Artificial Neural Network

Intelligent System Course

Questions

1. What tasks are machines good at doing that humans are not?
2. What tasks are humans good at doing that machines are not?
3. What tasks are both good at?
4. What does it mean to learn?
5. How is learning related to intelligence?
6. What does it mean to be intelligent? Do you believe a machine will ever be built that exhibits intelligence?
7. Have the above definitions changed over time?
8. If a computer were intelligent, how would you know?
9. What does it mean to be conscious?
10. Can one be intelligent and not conscious or vice versa?

Definition…

... a neural network is a system composed of many simple processing elements operating in parallel whose function is determined by network structure, connection strengths, and the processing performed at computing elements or nodes. DARPA Neural Network Study (1988, AFCEA International Press, p. 60)

A neural network is a massively parallel distributed processor that has a natural propensity for storing experiential knowledge and making it available for use. Haykin, S. (1994), Neural Networks: A Comprehensive Foundation, NY: Macmillan, p. 2

Why ANN?

1. Adaptive learning: An ability to learn how to do tasks based on the data given for training or initial experience.
2. Self-Organisation: An ANN can create its own organisation or representation of the information it receives during learning time.
3. Real Time Operation: ANN computations may be carried out in parallel, and special hardware devices are being designed and manifactured which take advantage of this capability.

Why ANN (continued)?

4. Fault Tolerance via Redundant Information Coding: Partial destruction of a network leads to the corresponding degradation of performance. However, some network capabilites may be retained even with major network damage.

History

- McCulloch & Pitts (1943) are generally recognised as the designers of the first neural network
- Many of their ideas still used today (e.g. many simple units combine to give increased computational power and the idea of a threshold)
- Hebb (1949) developed the first learning rule (on the premise that if two neurons were active at the same time the strength between them should be increased)

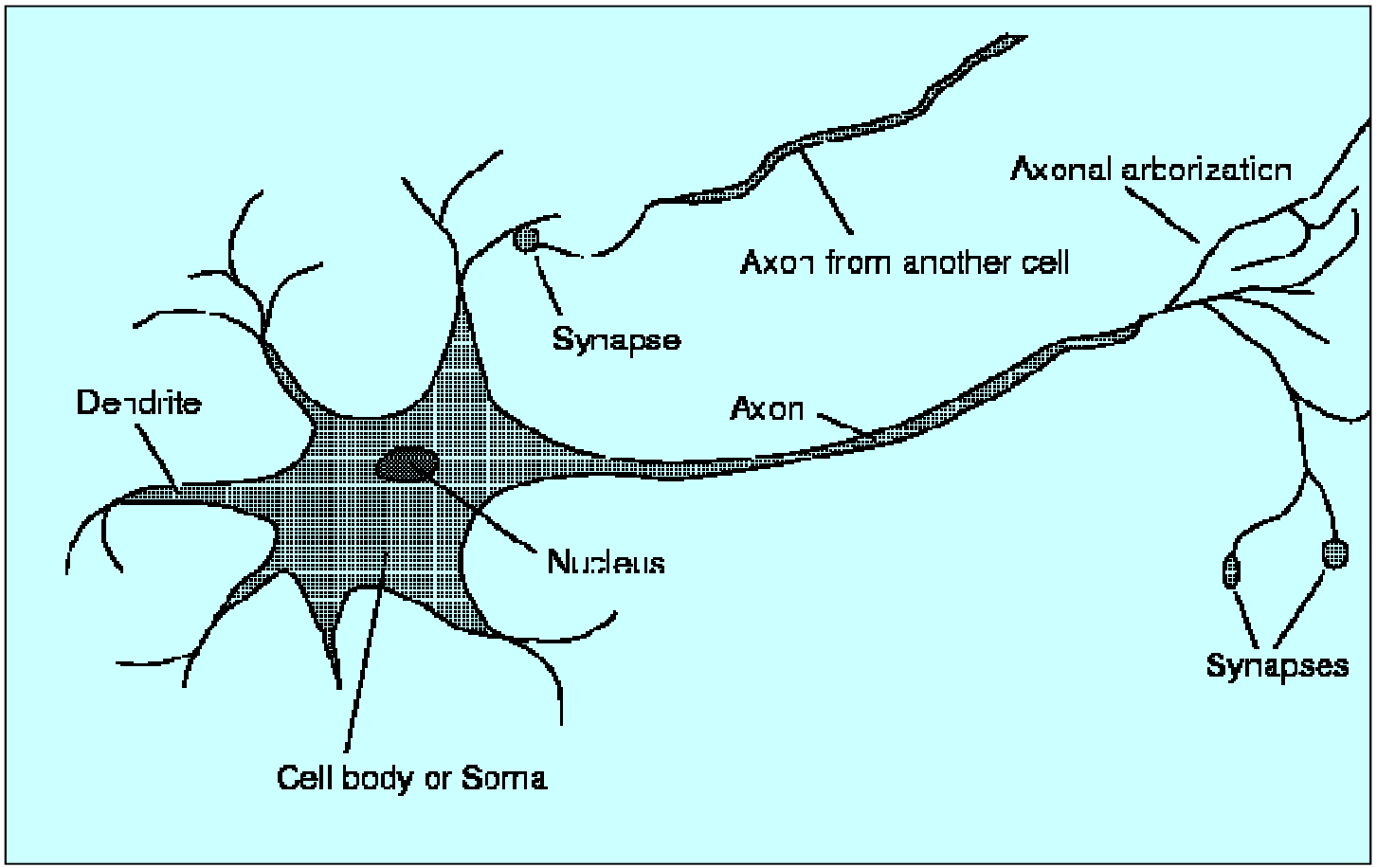
History (continued)

