



NEURAL NETWORK

1.

Neural network

Neural network được xây
dựng từ ý tưởng mô phỏng
mạng neuron sinh học

“

1. Mạng neural network được xây dựng dựa trên ý tưởng mô phỏng cấu trúc và hoạt động của mạng neuron sinh học



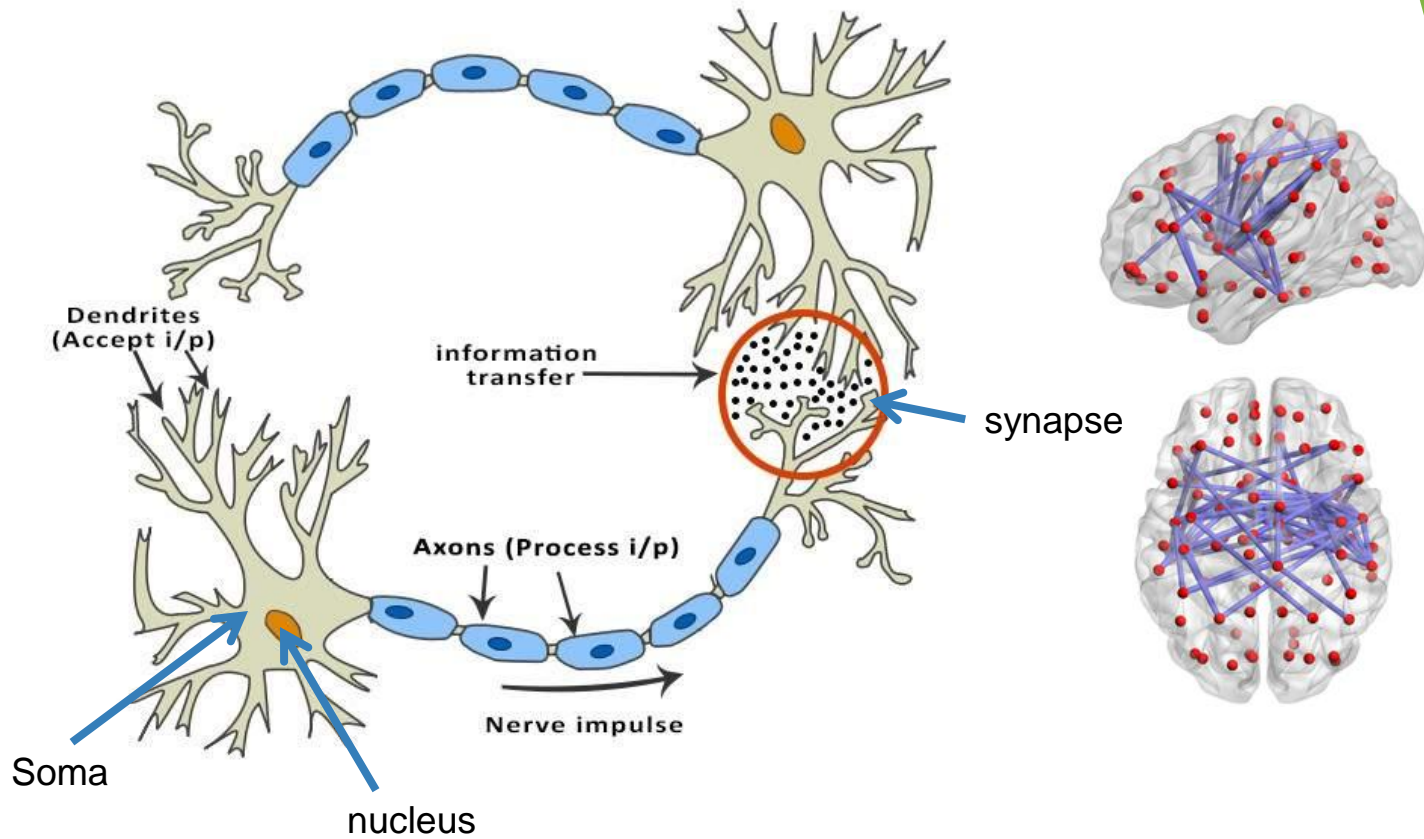
TODAY'S TASKS

