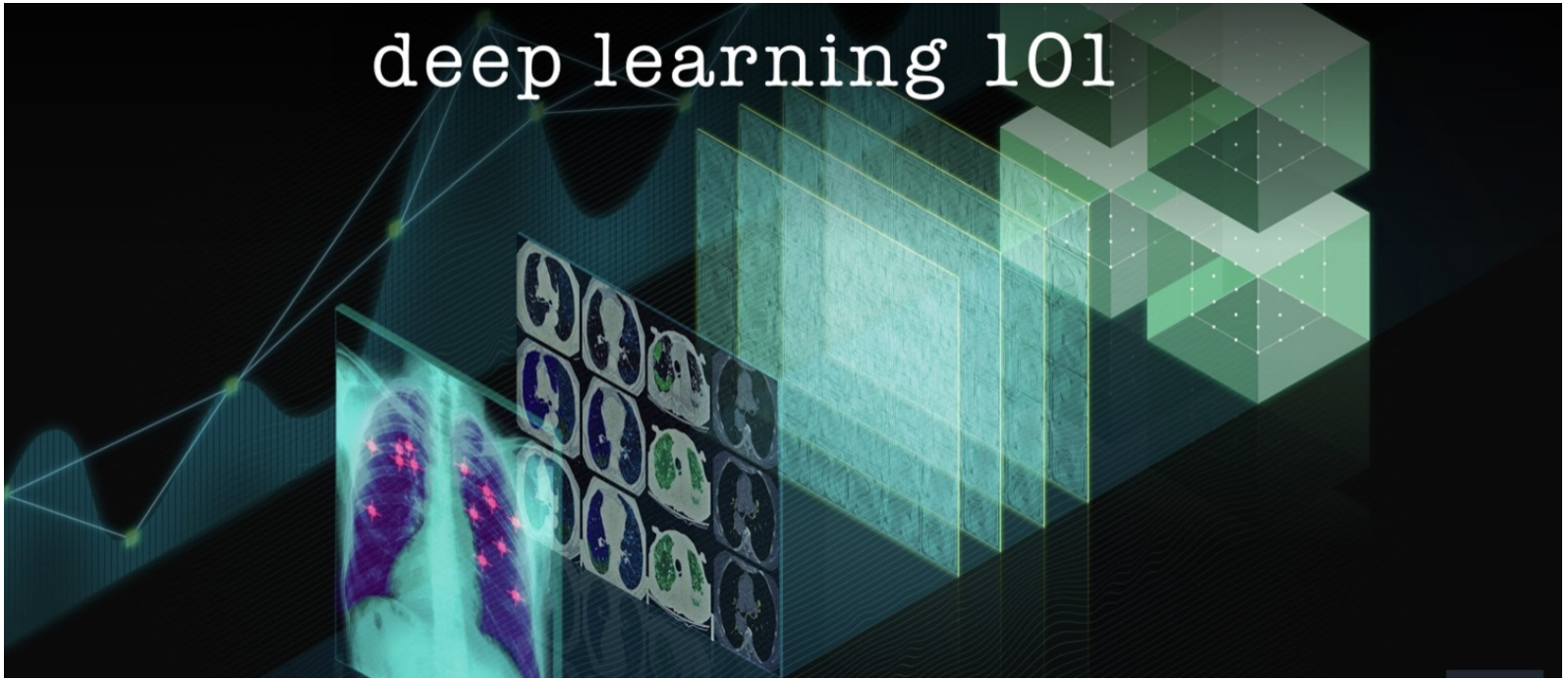
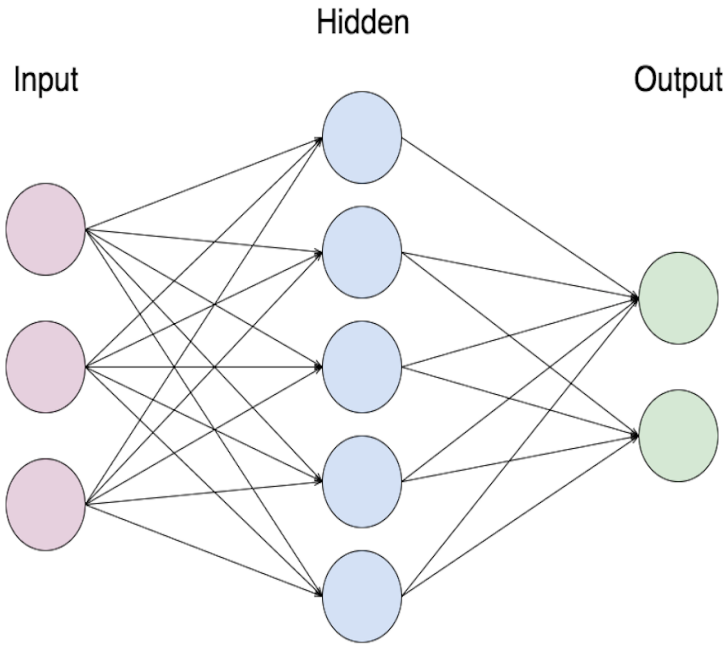
Introduction to Neural Networks and Deep Learning



