Comprehensive Metaheuristics

Algorithms and Applications

Edited by

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CHAPTER

Employment of bio-inspired algorithms in the field of antenna array optimization: A review

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1. Introduction

Numerous variants of Evolutionary Algorithms (EAs) have been developed in the past few decades. The concept of EAs was first presented by Alan Turing in 1948. EAs are based on the characteristics and evolution of several biological species. Much research has been carried on Genetic Algorithms (GAs) [1,2] as well as Evolutionary Programming (EP) approaches [3,4]. EAs can provide effective solutions for single as well as multiobjective optimization problems. The GA was invented by John Holland in 1962. This algorithm is based on genetics and the concept of evolution. Genetics is based on inheritance and deviation of biological properties. According to GA, a set of chosen individuals evolves toward an optimal solution with respect to the selective pressure of the fitness function. The Tabu Search (TS) algorithm was developed by Fred Glover in 1986 [5]. The tendency of local search to get stuck in the region consisting of numerous equal-fit solutions is GA's greatest disadvantage. TS eliminates this drawback. Ant Colony Optimization (ACO) was developed by Marco Dorigo in 1992 [6]. It is inspired by the foraging behavior of ants and their usage of pheromones to exchange information. Ants deposit pheromones on the ground to mark favorable paths. The idea is that the rest of the colony members will follow these demarcated paths to reach the destination (food source) more conveniently. A similar mechanism is used in ACO to solve optimization problems. Significant progress in the history of EAs occurred with the invention of Particle Swarm Optimization (PSO) by James Kennedy in 1995 [7]. This algorithm is inspired by the swarm intelligence of birds as well as fish. Another vector-based EA known as Differential Evolution (DE) was industrialized in 1997 [8]. The Harmony Search (HS) algorithm was introduced by Geem et al. in 2001 [9]. This algorithm is based on music, as finding harmony is the same as finding optimality in an optimization process. For optimization of Internet-hosting centers, Nakrani and Tovey suggested a new algorithm called the Honey Bee Algorithm (HBA) in 2004 [10]. Yang invented the Virtual Bee Algorithm (VBA) in 2005 [11]. In the same year, Karaboga developed Artificial Bee Colony (ABC) [12]. In 2006, Chu and Tsai discovered Cat Swarm Optimization (CSO), which is inspired by the seeking and tracing behavior of cats [13]. In 2008 [14], Yang proposed the Firefly Algorithm (FA), taking inspiration from the flashing behavior

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COMPREHENSIVE METAHEURISTICS

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Metaheuristics are general-purpose problem-solving Artificial Intelligence (AI) techniques that can be used to solve any sort of optimization problems, subject to the proper configuration. *Comprehensive Metaheuristics: Algorithms and Applications* presents the foundational underpinnings of metaheuristics and the broad scope of algorithms and real-world applications across a variety of research fields.

The book begins by presenting fundamentals, mathematical prerequisites, and conceptual approaches to provide readers with a solid foundation of understanding. After presenting multi-objective optimization, constrained optimization, and problem formation for metaheuristics, world-renowned authors give readers in-depth understanding of the full spectrum of algorithms and techniques. Algorithms and techniques covered in Part 1 include Genetic Algorithm, Particle Swarm Optimization, Krill Herd Algorithm, Cuckoo Search Algorithm, Bat Algorithm, Grey Wolf Optimizer, Salp Swarm Optimizer, Dragonfly Algorithm, Grasshopper Optimization Algorithm, Whale Optimization Algorithm, Equilibrium Optimizer, Marine Predator Algorithm, Arithmetic Optimization Algorithm, and Differential Evolution. Scientists, researchers, academicians, and practitioners who are interested in optimizing a process or procedure to achieve a goal will benefit from the case studies of real-world applications from different domains presented in Part 2 of the book.

This book takes a much-needed holistic approach, combining the most widely used metaheuristic algorithms with an in-depth treatise on multi-disciplinary applications of metaheuristics. Each algorithm is thoroughly analyzed to observe its behavior, providing a detailed tutorial on how to solve problems using metaheuristics. New case studies and research problem statements are also discussed, which will help researchers in their application of the concepts, algorithms, and techniques of metaheuristics.

Key Features

- World-renowned researchers and practitioners in metaheuristics present techniques, algorithms, and applications based on real-world case studies
- The book presents methodology for formulating optimization problems for metaheuristics
- The book teaches readers to analyze and tune the performance of a metaheuristic and integrate metaheuristics into other AI techniques
- All source code from the applications and algorithms is available online

About the Editors

Seyedali Mirjalili is a Professor at Torrens University Australia and the founding director of the Center for Artificial Intelligence Research and Optimization. He has published more than 300 journal articles with an H-index of 80. He has been listed on the top 1% of highly cited researchers and named one of the most influential researchers in the world by Web of Science since 2019. In 2021, The Australian newspaper named him the top researcher in Australia in artificial intelligence, evolutionary computation, and fuzzy systems. Professor Mirjalili is a senior member of the Institute of Electrical and Electronics Engineers (IEEE) and an editor of leading AI journals including Neurocomputing, Applied Soft Computing, Advances in Engineering Software, Computers in Biology and Medicine, Healthcare Analytics, Applied Intelligence, and Decision Analytics. His research interests are optimization, evolutionary computation, meta-heuristics, machine learning, and data science.

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