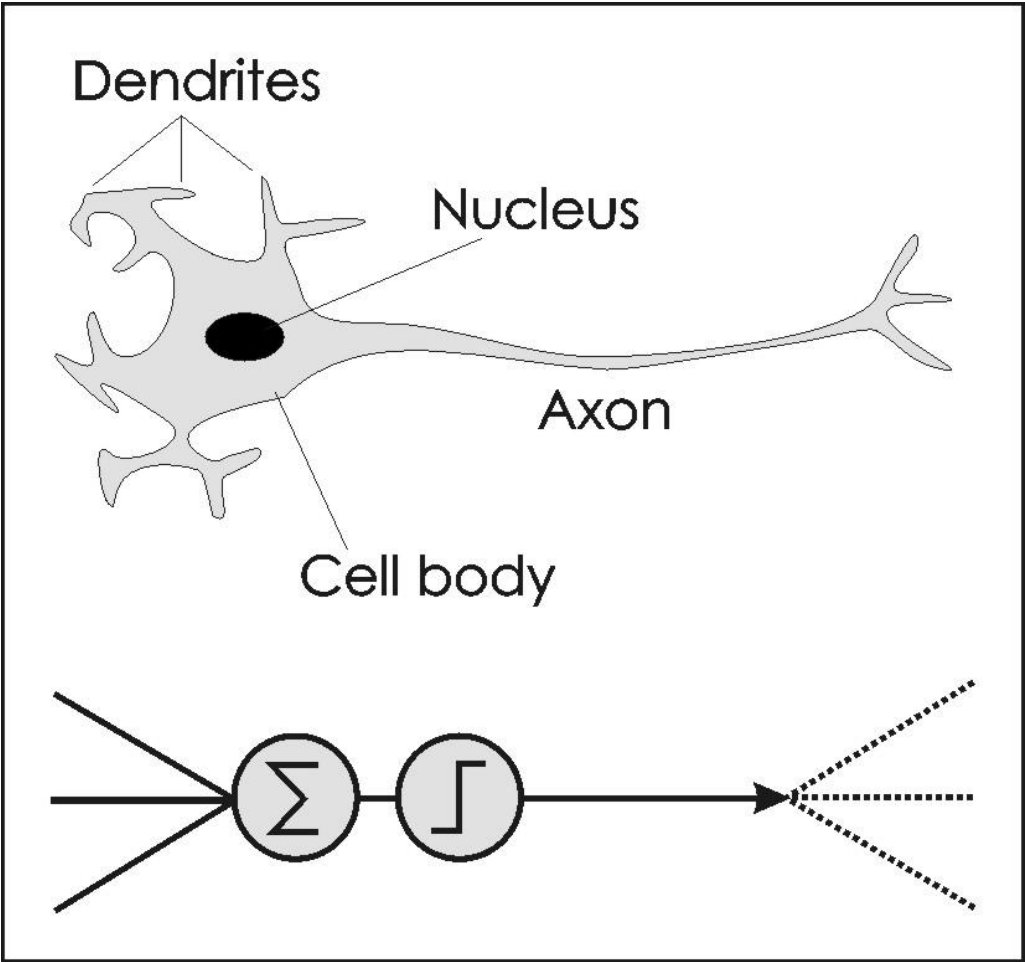
- ▶ Cấu trúc của mạng neural network.
- ▶ Concepts: perceptron, weights, bias, activation function, layers
- ▶ Xây dựng một perceptron
- ▶ Back-propagation
- ▶ Các mô hình neural networks
- ▶ Sử dụng neural network model trong sklearn



