Metaheuristics From Design To Implementation

This book highlights state-of-the-art developments in metaheuristics research. It examines all aspects of metaheuristic research including new algorithmic developments, applications, new research challenges, theoretical developments, implementation issues, in-depth experimental studies. The book is divided into two sections. Part I is focused on new optimization and modeling techniques based on metaheuristics. The chapters in this section cover topics from multi-objective problems with fuzzy data with triangular-valued objective functions, to hyper-heuristics optimization methodology, designing genetic algorithms, and also the cuckoo search algorithm. The techniques described help to enhance the usability and increase the potential of metaheuristic algorithms. Part II showcases advanced metaheuristic approaches to solve real-life applications issues. This includes an examination of scheduling, the vehicle routing problem, multimedia sensor network, supplier selection, bin packing, objects tracking, and radio frequency identification. In the fields covered in the chapters are of high-impact applications of metaheuristics. The chapters offer innovative applications of metaheuristics that have a potential of widening research frontiers. Altogether, this book offers a comprehensive look at how researchers are currently using metaheuristics in different domains of design and application.

Due to increasing industry 4.0 practices, massive industrial process data is now available for researchers for modelling and optimization. Artificial Intelligence methods can be applied to the ever-increasing process data to achieve robust control against foreseen and unforeseen system fluctuations. Smart computing techniques, machine learning, deep learning, computer vision, for example, will be inseparable from the highly automated factories of tomorrow. Effective cybersecurity will be a must for all Internet of Things (IoT) enabled work and office spaces. This book addresses metaheuristics in all aspects of Industry 4.0. It covers metaheuristic applications in IoT, cyber physical systems, control systems, smart computing, artificial intelligence, sensor networks, robotics, cybersecurity, smart factory, predictive analytics and more. Key features: Includes industrial case studies. Includes chapters on cyber physical systems, machine learning, deep learning, cybersecurity, robotics, smart manufacturing and predictive analytics. surveys current trends and challenges in metaheuristics and industry 4.0. Metaheuristic Algorithms in Industry 4.0 provides a guiding light to engineers, researchers, students, faculty and other professionals engaged in exploring and implementing industry 4.0 solutions in various systems and processes.

Interested in the Genetic Algorithm? Simulated Annealing? Ant Colony Optimization? Essentials of Metaheuristics covers these and other metaheuristics algorithms, and is intended for undergraduate students, programmers, and non-experts. The book covers a wide range of algorithms, representations, selection and modification operators, and related topics, and includes 71 figures and 135 algorithms great and small. Algorithms include: Gradient Ascent techniques, Hill-Climbing variants, Simulated Annealing, Tabu Search variants, Iterated Local Search, Evolution Strategies, the Genetic Algorithm, the Steady-State Genetic Algorithm, Differential Evolution, Particle Swarm Optimization, Genetic Programming variants, One- and Two-Population Competitive Coevolution, N-Population Cooperative Coevolution, Implicit Fitness Sharing, Deterministic Crowding, NSGA-II, SPEA2, GRASP, Ant Colony Optimization variants, Guided Local Search, LEM, PBIL, UMDA, cGA, BOA, SAMUEL, ZCS, XCS, and XCSF.

This book lays the foundations for a scientific approach to tuning metaheuristics. The fundamental intuition that underlies Birattari's approach is that the tuning problem has much in common with the problems that are typically faced in machine learning.

This book is a collection of the most recent approaches that combine metaheuristics and machine learning. Some of the methods considered in this book are evolutionary, swarm, machine learning, and deep learning. The chapters were classified based on the content; then, the sections are thematic. Different applications and implementations are included; in this sense, the book provides theory and practical content with novel machine learning and metaheuristic algorithms. The chapters were compiled using a scientific perspective. Accordingly, the book is primarily intended for undergraduate and postgraduate students of Science, Engineering, and Computational Mathematics and is useful in courses on Artificial Intelligence, Advanced Machine Learning, among others. Likewise, the book is useful for research from the evolutionary computation, artificial intelligence, and image processing communities.

