Deep-Learning

By
Nitin Sethi

Human Brain VS Computer

Motivation

Human mind - Good at image recognition, pattern recognition etc
Computer - Good at arithmetic calculations

$$2574304 \times e^{354} \div \tan 5.1\pi$$

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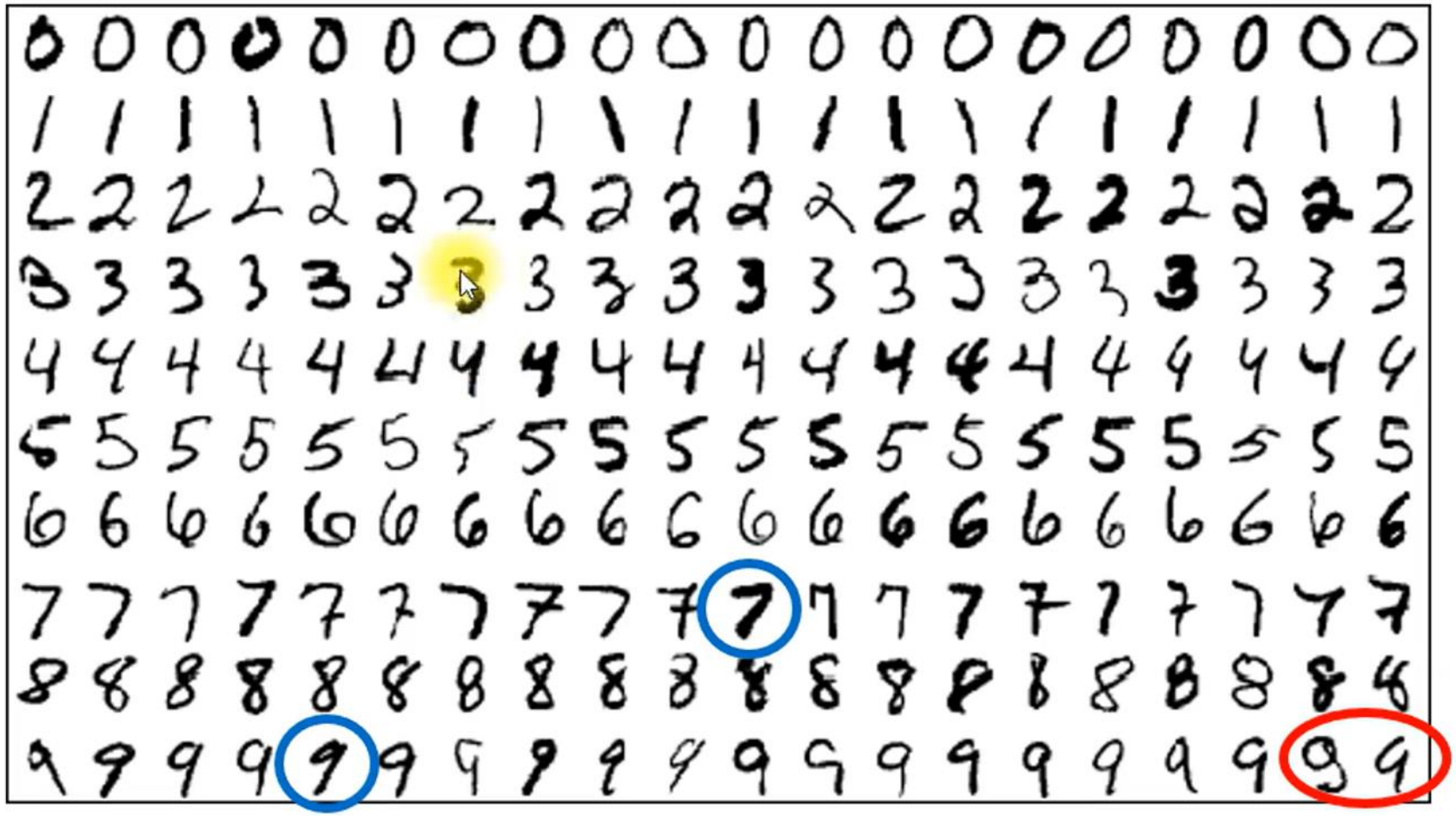
Handwriting recognition