Agenda

1. **Neural Network Building Blocks**
    - What is a Neuron?
    - Working of a Neuron
    - Analogy with Human Brain
    - Perceptron
2. Why we need Neural Networks
3. Working of a Neural Network
    - Forward Propagation
    - Backward Propagation
4. Deep Neural Networks
    - Hidden Layers
    - Why Deep Neural Networks?
    - Types of DNNs
        - Multilayer Perceptron (ANN)
        - Convolutional Neural Network
        - Recurrent Neural Network
        - Generative Adversarial Networks (GANs)
5. Applications of Deep Neural Networks

1. Artificial Neural Network (ANNs)



- Composed of a large number of highly interconnected processing elements called neurons
- Like people, learn by example
- Configured for specific applications
- Like pattern recognition or data classification

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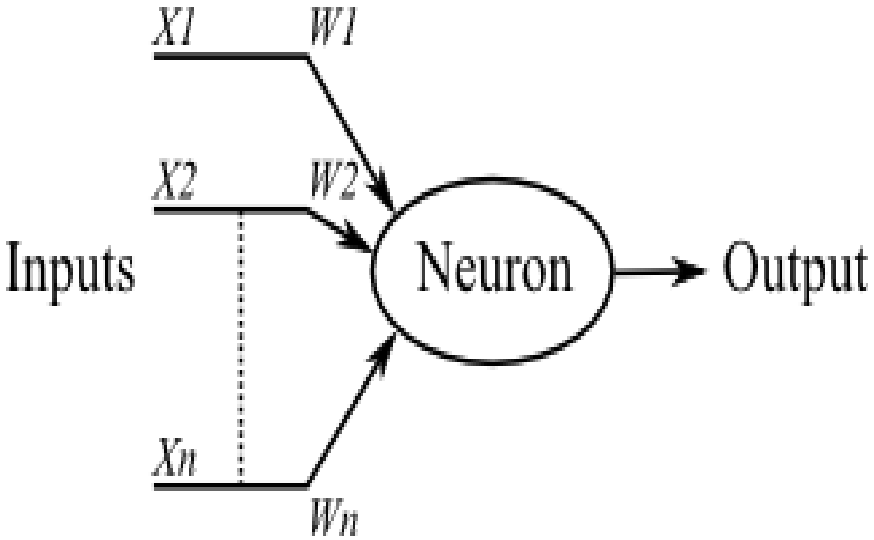
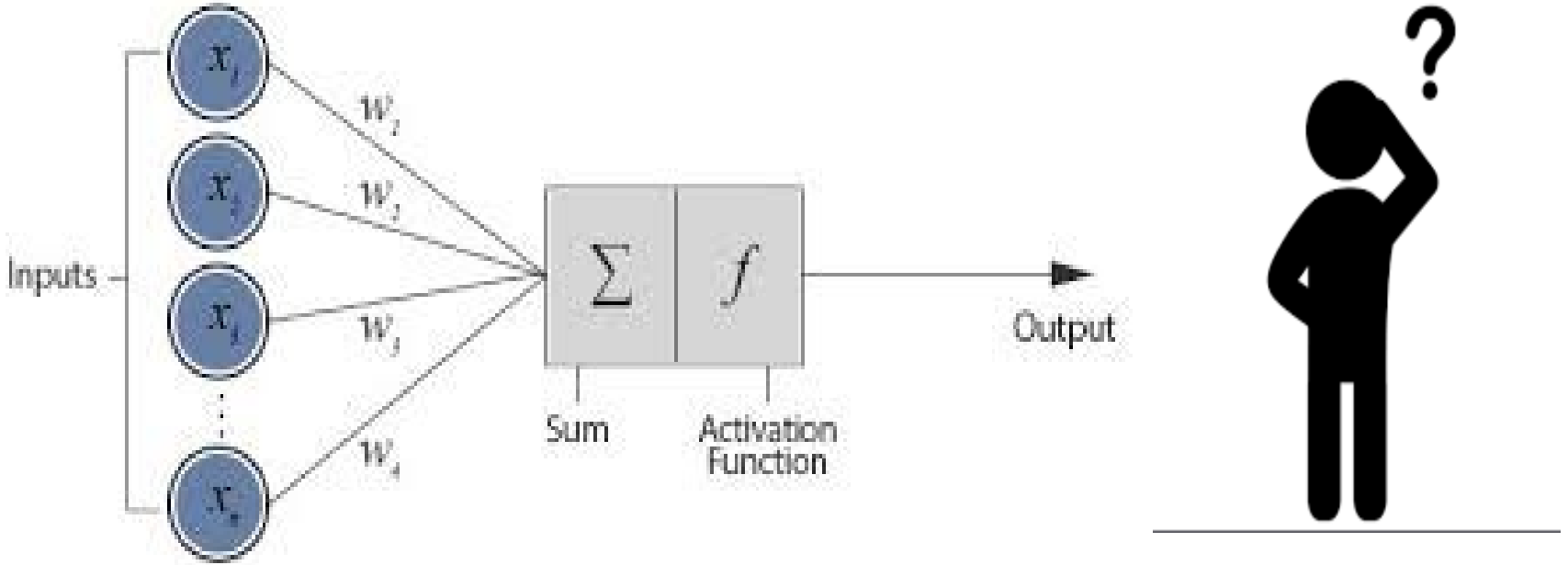
What is a Neuron?



