Human Brain VS Computer

Motivation

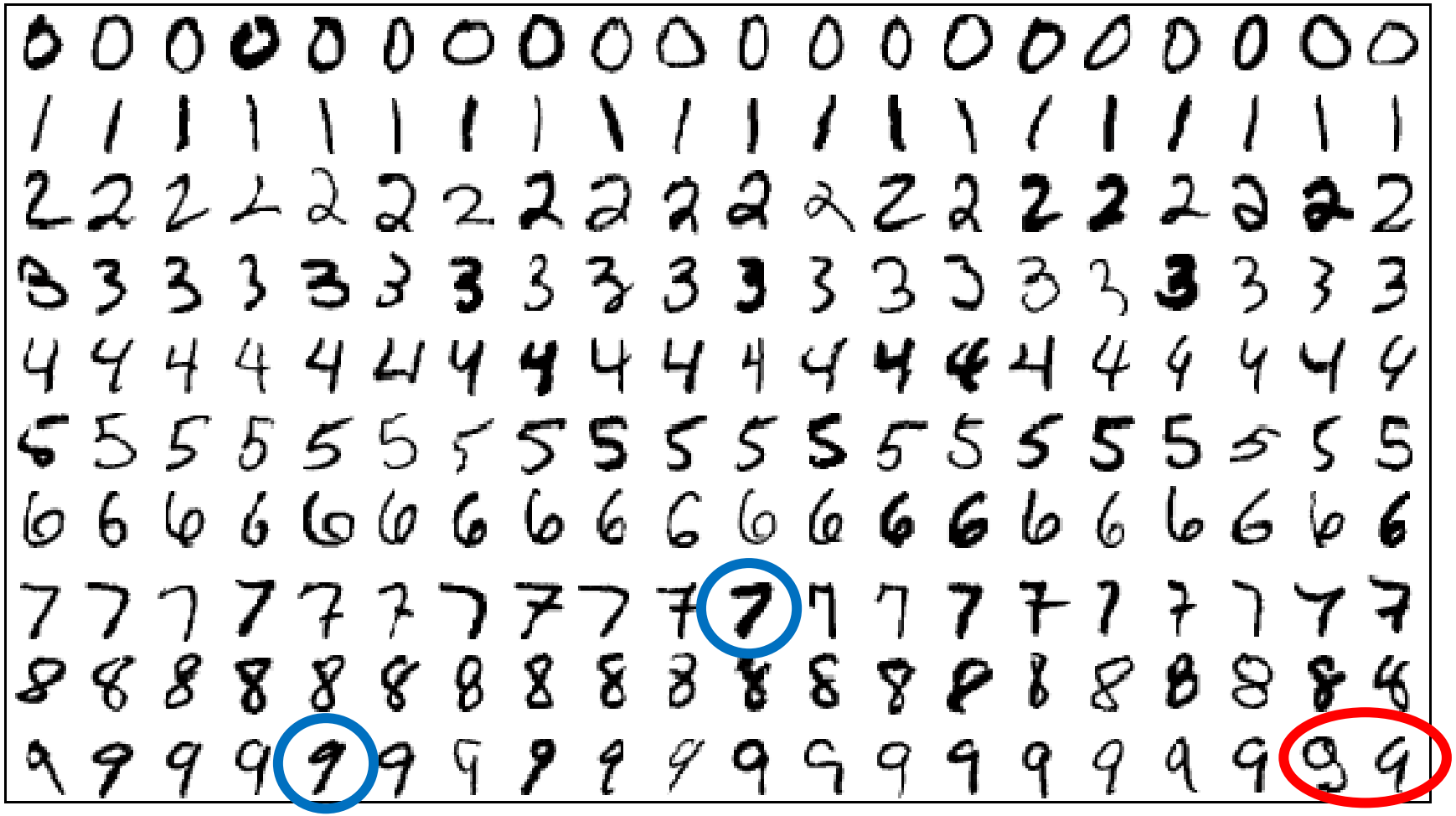
Human mind - Good at image recognition, pattern recognition etc

