Chapter - 5

Implementation of Deep Learning Algorithms

Unit
1

Deep Learning Techniques

DISCLAIMER

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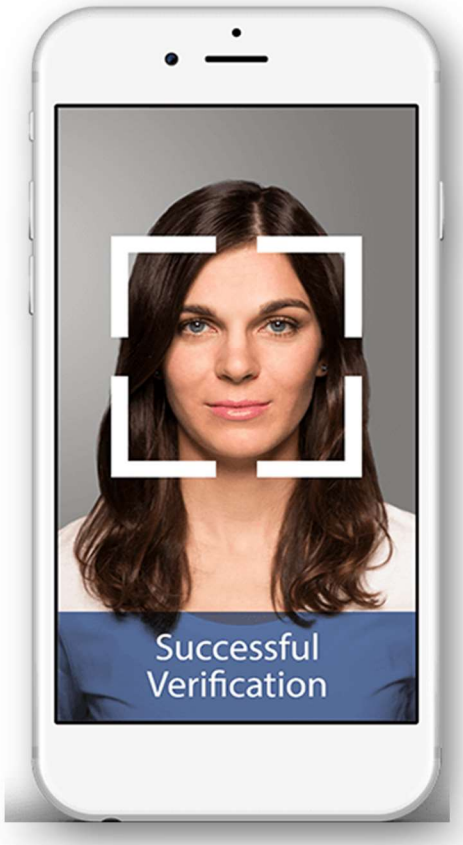

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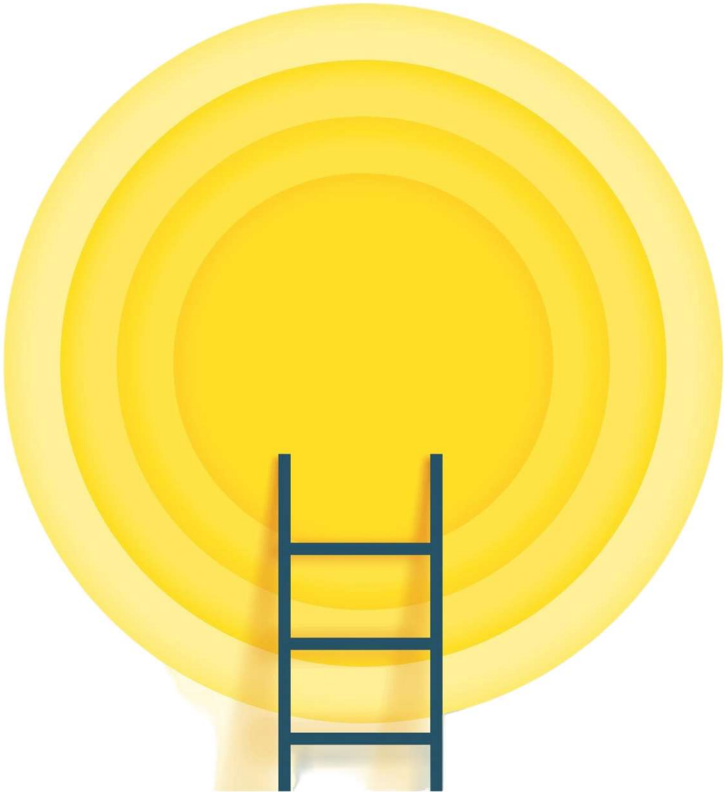
Learning Objectives

Deep Learning:

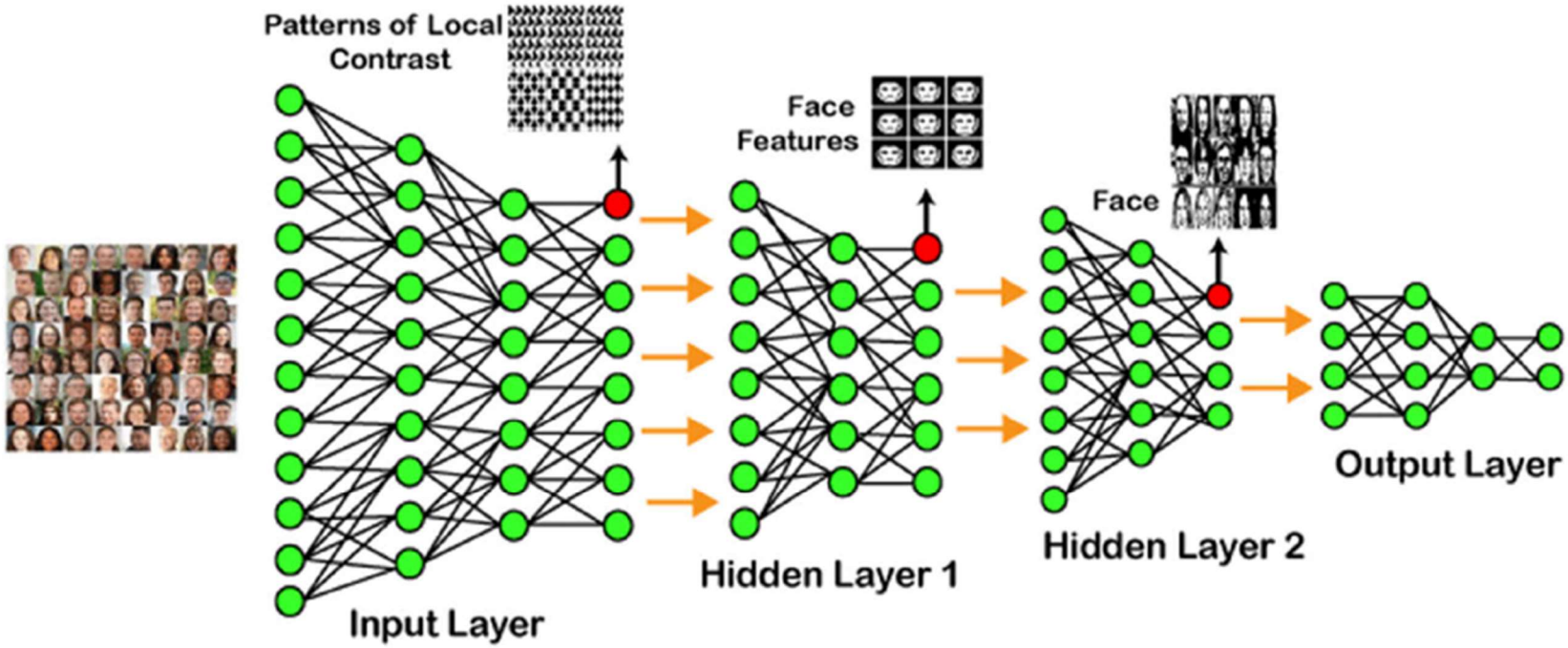
- Understand definition of deep learning
- How deep learning is different from Machine learning
- Understand fundamentals of deep neural network like neuron, activation functions, bias, weight, hyperparameters in neural network etc.
- Convolutional Neural Network



What is Deep Learning?

