CSE 5368
Neural Networks

Introduction

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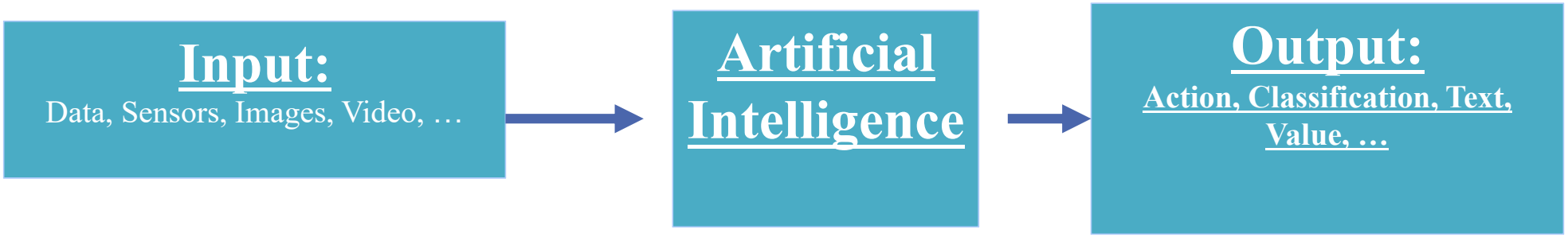
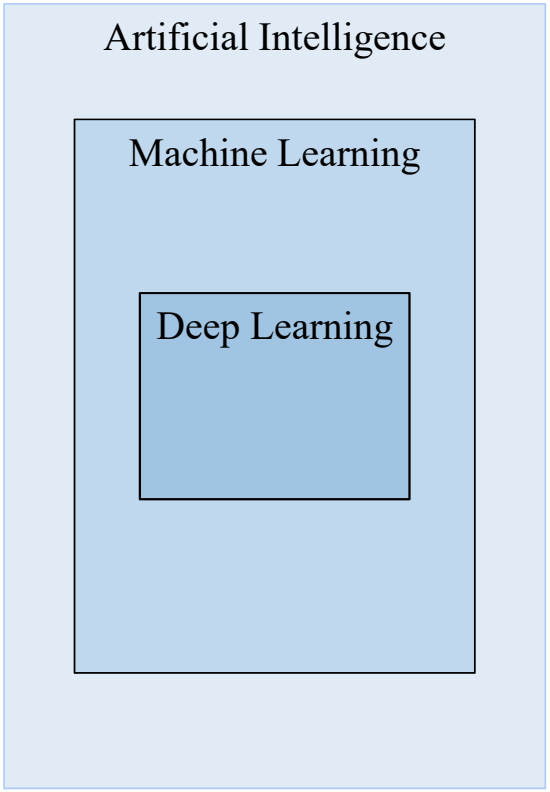
What is Artificial Intelligence?



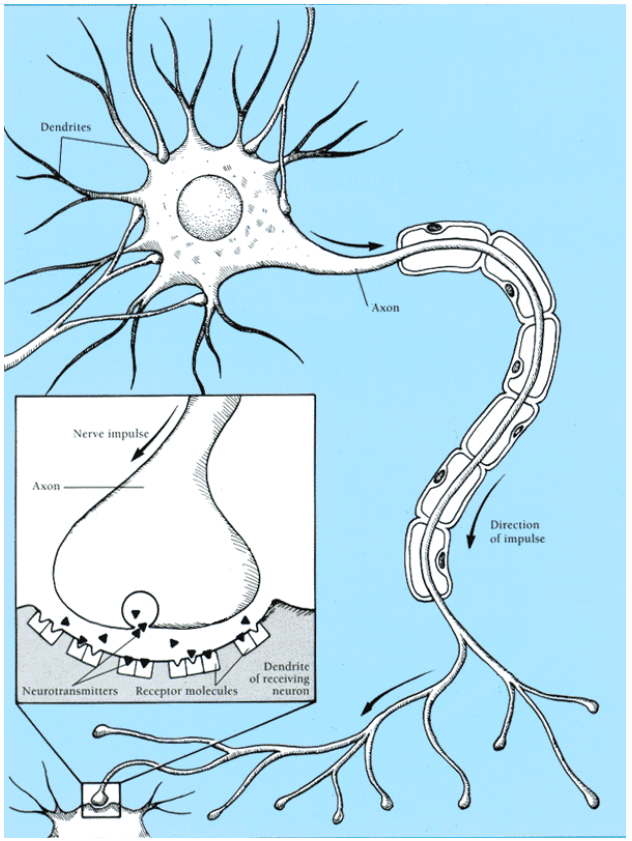
Machine Learning VS Deep Learning?

