

Metaheuristics For Hard Optimization Methods And Case Studies 2006 Edition By Dri 1 2 O Johann Pi 1 2 Trowski Alain Siarry Patrick Taillard E 2005 Hardcover

Handbook of Approximation Algorithms and Metaheuristics, Second Edition reflects the tremendous growth in the field, over the past two decades. Through contributions from leading experts, this handbook provides a comprehensive introduction to the underlying theory and methodologies, as well as the various applications of approximation algorithms and metaheuristics. Volume 1 of this two-volume set deals primarily with methodologies and traditional applications. It includes restriction, relaxation, local ratio, approximation schemes, randomization, tabu search, evolutionary computation, local search, neural networks, and other metaheuristics. It also explores multi-objective optimization, reoptimization, sensitivity analysis, and stability. Traditional applications covered include: bin packing, multi-dimensional packing, Steiner trees, traveling salesperson, scheduling, and related problems. Volume 2 focuses on the contemporary and emerging applications of methodologies to problems in combinatorial optimization, computational geometry and graphs problems, as well as in large-scale and emerging application areas. It includes approximation algorithms and heuristics for clustering, networks (sensor and wireless), communication, bioinformatics search, streams, virtual communities, and more. About the Editor Teofilo F. Gonzalez is a professor emeritus of computer science at the University of California, Santa Barbara. He completed his Ph.D. in 1975 from the University of Minnesota. He taught at the University of Oklahoma, the Pennsylvania State University, and the University of Texas at Dallas, before joining the UCSB computer science faculty in 1984. He spent sabbatical leaves at the Monterrey Institute of Technology and Higher Education and Utrecht University. He is known for his highly cited pioneering research in the hardness of approximation; for his sublinear and best possible approximation algorithm for k -tMM clustering; for introducing the open-shop scheduling problem as well as algorithms for its solution that have found applications in numerous research areas; as well as for his research on problems in the areas of job scheduling, graph algorithms, computational geometry, message communication, wire routing, etc.

Finding exact solutions to many combinatorial optimization problems in business, engineering, and science still poses a real challenge, despite the impact of recent advances in mathematical programming and computer technology. New fields of applications, such as computational biology, electronic commerce, and supply chain management, bring new challenges and needs for algorithms and optimization techniques. Metaheuristics are master procedures that guide and modify the operations of subordinate heuristics, to produce improved approximate solutions to hard optimization problems with respect to more simple algorithms. They also provide fast and robust tools, producing high-quality solutions in reasonable computation times. The field of metaheuristics has been fast evolving in recent years. Techniques such as simulated annealing, tabu search, genetic algorithms, scatter search, greedy randomized adaptive search, variable

neighborhood search, ant systems, and their hybrids are currently among the most efficient and robust optimization strategies to find high-quality solutions to many real-life optimization problems. A very large number of successful applications of metaheuristics are reported in the literature and spread throughout many books, journals, and conference proceedings. A series of international conferences entirely devoted to the theory, applications, and computational developments in metaheuristics has been attracting an increasing number of participants, from universities and the industry.

The use of artificial intelligence, especially in the field of optimization is increasing day by day. The purpose of this book is to explore the possibility of using different kinds of optimization algorithms to advance and enhance the tools used for computer and electrical engineering purposes.

Improving the performance of existing technologies has always been a focal practice in the development of computational systems. However, as circuitry is becoming more complex, conventional techniques are becoming outdated and new research methodologies are being implemented by designers. Performance Optimization Techniques in Analog, Mix-Signal, and Radio-Frequency Circuit Design features recent advances in the engineering of integrated systems with prominence placed on methods for maximizing the functionality of these systems. This book emphasizes prospective trends in the field and is an essential reference source for researchers, practitioners, engineers, and technology designers interested in emerging research and techniques in the performance optimization of different circuit designs.

