AI Lab

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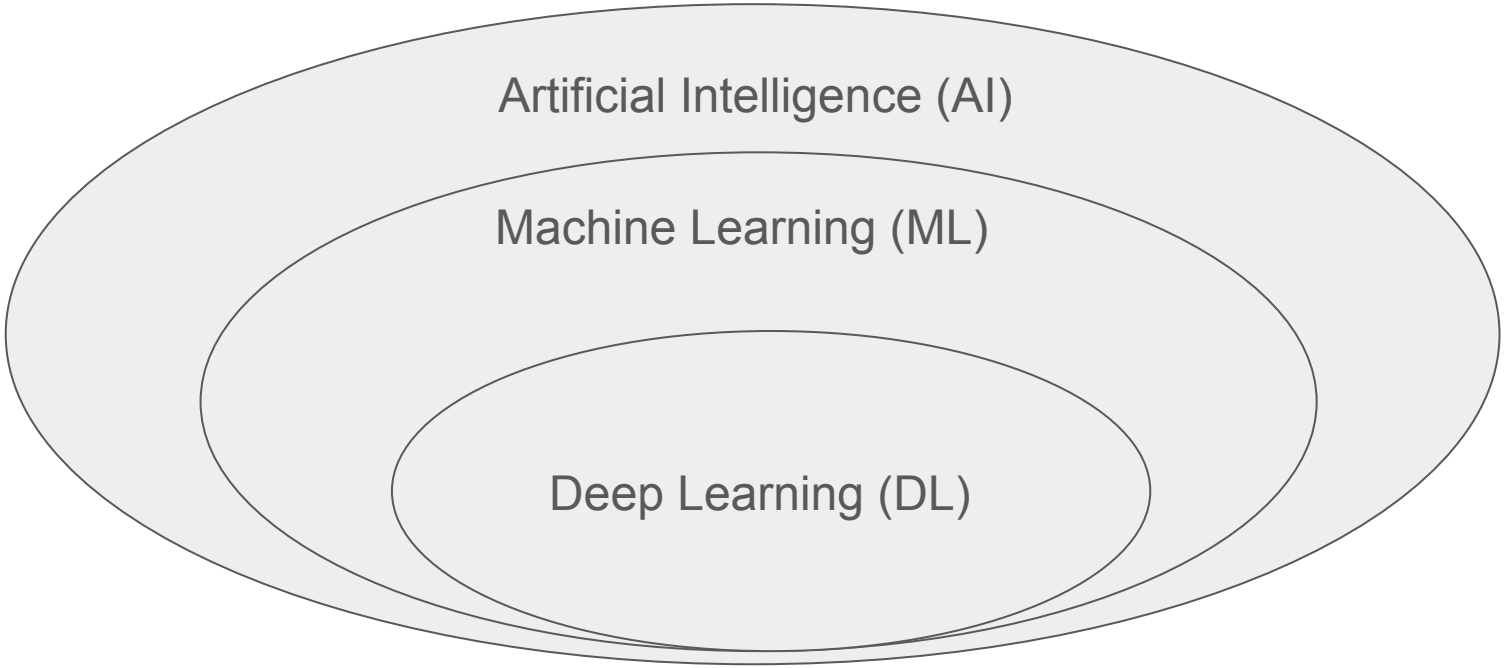
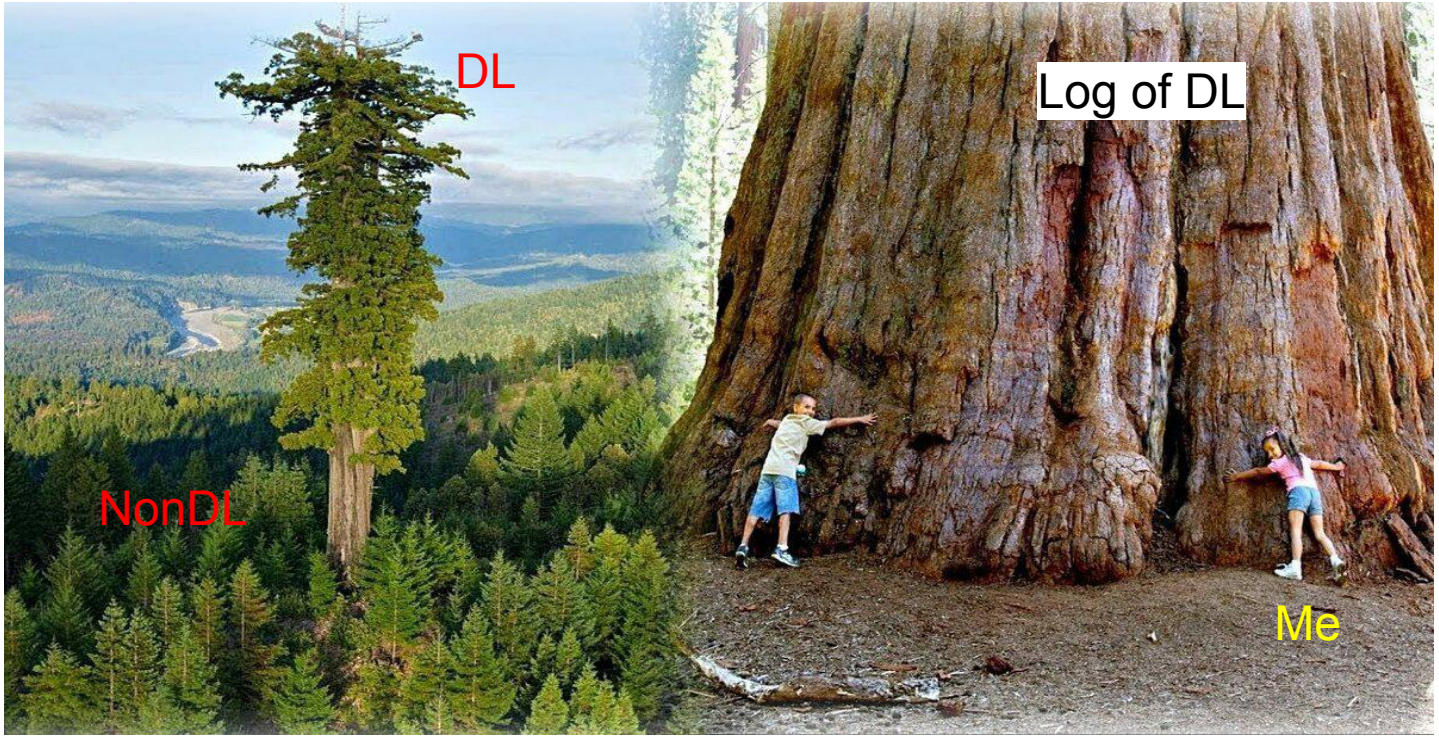
AI, ML, and DL



