Book Review

A review on the book, *Self-organization: Theories and Methods*

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Abstract
The book, *Self-organization: Theories and Methods*, edited by WenJun Zhang and published by Nova Science Publishers, USA, was briefly reviewed in present report.

Keywords self-organization; book; review.

Selforganizology
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Self-organization is a universal mechanism in nature. In the past thirty years, numerous phenomena, theories and methods on self-organization have been founded around the world. The book, Self-organization: Theories and Methods, is published to present recent achievements in theories and methods of self-organization. This book includes such theories and methods of self-organization as ant algotithms, particle swarm algorithm, artificial neural network, motion and migration algorithms, self-adaptive Kalman Filter, finite state approximation, etc. Chapters are contributed by more than 20 scientists from China, Italy, Spain, Japan, Russia, Serbia, India, Turkey, in the areas of mathematics, computational science, artificial intelligence, aeronautics and astronautics, automation and control, and life sciences. It will provide researchers with various aspects of the latest advances in self-organization. It is a valuable reference for the scientists, university teachers and graduate students in mathematics, natural science, engineering science, and social science.

The main contents are included as follows:

Chapter 1 (Zhang, 2013). In this chapter, concepts, theories, and methods of self-organization are briefly overviewed.

Chapter 2 (Sreeja and Sankar, 2013). Classification is a data mining functionality that assigns instances in a collection to target classes. The goal of classification is to accurately predict the target class for an unlabelled sample by learning from instances described by a set of attributes and a class label. Conventional classification methods specified in literature are less efficient in classifying very small datasets with repeated attribute values. To overcome this drawback, the study explores a classification method by mining similar patterns among the instances in very small datasets. Classification by Mining Patterns (CMP) algorithm is proposed to predict the class label of the unlabelled sample by mining similar patterns among the instances in the dataset. To mine similar patterns, the instances in the dataset belonging to the same class label are grouped. The instances in each group that differ by one attribute value are merged. Such merged instances form mined patterns. To predict the class label of the unlabelled samples, the attribute values in the mined patterns are compared with the corresponding attribute values of the unlabelled sample. The count of number of attribute values in the mined patterns matching with that of the unlabelled sample gives the attribute match count. The mined patterns having the maximum attribute match count are grouped and the majority class label of the mined patterns is predicted as the class label of the unlabelled sample. To choose the attributes in the mined patterns for comparison, an Ant Colony Optimization based Feature Selection Mined Patterns (ACOFSMP) is proposed. Simulation results are shown to prove that the CMP algorithm is efficient for classifying very small datasets with repeated attribute values.

Chapter 3 (Escario et al., 2013). This chapter aims to present a study on auto-organisation in the context of Ant Colony Optimisation (ACO) metaheuristic. Heuristic optimisation algorithms should decide how to share efforts between exploration of newer solutions, and the exploitation of those previously discovered. In classical ACO algorithms this decision is taken beforehand, by setting up the algorithm parameters' values. Usually it is necessary to change them every time a new problem is tackled. The purpose is to introduce in ACO a self-organisation dynamics that allows to balance the exploitation and the exploration. Inspired by the biological studies on the organisation of the real ant colonies, two kinds of ants are defined: one dedicated to the exploration, and the other assigned to the exploitation. Besides, it is defined a population dynamics to establish a relationship between both populations. This allows to self-regulate the populations between them according to the quality of the solutions found. The ultimate outcome is the Ant Colony Extended (ACE), a new algorithm with the capability of self-organise, which eliminates the necessity of using parameters. The chapter is focused on the population dynamics and its influence on the algorithm's behaviour. The results are promising and encourage further investigation of how to apply this approach to other heuristic optimisation algorithms.

Chapter 4 (Kanovic et al., 2013.). In this chapter, a generalization of the popular and widely used Particle Swarm Optimization (PSO) algorithm is presented. This novel optimization technique, named Generalized PSO (GPSO), is inspired by linear control theory. It overcomes some typical flaws of the classical PSO, enabling direct control over the key aspects of particle dynamics during the optimization process. The basic idea of this algorithm with its detailed theoretical and empirical analysis is presented, and parameter-tuning schemes are proposed. GPSO is also compared to the classical PSO and Genetic Algorithm (GA) on a set of benchmark problems. The presented results demonstrate the effectiveness of the proposed algorithm. Finally, two practical engineering applications of the GPSO algorithm are described, in the area of optimal gear design and architecture and urban design.