Statistical and Computational Techniques in Manufacturing

Introduction to Evolutionary Algorithms

Evolutionary Algorithms

Metaheuristics

This book describes the main classical combinatorial problems that can be encountered when designing a logistics network or driving a supply chain. It shows how these problems can be tackled by metaheuristics, both separately and using an integrated approach. A huge number of techniques, from the simplest to the most advanced ones, are given for helping the reader to implement efficient solutions that meet its needs. A lot of books have been written about metaheuristics (methods for solving hard optimization problems) and supply chain management (the field in which we find a huge number of combinatorial optimization problems) in the last decades. So, the main reason of this book is to describe how these methods can be implemented for this class of problems.

In recent years, interest in developing statistical and computational techniques for applied manufacturing engineering has been increased. Today, due to the great complexity of manufacturing engineering and the high number of parameters used, conventional approaches are no longer sufficient. Therefore, in manufacturing, statistical and computational techniques have achieved several applications, namely, modelling and simulation manufacturing processes, optimization manufacturing parameters, monitoring and control, computer-aided process planning,

etc. The present book aims to provide recent information on statistical and computational techniques applied in manufacturing engineering. The content is suitable for final undergraduate engineering courses or as a subject on manufacturing at the postgraduate level. This book serves as a useful reference for academics, statistical and computational science researchers, mechanical, manufacturing and industrial engineers, and professionals in industries related to manufacturing engineering.

Modern optimization approaches have attracted many research scientists, decision makers and practicing researchers in recent years as powerful intelligent computational techniques for solving several complex real-world problems. The Handbook of Research on Modern Optimization Algorithms and Applications in Engineering and Economics highlights the latest research innovations and applications of algorithms designed for optimization applications within the fields of engineering, IT, and economics. Focusing on a variety of methods and systems as well as practical examples, this book is a significant resource for graduate-level students, decision makers, and researchers in both public and private sectors who are seeking research-based methods for modeling uncertain real-world problems. .

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 metaheuristic 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.

Metaheuristics and Optimization in Computer and Electrical Engineering

An Introduction with Metaheuristic Applications

Hybrids of Stochastic Metaheuristics and Constraint Programming for Combinatorial Optimization

Computer Decision-Making

Engineering Optimization

Metaheuristics exhibit desirable properties like simplicity, easy parallelizability, and ready applicability to different types of optimization problems. After a comprehensive introduction to the field, the contributed chapters in this book include explanations of the main metaheuristics techniques, including simulated annealing, tabu search, evolutionary algorithms, artificial ants, and particle swarms, followed by chapters that demonstrate their applications to problems such as multiobjective optimization, logistics, vehicle routing, and air traffic management. The authors are leading researchers in this domain, with considerable teaching and applications experience, and the book will be of value to industrial practitioners, graduate students, and research academics.

Solving complex optimization problems with parallelmetaheuristics Parallel Metaheuristics brings together an international group of experts in parallelism and metaheuristics to provide a much-needed synthesis of these two fields. Readers discover how metaheuristic techniques can provide useful and practical solutions for a wide range of problems and application domains, with an emphasis on the fields of telecommunications and bioinformatics. This volume fills a long-existing gap, allowing researchers and practitioners to develop 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, Measuring the Performance of Parallel Metaheuristics, New Technologies in Parallelism, and a head-to-head discussion on Metaheuristics and Parallelism * Part Two: Parallel Metaheuristic Models, including Parallel Genetic Algorithms, Parallel Genetic Programming, Parallel Evolution Strategies, Parallel Ant Colony Algorithms, Parallel Estimation of Distribution Algorithms, Parallel Scatter Search, Parallel Variable Neighborhood Search, Parallel Simulated Annealing, Parallel Tabu Search, Parallel GRASP, Parallel Hybrid Metaheuristics, Parallel Multi-Objective Optimization, and Parallel Heterogeneous Metaheuristics * Part Three: Theory and Applications, including Theory of Parallel Genetic Algorithms, Parallel Metaheuristics Applications, Parallel Metaheuristics in Telecommunications, and a final chapter on Bioinformatics and Parallel Metaheuristics Each self-contained chapter begins with clear overviews and introductions that bring the reader up to speed, describes basic techniques, and ends with a reference list for further study. Packed with numerous tables and figures to illustrate the complex theory and processes, this comprehensive volume also includes numerous practical real-world optimization problems and their solutions. This is essential reading for students and researchers in computer science, mathematics, and engineering who deal with parallelism, metaheuristics, and optimization in general.