- During the 50's and 60's many researchers worked on the perceptron amidst great excitement.
- 1969 saw the death of neural network research for about 15 years – Minsky & Papert
- Only in the mid 80's (Parker and LeCun) was interest revived (in fact Werbos discovered algorithm in 1974)

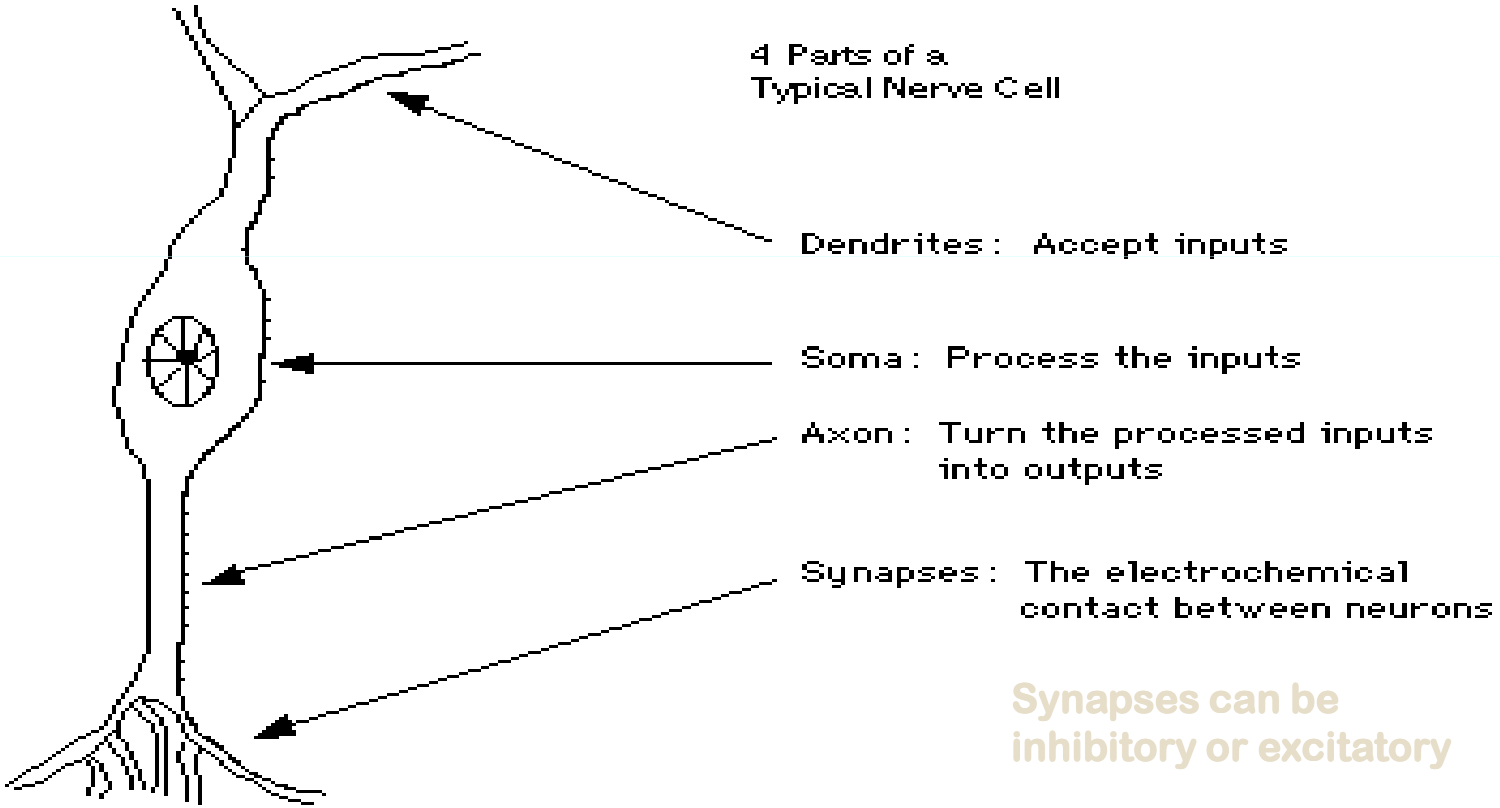
What is ANN?