BIOLOGICAL NEURAL NETWORK

Biological neural network là mạng lưới của các neurons



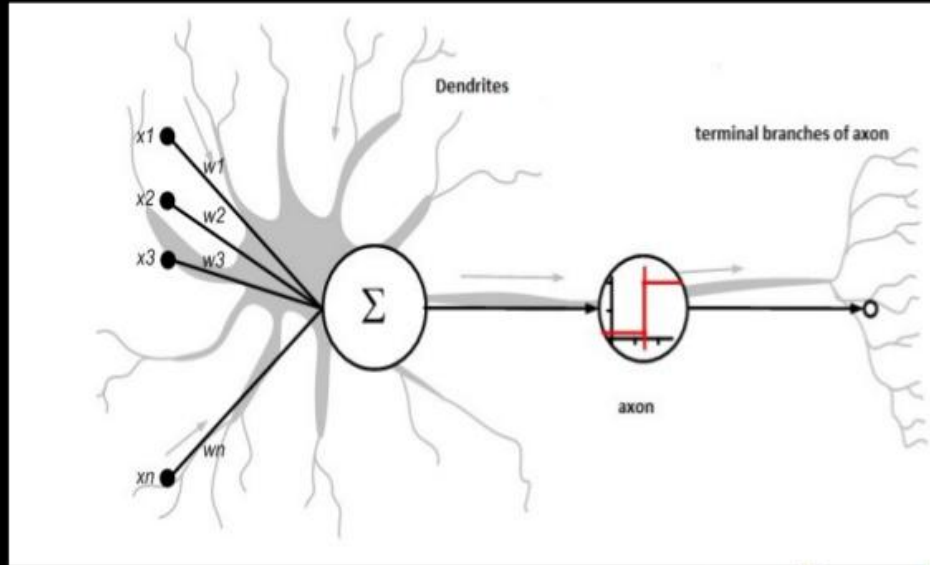




PERCEPTRON

Perceptron là một processing unit trong mạng artificial neural network

Biologically Inspired Neuron



Perceptron mô phỏng cấu trúc và hoạt động của neuron

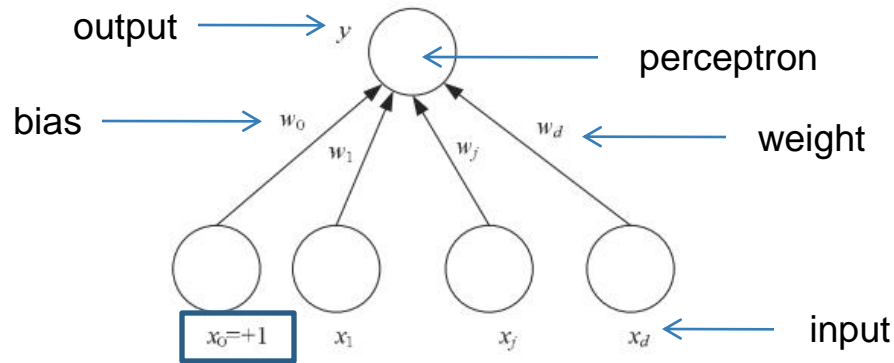
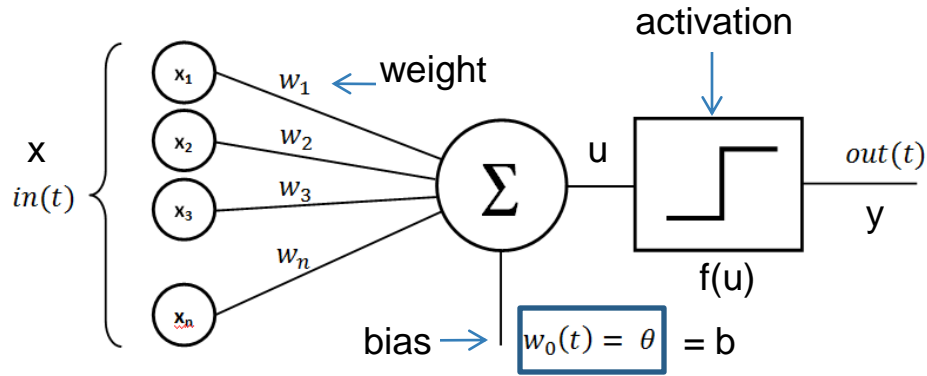


Figure 11.1 Simple perceptron. $x_j, j = 1, \dots, d$ are the input units. x_0 is the bias unit that always has the value 1. y is the output unit. w_j is the weight of the directed connection from input x_j to the output.