- Machine Learning is a type of Artificial Intelligence that provides computers with the ability to learn without being explicitly programmed.
- The intention of ML is to enable machines to learn by themselves using the provided data and make accurate predictions.
- Machine learning is a subset of artificial intelligence.
- Training in machine learning involves giving a lot of data to the algorithm.
- Deep learning is a subset of machine learning.
- Deep learning (Neural Networks) is inspired by the information processing patters in the brain.



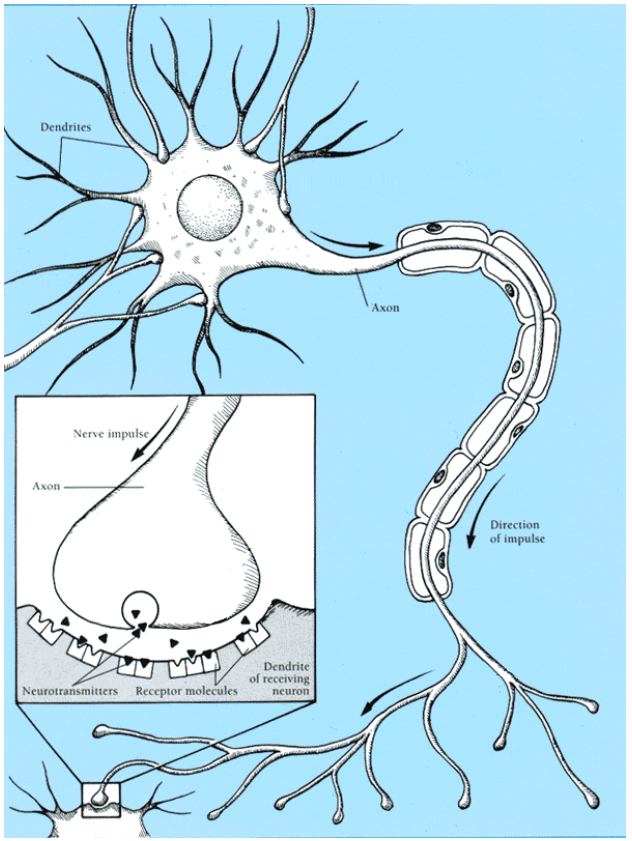
Biology

- Human nervous system is built of cells call neuron.
- Neurons respond slowly
  - – 10^{-3} s compared to 10^{-9} s for electrical circuits
- The brain uses massively parallel computation
  - – $\approx 10^{11}$ neurons in the brain
  - – $\approx 10^{4}$ connections per neuron
- Each neuron can receive, process and transmit electrochemical signals.
- Dendrites extend from the cell body to other neurons, and the connection point is called synapse.
- Signals received from dendrites are transmitted to and summed in the cell body.
- If the cumulative excitation exceed a threshold, the cell fires, which sends a signal down the axon to other neurons

