The original Neural Networks

The requirements for NN

- Most flexible on changing environment
- Save good states
  - Increase length of life and joy
- Forget bad states
  - Don't become afraid or depressive
- Filter environmental input
  - To avoid information overload

http://www.yeahimageek.com/wp-content/uploads/2009/03/brain-763982-1-300x299.jpg
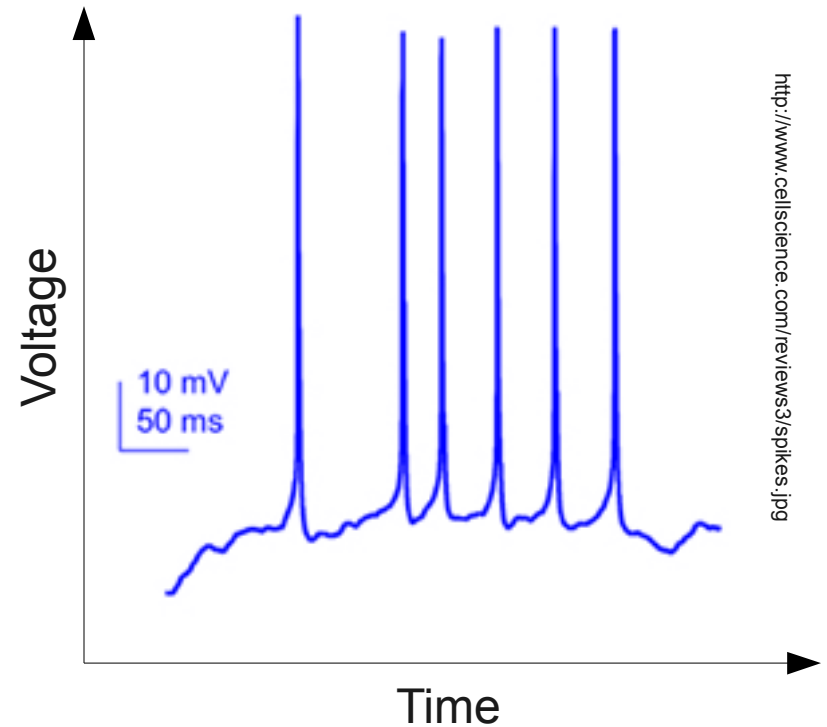
The Neuron