- A device with many inputs and one output
- Also called McCulloch and Pitts model
- Effect that each input has at decision making depends on the weight of the particular input

Can You Suggest the Final Outcome?



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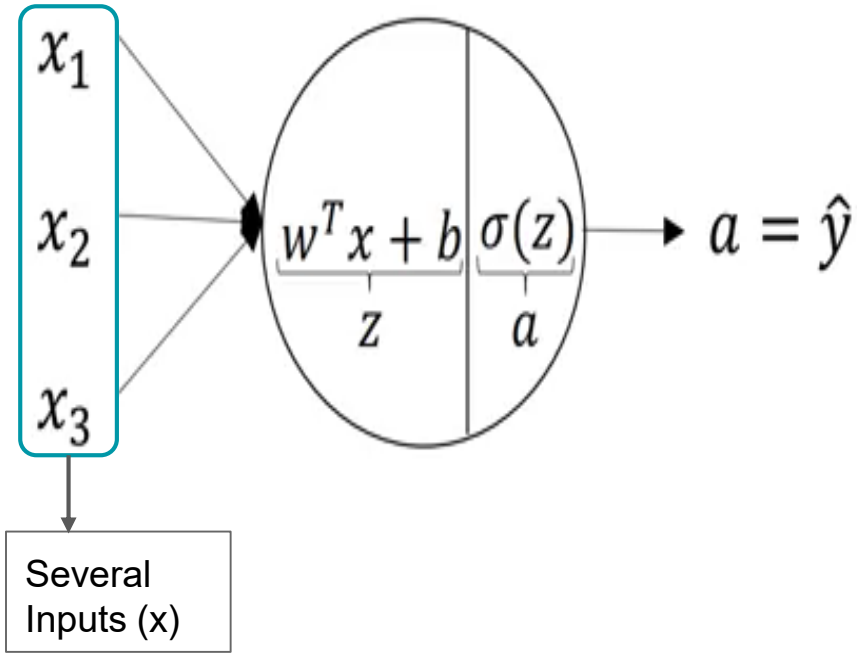
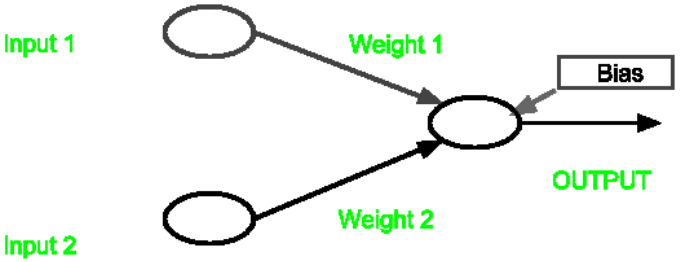
Working of a Neuron



- First, a neuron computes the matrix product of the weights and inputs
- It also adds a bias to the above term
- Second, it uses an activation function to get the output