Making precise rules is difficult



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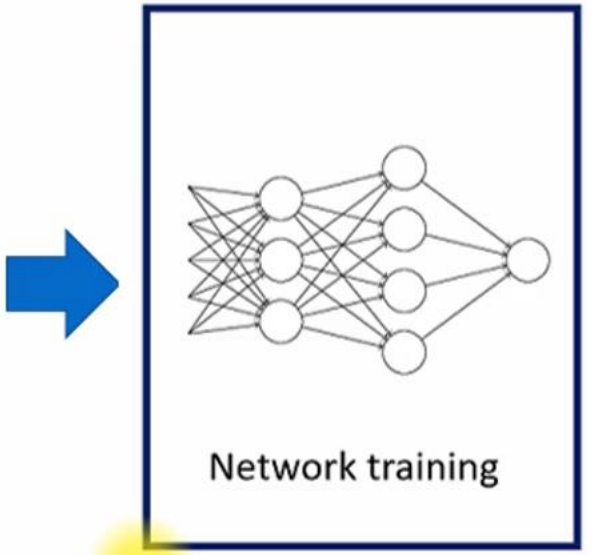
Neural Networks

Pattern recognition

Neural Networks creates own complex pattern recognition rules

Training data



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Future Prediction

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Dataset

Fashion MNIST

We will classify images into 10 fashion items

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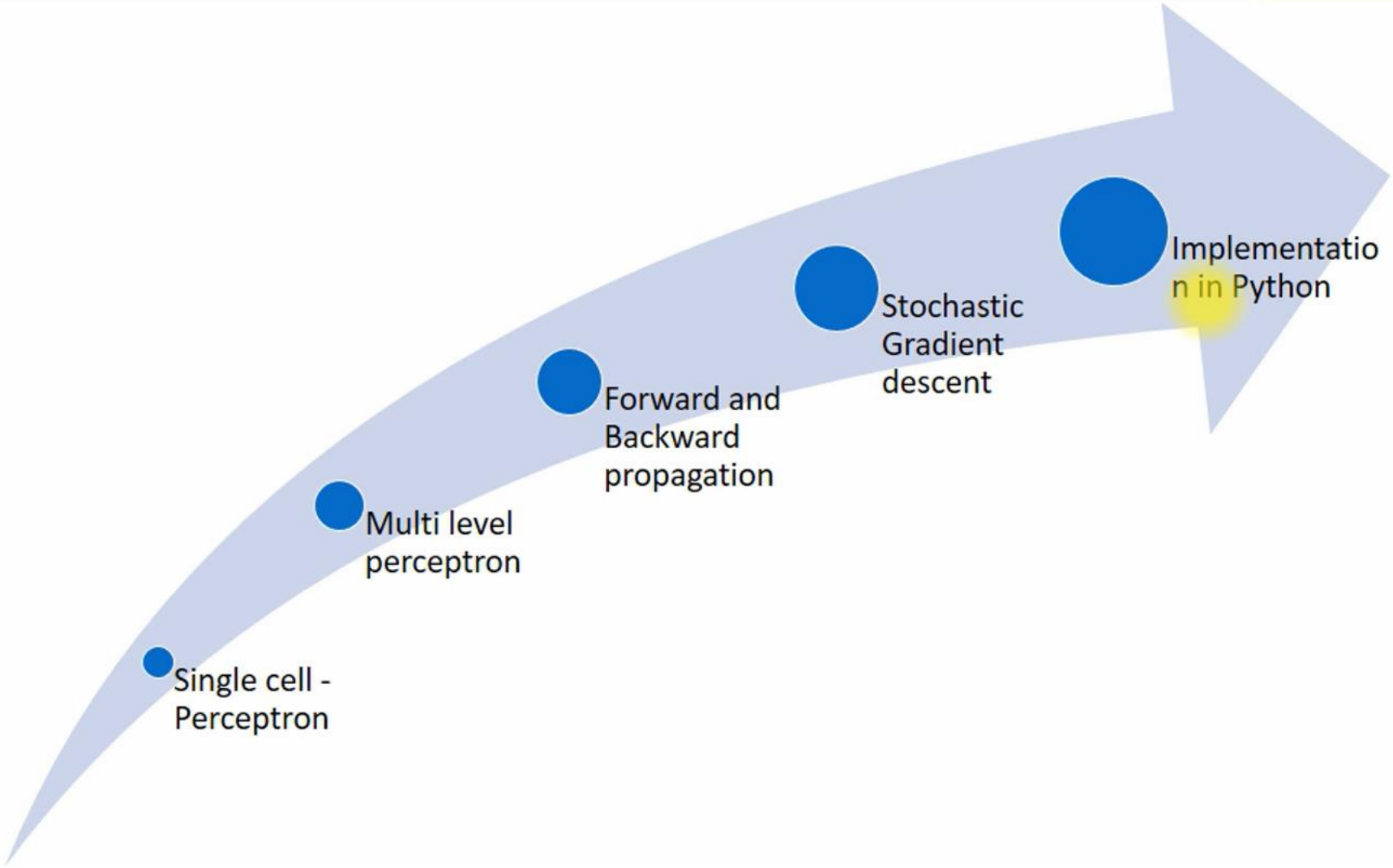
Course Flow

