

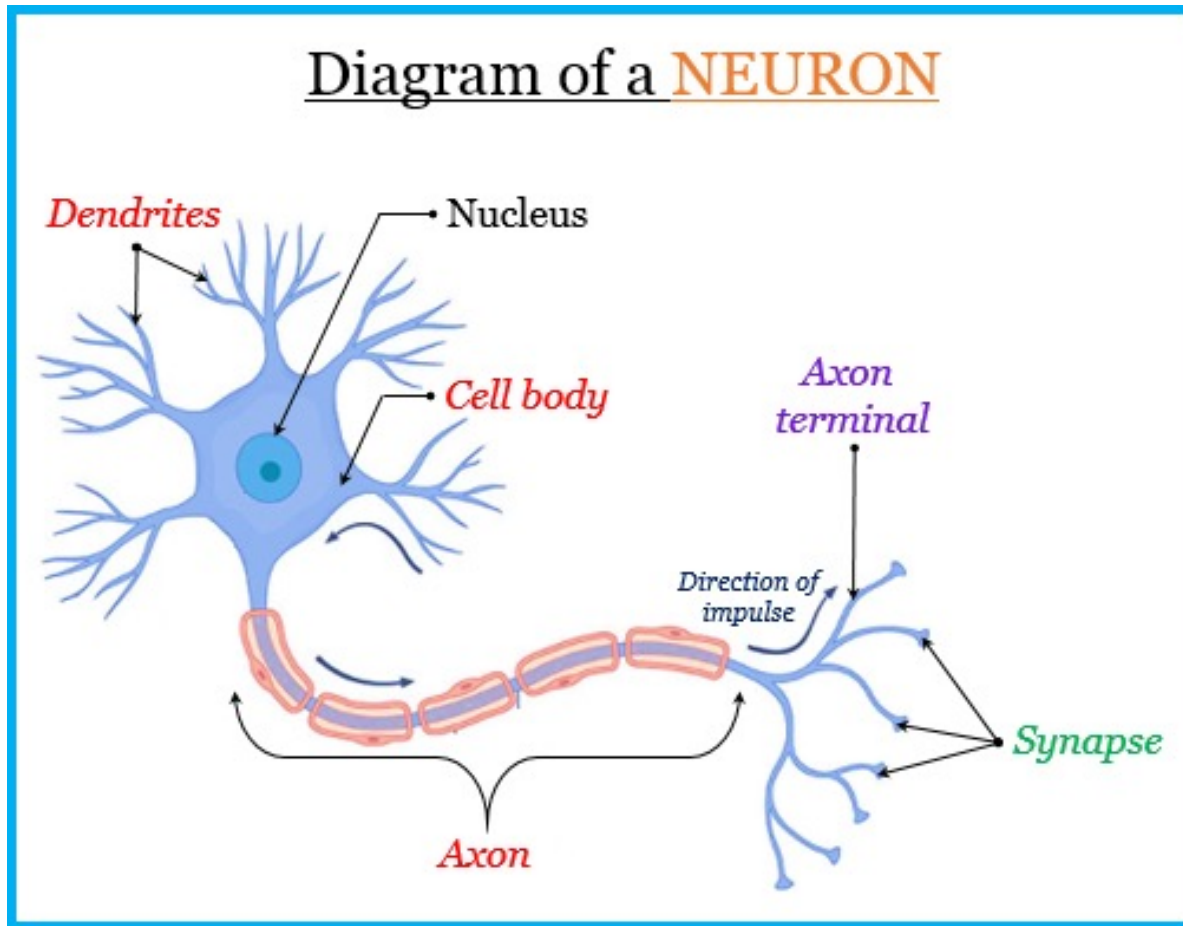
# Introduction to Artificial Neural Networks - ANN