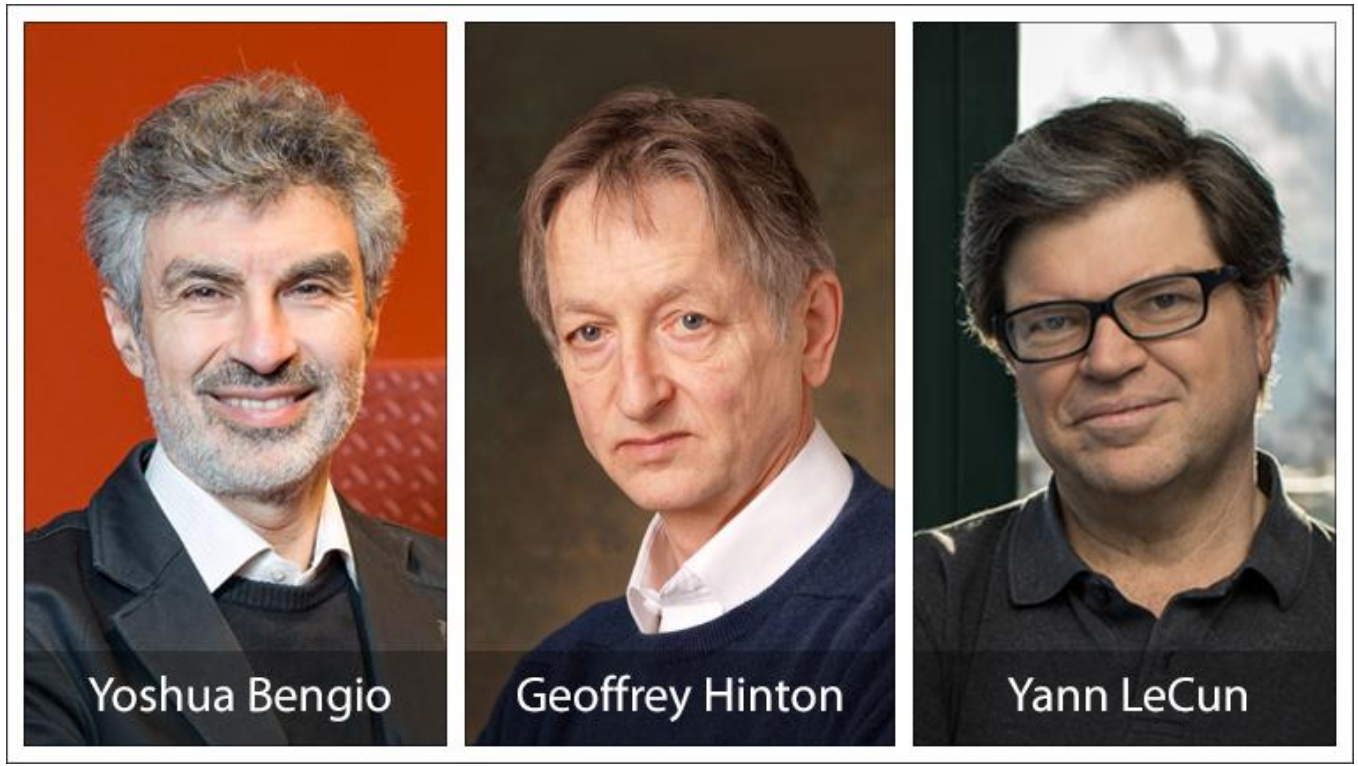
AI ⊃ ML ⊃ DL

Machine Learning Vs Deep Learning



Pioneers of DL

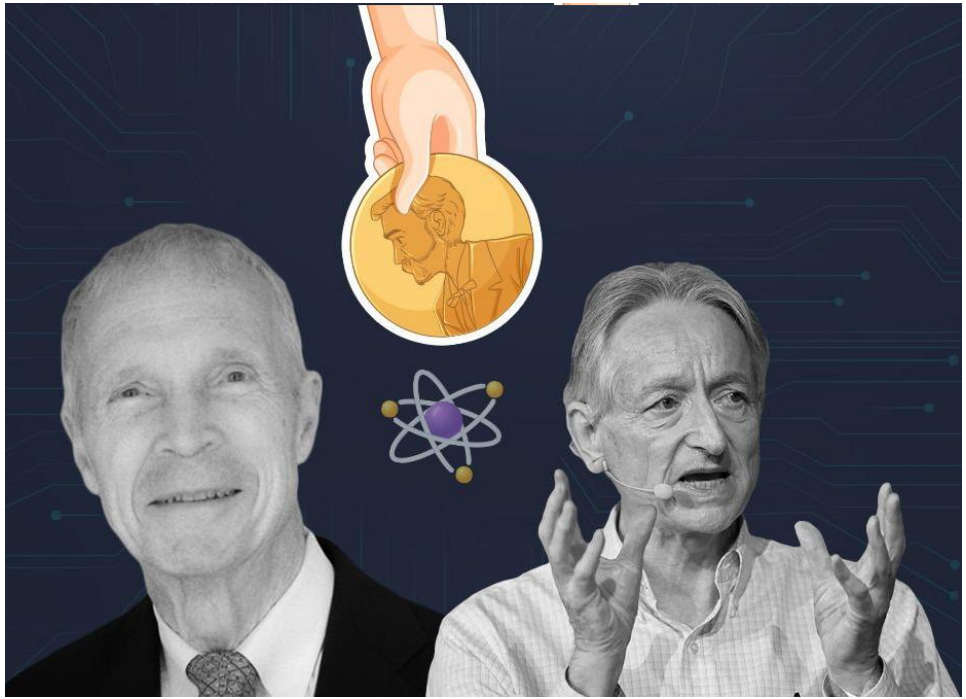
- They won Turing Prize in 2018



Awards in the Bag of DL

- **John Hopfield and Geoffrey Hinton were awarded Nobel Prize in Physics in 2024**

- Because of them and many more researchers we entered in a successful DL era.



Deep Neural Network

