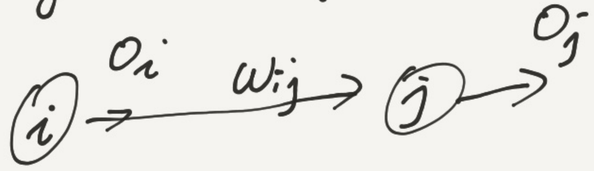
Lecture 12. MLP, autoencoder, and SOM

1. Hebb's Rule.

① if two neurons always fire simultaneously, then their connection should become stronger.

② If they never fire simultaneously, their connection will die away.



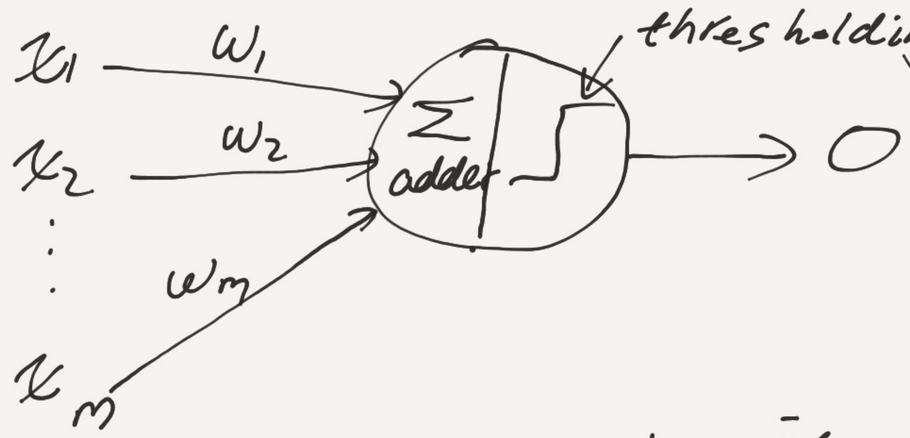
O_i	O_j	w_{ij}
1	1	↑ (increase)
−1	−1	↑
−1	1	↓ (decrease)
1	−1	↓

$$w_{ij} = w_{ij} + \underbrace{2}_{>0} \cdot o_i \cdot o_j$$

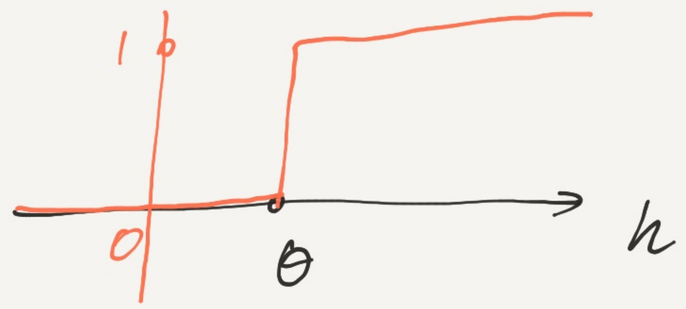
2. M-P model (1943)

(McCulloch & Pitts)

① First mathematical model nerons.

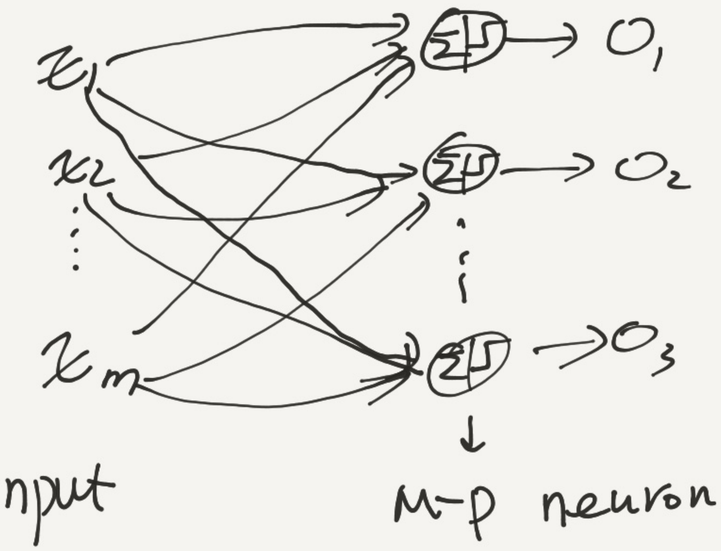


$$O = \begin{cases} 1 & \text{if } h = \sum w_i x_i > \theta \text{ (threshold)} \\ 0 & \text{if } h \le \theta \end{cases}$$



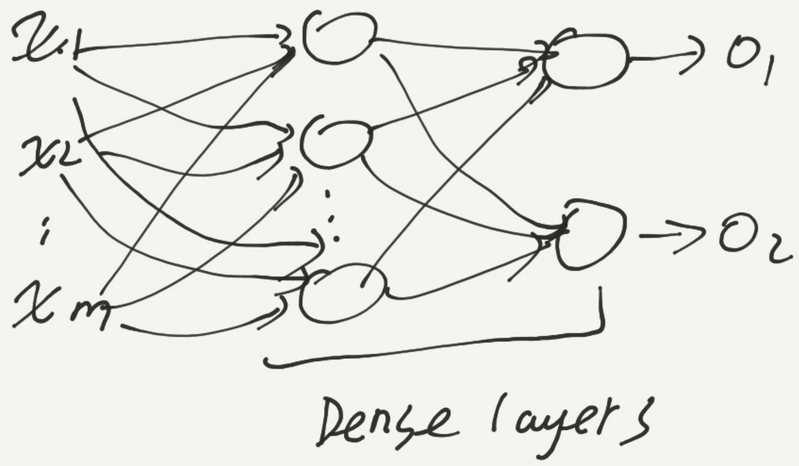
3. Perception Networks

⊙ Collection of M-p neurons / 2-layer Network



4. Multi-layer perception (MLP) networks / Fully connected networks

FC



Error-correction training

① Feed forward. network.