Computer - Good at arithmetic calculations

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

Handwriting recognition

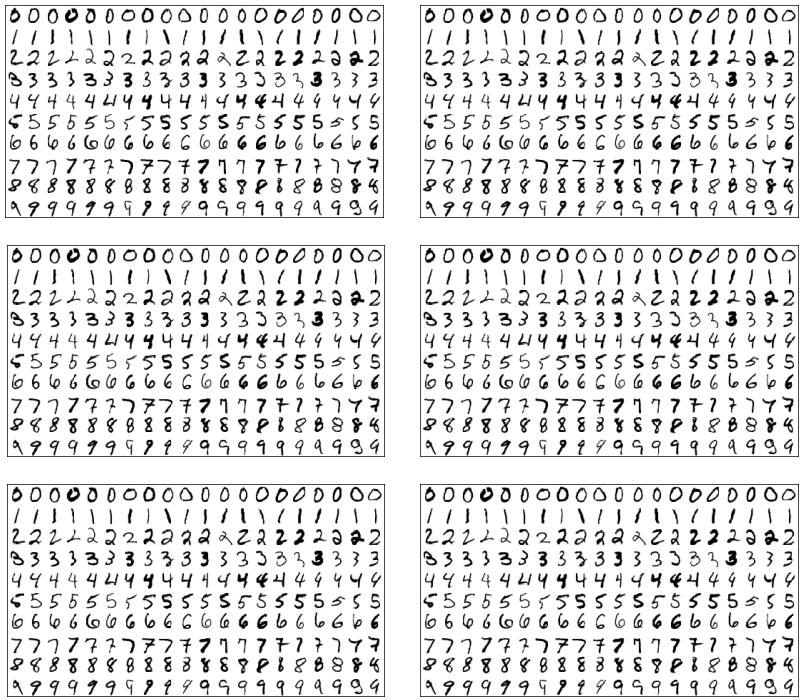
Making precise rules is difficult

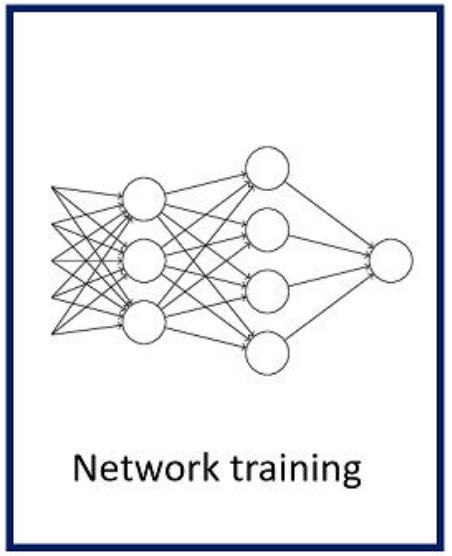


Neural Networks

Pattern recognition

Neural Networks creates own complex pattern recognition rules





1
2
3
4
5
6
7
8
9
0

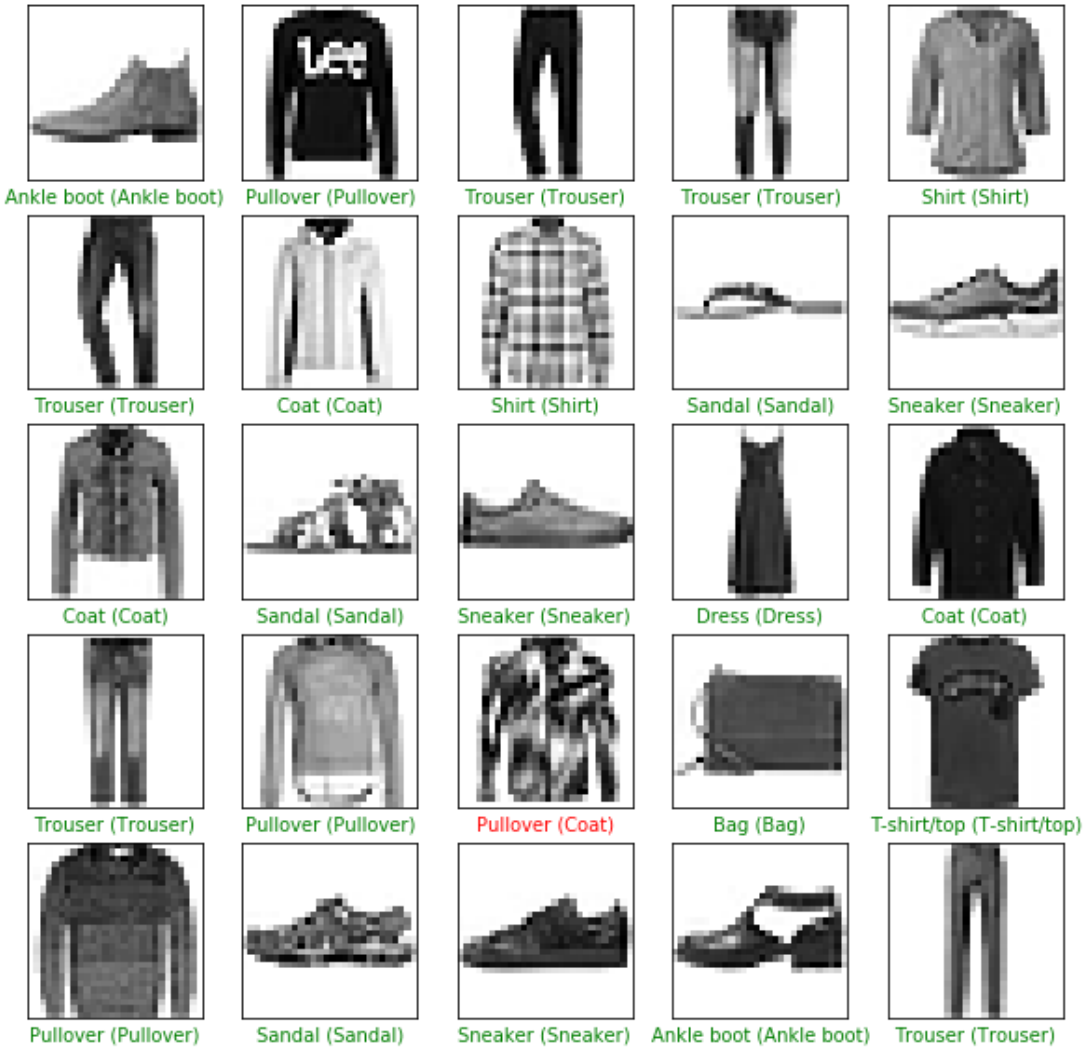
Training data

Future Prediction

Dataset

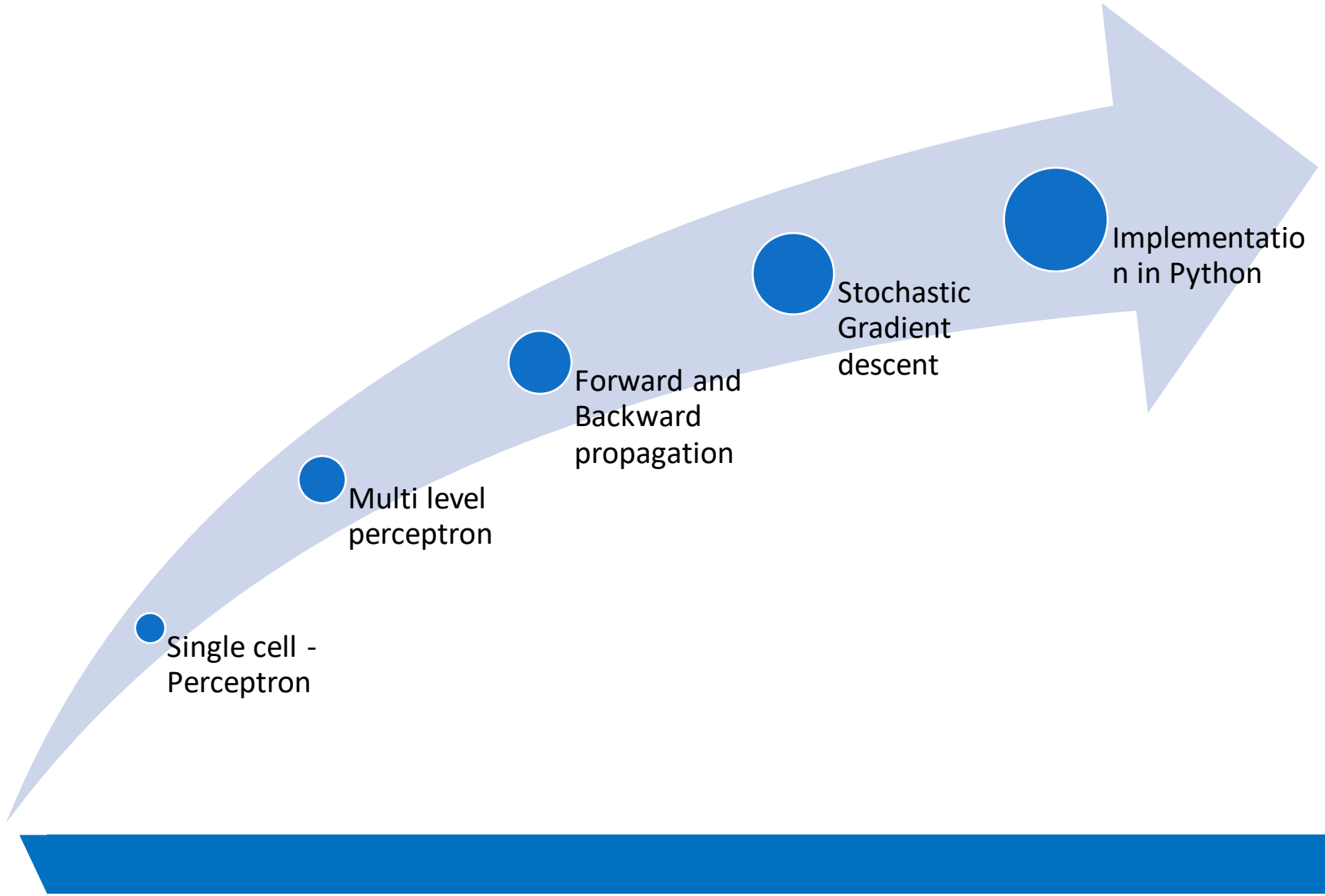
Fashion MNIST

