

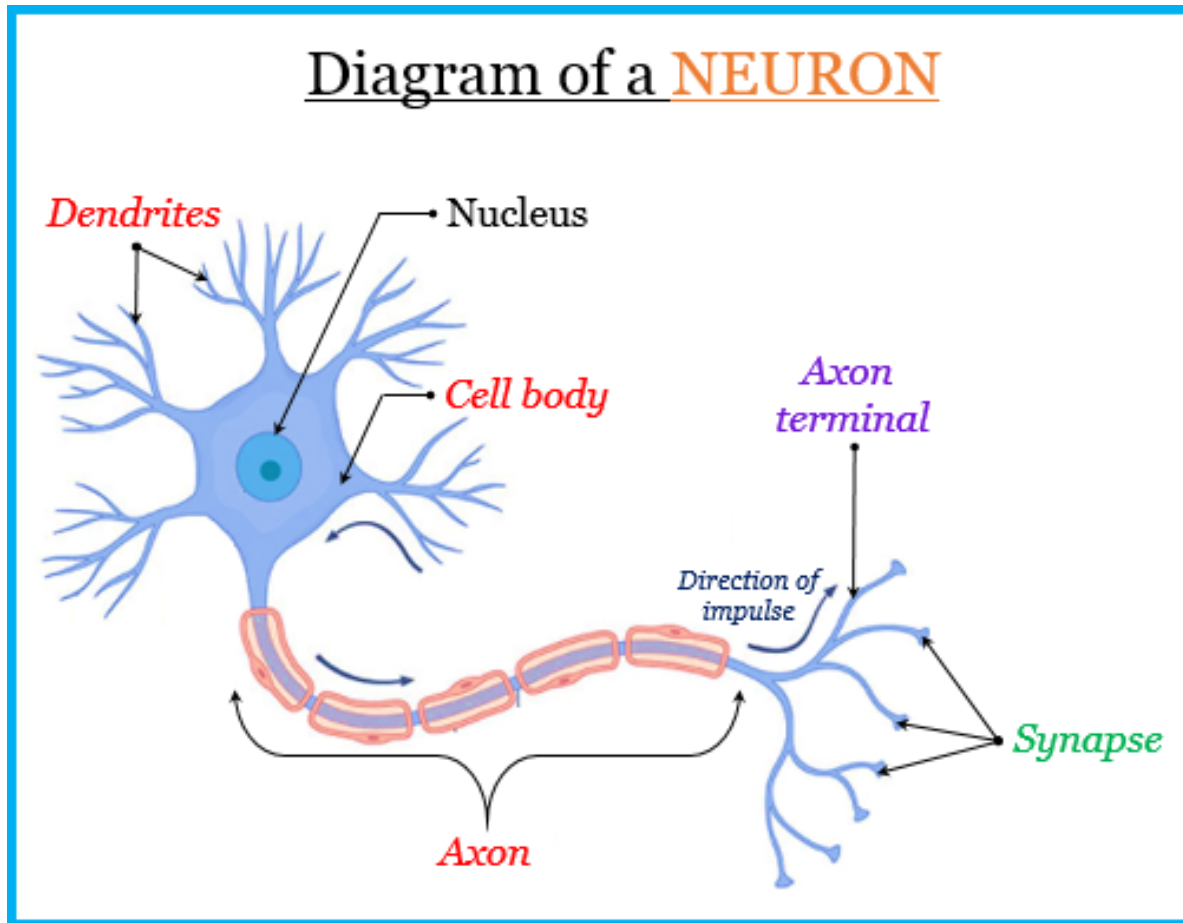
Introduction to Artificial Neural Networks - ANN

Spring 2025

ANN – In principle

- Inspired by biological neurons
 - Approximately 10 billion in an average human brain
 - Each has many thousands of connections
 - Die off and are not replaced
 - Low level of reliability (as we all know)
 - Massively parallel architecture (true parallelism)

