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Editorial

Evolutionary Algorithms in Intelligent Systems

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Evolutionary algorithms and metaheuristics are widely used to provide efficient and effective approximate solutions to computationally difficult optimization problems. Successful early applications of the evolutionary computational approach can be found in the field of numerical optimization, while they have now become pervasive in applications for planning, scheduling, transportation and logistics, vehicle routing, packing problems, etc. With the widespread use of intelligent systems in recent years, evolutionary algorithms have been applied, beyond classical optimization problems, as components of intelligent systems for supporting tasks and decisions in the fields of machine vision, natural language processing, parameter optimization for neural networks, and feature selection in machine learning systems. Moreover, they are also applied in areas like complex network dynamics, evolution and trend detection in social networks, emergent behavior in multi-agent systems, and adaptive evolutionary user interfaces to mention a few. In these systems, the evolutionary components are integrated into the overall architecture and they provide services to the specific algorithmic solutions. This paper selection aims to provide a broad view of the role of evolutionary algorithms and metaheuristics in artificial intelligent systems.

A first relevant issue discussed in the volume is the role of multi-objective meta-optimization of evolutionary algorithms (EA) in continuous domains. The challenging tasks of EA parameter tuning are the many different details that affect EA performance, such as the properties of the fitness function as well as time and computational constraints. EA meta-optimization methods in which a metaheuristic is used to tune the parameters of another (lower-level) metaheuristic, which optimizes a given target function, most often rely on the optimization of a single property of the lower-level method. A multi-objective genetic algorithm can be used to tune an EA, not only to find good parameter sets considering more objectives at the same time but also to derive generalizable results that can provide guidelines for designing EA-based applications. In a general framework for multi-objective meta-optimization, it is necessary to show that "going multi-objective" allows one to generate configurations, besides optimally fitting an EA.

A significant example of this approach is the application of differential evolution-based methods for the optimization of neural networks (NN) structure and NN parameter optimization. Such an adaptive differential evolution system can be seen as an optimizer which applies mutation and crossover operators to vary the structure of the neural network according to per layer strategies. Self-adaptive variants of differential evolution algorithms tune their parameters on the go by learning from the search history. Adaptive differential evolution with an optional external archive and self-adaptive differential evolution are well-known self-adaptive versions of differential evolution (DE). They are optimization algorithms based on unconstrained search.

Another relevant general area of evolutionary algorithms is represented by the Particle Swarm Optimization (PSO), which is based on the concept of swarm of particles, i.e., individual solutions and computational entities. A swarm extends the concept of a set of solutions of the early classical genetic algorithms to a set of related, coordinated, and interacting search threads. On this basis, it is interesting to explore the many variants of PSO, like, for instance, the memetic variant. The memetic evolution of local search operators can be introduced in PSO continuous/discrete hybrid search spaces.

The evolution of local search operators overcome the rigidity of uniform local search strategies. The memes provide each particle of a PSO scheme with the ability to adapt its exploration dynamics to the local characteristics of the search space landscape. A further step is to apply a co-evolving scheme to PSO. Co-evolving memetic PSO can evolve both the solutions and their associated memes, i.e., the local search operators.

PSO can be straightforwardly adapted to multi-objective optimization, an innovative contribution, explore methods for obtaining high convergence and uniform distributions, which remains a major challenge in most metaheuristic multi-objective optimization problems. The selected article proposes a novel multi-objective PSO algorithm based on the Gaussian mutation and an improved learning strategy to improve the uniformity of external archives and current populations.

A common trend of an evolutionary algorithm scenario is the constantly increasing number of new proposals of nature-inspired metaheuristics. These proposed approaches usually take inspiration from groups of distributed agents existing in nature, i.e., ants, flock of birds, bees, etc., which apply simple local rules, but globally result in a complex emerging behavior which optimizes some specific feature, i.e., amount of found food, shortest path, the change of surviving to predators, etc. We found it to be interesting to propose, among the selected articles, an application to Internet of Things, in particular, the optimal task allocation problem in wireless sensor networks. The nature-inspired evolutionary algorithm proposed for wireless sensor networks is the recently developed Social Network Optimization, which is a significant example of using behavioral rules of social network users for obtaining an emerging optimization behavior.

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