Introduces quantum inspired techniques for image analysis for pure and true gray scale/color images in a single/multi-objective environment This book will entice readers to design efficient meta-heuristics for image analysis in the quantum domain. It introduces them to the essence of quantum computing paradigm, its features, and properties, and elaborates on the fundamentals of different meta-heuristics and their application to image analysis. As a result, it will pave the way for designing and developing quantum computing inspired meta-heuristics to be applied to image analysis. Quantum Inspired Meta-heuristics for Image Analysis begins with a brief summary on image segmentation, quantum computing, and optimization. It also highlights a few relevant applications of the quantum based computing algorithms, meta-heuristics approach, and several thresholding algorithms in vogue. Next, it discusses a review of image analysis before moving on to an overview of six popular meta-heuristics and their algorithms and pseudo-codes. Subsequent chapters look at quantum inspired meta-heuristics for bi-level and gray scale multi-level image thresholding; quantum behaved meta-heuristics for true color multi-level image thresholding; and quantum inspired multi-objective algorithms for gray scale multi-level image thresholding. Each chapter concludes with a summary and sample questions. Provides in-depth analysis of quantum mechanical principles Offers comprehensive review of image analysis Analyzes different state-of-the-art image thresholding approaches Detailed current, popular standard meta-heuristics in use today Guides readers step by step in the build-up of quantum inspired meta-heuristics Includes a plethora of real life case studies and applications Features statistical test analysis of the performances of the quantum inspired meta-heuristics vis-à-vis their conventional counterparts Quantum Inspired Meta-heuristics for Image Analysis is an excellent source of information for anyone working with or learning quantum inspired meta-heuristics for image analysis.

This new, expanded textbook describes all phases of a modern compiler: lexical analysis, parsing, abstract syntax, semantic actions, intermediate representations, instruction selection via tree matching, dataflow analysis, graph-coloring register allocation, and runtime systems. It includes good coverage of current techniques in code generation and register allocation, as well as functional and object-oriented languages, that are missing from most books. In addition, more advanced chapters are now included so that it can be used as the basis for two-semester or

graduate course. The most accepted and successful techniques are described in a concise way, rather than as an exhaustive catalog of every possible variant. Detailed descriptions of the interfaces between modules of a compiler are illustrated with actual C header files. The first part of the book, Fundamentals of Compilation, is suitable for a one-semester first course in compiler design. The second part, Advanced Topics, which includes the advanced chapters, covers the compilation of object-oriented and functional languages, garbage collection, loop optimizations, SSA form, loop scheduling, and optimization for cache-memory hierarchies.

This book gathers together a set of chapters covering recent development in optimization methods that are inspired by nature. The first group of chapters describes in detail different meta-heuristic algorithms, and shows their applicability using some test or real-world problems. The second part of the book is especially focused on advanced applications and case studies. They span different engineering fields, including mechanical, electrical and civil engineering, and earth/environmental science, and covers topics such as robotics, water management, process optimization, among others. The book covers both basic concepts and advanced issues, offering a timely introduction to nature-inspired optimization method for newcomers and students, and a source of inspiration as well as important practical insights to engineers and researchers.

The main goal of this book is to provide a state of the art of hybrid metaheuristics. The book provides a complete background that enables readers to design and implement hybrid metaheuristics to solve complex optimization problems (continuous/discrete, mono-objective/multi-objective, optimization under uncertainty) in a diverse range of application domains. Readers learn to solve large scale problems quickly and efficiently combining metaheuristics with complementary metaheuristics, mathematical programming, constraint programming and machine learning. Numerous real-world examples of problems and solutions demonstrate how hybrid metaheuristics are applied in such fields as networks, logistics and transportation, bio-medical, engineering design, scheduling.

Renewable Energy Systems: Modelling, Optimization and Control aims to cross-pollinate recent advances in the study of renewable energy control systems by bringing together diverse scientific breakthroughs on the modeling, control and optimization of renewable energy systems by leading researchers. The book brings together the most comprehensive collection of modeling, control theorems and optimization techniques to help solve many scientific issues for researchers in renewable energy and control engineering. Many multidisciplinary applications are discussed, including new fundamentals, modeling, analysis, design, realization and experimental results. The book also covers new circuits and systems to help researchers solve many nonlinear problems. This book fills the gaps between different interdisciplinary applications, ranging from mathematical concepts, modeling, and analysis, up to the realization and experimental work. Covers modeling, control theorems and optimization techniques which will solve many scientific issues for researchers in renewable energy Discusses many multidisciplinary applications with new fundamentals, modeling, analysis, design, realization and experimental results Includes new circuits and systems, helping researchers solve many nonlinear problems

This book engages in an ongoing topic, such as the implementation of nature-inspired metaheuristic algorithms, with a main concentration on optimization problems in different fields of engineering optimization applications. The chapters of the book provide concise overviews of various nature-inspired metaheuristic algorithms, defining their profits in obtaining the optimal solutions of tiresome engineering design problems that cannot be efficiently resolved via conventional mathematical-based techniques. Thus, the chapters report on advanced studies on the applications of not only the traditional, but also the contemporary certain nature-inspired metaheuristic algorithms to specific engineering optimization problems with single and multi-objectives. Harmony search, artificial bee colony, teaching learning-based optimization, electrostatic discharge, grasshopper, backtracking search, and interactive search are just some of the methods exhibited and consulted step by step in application contexts. The book is a perfect guide for graduate students, researchers, academicians, and professionals willing to use metaheuristic algorithms in engineering optimization applications.