- Deep Learning (DL) is a field of AI that uses Deep Neural Network (DNN)s to teach computers to process data in a way inspired by the human brain.

- A DNN consists of interconnected nodes or artificial neurons in a multi-layered structure.

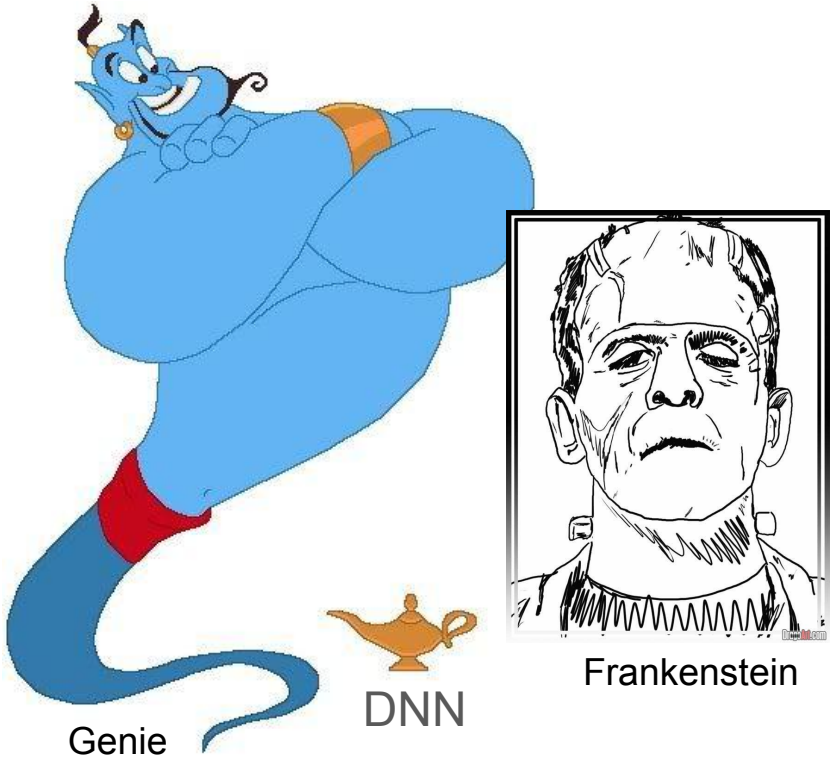
- DNNs can recognize data patterns like complex pictures, text, and sounds to produce accurate insights and predictions.