Working of a Neuron - Summation

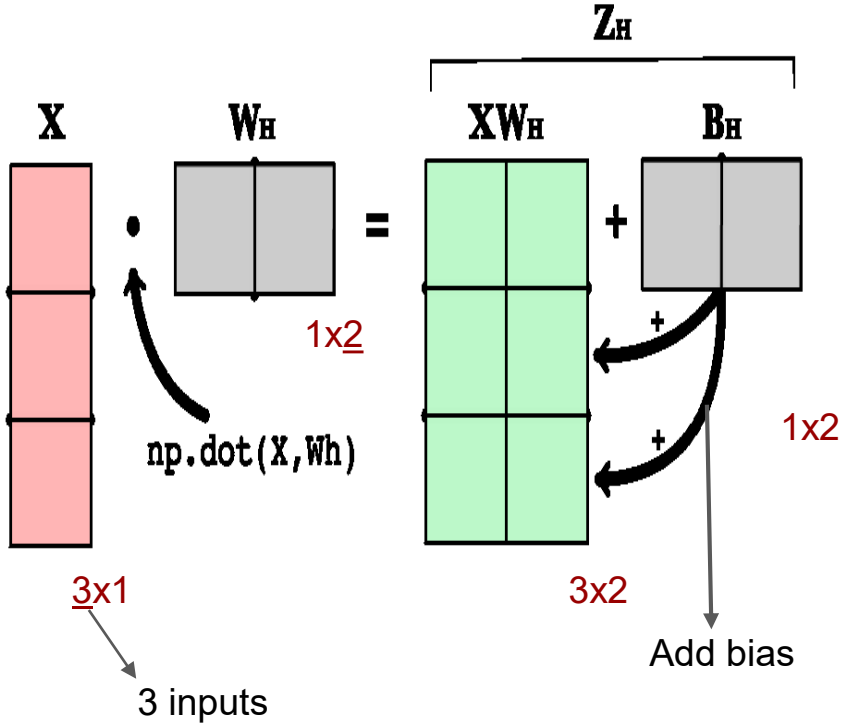


Output = weight1 * input1 + weight2 * input2 +bias

- Firstly, the inputs are matrix multiplied to the weight vector

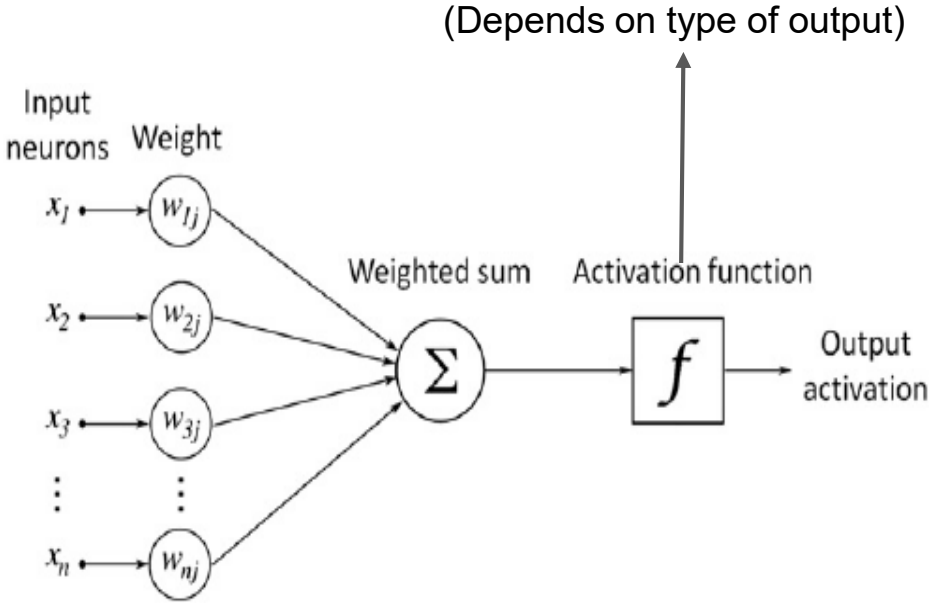
- Size of the weight vector = Number of inputs
- Then, bias is added to get the output ‘z’

