

Preface

Nature-inspired computation has become increasingly popular in engineering and is thus leading to a paradigm shift in problem-solving and design approaches. Many design problems in engineering are complex with multiple nonlinear constraints, and their design objectives can often be conflicting under stringent design requirements. Such problems can be very challenging to solve because of their complexity, nonlinearity and potentially high-dimensionality. Traditional algorithms, especially gradient-based algorithms, can struggle to cope and the results are not satisfactory. New and alternative methods are highly needed.

In the last two decades, nature-inspired computation and optimization algorithms have demonstrated their effectiveness as an alternative set of design tools to deal with such complex design problems. As a result, the popularity of nature-inspired optimization algorithms has started to increase significantly in recent years. These nature-inspired algorithms include particle swarm optimization, differential evolution, cuckoo search, firefly algorithm, bat algorithm, bee algorithms and ant colony optimization as well as others. The key features of these algorithms are their simplicity and flexibility, which enable them to be highly adaptable and sufficiently efficient to deal with a wide range of optimization problems. In practice, they are also easy to be implemented in almost any programming languages, and all these factors have contributed to their popularity in engineering.

A majority of nature-inspired optimization algorithms can be said to belong to the class of swarm intelligence (SI) based algorithms. Swarm intelligence concerns the high-level behaviour arising from simple interactions among multiple agents. Though the main characteristics of swarming behaviour may be drawn from different sources of inspiration in nature, the procedures and steps of each algorithm can be very different. However, they seem to use the self-organized abilities of complex systems based on simple interaction rules. Since most algorithms treat problems under consideration as a black box, it is possible for such algorithms to deal with complex problems with different properties whether continuous, discrete or mixed. In a broad sense, swarm intelligence is part of evolutionary computation paradigm and bio-inspired computation is part of nature-inspired computation;

however, there is still some confusion about some terminologies in the literature. For example, there are some overlaps and there are no agreed standard definitions about bio-inspired computation, nature-inspired computation, metaheuristic and computational intelligence. Therefore, we will not enter the debate about what the right terminology or subject fields should be, but we will rather focus our attention on nature-inspired computation and its applications in engineering.

The diversity and rapid advances in nature-inspired computation have resulted in a much richer literature. Therefore, a timely review is necessary to summarize the latest developments in terms of algorithm developments and their applications in engineering. Algorithms and topics include discrete firefly algorithm, discrete cuckoo search, plant propagation algorithm, parameter-free bat algorithm, gravitational search, biogeography-based algorithm, differential evolution, particle swarm optimization and others. State-of-the-art applications and case studies include vehicle routing, swarming robots, discrete and combinatorial optimization, clustering of wireless sensor networks, cell formation, economic load dispatch, metamodeling, surrogate-assisted cooperative co-evolution, data fitting and reverse engineering as well as other real-world applications.

As a timely review volume, this book can be an ideal reference for researchers, lecturers, graduates and engineers who are interested in latest developments in nature-inspired computation, artificial intelligence and computational intelligence. It can also serve as a reference for relevant courses in computer science, artificial intelligence, machine learning, natural computation, engineering optimization and data mining.

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