- Nucleus
- Axon (output)
  - Terminals (interface)
- Dendrites (input)
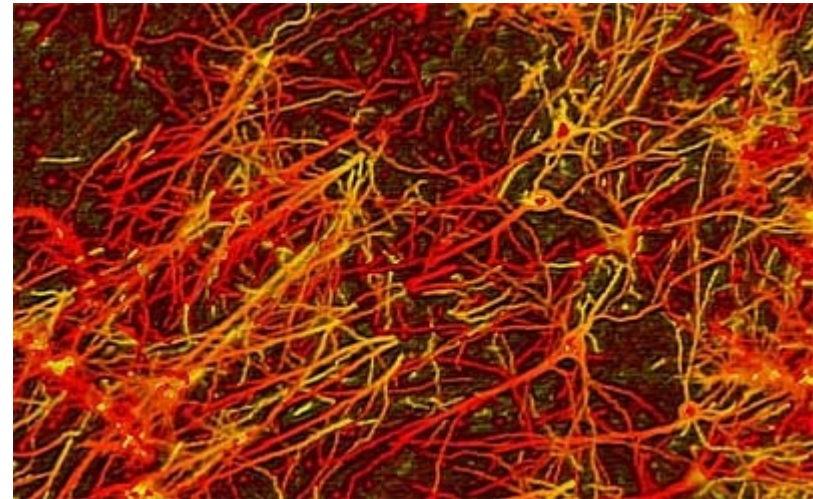