Working of a Neuron - Matrix Operations



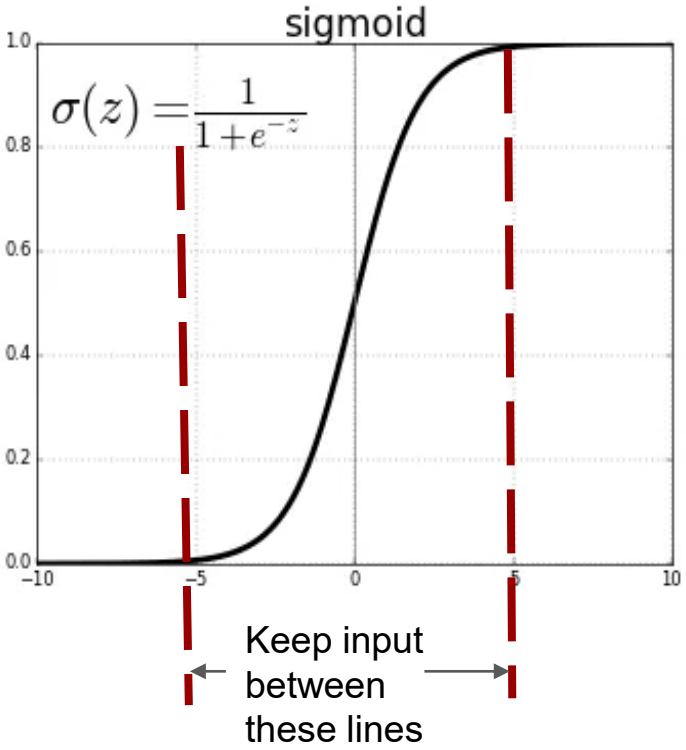
- Ensure that dimensions of input and weights are set up for matrix multiplication
- Bias is broadcasted to be added to each row

Working of a Neuron - Activation



- An activation is applied to output ‘z’ to compute final output ‘a’ of a neuron
- Different activations modify the output in different ways

Working of a Neuron - Sigmoid Activation Function

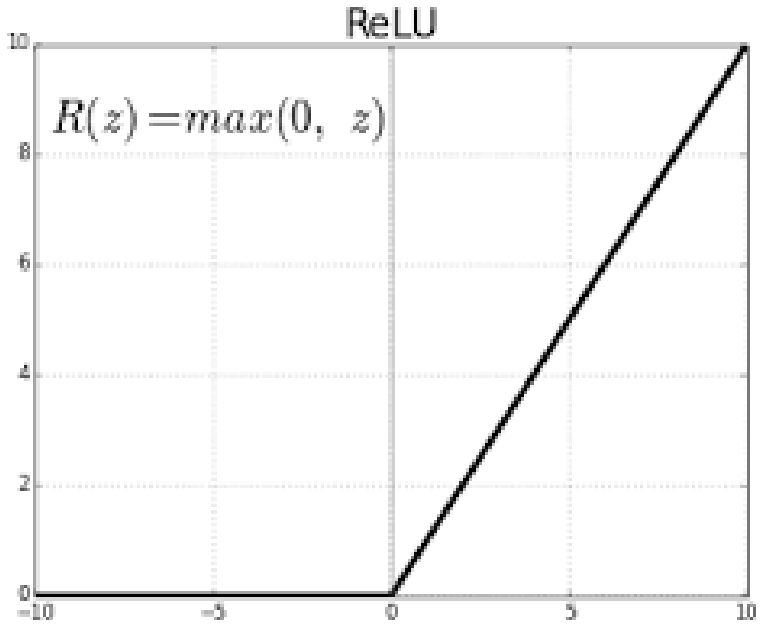


- Sigmoid activation is a nonlinear function
- It exponentially transforms the values the further away they are from 0

- We expect to get a non-zero gradient

  between the red lines

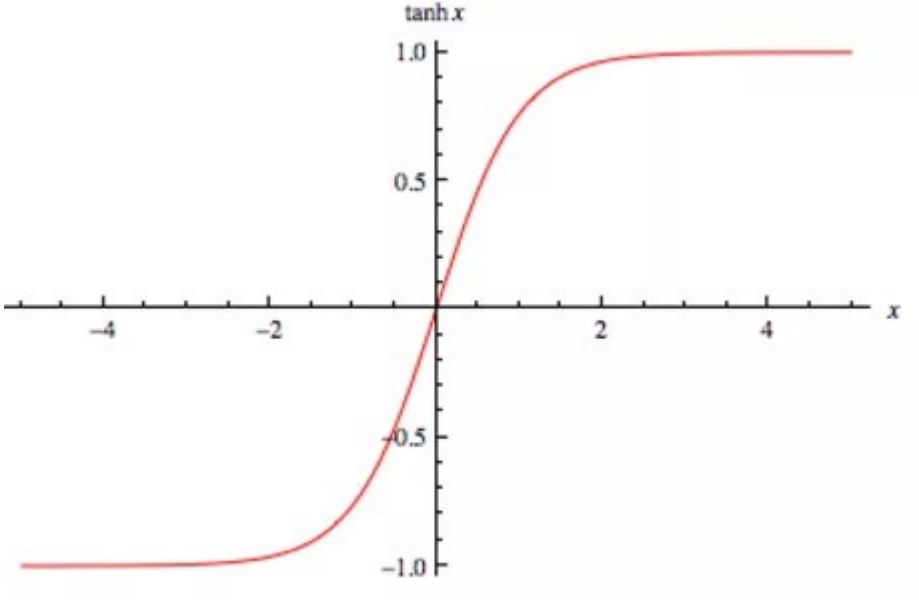
Working of a Neuron - ReLU Activation Function



