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Evolutionary and Swarm Intelligence Algorithms

Springer

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Preface

Due to the high complexity of real-world optimization problems, often it is not easy to solve them using traditional or deterministic optimization methods. There are many real-world optimization problems for which one can afford near-optimal solution rather than an exact solution. Therefore, a class of robust algorithms is required, which does not depend upon the particular characteristics of the problems and hence can be applied to a wide variety of problems. Evolutionary computation and swarm intelligence-based optimization algorithms serve the purpose. Swarm and evolutionary algorithms are probabilistic algorithms, which are often very effective with problems that are not easy to deal with classical optimization methods. However, we want to emphasize that it is not our intention to say that these families provide a set of all-cure solutions. In fact, because of the stochastic nature of the search process, reproducibility may become a challenging issue unless one is careful about the experiments. Often, the computational overhead could be very high also. If a problem can be tackled with a classical optimization method for which the characteristics of the solutions can be analyzed easily, our prescription is not to use swarm or evolutionary algorithms for such a problem.

This book provides a detailed study and working procedure of few algorithms in the area of swarm intelligence and evolutionary computation. It contains totally nine chapters on various swarm and evolutionary algorithms and their recent application areas. Chapters "Swarm and Evolutionary Computation" to "Spider Monkey Optimization Algorithm" deal with swarm intelligence; Chapters "Genetic Algorithm and Its Advances in Embracing Memetics" and "Constrained Multi-objective Evolutionary Algorithm" focus on genetic algorithms and evolutionary multi-objective optimization, while Chapters "Genetic Programming for Classification and Feature Selection" to "Evolutionary Fuzzy Systems: A Case Study for Intrusion Detection Systems" are on genetic programming.

Chapter "Swarm and Evolutionary Computation" provides a detailed introduction to the two families of algorithms: swarm intelligence and evolutionary computation. This chapter also makes a comparative discussion of the two families and presents their advantages and limitations. Chapter "Particle Swarm Optimization" presents one of the most significant swarm intelligence-based algorithms, Particle Swarm

Optimization (PSO). Apart from its working mechanism, this chapter also explains the significance of each term of the update equation in PSO. Artificial Bee Colony (ABC) optimization algorithm, another very popular member of the swarm intelligence family, is discussed in Chapter "Artificial Bee Colony Algorithm Variants and Its Application to Colormap Quantization". This chapter details the ABC for constrained, multi-objective, and combinatorial optimization problems. ABC has also been applied to colormap quantization problem. In Chapter "Spider Monkey Optimization Algorithm", the Spider Monkey Optimization (SMO), a relatively new member of the swarm intelligence family is introduced. The SMO is a fission-fusion social structure-based optimization algorithm. The chapter explains the motivation and the detailed working mechanism along with a numerical example.

Chapter "Genetic Algorithm and Its Advances in Embracing Memetics" deals with genetic algorithms, particularly genetic algorithms with memetics. Authors first consider meme as a local search process, or an individual learning procedure, whose intensity can be governed by a theoretically derived upper bound. Then, they also treat meme as a building block of structured knowledge, which can be learned and transferred across problem instances for more efficient search. Genetic algorithms with memetics are applied to solve NP-hard capacitated arc routing problem. Evolutionary bilevel optimization is also discussed briefly in this chapter. Evolutionary multi-objective optimization (EMO) algorithms that are specifically designed for handling constraints are discussed in Chapter "Constrained Multi-objective Evolutionary Algorithm". Some numerical test problems as well some engineering design problems involving constraints are discussed. The authors provide a number of future research directions in the field of EMO also. Chapter "Genetic Programming for Classification and Feature Selection" presents a detailed application of the evolutionary fuzzy systems on intrusion detection. Evolutionary fuzzy systems is a generalization of genetic fuzzy systems. Apart from the taxonomy of evolutionary fuzzy systems, the chapter very nicely explains every step of generating an evolutionary fuzzy system. Finally, an application to intrusion detection is presented.

The remaining two chapters cover different aspects of genetic programming. Chapter "Genetic Programming for Job Shop Scheduling" focuses on genetic programming (GP). Naive model of GP-based binary classification strategy is provided. The chapter also discusses important issues related to GP when it is used for classification and feature selection. In Chapter "Evolutionary Fuzzy Systems: A Case Study for Intrusion Detection Systems," authors present an interesting application of genetic programming, job shop scheduling (JSS), a difficult operations research problem. This chapter also provides a brief survey of studies on the dispatching rules for job shop scheduling. Ideas to improve GP for job shop scheduling are also presented.

New Delhi, India — Jagdish Chand Bansal
Gwalior, India — Pramod Kumar Singh
Kolkata, India — Nikhil R. Pal

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He is a recipient of the 2015 IEEE Computational Intelligence Society (CIS) Fuzzy Systems Pioneer Award, and he has given many plenary/keynote speeches in different premier international conferences in the area of computational intelligence. He is Distinguished Lecturer of the IEEE CIS (2010–2012, 2016–2018) and was Member of the Administrative Committee of the IEEE CIS (2010–2012). He has served as Vice President for Publications of the IEEE CIS (2013–2016). He is serving as President of the IEEE CIS (2018–2019).

He is Fellow of the National Academy of Sciences, India, Indian National Academy of Engineering, Indian National Science Academy, International Fuzzy Systems Association (IFSA), The World Academy of Sciences, and Fellow of the IEEE, USA.