We will classify images into 10 fashion items



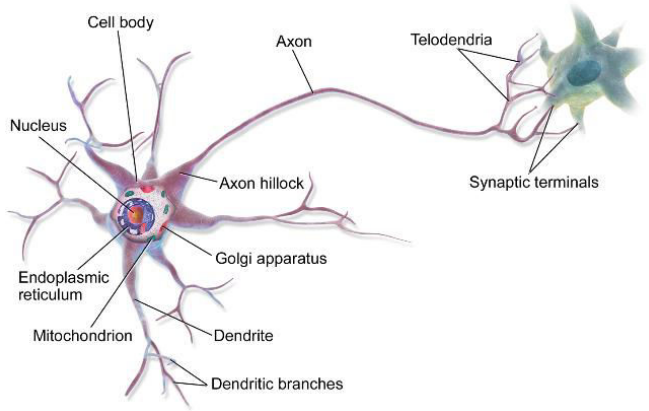
Course Flow

Course Flow

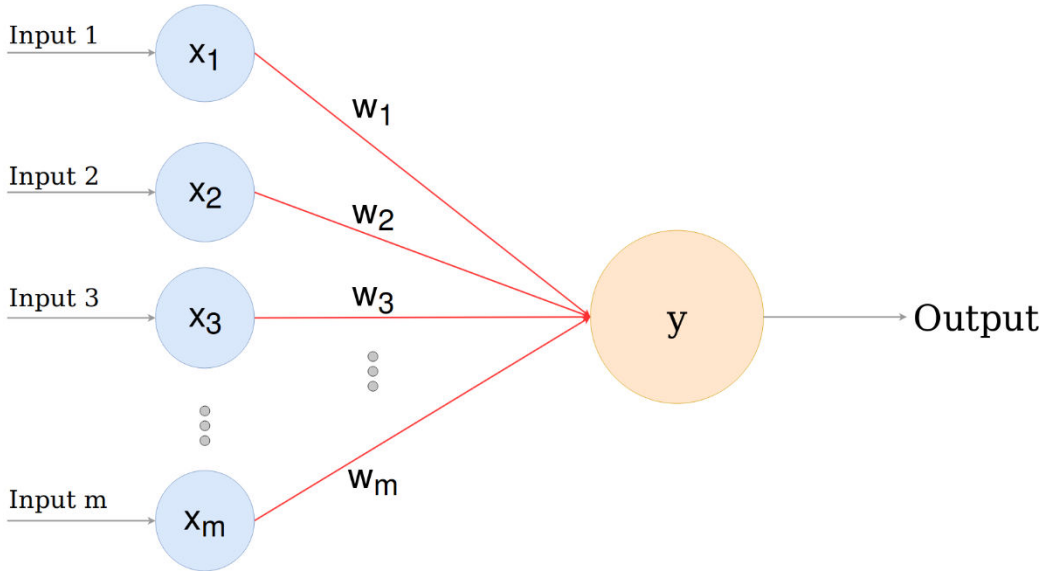


Perceptron

Artificial Neuron



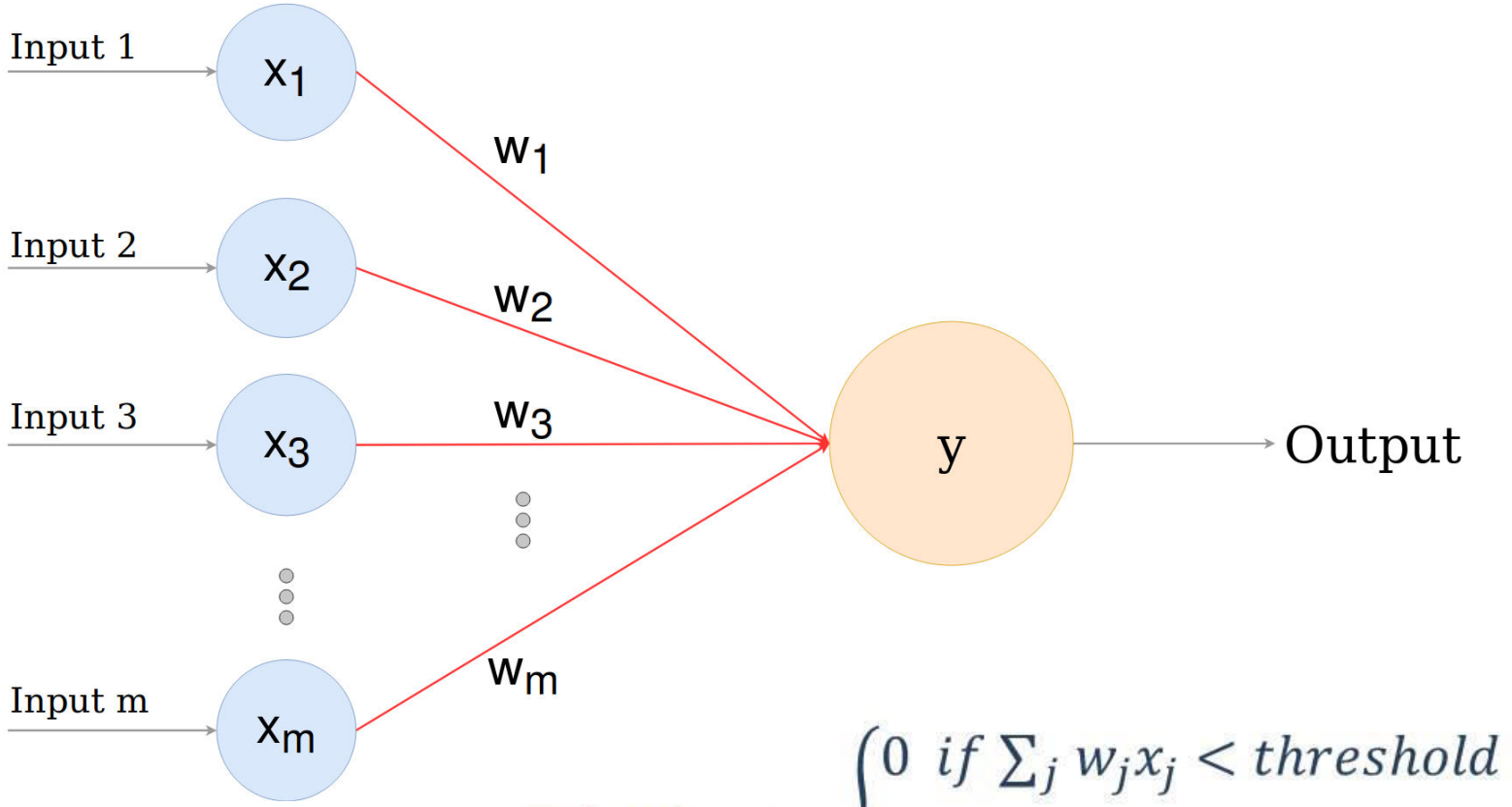
Biological Neuron



Artificial Neuron

Perceptron

Artificial Neuron



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

Example

Purchasing a Shirt

Color

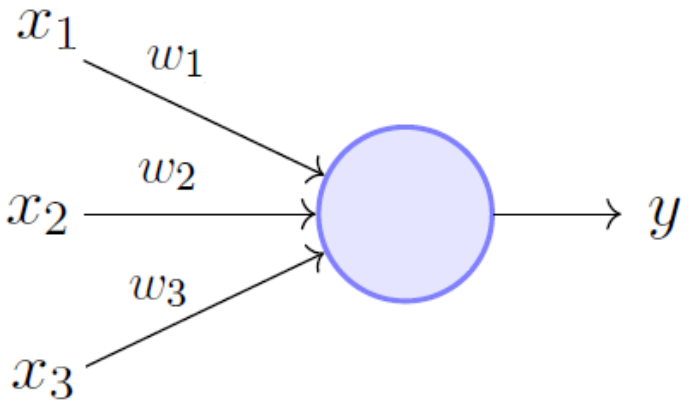
- Blue or Not

Sleeves

- Full or half

Fabric

- Cotton or not



