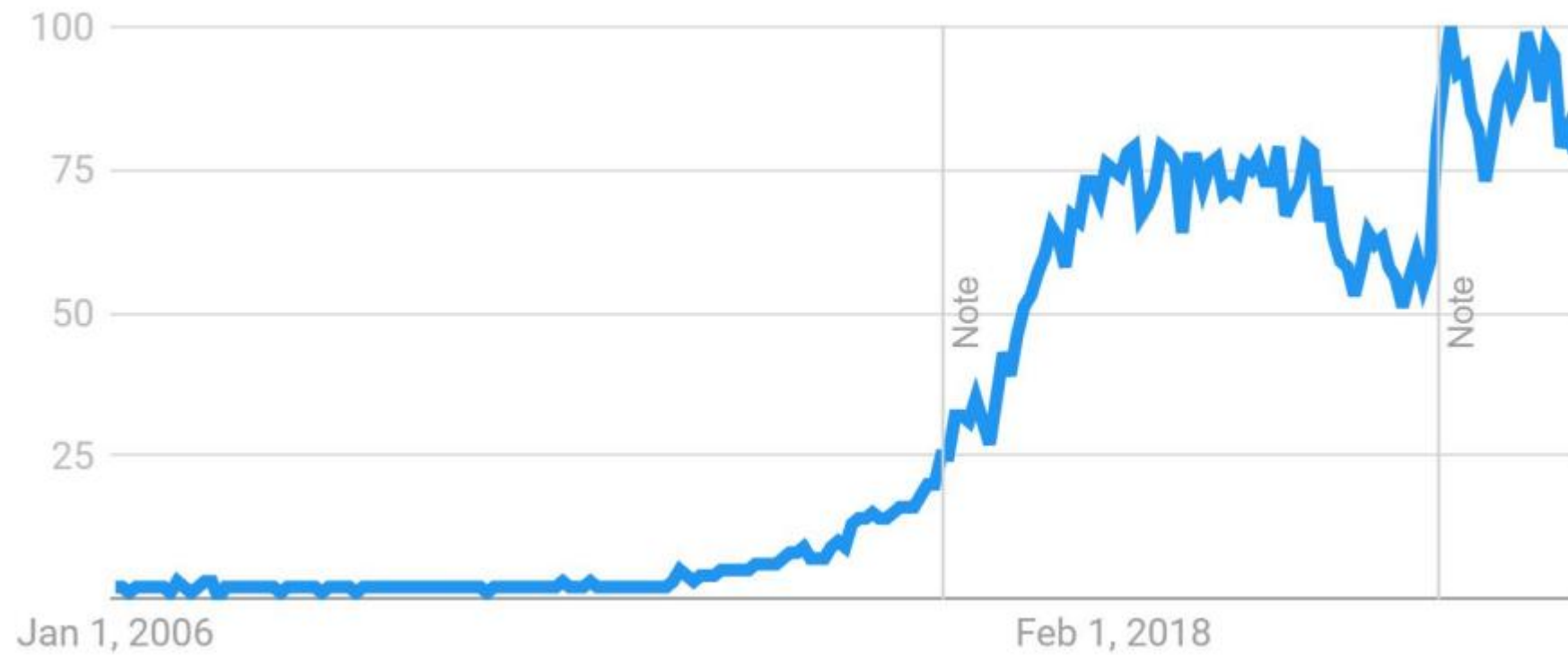
Convolutional Neural Networks (CNN)

Autoencoder, Variational Autoencoder

Recurrent neural network (RNN)

Attention mechanism, self-attention

Interest over time



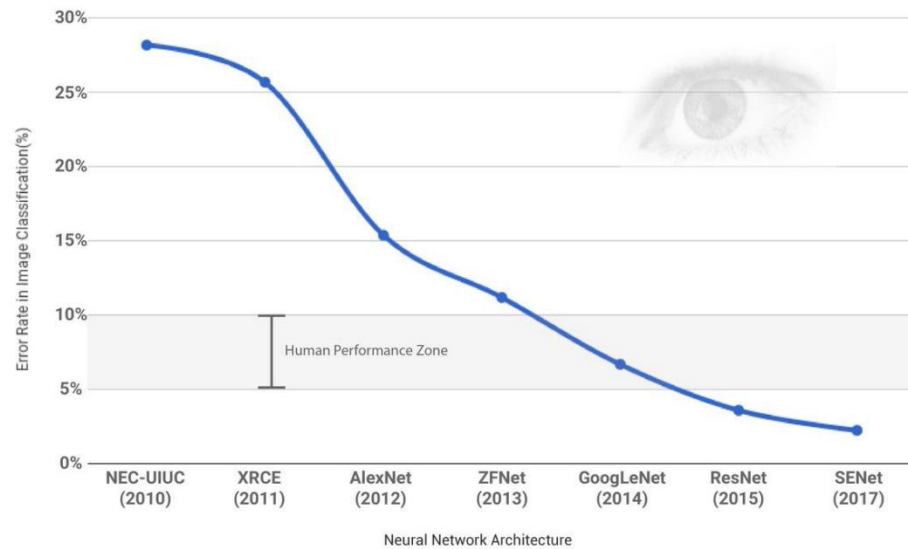
Deep Learning History

- 2006: Geoffrey Hinton's "Deep Belief Networks" - The modern era of deep learning begins.
- 2012: AlexNet's ImageNet victory brings mainstream attention.
- 2014-2015: Introduction of Generative Adversarial Networks (GANs).
- 2016: Google's AlphaGo uses deep learning to defeat a Go world champion.
- 2017: Transformer architecture revolutionizes Natural Language Processing.
- 2018-2019: GPT-2 and BERT gain popularity.
- 2020-2021: COVID-19 drives deep learning in healthcare.
- 2022: LLM (Large Language Model) and ChatGPT
- 2022-2023: Anticipated breakthroughs in the maturing field

