Neural Networks

COMP4211

THE DEPARTMENT OF
COMPUTER SCIENCE & ENGINEERING
計算機科學及工程學系

Science Fiction

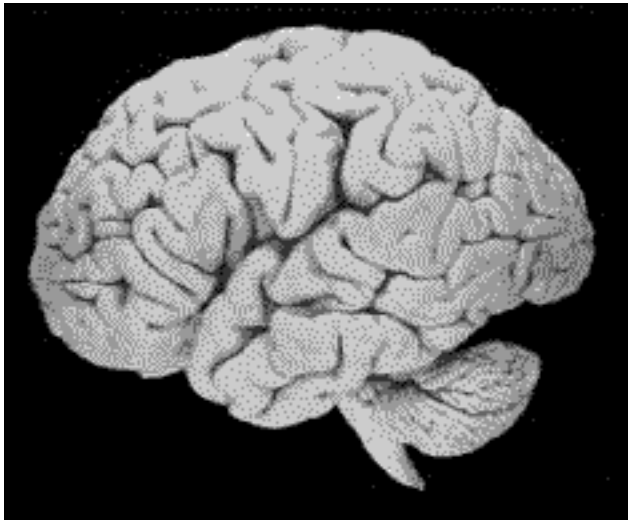
"Science fiction is the great opportunity to speculate on what could happen" $\sim$ Ray Kurzweil (Director of Engineering, Google)

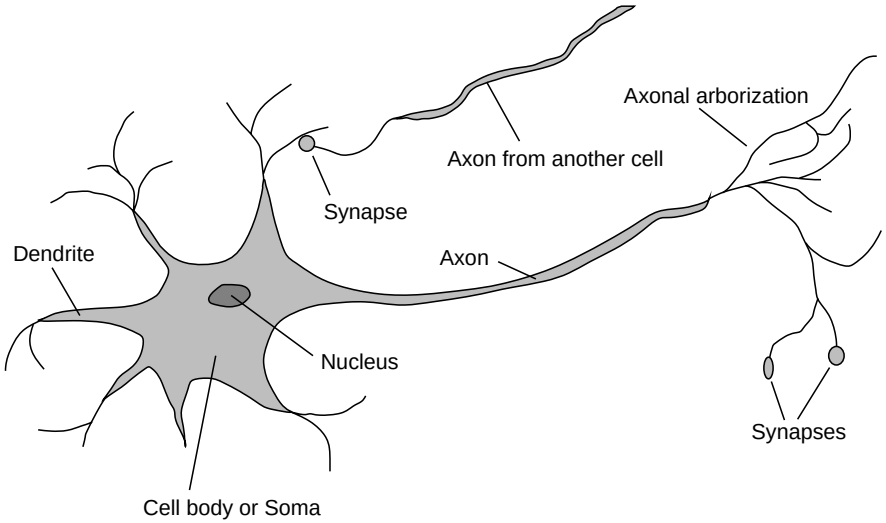
Terminator 2 (1991)

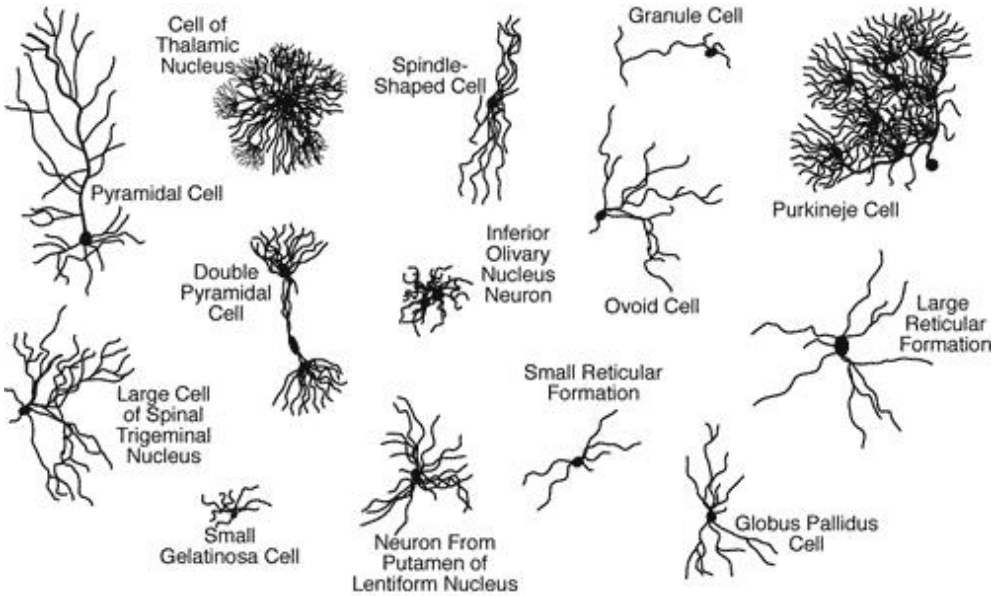
My CPU is a neural-net processor ... a learning computer.