Course Flow



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So, what exactly is an Artificial Neural Network? Well, an ANN is a computational model inspired by the structure and functioning of the human brain. It consists of interconnected artificial neurons, also known as nodes or units, organized into layers. These neurons work together to process and transmit information, enabling the network to learn and make predictions.
Let's break down the key components of an ANN:

1.Neurons: The basic building blocks of an ANN are artificial neurons. They receive input signals, perform calculations, and produce output signals. Each neuron is connected to several other neurons, forming a complex network.

2.Layers: Neurons are organized into layers within an ANN. The most common layers are the input layer, hidden layers, and the output layer. The input layer receives the initial data, the hidden layers process this data, and the output layer produces the final results.

3.Weights and Biases: Each connection between neurons in an ANN is assigned a weight. These weights determine the strength of the connection and influence the impact of one neuron's output on another. Additionally, each neuron usually has a bias, which is an additional value that helps adjust the output of the neuron.

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4. Activation Function: An activation function is applied to the output of each neuron in an ANN. It introduces non-linearity into the network, enabling it to learn complex patterns and relationships. Common activation functions include sigmoid, ReLU (Rectified Linear Unit), and tanh.

Now, let's understand how ANNs learn:

1.Feedforward Propagation: In the feedforward phase, information flows through the network from the input layer to the output layer. Each neuron receives inputs, multiplies them by the corresponding weights, adds biases, applies the activation function, and passes the result to the next layer.

2.Loss Function: During training, an ANN aims to minimize the difference between its predicted output and the desired output. This difference is quantified by a loss function, such as mean squared error (MSE) or cross-entropy. The goal is to find the optimal weights and biases that minimize the loss.

3.Backpropagation: Backpropagation is the key algorithm used to train ANNs. It calculates the gradients of the loss function with respect to the weights and biases in the network. By iteratively adjusting the weights and biases in the opposite direction of the gradient, the network learns to make better predictions.

4.Training and Optimization: ANNs are typically trained using large datasets through an iterative process. Training examples are presented to the network, and the weights and biases are updated using backpropagation. Optimization techniques like gradient descent are often employed to efficiently adjust the parameters.

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Let's delve deeper into the concept of neurons in Artificial Neural Networks (ANNs).

In ANNs, neurons are the fundamental units responsible for processing and transmitting information. These artificial neurons are designed to mimic the behavior of biological neurons found in the human brain. While they are simplified abstractions, they serve as the building blocks of the network.

Each artificial neuron receives input signals from other neurons and performs computations on those inputs to produce an output signal. The output signal, in turn, serves as the input for other neurons in the network. This interconnected structure allows information to flow through the network, enabling it to learn and make predictions.
To understand the workings of a neuron, let's break it down into its components:

1.Inputs: Neurons receive inputs from other neurons or external sources. Each input is associated with a weight, which represents the strength of the connection between the neurons. The inputs are multiplied by their respective weights to determine their impact on the neuron's output.