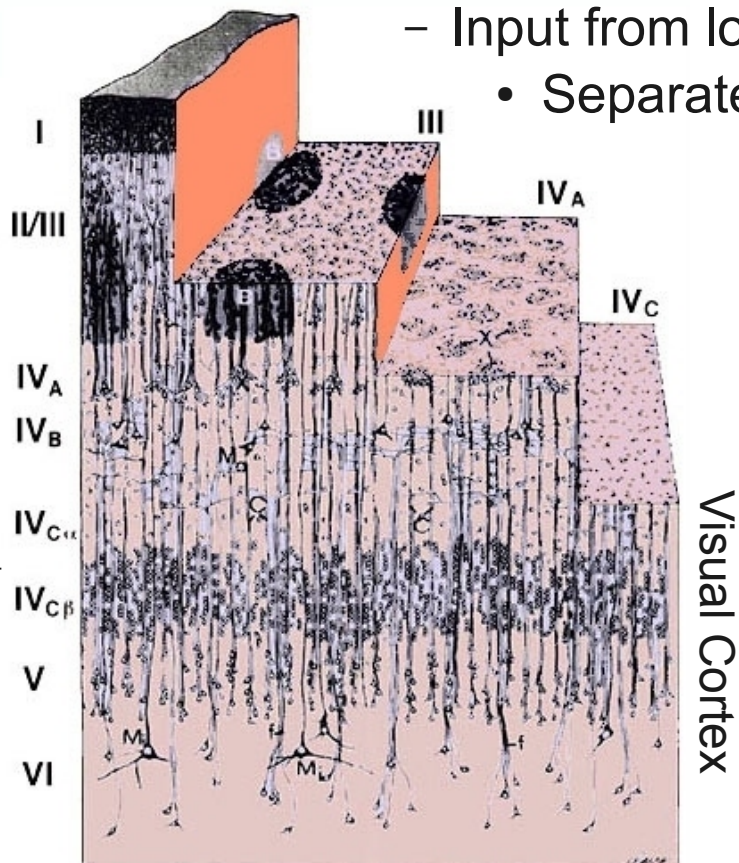- Neurotransmitter as messengers
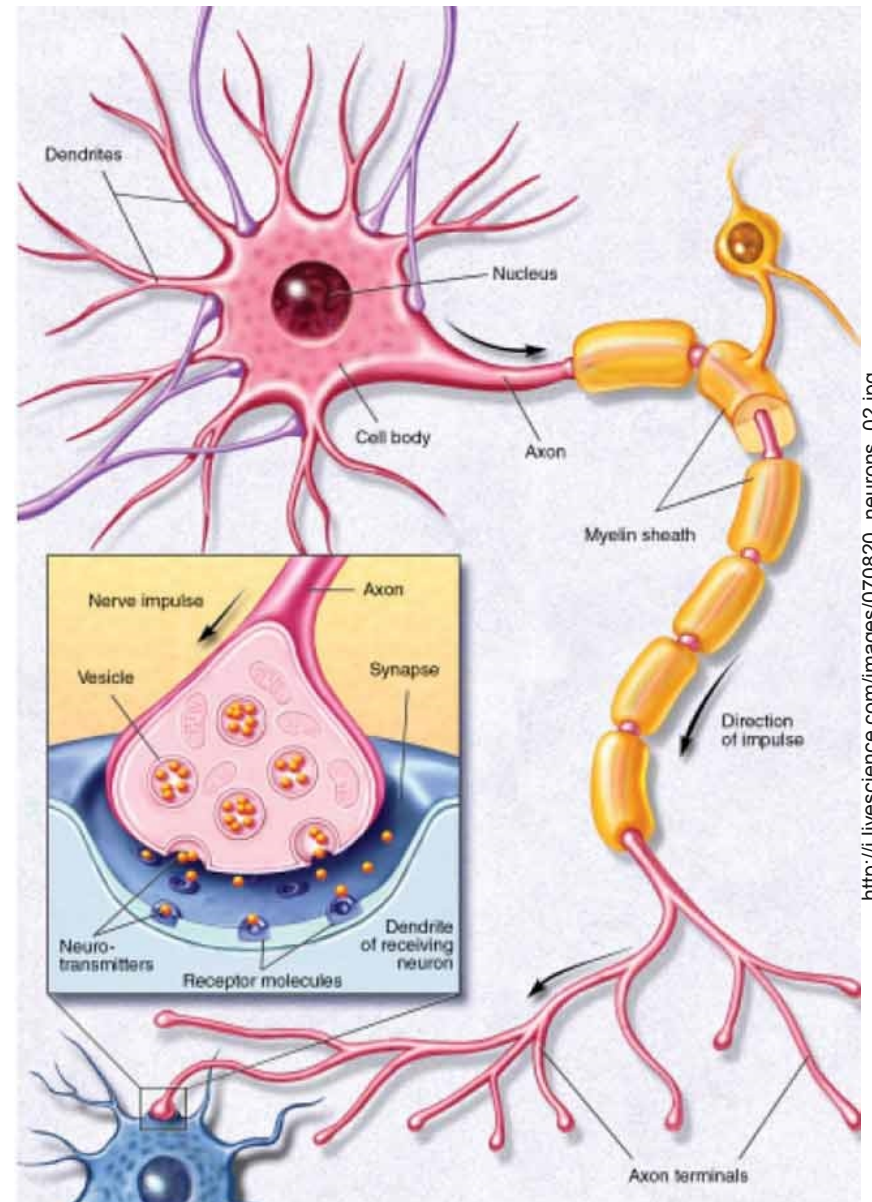
How neurons talk