x – input
 y – output
 w – weight
 w_0 – bias (b)

$$y = wx + b$$



$f(u)$ is a non-linear function. E.g. sigmoid, tanh ...
 f is called activation function

$$u = wx + b$$

$$f(u) = \frac{1}{1 + e^{-u}}$$

$$y = f(u) = \frac{1}{1 + e^{-u}} = \frac{1}{1 + e^{-wx+b}}$$



NEURAL NETWORK

Artificial neural network (ann) là mạng lưới của các perceptron (mô phỏng một neuron)

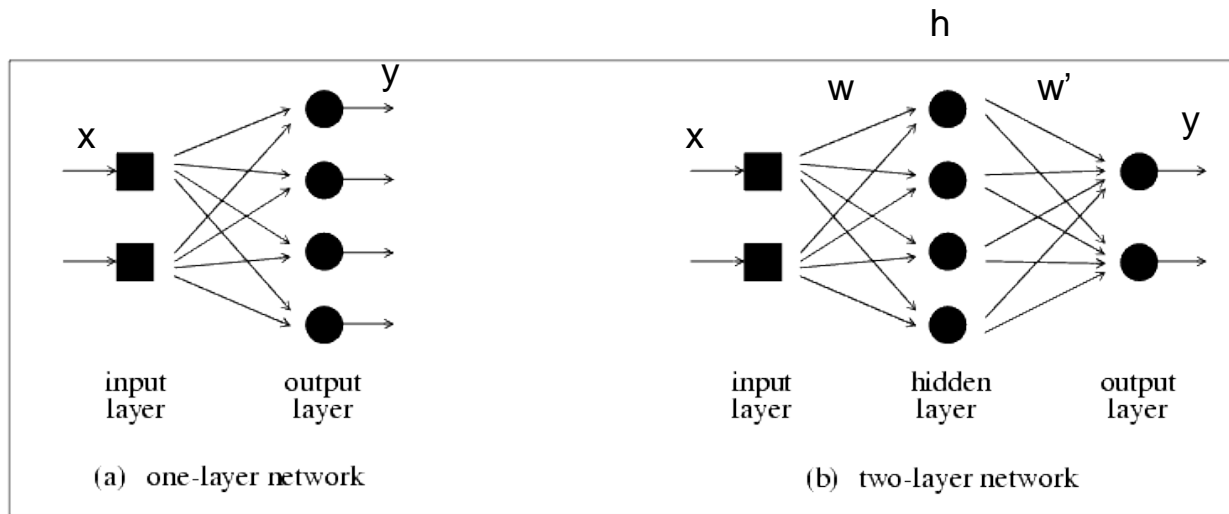
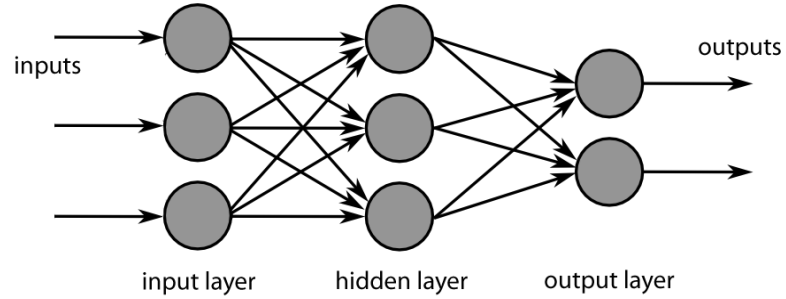


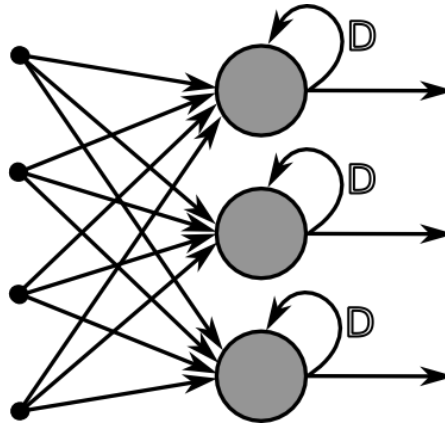
Figure 3 Simple feedforward artificial neural networks.