2.Weights: Weights play a crucial role in ANNs. They determine the influence of each input on the neuron's output. During the training phase, these weights are adjusted iteratively to optimize the performance of the network. The network learns to assign higher or lower weights to inputs based on their relative importance in making accurate predictions.

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3.Bias: A bias term is added to the weighted sum of the inputs. The bias helps shift the activation function applied to the neuron's output. It allows the network to capture relationships that cannot be represented purely through the weighted inputs.

4.Activation Function: The weighted sum of inputs and bias is passed through an activation function. The activation function introduces non-linearity into the neuron's output. Non-linearity is essential for ANNs to learn complex patterns and relationships in the data. Common activation functions include sigmoid, ReLU (Rectified Linear Unit), tanh, and softmax.

5.Output: The output of a neuron is the result of applying the activation function to the weighted sum of inputs and bias. This output is then passed to the neurons in the next layer as their inputs.
Through the interconnectedness of neurons and the activation functions applied to their outputs, ANNs can model and approximate complex functions. By adjusting the weights and biases during the training phase, the network can learn to recognize patterns, classify data, and make predictions.

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It's important to note that the structure and behavior of neurons in ANNs are vastly simplified compared to biological neurons. Biological neurons are much more intricate and involve complex biochemical and electrical processes. However, the artificial neurons in ANNs serve as effective computational units for learning and processing information. By leveraging the collective power of interconnected neurons, ANNs can solve a wide range of problems and have demonstrated remarkable success in various domains of artificial intelligence.

Once an ANN is trained, it can be used for various tasks, such as classification, regression, pattern recognition, and even decision-making. It has found applications in image and speech recognition, natural language processing, autonomous vehicles, and many other fields.

To summarize, Artificial Neural Networks are computational models inspired by the human brain. They consist of interconnected neurons organized into layers, and through training and optimization, they can learn complex patterns and make predictions. ANNs have revolutionized the field of AI and continue to advance our capabilities in solving challenging problems.

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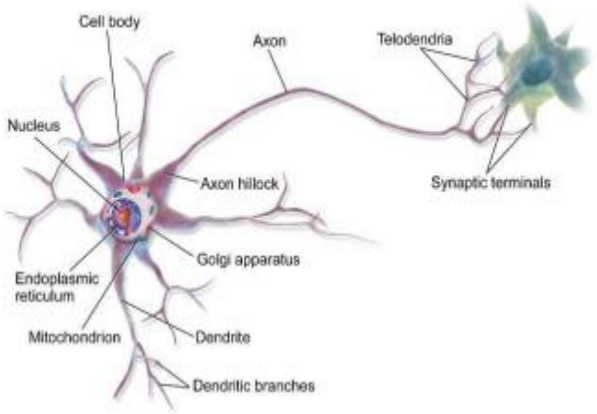
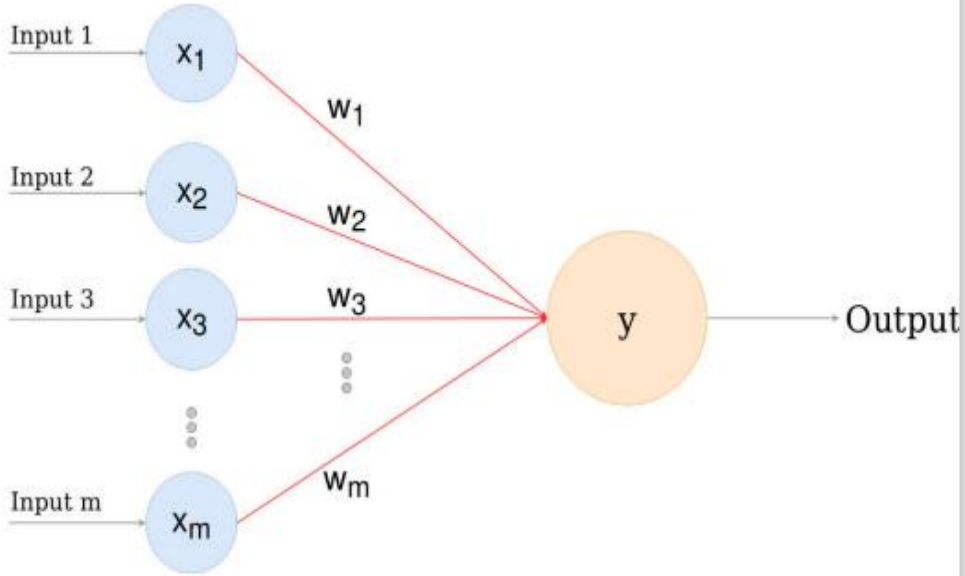
Perceptron

