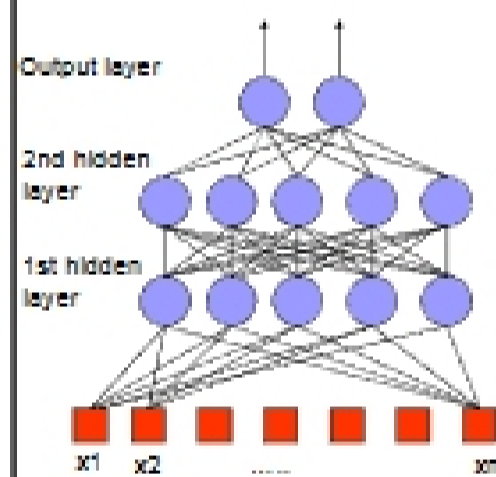


Various Neural Networks

Neural Networks

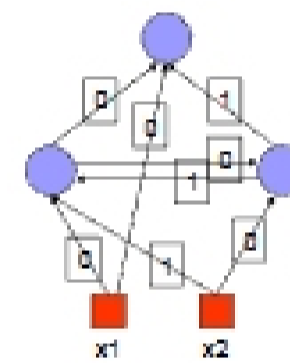
- A mathematical model to solve engineering problems
 - Group of connected neurons to realize compositions of non linear functions
- Tasks
 - Classification
 - Discrimination
 - Estimation
- 2 types of networks
 - Feed forward Neural Networks
 - Recurrent Neural Networks

Feed Forward Neural Networks



- The information is propagated from the inputs to the outputs
- Computations of functions from n input variables by compositions of algebraic functions
- Time has no role (NO cycle between outputs and inputs)

Recurrent Neural Networks



- Can have arbitrary topologies
- Can model systems with internal states (dynamic ones)
- Delays are associated to a specific weight
- Training is more difficult
- Performance may be problematic
 - Stable Outputs may be more difficult to evaluate
 - Unexpected behavior (oscillation, chaos, ...)

Properties of Neural Networks

- Supervised networks are universal approximators networks)
- Theorem : Any limited function can be approximated by a neural network with a finite number of hidden neurons to an arbitrary precision

Supervised learning

- The desired response of the neural network in function of particular inputs is well known.
- A "Professor" may provide examples and teach the neural network how to fulfill a certain task

Unsupervised learning

- Idea : group typical input data in function of resemblance criteria un-known a priori
- Data clustering
- No need of a professor
 - The network finds itself the correlations between the data
 - Examples of such networks :
 - Kohonen feature maps

Classification (Discrimination)

- Class objects in defined categories
 - Rough decision OR
 - Estimation of the probability for a certain object to belong to a specific class
- Example : Data mining
- Applications : Economy, speech and patterns recognition, sociology, etc.

Example

65473 60198 68544
 70065 70117 14032 9720
 27260 61820 19559
 74136 19137 03101
 20878 60521 38002
 48640-2398 20907 14862

Examples of handwritten postal codes
 drawn from a database available from the US Postal service

What needed to create NN ?

- Determination of relevant inputs
- Collection of data for the learning and testing phases of the neural network
- Finding the optimum number of hidden nodes
- Learning the parameters
- Evaluate the performances of the network
- If performances are not satisfactory then review all the precedent points

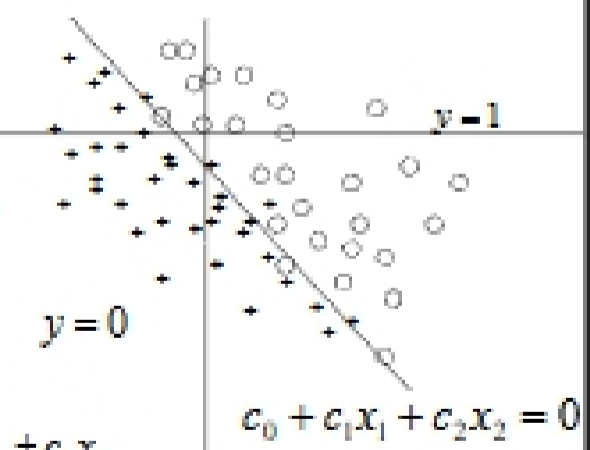
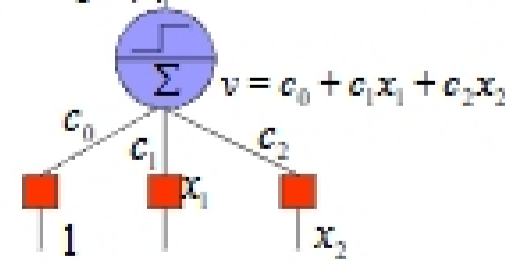
Popular neural architectures