Biological Neurons

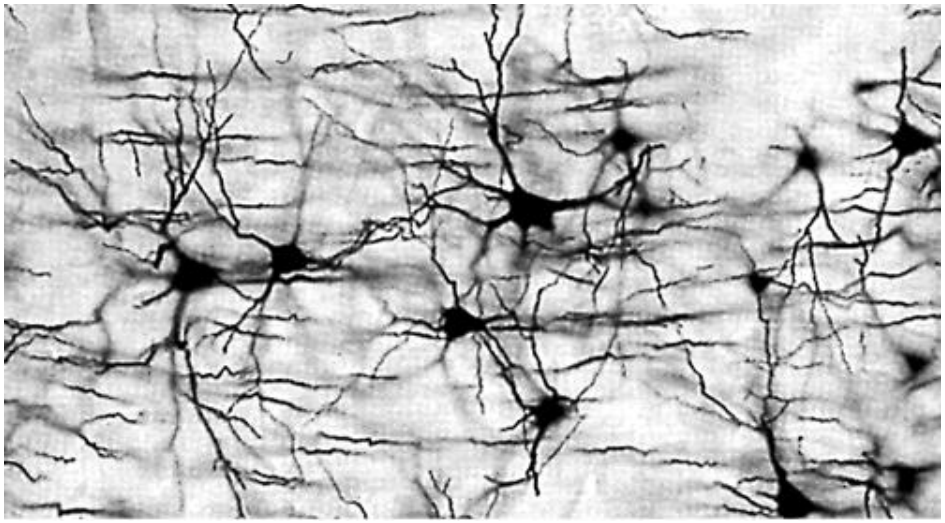
Human brain: 100,000,000,000 neurons



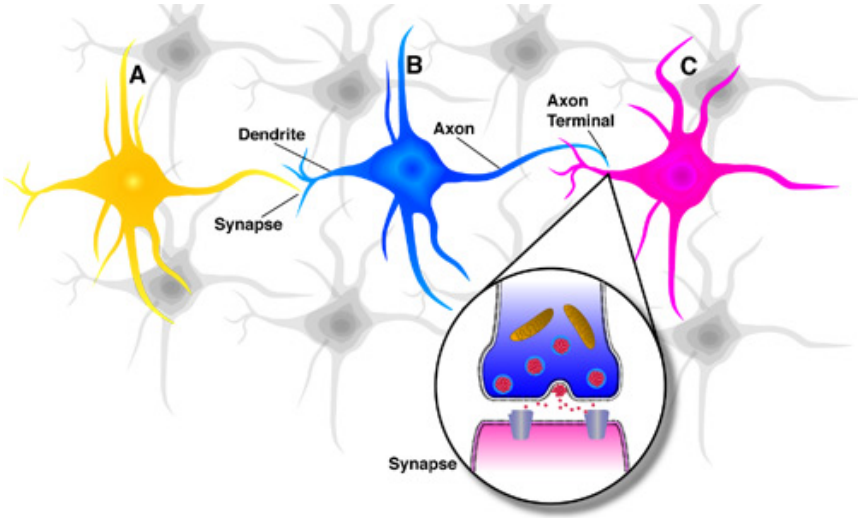




Biological Neurons...