Spring 2022

# 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

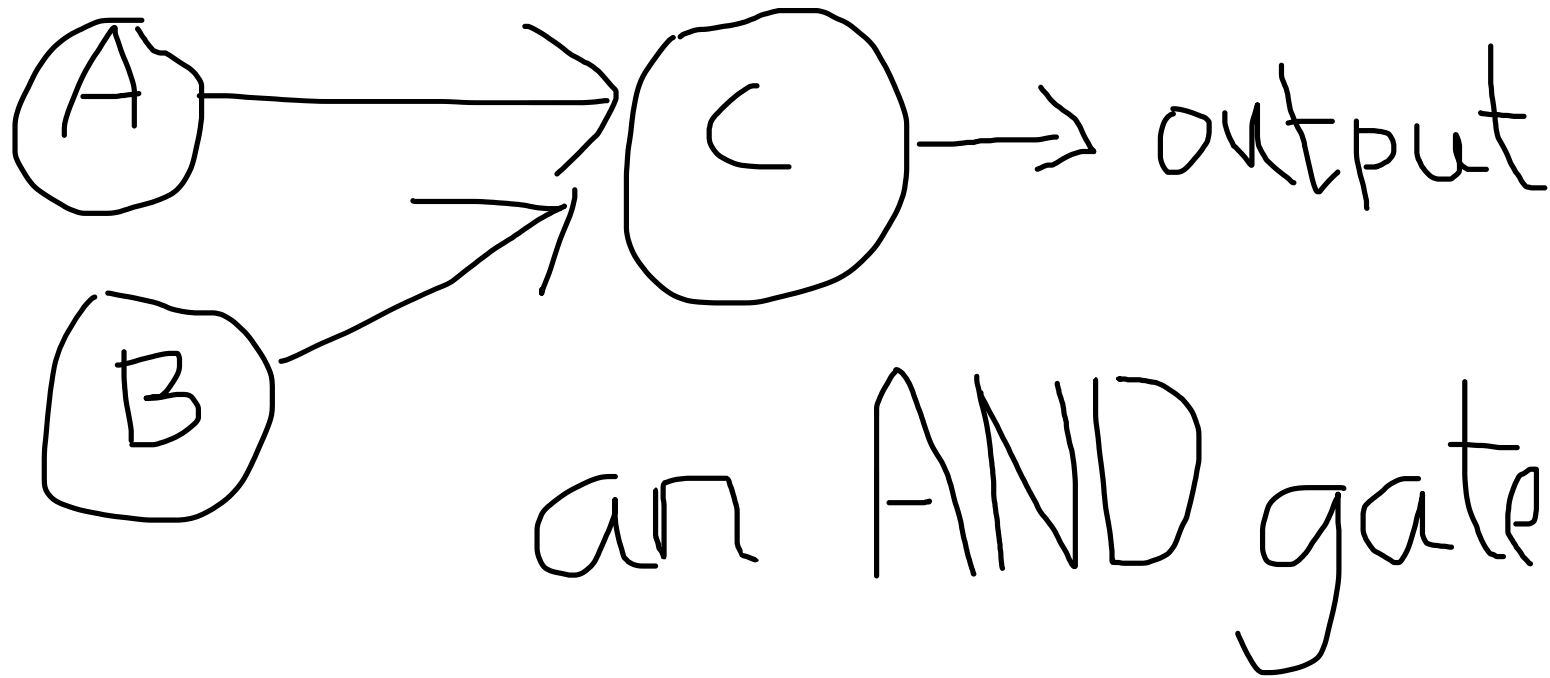
Cell Body (soma) = tree trunk

Axons can be short or v long – the 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