Why DNN is So Impressive!

DNN achieves:

- Discriminative power
- Predictive Power
- Generative power

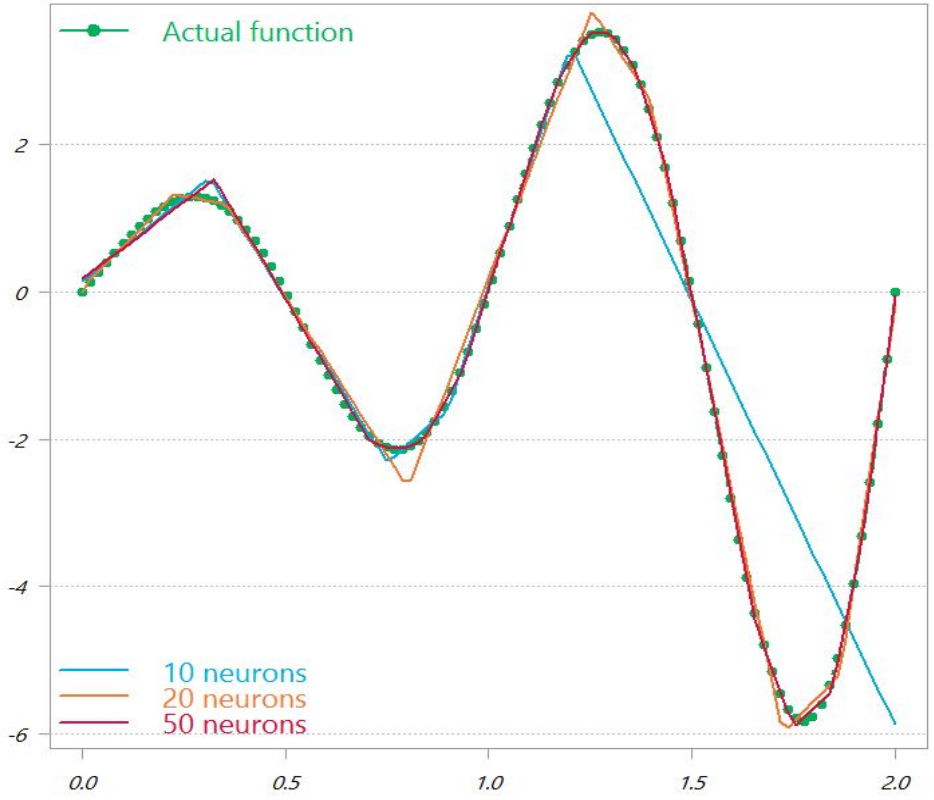
Because of the generative power, DNN could build a helpful,obedient Genie or a harmful Frankenstein for us.



Universal Function Approximator

The main strong point of a deep Neural Network (DNN) is its universality power.

An DNN can approximate any function no matter how complicated the function is if we can ensure that the network has sufficient number of neurons.



Artificial Neuron

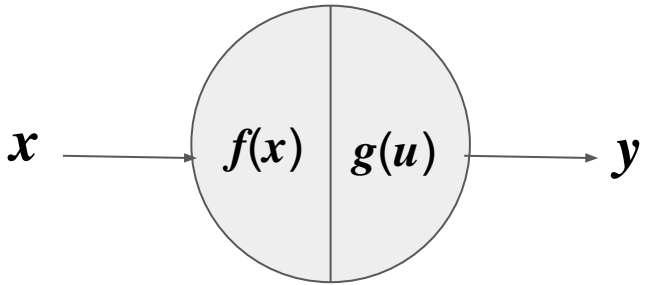
Artificial neuron is nothing but a composite function, $(g \circ f)(x)$

$$u = f(x)$$

$$y = g(u)$$

where

- x is input and y is output
- $f(x)$ is a linear function
- $g(u)$ is generally a nonlinear function