A unified view of metaheuristics This book provides a complete background on metaheuristics and shows readers how to design and implement efficient algorithms to solve complex optimization problems across a diverse range of applications, from networking and bioinformatics to engineering design, routing, and scheduling. It presents the main design questions for all families of metaheuristics and clearly illustrates how to implement the algorithms under a software framework to reuse both the design and code. Throughout the book, the key search components of metaheuristics are considered as a toolbox for: Designing efficient metaheuristics (e.g. local search, tabu search, simulated annealing, evolutionary algorithms, particle swarm optimization, scatter search, ant colonies, bee colonies, artificial immune systems) for optimization problems Designing efficient metaheuristics for multi-objective optimization problems Designing hybrid, parallel, and distributed metaheuristics Implementing metaheuristics on sequential and parallel machines Using many case studies and treating design and implementation independently, this book gives readers the skills necessary to solve large-scale optimization problems quickly and efficiently. It is a valuable reference for practicing engineers and researchers from diverse areas dealing with optimization or machine learning; and graduate students in computer science, operations research, control, engineering, business and management, and applied mathematics.

Due to an ever-decreasing supply in raw materials and stringent constraints on conventional energy sources, demand for lightweight, efficient and low cost structures has become crucially important in modern engineering design. This requires engineers to search for optimal and robust design options to address design problems that are often large in scale and highly nonlinear, making finding solutions challenging. In the past two decades, metaheuristic algorithms have shown promising power, efficiency and versatility in solving these difficult optimization problems. This book examines the latest developments of metaheuristics and their applications in water, geotechnical and transport engineering offering practical case studies as examples to demonstrate real world applications. Topics cover a range of areas within engineering, including reviews of optimization algorithms, artificial intelligence, cuckoo search, genetic programming, neural networks, multivariate adaptive regression, swarm intelligence, genetic algorithms, ant colony optimization, evolutionary multiobjective optimization with diverse applications in engineering such as behavior of materials, geotechnical design, flood control, water distribution and signal networks. This book can serve as a supplementary text for design courses and computation in engineering as well as a reference for researchers and engineers in metaheursitics, optimization in civil engineering and computational intelligence. Provides detailed descriptions of all major metaheuristic algorithms with a focus on practical implementation Develops new hybrid and advanced methods suitable for civil engineering problems at all levels Appropriate for researchers and advanced students to help to develop their work

Modern metaheuristic algorithms such as bee algorithms and harmony search start to demonstrate their power in dealing with tough optimization problems and even NP-hard problems. This book reviews and introduces the state-of-the-art nature-inspired metaheuristic algorithms in optimization, including genetic algorithms, bee algorithms, particle swarm optimization, simulated annealing, ant colony optimization, harmony search, and firefly algorithms. We also briefly introduce the photosynthetic algorithm, the enzyme algorithm, and Tabu search. Worked examples with implementation have been used to show how each algorithm works. This book is thus an ideal textbook for an undergraduate and/or graduate course. As some of the algorithms such as the harmony search and firefly algorithms are at the forefront of current research, this book can also serve as a reference book for researchers.

This book presents efficient metaheuristic algorithms for optimal design of structures. Many of these algorithms are developed by the author and his colleagues, consisting of Democratic Particle Swarm

Optimization, Charged System Search, Magnetic Charged System Search, Field of Forces Optimization, Dolphin Echolocation Optimization, Colliding Bodies Optimization, Ray Optimization. These are presented together with algorithms which were developed by other authors and have been successfully applied to various optimization problems. These consist of Particle Swarm Optimization, Big Bang-Big Crunch Algorithm, Cuckoo Search Optimization, Imperialist Competitive Algorithm, and Chaos Embedded Metaheuristic Algorithms. Finally a multi-objective optimization method is presented to solve large-scale structural problems based on the Charged System Search algorithm. The concepts and algorithms presented in this book are not only applicable to optimization of skeletal structures and finite element models, but can equally be utilized for optimal design of other systems such as hydraulic and electrical networks. In the second edition seven new chapters are added consisting of the new developments in the field of optimization. These chapters consist of the Enhanced Colliding Bodies Optimization, Global Sensitivity Analysis, Tug of War Optimization, Water Evaporation Optimization, Vibrating Particle System Optimization and Cyclical Parthenogenesis Optimization algorithms. A chapter is also devoted to optimal design of large scale structures.