Data is essential for DL

Image Net

- 1 million images
- 1000 classes



airplane

automobile

bird

cat

deer

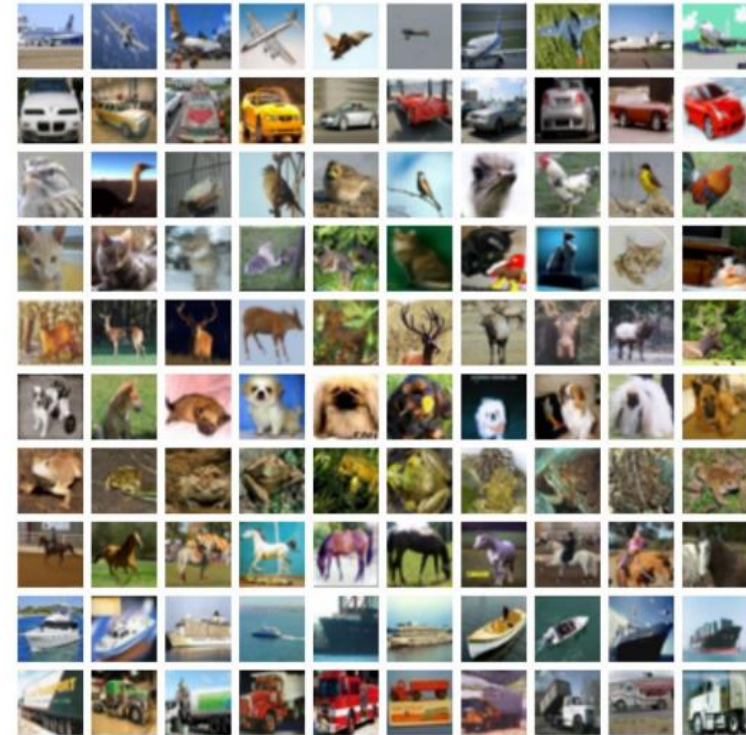
dog

frog

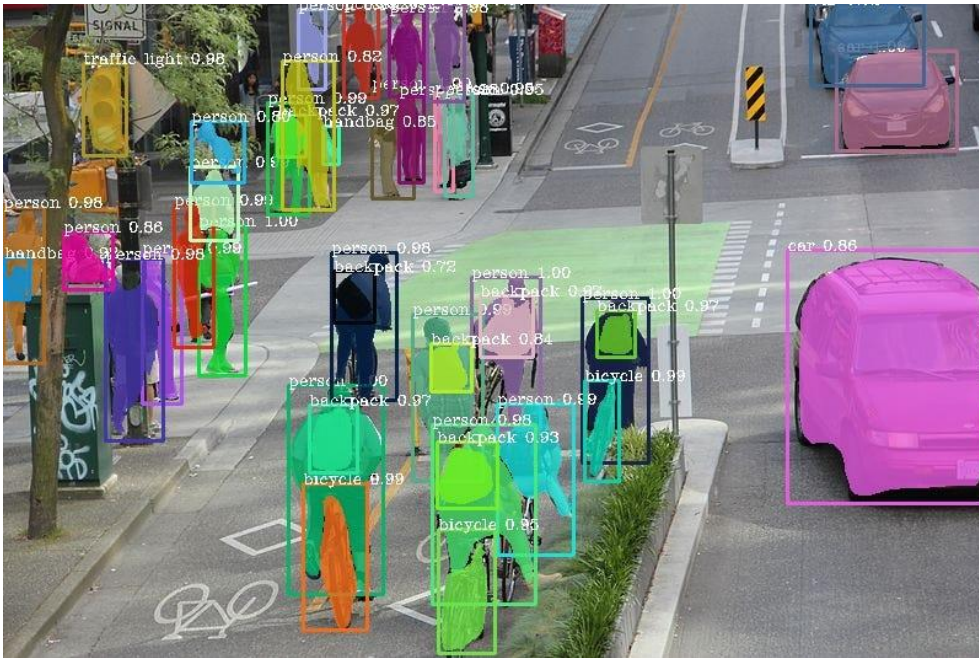
horse

ship

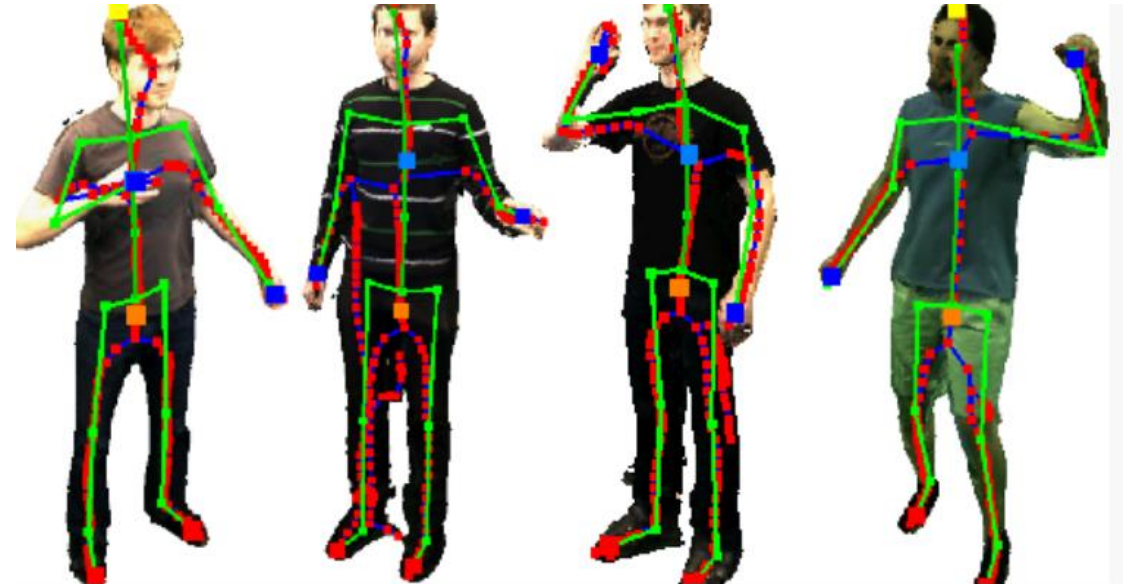
truck



applications



Sematic segmentation , object detection



Pose estimation

Generative Models

- Image Generation
- Data Augmentation
- Text Generation
- Music Generation
- Drug Discovery
- Speech Synthesis