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.

Many advances have recently been made in metaheuristic methods, from theory to applications. The editors, both leading experts in this field, have assembled a team of researchers to contribute 21 chapters organized into parts on simulated annealing, tabu search, ant colony algorithms, general purpose studies of evolutionary algorithms, applications of evolutionary algorithms, and metaheuristics.

Meta-Heuristics

Techniques and Algorithms Inspired by Nature

Essentials of Metaheuristics (Second Edition)

Methods and Case Studies

Handbook of Heuristics

The digital age is ripe with emerging advances and applications in technological innovations. Mimicking the structure of complex systems in nature can provide new ideas on how to organize mechanical and personal systems. The Handbook of Research on Modeling, Analysis, and Application of Nature-Inspired Metaheuristic Algorithms is an essential scholarly resource on current algorithms that have been inspired by the natural world. Featuring coverage on diverse topics such as cellular automata, simulated annealing, genetic programming, and differential evolution, this reference publication is ideal for scientists, biological engineers, academics, students, and researchers that are interested in discovering what models from nature influence the current technology-centric world.

Metaheuristics for Hard Optimization Methods and Case Studies Springer Science & Business Media

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. The authors stress the relative simplicity, efficiency, flexibility of use, and suitability of various approaches used to solve difficult optimization problems. The authors are experienced, interdisciplinary lecturers and researchers and in their explanations they demonstrate many shared foundational concepts among the key methodologies. This textbook is a suitable introduction for undergraduate and graduate students, researchers, and professionals in computer science, engineering, and logistics.

Computational Optimization, Methods and Algorithms

Handbook of Approximation Algorithms and Metaheuristics

Nature-Inspired Optimization Algorithms

Proceedings of Sixth International Conference on Soft Computing for Problem Solving

An Introduction to Metaheuristics for Optimization

This book presents powerful techniques for solving global optimization problems on manifolds by means of evolutionary algorithms, and shows in practice how these techniques can be applied to solve real-world problems. It describes recent findings and well-known key facts in general and differential topology, revisiting them all in the context of application to current optimization problems. Special emphasis is put on game theory problems. Here, these problems are reformulated as constrained global optimization tasks and solved with the help of Fuzzy ASA. In addition, more abstract examples, including minimizations of well-known functions, are also included. Although the Fuzzy ASA approach has been chosen as the main optimizing paradigm, the book suggests that other metaheuristic methods could be used as well. Some of them are introduced, together with their advantages and disadvantages. Readers should possess some knowledge of linear algebra, and of basic concepts of numerical analysis and probability theory. Many necessary definitions and fundamental results are provided, with the formal mathematical requirements limited to a minimum, while the focus is kept firmly on continuous problems. The book offers a valuable resource for students, researchers and practitioners. It is suitable for university courses on optimization and for self-study.

Combinatorial optimization problems are frequently encountered in scientific and industrial applications. A large number of these problems are known to be NP-hard and solving these problems by exact/complete