- Input (dendrites)
- Output (axon)
- Spike Train instead of continuous current
- Speed of spikes in axons
    - 119m/s (muscles)
    - 76.2m/s (touch)
    - 0.61m/s (pain)

http://www.cellscience.com/reviews3/spikes.jpg

How fast do nerve impulses travel? www.pondicherry.com,2000.

Connectivity of neurons

- The brain has circa 10^9 neurons connections
- Neurons can have up to 1000 connections
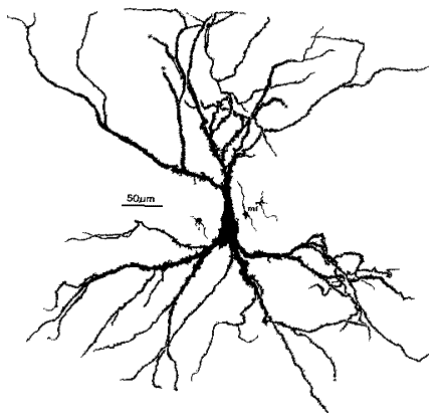 - Input from low abstract neurons to higher abstract neurons
    - Separated in layers

Visual Cortex

Different types of neurons
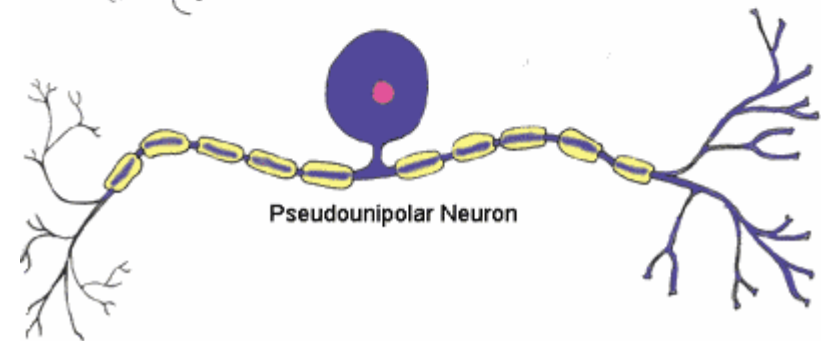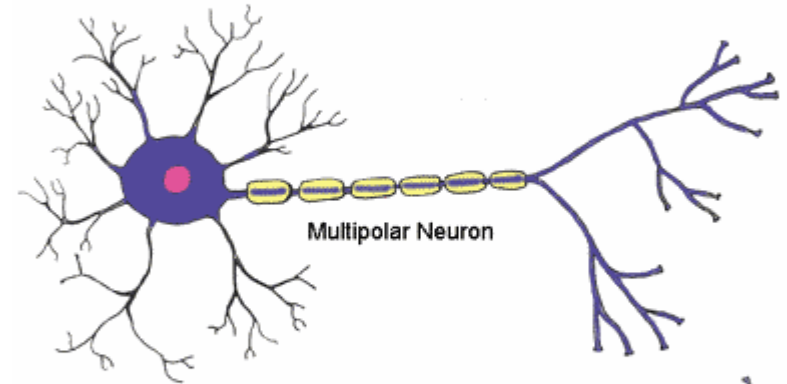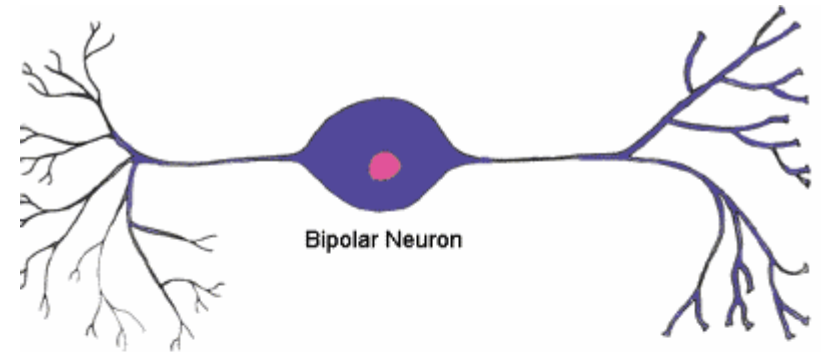
- Long axons
- Many branches

