Applications of Neural Networks

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1 Athors

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2 Introduction

This article intends to describe *how* and *why* artificial neural networks (further referred to as *NN* or just *neural networks*) are used, and where they are applied as a predominate practical algorithmic tool to solve problems. We discuss current as well as possible future applications of neural networks and their algorithmic properties from an engineering point of view.

3 What are Artificial Neural Networks?

Artificial neural networks are engineered mathematical models inspired by the structure of the biological brain. As the name implies, an artificial neural network, like a neural network, consists of a set of inter-connected *neurons*, a network. Each connection is associated with a real value, fixed or computed depending on the type of network. Mathematically, this model yields a parameterized function $f : X \to Y$, which given an input will produce an output. The most prominent aspect of the concept of artificial neural networks is the possibility of *learning*. The output is analyzed and used for improving of the network. This is equivalent of modifying the parameter coefficients of the function by updating the weights in the network. To learn, in this context, is to find a better parameterization of the function being modeled with respect to some cost function $C : f \to \mathbb{R}$ such that for an optimal function $f^* \in F$ we have that $C(f^*) \leq C(f)$ for all $f \in F$. In this sense, the cost function measures the distance to the optimal solution.

Different artificial neural networks implement different learning paradigms, different schemes to update the weights in order to improve the network as fast and correctly as possible. These *learning algorithms* can in general be derived from or compared to traditional mathematical optimization and statistics. Due

to the imprecise nature of biological neural networks, noise is introduced to artificial neural networks in order to simulate this. The noise, directly or indirectly implemented, can work both as a catalyst and as a help when the learning process "gets stuck" in a sub-optimal local minima – similar to the process of simulated annealing.

4 Problems Solvable with Artificial Neural Networks?

The most predominate class of problems solved with artificial neural network schemes are diffuse *recognition* and *association* problems like

- sound/voice recognition.
- image/text/face recognition.
- function approximation and regression analysis.
- classification, including pattern and sequence recognition.
- data processing, including filtering, clustering and compression.

There are a number of areas in which artificial neural networks are applied such as control systems in vehicles and industrial processes, radar systems, face identification and authorization systems, object, movement, gesture and speech recognition systems, medical diagnosis systems, financial analysis systems, knowledge discovery in databases and visualisation systems as well as e-mail spam filtering systems.