methods is often impractical. Therefore, heuristic methods are often the best way to deal with such problems. However, when these problems additionally include hard constraints, heuristic/metaheuristic methods often fail and perform poorly. A solution to this is to integrate these methods with techniques like constraint programming (CP) where constraints maybe easily specified and efficiently dealt with thereby providing effective solutions to combinatorial optimization problems with non-trivial hard constraints. This thesis specifically investigates the integration of stochastic metaheuristics and constraint programming for combinatorial optimization problems (COPs) with non-trivial hard constraints. Among stochastic metaheuristics, we consider ant colony optimization (ACO) and beam search. The base algorithm we begin with is the hybrid CP-ACO (Meyer and Ernst, 2004) and the aim of the thesis is to show that this algorithm can be made efficient by parallelizing the solution construction of ACO (dependent solution construction as opposed to solution construction on multiple machines/cores) via beam search leading to the hybrid CP-Beam-ACO. We consider three case studies to demonstrate the effectiveness of the new hybrid. The first problem is single machine job scheduling with sequence dependent setup times (SMJS). The aim here is to minimize makespan making sure hard release and due time constraints are not violated. Secondly, a resource constrained multiple machine job scheduled (MMJS) problem is tackled. Here, constraints include release times, due times, precedences, and a resource constraint across the machines. The aim is to minimize the total weighted tardiness of the scheduled jobs. The last problem considered is the car sequencing (CS) problem. Here a number of cars requiring options must be sequenced such that sub-sequences of a particular length may only allow a specific number of each option. We investigate the performance of our algorithms on the optimization version which further requires the utilization of options be effectively modulated across the sub-sequences. By applying ACO, Beam-ACO, CP-ACO and CP-Beam-ACO to the above problems we see that CP-ACO methods are by far the best performing algorithms in terms of solution quality. This is clearly seen on the SMJS and CS problems for which complex CP models have been defined. There is a slight disadvantage to CP-ACO for the MMJS problem where the CP model is relatively simple. In terms of finding feasible solutions, the feasibility advantages of CP-ACO are inherited by CP-Beam-ACO. We also see for the MMJS problem that CP-Beam-ACO has a significant advantage in this respect. In conclusion, this thesis demonstrates that constraint-based ACO is an efficient and effective method to tackle real-world COPs. In particular, CP-ACO can be made efficient by parallelizing the solution construction of the ACO component resulting in CP-Beam-ACO. The new algorithm provides significant advantages for three different types of real-world COPs with non-trivial hard constraints and can be viewed as the practically viable option for implementing ACO with CP. The success of metaheuristics on hard single-objective optimization problems is well recognized today. However, many real-life problems require taking into account several conflicting points of view corresponding to multiple objectives. The use of metaheuristic optimization techniques for multi-objective problems is the subject of this volume. The book includes selected surveys, tutorials and state-of-the-art research papers in

this field, which were first presented at a free workshop jointly organized by the French working group on Multi-objective Mathematical Programming (PM2O) and the EURO working group on Metaheuristics in December 2002. It is the first book which considers both various metaheuristics and various kind of problems (e.g. combinatorial problems, real situations, non-linear problems) applied to multiple objective optimization. Metaheuristics used include: genetic algorithms, ant colony optimization, simulated annealing, scatter search, etc. Problems concern timetabling, vehicle routing, and more. Methodological aspects, such as quality evaluation, are also covered.

This book explains the most prominent and some promising new, general techniques that combine metaheuristics with other optimization methods. A first introductory chapter reviews the basic principles of local search, prominent metaheuristics, and tree search, dynamic programming, mixed integer linear programming, and constraint programming for combinatorial optimization purposes. The chapters that follow present five generally applicable hybridization strategies, with exemplary case studies on selected problems: incomplete solution representations and decoders; problem instance reduction; large neighborhood search; parallel non-independent construction of solutions within metaheuristics; and hybridization based on complete solution archives. The authors are among the leading researchers in the hybridization of metaheuristics with other techniques for optimization, and their work reflects the broad shift to problem-oriented rather than algorithm-oriented approaches, enabling faster and more effective implementation in real-life applications. This hybridization is not restricted to different variants of metaheuristics but includes, for example, the combination of mathematical programming, dynamic programming, or constraint programming with metaheuristics, reflecting cross-fertilization in fields such as optimization, algorithmics, mathematical modeling, operations research, statistics, and simulation. The book is a valuable introduction and reference for researchers and graduate students in these domains.

**Why Simheuristics? Benefits, Limitations, and Best Practices When Combining Metaheuristics with Simulation
Metaheuristics for Logistics**