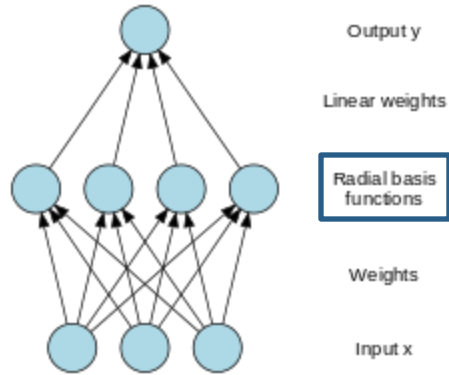
- Neural network được xây dựng lên từ nhiều các perceptron
- Các perceptron nhận cùng một input tạo lên một tầng (layer)
- Mạng neural network có thể gồm 1 tầng (one-layer) hay nhiều tầng (multi-layer)

Feed forward
Neural network

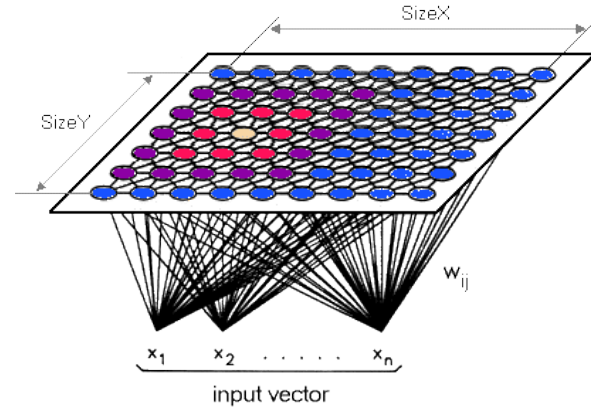


Feedback
Neural network

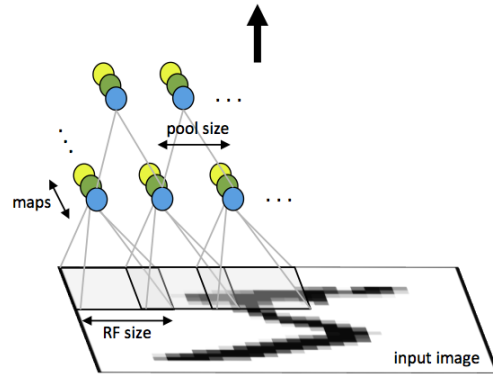




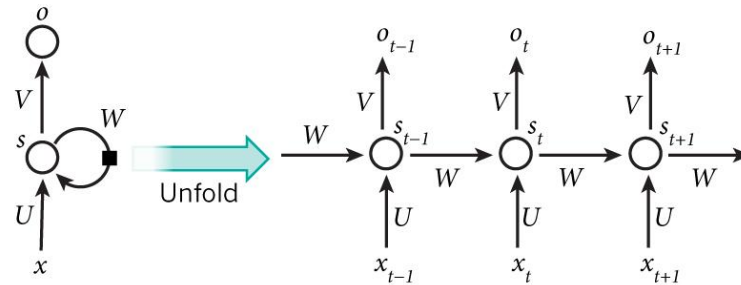
RBF radial basis function



SOM self organizing map



CNN convolution neural network



RNN recurrent neural network



BACK PROPAGATION

Artificial neural network (ann) là mạng lưới của các perceptron
(mô phỏng một neuron)



Train a perceptron

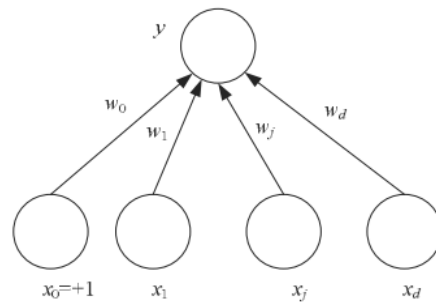
► Regression

$$E^t(\mathbf{w}|\mathbf{x}^t, r^t) = \frac{1}{2}(r^t - y^t)^2 = \frac{1}{2}[r^t - (\mathbf{w}^T \mathbf{x}^t)]^2$$

Error

$$\Delta \mathbf{w}_j^t = \eta(r^t - y^t)x_j^t$$

Update value



► Classification

$$r_i^t = 1 \text{ if } \mathbf{x}^t \in C_1 \text{ and } r_i^t = 0 \text{ if } \mathbf{x}^t \in C_2$$