Solving complex optimization problems with parallelmetaheuristics Parallel Metaheuristics brings together an international group ofexperts in parallelism and metaheuristics to provide a much-neededsynthesis of these two fields. Readers discover how metaheuristictechniques can provide useful and practical solutions for a widerange of problems and application domains, with an emphasis on thefields of telecommunications and bioinformatics. This volume fillsa long-existing gap, allowing researchers and practitioners todevelop efficient metaheuristic algorithms to find solutions. The book is divided into three parts: * Part One: Introduction to Metaheuristics and Parallelism,including an Introduction to Metaheuristic Techniques, Measuringthe Performance of Parallel Metaheuristics, New Technologies inParallelism, and a head-to-head discussion on Metaheuristics andParallelism * Part Two: Parallel Metaheuristic Models, including ParallelGenetic Algorithms, Parallel Genetic Programming, ParallelEvolution Strategies, Parallel Ant Colony Algorithms, ParallelEstimation of Distribution Algorithms, Parallel Scatter Search,Parallel Variable Neighborhood Search, Parallel SimulatedAnnealing, Parallel Tabu Search, Parallel GRASP, Parallel HybridMetaheuristics, Parallel Multi-Objective Optimization, and ParallelHeterogeneous Metaheuristics * Part Three: Theory and Applications, including Theory of ParallelGenetic Algorithms, Parallel Metaheuristics Applications, ParallelMetaheuristics in Telecommunications, and a final chapter onBioinformatics and Parallel Metaheuristics Each self-contained chapter begins with clear overviews andintroductions that bring the reader up to speed, describes basictechniques, and ends with a reference list for further study.Packed with numerous tables and figures to illustrate the complextheory and processes, this comprehensive volume also includesnumerous practical real-world optimization problems and theirsolutions. This is essential reading for students and researchers in computerscience, mathematics, and engineering who deal with parallelism,metaheuristics, and optimization in general.

In the automotive industry, a Control Engineer must design a unique control law that is then tested and validated on a single prototype with a level of reliability high enough to to meet a number of complex specifications on various systems. In order to do this, the Engineer uses an experimental iterative process (Trial and Error phase) which relies heavily on his or her experience. This book looks to optimise the methods for synthesising servo controllers ny making them more direct and thus quicker to design. This is achieved by calculating a final controller to directly tackle the high-end system specs.

Nature-inspired computation and swarm intelligence have become popular and effective tools for solving problems in optimization, computational intelligence, soft computing and data science. Recently, the literature in the field has expanded rapidly, with new algorithms and applications emerging. Nature-Inspired Computation and Swarm Intelligence: Algorithms, Theory and Applications is a timely reference giving a comprehensive review of relevant state-of-the-art developments in algorithms, theory and applications of nature-inspired algorithms and swarm intelligence. It reviews and documents the new developments, focusing on nature-inspired algorithms and their theoretical analysis, as well as providing a guide to their implementation. The book includes case studies of diverse real-world applications, balancing explanation of the theory with practical implementation. Nature-Inspired Computation and Swarm Intelligence: Algorithms, Theory and Applications is suitable for researchers and graduate students in computer science, engineering, data science, and management science, who want a comprehensive review of algorithms, theory and implementation within the fields of nature inspired computation and swarm intelligence. Introduces nature-inspired algorithms and their fundamentals, including: particle swarm optimization, bat algorithm, cuckoo search, firefly algorithm, flower pollination algorithm, differential evolution and genetic algorithms as well as multi-objective optimization algorithms and others Provides a theoretical foundation and analyses of algorithms, including: statistical theory and Markov chain theory on the convergence and stability of algorithms, dynamical system theory, benchmarking of optimization, no-free-lunch theorems, and a generalized mathematical framework Includes a diversity of case studies of real-world applications: feature selection, clustering and classification, tuning of restricted Boltzmann machines, travelling salesman problem, classification of white blood cells, music generation by artificial intelligence, swarm robots, neural networks, engineering designs and others

Building accurate algorithms for the optimization of picking orders is a difficult task, especially when one considers the delays of real-world situations. In warehouse environments, diverse algorithms must be developed to enhance the global performance relating to combining customer orders into picking orders to reduce wait times. The Handbook of Research on Metaheuristics for Order Picking Optimization in Warehouses to Smart Cities is a pivotal reference source that addresses strategies for developing able algorithms in order to build better picking orders and the impact of these strategies on the picking systems in which diverse algorithms are implemented. While highlighting topics such ABC optimization, environmental intelligence, and order batching, this publication examines common picking aspects in warehouse environments ranging from manual order picking systems to automated retrieval systems. This book is intended for researchers, teachers, engineers, managers, and practitioners seeking research on algorithms to enhance the order picking performance.