- Deep Learning is the subset of machine learning or can be said as a special kind of machine learning.
- It works technically in the same way as machine learning does, but with different capabilities and approaches.
- Deep learning models are capable enough to focus on the accurate features themselves by requiring a little guidance from the programmer.
- Deep learning is implemented with the help of Neural Networks, and the idea behind the motivation of neural network is the biological neurons, which is nothing but a brain cell.

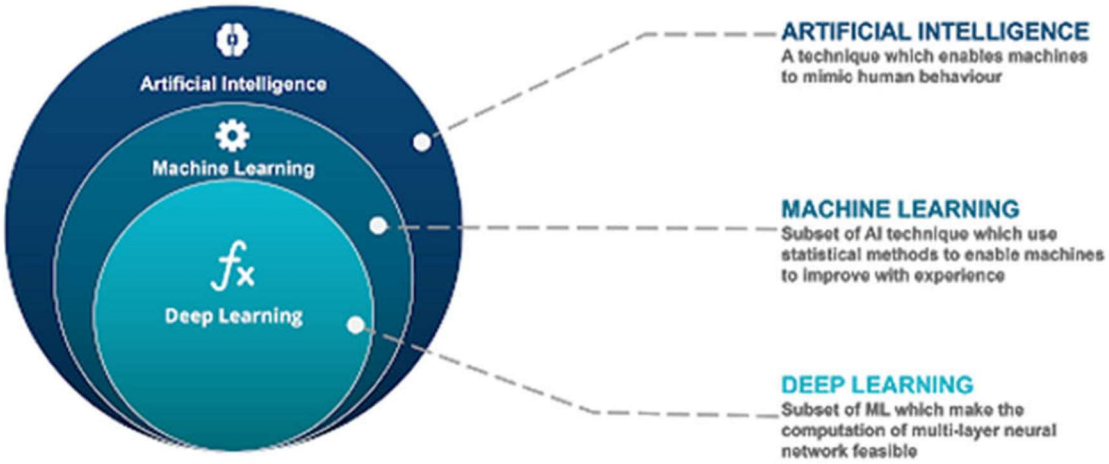
Example of Deep Learning?



Source : https://www.javatpoint.com/deep-learning

Machine Learning Vs Deep Learning

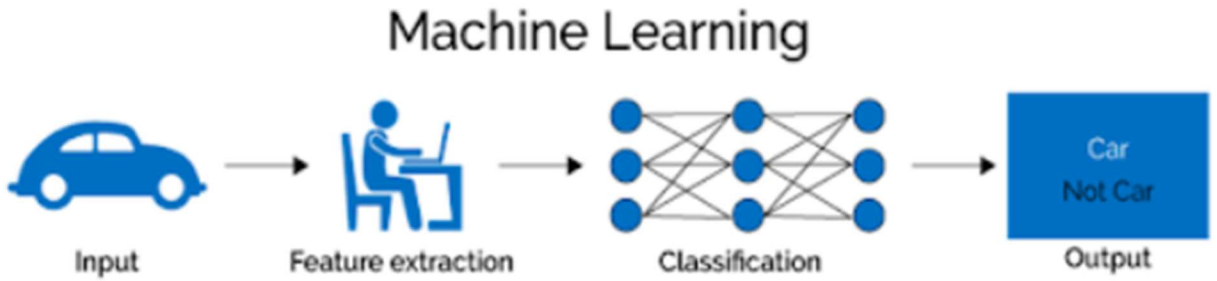
- Machine Learning and Deep Learning are the two main concepts of Data Science and the subsets of Artificial Intelligence.
- Most of the people think the machine learning, deep learning, and as well as artificial intelligence as the same buzzwords. But in actuality, all these terms are different but related to each other.



Source : https://www.edureka.co/blog/ai-vs-machine-learning-vs-deep-learning/

How Machine Learning Works?

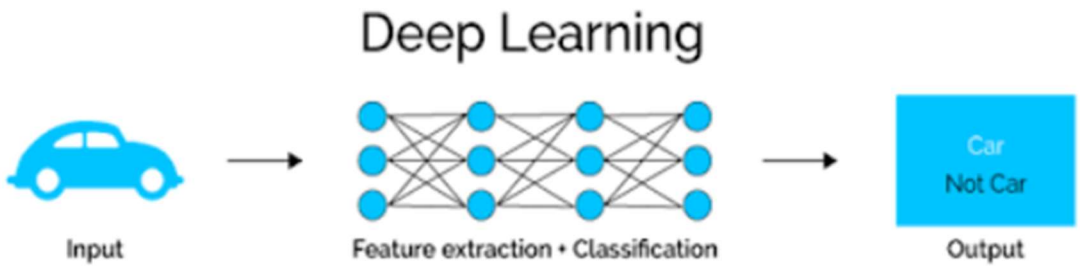
- The working of machine learning models can be understood by the example of identifying the image of a car or Not car.
- To identify this, the ML model takes images of car as input, extracts the different features of images such as shape, height, etc., applies the classification algorithm, and predict the output.



Source : https://builtin.com/machine-learning/deep-learning

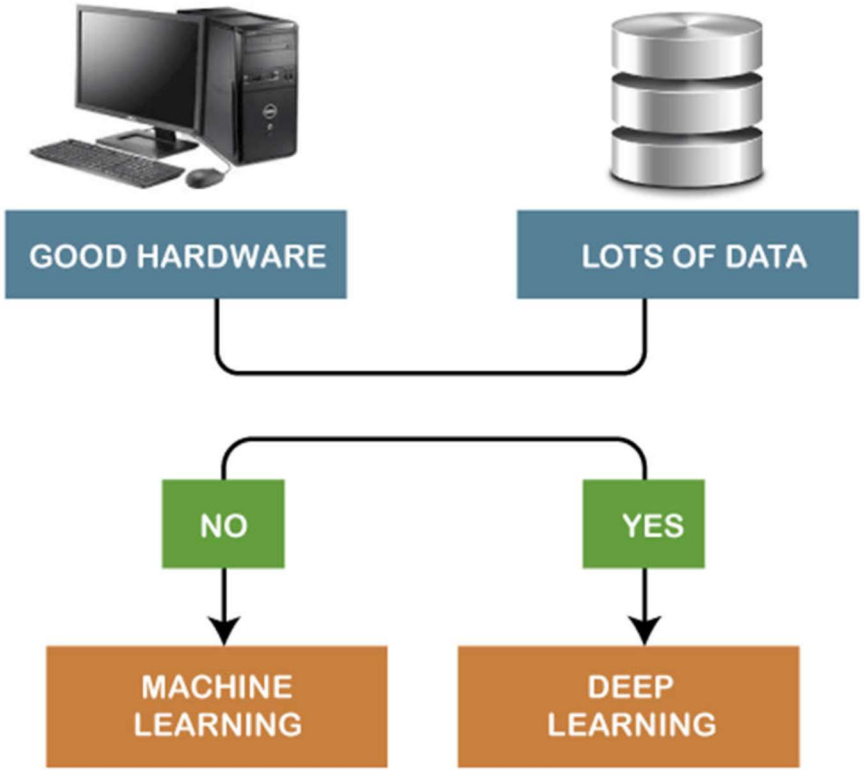
How Deep Learning Works?