You will buy the shirt or not

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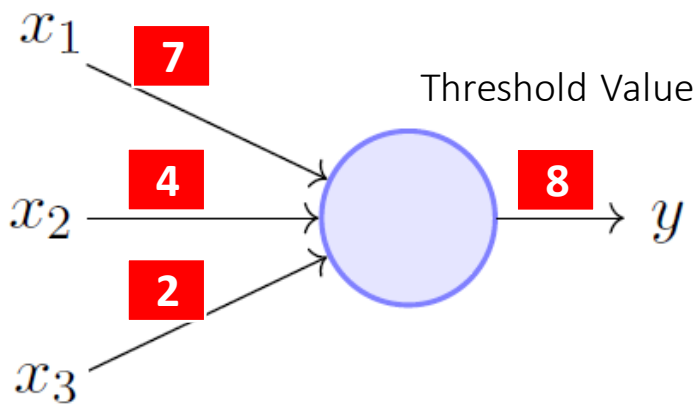

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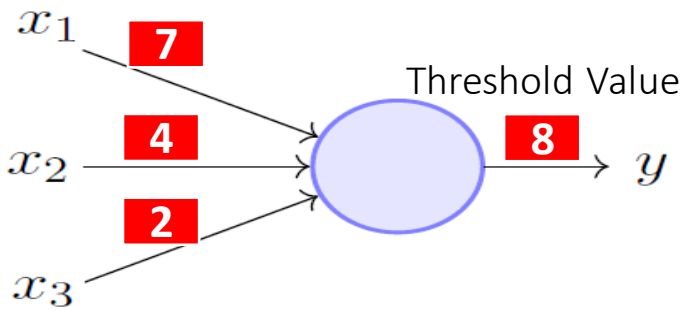

You will buy the shirt or not

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

Example

Purchasing a Shirt

Color

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Sleeves

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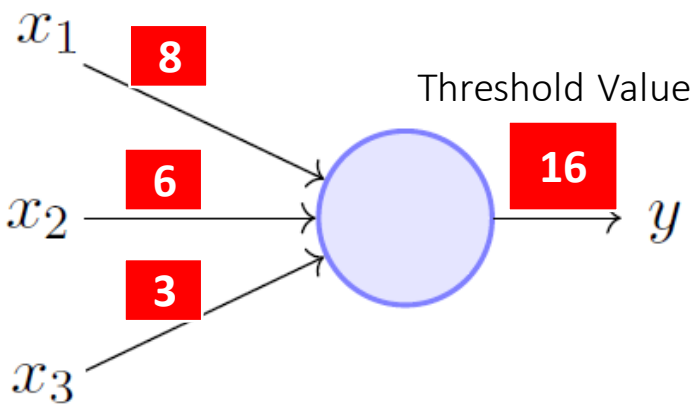
Fabric