Optimization problems are of great importance across a broad range of fields. They can be tackled, for example, by approximate algorithms such as metaheuristics. This book is intended both to provide an overview of hybrid metaheuristics to novices of the field, and to provide researchers from the field with a collection of some of the most interesting recent developments. The authors involved in this book are among the top researchers in their domain.

This timely book deals with a current topic, i.e. the applications of metaheuristic algorithms, with a primary focus on optimization problems in civil engineering. The first chapter offers a concise overview of different kinds of metaheuristic algorithms, explaining their advantages in solving complex engineering problems that cannot be effectively tackled by traditional methods, and citing the most important works for further reading. The remaining chapters report on advanced studies on the applications of certain metaheuristic algorithms to specific engineering problems. Genetic algorithm, bat algorithm, cuckoo search, harmony search and simulated annealing are just some of the methods presented and discussed step by step in real-application contexts, in which they are often used in combination with each other. Thanks to its synthetic yet meticulous and practice-oriented approach, the book is a perfect guide for graduate students, researchers and professionals willing to applying metaheuristic algorithms in civil engineering and other related engineering fields, such as mechanical, transport and geotechnical engineering. It is also a valuable aid for both lectures and advanced engineering students.

Most textbooks on modern heuristics provide the reader with detailed descriptions of the functionality of single examples like genetic algorithms, genetic programming, tabu search, simulated annealing, and others, but fail to teach the underlying concepts behind these different approaches. The author takes a different approach in this textbook by focusing on the users' needs and answering three fundamental questions: First, he tells us which problems modern heuristics are expected to perform well on, and which should be left to traditional optimization methods. Second, he teaches us to systematically design the "right" modern heuristic for a particular problem by providing a coherent view on design elements and working principles. Third, he shows how we can make use of problem-specific knowledge for the design of efficient and effective modern heuristics that solve not only small toy problems but also perform well on large real-world problems. This book is written in an easy-to-read style and it is aimed at students and practitioners in computer science, operations research and information systems who want to understand modern heuristics and are interested in a guide to their systematic design and use. This book is written in an easy-to-read style and it is aimed at students and practitioners in computer science, operations research and information systems who want to understand modern heuristics and are interested in a guide to their systematic design and use. This book is written in an easy-to-read style and it is aimed at students and practitioners in computer science, operations research and information systems who want to understand modern heuristics and are interested in a guide to their systematic design and use.

Modern optimization approaches have attracted an increasing number of scientists, decision makers, and researchers. As new issues in this field emerge, different optimization methodologies must be developed and implemented. The Handbook of Research on Emergent Applications of Optimization Algorithms is an authoritative reference source for the latest scholarly research on modern optimization techniques for solving complex problems of global optimization and their applications in economics and engineering. Featuring coverage on a broad range of topics and perspectives such as hybrid systems, non-cooperative games, and cryptography, this publication is ideally designed for students, researchers, and engineers interested in emerging developments in optimization algorithms.

This book provides a handbook of algorithmic recipes from the fields of Metaheuristics, Biologically Inspired Computation and Computational Intelligence that have been described in a complete, consistent, and centralized manner. These standardized descriptions were carefully designed to be accessible, usable, and understandable. Most of the algorithms described in this book were originally inspired by biological and natural systems, such as the adaptive capabilities of genetic evolution and the acquired immune system, and the foraging behaviors of birds, bees, ants and bacteria. An encyclopedic algorithm reference, this book is intended for research scientists, engineers, students, and interested amateurs. Each algorithm description provides a working code example in the Ruby Programming Language.

Pinedo is a major figure in the scheduling area (well versed in both stochastics and combinatorics) , and knows both the academic and practitioner side of the discipline. This book includes the integration of case studies into the text. It will appeal to engineering and business students interested in operations research.

