Chapter 29
Visualization of Neuro-Fuzzy Networks Training Algorithms:
The Backpropagation Algorithm Approach

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ABSTRACT

The fusion of Artificial Neural Networks and Fuzzy Logic Systems allows researchers to model real world problems through the development of intelligent and adaptive systems. Artificial Neural networks are able to adapt and learn by adjusting the interconnections between layers while fuzzy logic inference systems provide a computing framework based on the concept of fuzzy set theory, fuzzy if-then rules, and fuzzy reasoning. The combined use of those adaptive structures is known as "Neuro-Fuzzy" systems. In this chapter, the basic elements of both approaches are analyzed while neuro-fuzzy networks learning algorithms are presented. Here, we combine the use of neuro-fuzzy algorithms with multimedia-based signals for training. Ultimately this process may be employed for automatic identification of patterns introduced in medical applications and more specifically for analysis of content produced by brain imaging processes.

INTRODUCTION

This chapter focuses on artificial and fuzzy artificial networks structures and applications. Several structures of artificial neural networks are evaluated as well as methods in which those system and fuzzy logic techniques could be combined in order to enhance pattern recognition efficiency. This study focuses on the power of visualization and efficiency of several training algorithms in order to minimize the typical network performance errors and enhance the network's efficiency. We focus on the performance of generalized Multi-Layer Perception architectures trained with the Backpropagation algorithm using

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various different activation functions for the neurons of hidden and output layers. For the visualization of neuro-fuzzy networks performance, different variants of sigmoid activations functions such as Bi-polar and Uni-polar sigmoid were simulated using Matlab within the frame of fuzzy logic. Simulation outcomes demonstrate the efficiency of neuro-fuzzy networks, the importance of visualization and the wide applicability of experimental multimedia methods in the process that enables interactive features such as action-response events (Tsiridou, Zannos, & Strapatsakis, 2011) (Timmerer, Waltl, Rainer, & Hellwagner, 2012) (Weyns, Malek, & Andersson, 2012) (Deliyannis, 2013) that can help enhance further the simulation process.

Cognitive Science and Biological Neural Networks

The structural differences between the human brain and the computer do not prevent the attempt to substitute some cognitive functions of the brain by a computer system. Under this perspective the branch of computer science which deals with the design and the implementation of systems that simulate human intelligence, logical thinking and behavior known as artificial intelligence may be employed for the task in hand (O'Regan & Noë, 2001). Interdisciplinary issues that are addressed within this research include the representation of knowledge and the adaptation of semantic descriptions.

The idea that the human mind is a computer whose operation is perceived via a process of reverse engineer returned to the forefront of cognitive science a number of issues that relate with evolutionary theory and natural evolution of the mind. According to the evolutionary theory, living species does not remain unaffected over time (Matthen & Stephens, 2007). Brain functions have changed over time under a series of adaptive changes. Several psychologists and cognitive scientists suggest that this approach renders the reverse approach as a strong candidate, allowing to study the human brain structure (Ivancevic & Ivancevic, 2007). Computer simulation may be employed to examine the cognitive function processes. Cognitive processes simulation is related to the perception and the analysis of brain process under mental or cognitive function. The simulation program uses a computational model that consists of a series mathematical equations or algorithms. Such systems are inspired by the biological neural networks are the artificial neural networks (Kowaliw, Bredeche, Chevallier, & Doursat, 2014). Artificial neural networks provide an alternative model, which is inspired, by biological models. Here, calculations are conducted massively and in parallel. A neuron is the smallest part of the brain that processes information and is identified as the basic difference between animals and plants (plants do not have neurons). There are approximately 10 billion neurons and 60 trillion connections in the cortex of the brain. A biological neuron consists of three main sections, which is the body, the axis, and dendrites. The dendrites, receive signals from neighboring neurons. These signals are electrical pulses that spread between the axis of the neuron transmitter and receiver dendrites of the neuron with the help of chemical processes. The point of a chemical process where the axis of a neuron transmits a signal to the dendrites of the next is called the conclusion. Then the body accumulates incoming signals where several brands have been sending the processed signal to adjacent neurons through the shaft. Thus, each neuron receives many signals as input and after processing only one spreading all the neurons with which it is linked (Levine et al., 2014).

Artificial Neural Networks

Artificial neural networks approach the function of the human brain and perform calculations on a massively parallel way (Kalogirou, 2001). The artificial neural network is a computing model inspired by

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