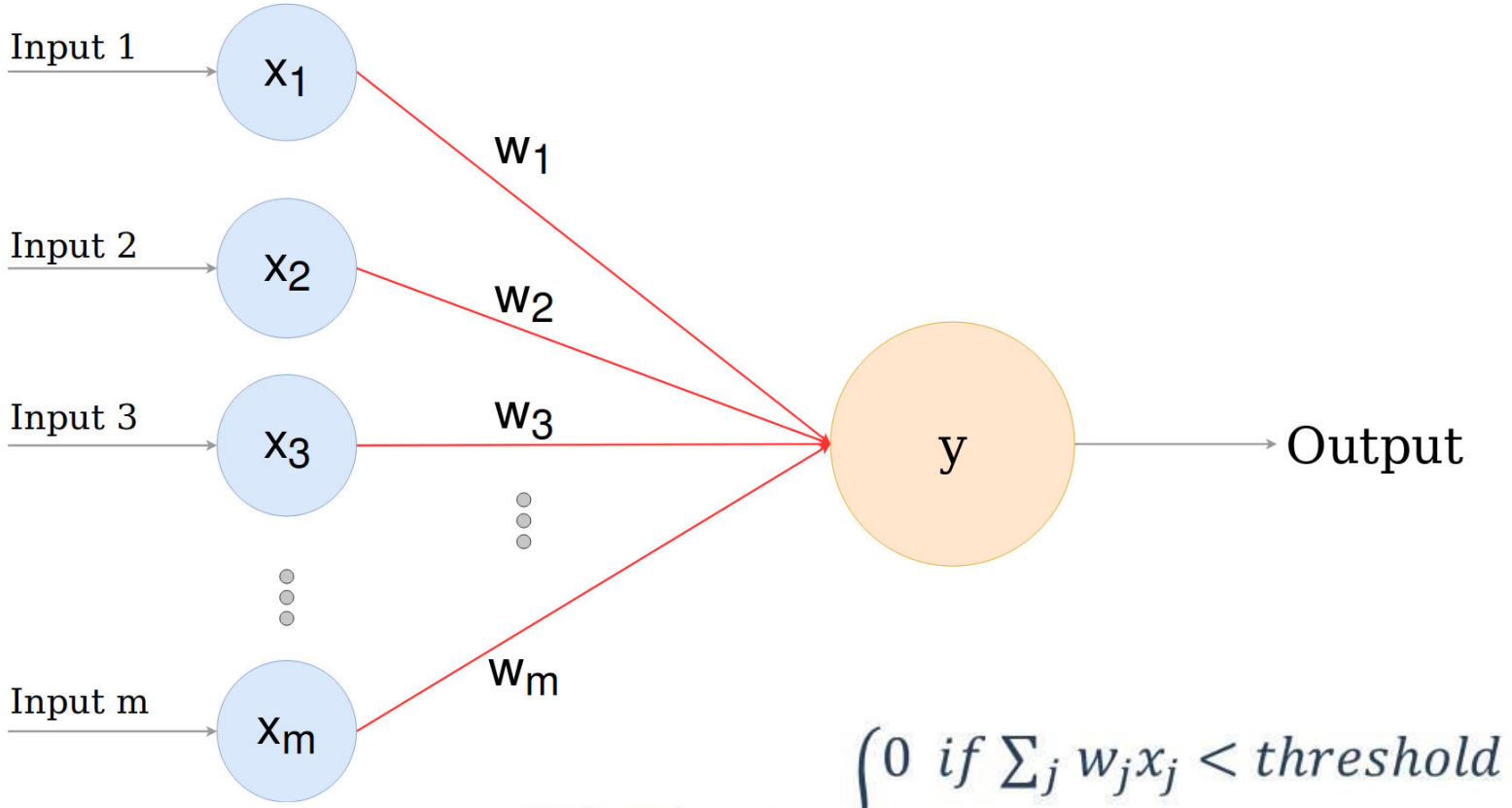
- Cotton or not



You will buy the shirt or not

Perceptron

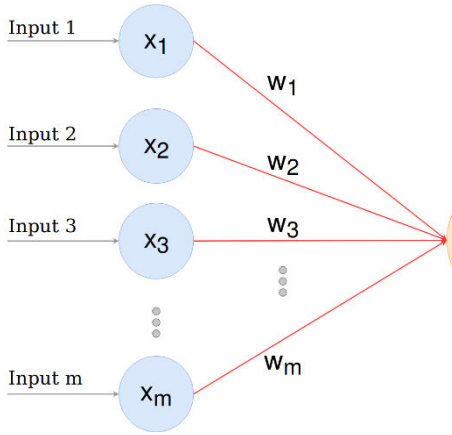
Removing Binary Restriction



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

Perceptron

Standard Equation



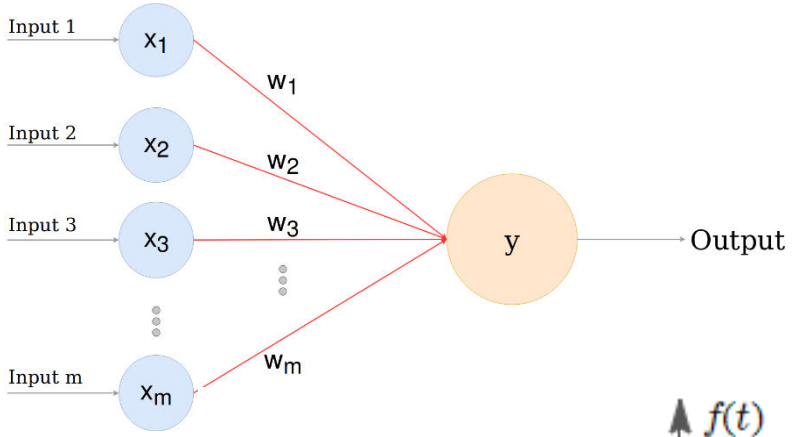
$$output = \begin{cases} 0 \ if \ \sum_j w_j x_j < threshold \\ 1 \ if \ \sum_j w_j x_j > threshold \end{cases}$$

$$Output = \begin{cases} 0, & \sum_j w_j \, x_j + b \ < 0 \\ 1, & \sum_j w_j \, x_j + b \geq 0 \end{cases}$$

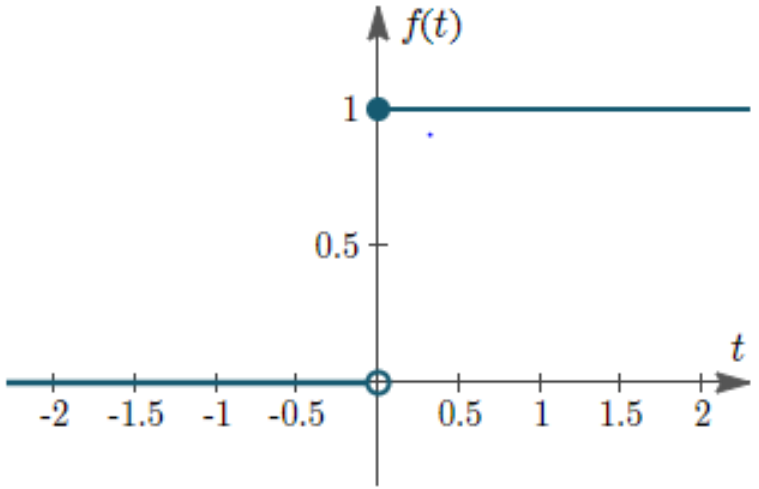
b is called Bias

Perceptron

Graphical Representation



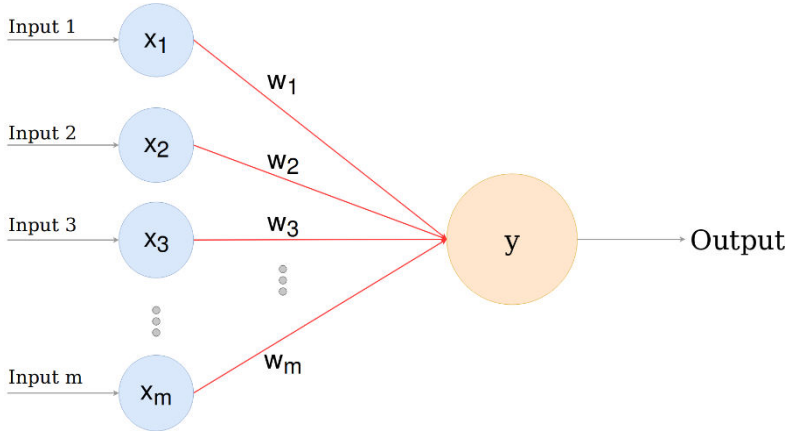
$$Output = \begin{cases} 0, & \sum_j w_j x_j + b < 0 \\ 1, & \sum_j w_j x_j + b \geq 0 \end{cases}$$



Step Activation function

Perceptron

Sigmoid Activation



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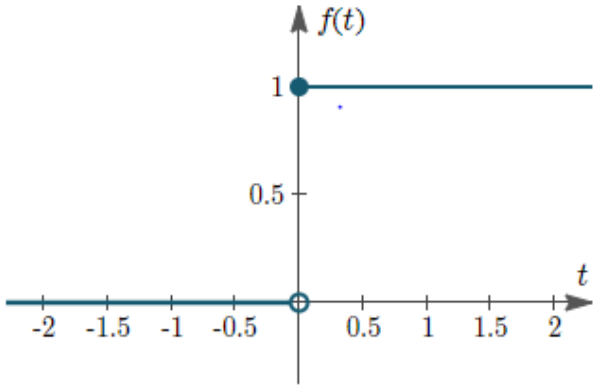
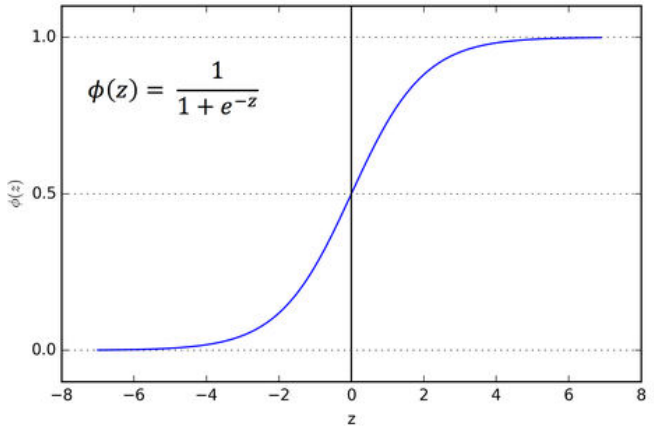