- We can understand the working of deep learning with the same example of identifying Car vs. Not car.
- The deep learning model takes the images as the input and feed it directly to the algorithms without requiring any manual feature extraction step.
- The images pass to the different layers of the artificial neural network and predict the final output.



Source : https://builtin.com/machine-learning/deep-learning

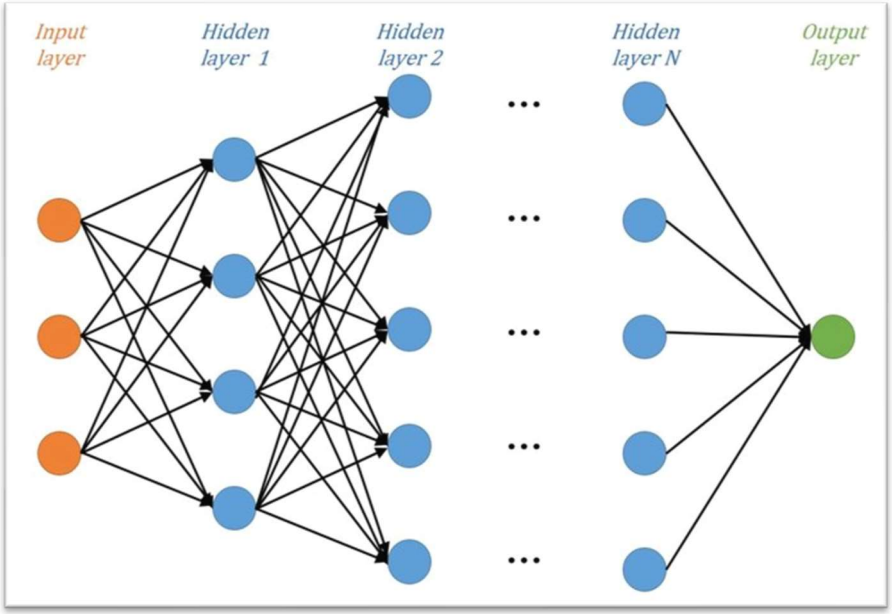
Which one to Select – ML or DL?



Source : https://www.javatpoint.com/machine-learning-vs-deep-learning

Deep Neural Networks(DNN)

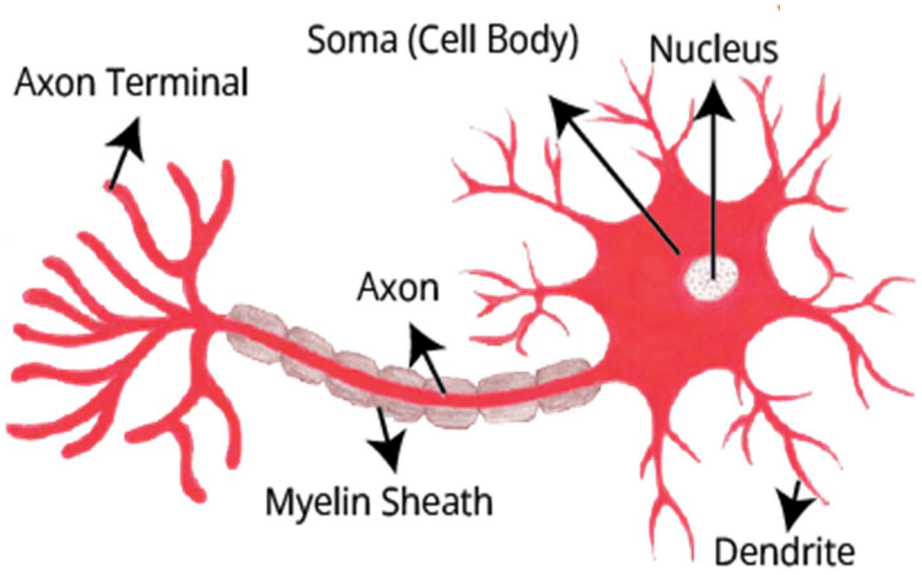
- A hierarchical organization of neurons with connections to other neurons is a simplified representation of a DNN.
- Deep Neural Networks gained their name from the fact that they utilized a lot of hidden layers to learn more intricate patterns, giving them the label "deep".
- Based on the received input, these neurons send a message or signal to other neurons, forming a complex network that learns through a feedback loop.



Reference link

Neurons

- Neurons in deep learning models are nodes through which data and computations flow.
- Neurons receive one or more input signals.
- These input signals can come from either the raw data set or from neurons positioned at a previous layer of the neural net.



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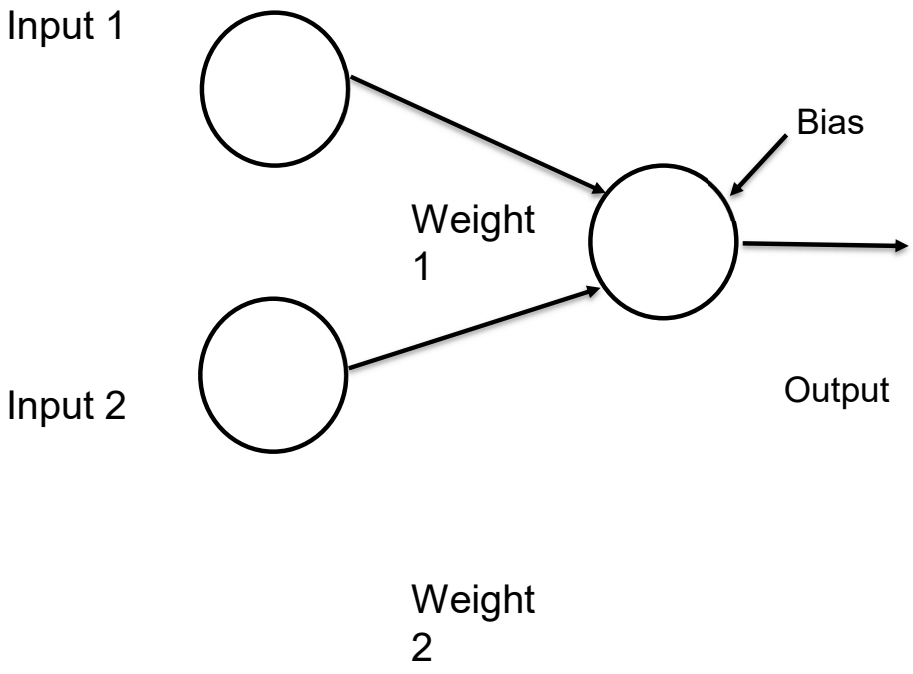
Weights and Bias

- Weights enable the artificial neural network to dial up or dial down connections between neurons.
- Bias can be used to make adjustments within neurons.
- Bias can be positive or negative, increasing or decreasing a neuron's output