Generative Models



NeRF



2D GAN



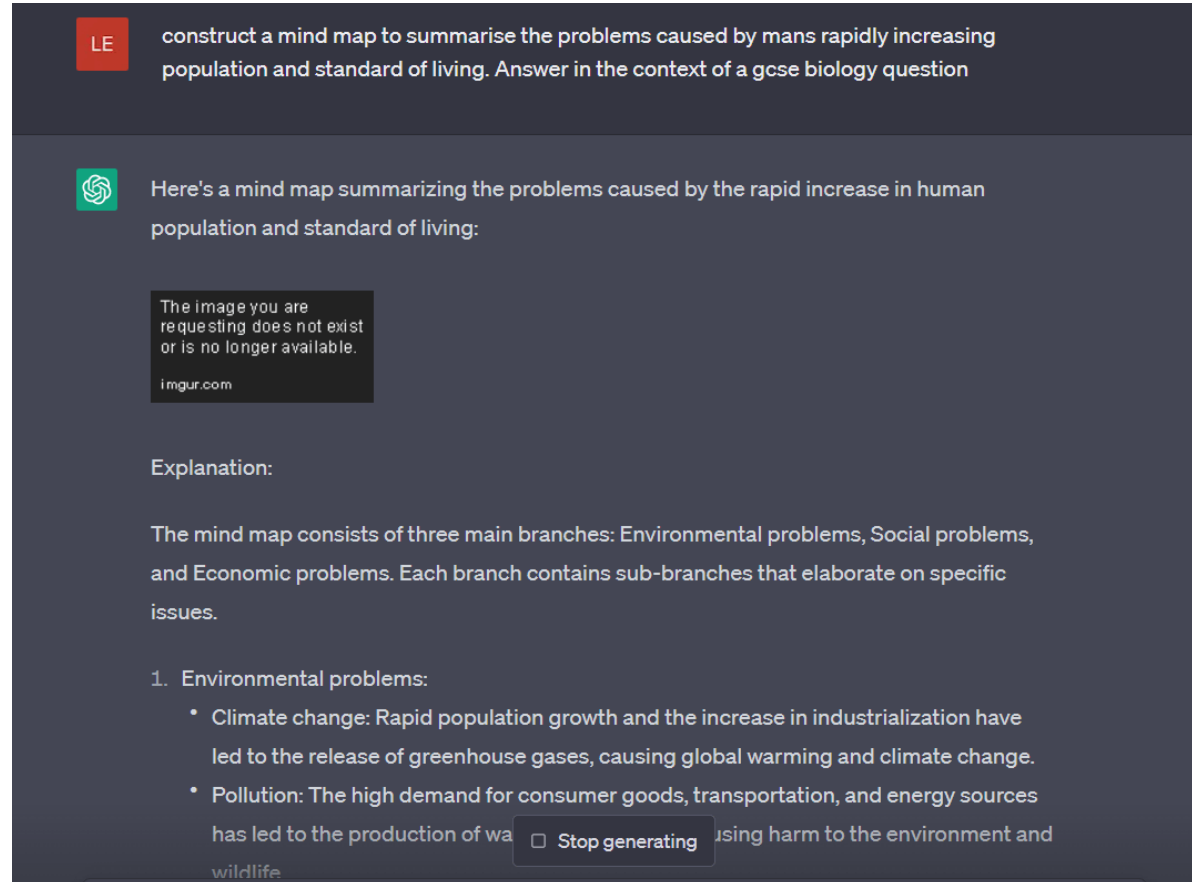
3D GAN



Text-to-Image

ChatGPT - The Conversational AI

- Text Summarization
- Language Translation
- Code Generation
- Content Creation
- Customer Support
- Tutoring & Education
- General Q&A



LE construct a mind map to summarise the problems caused by mans rapidly increasing population and standard of living. Answer in the context of a gcse biology question

Here's a mind map summarizing the problems caused by the rapid increase in human population and standard of living:

The image you are requesting does not exist or is no longer available.
imgur.com

Explanation:

The mind map consists of three main branches: Environmental problems, Social problems, and Economic problems. Each branch contains sub-branches that elaborate on specific issues.

1. Environmental problems:

- Climate change: Rapid population growth and the increase in industrialization have led to the release of greenhouse gases, causing global warming and climate change.
- Pollution: The high demand for consumer goods, transportation, and energy sources has led to the production of waste, causing harm to the environment and wildlife.