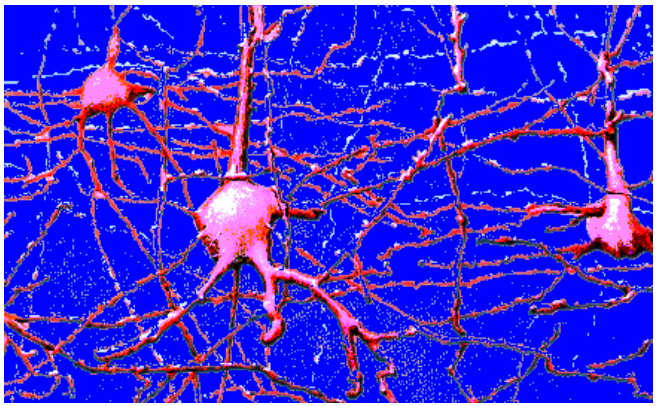


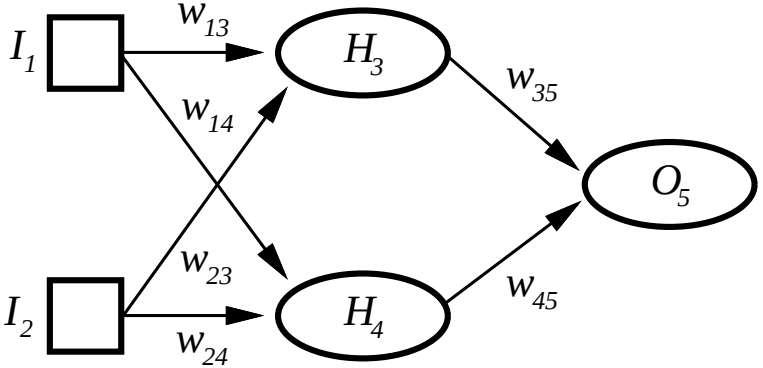
- each neuron receives input from 1,000 others



"Artificial" Neural Networks

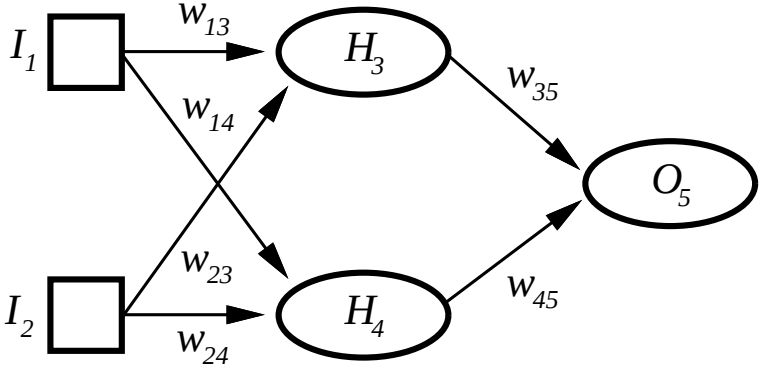
- use complex networks of simple computing elements as mathematical models to mimic the functions of the brain