- A system loosely modeled on the human brain. The most basic component of ANN are modeled after the structure of the brain
- Some ANN structures are not closely to the brain and some does not have a biological counterpart in the brain
- However, ANN has a strong similarity to the biological brain and therefore a great deal of terminology is borrowed from neuroscience

Biological Neuron



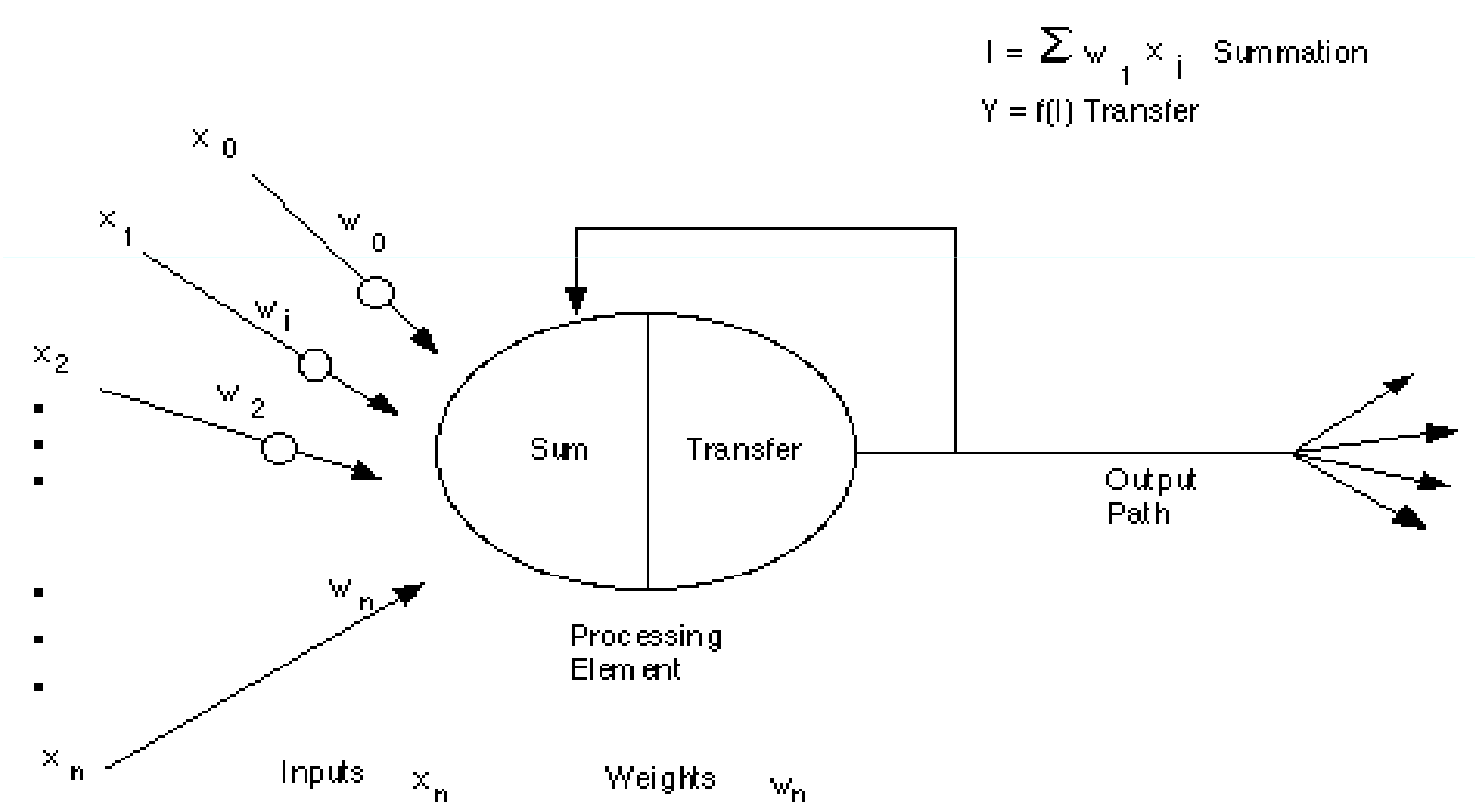
The biological neuron



Facts about biological neuron:

- We are born with about 100 billion neurons
- A neuron may connect with up to 200,000 other neurons
- Neurons provide us with the abilities to remember, think, and apply previous experiences to our action
- All natural neurons have four basic components, which are dendrites, soma, axon, and synapses