Chapter 5 (Zhang et al., 2013b). Artificial neuronets (AN), especially with error back-propagation (BP) training algorithms, have been widely investigated and applied in various science and engineering fields. However, BP-type neuronets, which are self-adaptive systems, have shown some inherent weaknesses, such as, the possibility of being trapped into local minima, the difficulty in choosing appropriate learning rate, and most importantly, the inability to determine the optimal neuronet structure. To solve the inherent weaknesses of AN, lots of improvements for BP-type algorithms have been investigated. However, as researchers (including the authors) realize and experience quite frequently, the inherent weaknesses of BP-type neuronets still exist. In this chapter, differing from others' algorithmic improvements on the training procedure, our way about the problem solving exploits some elegant structuredesign, parameter-setting, pseudoinverse and numerical optimization techniques. In other words, a new type of AN using linearly-independent or orthogonal polynomials as activation functions, is presented and analyzed by us (the authors). These finally lead us to propose a weights and structure determination (WASD) method, which is based on a weights-direct-determination (WDD) method, for our presented feedforward AN. Based on the authors' previous work, single-input neuronets equipped with the WASD method have successfully overcome the above weaknesses. To investigate and verify two- or multiple-input neuronets equipped with this method, the authors firstly put forward various novel neuronets based on different activation functions. Then, corresponding WASD algorithms are proposed for the presented neuronets. For better performance (e.g., more efficiency and conciseness in self-organizing systems), the authors further propose pruning techniques in the neuronet structure determination. Finally, based on various target functions, numerical results further substantiate the efficacy of the proposed neuronets equipped with the corresponding WASD algorithms, which shows the better performance in terms of training (or say, approximation or learning), generalization (or say, testing or validation) and prediction.

Chapter 6 (Aoi, 2013). Humans produce adaptive locomotion through dynamic interactions among the nervous system, the musculoskeletal system, and the environment in a self-organized manner. A human musculoskeletal system has more degrees of freedom (DOFs) than necessary for locomotion and humans solve the redundancy problem in some way to establish locomotion. It has been suggested that individual DOFs are not manipulated independently, but some DOFs are functionally connected by object tasks to reduce the number of DOFs. These relationships among DOFs appear as low-dimensional structures in the DOFs. This chapter shows such low-dimensional structures in joint movements and muscle activities (kinematic and muscle synergies) during human locomotion based on the analysis of measured data. In addition, it shows a constructive approach using a computer simulation with a neuromusculoskeletal model based on anatomical and physiological findings to examine the functional roles of the low-dimensional structures that generate adaptive locomotor behaviors through dynamic interactions among the nervous system, the musculoskeletal system, and the environment.

Chapter 7 (Zivanovic and Stojkovic, 2013). This chapter discusses the self-organized movement of a set of some individuals. It is adopted that individuals perceive reality as its projection on coordinate system that is firmly attached to the individual. The movement of individuals is interpreted as the movement of points in this coordinate system according to the algorithms by which each individual is equipped. The projection of reality and other individuals simultaneously changing the parameters of algorithms and simultaneously impose constraints on the movement of these points. The set of individuals moves so that each individual performs arbitrary motion within the allowed constraints on one of two ways: a) individuals follow one or more leaders, b) individuals preserve system configuration during movement, i.e. not change some typical magnitude of set. Motion of individuals or of set of individuals from one position to another always takes place according to the functions of natural impulses. Short was given comparison between function of the natural impulse and other custom-fit functions.

Chapter 8 (Zhang et al., 2013a). Habitat diversity is an important mechanism for species migration and distribution. A stochastic model for species migration in heterogeneous environment is described in this chapter. This model is used to describe various dynamics types in biological process such as periodic oscillation, monotonic increase and decline, and fluctuation. The species extinction likelihood in migrated area largely determines the dynamics and pattern of species migration. There is a significant difference in species migration between heterogeneous and homogeneous habitats. Higher fitness to species will lead to a faster migration and higher percentage of migrated areas. Existence of boundary areas may retard species migration.

Chapter 9 (Hajiyev and Soken, 2013). In this chapter a Robust Self-Adaptive Kalman Filter (RSAKF) algorithm with the filter gain correction is developed for the case of sensor/actuator malfunctions. The proposed RSAKF utilizes time variable factors in order to reduce the effect of the faults on the estimation procedure. In this sense, the procedures with single and multiple factors for the adaptation of the filter are presented. In the first case, the filter is adapted by using single adaptive factor as a corrective term on the filter gain while in the second one, an adaptive matrix built of multiple adaptive factors is used to fix the relevant term of the Kalman gain matrix, individually. After chosing the efficent method of adaptation, an overall concept for the RSAKF is proposed. In this concept, the filter detects the type of the fault, either in the sensors or actuators, and after the fault isolation it applies the required adaptation process such that the estimation characteristic is not deteriorated. Effectiveness of the proposed filters are investigated via simulations for the state estimation problem of an UAV. The results of the presented algorithms are compared for different types of sensor/actuator faults and in this context recommendations about their utilization are given.

Chapter 10 (Carpentieri, 2013). This chapter takes into account the problem of designing regular approximations for the stochastic pushdown computing. It is prove that stochastic pushdown automata accepting with finite cut point and for which equivalent non-dirty context-free grammars exist admit arbitrarily accurate regular approximations. The uthor addresses the problem of designing the uniform representation of the stochastic (context-free/pushdown) computing characterizing it in terms of converging sequences of finite state approximations.

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