Essays and Surveys in Metaheuristics

Lie Groups and Algebraic Groups

A New Class of Algorithms

Heuristics are strategies using readily accessible, loosely applicable information to control problem solving. Algorithms, for example, are a type of heuristic. By contrast, Metaheuristics are methods used to design Heuristics and may coordinate the usage of several Heuristics toward the formulation of a single method. GRASP (Greedy Randomized Adaptive Search Procedures) is an example of a Metaheuristic. To the layman, heuristics may be thought of as 'rules of thumb' but despite its imprecision, heuristics is a very rich field that refers to experience-based techniques for problem-solving, learning, and discovery. Any given solution/heuristic is not guaranteed to be optimal but heuristic methodologies are used to speed up the

process of finding satisfactory solutions where optimal solutions are impractical. The introduction to this Handbook provides an overview of the history of Heuristics along with main issues regarding the methodologies covered. This is followed by Chapters containing various examples of local searches, search strategies and Metaheuristics, leading to an analyses of Heuristics and search algorithms. The reference concludes with numerous illustrations of the highly applicable nature and implementation of Heuristics in our daily life. Each chapter of this work includes an abstract/introduction with a short description of the methodology. Key words are also necessary as part of top-matter to each chapter to enable maximum search engine optimization. Next, chapters will include discussion of the adaptation of this methodology to solve a difficult optimization problem, and experiments on a set of representative problems.

For decades, optimization methods such as Fuzzy Logic, Artificial Neural Networks, Firefly, Simulated annealing, and Tabu search, have been capable of handling and tackling a wide range of real-world application problems in society and nature. Analysts have turned to these problem-solving techniques in the event during natural disasters and chaotic systems research. The Handbook of Research on Artificial Intelligence Techniques and Algorithms highlights the cutting edge developments in this promising research area. This premier reference work applies Meta-heuristics Optimization (MO) Techniques to real world problems in a variety of fields including business, logistics, computer science, engineering, and government. This work is particularly relevant to researchers, scientists, decision-makers, managers, and practitioners. This handbook is an endeavour to cover many current, relevant, and essential topics related to decision sciences in a scientific manner. Using this handbook, graduate students, researchers, as well as practitioners from engineering, statistics, sociology, economics, etc. will find a new and refreshing paradigm shift as to how these topics can be put to use beneficially. Starting from the basics to advanced concepts, authors hope to make the readers well aware of the different theoretical and practical ideas, which are the focus of study in decision sciences nowadays. It includes an excellent bibliography/reference/journal list, information about a variety of datasets, illustrated pseudo-codes, and discussion of future trends in research. Covering topics ranging from optimization, networks and games, multi-objective optimization, inventory theory, statistical methods, artificial neural networks, times series analysis, simulation modeling, decision support system, data envelopment analysis, queueing theory, etc., this reference book is an attempt to make this area more meaningful for varied readers. Noteworthy features of this handbook are in-depth coverage of different topics, solved practical examples, unique datasets for a variety of examples in the areas of decision sciences, in-depth analysis of problems through colored charts, 3D diagrams, and discussions about software.

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
Stochastic Global Optimization and Its Applications with Fuzzy Adaptive Simulated Annealing

Advances and Trends in Local Search Paradigms for Optimization

Handbook of Research on Modeling, Analysis, and Application of Nature-Inspired Metaheuristic Algorithms

Recent Developments in Metaheuristics

SocProS 2016, Volume 2

Computational optimization is an important paradigm with a wide range of applications. In virtually all branches of engineering and industry, we almost always try to optimize something - whether to minimize the cost and energy consumption, or to maximize profits, outputs, performance and efficiency. In many cases, this search for optimality is challenging, either because of the high computational cost of evaluating objectives and constraints, or because of the nonlinearity, multimodality, discontinuity and uncertainty of the problem functions in the real-world systems. Another complication is that most problems are often NP-hard, that is, the solution time for finding the optimum increases exponentially with the problem size. The development of efficient algorithms and specialized techniques that address these difficulties is of primary importance for contemporary engineering, science and industry. This book consists of 12 self-contained chapters, contributed from worldwide experts who are working in these exciting areas. The book strives to review and discuss the latest developments concerning optimization and modelling with a focus on methods and algorithms for computational optimization. It also covers well-chosen, real-world applications in science, engineering and industry. Main topics include derivative-free optimization, multi-objective evolutionary algorithms, surrogate-based methods, maximum simulated likelihood estimation, support vector machines, and metaheuristic algorithms. Application case studies include aerodynamic shape optimization, microwave engineering, black-box optimization, classification, economics, inventory optimization and structural optimization. This graduate level book can serve as an excellent reference for lecturers, researchers and students in computational science, engineering and industry.

