Chapter 8.9
Dynamic Pattern Recognition in Sport by Means of Artificial Neural Networks

Jürgen Perl
Johannes Gutenberg University, Germany

Peter Dauscher
Johannes Gutenberg University, Germany

ABSTRACT

Behavioural processes like those in sports, motor activities or rehabilitation are often the object of optimization methods. Such processes are often characterized by a complex structure. Measurements considering them may produce a huge amount of data. It is an interesting challenge not only to store these data, but also to transform them into useful information. Artificial Neural Networks turn out to be an appropriate tool to transform abstract numbers into informative patterns that help to understand complex behavioural phenomena. The contribution presents some basic ideas of neural network approaches and several examples of application. The aim is to give an impression of how neural methods can be used, especially in the field of sport.

INTRODUCTION

If dynamic behavioural processes (e.g., those dealt with in biomechanics, game analysis or medical therapy) are to be analysed, statistical methods are helpful, but not sufficient. In order to understand the dynamics of a process, time-dependent development has to be taken into consideration, quantitatively as well as qualitatively. This means that in addition to quantitative characteristic parameters in particular qualitative information like patterns are necessary for an appropriated identification and characterisation of processes. The problem, however, is that we can automatically record huge amounts of data from processes, but then we have to find out the particularly relevant information within the data. This is the point where Artificial Neural Networks can become extremely helpful. They are able to learn from data, compressing them to useful information. They can recognize patterns indicating characteristic properties of the process. They are also helpful in detecting hidden information and striking features that cannot be seen from data or even video pictures.

The contribution starts with a brief introduction to the main ideas and concepts of Artificial Neural Networks and then gives a number of applications that demonstrate their usability.

BACKGROUND

Neural Networks

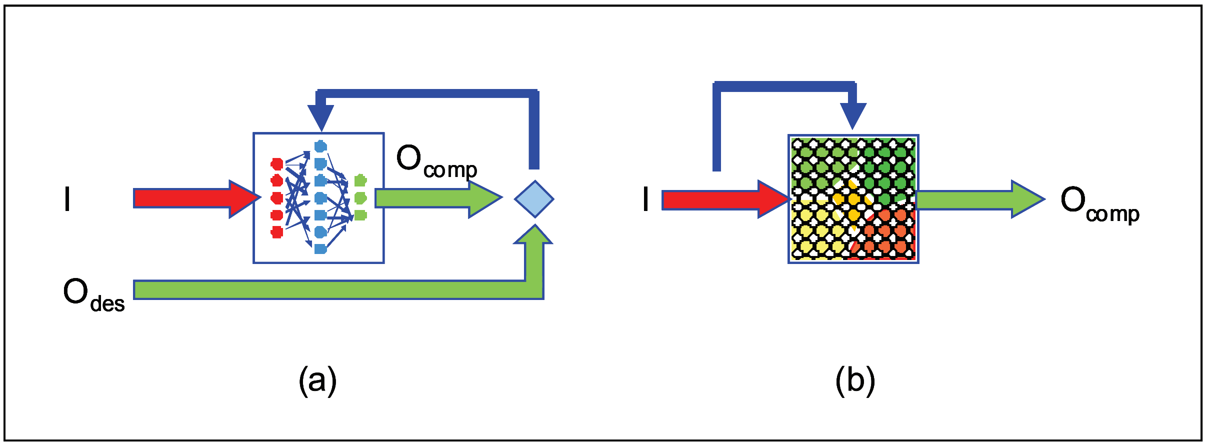
Artificial Neural Networks are presumably the best known biologically inspired approach within the field of artificial intelligence and machine learning. By developing abstract models of biological neural structures and performing them on standard computers or special hardware, researchers have been trying to reproduce some of the cognitive abilities one can observe in higher animals and, of course, in humans.

First approaches of neuron-like circuitry go back to the early 1940s (McCulloch & Pitts, 1943). A simple kind of learning behaviour was implemented in the model by the psychologist Donald Hebb (1949).

The best known model of these pioneer years is the so-called *perceptron* (Rosenblatt, 1958), which was able to learn a binary classification of patterns. However, it was shown in the 1960's that Rosenblatt's *perceptrons* were able to implement only a rather restricted class of classifications (Minsky & Papert, 1969). Even simple concepts like *"either ... or"* cannot be learnt by this approach.

This (legitimate) fundamental criticism meant a major set-back for Artificial Neural Network research followed by a period sometimes referred to as "neural winter." The shortcomings of the *perceptrons* were not overcome until the mid-1980s, when a learning algorithm was developed that was applicable to an Artificial Neural Network consisting of several layers of neurons (Rumelhart & McClelland, 1986). The connection of multiple layers of adaptive nonlinear neurons allows for the

Figure 1a. Supervised learning: Input I and desired output Odes are presented to a learning algorithm



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