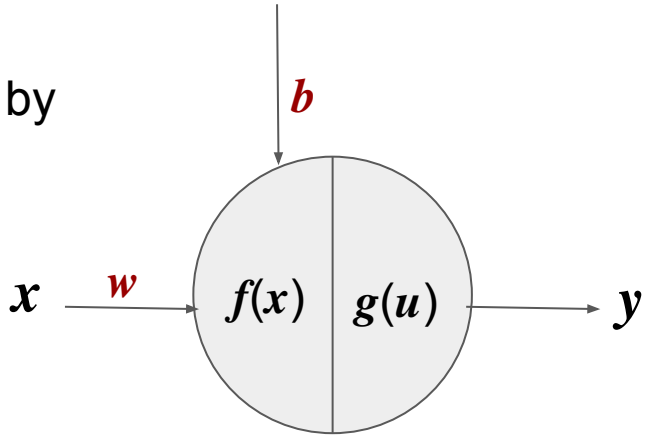
Artificial Neuron

Artificial Neuron

In an artificial neuron, at first input is multiplied by a weight and summed with bias.

$$y = g(f(x))$$

$$u = f(x) = wx + b$$



Artificial Neuron

where

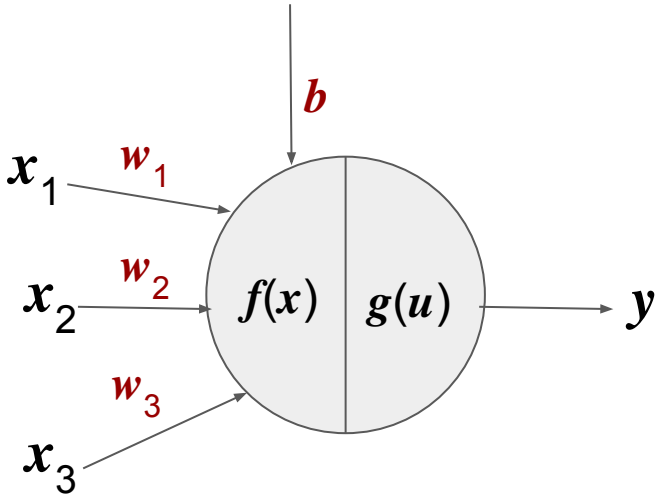
- w is weight which decides how much influence x will have on u.
- b is bias which ensures that u is not too big or too small on average

Artificial Neuron

For a vector x, weight w is a vector and bias b is a scalar.

$$u = f(x)$$
$$= w_1 x_1 + w_2 x_2 + w_3 x_3 + b$$
$$= w^T x + b$$

$g(u)$ is known as **activation function**. Generally nonlinear functions are used as activation functions.



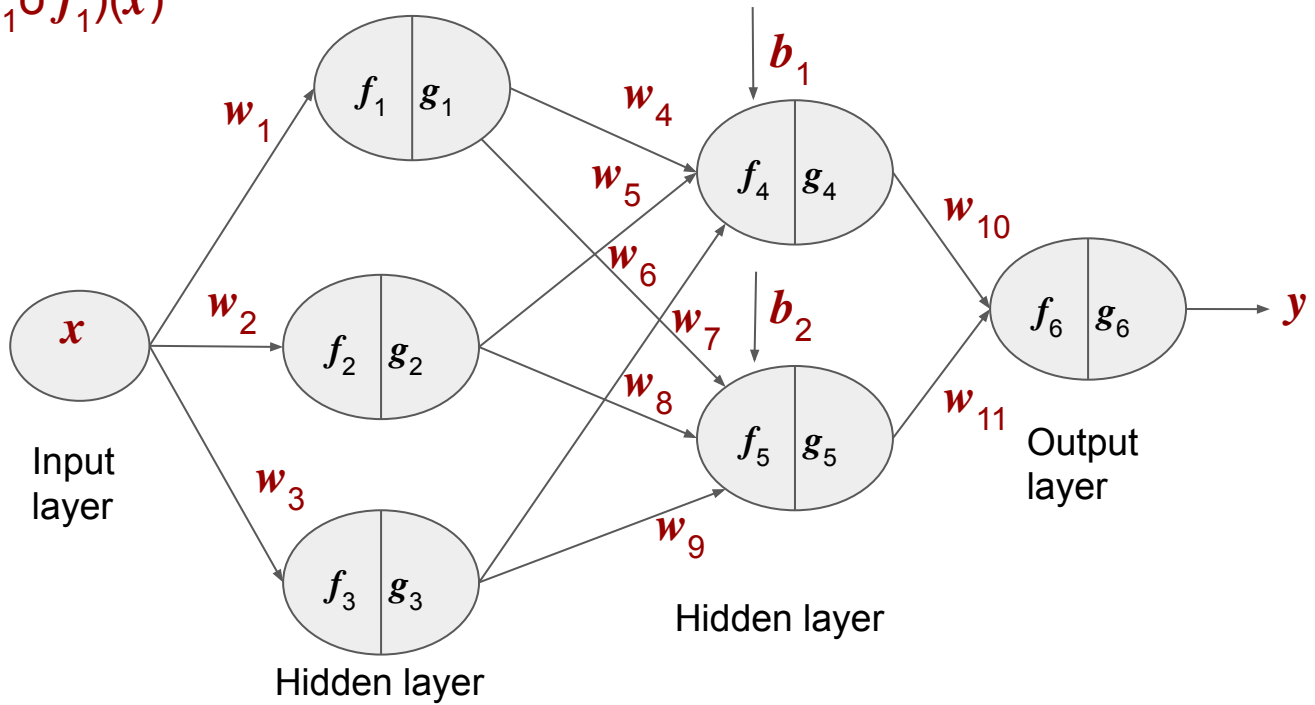
Artificial Neuron

Artificial Neural Network (ANN)