Pyramidal cell

Purkinje cell

http://upload.wikimedia.org/wikipedia/commons/5/51/Hippocampal-pyramidal-cell.png

http://upload.wikimedia.org/wikipedia/commons/thumb/1/15/PurkinjeCell.jpg/240px-PurkinjeCell.jpg

Bipolar Neuron

Multipolar Neuron

Pseudounipolar Neuron
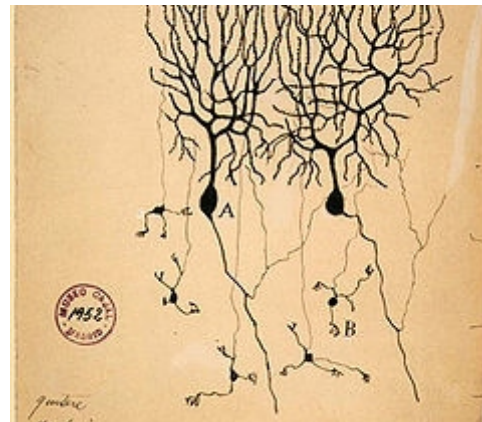
http://library.thinkquest.org/C0126536/neuron_type.gif

Neurotransmitter

- More than 100 in the human brain

- Inhibiting

  - In parkinson disease the inhibiting axons are lost

    – The person cannot stabilize their movements

  - Neurotransmitter: e.g. GABA

- Exciting

  - In schizophrenia some neurons are to receptive and create hallucinations
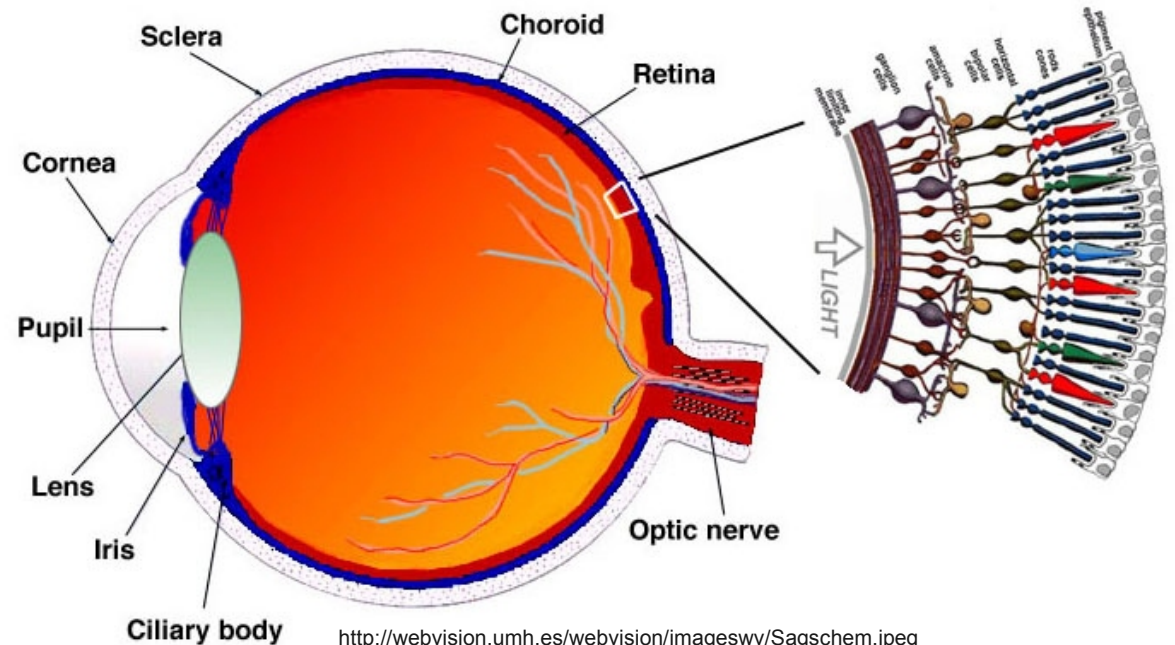
  - Neurotransmitter: e.g. Glutamate
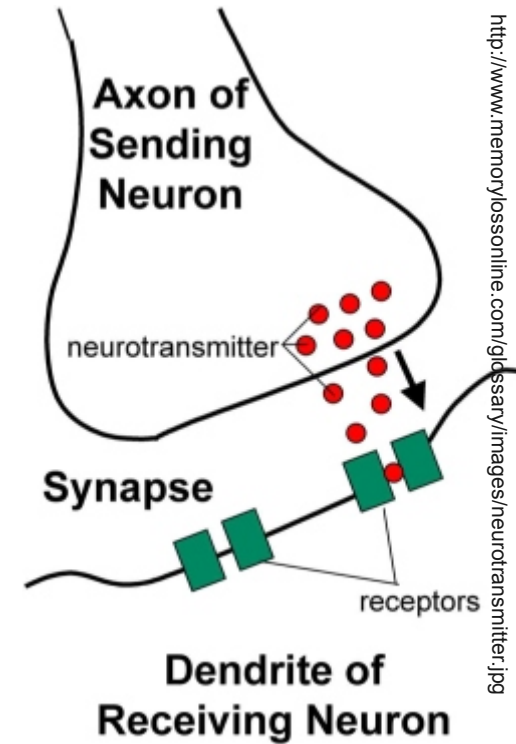
Shielded communication

- Myelin (a good shield)
  - For long range travel
    - Axon length up to 1m
  - Isolation of electric signal
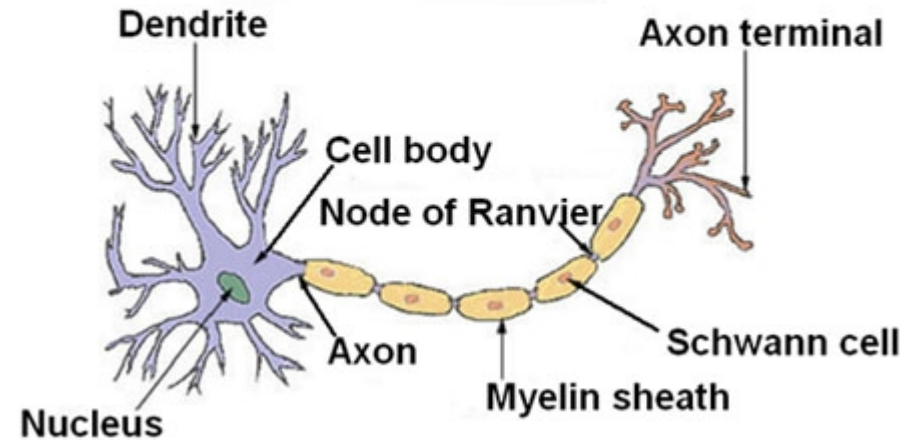
http://www.epilepsyresearch.org.uk/news/0810enews/nwasp_diagram.jpg