Artificial Neuron



Biological Neuron



Artificial Neuron

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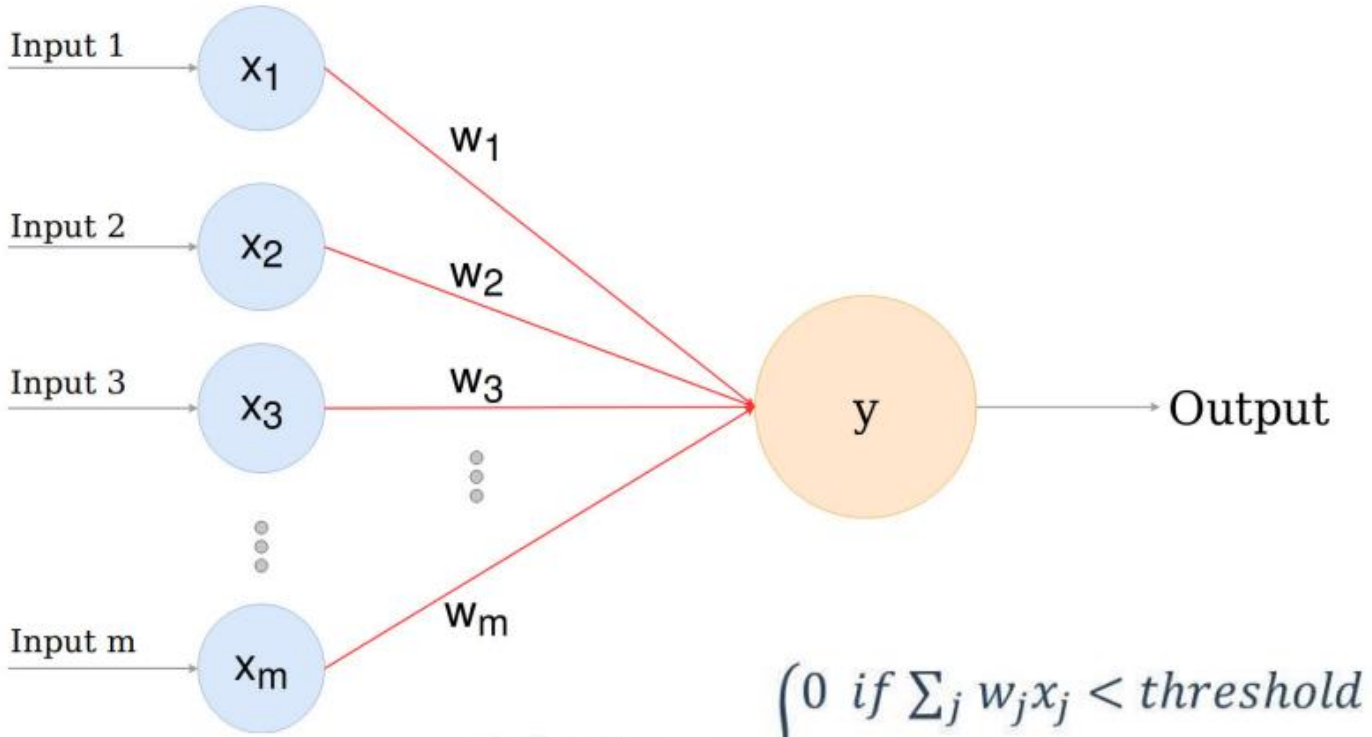
Perceptron

Artificial Neuron



$$output = \begin{cases} 0 \ if \ \sum_j w_j x_j < threshold \\ 1 \ if \ \sum_j w_j x_j > threshold \end{cases}$$