② no connection among neurons in the same layer.

③ Full connections between neurons from two neighboring layers.

5. Self-organizing map (SOM)

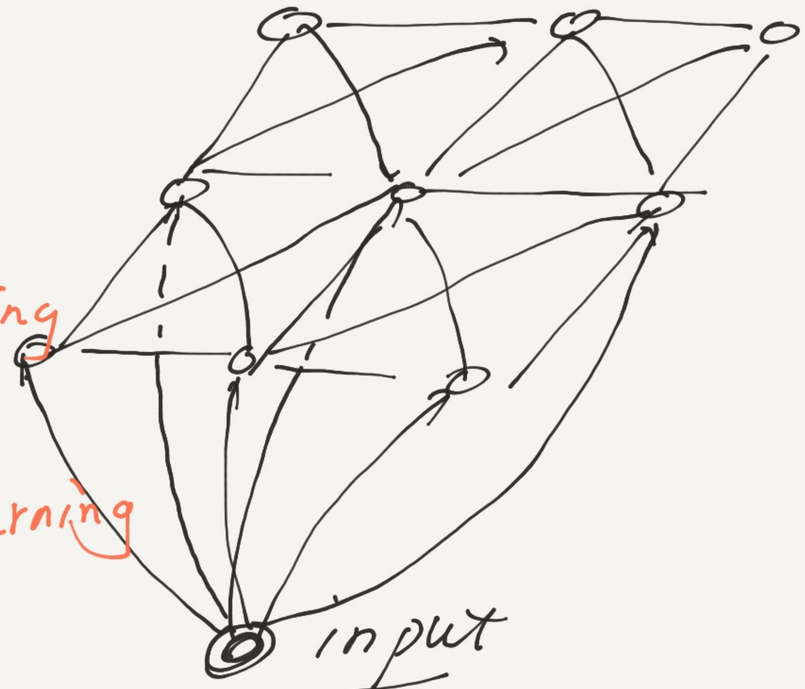
① Teuvo Kohonen in 1980s. Kohonen network.

② unsupervised learning network to produce low-dimensional representations of a high-dimensional data set. while preserve the topological structure of the data.

③ Network architecture.

- 1. layer of 2D Grid.

SOM grid.



④ Weight matrix

$$U = \{u_{ij}\}_{M \times N}$$

⑥. Competitive learning rather than the error-correction learning ($M \ll N$)

M: # nodes. / neurons

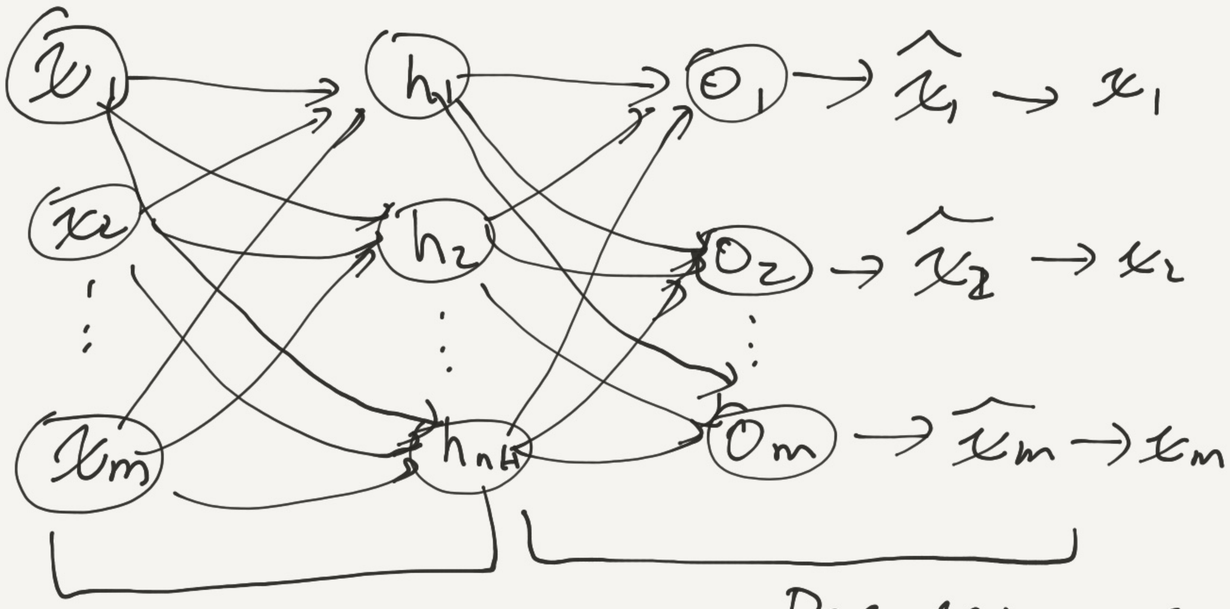
⑤ neuron feedback: $w = \{w_{ij}\}_{M \times M}$

6. Autoencoder Network.

① unsupervised NN.

② feed forward.

$n_H << m$



Encoder
convert high-dimensional data to low-dim. data.

Decoder: reconstruct original high-dim data using the low-dim. features.

③ We still can use the GD/SGD + BP to train this nn.

④ Dimensionality reduction algo. & anomaly detection. algo. ★