- Perceptron
- Multi-Layer Perceptron (MLP)
- Radial Basis Function Network (RBFN)
- Time Delay Neural Network (TDNN)
- Other architectures

Perceptron

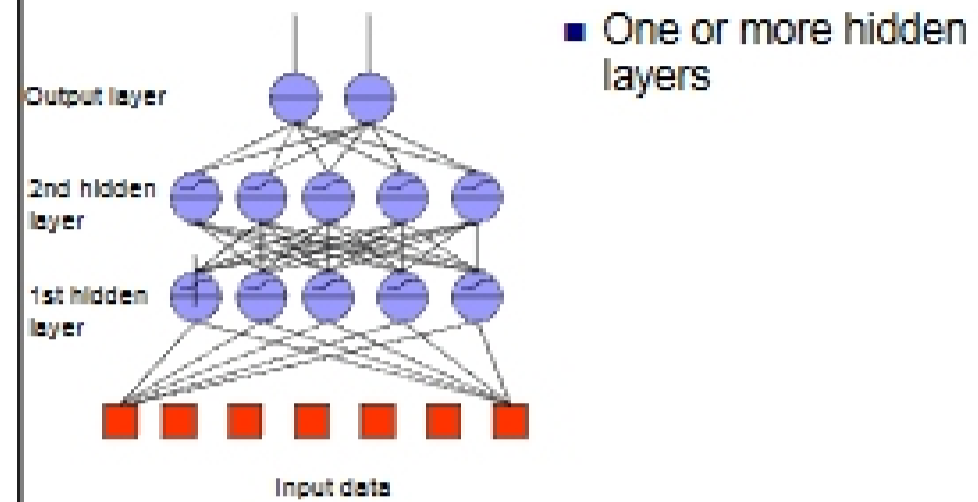
- Rosenblatt (1962)
- Linear separation
- Inputs : vector of real values
- Outputs : 1 or -1

$$y = \text{step0}(v)$$



- The perceptron algorithm converges if examples are linearly separable

Multi-Layer Perceptron



Different non linearly separable problems

Structure	Types of Decision Regions	Exclusive-OR Problem	Classes with Masked regions	Most General Region Shapes
Single-Layer 	Half Plane Bounded By Hyperplane			
Two-Layer 	Convex Open Or Closed Regions			
Three-Layer 	Arbitrary (Complexity Limited by No. of Nodes)			

Radial Basis Functions

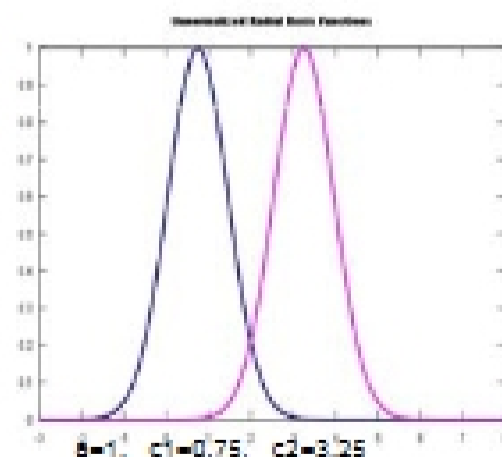
- A radial basis function (RBF) is a real-valued function whose value depends only on the distance from some other point c , called a center, $\phi(\mathbf{x}) = f(\|\mathbf{x}-\mathbf{c}\|)$
- Any function ϕ that satisfies the property $\phi(\mathbf{x}) = f(\|\mathbf{x}-\mathbf{c}\|)$ is a radial function.
- The distance is usually the Euclidean distance

$$\|\mathbf{x}-\mathbf{c}\|^2 = \sum_{i=1}^N (x_i - c_i)^2$$

Radial Basis Functions

- The popular output of radial basis functions is the Gaussian function:

$$\Phi(\|\mathbf{x}-\mathbf{c}_j\|) = \exp\left(-\alpha\left(\frac{\|\mathbf{x}-\mathbf{c}_j\|}{\sigma_j}\right)^2\right)$$



Radial Basis Functions Network (RBFN)

- Features
 - One hidden layer
 - The activation of a hidden unit is determined by a radial basis function