This book is based on the notes of the authors' seminar on algebraic and Lie groups held at the Department of Mechanics and Mathematics of Moscow University in 1967/68. Our guiding idea was to present in the most economic way the theory of semisimple Lie groups on the basis of the theory of algebraic groups. Our main sources were A. Borel's paper [34], C. Chevalley's seminar [14], seminar "Sophus Lie" [15] and

monographs by C. Chevalley [4], N. Jacobson [9] and J-P. Serre [16, 17]. In preparing this book we have completely rearranged these notes and added two new chapters: "Lie groups" and "Real semisimple Lie groups". Several traditional topics of Lie algebra theory, however, are left entirely disregarded, e.g. universal enveloping algebras, characters of linear representations and (co)homology of Lie algebras. A distinctive feature of this book is that almost all the material is presented as a sequence of problems, as it had been in the first draft of the seminar's notes. We believe that solving these problems may help the reader to feel the seminar's atmosphere and master the theory. Nevertheless, all the non-trivial ideas, and sometimes solutions, are contained in hints given at the end of each section. The proofs of certain theorems, which we consider more difficult, are given directly in the main text. The book also contains exercises, the majority of which are an essential complement to the main contents.

Contains case studies from engineering and operations research Includes commented literature for each chapter

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.

Metaheuristics for Multiobjective Optimisation

Hybrid Metaheuristics

Ant Colony Optimization

Meta-Heuristics Optimization Algorithms in Engineering, Business, Economics, and Finance

Search and Optimization by Metaheuristics

Evolutionary algorithms are becoming increasingly attractive across various disciplines, such as operations research, computer science, industrial engineering, electrical engineering, social science and economics. Introduction to Evolutionary Algorithms presents a comprehensive, and up-to-date treatment of evolutionary algorithms. It covers such hot topics as: • genetic algorithms, • differential evolution, • swarm intelligence, and • artificial immune systems. The reader is introduced to a range of applications, as Introduction to Evolutionary Algorithms demonstrates how to model real world problems, how to encode and decode individuals, and how to design effective operators according to the chromosome structures with examples of constraint optimization, multiobjective optimization, combinatorial optimization, and supervised/unsupervised learning. This emphasis on practical applications will benefit all students, whether they continue their academic career or to enter a particular industry. Introduction to Evolutionary Algorithms is intended as a textbook material for both advanced undergraduates and graduate students. Additional features such as recommended further reading and research projects combine to form an accessible and interesting pedagogical approach to this widely used discipline.

Evolutionary algorithms are bio-inspired algorithms based on Darwin's theory of evolution. They are expected to provide non-good quality solutions to problems whose resolution is impracticable by exact methods. In six chapters, this book presents the knowledge required to efficiently implement evolutionary algorithms. Chapter 1 describes a generic evolutionary algorithm as operators that compose it. Chapter 2 is devoted to the solving of continuous optimization problems, without constraint. Three approaches are described and compared on a set of test functions. Chapter 3 considers continuous optimization problems with various approaches suitable for evolutionary methods are presented. Chapter 4 is related to combinatorial optimization. It presents operators of variation operators to deal with order-based problems. Chapter 5 introduces the basic notions required to understand the objective optimization and a variety of approaches for its application. Finally, Chapter 6 describes different approaches of genetic programming able to evolve computer programs in the context of machine learning.

