-Artificial Neural Network-
Chapter 2 Basic Model

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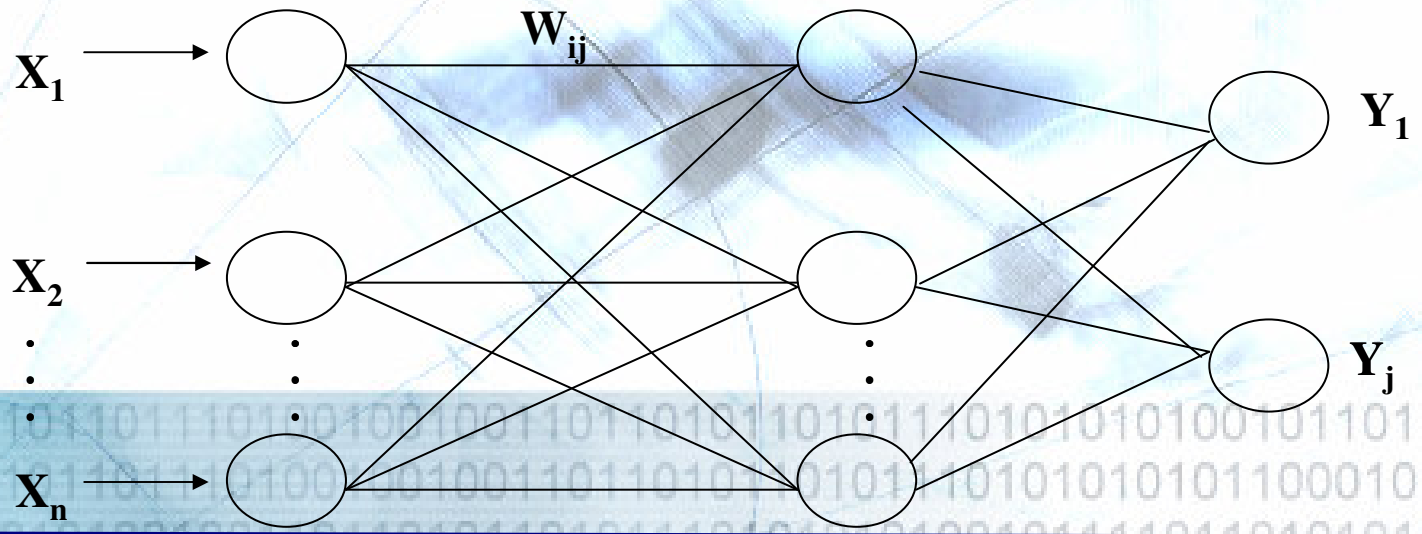
Introduction to ANN Basic Model

1. Input layer
2. Hidden layer
3. Output layer
4. Weights
5. Processing Element(PE)
6. Learning
7. Recalling
8. Energy function

ANN Components (1/4)

1. Input layer:$[X_1,X_2,.....X_n]^t$, where t means vector transpose.
2. Hidden layer: I_j => net_j => Y_j
3. Output layer:Y_j
   - Three ways of generating output: normalized, competitive output, competitive learning
4. Weights :W_{ij} means the connection value between layers



ANN Components (2/4)

5. Processing Element(PE)

(A)Summation Function: $I_j = \sum_i W_{ij} X_i$ **(supervised)**

or $I_j = \sum_i (X_i - W_{ij})^2$ **(unsupervised)**

(B)Activity Function: $net_j = I_j^n$ **or** $net_j^n = I_j^n + C \times net_j^{n-1}$

or $net_j = I_j^n + C \times I_j^{n-1}$

(C)Transfer Function:

1. **Discrete type**
2. **Linear type**
3. **Non-linear type**

ANN Components (3/4)

6. Learning:

- **Based on the ANN model used, learning is to adjust weights to accommodate a set of training pattern in the network.**

7. Recalling:

- **Based on the ANN model used, recalling is to apply the real data pattern to the trained network so that the outputs are generated and examined.**

ANN Components (4/4)

8. Energy function:

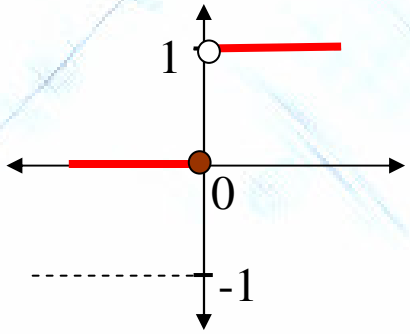
- **Energy function is a verification function which determines if the network energy has converged to its minimum. Whenever the energy function approaches to zero, the network approaches to its optimum solution.**