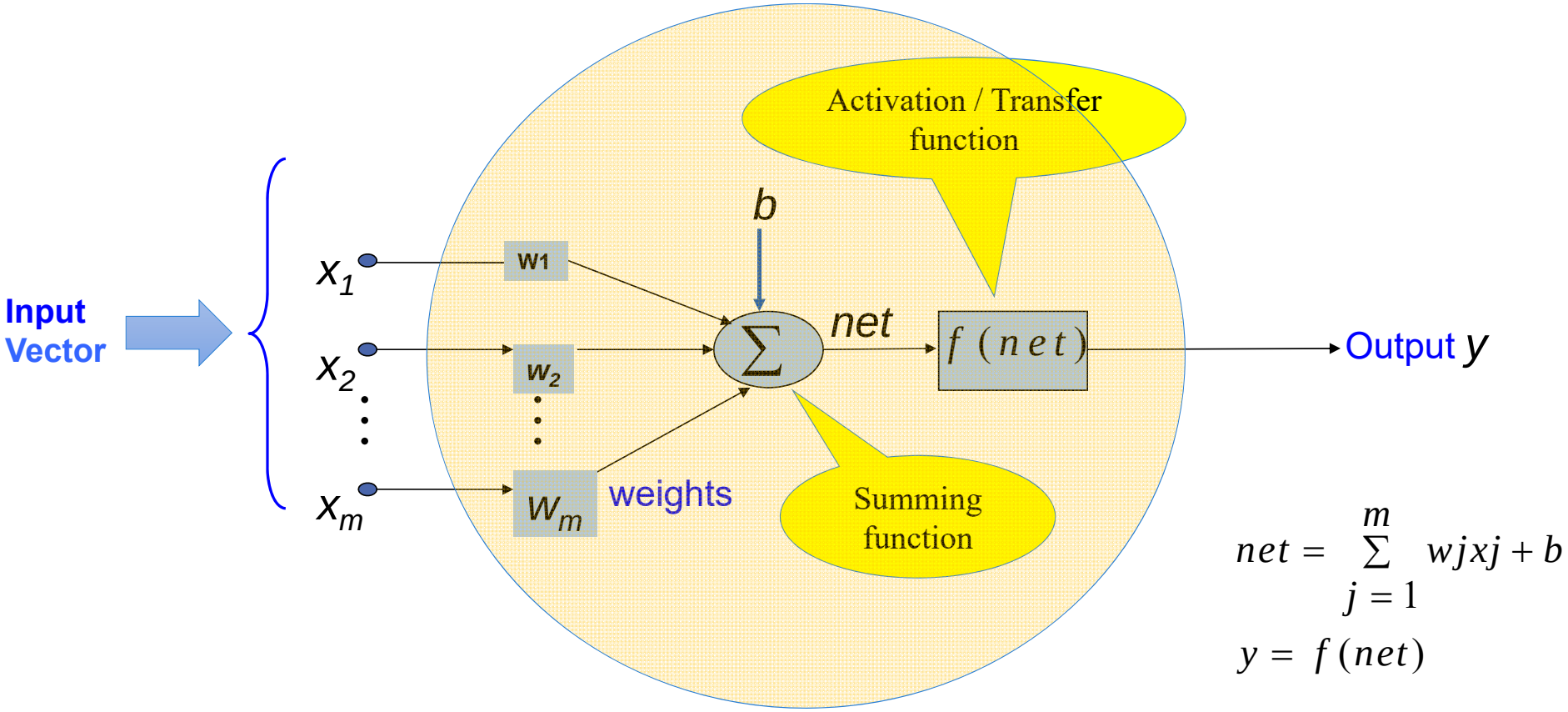


Biology

- ***Soma* or *body cell*** **-** is a large, round central body (the processing unit).
- ***The axon (output),*** is a nerve fiber attached to the soma which is the output of the neuron. An axon is usually highly branched.
- ***The dendrites*** **(inputs)-** represent a branching tree of fibers. These long nerve fibers are attached to the soma carrying electrical signals into the cell
- ***Synapses*** are the point of contact between the axon of one cell and the dendrite of another, regulating a chemical connection whose strength affects the input to the cell.



