Artificial Neural Networks

Amuche Onyemelukwe
Framingham State College
November, 2002

Introduction
- What is a neural network?
- Conventional computers follow a set of instructions in order to solve a problem.
- Neural nets learn to solve problems by example.

Contents
- What do we know about the human brain?
- Rivaling approaches to achieving AI.
- What is a neuron?
- How is one implemented in an artificial Neural Net
- How is learning implemented?

Rivaling approaches to AI research
- Top-down theorists believe that the best way to achieve AI is to mimic the brain’s behavior with computer programs.
- Bottom-up theorists believe that the best approach is to build electronic replicas of the human brain’s complex networks of neurons.

Biological neural nets
- The human brain is made up of billions of cells called neurons.
- Neuron emits energy through axon.

Artificial Neural Nets
- Made up of nodes connected by links
- Each node has a numeric weight
- Each has a set of input and output links to and from other nodes
- Each performs a local computation to determine activation level
Function of a node

- Receives signals from input links
- Computes activation level
- Sends out signals

Computation of activation level (split into two components)

- Input Function in I
- Computes the weighted sum of the node’s input values
  \[ in = \sum W_j a_j = Wi \]
- Activation function \( g \)
- Transforms the weighted sum into the final value that serves as the units activation value \( a_i \)
  \[ a_i \leftarrow g(in_i) = g(\sum W_j a_j) \]

Step Function

- Has a threshold \( t \)
- 1, if input \( \geq t \)
- 0, if input < \( t \)

Learning

- Achieved by adjusting weights that are attached to the links
- Occurs by example through exposure to a set of input/output data.
- The examples include input and desired output
- Proximity is measured. Error is calculated
  - Weights are adjusted

Learning Example

- A network is trained to recognize handwritten digits.
- 256 input units, 10 output units

Back-Propagation Algorithm

- Algorithm to calculate error
- \( EW \) is the error derivative for the weights
- To calculate \( EW \), \( EA \) must first be calculated
- \( EA \) is the rate at which the error changes as the activity level of a unit is changed.
- \( EW \) is the product of the \( EA \) and the activity through the incoming connection