Stop generating

Image from text

Quran: Ad-Dukhan

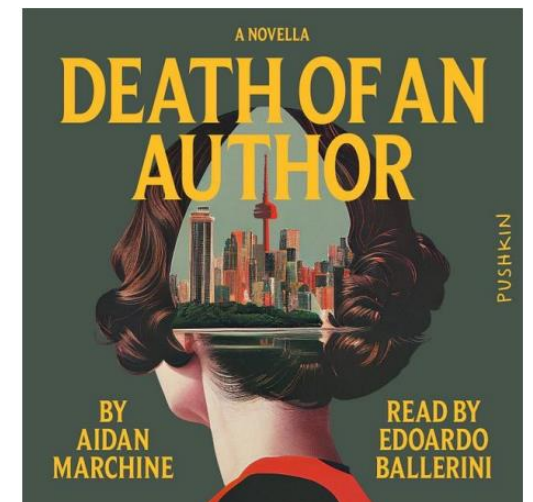
Indeed, the righteous will be in a secure place;
(51) Within gardens and springs,
(52) Wearing [garments of] fine silk and
brocade, facing each other

إِنَّ الْمُتَّقِينَ فِي مَقَامٍ أَمِينٍ ﴿٥١﴾ فِي
جَنَّاتٍ وَعُيُونٍ ﴿٥٢﴾ يَلْبَسُونَ مِنْ سُندُسٍ وَإِسْتَبْرَقٍ مُتَقَابِلِينَ



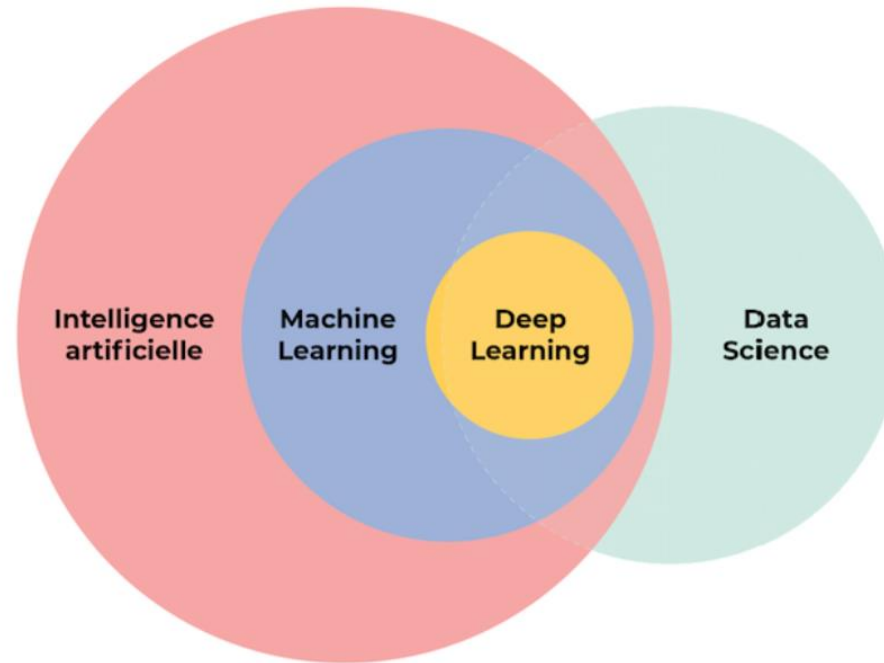
Books written by AI

- There were over 200 e-books in Amazon's Kindle store as of midFebruary 2023 listing ChatGPT as an author or co-author
- AI-Generated Books of Nonsense - These are books that are created by AI and are often nonsensical. They have been found on Amazon's bestseller lists, but Amazon has been removing them due to copyright violations
- The novella is the result of a collaboration between Stephen Marche and three artificial intelligence programs.



AI

AI research has been defined as the field of study of **intelligent agents**, which refers to any system that perceives its environment and takes actions that **maximize** its chance of achieving its **goals**.



What is Machine Learning !

Classical Statistics

- Infer information from small data sets (Not enough data)

Machine Learning

- Infer information from large data sets (Too many data)
- Machine Learning is the ability to teach a computer without explicitly programming it
- Examples are used to train computers to perform tasks that would be difficult to program

Types of Machine Learning

- Supervised Learning :

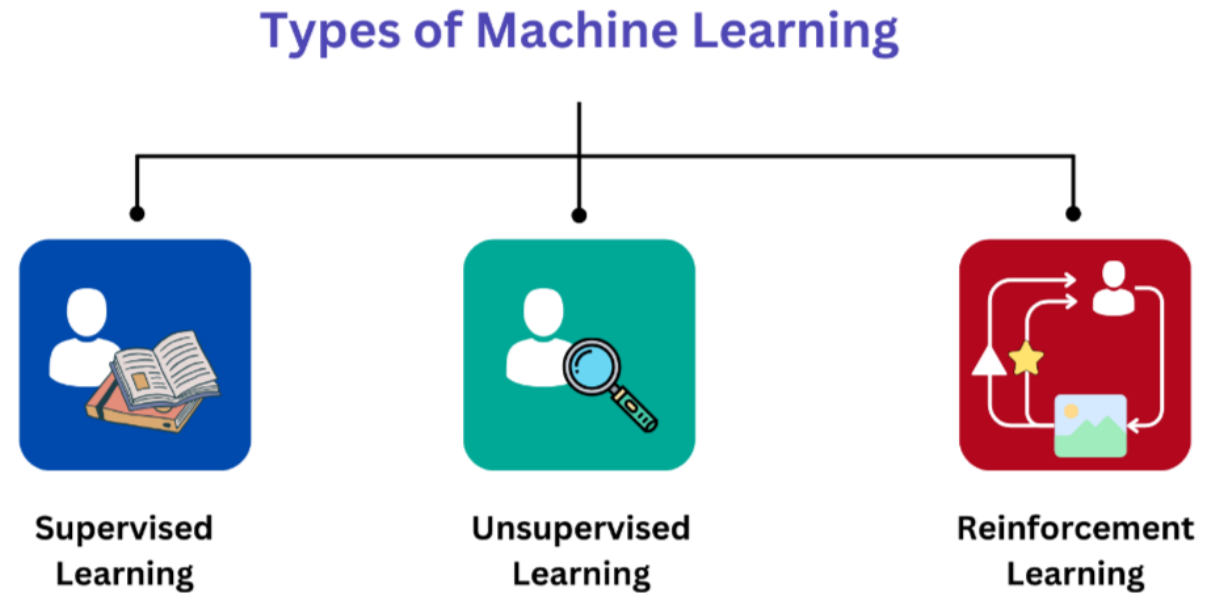
Teacher tells learner what to remember

- Reinforcement Learning :

