Guest Editorial
Nature-Inspired Approaches for IoT and Big Data

Nature-inspired approaches have been widely used for different purposes over the last two decades and are still extensively researched, especially for complex real-world problems. Biological systems, or nature in general, serve as the source of the intelligence of nature-inspired approaches. The efficiency of nature-inspired approaches is due to their significant ability to imitate the best features of nature that evolved by natural selection over millions of years. These approaches have been successfully used for Internet of Things (IoT) and big data handling and relevant examples of these topics may be artificial neural networks (ANNs) and deep learning applications. On this basis, the main theme of this special issue (SI) addresses recent advances in the use of the nature-inspired approaches for IoT and big data problems.

We received 40 original submissions from all over the world for this SI. After a rigorous review process, ten articles were accepted and are presented in this SI. The first two articles address the use of a well-known genetic algorithm that mimics the process of Darwinian natural selection. ANN is one of the most successful nature-inspired approaches. ANNs, and particularly deep ANNs, have lately received much attention, particularly because of their successful use in helping to solve image- and video-based problems. The third and fourth articles discuss deep ANN systems that are implemented for different types of image recognition problems. The fifth and sixth articles discuss the application of the bio-inspired approaches in wireless networks. The fifth article uses ant colony optimization and the sixth article uses a biologically inspired resource allocation scheme for this purpose. The seventh, eighth, and ninth articles of this SI use nature-inspired heuristics for multiview recognition, cognitive IoT, and chain coding problems, respectively. The final article of this SI implements two-hybrid ANN systems that are coupled with two nature-inspired optimization techniques for the Internet of Medical Things problems.

This SI starts with the article titled “A nature-inspired node deployment strategy for connected confident information coverage in Industrial Internet of Things.” This study adopts an evolutionary approach with multiple evolutionary mechanisms to optimize IoT node deployment, in terms of network lifetime and coverage ratio. The results show that using the proposed evolutionary computation scheme to evolve the system provides a clear advantage.

The article titled “An efficient evolutionary user interest community discovery model in dynamic social networks for Internet of people” also addresses the use of an evolutionary approach in an IoT system. The authors implement a multi-objective genetic algorithm to evolve the user interest community discovery model. The authors adopt the evolutionary algorithm for a microblogging social network that represents a dynamic network. The proposed evolutionary approach is benchmarked against other published methods and the results confirm the advantage of the evolutionary approach over other approaches.

A deep-learning-based system is used to investigate smoke detection in the article titled “Energy-efficient deep CNN for smoke detection in foggy IoT environment.” In this study, for early smoke detection problems in different IoT environments, the authors propose a deep convolutional neural network (CNN) model and benchmark it against GoogleNet and AlexNet. The results are competitive and show that the discussed CNN models are promising solutions for these problems.

The article titled “Efficient image recognition and retrieval on IoT assisted energy-constrained platforms from big data repositories” also uses a well-known CNN model as a nature-inspired approach to address the challenges with big data in IoT-assisted energy-constrained devices. The proposed algorithm is a light-weight deep system and is used for image recognition. The results show that the proposed ANN-based systems outperform previously published models.

Ant colony optimization, which mimics the foraging behavior of ants, is used in the article titled “Load-balanced data dissemination for wireless sensor networks: A nature-inspired approach.” This nature-inspired approach is used to seek optimal path trees in wireless sensor networks. The proposed system in this study shows good performance as compared to other published approaches.

The article titled “Biologically inspired resource allocation for network slices in 5G-enabled Internet of Things” also addresses the use of the bio-inspired approaches in wireless networks. A bio-inspired heuristic is proposed for resource allocation in 5G-enabled IoT networks in which the bio-inspired approach is coupled with the cellular automaton model. The results clearly show the advantages of the system and demonstrate that this bio-inspired strategy works for 5G wireless networks.

The article titled “Adaptive fusion and category-level dictionary learning model for multi-view human action recognition” explores a new nature-inspired model in the IoT environment. Inspired by nature, the proposed adaptive fusion and dictionary learning model mines the latent relationships among different views for human action recognition. The performance of this approach is validated by comparing it with several well-known published models.
The next article, titled “A bio-inspired solution to cluster-based distributed spectrum allocation in high-density cognitive Internet of Things” addresses a nature-inspired approach for cognitive IoT. A bio-inspired spectrum allocation solution is proposed for cluster-based architecture in order to maximize clustered throughput and to minimize communication delay. In this study, the authors use a biological mechanism first proposed by Turing in 1952 to explain the formation of patterns in biological systems. The Turing model is called reaction–diffusion, which specifically explains spatial concentration patterns using features from biological systems. This model is altered in the article so that it can modify a distributed cluster formation model in cognitive IoT.

The article titled “An innovative chain coding technique for compression based on the concept of biological reproduction: An agent-based modeling approach” uses an approach inspired by biological reproduction. The biological reproduction method is implemented in order to improve a chain coding technique for compression. In this nature-inspired and agent-based model, rabbits work as agents who consume carrots in order to qualify for reproduction.

The article titled “Dynamic adaptive network-based fuzzy inference system (D-ANFIS) for the imputation of missing data for Internet of Medical Things applications” attempts to optimize a hybrid fuzzy and neural network system using two nature-inspired approaches. This system is designed specifically to impute missing medical data in an IoT system. Two medical cases are discussed and both models are shown to be beneficial.

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