How does a neuron work



The 'tree' model

Dendrites = branch

Axon = roots

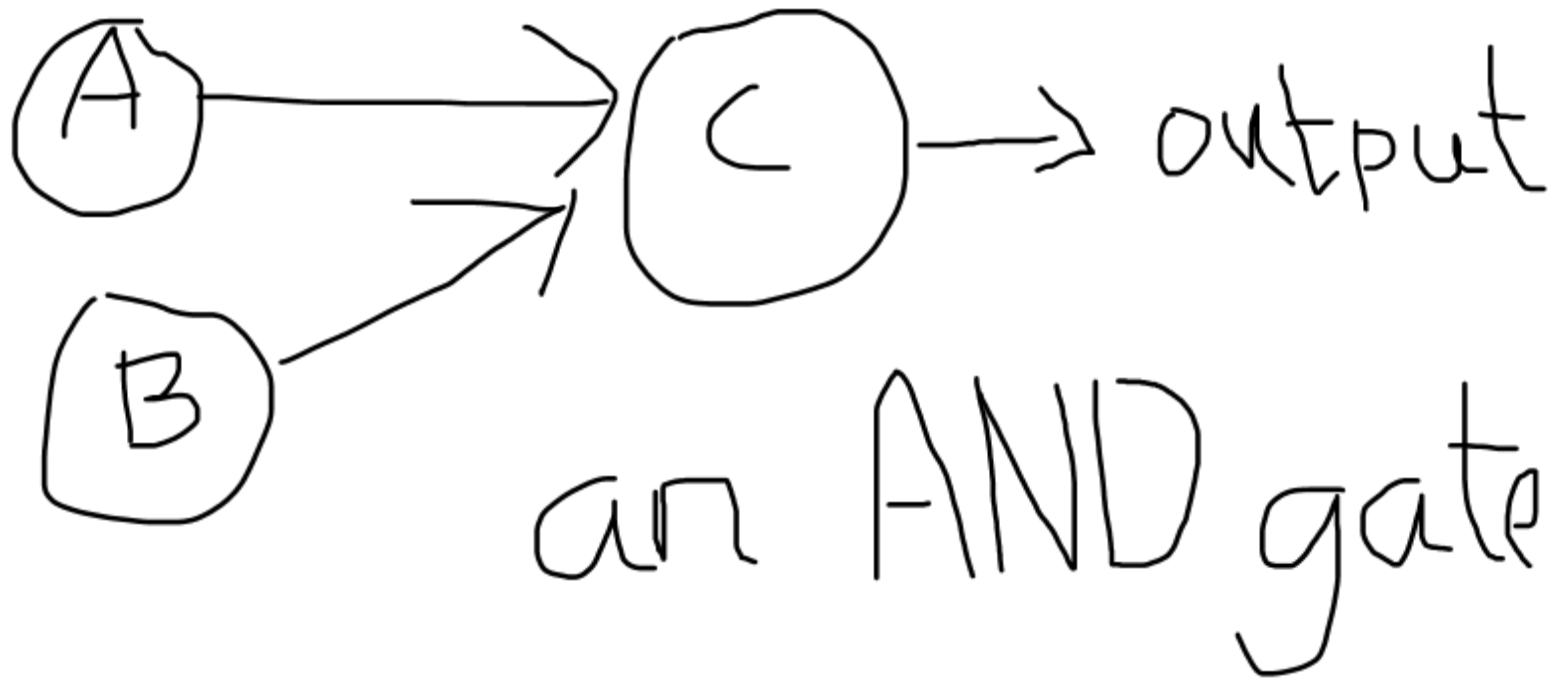
Cell Body (soma) = tree trunk

Axons can be short or v long – they end in synapses which connect to the dendrites of other neurons.

Each neuron can send a signal and if sufficiently strong it causes related neurons to fire. A simple system capable of complex processing

