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Editorial

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Hybrid Nature-Inspired Computing (NIC) Methods: Motivation and Prospection

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Editorial

During the recent years, nature has been a rich information resource, inspired by which numerous intelligent computing methodologies have been proposed, developed, and studied [1]. The Nature-Inspired Computing (NIC) methods use the nature as a metaphor, inspiration, and enabler. The typical NIC methods include Genetic Algorithms (GA), Tabu Search (TS), Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Bacteria Foraging (BF), Differential Evolution (DE), Clonal Selection Algorithm (CSA), Harmony Search (HS), Cultural Algorithms (CA), Simulated Annealing (SA), Memetic Computing (MC), etc [2]. They have been successfully applied in such emerging fields as optimization, machine learning, data mining, and fault diagnosis. Unfortunately, each NIC method has its own strengths and drawbacks, since they are based on only certain phenomena of the nature. Moreover, the standalone NIC methods are usually not efficient at handling the uncertainty and imprecision in practice. Therefore, fusion of them can indeed offer us competitive solutions to the practical problems [3].

We can observe that the aforementioned NIC methodologies share a lot of similarities, e.g., adaptation, learning, and evolution. On the other hand, there are some distinct differences among themselves, and all the NIC methods have advantages and disadvantages. However, compared with their hybridizations, the individual NIC methods are not always effective enough. Additionally, practicing engineers often face the difficulty of choosing the best suited NIC methods to meet particular engineering requirements. The inspiration and fusion of these NIC techniques are shown in Figure 1. How to combine the existing NIC methods together so that they can benefit from each other and achieve superior performances has been a popular research subject. The most important topics focus on the different fusion types of merging the NIC methods, such as application of efficient local search strategies in the NIC to build up novel hybrid approaches, solution diversity maintenance techniques for finding suitable balance between exploration and exploitation of the hybrid NIC methods, and comparison of performances of effectiveness, convergence, and computational complexities of the hybrid NIC algorithms using statistics techniques. In addition, the robustness of the hybrid NIC methods against the parameter variation and 'noisy' fitness landscapes and their adaptation capability to the time-varying environments should be examined as well. Therefore, the following issues are usually under investigation in the current research work of the fusion of these NIC methods.

(1) Exploration of different fusion types of merging the NIC methods together, i.e., how to integrate certain NIC methods into the others so that their short comings are overcome and their advantages can be enhanced.

(2) Examining the effects of different meta-heuristic operations, e.g., GA crossover & mutation and BF chemo taxis and swarming, on the hybrid NIC methods.

(3) How to apply efficient local search strategies in the MC to build up novel hybrid NIC approaches.

(4) Study of the appropriate selections of the coefficients in the hybrid NIC methods.

(5) Investigation of the maintenance techniques for finding suitable balance between exploration and exploitation of the hybrid NIC methods.

(6) Comparison of the performances including effectiveness, convergence, and computational complexities of the hybrid NIC algorithms using statistics approaches.

(7) Test of the robustness of the hybrid NIC methods against the parameter variation and 'noisy' fitness landscapes.

(8) Study of the adaptation capability of the hybrid NIC methods to the time-varying environments.

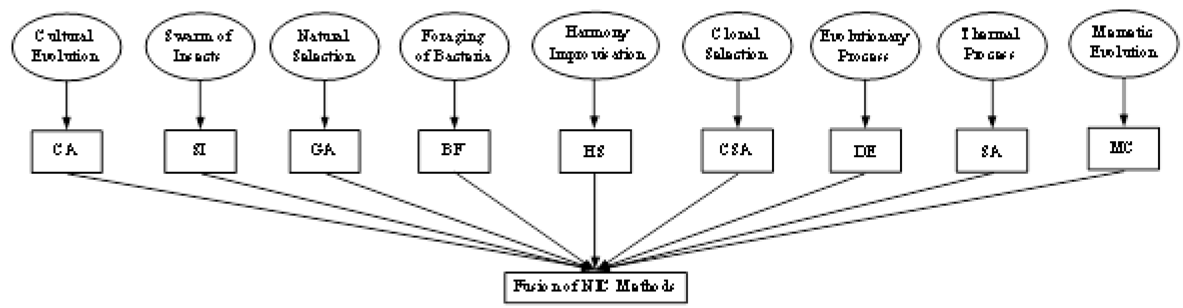

Figure 1: Inspiration and fusion of typical NIC methods.

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Although various hybrid NIC methods have been shown to offer better optimization performances than that of the standalone versions, the 'No Free Lunch (NFL)' theorem is a fundamental barrier to the exaggerated claims of the power and efficiency of any specific optimization algorithms [4]. In other words, there is no single optimization method in practice that can be the best for all kinds of engineering problems. Therefore, one possible way to handle the negative implication of the NFL theorem is to develop hybrid solutions based on the fusion of existing ones and restrict the applications of a given algorithm to only a particular type of optimization tasks.

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