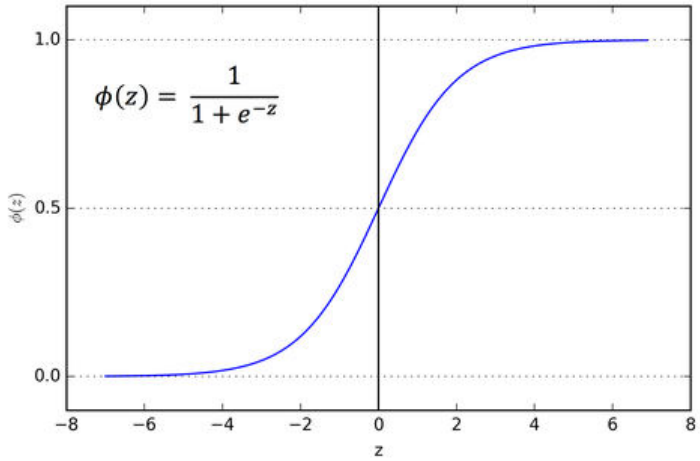
Step Activation function



Sigmoid Activation function

Perceptron

Sigmoid Activation



Sigmoid Activation function

- Sigmoid is better because it is less sensitive to individual observation
- Artificial neuron with sigmoid activation is called sigmoid or logistic neuron

$$\sigma(z) \equiv \frac{1}{1+e^{-z}}.$$

$$Output = \frac{1}{1+\exp(-\sum_j w_j x_j - b)}.$$

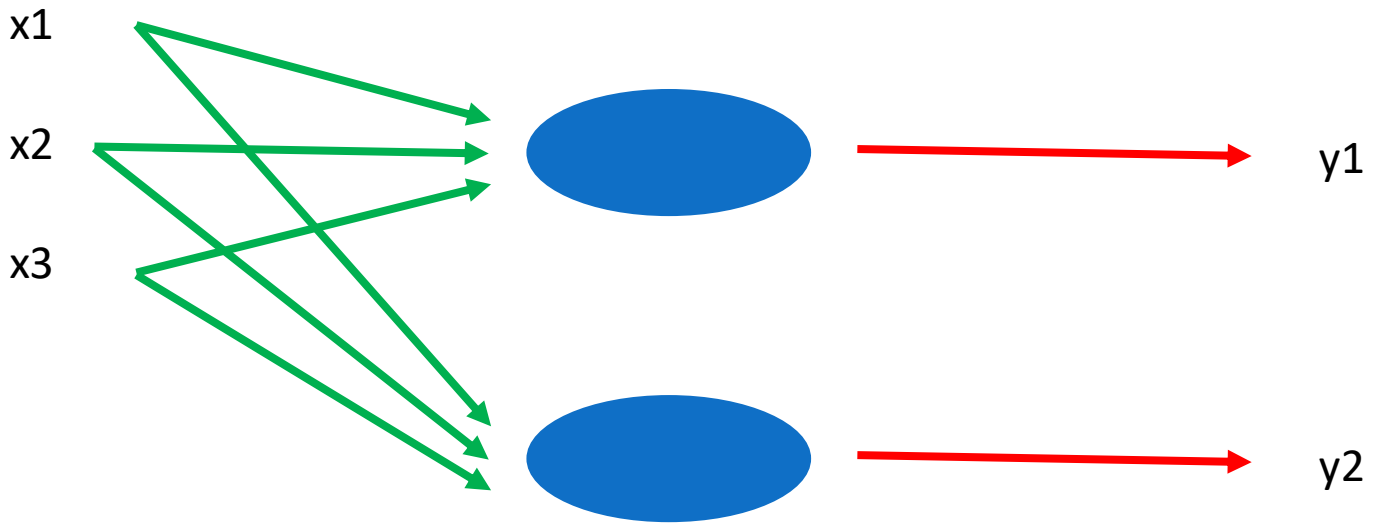
Making Networks

Two types of Stacking

- Parallel
- Sequential

Making Networks

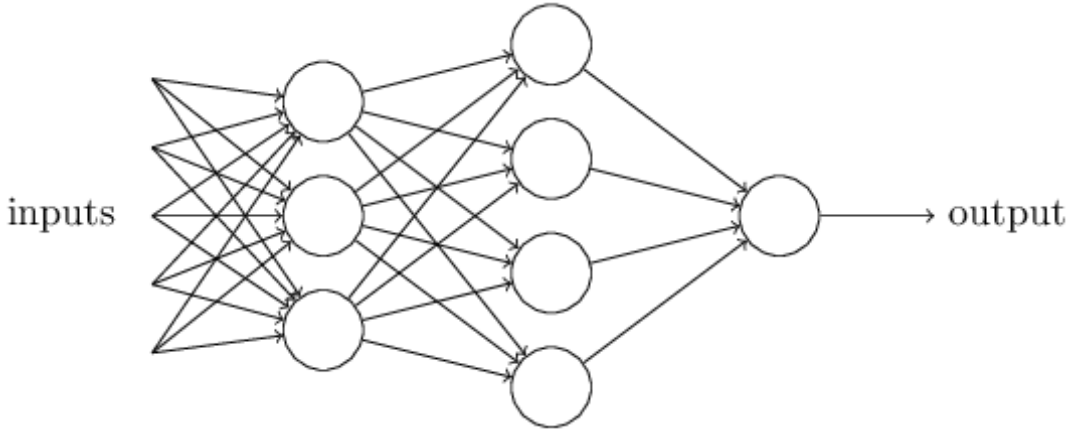
Parallel Stacking



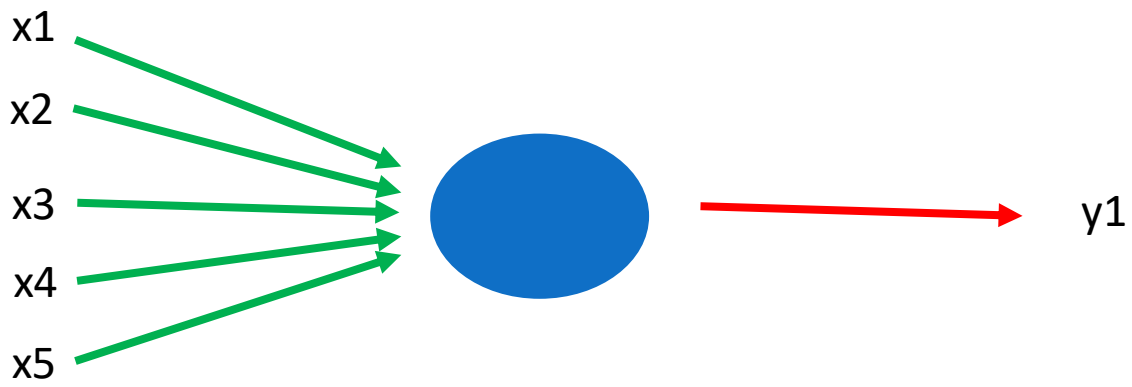
With parallel stacking we can get multiple outputs with the same input