ANN is nothing but a composite of composite functions:

$(g_n \circ f_{n.....} g_2 \circ f_2 \circ g_1 \circ f_1)(x)$

Number of parameters: weights + bias (optional) + any variables in $g(.)$ (optional)

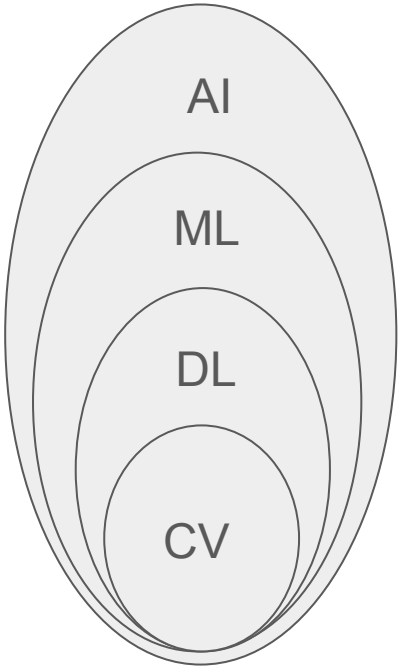


Presently Main Research Areas of DNN

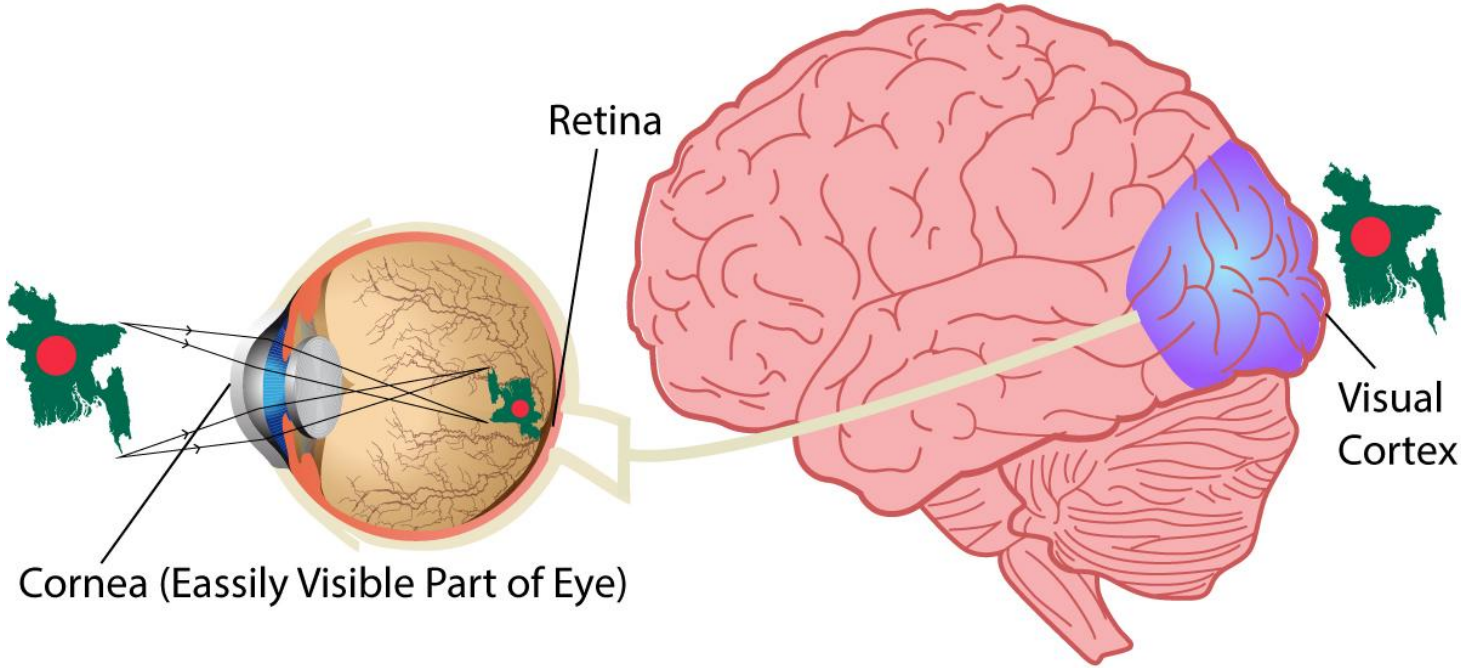
- Natural Language Processing (NLP)
  - NLP is a subfield of AI which which works on giving computers the ability to interpret, manipulate, and comprehend human language.
  - It includes text to speech generation, sentiment understanding, or classifying text based on content.
- Large Language Model (LLM)
  - LLM is a branch of AI system that generates human-like text based on vast amounts of training data.
  - ChatGPT
- **Computer Vision (CV)**

