Chapter 3
Definition of Artificial Neural Network

ABSTRACT

This chapter is an explanation of artificial neural network (ANN), which is one of the machine learning tools applied for medical purposes. The biological and mathematical definition of neural network is provided and the activation functions effective for processing are listed. Some figures are collected for better understanding.

3.1 BIOLOGICAL NEURAL NETWORK

In the nervous system of the living creatures, there are fluid-filled sacs which bound by a lipid bilayer for separating the intracellular contents from the extracellular space and they are called Neurons, or brain cells. Inside the body, Neurons are responsible to maintain a negative internal voltage, which is related to the extracellular space; ion channels and pumps maintain this potential difference. In most neurons of the central nervous system, spike is responsible to send the signals of neural activity, or rapid intracellular depolarization followed by repolarization; in order to adjust the neurons, it is necessary to communicate information about a neuron's activity. Some neurons communicate with simple resistive coupling, via channels that allow direction flow. However, for higher animals, most neurons in the central nervous system (CNS), communicate through chemical synapses: triggering the release of chemicals using the neural spike is called neurotransmitters

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into the extracellular space. These neurotransmitters bind to ion channels in adjacent neurons, causing a brief ionic current to flow into the neuron. The resulting current flow in the recipient neuron will be depoloraizing, or hyperpolarizing and it depends on whether the neurotransmitter is excitatory or inhibitory, respectively.

It is very useful to have some knowledge of the way the biological nervous system is organized. Since the artificial neural network, draw much of their inspiration from the biological nervous system.

There is difference among the nervous system of creatures. Most living creatures, which have the ability to adapt to a changing environment, need a controlling unit, which is able to learn. Higher developed animals and humans use very complex networks of highly specialized neurons to perform this task.

In the living creatures, the brain is the control unit and it can be divided in different anatomic and functional sub-units. Each unit is responsible to do certain tasks like vision, hearing, motor and sensor control. The brain is connected by nerves to the sensors and actors in the rest of the body.

The brain consists of a very large number of neurons, about 10^{11} in average. These can be seen as the basic building bricks for the central nervous system (CNS). The neurons are interconnected at points called synapses. The massive number of highly interconnected simple units working in parallel, with an individual neuron receiving input from up to 10000 others causes the complexity of the brain (Bishop, C.M., 1995).

The neuron contains all structures of an animal cell. The complexity of the structure and of the processes in a simple cell is enormous. Even the cell body contains the organelles of the neuron and also the 'dendrites' originate there. These are thin and widely branching fibers, reaching out in different directions to make connections to a larger number of cells within the cluster. Input connections are made from the axons of other cells to the dendrites or directly to the body of the cell. These are known as axondentritic and axonsomatic synapses. There is only one axon per neuron. It is a single and long fiber, which transports the output signal of the cell as electrical impulses (action potential) along its length. The end of the axon may divide in many branches, which are then connected to other cells. The branches have the function to fan out the signal to many other inputs (Hassoun, M. H., 1995).

There are many different types of neuron cells found in the nervous system. The differences are due to their location and function. The neurons perform basically the following function: all the inputs to the cell, which may vary