Transfer Functions (1/3)

- **Discrete type transfer function:**

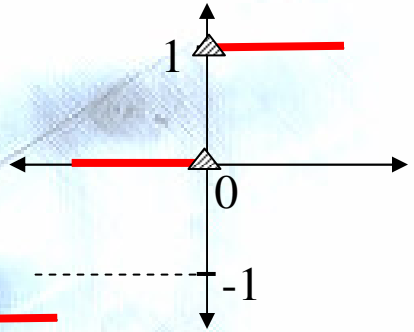
$$Y_j = \begin{cases} 1 & \text{if } net_j > 0 \\ 0 & \text{if } net_j <= 0 \end{cases}$$

Step function or perceptron fc.



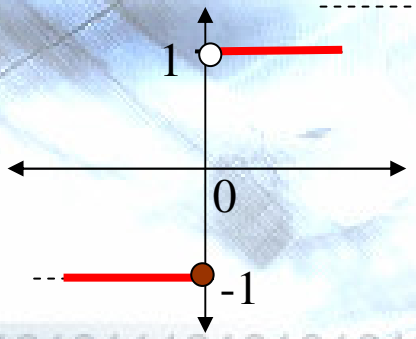
$$Y^n_j = \begin{cases} 1 & \text{if } net_j > 0 \\ Y^{n-1}_j & \text{if } net_j = 0 \\ 0 & \text{if } net_j < 0 \end{cases}$$

Hopfield-Tank fc.



$$Y_j = \begin{cases} 1 & \text{if } net_j > 0 \\ -1 & \text{if } net_j <= 0 \end{cases}$$

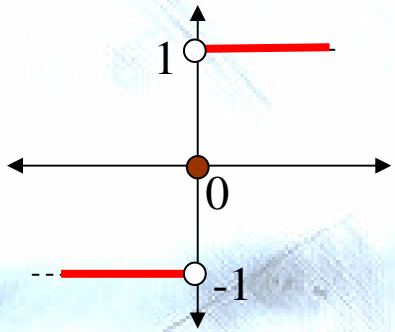
Signum fc.



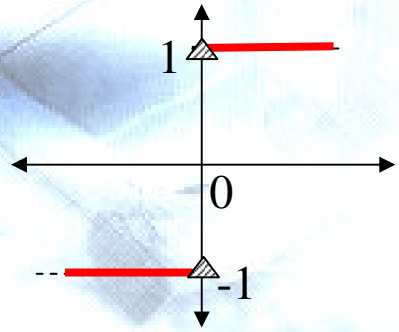
Transfer Functions (2/3)

- **Discrete type transfer function:**

$$Y_j = \begin{cases} 1 & net_j > 0 \\ 0 & \text{if } net_j = 0 \\ -1 & net_j < 0 \end{cases} \quad \text{Signum0 fc.}$$



$$Y^n_j = \begin{cases} 1 & net_j > 0 \\ Y^{n-1}_j & \text{if } net_j = 0 \\ -1 & net_j < 0 \end{cases} \quad \text{BAM fc.}$$



Transfer Functions (3/3)

- Linear type:

$$Y_j = net_j$$

$$Y_j = \begin{cases} net_j & net_j > 0 \\ & \text{if} \\ 0 & net_j <= 0 \end{cases}$$

- Nonlinear type transfer function:

$$Y_j = \frac{1}{1 + \ell^{-net_j}} \quad \text{Sigmoid function}$$

$$Y_j = \frac{\ell^{net_j} - \ell^{-net_j}}{\ell^{net_j} + \ell^{-net_j}} \quad \text{Hyperbolic Tangent function}$$

Energy function

(a) The energy function for supervised network learning:

$$E = \frac{1}{2}\sum_{j}\left(T_j - Y_j\right)^2$$ **where E is the energy value**

$$\Delta W = -\eta \cdot \frac{\partial E}{\partial W_{ij}}$$ **this is the value for adjusting weight W_{ij}**

(b) The energy function for unsupervised network learning:

$$E = \frac{1}{2}\sum_{i}\left(X_i - W_{ij}\right)^2$$

$$\Delta W = -\eta \cdot \frac{\partial E}{\partial W_{ij}}$$ **this is the value for adjusting weight W_{ij}**