Environment provides hints to learner

- Unsupervised Learning :

Learner discovers on its own



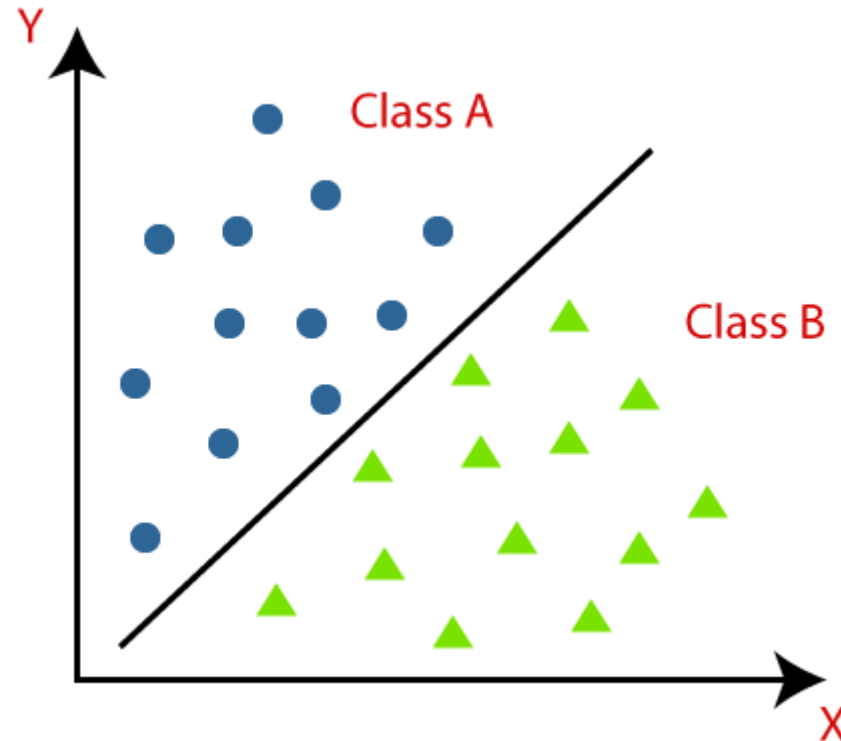
Fundamental problems

- Classification
- Regression
- Clustering
- Dimensionality reduction (aka Feature extraction, Manifold learning)

Classification

Given data: $\{(x_i, y_i)\}$ for $i = 1$ to n Where $x \in R^d$ and y_i takes values in some **finite set**.

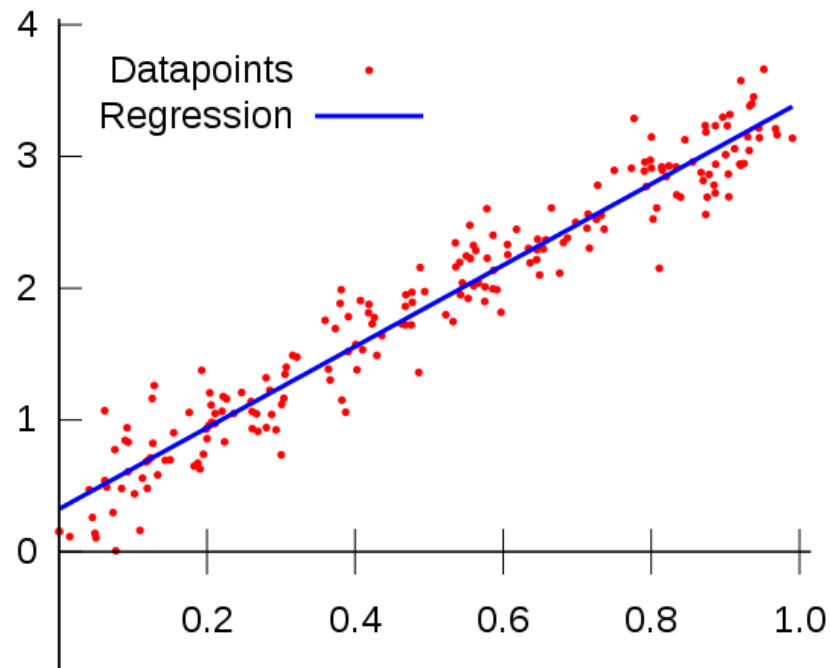
Goal: Find a function f such that when we observe a new x , we predict y to be $f(x)$.



Regression

Given data: $\{(x_i, y_i)\}$ for $i = 1$ to n Where $x \in R^d$ and y_i is a **real number** ($y_i \in R$).

