

# Preface

Recent advances in structural technology require greater accuracy, efficiency and speed in design of structural systems. It is therefore not surprising that new methods have been developed for optimal design of real-life structures and models with complex configurations and a large number of elements.

This book can be considered as an application of meta-heuristic algorithms to optimal design of skeletal structures. The present book is addressed to those scientists and engineers, and their students, who wish to explore the potential of newly developed meta-heuristics. The concepts presented in this book are not only applicable to skeletal structures and finite element models, but can equally be used for design of other systems such as hydraulic and electrical networks.

The author and his graduate students have been involved in various developments and applications of different meta-heuristic algorithms to structural optimization in the last two decades. The present book contains part of this research suitable for various aspects of optimization for skeletal structures.

The book is likely to be of interest to civil, mechanical and electrical engineers who use optimization methods for design, as well as to those students and researchers in structural optimization who will find it to be necessary professional reading.

In Chap. 1, a short introduction is provided for development of optimization and different meta-heuristic algorithms. Chapter 2 contains one of the most popular meta-heuristic known as the Particle Swarm Optimization (PSO). Chapter 3 provides an efficient meta-heuristic algorithm known as Charged System Search (CSS). This algorithm has found many applications in different fields of civil engineering. In Chap. 4, Magnetic Charged System Search (MCSS) is presented. This algorithm can be considered as an improvement to CSS, where the physical scenario of electrical and magnetic forces is completed. Chapter 5 contains a generalized meta-heuristic so-called Field of Forces Optimization (FFO) approach and its applications. Chapter 6 presents the recently developed algorithm known as Dolphin Echolocation Optimization (DEO) mimicking the behavior of dolphins.

Chapter 7 contains a powerful parameter independent algorithm, called Colliding Bodies Optimization (CBO). This algorithm is based on one-dimensional collisions between bodies, with each agent solution being considered as the massed object or body. After a collision of two moving bodies having specified masses and velocities, these bodies are separated with new velocities. This collision causes the agents to move toward better positions in the search space. In Chap. 8, Ray Optimization Algorithm (ROA) is presented in which agents of the optimization are considered as rays of light. Based on the Snell's light refraction law when light travels from a lighter medium to a darker medium, it refracts and its direction changes. This behavior helps the agents to explore the search space in early stages of the optimization process and to make them converge in the final stages. In Chap. 9, the well known Big Bang-Big Crunch (BB-BC) algorithm is improved (MBB-BC) and applied to structural optimization. Chapter 10 contains application of Cuckoo Search Optimization (CSO) in optimal design of skeletal structures. In Chap. 11, Imperialist Competitive Algorithm (ICA) and its application are discussed. Chaos theory has found many applications in engineering and optimal design. Chapter 12 presents Chaos Embedded Meta-heuristic (CEM) Algorithms. In Chap. 13 the Enhanced Colliding Bodies Optimization (ECBO) is presented. Chapter 14 contains Global Sensitivity Analysis Based (GSAB) optimization method. Chapter 15 presents another recently developed metaheuristic so-called Tug of War Optimization (TWO) method. In Chap. 16, the Water Evaporation Optimization (WEO) is presented that is another new addition to the optimization algorithms. Chapter 17 presents the Vibrating Particle System (VPS) Optimization. In Chap. 18 the Cyclical Parthenogenesis Optimization (CPO) algorithms is presented. Chapter 19 is devoted to optimal design of large scale frame structures. Finally, Chap. 20 can be considered as a brief introduction to multi-objective optimization. In this chapter a multi-objective optimization algorithm is presented and applied to optimal design of truss structures.

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Every effort has been made to render the book error free. However, the author would appreciate any remaining errors being brought to his attention through by his email-address: [alikhavah@iust.ac.ir](mailto:alikhavah@iust.ac.ir).

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