Local Electricity Markets introduces the fundamental characteristics, needs, and constraints shaping the design and implementation of local electricity markets. It addresses current proposed local market models and lessons from their limited practical implementation. The work discusses relevant decision and informatics tools considered important in the implementation of local electricity markets. It also includes a review on management and trading platforms, including commercially available tools. Aspects of local electricity market infrastructure are identified and discussed, including physical and software infrastructure. It discusses the current regulatory frameworks available for local electricity market development internationally. The work concludes with a discussion of barriers and opportunities for local electricity markets in the future. Delineates key components shaping the design and implementation of local electricity market structure Provides a coherent view on the enabling infrastructures and technologies that underpin local market expansion Explores the current regulatory environment for local electricity markets drawn from a global panel of contributors Exposes future paths toward widespread implementation of local electricity markets using an empirical review of barriers and opportunities Reviews relevant local electricity market case studies, pilots and demonstrators already deployed and under implementation

The book presents eight well-known and often used algorithms besides nine newly developed algorithms by the first author and his students in a practical implementation framework. Matlab codes and some benchmark structural optimization problems are provided. The aim is to provide an efficient context for experienced researchers or readers not familiar with theory, applications and computational developments of the considered metaheuristics. The information will also be of interest to readers interested in application of metaheuristics for hard optimization, comparing conceptually different metaheuristics and designing new metaheuristics.

Mathematicians have devised different chaotic systems that are modeled by integer or fractional-order differential equations, and whose mathematical models can generate

chaos or hyperchaos. The numerical methods to simulate those integer and fractional-order chaotic systems are quite different and their exactness is responsible in the evaluation of characteristics like Lyapunov exponents, Kaplan-Yorke dimension, and entropy. One challenge is estimating the step-size to run a numerical method. It can be done analyzing the eigenvalues of self-excited attractors, while for hidden attractors it is difficult to evaluate the equilibrium points that are required to formulate the Jacobian matrices. Time simulation of fractional-order chaotic oscillators also requires estimating a memory length to achieve exact results, and it is associated to memories in hardware design. In this manner, simulating chaotic/hyperchaotic oscillators of integer/fractional-order and with self-excited/hidden attractors is quite important to evaluate their Lyapunov exponents, Kaplan-Yorke dimension and entropy. Further, to improve the dynamics of the oscillators, their main characteristics can be optimized applying metaheuristics, which basically consists of varying the values of the coefficients of a mathematical model. The optimized models can then be implemented using commercially available amplifiers, field-programmable analog arrays (FPAA), field-programmable gate arrays (FPGA), microcontrollers, graphic processing units, and even using nanometer technology of integrated circuits. The book describes the application of different numerical methods to simulate integer/fractional-order chaotic systems. These methods are used within optimization loops to maximize positive Lyapunov exponents, Kaplan-Yorke dimension, and entropy. Single and multi-objective optimization approaches applying metaheuristics are described, as well as their tuning techniques to generate feasible solutions that are suitable for electronic implementation. The book details several applications of chaotic oscillators such as in random bit/number generators, cryptography, secure communications, robotics, and Internet of Things.

Metaheuristic algorithms are considered as generic optimization tools that can solve very complex problems characterized by having very large search spaces. Metaheuristic methods reduce the effective size of the search space through the use of effective search strategies. Book Features: Provides a unified view of the most popular metaheuristic methods currently in use Includes the necessary concepts to enable readers to implement and modify already known metaheuristic methods to solve problems Covers design aspects and implementation in MATLAB® Contains numerous examples of problems and solutions that demonstrate the power of these methods of optimization The material has been written from a teaching perspective and, for this reason, this book is primarily intended for undergraduate and postgraduate students of artificial intelligence, metaheuristic methods, and/or evolutionary computation. The objective is to bridge the gap between metaheuristic techniques and complex optimization problems that profit from the convenient properties of metaheuristic approaches. Therefore, engineer practitioners who are not familiar with metaheuristic computation will appreciate that the techniques discussed are beyond simple theoretical tools, since they have been adapted to solve significant problems that commonly arise in such areas.

Nature-Inspired Optimization Algorithms provides a systematic introduction to all major nature-inspired algorithms for optimization. The book's unified approach, balancing algorithm introduction, theoretical background and practical implementation, complements extensive literature with well-chosen case studies to illustrate how these algorithms work. Topics include particle swarm optimization, ant and bee algorithms, simulated annealing, cuckoo search, firefly algorithm, bat algorithm, flower algorithm, harmony search, algorithm analysis, constraint handling, hybrid methods, parameter tuning and control, as well as multi-objective optimization. This book can serve as an introductory book for graduates, doctoral students and lecturers in computer science, engineering and natural sciences. It can also serve a source of inspiration for new applications. Researchers and engineers as well as experienced experts will also find it a handy reference. Discusses and summarizes the latest developments in nature-inspired algorithms with comprehensive, timely literature Provides a theoretical understanding as well as practical implementation hints Provides a step-by-step introduction to each algorithm