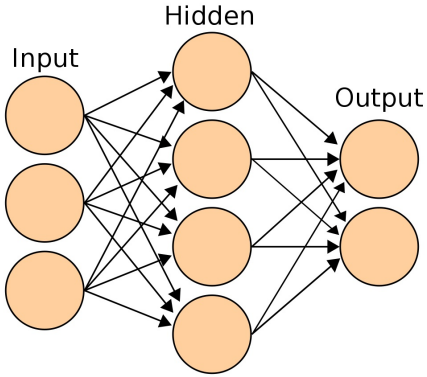




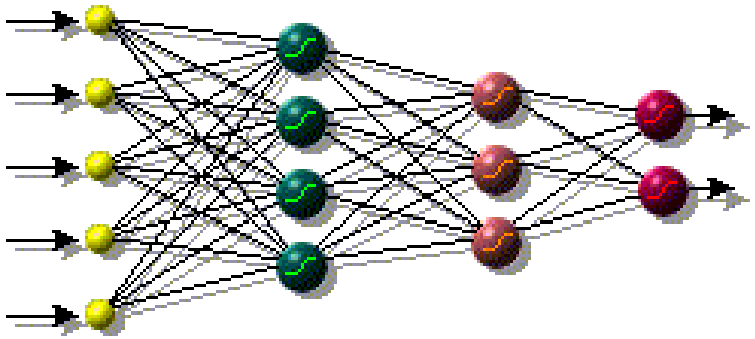
Structure

(i) Unit, (ii) Link, (iii) Weight

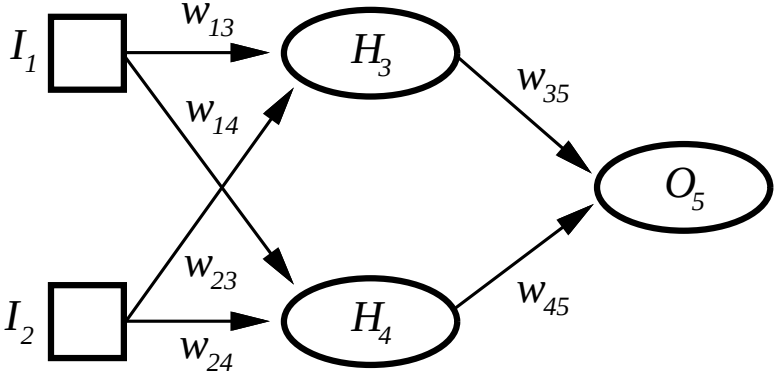


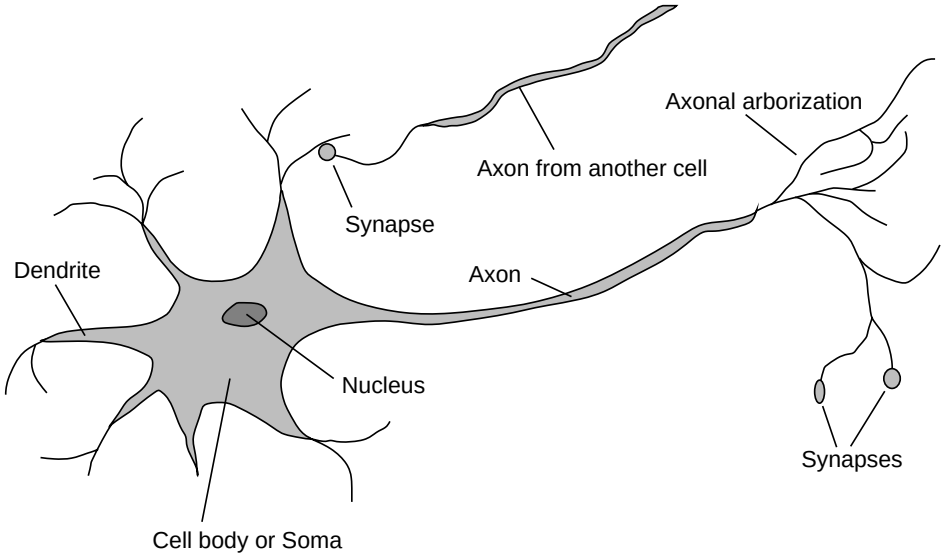


- unit types: input units, hidden units, output units



Structure: Weight

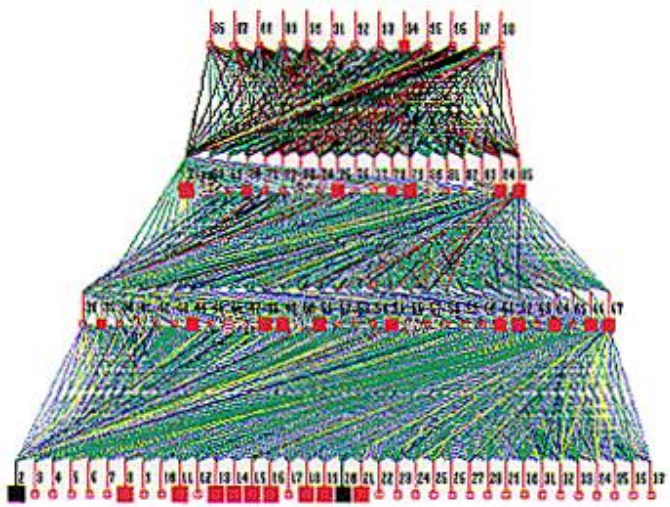




signal transmission in biological neurons

- impulses arrive simultaneously
- added together
- if sufficiently strong, an electrical pulse is sent down the axon
- reaches the synapses, and releases transmitters into the bodies of other cells

