

IFA-305 Sistem Cerdas (Intelligent System) Lecture 3

Introduction to Neural Networks

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Motivation of Neural Network

- Motivation: human brain computes in an entirely different way from conventional digital computers.
- The brain is highly complex, nonlinear, and parallel computer.

Note:

Compute : process information Computer : information-processing system



Example: Human Vision

- A human vision is an information-processing system to provide a visual representation of the environment around us.
- The brain routinely accomplishes perceptual recognition tasks (e.g., recognizing a familiar face in an unfamiliar scene) in approximately 100–200 ms, whereas tasks of much lesser complexity take a great deal longer on a powerful computer).



How Does the Brain Work ?

- At birth, a brain already has considerable structure and the ability to build up its own rules of behavior through what we usually refer to as "experience."
- Indeed, experience is built up over time, with much of the development (i.e., hardwiring) of the human brain taking place during the first two years from birth, but the development continues well beyond that stage.



Nervous System



- The brain continually receives information, perceives it, and makes appropriate decisions.
- Two sets of arrows are shown in the figure:
 - Forward transmission
 - Feedback in the system.
- The *receptors* convert stimuli from the human body or the external environment into electrical impulses that convey information to the brain.
- The *effectors* convert electrical impulses generated by the neural net into discernible responses as system outputs.



Nervous System vs Computer





Human Brain





Human Brain

Processing element of brain is known as neuron.





Neural Network as an Adaptive Machine®

- A neural network is a massively parallel distributed processor made up of simple processing units that has a natural propensity for storing experiential knowledge and making it available for use.
- It resembles the brain in two respects:
 - 1. Knowledge is acquired by the network from its environment through a learning process.
 - 2. Interneuron connection strengths, known as synaptic weights, are used to store the acquired knowledge.

Artificial Neural Network



- Commonly referred to as "neural networks".
- A neural network is a machine that is designed to *model* the way in which the brain performs a particular task or function of interest.
- The neural network is usually implemented by using electronic components or is simulated in software on a digital computer.



Model of Neuron





Elements of Neuron Model



- A set of *synapses*, each synapse is characterized by a *weight* to strength the input signals.
- An *adder* for summing the weighted input signals.
- An *activation function* for limiting the amplitude of the output of a neuron
- A *bias* for increasing or lowering the net input of the activation function.



Mathematical Model of Neuron



$$v_k = \sum_{j=1}^m w_{kj} x_j + b_k$$
$$y_k = \varphi(v_k)$$



Example











V = 7





V = WX + b



Mathematical Model of Neuron (Cont'd)





Activation Function

1. Threshold function





Activation Function (Cont'd)

2. Sigmoid function

$$\varphi(v) = \frac{1}{1 + \exp(-av)}$$





Activation Function (Cont'd)

3. Signum function







Activation Function (Cont'd)

4. Hyperbolic tangent function

 $\varphi(v) = \tanh(v)$