Target value

$$y^t = \text{sigmoid}(\mathbf{w}^T \mathbf{x}^t)$$

$$E^t(\mathbf{w}|\mathbf{x}^t, r^t) = -r^t \log y^t - (1 - r^t) \log(1 - y^t)$$

Cross-entropy

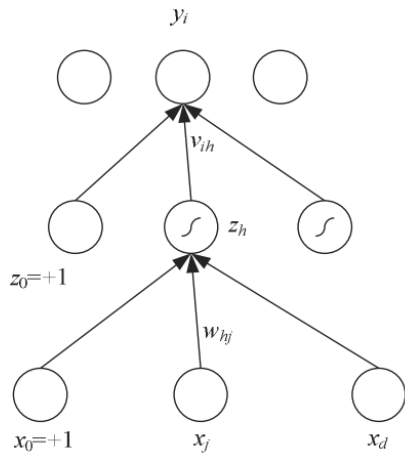
$$\Delta \mathbf{w}_j^t = \eta(r^t - y^t)x_j^t$$

Update value

Stochastic gradient descent



Multi-layer perceptrons

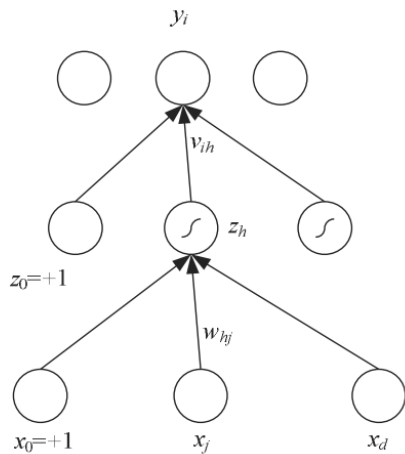


$$y_i = \mathbf{v}_i^T \mathbf{z} = \sum_{h=1}^H v_{ih} z_h + v_{i0}$$

$$z_h = \text{sigmoid}(\mathbf{w}_h^T \mathbf{x}) = \frac{1}{1 + \exp \left[- \left(\sum_{j=1}^d w_{hj} x_j + w_{h0} \right) \right]}, \quad h = 1, \dots, H$$



Back propagation



$$\frac{\partial E}{\partial w_{hj}} = \frac{\partial E}{\partial y_i} \frac{\partial y_i}{\partial z_h} \frac{\partial z_h}{\partial w_{hj}}$$

Gradient descent

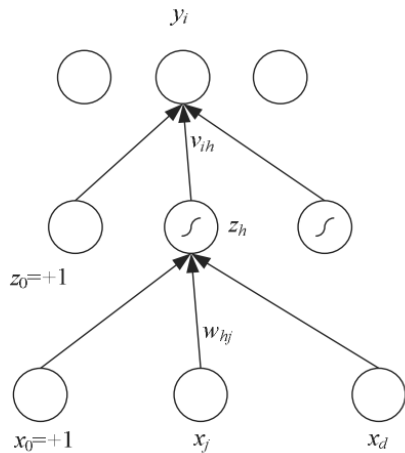
$$y^t = \sum_{h=1}^H v_h z_h^t + v_0$$

$$E(\mathbf{W}, \mathbf{v} | \mathcal{X}) = \frac{1}{2} \sum_t (r^t - y^t)^2$$

$$\Delta v_h = \eta \sum_t (r^t - y^t) z_h^t$$



Back propagation



$$\begin{aligned}\Delta w_{hj} &= -\eta \frac{\partial E}{\partial w_{hj}} \\&= -\eta \sum_t \frac{\partial E^t}{\partial y^t} \frac{\partial y^t}{\partial z_h^t} \frac{\partial z_h^t}{\partial w_{hj}} \\&= -\eta \sum_t \underbrace{-(r^t - y^t)}_{\partial E^t / \partial y^t} \underbrace{v_h}_{\partial y^t / \partial z_h^t} \underbrace{z_h^t (1 - z_h^t) x_j^t}_{\partial z_h^t / \partial w_{hj}} \\&= \eta \sum_t (r^t - y^t) v_h z_h^t (1 - z_h^t) x_j^t\end{aligned}$$