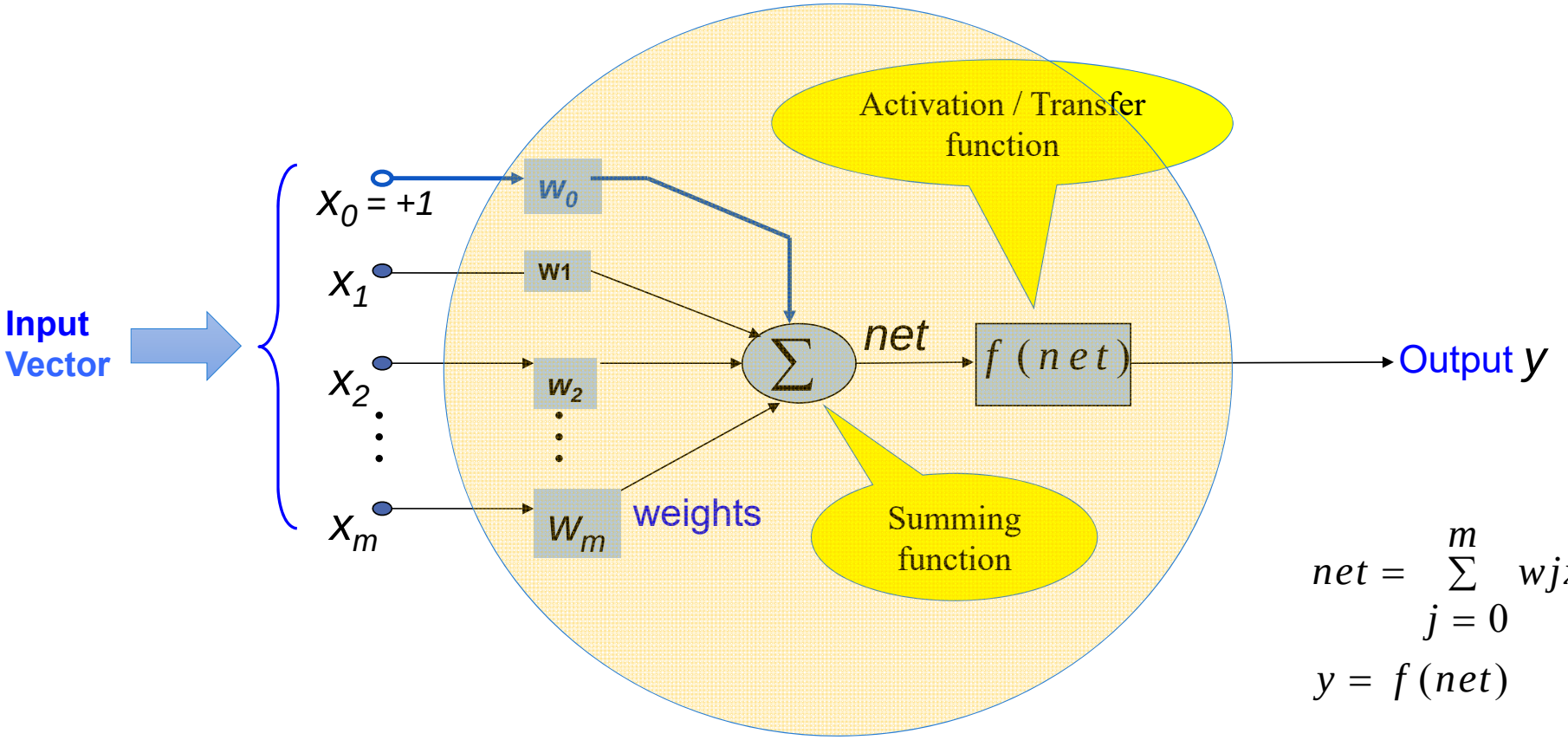
Single Artificial Neuron



$$net = \sum_{j=1}^{m} wjxj + b$$

$$y = f(net)$$

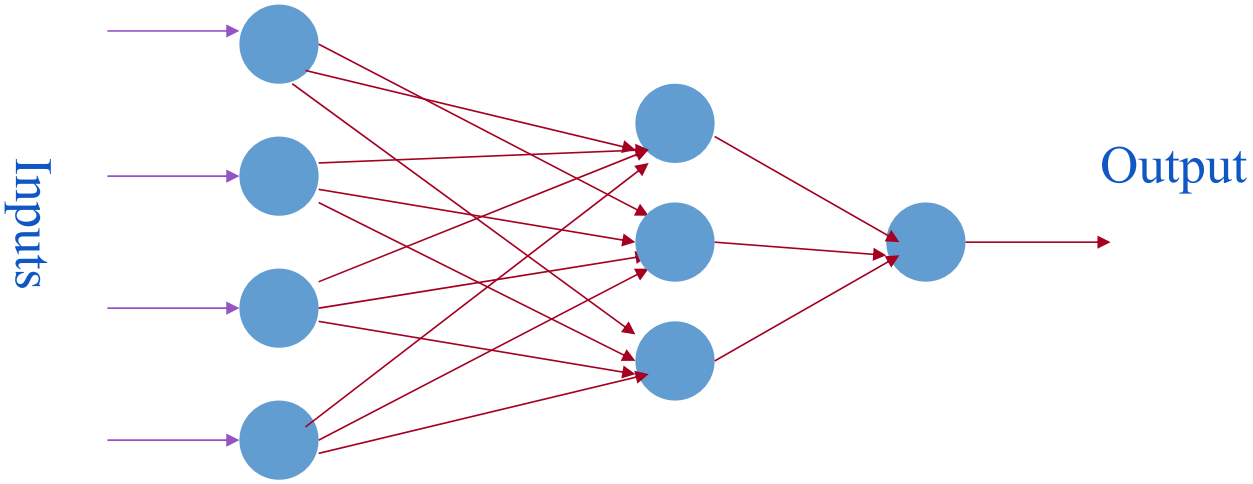
Bias as extra input



$$net = \sum_{j=0}^{m} wjxj$$

$$y = f(net)$$

Artificial neural networks



An artificial neural network is composed of many artificial neurons that are linked together according to a specific network architecture.

$$y_{out} = F(x, W)$$

W is the matrix of all weight vectors.

Artificial Neural Networks

- Artificial neural networks are inspired by biological systems.
- Biological learning happens by the modification of the synaptic strength. Artificial neural networks learn by adjusting weights.
- The weight modification rules for artificial neural networks can be derived by applying optimization methods.
- The optimization is done to minimize error (cost) function.
- Neural networks can be considered function approximating tools.

Properties of Artificial Neural Networks

- ANNs Learn from examples: Labeled or unlabelled (Supervised or unsupervised).
- ANNs are Adaptive: Changing the connection strengths to learn things.
- ANNs are usually non-linear: The non-linear activation functions are essential.
- ANNs are fault tolerant: If one of the neurons or connections is damaged, the whole network still works.

Questions