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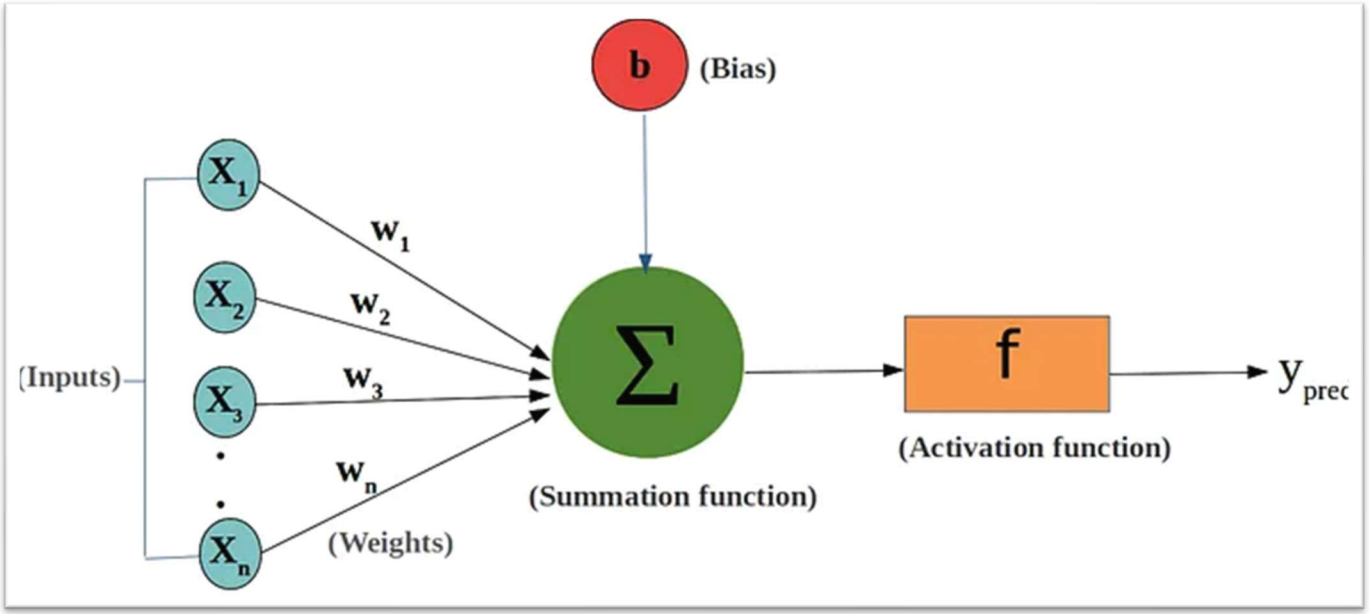
Components of Artificial Neuron



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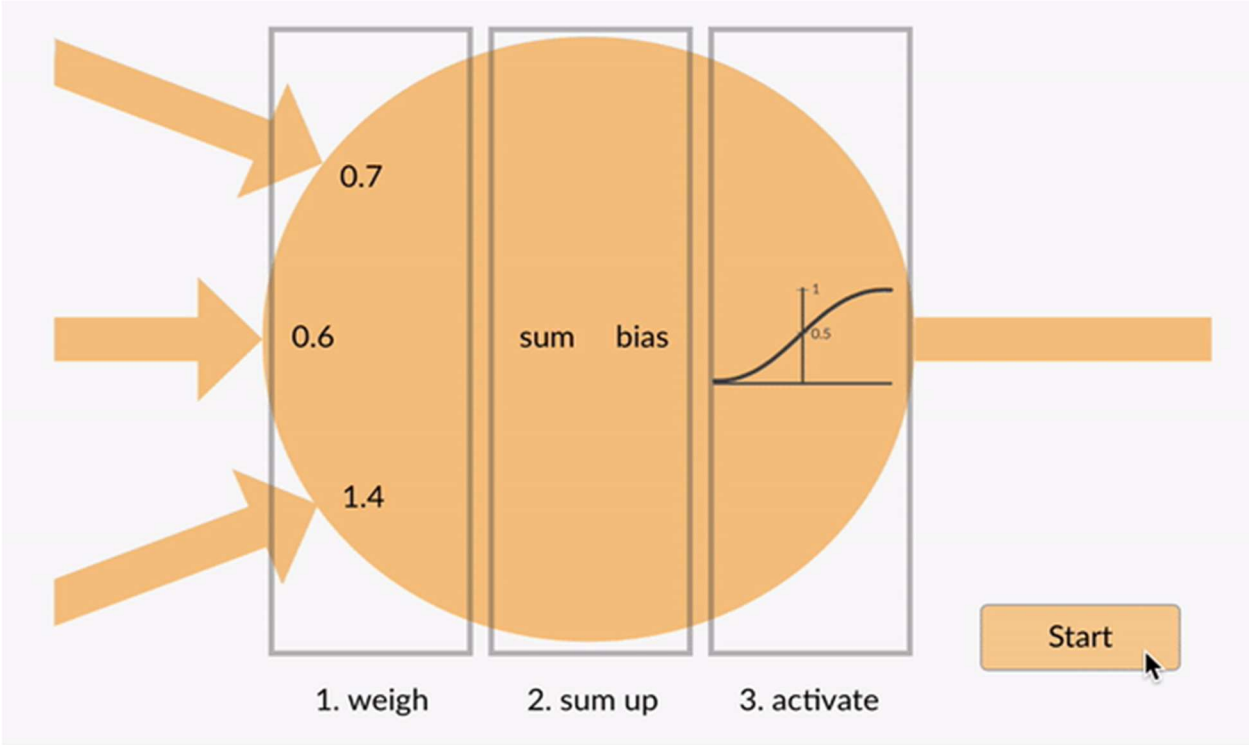
Single Neuron