Making Networks

Sequential Stacking

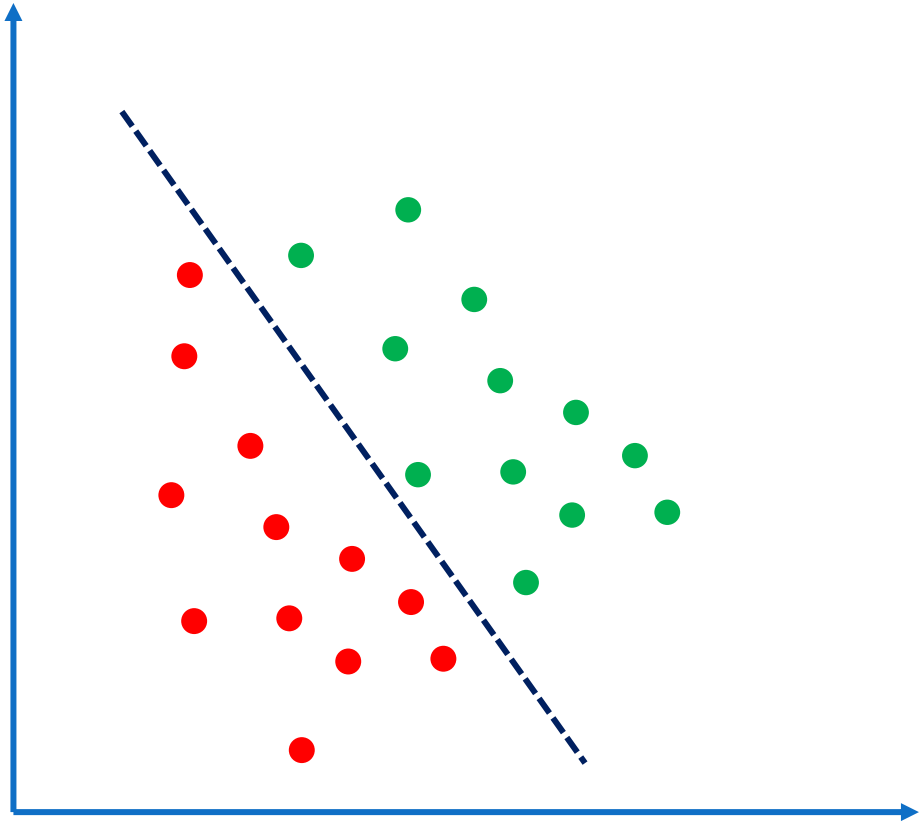


Why not use a single neuron



Making Networks

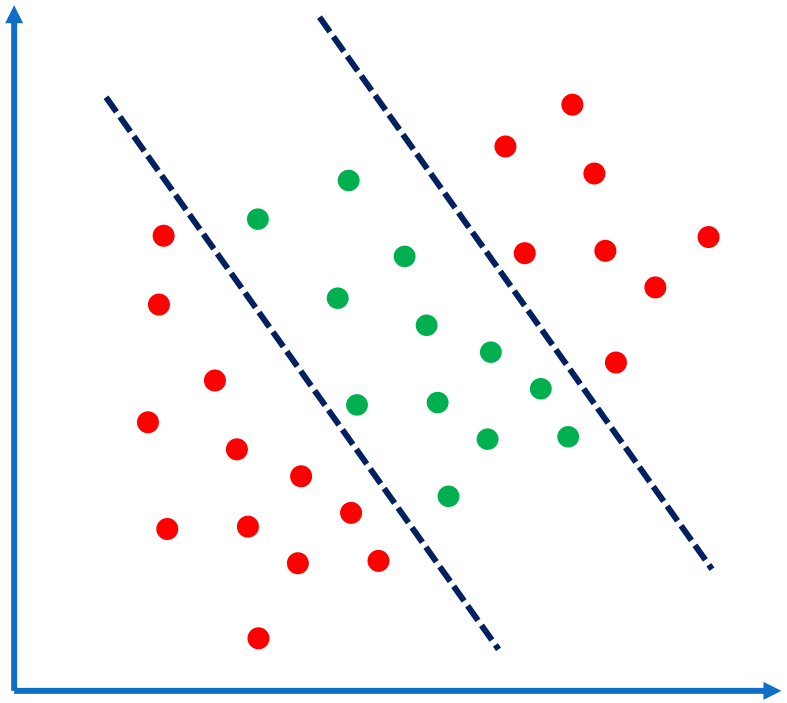
Sequential Stacking

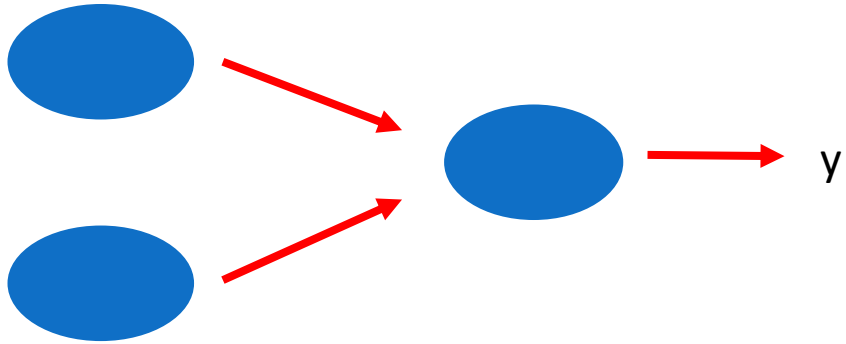


Single neuron can handle such linear classification problem

Making Networks

Sequential Stacking

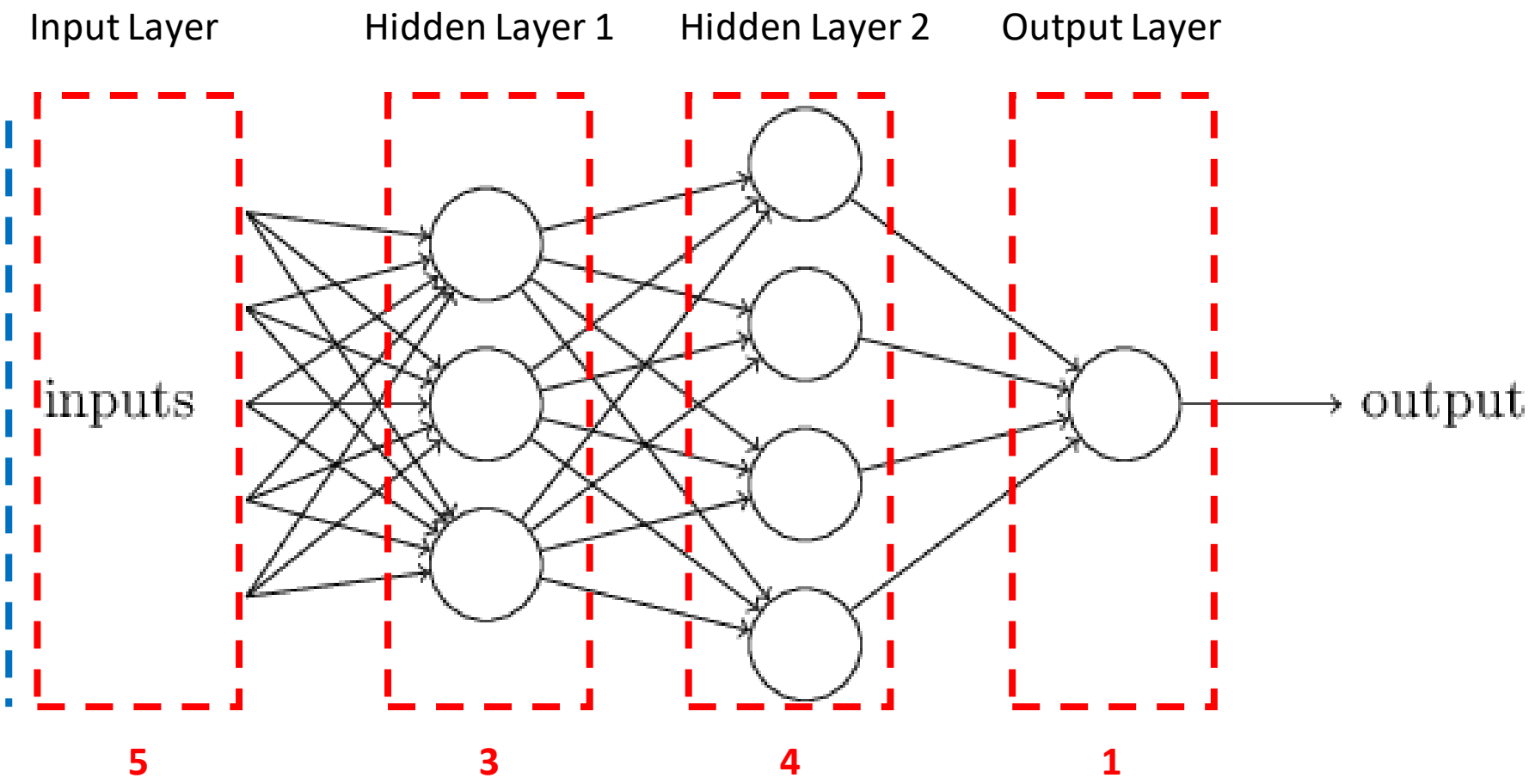




Each neuron can focus on the particular features of the object instead of the final outcome