This book highlights state-of-the-art developments in metaheuristics research. It examines all aspects of metaheuristic research: algorithmic developments, applications, new research challenges, theoretical developments, implementation issues, in-depth case studies. The book is divided into two sections. Part I is focused on new optimization and modeling techniques based on metaheuristics. Chapters in this section cover topics from multi-objective problems with fuzzy data with triangular-valued objective functions, heuristic optimization methodology, designing genetic algorithms, and also the cuckoo search algorithm. The techniques described enhance the usability and increase the potential of metaheuristic algorithms. Part II showcases advanced metaheuristic approaches for real-life applications issues. This includes an examination of scheduling, the vehicle routing problem, multimedia sensor network selection, bin packing, objects tracking, and radio frequency identification. In the fields covered in the chapters are of high-impact of metaheuristics. The chapters offer innovative applications of metaheuristics that have a potential of widening research frontiers. This book offers a comprehensive look at how researchers are currently using metaheuristics in different domains of design and optimization. Optimization techniques have developed into a significant area concerning industrial, economics, business, and financial systems. The development of engineering and financial systems, modern optimization has played an important role in service-centered operations. Such has attracted more attention to this field. Meta-heuristic hybrid optimization is a newly developed mathematical framework for optimization technique. Designed by logicians, engineers, analysts, and many more, this technique aims to study the complexity of real-world problems. Meta-Heuristics Optimization Algorithms in Engineering, Business, Economics, and Finance explores the emerging meta-heuristics optimization algorithms and methods and their role in innovated real world practical applications. This book is a comprehensive research on the areas of meta-heuristics optimization algorithms in engineering, business, economics, and finance and aims to be a comprehensive reference for decision makers, managers, engineers, researchers, scientists, financiers, and economists as well.

Evolutionary Global Optimization, Manifolds and Applications

From Design to Implementation

Parallel Metaheuristics

Powerful Tools for Optimization

Performance Optimization Techniques in Analog, Mixed-Signal, and Radio-Frequency Circuit Design

This two-volume book gathers the proceedings of the Sixth International Conference on Soft Computing for Problem Solving (SocProS 2016), offering a collection of research papers presented during the conference at Thapar University, Patiala, India. Providing a veritable treasure trove for scientists and researchers working in the field of soft computing, it highlights the latest developments in the broad area of “ Computational Intelligence ” and explores both theoretical and practical aspects using fuzzy logic, artificial neural networks, evolutionary algorithms, swarm intelligence, soft computing, computational intelligence, etc.

From smart cities to factories and business, many decision-making processes in our society involve NP-hard optimization problems. In a real environment, these problems are frequently large-scale, which limits the potential of exact optimization methods and justifies the use of metaheuristic algorithms in their resolution. Real-world problems are also distinguished by high levels of dynamism and uncertainty, which affect the formulation of the optimization model, its input data, and constraints. However, metaheuristic algorithms usually assume deterministic inputs and constraints, and thus end up solving oversimplified models of the real system being considered, casting doubt on validity and even meaning of the results and recommendations. Accordingly, this paper argues that approaches combining simulation with metaheuristics, i.e., simheuristics, not only constitute a natural extension of metaheuristics, but also should be considered as a “ first resort ” method when dealing with large-scale stochastic optimization problems, which constitute most realistic problems in industry and business. To this end, this paper highlights the main benefits and limitations of these simheuristic algorithms, reviews some examples of applications to different fields, and analyzes the most suitable simulation paradigms to be used within a simheuristic. Finally, we outline a series of best practices to consider during the design and implementation stages of a simheuristic algorithm.

This textbook provides a comprehensive introduction to nature-inspired metaheuristic methods for search and optimization, including the latest trends in evolutionary algorithms and other forms of natural computing. Over 100 different types of these methods are discussed in detail. The authors emphasize non-standard optimization problems and utilize a natural approach to the topic, moving from basic notions to more complex ones. An introductory chapter covers the necessary biological and mathematical backgrounds for understanding the main material. Subsequent chapters then explore almost all of the major metaheuristics for search and optimization created based on natural phenomena, including simulated annealing, recurrent neural networks, genetic algorithms and genetic programming, differential evolution, memetic algorithms, particle swarm optimization, artificial immune systems, ant colony optimization, tabu search and scatter search, bee and bacteria foraging algorithms, harmony search, biomolecular computing, quantum computing, and many others. General topics on dynamic, multimodal, constrained, and multiobjective optimizations are also described. Each chapter includes detailed flowcharts that illustrate specific algorithms and exercises that reinforce important topics. Introduced in the appendix are some benchmarks for the evaluation of metaheuristics. Search and Optimization by Metaheuristics is intended primarily as a textbook for graduate and advanced undergraduate students specializing in engineering and computer science. It will also serve as a valuable resource for scientists and researchers working in these areas, as well as those who are interested in search and optimization methods.