- Un-shielded
  - Short-range mass communication
  - e.g. in the retina

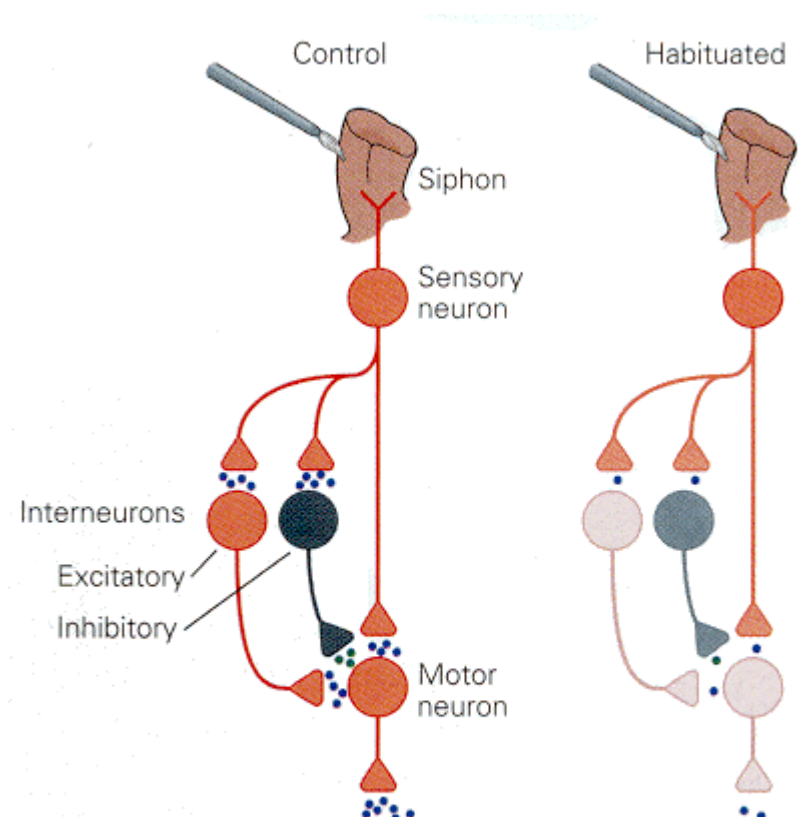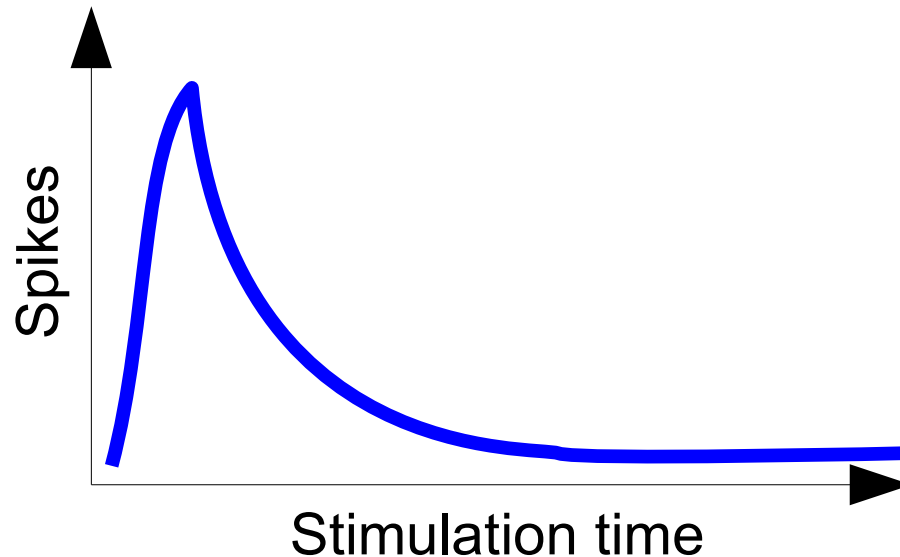http://webvision.umh.es/webvision/imageswv/Sagschem.jpeg