To date, reconfigurable manufacturing systems (RMSs) are among the most effective manufacturing styles that can offer manufacturers an alternative way of facing up to the challenges of continual changes in production requirements within the global, competitive and dynamic manufacturing environments. However, availability of optimal process plans that are suitable for reconfigurable manufacturing is one of the key enablers - yet to be fully unlocked - for realizing the full benefits of true RMSs. To unlock the process planning key and advance the state of art of reconfigurable manufacturing in the manufacturing industry, a number of questions need to be answered: (i) what decision making models and (ii) what computational techniques, can be applied to provide optimal manufacturing process planning solutions that are suitable for logical reconfiguration in manufacturing systems? To answer these questions, you must understand how to model reconfigurable manufacturing activities in an optimization perspective. You must also understand how to develop and select appropriate optimization techniques for solving process planning problems in manufacturing systems. To this end, Process Planning Optimization in Reconfigurable Manufacturing Systems covers: the design and operation of RMSs, optimal process planning modelling for reconfigurable manufacturing and the design and implementation of heuristic algorithm design techniques. The author explores how to: model optimization problems, select suitable optimization techniques, develop optimization algorithms, comparatively analyze the performance of candidate metaheuristics and how to investigate the effects of optimal process planning solutions on operating levels in manufacturing systems. This book delineates five alternative heuristic algorithm design techniques based on simulated annealing, genetic algorithms and the boltzmann machine that are tasked to solve manufacturing process planning optimization problems in RMSs. After reading this book, you will understand: how a reconfigurable manufacturing system works, the different types of manufacturing optimization problems associated with reconfigurable manufacturing, as well as the conventional and intelligent techniques that are suitable for solving process planning optimization problems. You will also be able to develop and implement effective optimization procedures and algorithms for a wide spectrum of optimization problems in design and reconfigurable manufacturing."

An overview of the rapidly growing field of ant colony optimization that describes theoretical findings, the major algorithms, and current applications. The complex social behaviors

of ants have been much studied by science, and computer scientists are now finding that these behavior patterns can provide models for solving difficult combinatorial optimization problems. The attempt to develop algorithms inspired by one aspect of ant behavior, the ability to find what computer scientists would call shortest paths, has become the field of ant colony optimization (ACO), the most successful and widely recognized algorithmic technique based on ant behavior. This book presents an overview of this rapidly growing field, from its theoretical inception to practical applications, including descriptions of many available ACO algorithms and their uses. The book first describes the translation of observed ant behavior into working optimization algorithms. The ant colony metaheuristic is then introduced and viewed in the general context of combinatorial optimization. This is followed by a detailed description and guide to all major ACO algorithms and a report on current theoretical findings. The book surveys ACO applications now in use, including routing, assignment, scheduling, subset, machine learning, and bioinformatics problems. AntNet, an ACO algorithm designed for the network routing problem, is described in detail. The authors conclude by summarizing the progress in the field and outlining future research directions. Each chapter ends with bibliographic material, bullet points setting out important ideas covered in the chapter, and exercises. Ant Colony Optimization will be of interest to academic and industry researchers, graduate students, and practitioners who wish to learn how to implement ACO algorithms.

The third edition of this handbook is designed to provide a broad coverage of the concepts, implementations, and applications in metaheuristics. The book's chapters serve as stand-alone presentations giving both the necessary underpinnings as well as practical guides for implementation. The nature of metaheuristics invites an analyst to modify basic methods in response to problem characteristics, past experiences, and personal preferences, and the chapters in this handbook are designed to facilitate this process as well. This new edition has been fully revised and features new chapters on swarm intelligence and automated design of metaheuristics from flexible algorithm frameworks. The authors who have contributed to this volume represent leading figures from the metaheuristic community and are responsible for pioneering contributions to the fields they write about. Their collective work has significantly enriched the field of optimization in general and combinatorial optimization in particular.Metaheuristics are solution methods that orchestrate an interaction between local improvement procedures and higher level strategies to create a process capable of escaping from local optima and performing a robust search of a solution space. In addition, many new and exciting developments and extensions have been observed in the last few years. Hybrids of metaheuristics with other optimization techniques, like branch-and-bound, mathematical programming or constraint programming are also increasingly popular. On the front of applications, metaheuristics are now used to find high-quality solutions to an ever-growing number of complex, ill-defined real-world problems, in particular combinatorial ones. This handbook should continue to be a great reference for researchers, graduate students, as well as practitioners interested in metaheuristics.

This book is the first comprehensive tutorial on matheuristics. Matheuristics are based on mathematical extensions of previously known heuristics, mainly metaheuristics, and on original, area-specific approaches. This tutorial provides a detailed discussion of both contributions, presenting the pseudocodes of over 40 algorithms, abundant literature references, and for each case a step-by-step description of a sample run on a common Generalized Assignment Problem example. C++ source codes of all algorithms are available in an associated SW repository.

