# Chapter 30
# The Methodical Complex of Laboratory Works on the Study of Neural Network Technologies

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## ABSTRACT

*The chapter considers a task of teaching undergraduate students practical skills using artificial neural networks to solve problems of information processing and control systems. It represents and proves the methods of teaching, based on the gradual increase in the complexity of tasks to be solved by students. The developed complex of laboratory works includes classical problems and methods of their solutions, as well as original methods for solving problems of automatic control. The technology base of the laboratory works are both well-known programs and software package developed by the authors. In addition to the practical experience in the use of software packages, students obtain experience in conducting comparative studies of traditional and neural network methods for solving control problems.*

## INTRODUCTION

The course on artificial neural networks (ANN) has long been a mandatory component of technical universities educational program (Siegwart, 1998). This is due to the high demand for this problem-solving paradigm in various fields from image recognition and clustering of images to prediction of time series, anomalies recognition and system control (Mnasser, 2016). Meanwhile non-parametric nature of neural

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network models, the nonlinearity of the conducted transformation and lack of constructive theory of neural networks complicate the understanding of the students, who had received in the first courses the experience of studying classical subjects, based on the axiomatic construction, strict proof and analytically detectable properties. This dissonance requires the development of such training course on ANN, which will allow students to gain the necessary experience of their application despite the obvious incompleteness of the theory and a large array of diverse information about the architecture and the properties of ANN in different paradigms. One needs modern educational technologies to be implemented to solve mentioned problem (Van Ryneveld, 2016). A necessary component of an effective course on ANN is a set of laboratory works, which will not only provide students with evidence of the effectiveness of the knowledge gained them in lectures, but will also give the experience in conducting experiments with neural networks to overcome some specific and quite common problems. In particular, students should learn the proper selection of training and test data, the proper scaling of sample values, approaches to overcome local minima, the conscious choice of network type and architecture.

A less trivial task for a traditional course of ANN is an introduction to neural network control algorithms. Such knowledge is very important for students with control theory and practice specialization, because it provides novel non-linear and machine learning based methods for the well-known control problems.

Some innovative approaches in engineering education, such as CDIO (Clark, 2012), also require fast and efficient ways to activate student's problem-solving skills. The approach presented in this paper is directed to lift student's knowledge about ANN quickly from the complete ignorance to a discovery of ANN applications for real-world engineering tasks.

## BACKGROUND

As a result of the analysis of experience and the available sources we can distinguish three levels of presentation of the information about neural networks in depth and detail:

1. as a part of the course on intellectual technologies;
2. as a separate course involving the consideration of different neural network algorithms, but without specialization on the applications;
3. as a special course which culminates in a discussion of examples of neural networks application for solving various problems.

It should be noted that the courses of the first type because of its breadth does not allow students a deep understanding of the neural networks. Considering different Intelligent technologies, including expert systems, fuzzy logic and genetic algorithms, duration of one semester course is usually enough only for exposition of the basic principles and the most common neural network paradigms (Makarenko, 2009). If such courses include laboratory work, that is only for acquaintance with any single neural network paradigm on a typical example (Benjaminsson, 2008).

The second type of course suggests separate one-semester program and involves consistent and profound study of various neural network architectures and training algorithms (Terehov, 1998). As a rule, such a course is accompanied by laboratory classes, allowing consolidating the obtained knowledge on the experience. But often in specialized courses on neural networks much attention is paid to the theme