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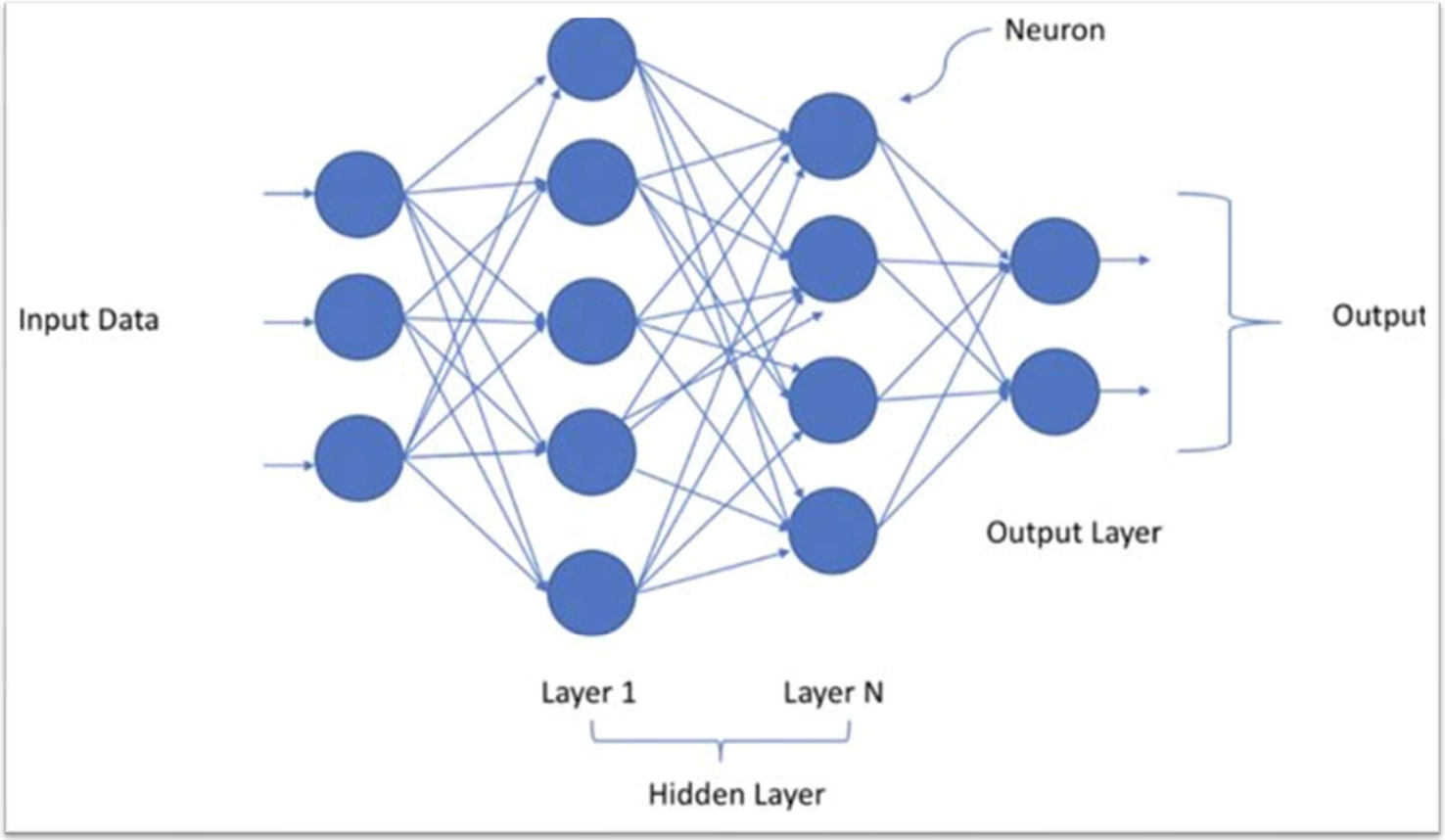
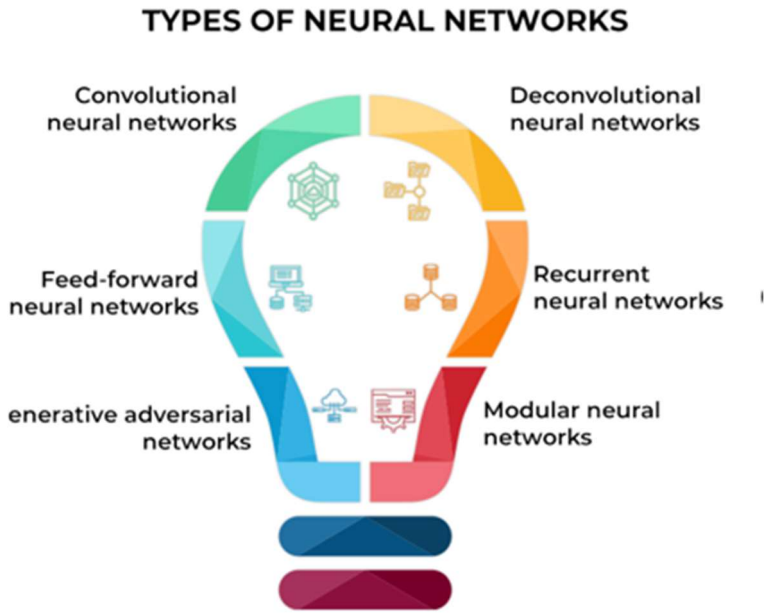
Representation of DNN



Types of Deep Neural Networks

Four Types of Neural Network Architecture:

- Feedforward Neural Networks (FNNs)
- Convolutional Neural Networks (CNNs)
- Recurrent Neural Networks (RNNs)
- Generative Adversarial Networks (GANs)



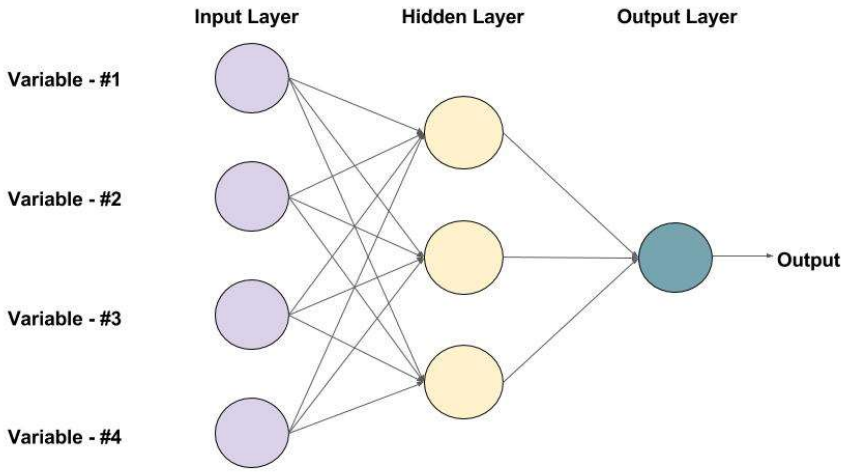
Source

https://www.coursera.org/articles/neural-network-architecture

Feedforward Neural Networks

Feedforward Neural Networks
- Basic form of neural networks
- Data flows forward from input to output
- No loops or cycles
- Used for:
  - Pattern and image recognition
  - Regression analysis
  - Classification

How FNNs Work
- Consist of input layer, hidden layers, and output layer
- Data passes through nodes in each layer
- Each node connects to every node in the next layer



An example of a Feed-forward Neural Network with one hidden layer (with 3 neurons)

Figure 2.5

Source

https://www.coursera.org/articles/neural-network-architecture

Backpropagation Algorithm

- Backpropagation is an efficient algorithm for calculating gradients (derivatives of the error function) with respect to weights and biases in a multi-layered neural network.
- It works by propagating the error backward through the network, layer by layer.
- At each layer, the error is used to calculate the gradients for the weights and biases connecting that layer to the previous layer.