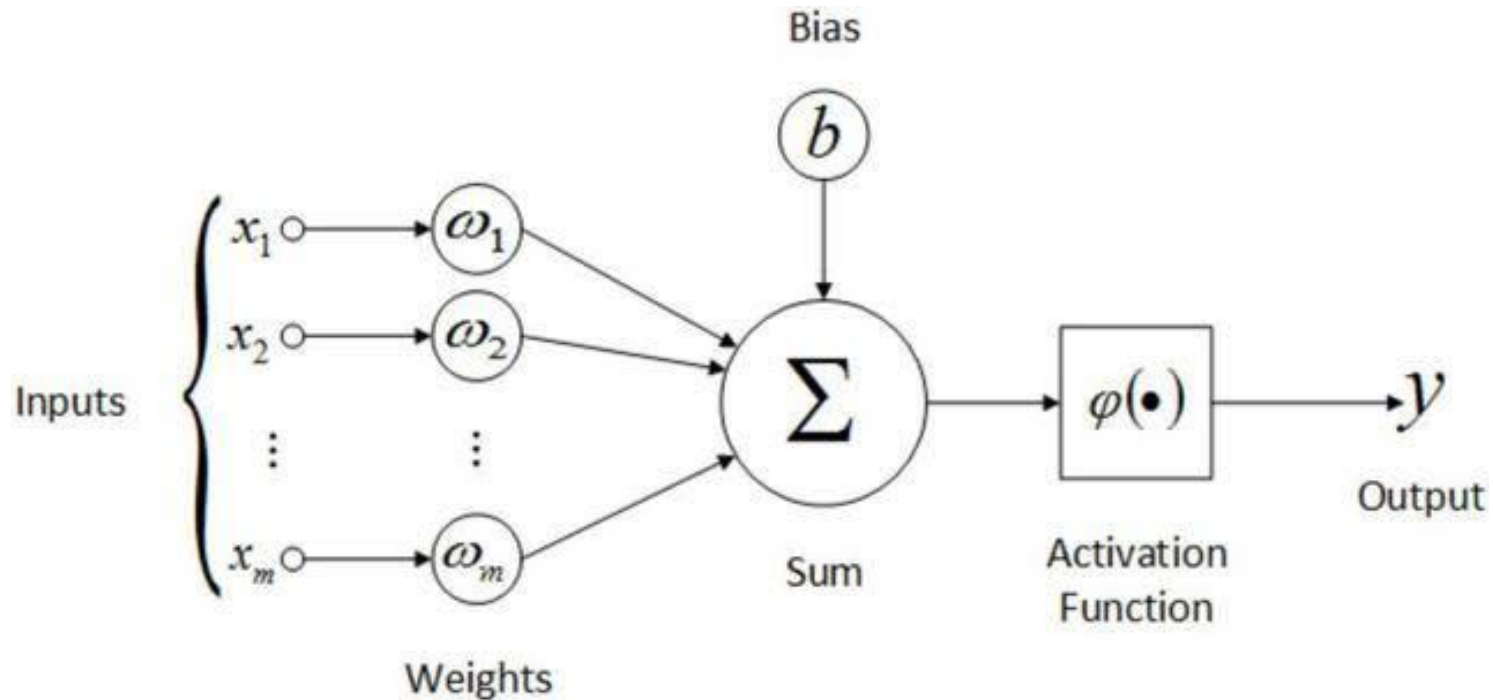
Artificial Neurons – logical operations

- A logical AND can be constructed by firing a neuron if both its inputs are fired.



The single layer perceptron

- A perceptron is a more complex design of artificial neuron



Perceptron continued – the Threshold Logic Unit or TLU

- Multiple inputs
- Each input given a 'weight' (how important it is to the final result)
- The TLU calculates the sum of the inputs x weights
- A 'step' function is applied and then a single output is given
- The 'heaviside' step function is common in single TLUs