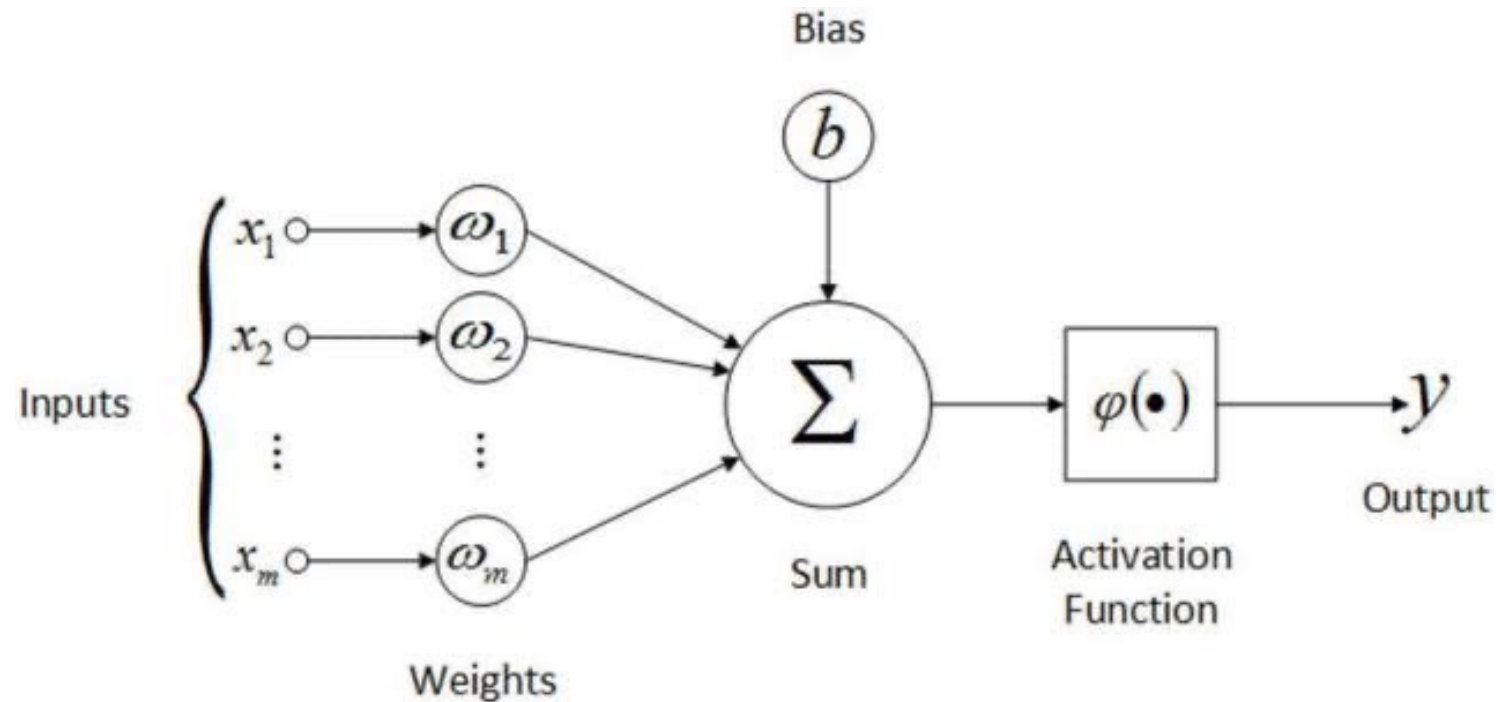
# Artificial Neurons – logical operations

