

# Preface

The intention of mankind to reveal the essence of brain intelligence and utilize it in computers arose already at the initial stage of cybernetics. These aspirations led to the appearance of new scientific field—artificial intelligence (AI) in the middle of the twentieth century. The main goal of new science became the detection of brain work mechanism and development on this base artificial systems for creative processes automation in information processing and decision-making.

In the past 60 years artificial intelligence has passed complex way of its evolutionary development. On this way were both significant achievements and failures. During the first 40 years of its development in AI several scientific branches were formed such as knowledge bases, expert systems, pattern recognition, neural networks, fuzzy logic systems, learning and self-learning, self-organization, robotics, etc.

In the 1990s by integrating various AI technologies and methods new scientific branch in AI was formed which was called “computational intelligence.” This branch appeared as a consequence of practical problems which could not be solved using conventional approaches and methods. In particular these problems have occurred while solving the problems of data mining, problems of decision-making under uncertainty, so-called ill-structured problems for which the crisp problem statement was impossible.

The suggested monograph is dedicated to systematic presentation of main trends, approaches, and technologies of computational intelligence (CI). The introduction includes brief review of CI history, the authors’ interpretation of CI, the analysis of main CI components: technologies, models, methods, and applications. The interconnections among these components are considered and relations between CI and soft computing are indicated.

Significant attention in the book is paid to analysis of the first CI technology—neural networks. The classical neural network backpropagation (NN BP) is described, the main training algorithms are considered. The important class of neural networks—with radial basic functions is described and its properties are compared with NNBP. The class of neural networks with backfeed—Hopfield and

Hamming are described and their properties and methods of weights adjustment are considered. The results of experimental investigations of these networks in the problem of images recognition under high level of noise are presented and compared. NN with self-organization by Kohonen are considered, its architecture and properties are described and various algorithms of self-organization are analyzed. The application of Kohonen neural networks in the problems of automatic classification and multidimensional visualization is considered.

Great attention in monograph is paid to novel important CI technology—fuzzy logic (FL) systems and fuzzy neural networks (FNN). The general description of fuzzy logic systems is provided, main stages of fuzzy inference process and fuzzy logic algorithms are described. The comparative analysis of fuzzy logic systems properties is presented, their advantages and drawbacks are analyzed. On this base the integration of two CI technologies—NN and FL was performed and as a result the new CI technology was created—fuzzy neural networks. Different FNN are described and their training algorithms are considered and compared.

New class of FNN—cascade neo-fuzzy neural networks (CNFNN) are considered, its architecture, properties, and training algorithms are analyzed. The applications of FNN to the forecast in economy and at stock markets are presented. The most efficient algorithms of fuzzy inference for the problem of forecasting in economy and financial sphere are determined.

The problem of investment portfolio optimization under uncertainty is considered. The classical portfolio optimization problem by Markovitz is described, its advantages and drawbacks are analyzed. The new problem statement of portfolio optimization under uncertainty is considered, which is free of drawbacks of classical model. The novel theory of fuzzy portfolio optimization is presented. For its solution corresponding method based on fuzzy sets approach is suggested. The application of the elaborated theory for investment portfolios determination at Ukrainian, Russian, and American stock exchanges is presented and analyzed.

The problem of corporations bankruptcy risk forecasting under incomplete and fuzzy information is considered. The classical method by Altman is described and analyzed. New methods based on fuzzy sets theory and fuzzy neural networks are suggested. Results of fuzzy methods application for corporations bankruptcy risk forecasting are presented, analyzed, compared with Altman method and the most adequate method was determined.

This approach was extended to the problem of banks bankruptcy risk forecasting under uncertainty. The experimental results of financial state analysis and bankruptcy risk forecasting of Ukrainian and leading European banks with application of fuzzy neural networks ANFIS, TSK, and fuzzy GMDH are presented and analyzed.

The actual problem of creditability analysis of physical persons and corporations is considered. The classical scoring method of creditability analysis is described and its drawbacks are detected. New method of corporations creditability estimation under uncertainty is suggested based on application of FNN. The comparative investigations of corporations creditability forecasting using classical scoring method and FNN are presented and discussed.

The application fuzzy neural networks in the problem of pattern recognition is considered. The applications of FNN for pattern recognition of optical images, handwritten text, are considered.

Great attention in monograph is paid to inductive modeling method, so-called group method of data handling (GMDH). Its main advantage lies therein it enables to construct the structure of forecasting model automatically without participation of an expert. By this possibility GMDH differs from other identification methods. The new fuzzy GMDH method suggested by authors is described which may work under fuzzy and incomplete information. The problem of inductive models adaptation obtained by FGMDH is considered. The results of numerous experimental investigations of GMDH for forecasting at stock exchanges in Ukraine, Russia, and USA are presented and analyzed.

The problems of cluster analysis and automatic classification are considered in detail. The classical and new methods of cluster analysis based on fuzzy sets and FNN are described and compared. The applications of cluster methods for automatic classification of UNO countries by indices of sustainable development are presented and analyzed.

The final chapters are devoted to theory and applications of evolutionary modeling (EM) and genetic algorithms (GA). The general schema and main mechanisms of GA are considered, their properties and advantages are outlined. Special section is devoted to new extended GA. The applications of GA for computer networks structure optimization are considered.

Basic concept and main trends in evolutionary modeling are considered. The evolutionary strategies for artificial intelligence problems solution are presented and discussed. Special attention is paid to the problem of accelerating the convergence of genetic and evolutionary algorithms.

In the conclusion the perspectives of computer intelligence technologies and methods development and implementation are outlined.

The distinguishing features of this monograph are a great number of practical examples of CI technologies and methods and applications for solution of real problems in economy and financial sphere, in particular forecasting, classification, pattern recognition, portfolio optimization, bankruptcy risk prediction of corporations and banks under uncertainty which were developed by the authors and are published in the book for the first time. Just system analysis of presented experimental and practical results enables to estimate the efficiency of the presented methods and technologies of computational intelligence.

All CI methods and algorithms are considered from the general system approach and the system analysis of their properties, advantages, and drawbacks is performed that enables practitioners to choose the most adequate method for their own problems solution.

The proposed monograph is oriented first of all to the persons who aspire to make acquaintance with possibilities of current computer intelligence technologies and methods and to implement them in practice. It may also serve as inquiry book on contemporary technologies and methods of CI, it will be useful for students of corresponding specialties.

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System Approach

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