- Rectified Linear Unit or ReLU is also a nonlinear function

- It nullifies inputs less than zero to zero
- The inputs greater than zero are kept same

Working of a Neuron - tanh Activation Function



- Hyperbolic tangent or tanh is another nonlinear activation
- Similar to sigmoid except that for negative inputs, it gives negative output

*Details of the activation functions will be covered in later sessions

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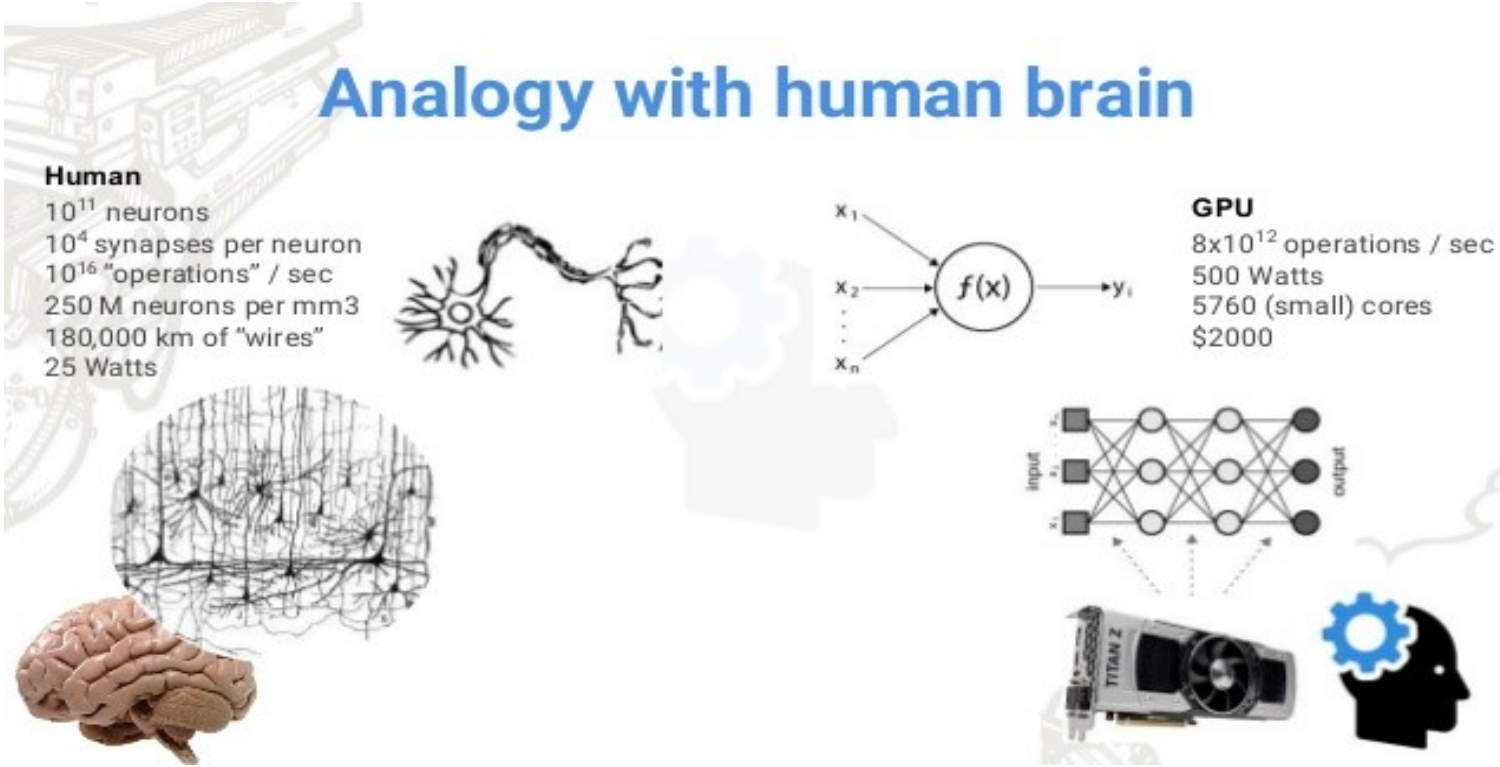
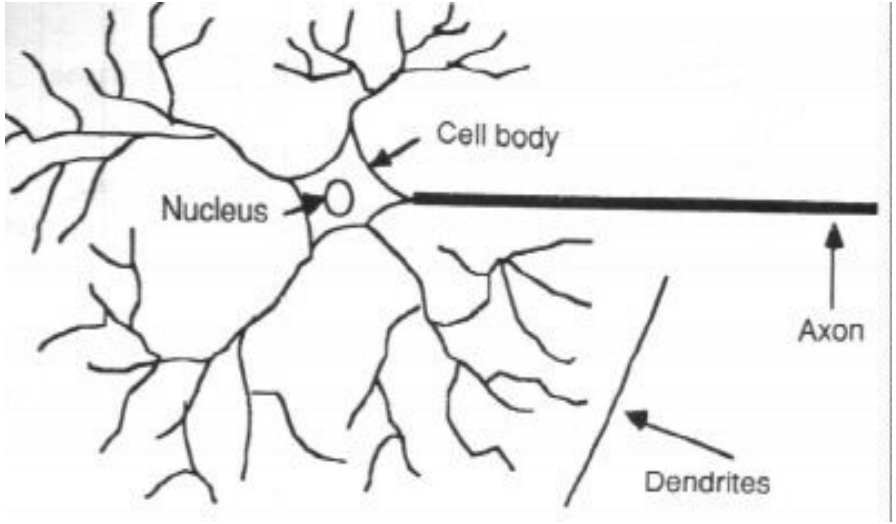
Analogy with Human Brain