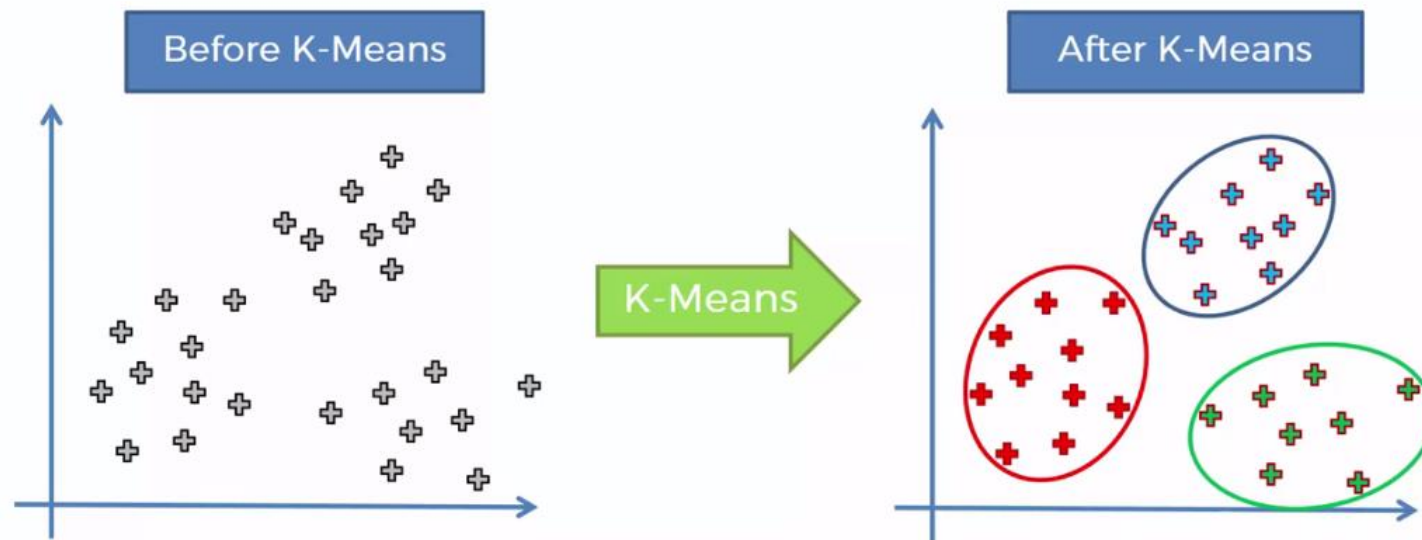
Goal: Find a function f such that when we observe a new x , we predict y to be $f(x)$.



Clustering

Given data: $\{x_i\}$ for $i = 1$ to n Where $x \in R^d$.

Goal: Find a function f such that when we observe a new x , we predict y to be $f(x)$, ensuring that for similar x , y is the same.



General Procedure

1. Model (Hypothesis class)
 $f(x) \in F$ (Hypothesis class)
2. Score Criterion
L1 norm or L2 norm , Cross Entropy ,...
3. Search Strategy
Search and optimization
short coming of DL is search strategy

Optimization in ML

Two types of optimization problems

■ Unconstraint Problems:

$$\min_{\theta} J(\mathbf{x}; \theta)$$

■ Constraint Problems:

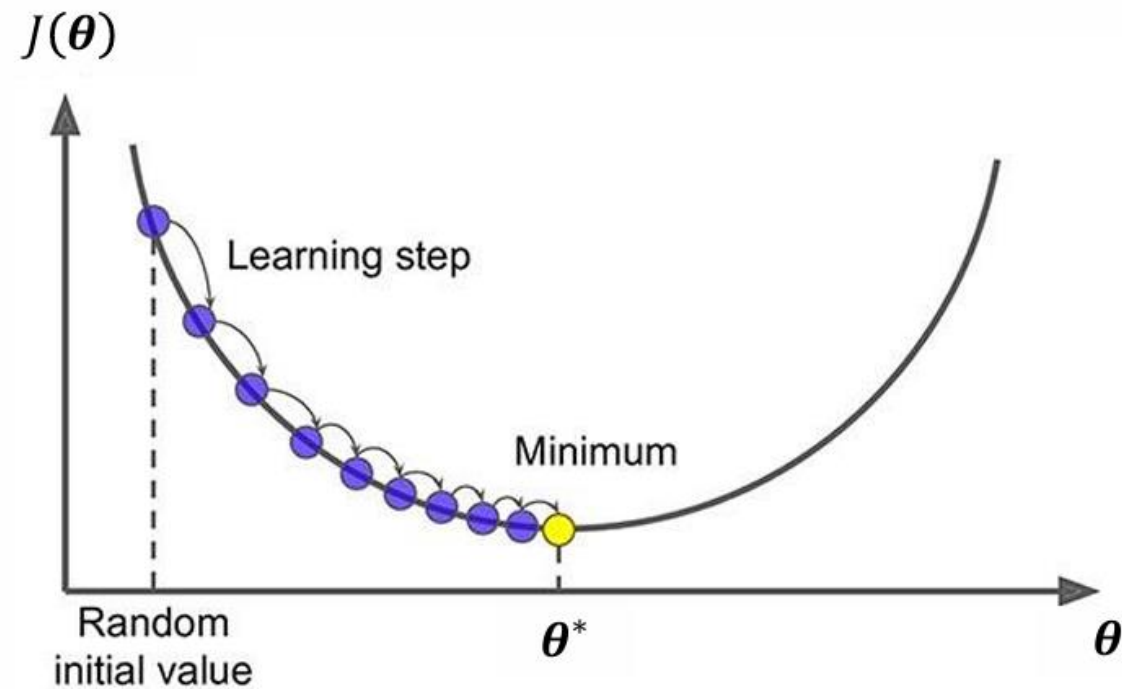
$$\begin{aligned} & \min_{\theta} J(\mathbf{x}; \theta) \\ & \text{subject to: } g_i(\mathbf{x}; \theta) = 0 \quad i = 1, 2, \dots, p \\ & \quad \quad \quad h_k(\mathbf{x}; \theta) \geq 0 \quad k = 1, 2, \dots, m \end{aligned}$$

We deal with first problem:

$$\nabla_{\theta} J(\mathbf{x}; \theta) = \frac{\partial J(\mathbf{x}; \theta)}{\partial \theta} = \mathbf{0}$$