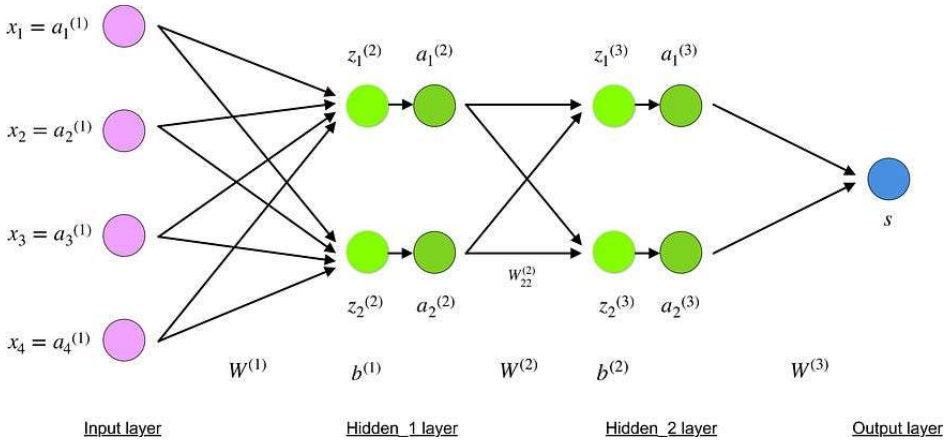


Figure 5.43

Source

https://towardsdatascience.com/understanding-backpropagation-algorithm-7bb3aa2f95fd

Steps in Backpropagation

1. Forward Pass:
   - The input data is propagated forward through the network, calculating activations at each layer.
2. Error Calculation:
   - The error (difference between predicted and actual output) is computed at the output layer.
3. Backward Pass:
   - The error is propagated backward through the network, layer by layer.At each layer, gradients for weights and biases are calculated using the chain rule.
4. Weight Update:
   - The weights and biases are updated using an optimization algorithm (e.g., gradient descent) based on the calculated gradients.

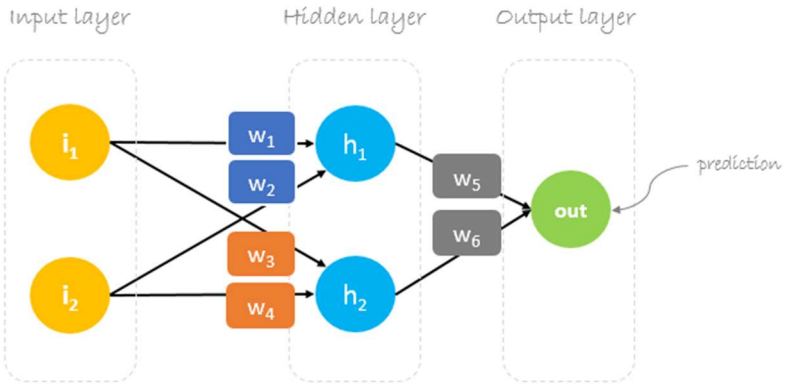


Figure 5.44

Source

https://paperswithcode.com/method/leaky-relu

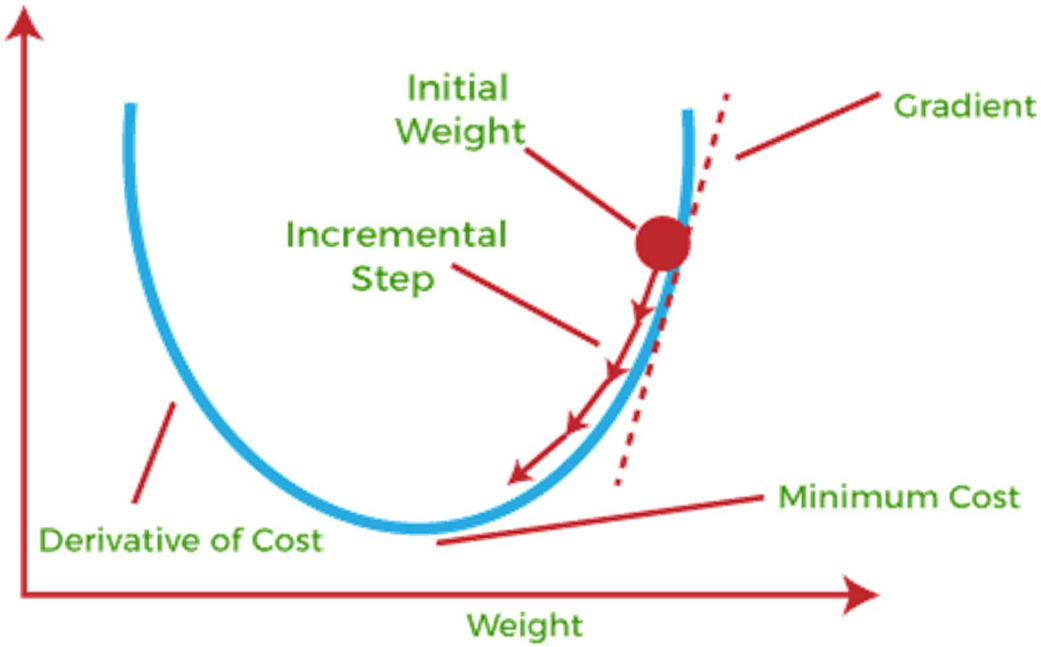
Gradient Descent

- Gradient Descent is known as one of the most used optimization algorithms to train machine learning models by means of minimizing errors between actual and expected results.
- Gradient descent was initially discovered by "Augustin-Louis Cauchy" in the mid 18th century.
- Gradient Descent is defined as one of the most used iterative optimization algorithms of machine learning to train the machine learning and deep learning models. It helps in finding the local minimum of a function.

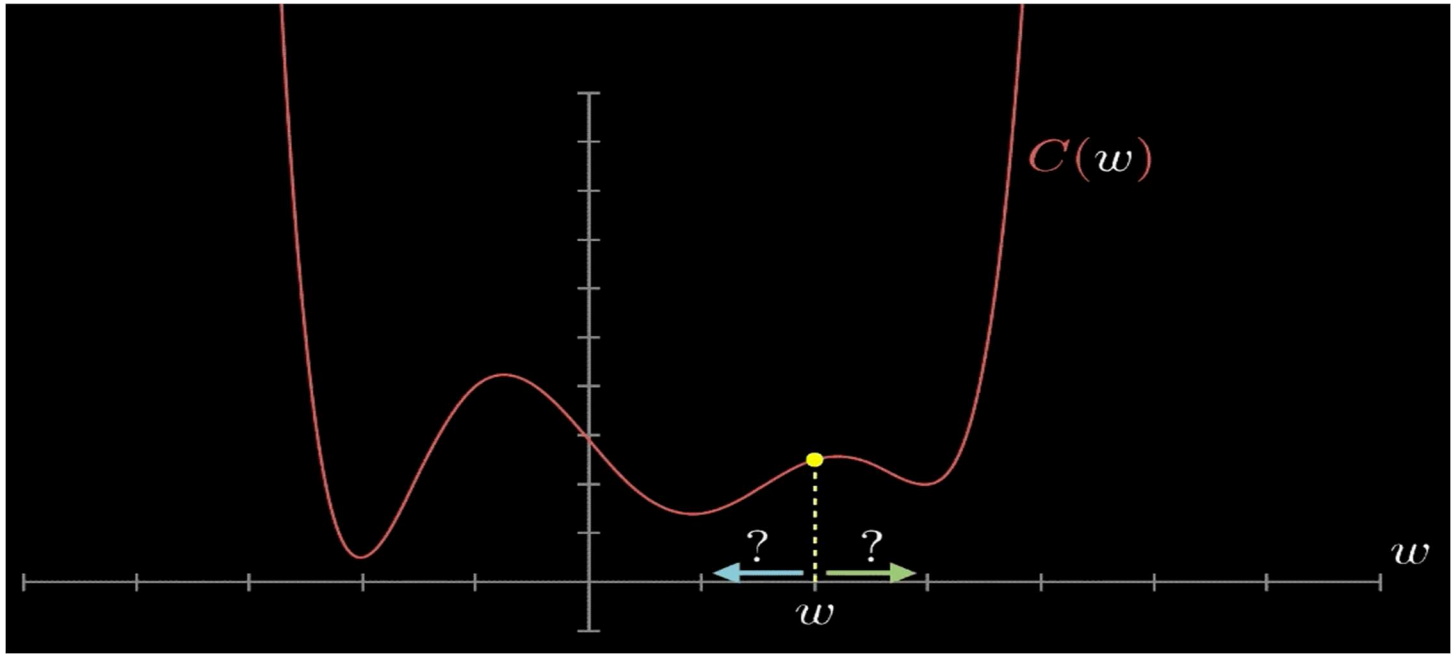
The best way to define the local minimum or local maximum of a function using gradient descent is as follows:

- If we move towards a negative gradient or away from the gradient of the function at the current point, it will give the local minimum of that function.
- Whenever we move towards a positive gradient or towards the gradient of the function at the current point, we will get the local maximum of that function.