Vision

- Vision: দৃষ্টি
- দৃষ্টিশক্তি, দূরদৃষ্টি, কল্পনা, কল্পনায় দেখতে পাওয়ার অভিজ্ঞতা
- Human Vision: A complex process of creating a visual representation of the world around us with the help of our eyes and brain.
- Computer Vision (CV):
  - A complex process of deriving meaningful information from digital images, videos and other visual inputs with the help of Computers' artificial intelligence ability.
  - Different non-neural techniques were used at earlier stage.
  - Now-a-days **Deep Learning** based techniques are dominating CV

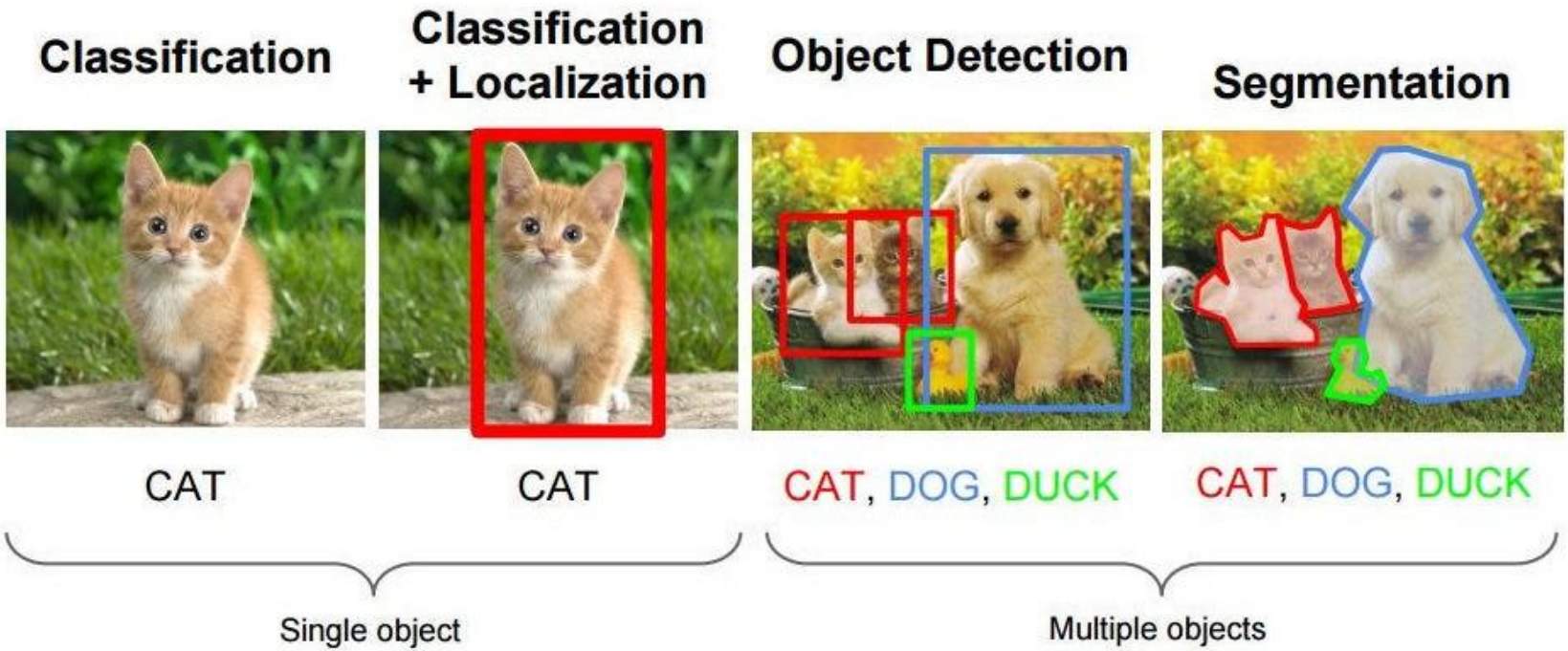


Human Vision



Khan et al., ICCIT, Dhaka, 2024

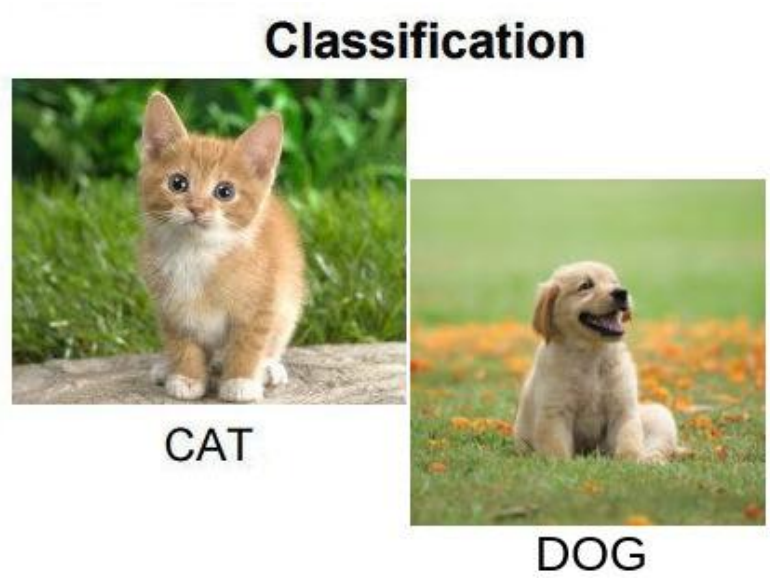
Computer Vision Tasks



What We will Use

In this Lab, we will focus on only the Classification problem of CV.

- Linux Environment
- Tensorflow, Keras
- Python
- OpenCV
- Other Python Libraries such as matplotlib, scikit, pandas
- Google Colab https://colab.research.google.com/



MNIST Fashion Dataset

- 70000 images 28 x 28
  - 60000 for training
  - 10000 for testing
- 10 classes
  - 0: T-shirt/top, 1: Trouser

    2: Pullover, 3: Dress

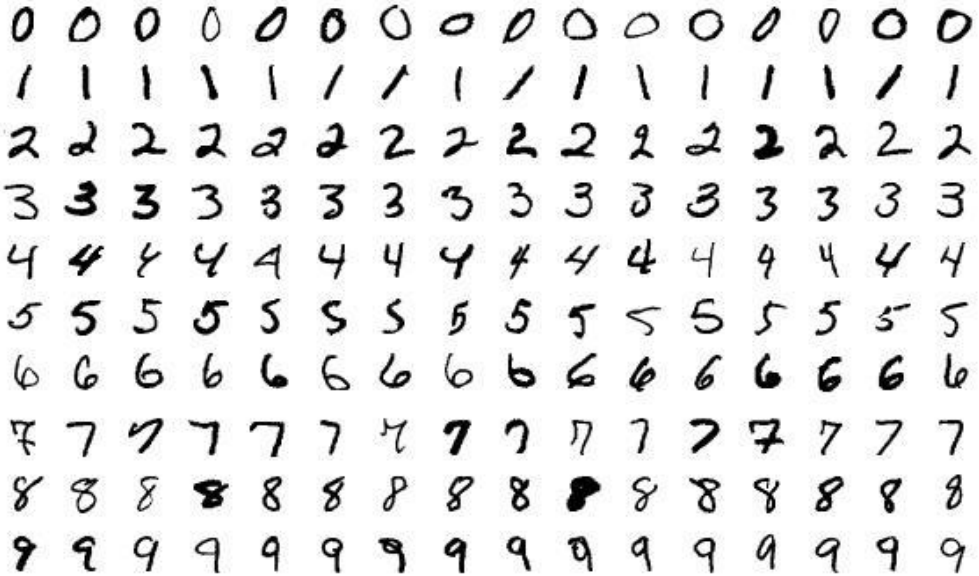
    4: Coat, 5: Sandal

    6: Shirt, 7: Sneaker

    8: Bag, 9: Ankle boot