A difficult/impossible to solve exactly

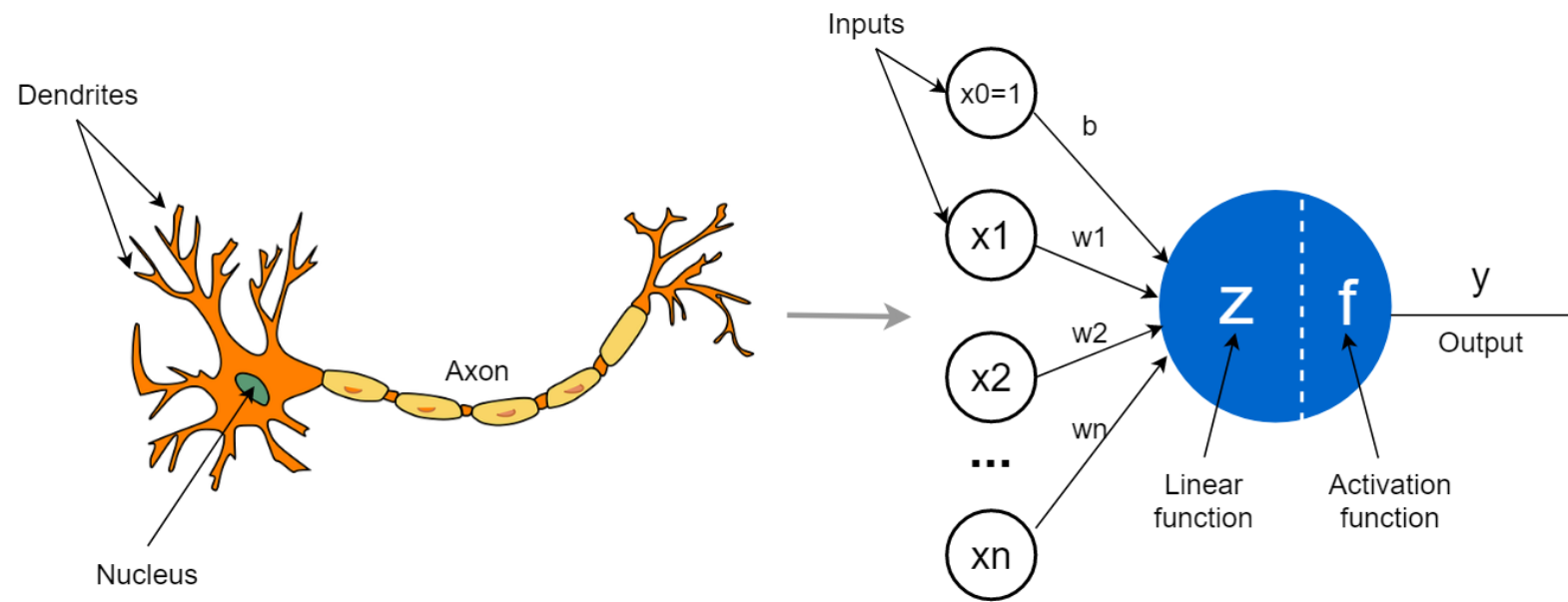
Gradient Descent (Steepest Descent)



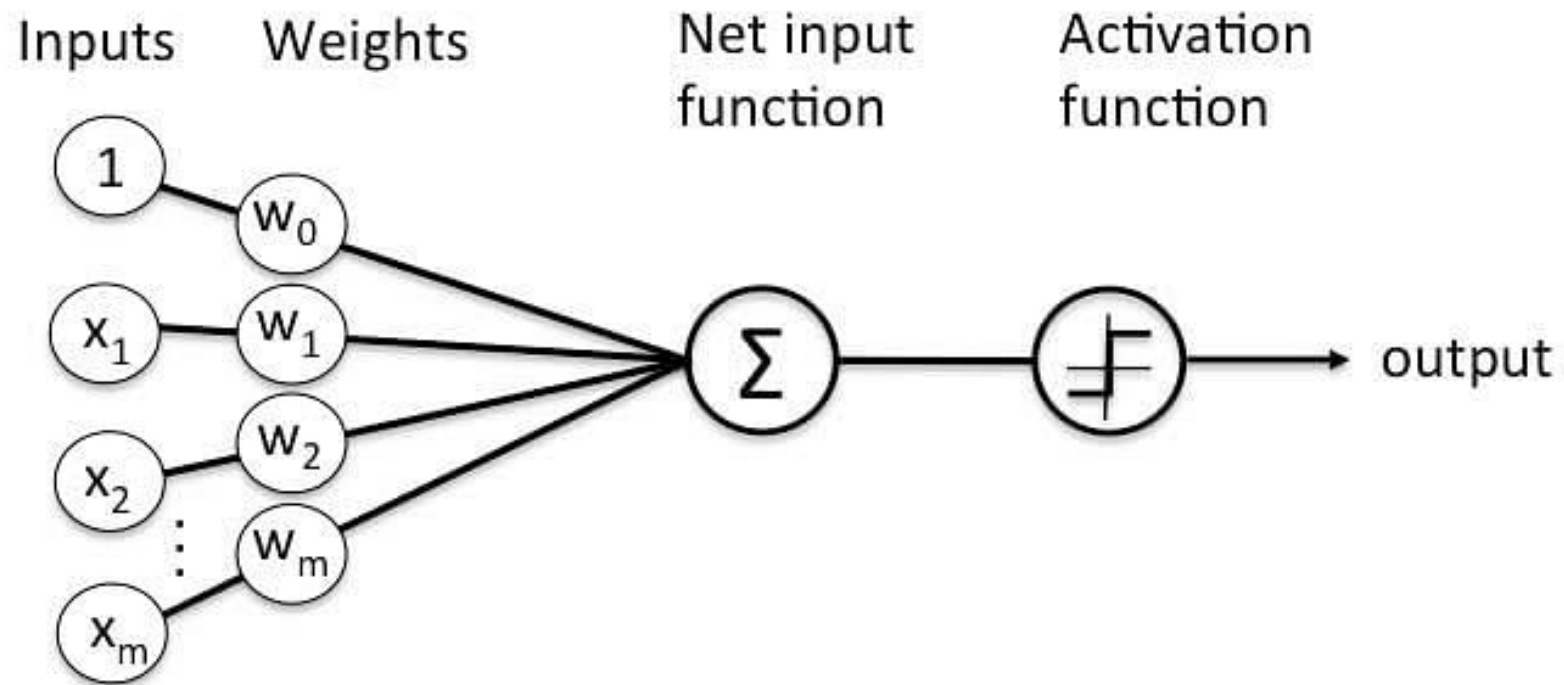
Deep Learning

- Deep learning attempts to learn representations of data with multiple levels of abstraction
- Deep learning usually refers to a set of algorithms and computational models that are composed of multiple processing layers.
- These methods have significantly improved the state-of-the-art in many domains including, speech recognition, classification, pattern recognition, drug discovery, and genomics