The role of habituation

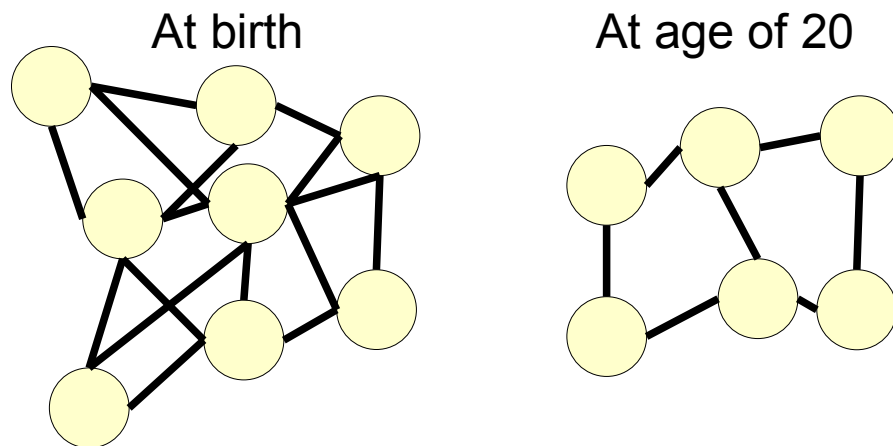- What happens if neurons are stimulated all the time
  - Implementation:
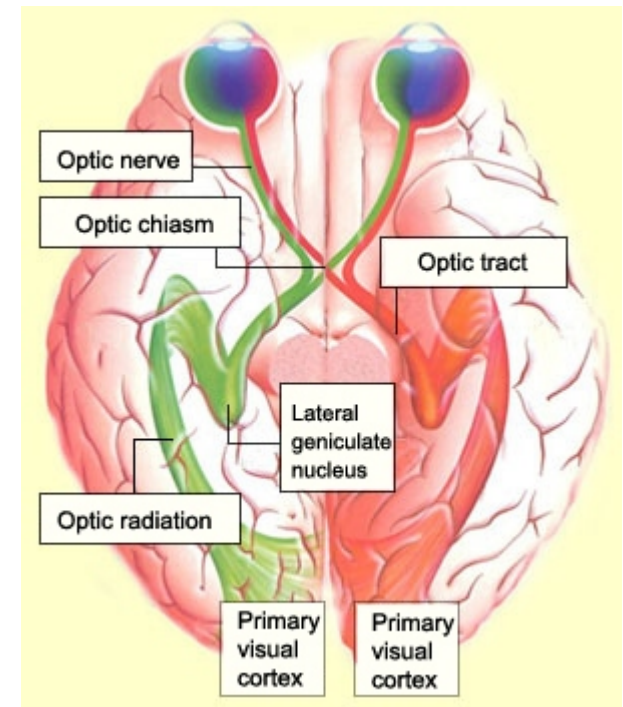   - The synapse just runs out of neurotransmitters

http://www.unmc.edu/physiology/Mann/pix_19/habituation.gif

Neural growth

- fetal growth of neurons follows markers of neurotrophines (food)
  - e.g. visual system (the optic nerve and optic radiation growth into right direction)
- Connectivity decreasing

The neural pathways of the visual system

Optic nerve
Optic chiasm
Optic tract
Lateral geniculate nucleus
Optic radiation
Primary visual cortex
Primary visual cortex

At birth

At age of 20

Artifical Brains

- CAM-Brain-Machine
  - 50,000 neural network modules connected
  - still less than 10^9 neurons of the human brain
  - FPGA
    - Field Programmable Gate Array

A FPGA element

http://retrothing.typepad.com/photos/un categorized/2008/04/10/minimig.jpg