Making Networks

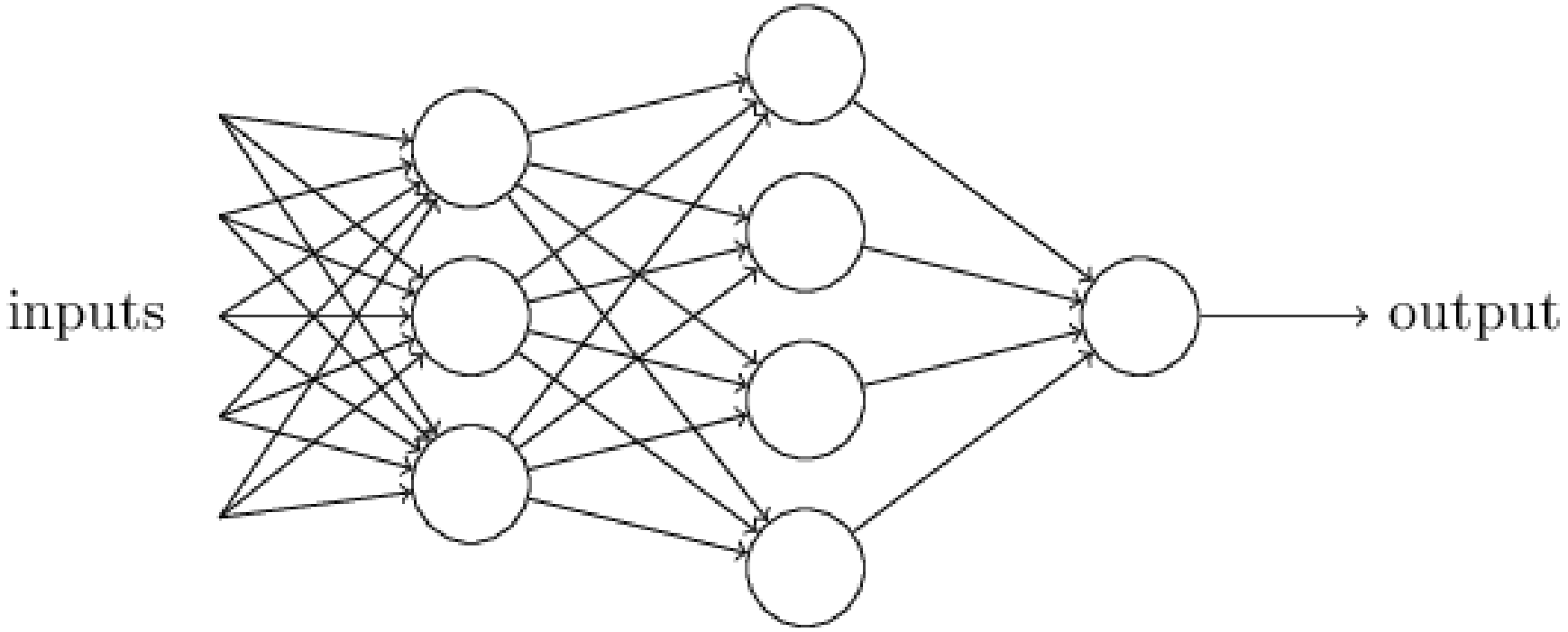
Nomenclature



5-3-4-1 Network

Making Networks

Nomenclature



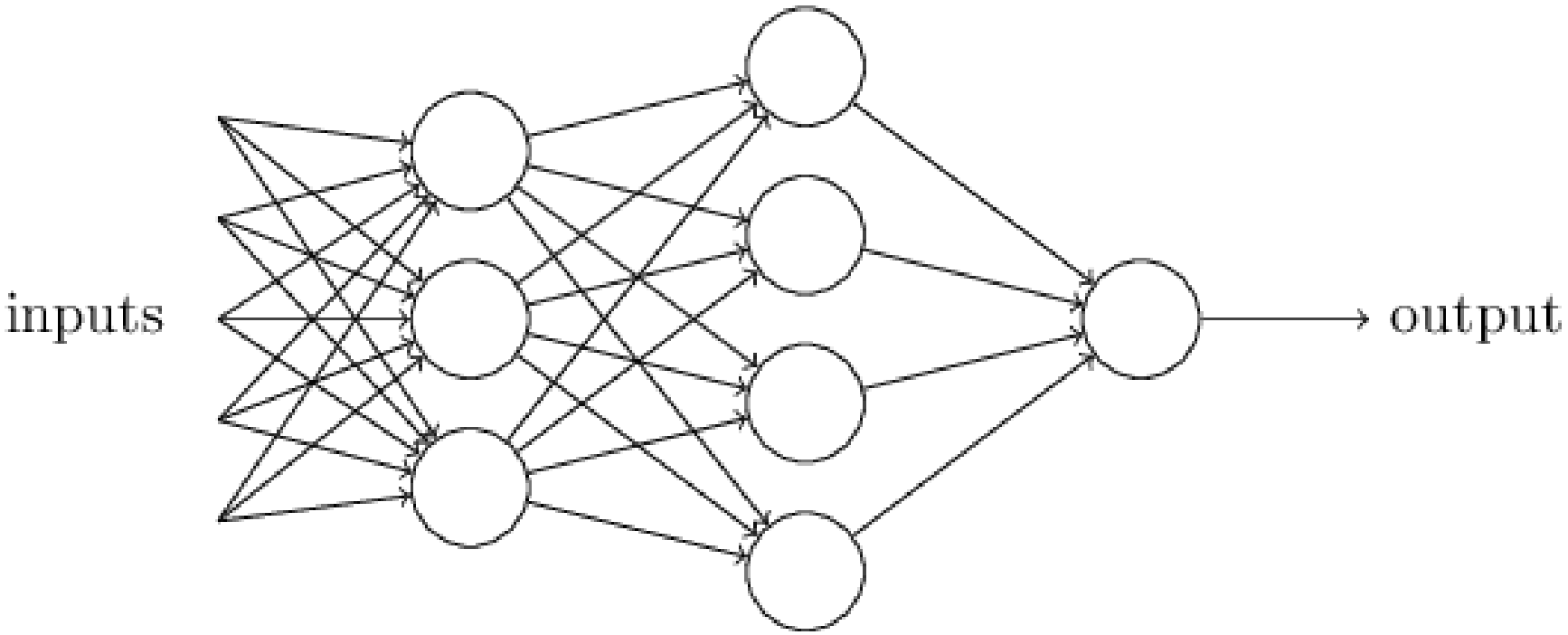
Feed Forward Network – One directional processing

Fully connected network – Output from a neuron goes to all neurons of next layer

Deep Learning

Deep Learning

Such artificial neural networks primarily constitutes deep learning



More number of layers => Deeper network => More complex relationships