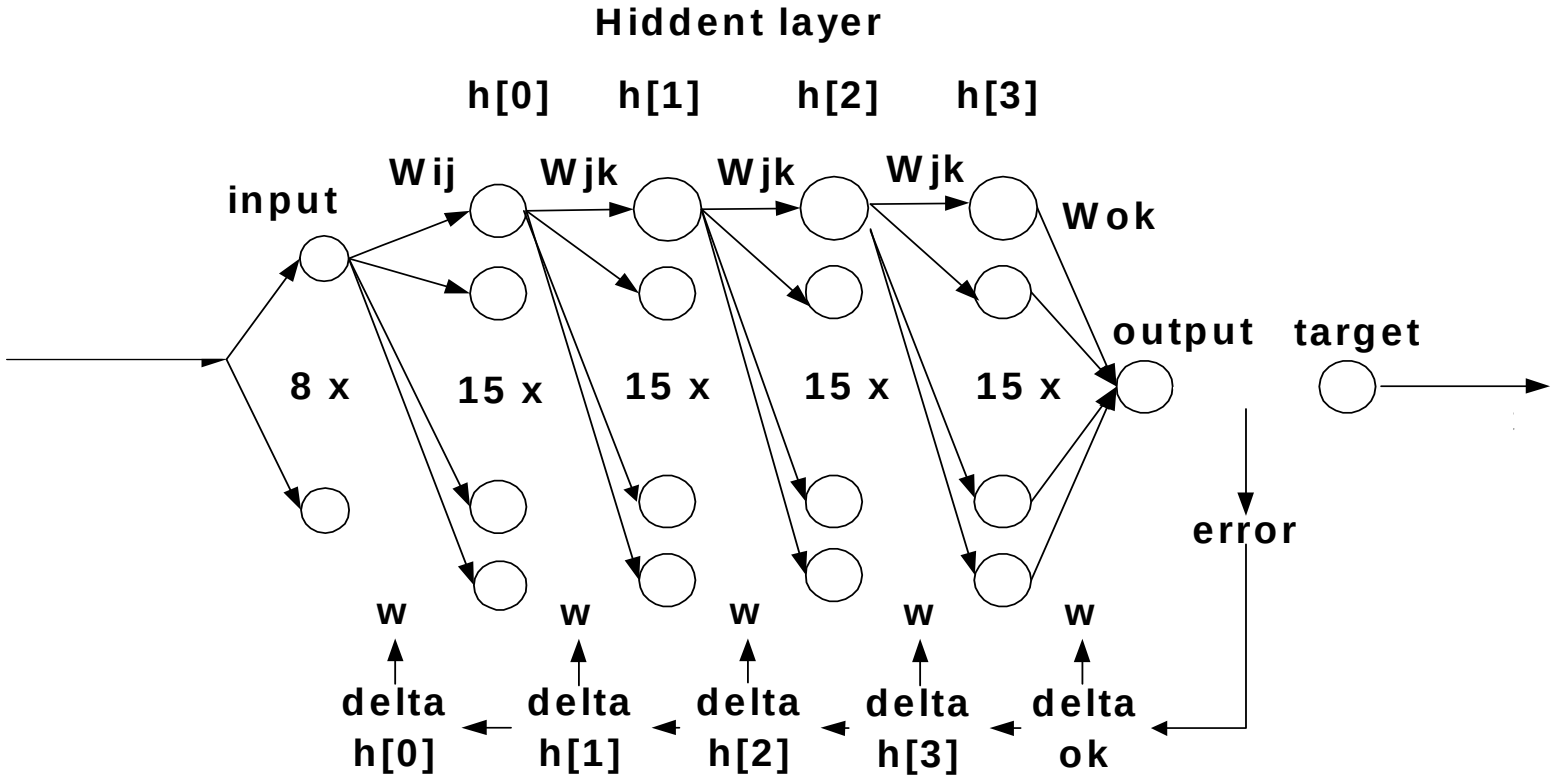
Artificial Neuron



The ANN structure – layers

- ANN are the simple clustering of the primitive artificial neuron
- Basically, all ANN have similar structure of topology
- Some of the neuron interface the real world to receive its inputs → Input Layer
- Other neurons provide the real world with the network's outputs → Output Layer
- All the rest neurons are hidden form view → Hidden Layer

The ANN structure – an example



The ANN structure - connections

- Fully connected : Each neuron on the first layer is connected to all neurons on the second layer
- Partially connected : A neuron on the first layer does not have to be connected to all neurons on the second layer

The ANN structure – connection

- Feed forward : The neurons on the first layer send their output to the neurons on the second layer, but they do not receive any input back form the neurons on the second layer
- Bi-directional : There is another set of connections carrying the output of the neurons on the second layer into neurons on the first layer
- Feed forward and bi-directional connections could be fully or partially connected