NEURAL NETWORKS

-Taxonomies
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The brain - that's my second most favourite organ! (Woody Allen)

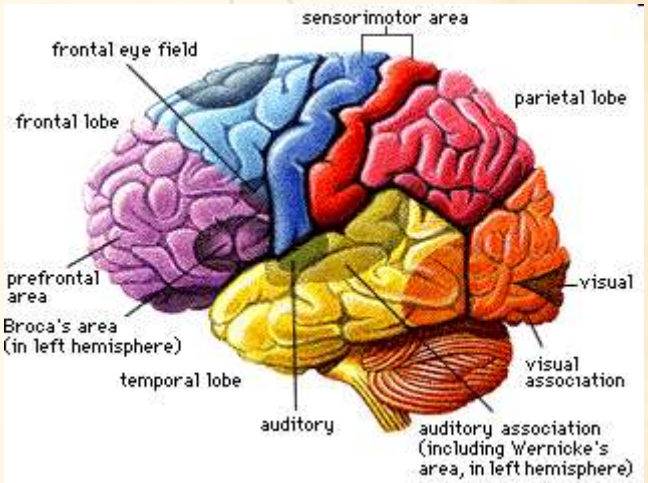
1. How does it work?

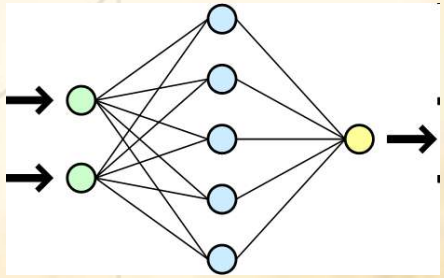
…it performs massively parallel computations extremely efficiently (For example, complex visual perception occurs within less than 100 ms, that is, 10 processing step)

…its performance tends to degrade gracefully under partial damage

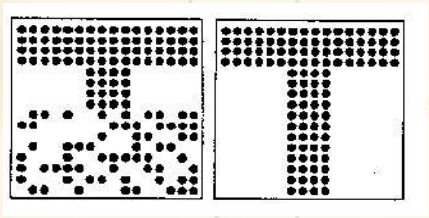
…it can learn from experience (this means that partial recovery from damage is possible if healthy units can learn to take over the functions previously carried out by the damaged areas)

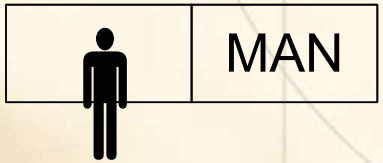
…it supports our intelligence and self-awareness (Nobody knows yet how this occurs)





2 Classifying neural net structures





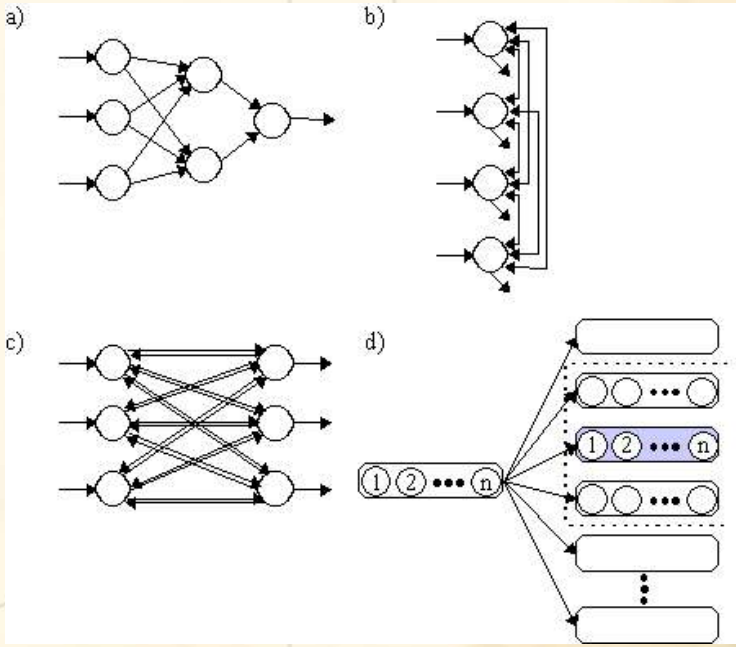
Recognizing patterns is what NN do best!

- **Classification**
- **Prediction**
- **Clustering**
- **Association**

2.1 Neural network types and tasks

The artificial neural networks can be classified according to the structure that they exhibit

c) Multi-layered feedforward network
d) Single-layered fully connected network
e) Two-layered feedforward/feedbackward network
f) Topographically organized vector map

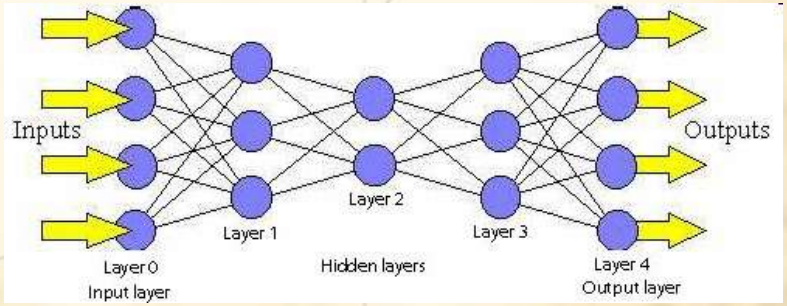


Feed-Forward network

1. Perceptrons are arranged in layers, with the first layer taking in inputs and the last layer producing outputs. The middle layers have no connection with the external world, and hence are called hidden layers.

