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Editorial

Special Issue on Interdisciplinary Artificial Intelligence: Methods and Applications of Nature-Inspired Computing

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1. Introduction

Inspiration in nature has been widely explored, from the macro to micro-scale. From a scientific perspective, these methods inspired by nature have proven to be efficient tools for tackling real-world problems because most of the latter are highly complex or the resources are limited to analyze them. This inspiration is justified by the fact that natural phenomena mainly emphasize adaptability, optimization, robustness, and organization, among other properties, to deal with complexity. In that sense, three methodologies are commonly considered: human-designed problem-solving techniques inspired by nature, the synthesis of natural phenomena to develop algorithms, and the use of nature-inspired materials to perform computations. Some applications of nature-inspired computing include data mining, machine learning, optimization, robotics, engineering control systems, human–machine interaction, healthcare, the Internet of Things, cloud computing, smart cities, and many others.

This Special Issue aimed to cover original research works with emphasis on the methodologies and applications of nature-inspired computing to handle the above-mentioned complex systems. We received a total of 38 submitted papers, and 18 papers were accepted (covering 47% of acceptance rate).

The Special Issue presents different works related to metaheuristic optimization methods and their applications of human brain inspiration and neural networks, natural language processing-based applications, and fuzzy-logic-based applications.

2. Metaheuristic Optimization Methods and Their Applications

Metaheuristic optimization methods are commonly inspired by natural phenomena (physics, biology, and chemistry, among others), the relationship between agents participating in the scenario, and the criteria that define the behavior of agents.

These methods can be found as population-based algorithms. For example, in the work of Dehghani et al. [1], the authors propose a novel metaheuristic optimization algorithm, namely, a spring search algorithm. This method is inspired by the physical phenomenon of the Hooke's law, and the interaction of forces over objects. The novel method is validated using an established benchmark and applied in five engineering problems. In addition, Dehghani et al. [2] propose another novel method called doctor and patient optimization that simulates the relationship of a doctor and the treatment procedure of a patient. The authors assess the method in 23 benchmark functions, and then they applied the method into the energy commitment problem. In addition, Dehghani et al. [3] proposed a method for improving the population-based algorithms for optimization. The authors claim that all individuals in the population play an important role, and they can give more information to the best member, amplifying its potential. The work reports a set of experiments in which the method is hybridized with other metaheuristic algorithms such as particle swarm

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optimization, genetic algorithms, and grey wolf optimizer, among others. The results show that the hybrid methods improved the optimization process.

A biological-inspired study is presented in Segev et al. [4], the authors present a study on how trees in forests make relationships such that it can be viewed as a network of information, similarly to neural networks in brains. The authors validate their study by analyzing 323 forests concluding that there emerges a forest knowledge processing system.

Furthermore, Horng and Lee [5] propose an ordinal optimization method in combination with ant lion optimization to solve computationally expensive simulation optimization problems. The key feature of the proposal is to tackle the computationally extensive fitness functions, operate with intractable objective functions, and to work without sensitivity information. The results show less computational time when optimizing these complex problems.

Other works of applications using metaheuristic optimization methods are included in the Special Issue. In the work of Bautista-Sánchez et al. [6], the authors present a method called prediction vessel movements and route estimation, for selecting the historical data required to compute an optimal path planning of route vessels and an estimation of vessels' positions.

Santiago et al. [7] present an approach to optimize the parallelization of computing tasks. The approach consists of applying a greedy randomized adaptive search procedure for finding the most promising task order, and then it computes a heuristic method called a cellular processing algorithm for optimizing the task allocation problem. The approach was validated in an extensive state-of-the-art benchmark. Furthermore, the work of Velarde [8] proposes an alternative solution to the same parallel task allocation problem. The key idea is to perform the optimization using two algorithms, namely, the univariate marginal distribution algorithm and genetic algorithms, and using the provided information to select the best scheduling task.

Additionally, Mendez et al. [9] propose a novel design method for DC–DC converters through optimizing the inductance selection using the metaheuristic earthquake algorithm. They validated that the inductance selection is optimal under multi-objective criteria.

3. Human Brain Inspiration and Neural Networks

The human brain has inspired many of the intelligent systems known nowadays. This inspiration comes from the fact that small units called neurons can do simple actions that interconnected in networks can model complex behaviors, simulating learning, memory, and attention, among others.

In this Special Issue, there are different applications based on the human brain and neural networks. For instance, the work of Moreno Escobar et al. [10] presents a healthcare smart system that can measure the electroencephalogram bands to determine the effectiveness of a therapy on patients. The application demonstrates that it is possible to quantitatively determines if a therapy is effective or not. Another example of processing signals is the work of Naghshvarianjahromi et al. [11], in which authors present a cognitive decision-making system inspired by the human brain decision making at a low complexity. The system was validated in a fiber-optic transmission link that improves the performance. The authors claim that the cognitive decision-making system can work in real-time applications.

Furthermore, Hurst-Tarrab et al. [12] present a parking lot segmentation method using the power of deep convolutional neural networks and taking advantage of surveillance cameras and satellite images. They also propose a dataset for parking block segmentation, namely, APKLOT. In the same transportation field, Ochoa-Ruiz et al. [13] proposes a public and large dataset of images for road damage conditions. Then, they use their dataset to build neural network models for mobile devices that can handle road damage classification for further assessment of the roads.

In the work of Flores-López et al. [14], three approaches are presented to identify proteins by means of the electrophoresis analysis: a conventional method, neural networks,

and decision trees. The most promising approach resulted to be neural networks as shown in the work.

4. Natural-Language-Processing-Based Applications

Linguistics and understanding natural language processing have been addressed using artificial intelligence. In López-Ortega et al. [15], they propose the analysis of written documents within a natural-inspired process by means of the similarity measurement called the Hurst parameter. The authors report an extensive experiment in which the Hurst parameter can classify different types of written documents. Another application is reported in Xiao et al. [16]. They propose the use of semantic information, syntactic information, and the interaction information over texts to determine classify an intentional sentiment of a specific goal. The method includes an attentional-encoding-based graph convolutional network model. The proposal was validated using five datasets and compared within the state-of-the-art method.

5. Fuzzy-Logic-Based Applications

Fuzzy logic systems are inspired by the human reasoning. This type of methods can deal with uncertainty of information and producing a set of rules as knowledge-based systems. In this Special Issue, two works are included in this topic. In the work of Hribersek et al. [17], the authors propose a neuro-fuzzy inference system model to predict the cooling rate (temperature) conditions of the liquified nitrogen's cooling ability on a nickel super alloy Inconel 718. The model was trained, and after that, an optimization of the input parameters was performed using the particle swarm optimization algorithm. In the second work, de Campos Souza et al. [18] presents a fuzzy-based system to extract fuzzy rules from historical data. They applied their system to a rainfall forecasting, specifically for temperature and average rainfall indices. The study concludes that the approach can provide fuzzy rules able to inform of a future situation of rains in a location of Brazil.

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