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Time Series Analysis Based on Modular Architectures of Neural Networks

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Abstract

Paper presents a modular approach for time series analysis area. We consider the most important characteristics of modular architectures of neural networks and their advantages under traditional monolithic neural networks. The main idea of this paper is take answer - why modular neural networks have so high performance in many tasks. Also we present few examples of modular approaches which can be applied for time series analysis problem.

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1 Introduction

Nowadays modelling and forecasting time series are among the most active areas of research[16]. For example, depending on the historical data, situation on sales market, changes in prices for shares of population growth and banks deposits are forecast. Forecasting time series affects the lives of people around the world, so it has great practical value and perspectives of research in all areas of the modern society, which is also an important area in the field of computer application. The solution of problems of identification of dynamic objects should be used in a variety of fields: it can simplify temperature controllers, or complex management and forecasting. It can also solve the forecasting problem, along with a number of different methods, for example, statistical analysis, neural networks [9]. Identification of the object may be difficult if the exact structure of the model of the object is unknown, some of the parameters of the object change due to obscure principles, or the exact number of parameters of the object is unknown. In such cases, the hybrid neural network can be used for identification of dynamic objects. There are many types of neural networks that are used for identification of dynamic objects. Despite the large number of neural network methods for identification of dynamic objects, most of these algorithms have some limits, or do not provide the required accuracy. Among all kinds of neural networks, architectures that can be used for identification of dynamic objects

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allocated a class of neural networks based on self-organizing maps of Kohonen with hybrid architecture. Hybrid neural networks of this type will get special attention in this article because they are becoming more widespread and successful applications for solving various problems of recognition [4], identification [14], and forecasting. We will also consider a number of biomorphic neural networks applicable for solving identification problems and management.

2 Modular Neural Networks

2.1 The Main Idea of the Modularity

The core of the modular neural networks is based on the principle of decomposition of complex tasks into simpler ones. Separate modules make simple tasks. More simple subtasks are then carried through a series of special models. Each local model performs its own version of the problem according to its characteristics. The decision of the integrated object is achieved by combining the individual results of specialized local computer systems in a dependent task. The expansion of the overall problem into simpler subtasks can be either soft or hard-unit subdivision. In the first case, two or more subtasks of local computer systems can simultaneously assigned while in the latter case, only one local computing model is responsible for each of the tasks crushed. Each modular system has a number of special modules that are working in small main tasks. Each module has the following characteristics:

1. The domain modules are specific and have specialized computational architectures to recognize and respond to certain subsets of the overall task;

2. Each module is typically independent of other modules in its functioning and does not influence or become influenced by other modules;

3. The modules generally have a simpler architecture as compared to the system as a whole. Thus, a module can respond to given input faster than a complex monolithic system;

4. The responses of the individual modules are simple and have to combine by some integrating mechanism in order to generate the complex overall system response.

The best example of modular system is human visual system. In this system, different modules are responsible for special tasks, like a motion detection, color recognition and shape. The central nervous system, upon receiving responses of the individual modules, develops a complete realization of the object which was processed by the visual system.

2.2 Artificial Modular Neural Networks

Definition 1. A neural network is hybrid if it has a set of subsystems operating in parallel independently of each other and has different outputs which are indirectly integrated and do not interact with other.

Modular neural networks are especially effective for specific types of applications such as forecasting or classification problem, in contrast to traditional monolithic neural networks. These classes of problems include problems with different characteristics in different modules. For example, in the case of function approximation, piecewise continuous function does not model conventional neural networks, at the same time, modular neural networks solve this problem quite effectively[12]. Some of the main advantages of modular training systems are scalability,