Stochastic global optimization is a very important subject, that has applications in virtually all areas of science and technology. Therefore there is nothing more opportune than writing a book about a successful and mature algorithm that turned out to be a good tool in solving difficult problems. Here we present some techniques for solving several problems by means of Fuzzy Adaptive Simulated Annealing (Fuzzy ASA), a fuzzy-controlled version of ASA, and by ASA itself. ASA is a sophisticated global optimization algorithm that is based upon ideas of the simulated annealing paradigm, coded in the C programming language and developed to statistically find the best global fit of a nonlinear constrained, non-convex cost function over a multi-dimensional

space. By presenting detailed examples of its application we want to stimulate the reader ' s intuition and make the use of Fuzzy ASA (or regular ASA) easier for everyone wishing to use these tools to solve problems. We kept formal mathematical requirements to a minimum and focused on continuous problems, although ASA is able to handle discrete optimization tasks as well. This book can be used by researchers and practitioners in engineering and industry, in courses on optimization for advanced undergraduate and graduate levels, and also for self-study.

Decision Sciences

Metaheuristics for Hard Optimization

Handbook of Research on Artificial Intelligence Techniques and Algorithms

Nature-Inspired Methods for Metaheuristics Optimization

Advances in Metaheuristics for Hard Optimization

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.

Meta-Heuristics: Advances and Trends in Local Search Paradigms for Optimizations comprises a carefully refereed selection of extended versions of the best papers presented at the Second Meta-Heuristics Conference (MIC 97). The selected articles describe the most recent developments in theory and applications of meta-heuristics, heuristics for specific problems, and comparative case studies. The book is divided into six parts, grouped mainly by the techniques considered. The extensive first part with twelve papers covers tabu search and its application to a great variety of well-known combinatorial optimization problems (including the resource-constrained project scheduling problem and vehicle routing problems). In the second part we find one paper where tabu search and simulated annealing are investigated comparatively and two papers which consider hybrid methods combining tabu search with genetic algorithms. The third part has four papers on genetic and evolutionary algorithms. Part four arrives at a new paradigm within meta-heuristics. The fifth part studies the behavior of parallel local search algorithms mainly from a tabu search perspective. The final part examines a great variety of additional meta-heuristics topics, including neural networks and variable neighbourhood search as well as guided local search. Furthermore, the integration of meta-heuristics with the branch-and-bound paradigm is investigated.

Combinatorial optimization is the process of finding the best, or optimal, solution for problems with a discrete set of feasible solutions. Applications arise in numerous settings involving operations management and logistics, such as

routing, scheduling, packing, inventory and production management, location, logic, and assignment of resources. The economic impact of combinatorial optimization is profound, affecting sectors as diverse as transportation (airlines, trucking, rail, and shipping), forestry, manufacturing, logistics, aerospace, energy (electrical power, petroleum, and natural gas), telecommunications, biotechnology, financial services, and agriculture. While much progress has been made in finding exact (provably optimal) solutions to some combinatorial optimization problems, using techniques such as dynamic programming, cutting planes, and branch and cut methods, many hard combinatorial problems are still not solved exactly and require good heuristic methods. Moreover, reaching "optimal solutions" is in many cases meaningless, as in practice we are often dealing with models that are rough simplifications of reality. The aim of heuristic methods for combinatorial optimization is to quickly produce good-quality solutions, without necessarily providing any guarantee of solution quality. Metaheuristics are high level procedures that coordinate simple heuristics, such as local search, to find solutions that are of better quality than those found by the simple heuristics alone: Modern metaheuristics include simulated annealing, genetic algorithms, tabu search, GRASP, scatter search, ant colony optimization, variable neighborhood search, and their hybrids.

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.

Theory and Practice

Handbook of Research on Modern Optimization Algorithms and Applications in Engineering and Economics

Algorithms and Applications in Science and Engineering

Nature-inspired Metaheuristic Algorithms

Methodologies and Traditional Applications