Al-Hamdaniya University

College of Education

Computer Science

Stage: 3rd

Introduction to Neural Networks

What are Neural Networks?

• Neural Networks are networks of neurons, for example, as found in real (i.e. biological) brains.

• Artificial neurons are crude approximations of the neurons found in real brains. They may be physical devices, or purely mathematical constructs.

• Artificial Neural Networks (ANNs) are networks of Artificial Neurons and hence constitute crude approximations to parts of real brains. They maybe physical devices, or simulated on conventional computers.

- From a practical point of view, an ANN is just a parallel computational system consisting of many simple processing elements connected together in a specific way in order to perform a particular task.
- One should never lose sight of how crude the approximations are, and how over-simplified our ANNs are compared to real brains.

Why are Artificial Neural Networks worth studying?

• They are extremely powerful computational devices.

• Massive parallelism makes them very efficient.

• They can learn and generalize from training data – so there is no need for enormous feats of programming.

• They are particularly fault tolerant.

• They are very noise tolerant – so they can cope with situations where normal symbolic systems would have difficulty.

• In principle, they can do anything a symbolic/logic system can do, and more.

What are Neural Networks used for?

There are two basic goals for neural network research:

Brain modelling: The biological goal of constructing models of how real brains work. This can potentially help us understand the nature of perception, actions, learning and memory, thought and intelligence and/or formulate medical solutions to brain damaged patients.

Artificial System Construction: The engineering goal of building efficient systems for real world applications. This may make machines more powerful and intelligent, relieve humans of tedious tasks, and may even improve upon human performance.

Both methodologies **should be** regarded as complementary and not competing. We often use exactly the same network architectures and methodologies for both. Progress is made when the two approaches are allowed to feed one another. There are fundamental differences though, e.g. the need for biological plausibility in brain modelling, and the need for computational efficiency in artificial system construction.

Learning Processes in Neural Networks

Among the many interesting properties of a neural network, is the ability of the network to learn from its environment, and to improve its performance through learning. The improvement in performance takes place over time in accordance with some prescribed measure.

A neural network learns about its environment through an iterative process of adjustments applied to its synaptic weights and thresholds. Ideally, the network becomes more knowledgeable about its environment after each iteration of the learning process.

Neural Network Applications

Brain modelling

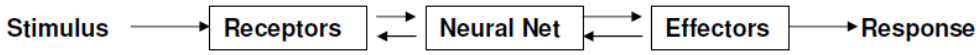
Aid our understanding of how the brain works, how behaviour emerges from the interaction of networks of neurons, what needs to "get fixed" in brain damaged patients.

Real world applications

- Financial modelling – predicting the stock market.
- Time series prediction – climate, weather, seizures.
- Computer games – intelligent agents, chess, backgammon.
- Robotics – autonomous adaptable robots.
- Pattern recognition – speech recognition, seismic activity, and sonar signals.
- Data analysis – data compression, data mining.
- Bioinformatics – DNA sequencing, alignment.

The Nervous System

The human nervous system can be broken down into three stages that can be represented in block diagram form as:



(adapted from Arbib, 1987)

The receptors convert stimuli from the external environment into electrical impulses that convey information to the neural net (brain).
The effectors convert electrical impulses generated by the neural net into responses as system outputs.
The neural net (brain) continually receives information, perceives it and makes appropriate decisions.
The flow of information is represented by arrows – feedforward and feedback.