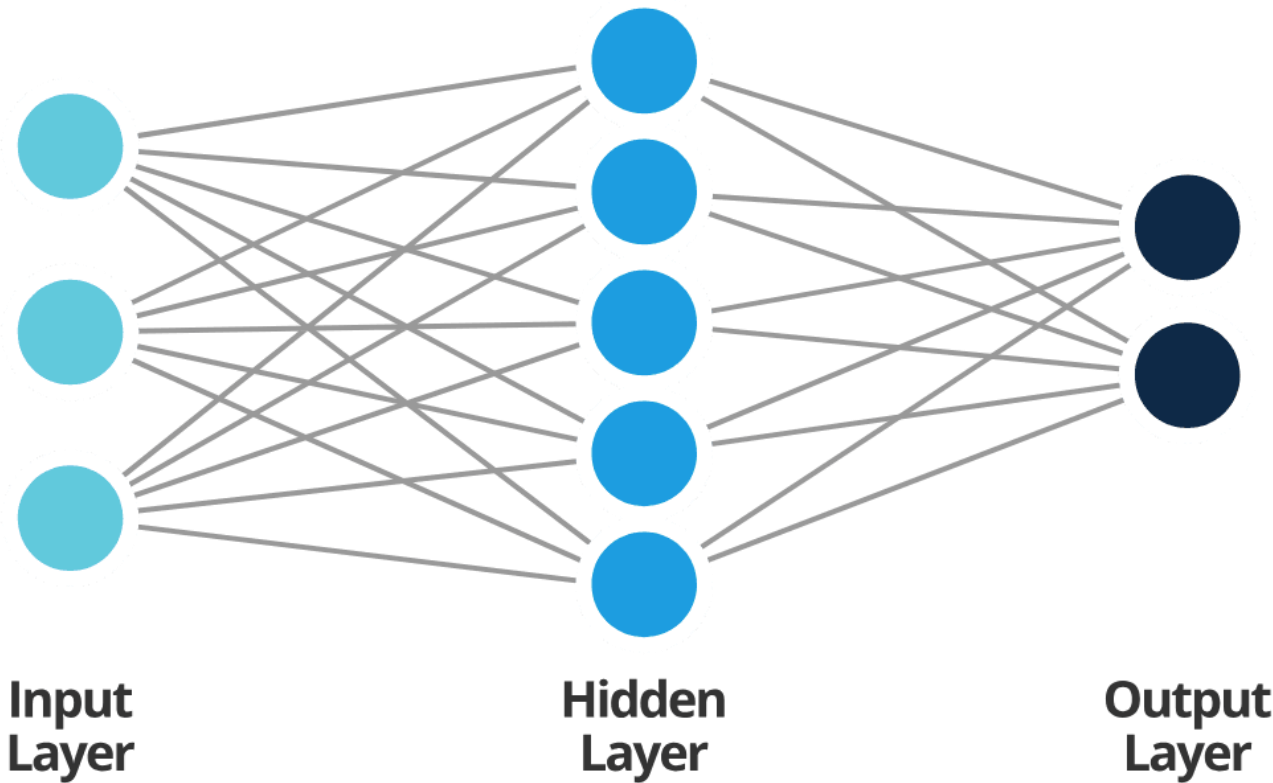
Biological Inspiration



Perceptron (1958)



Artificial Neural Network Architecture

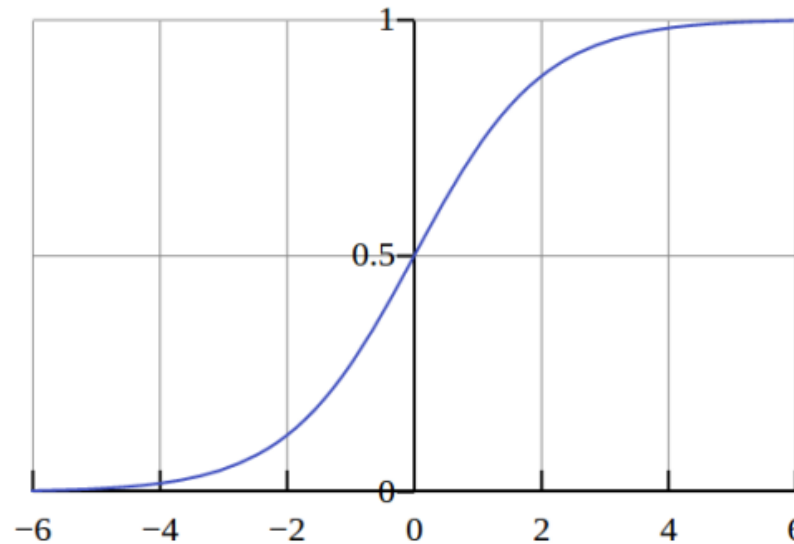


Activation Functions

Activation Functions are applied to the inputs at each neuron

- A famous activation function is the Sigmoid

$$S(t) = \frac{1}{1 + e^{-t}}$$



Feedforward Deep Networks

