SUPERVISED LEARNING NEURAL NETWORKS BASED ON POTENTIAL FUNCTIONS APPROACH

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Abstract: Artificial neural networks (ANN’s) are collections of mathematical models that emulate some of the observed properties of biological nervous systems and draw on the analogies of adaptive biological nervous systems. The key element of the ANN’s paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements that are analogous to neurons and are tied together with weighted connections that are analogous to synapses. A fundamental component in building neural network architectures with potential functions is the determination of potential function entity (PFE), which is designed to generate a respective potential function over the domain of input space. It is assumed that a certain input vector of the input space is comparable to an electrical charge, located at the same position, which generates an electrostatic potential.

Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons. This is true for ANN’s as well. Learning typically occurs by example through training, or exposure to a truth set of input/output data where the training algorithm iteratively adjusts the connection weights (synapses). These connection weights store the knowledge necessary to solve specific problems.

Although ANN’s have been around since the late 1950’s, it wasn’t until the mid-1980s that algorithms became sophisticated enough for general applications. The advantage of neural networks lies in their resilience against distortions in the input data and their capability of learning. They are often good at solving problems that are too complex for conventional technologies (e.g., problems that do not have an algorithmic solution or for which an algorithmic solution is too complex to be found) and are often well suited to problems that people are good at solving, but for which traditional methods are not. They are good pattern recognition engines and robust classifiers, with the ability to generalize in making decisions about imprecise input data. They offer ideal solutions to a variety of classification problems such as speech, character and signal recognition, as well as functional prediction and system modeling where the physical processes are not understood or are highly complex.

In this paper we present different neural network architectures based on potential functions and their implementation in solving classification problems. We assume that all inputs carry charges and generate potentials to all other inputs. We focus on the design of

- The basic topologies of the feed forward and RBF neural networks and building criteria for determination of the number of hidden layers and number of hidden units.
- Learning algorithms for the above supervised neural networks with dynamic allocation of the number of hidden neurons during the learning process.

We compare their performance and derive conclusions about their advantages, disadvantages and suggest ways for their improvement.

Keywords: neural networks, potential functions, radial basis functions