2. Each perceptron in one layer is connected to every perceptron on the next layer. Hence information is constantly "fed forward" from one layer to the next., and this explains why these networks are called feed-forward networks.

3. There is no connection among perceptrons in the same layer.



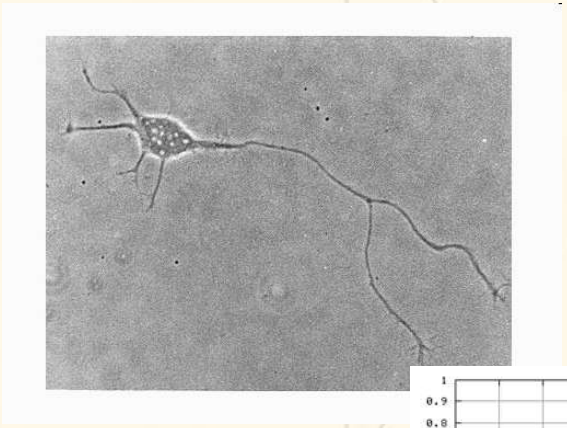
Summery: Neural network types and tasks

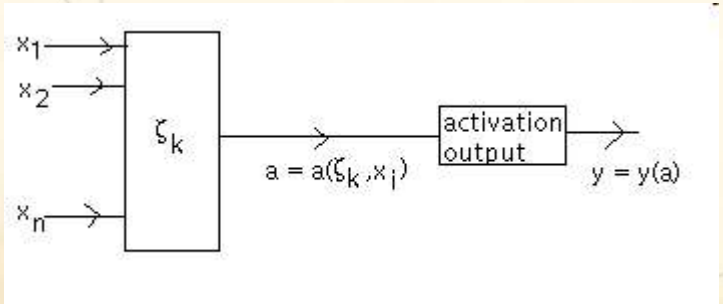
Network architecture	Tasks
Principally feedforward	▪ Classification ▪ Function interpolation
Principallu recurrent	▪ Associative memory ▪ Auto-association ▪ Noise filtering ▪ CAM ▪ Hetero-association
Competitive	▪ Cluster template formation ▪ Analysis of topological relationships

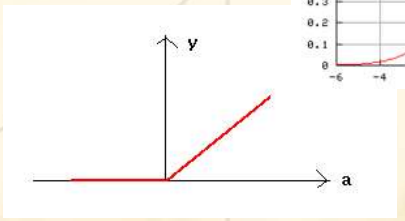
2.2 A taxonomy of artificial neurons

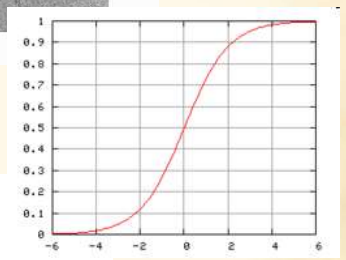
Adaline:

- inputs
- outputs
- weights
- threshold function









Criteria for classification

What was done for nodes in the last section is now done for net structures, so that the following is proposed as a set of attributes for net classification.

- Basic net topology: Recurrent , competitive, or feedforward.
- Hidden units: present - absent.
  - In case of feedforward net: layerd – not layerd
- Connectivity: complete - incomplete
- Dynamics: Synchronous - asynchronous.

2.3 A taxonomy of training algorithms

- Supervised
  - Complex signal fedback (backpropogation)
  - Simple signal fedback (R-P)
- Unsupervised (self-organized)
- Weights given by formulaic prescription (reinforcement learning)

3 Historical Background

The concept of neural networks started in the late-1800s as an effort to describe how the human mind performed.

First Attempts

- » Early 60es, McCulloch and Pitts - Simple logic functions

Promising & Emerging Technology

- » 1958, Rosenblatt – Perceptron
- » 1960 , Widrow and Hoff – ADALINE

Period of Frustration & Disrepute

- » 1969 Minsky and Papert - multilayered systems

Innovation

- » 1972, Henry Klopf – Learning basics
- » 1974 , Paul Werbos – Backpropagation
- » Fukushima - interpretation of handwritten characters (1975 Cognitron)

4 Neural Net VS Conventional Computers

Conventional computers:

- use an algorithmic approach (follow a set of instructions in order to solve a problem)
- specific steps must be welldefined
- must be given exactly how to solve a problem.

Neural networks:

- information is processed in much a similar way the human brain does
- consists of a large amounts of highly interconnected processing elements which works in parallel to solve a specific problem
- can self-study by examples but cannot be programmed to perform a specific task
- the examples must be selected carefully to be functioning incorrectly

Parallelism is NNs characteristics, because the computations of its components are largely independent of each other.

Neural networks and conventional algorithmic computers are not in competition but complement each other.

The von Neumann Machine and the Symbolic Paradigm

1. fetch an instruction from memory.
2. fetch any data required by the instruction from memory.
3. execute the instruction (process the data).
4. store results in memory. go back to step 1).

```
if (IsTired()) {
        GoToSleep();
} else {
        StayAwake();
}
```

Neural net VS von Neumann

```
if (IsTired()) {
        if (!IsInClass() && !WorkingOnProject()) {
            GoToSleep();
        } else {
            if (IsInClass()) {
                        Stay Awake();
            } else {
                        if (WorkingOnProject()) {
                                    if (AssignmentIsDueTomorrow()) {
                                                if (AssignmentIsCompleted()) {
                                                            GoToSleep();
                                                } else {
                                                            StayAwake();
                                                }
```

…

5 Neural Networks in Practice

MEDICINE

- sales forecasting
- industrial process control
- customer research
- data validation
- risk management
- target marketing

BUSINESS