Preface

Almost all design problems in engineering can be considered as optimization problems and thus require optimization techniques to solve. However, as most real-world problems are highly nonlinear, traditional optimization methods usually do not work well. The current trend is to use evolutionary algorithms and metaheuristic optimization methods to tackle such nonlinear optimization problems. Metaheuristic algorithms have gained huge popularity in recent years. These metaheuristic algorithms include genetic algorithms, particle swarm optimization, bat algorithm, cuckoo search, differential evolution, firefly algorithm, harmony search, flower pollination algorithm, ant colony optimization, bee algorithms, and many others. The popularity of nature-inspired metaheuristic algorithms can be attributed to their good characteristics because these algorithms are simple, flexible, efficient, and adaptable, and yet easy to implement. Such advantages make them versatile to deal with a wide range of optimization problems without much a priori knowledge about the problem to be solved.

Metaheuristic algorithms play an important role in the optimum design of complex engineering problems when analytical approaches and traditional methods are not effective for solving nonlinear design problems in civil engineering. Generally speaking, these design problems are highly nonlinear with complex constraints, and thus are also highly multimodal. These design constraints often come from design requirements and security measures such as the stresses on the members due to external loading, environmental factors, and usability under service loads. A mathematical solution may be the best approach in an ideal world, but in engineering designs, the values of a design variable such as mass or length must be realistic; for example, quantities must be nonnegative. In addition, such design values must correspond to something that can be manufacturable in practice.

For all engineering disciplines, optimization is crucially important in the design process so as to find a good balance between economy and security that are the primary goals of designs. Aesthetics and practicability are also important in real-world applications. Civil engineering is probably the oldest engineering discipline and it has always been linked to the construction and realization of civilization. In fact, optimization may be more relevant in civil engineering than in other engineering disciplines. For example, in designing a non-critical machine part in mechanical engineering, the stresses on the part must not exceed certain limits. If a stronger part is used, it may become too expensive. On the other hand, a weaker part may still be able to make the machine work properly, but in time such weak parts can be worn off or damaged. However, such parts may be easy to be replaced at low costs. If this is the case, machine serviceability can be maintained in practice. But in civil engineering, structural integrity and safety may impose stringent restrictions on the structural members that may not be easily replaced. In such cases, all design constraints and the best possible balance between security and economy must be found without risking lives. In addition, sometimes, the minor improvement may not be as important as robustness in applications. A robust design should be able to handle uncertainties in terms of material properties, manufacturing tolerance, and load irregularity in service. Due to complexity and a large number of design constraints in civil engineering, traditional methods often struggle to cope with such high nonlinearity and multimodality. Thus, metaheuristic optimization methods have become important tools in the optimum design in civil engineering.

This edited book strives to summarize the latest developments in optimization and metaheuristic algorithms with emphasis on applications in civil engineering. Topics include the overview of meteaheuristic algorithms and optimization, structural optimization by flower pollination algorithm, steel design by swarm intelligence, optimum seismic design of steel frames by bat algorithm, 3D truss optimization by genetic algorithms, reactive power optimization by cuckoo search, structural design by harmony search, asphalt pavement management, reinforced concrete beam design, transport infrastructure planning, water distribution networks, capacitated vehicle routing, slope stability problems, and others. Therefore, this timely book can serve as an ideal reference for graduates, lecturers, engineers, and researchers in civil engineering, mechanical engineering, transport and geotechnical engineering. It can also serve as a timely reference for relevant university courses in all disciplines in civil engineering.

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