Gradient Descent



Gradient Descent



Convolutional Neural Networks

- Specialized in recognizing patterns and images
- Used for:
  - Computer Vision
  - Handwritten zip code recognition

How CNNs Work

- Contain input, convolutional, pooling, and output layers
- Convolutional layers filter input to extract features
- Pooling layers simplify parameters while retaining key information

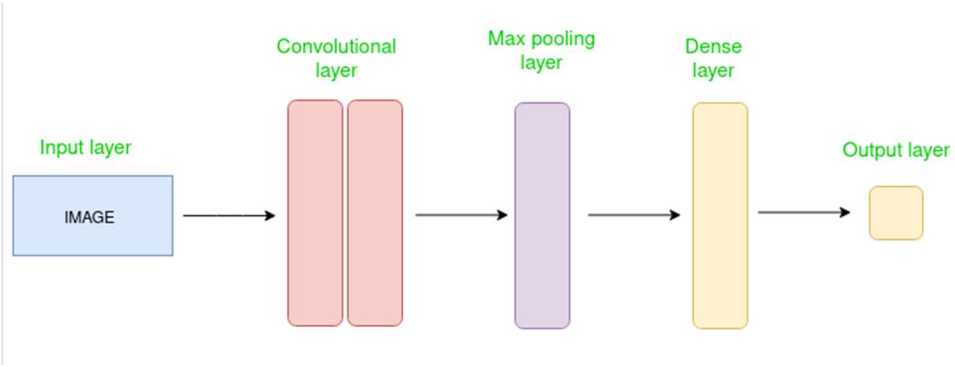


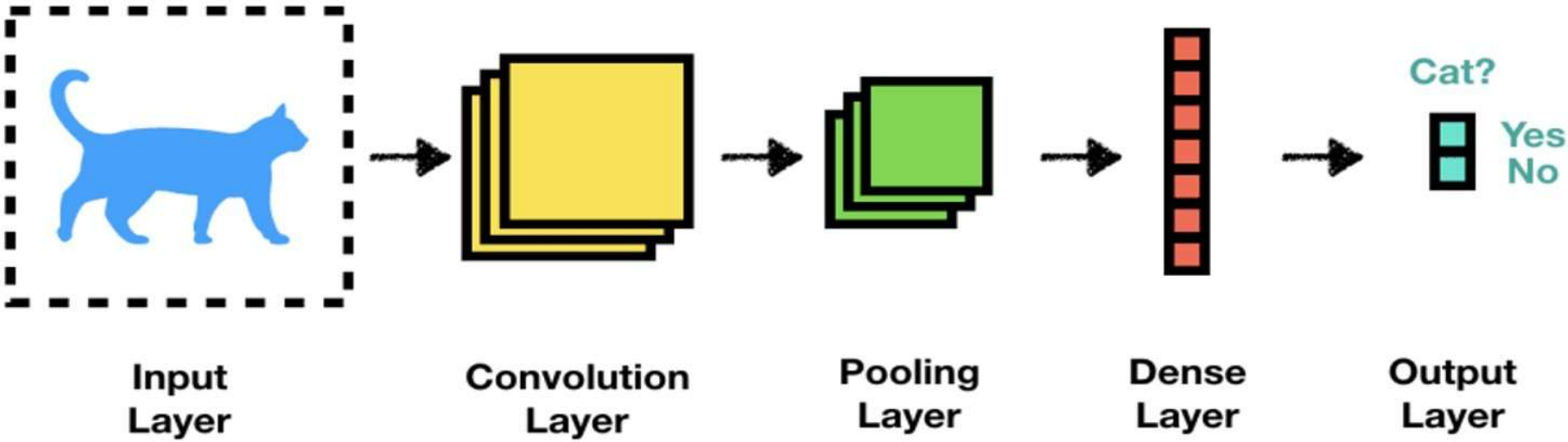
Figure 2.7

Source

https://www.coursera.org/articles/neural-network-architecture

Convolutional Neural Network

•CNNs have stacked layered architecture of several Convolution and Pooling Layers