MNIST Digit Dataset

- 70000 images 28 x 28
  - 60000 for training
  - 10000 for testing
- 10 classes
  - 0, 1, 2, 3, 4, 5, 6, 7, 8, 9



Other Datasets

- CIFAR 10 dataset
  - https://www.cs.toronto.edu/~kriz/cifar.html
  - 60000, 32x32 colour images in 10 classes, with 6000 images per class
  - 50000 training images and 10000 test images
- CIFAR 100 dataset
  - https://www.cs.toronto.edu/~kriz/cifar.html
  - 100 classes containing 600 images each
  - 500 training images and 100 testing images per class
- ImageNet 1000 dataset
  - https://www.image-net.org/
  - 1000 object classes
  - 1281167 training images, 50000 validation images and 100000 test images.

Your Own Dataset

Prepare an image dataset capturing pictures using your mobile phone or camera.

- Binary Class
  - For example, merry gold and rose
  - Captured images should not be offensive to any belief of any ethnic group
  - No human beings' images without their written permission
- At least 500 images for each class
  - Not more than 2 images from an object
- Register your class in the following excel sheet
  - https://docs.google.com/spreadsheets/d/1TIq35QJGJNwPIHzet4V68-sYufE_0iFphDcA3iz07ss/edit?usp=sharing
  - Two students cannot choose the same class to prepare their dataset