- 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

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

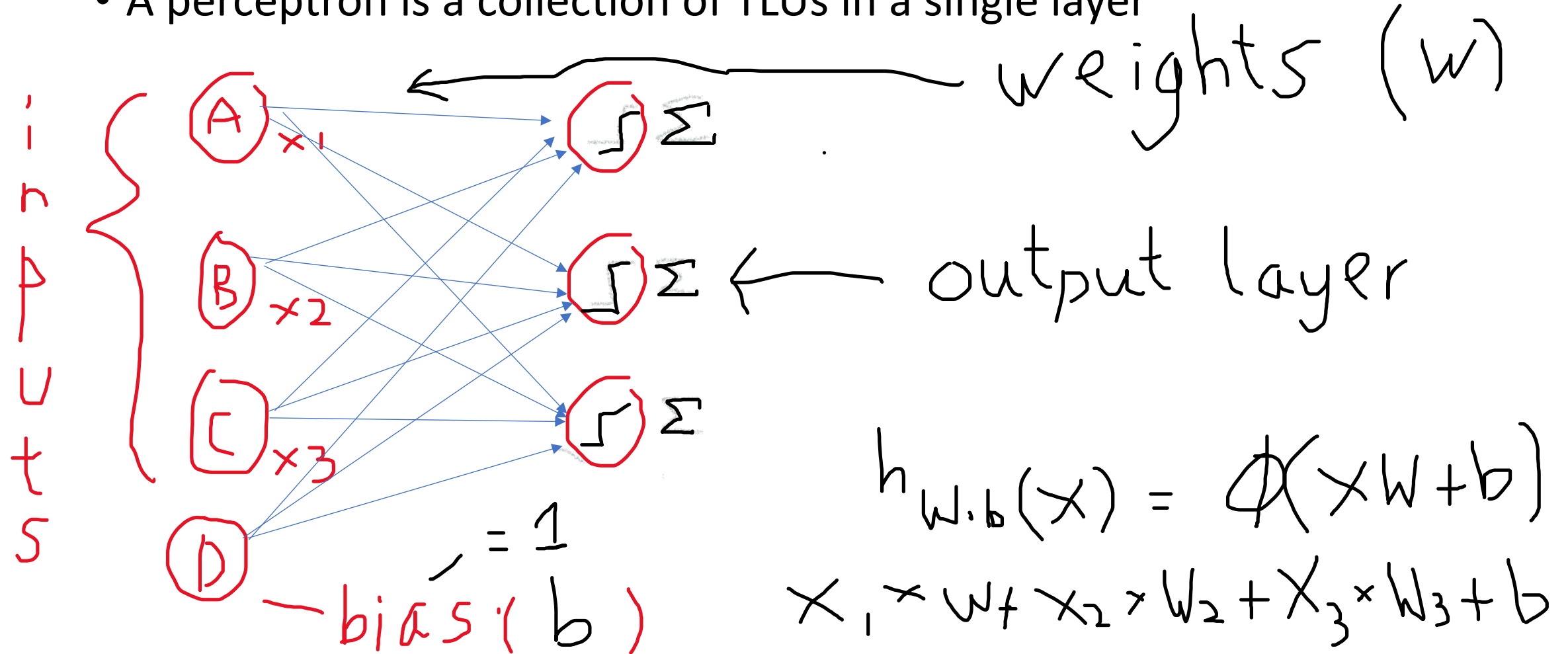
# A step function

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

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

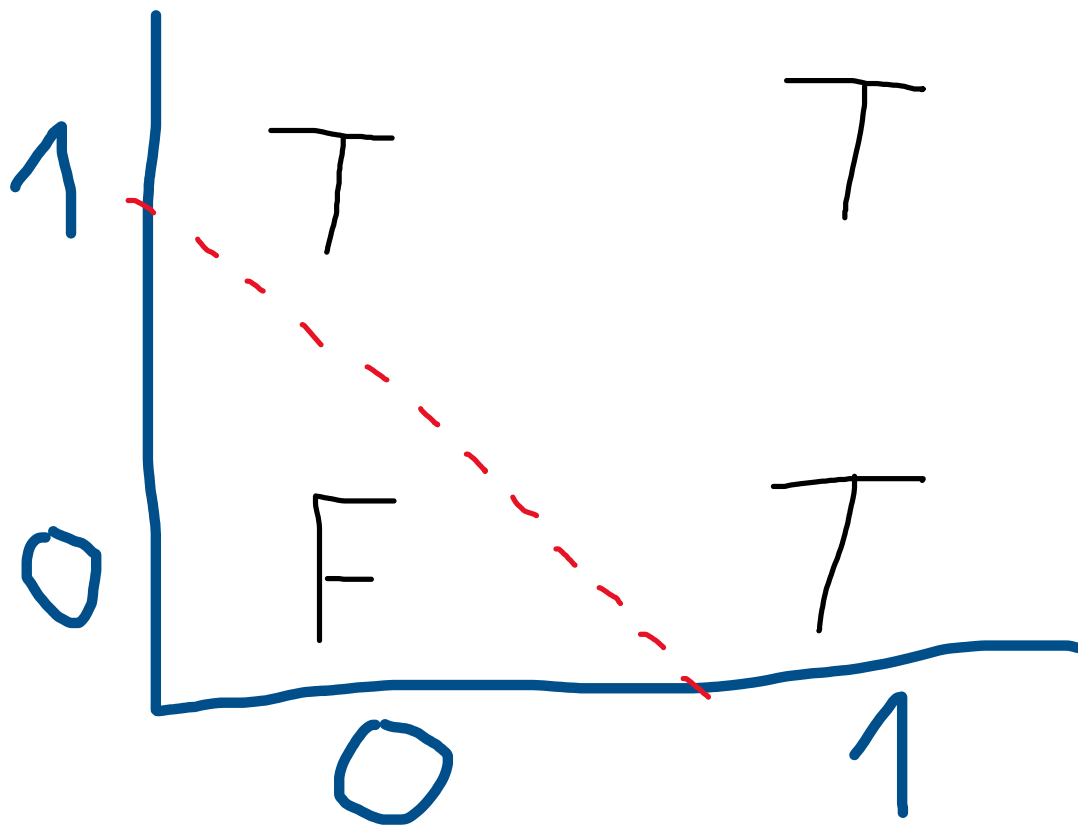




# Training Perceptrons

- 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.
- (pdf file – Scikit )
- Chapter 18 Data Science from scratch – code your own perceptron.