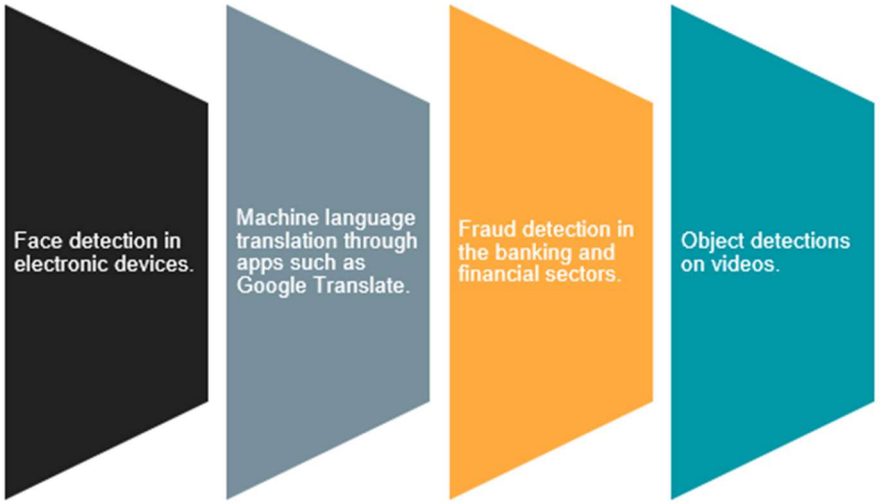


TensorFlow 2.0 & Keras API

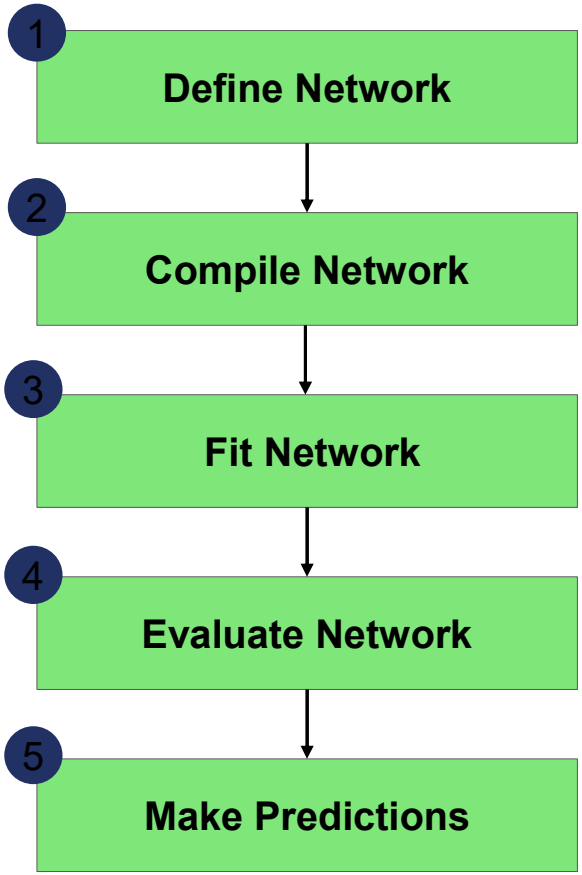
Tensor

- TensorFlow 2.0 is a library that provides a comprehensive ecosystem of tools for developers, researchers, and organizations who want to build scalable Machine Learning and Deep Learning applications.
- **TensorFlow Applications**

Syntax:
import tensorflow as tf



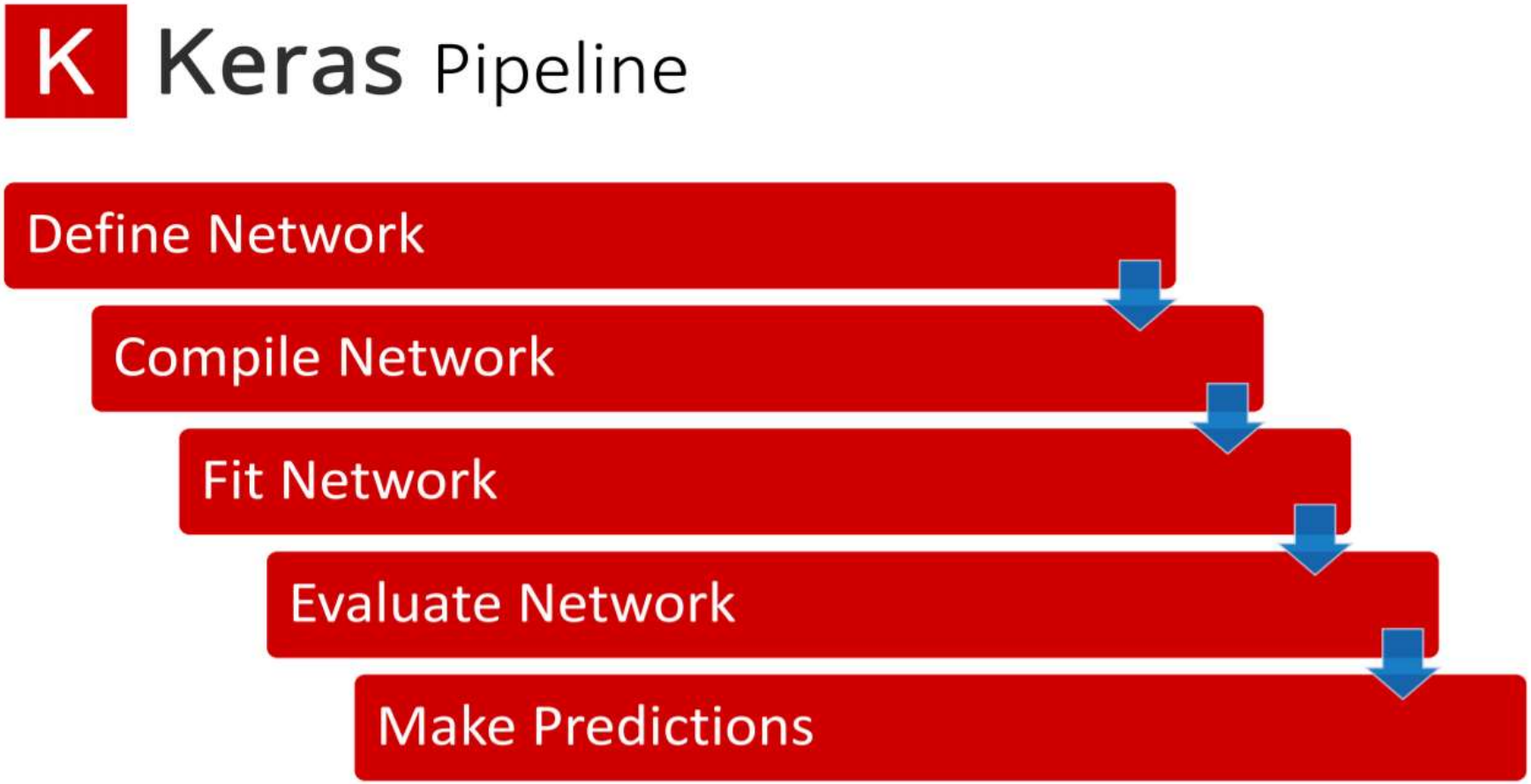
Building a model in Keras



What is Keras?

- Keras is a deep learning API written in Python, running on top of the machine learning platform TensorFlow.
- It was developed with a focus on enabling fast experimentation. Being able to go from idea to result as fast as possible is key to doing good research.

Reference link


Keras Pipeline
Define Network
Compile Network
Fit Network
Evaluate Network
Make Predictions

Lab Activity

Hands On

Lab 1

- First Neural Network with Keras

Conclusion

- So we have learned what is Deep Learning , and how it is related to AI and how it is different from AI and ML.
- Bias, weight, activation function are core components of a neuron.
- In Feedforward neural network the information moves in only one direction —forward—from the input nodes, through the hidden nodes (if any), and to the output nodes.
- Convolutional Neural Network

References

- https://setosa.io/ev/image-kernels/
- https://towardsdatascience.com/understand-transposed-convolutions-and-build-your-own-transposed-convolution-layer-from-scratch-4f5d97b2967
- https://www.simplilearn.com/tutorials/deep-learning-tutorial/deep-learning-algorithm
- https://medium.com/voice-tech-podcast/text-classification-using-cnn-9ade8155dfb9

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Quiz

1. In deep learning, what is backpropagation used for?

A) Initializing neural network weights

B) Calculating the loss function

C) Updating neural network weights

D) Determining the number of hidden layers

Answer: C

Quiz

2. What is the primary objective of deep learning?

A) Feature engineering

B) Data visualization

C) Automatic feature learning

D) Data preprocessing

Answer: C

Quiz

3. _____in which we give input to our model.

a) Input layer
b) Output layer
c) Hidden layer
d) None

Answer: A

Quiz

4. Which type of neural network is commonly used for image classification tasks?

a) Recurrent Neural Networks (RNNs)

b) Convolutional Neural Networks (CNNs)

c) Generative Adversarial Networks (GANs)

d) Long Short-Term Memory (LSTM) networks

Answer: B

Thank You