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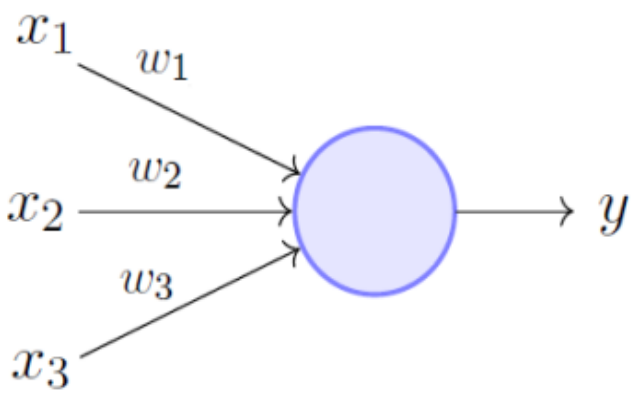
Example

Purchasing a Shirt

Color
- Blue or Not

Sleeves
- Full or half

Fabric
- Cotton or not



You will buy the shirt or not

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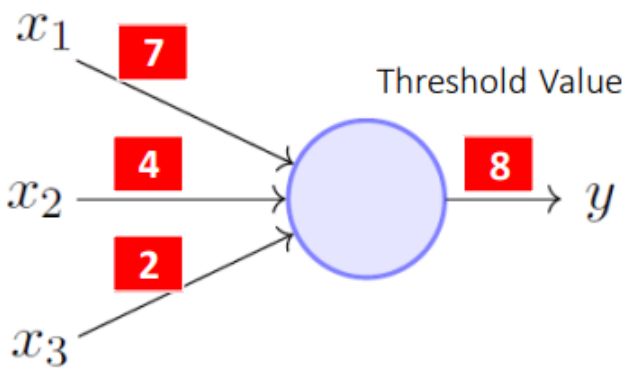
Example

Purchasing a Shirt

- **Color**
  - Blue or Not
- **Sleeves**
  - Full or half
- **Fabric**
  - Cotton or not



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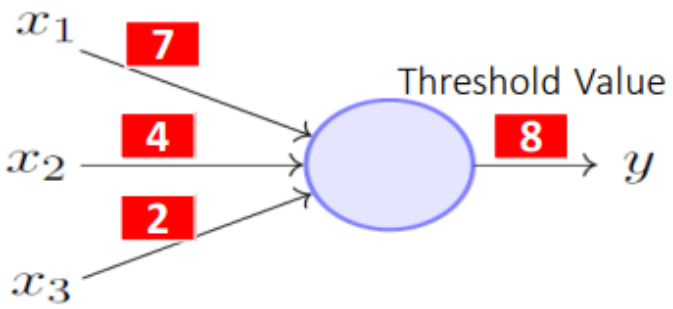

You will buy the shirt or not

Color	Sleeves	Fabric	Calculated Sum	Threshold	Buy / Not Buy
Blue	Half	Non Cotton	7*1 + 4*0 + 2*0 = 7	8	Not buy
Blue	Full	Non Cotton	11	8	Buy
Not Blue	Full	Cotton	6	8	Not Buy

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Example

Purchasing a Shirt

Color
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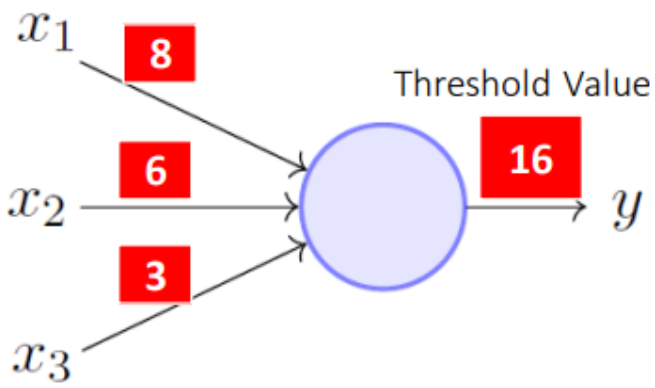
Sleeves
- Full or half