An accessible introduction to metaheuristics and optimization, featuring powerful and modern algorithms for application across engineering and the sciences From engineering and computer science to economics and management science, optimization is a core component for problem solving. Highlighting the latest developments that have evolved in recent years, Engineering Optimization: An Introduction with Metaheuristic Applications outlines popular metaheuristic algorithms and equips readers with the skills needed to apply these techniques to their own optimization problems. With insightful examples from various fields of study, the author highlights key concepts and techniques for the successful application of commonly-used metaheuristc algorithms, including simulated annealing, particle swarm optimization, harmony search, and genetic algorithms. The author introduces all major metaheuristic algorithms and their applications in optimization through a presentation that is organized into three succinct parts: Foundations of Optimization and Algorithms provides a brief introduction to the underlying nature of optimization and the common approaches to optimization problems, random number generation, the Monte Carlo method, and the Markov chain Monte Carlo method Metaheuristic Algorithms presents common metaheuristic algorithms in detail, including genetic algorithms, simulated annealing, ant algorithms, bee algorithms, particle swarm optimization, firefly algorithms, and harmony search Applications outlines a wide range of applications that use metaheuristic algorithms to solve challenging optimization problems with detailed implementation while also introducing various modifications used for multi-objective optimization Throughout the book, the author presents worked-out examples and real-world applications that illustrate the modern relevance of the topic. A detailed appendix features important and popular algorithms using MATLAB® and Octave software packages, and a related FTP site houses MATLAB code and programs for easy implementation of the discussed techniques. In addition, references to the current literature enable readers to investigate individual algorithms and methods in greater detail. Engineering Optimization: An Introduction with Metaheuristic Applications is an excellent book for courses on optimization and computer simulation at the upper-undergraduate and graduate levels. It is also a valuable reference for researchers and practitioners working in the fields of mathematics, engineering, computer science, operations research, and management science who use metaheuristic algorithms to solve problems in their everyday work.

"This book is a collection of the latest developments, models, and applications within the transdisciplinary fields related to metaheuristic computing, providing readers with insight into a wide range of topics such as genetic algorithms, differential evolution, and ant colony optimization"--Provided by publisher.

Discrete optimization problems are everywhere, from traditional operations research planning (scheduling, facility location and network design); to computer science databases; to advertising issues in viral marketing. Yet most such problems are NP-hard; unless P = NP, there are no efficient algorithms to find optimal solutions. This book shows how to design approximation algorithms: efficient algorithms that find provably near-optimal solutions. The book is organized around central algorithmic techniques for designing approximation algorithms, including greedy and local search algorithms, dynamic programming, linear and semidefinite programming, and randomization. Each chapter in the first section is devoted to a single algorithmic technique applied to several different problems, with more sophisticated treatment in the second section. The book also covers methods for proving that optimization problems are hard to approximate. Designed as a textbook for graduate-level algorithm courses, it will also serve as a reference for researchers interested in the heuristic solution of discrete optimization problems.

Advances in Metaheuristics: Applications in Engineering Systems provides details on current approaches utilized in engineering optimization. It gives a comprehensive background on metaheuristic applications, focusing on main engineering sectors such as energy, process, and materials. It discusses topics such as algorithmic enhancements and performance measurement approaches, and provides insights into the implementation of metaheuristic strategies to multi-objective optimization problems. With this book, readers can learn to solve real-world engineering optimization problems effectively using

the appropriate techniques from emerging fields including evolutionary and swarm intelligence, mathematical programming, and multi-objective optimization. The ten chapters of this book are divided into three parts. The first part discusses three industrial applications in the energy sector. The second focusses on process optimization and considers three engineering applications: optimization of a three-phase separator, process plant, and a pre-treatment process. The third and final part of this book covers industrial applications in material engineering, with a particular focus on sand mould-systems. It also includes discussions on the potential improvement of algorithmic characteristics via strategic algorithmic enhancements. This book helps fill the existing gap in literature on the implementation of metaheuristics in engineering applications and real-world engineering systems. It will be an important resource for engineers and decision-makers selecting and implementing metaheuristics to solve specific engineering problems.

This book constitutes the refereed proceedings of the 10th International Workshop on Hybrid Metaheuristics, HM 2016, held in Plymouth, UK, in June 2016. The 15 revised full papers presented were carefully reviewed and selected from 43 submissions. The selected papers are of interest for all the researchers working on integrating metaheuristics with other areas for solving both optimization and constraint satisfaction problems. They represent as well a sample of current research demonstrating how metaheuristics can be integrated with integer linear programming and other operational research techniques for tackling difficult and relevant problems.

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