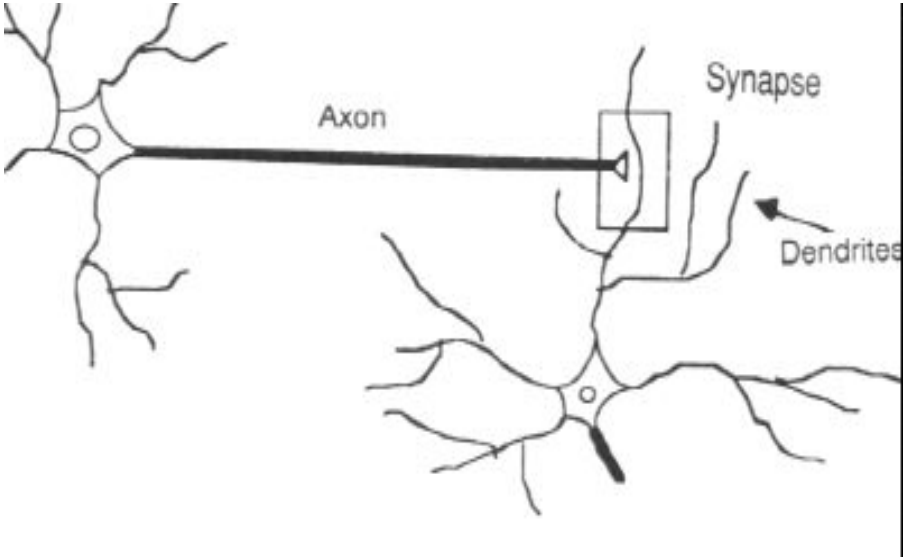


How Human Brain Learns



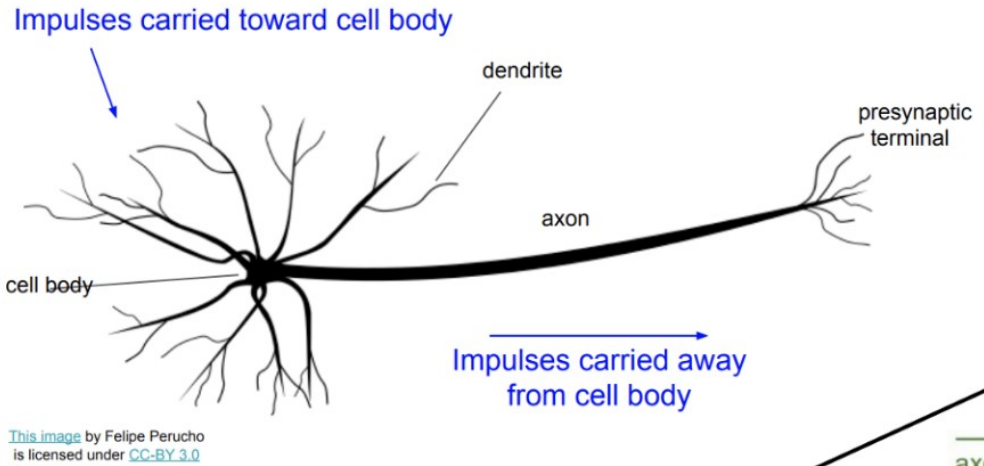
- A typical neuron collects signals through a host of fine structures called *dendrites*
- Neuron sends out spikes of electrical activity through a long thin strand known as an *axon*
- Axons split into thousands of branches