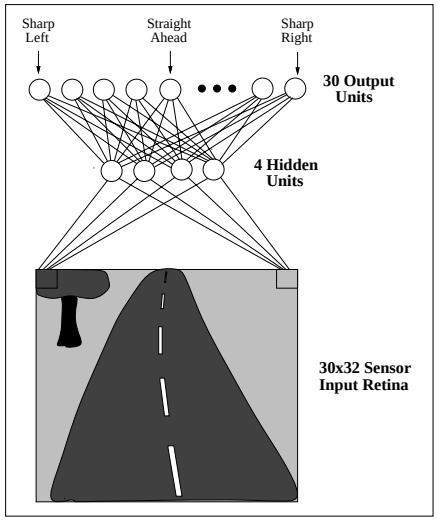
Examples



- deep learning (MIT Tech Review)
- google brain: more than 1 billion parameters
- GPT-3: 175 billion parameters
- Huawei, PanGu: 200 billion parameters
- Naver, HyperCLOVA: 204 billion parameters
- Baidu and Peng Cheng Laboratory, PCL-BAIDU Wenxin: 280 billion parameters
- Google, Switch Transformer: 1.6 trillion parameters
- Beijing Academy of AI, Wu Dao 2.0: 1.75 trillion parameters

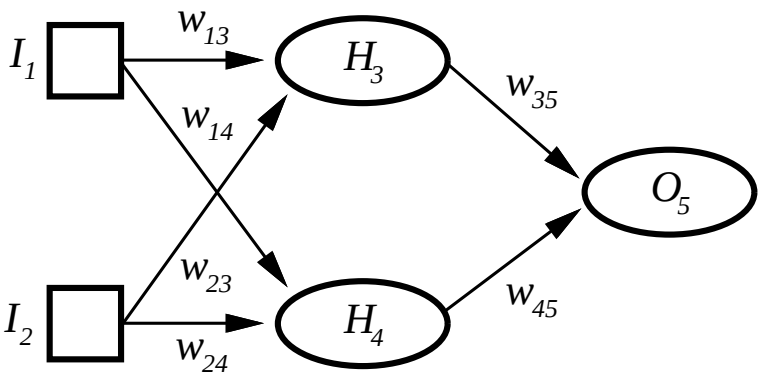
Example Application

ALVINN (Autonomous Land Vehicle In a Neural Network)



- input: video image; output: steering direction
- learns to control a vehicle by watching a person drive

Learning



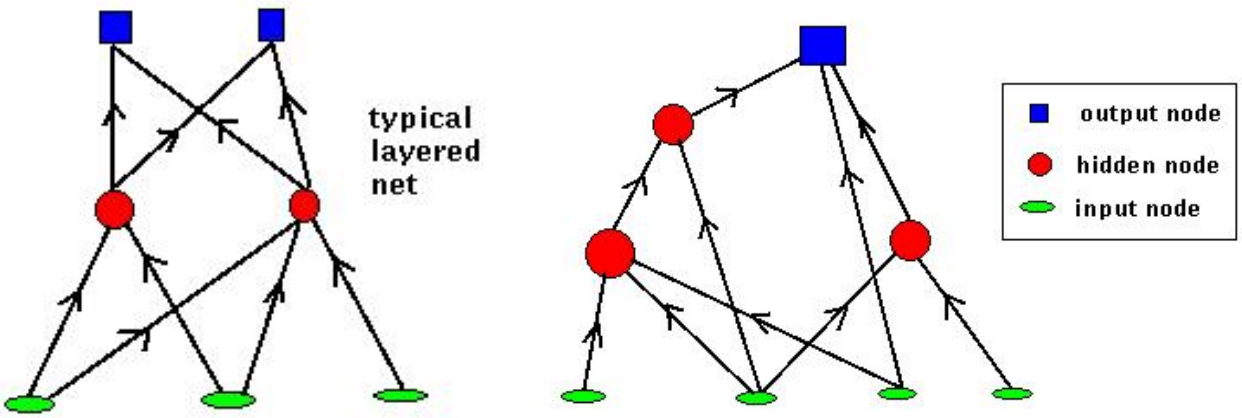
usually takes place by updating the weights

demo

tensorflow playground

Feedforward vs Feedback

Feedforward



Feedback