Fabric
- Cotton or not



You will buy the shirt or not

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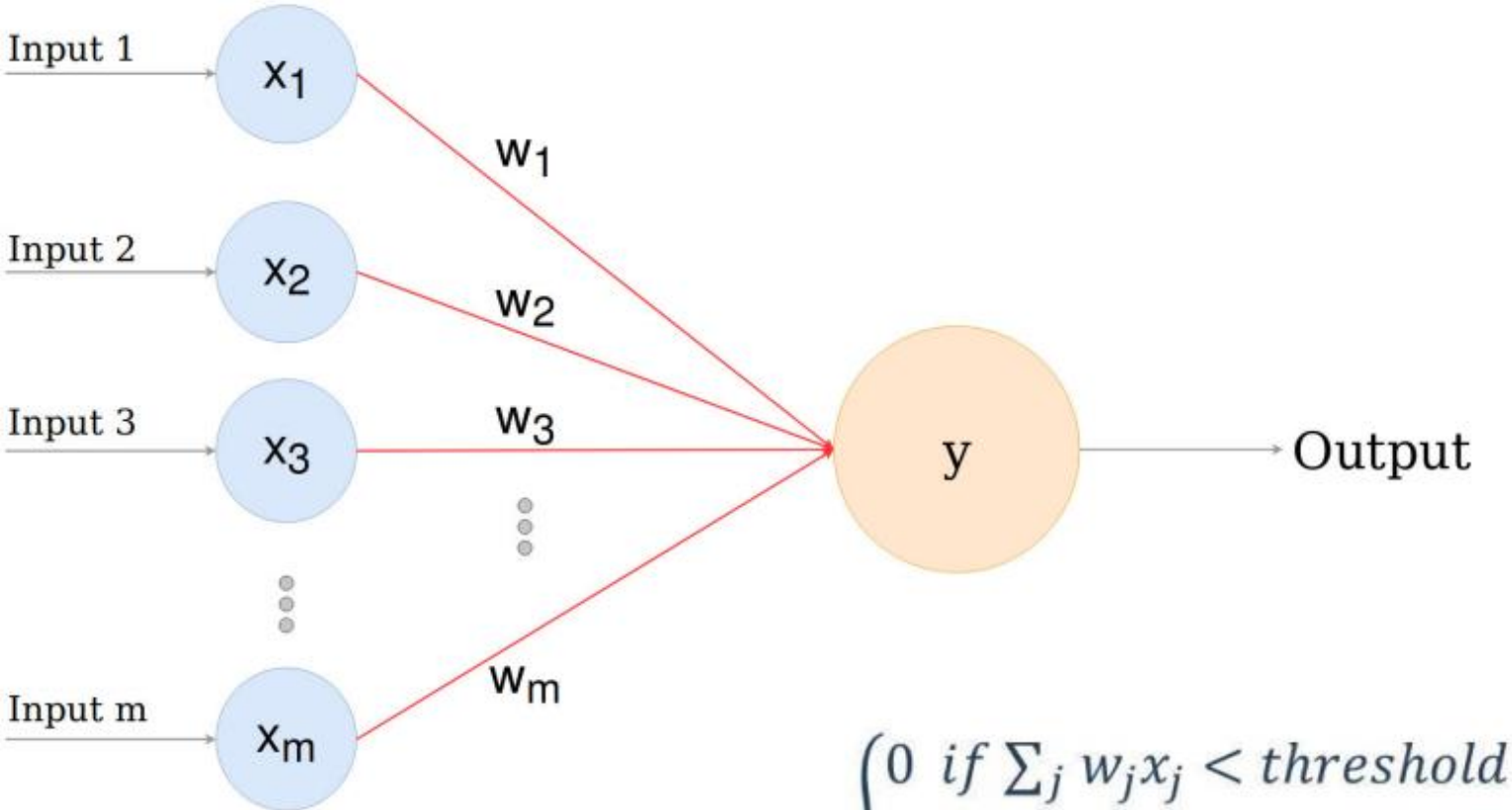
Perceptron

Removing Binary Restriction



$$output = \begin{cases} 0 \ if \ \sum_j w_j x_j < threshold \\ 1 \ if \ \sum_j w_j x_j > threshold \end{cases}$$

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Happy Learning – End of DAY-2