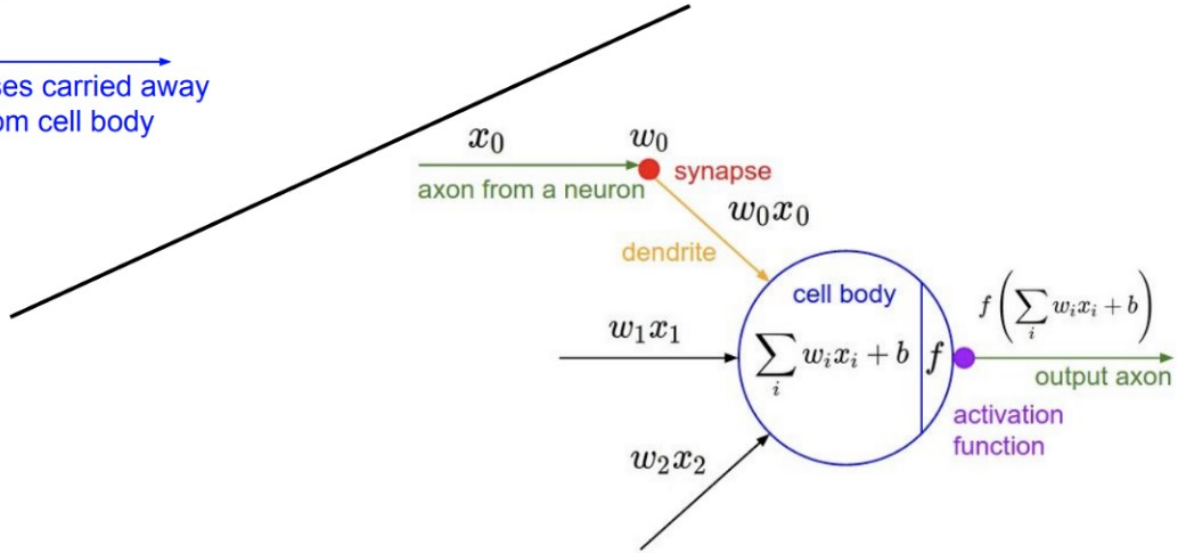
How Human Brain Learns



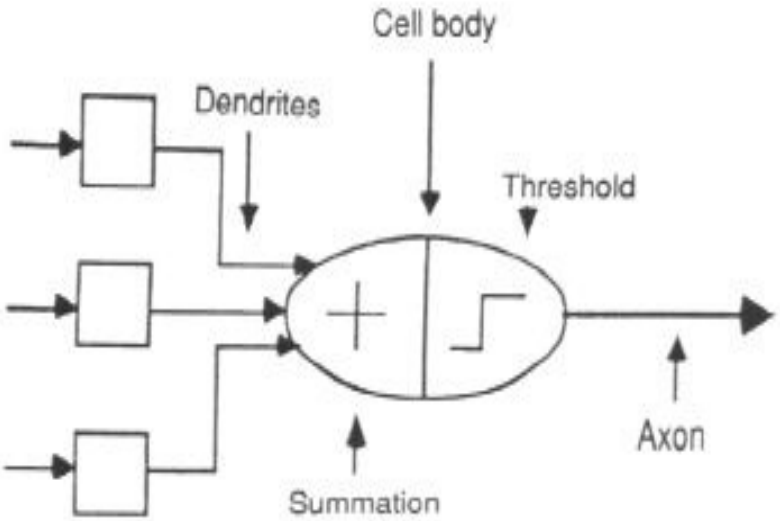
- At the end of each branch, a *synapse* converts activity from axon into electrical effects
- These inhibit or excite activity in the connected neurons
- Learning occurs by changing the effectiveness of the synapses so that the influence of one neuron on another changes.

Analogy of Brain to Neural Network





Neural Network terminology in a Neuron



- We first try to deduce essential features of neurons and their interconnections
- Since our knowledge of neurons is incomplete and computing power is limited
- Our models are actually gross idealisations of real networks of neurons