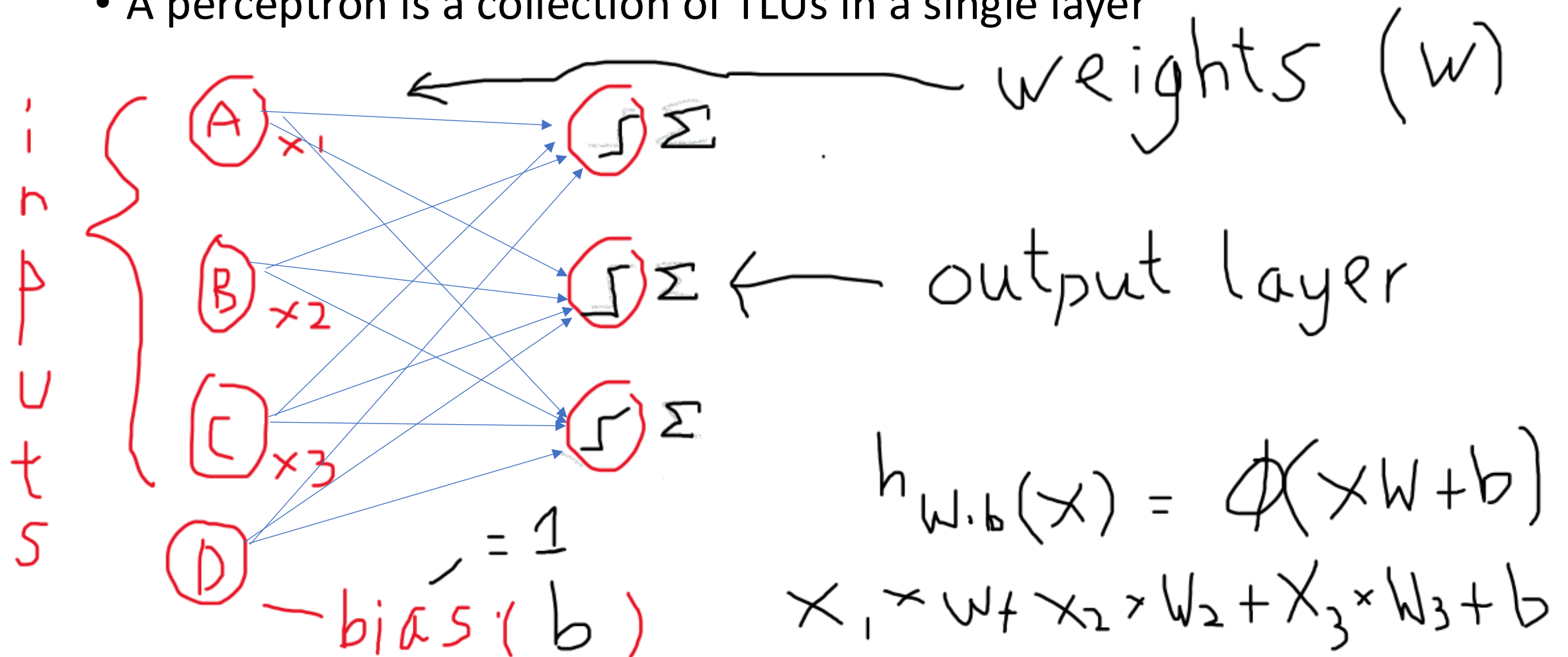
A step function

$$Z = \begin{cases} 0 & \text{if } Z < 0 \\ 1 & \text{if } Z > 0 \end{cases}$$

As you can see – this is a binary classifier – if the threshold value is reached it outputs a positive result otherwise a negative. Similar to a linear regression

Perceptron = a layer of TLUs

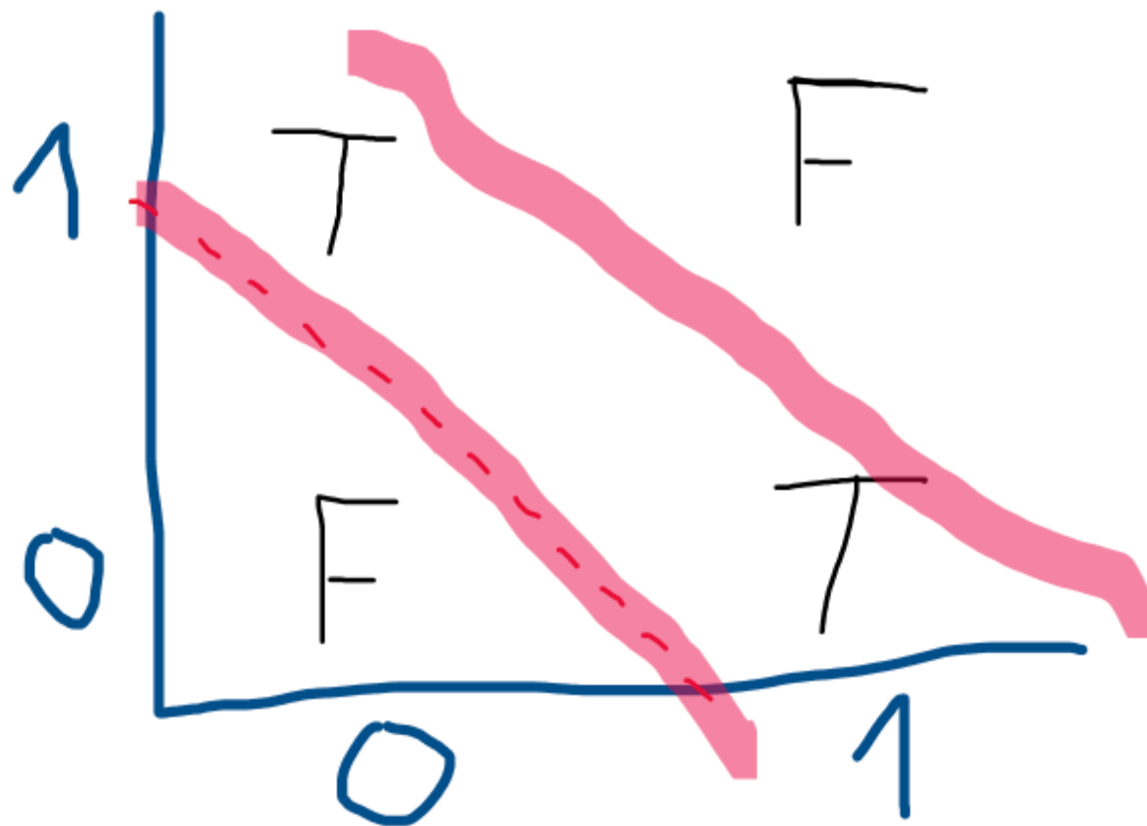
- A perceptron is a collection of TLUs in a single layer



Training Perceptrons

- Weights are adapted in training so that neurons that fire are given more weight
- The convergence rule for perceptrons says that any linearly separable problem WILL converge and there will be a solution.
- The solution is where the weights have been adjusted to minimise prediction error.

Example of linear separable problem (OR)



Task .

- Perceptron code from p287 Gueron – use the sci kit learn perceptron on the Iris data set. (check out the Kaggle solution for this)

<https://www.kaggle.com/code/choihanbin/iris-classification-with-sklearn-perceptron>

- Chapter 18 Data Science from scratch – code your own perceptron and solve the FizzBuzz problem.

Good tutorial on a perceptron with the Iris data set

https://www.bogotobogo.com/python/scikit-learn/Perceptron_Model_with_Iris_DataSet.php