Ant Colony Optimization And Constraint Programming

Ant Colony Optimization and Constraint ProgrammingHandbook of MetaheuristicsThe Quadratic Assignment ProblemPRICAI 2004: Trends in Artificial IntelligenceConstraint-Handling in Evolutionary OptimizationSwarm Intelligence AlgorithmsHigh Performance Algorithms and Software in Nonlinear OptimizationAnt Colony Optimization and Swarm IntelligenceHybrid MetaheuristicsAdvances in Biologically Inspired Information SystemsAnt Colony Optimization and Swarm IntelligenceOrienteering ProblemsAnt Colony Optimization and Constraint ProgrammingStochastic Global Optimization Methods and Applications to Chemical, Biochemical, Pharmaceutical and Environmental ProcessesOptimizationEvolutionary Algorithms in Engineering ApplicationsAnt Colony OptimizationNature Inspired Cooperative Strategies for Optimization (NICSO 2008)Computational Intelligence and BioinformaticsAnt Colony Optimization and Swarm IntelligenceMetaheuristics in Water, Geotechnical and Transport EngineeringStochastic Global OptimizationProject Scheduling under Resource ConstraintsRecent Advances on Hybrid Intelligent SystemsAnt Colony OptimizationAdvances in Computational IntelligenceNew Ideas in OptimizationHybrid Systems: Computation and ControlArtificial AntsMeta-HeuristicsLogic, Language, Information and ComputationProfessional Practice in

Artificial IntelligenceHarmony Search AlgorithmOver-Constrained SystemsApplications of Evolutionary ComputingDesign of Intelligent Systems Based on Fuzzy Logic, Neural Networks and Nature-Inspired OptimizationHandbook of HeuristicsHandbook of Approximation Algorithms and MetaheuristicsHandbook of Research on Modeling, Analysis, and Application of Nature-Inspired Metaheuristic AlgorithmsAnt Colony Optimization

Ant Colony Optimization and Constraint Programming

The 14th International Workshop on Logic, Language, Information and Computation focused on foundations of computing and programming; novel computation models and paradigms; broad notions of proof and belief; formal methods in software and hardware development; logical approach to natural language and reasoning; logics of programs, actions, and resources; and foundational aspects of information organization, search, flow, sharing, and protection.

Handbook of Metaheuristics

Ant colony optimization is a metaheuristic which has beensuccessfully applied to a wide range of combinatorial optimizationproblems. The author describes this metaheuristic and studies itsefficiency for solving some hard combinatorial

problems, with aspecific focus on constraint programming. The text is organizedinto three parts. The first part introduces constraint programming, which provideshigh level features to declaratively model problems by means ofconstraints. It describes the main existing approaches for solvingconstraint satisfaction problems, including complete tree searchapproaches and metaheuristics, and shows how they can be integratedwithin constraint programming languages. The second part describes the ant colony optimizationmetaheuristic and illustrates its capabilities on differentconstraint satisfaction problems. The third part shows how the ant colony may be integrated within aconstraint programming language, thus combining the expressivepower of constraint programming languages, to describe problems ina declarative way, and the solving power of ant colony optimizationto efficiently solve these problems.

The Quadratic Assignment Problem

This tutorial introduces readers to several variants of routing problems with profits. In these routing problems each node has a certain profit, and not all nodes need to be visited. Since the orienteering problem (OP) is by far the most frequently studied problem in this category of routing problems, the book mainly focuses on the OP. In turn, other problems are presented as variants of the OP, focusing on the similarities and differences. The goal of the OP is to determine a subset of nodes to visit and in which order, so that the total collected profit is maximized and

a given time budget is not exceeded.The book provides a comprehensive review of variants of the OP, such as the team OP, the team OP with time windows, the profitable tour problem, and the prize-collecting travelling salesperson problem. In addition, it presents mathematical models and techniques for solving these OP variants and discusses their complexity. Several simple examples and benchmark instances, together with their best-known results, are also included. Finally, the book reviews the latest applications of these problems in the fields of logistics, tourism and others.

PRICAI 2004: Trends in Artificial Intelligence

This book constitutes the refereed proceedings of the 6th International Workshop on Hybrid Metaheuristics, HM 2009, held in Udine, Italy, in October 2009. The 12 revised full papers presented together with one invited talk were carefully reviewed and selected from 22 submissions. The papers discuss current issues of combinations of metaheuristics and other solving techniques of universal concern such as novel combinations of components from different metaheuristics, hybridization of metaheuristics and AI/OR techniques, low-level hybridization, high-level hybridization, portfolio techniques, expert systems, cooperative search, automated parameter tuning, empirical and statistical comparison, theoretical aspects of hybridization, parallelization, and software libraries.

Constraint-Handling in Evolutionary Optimization

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.

Swarm Intelligence Algorithms

This book contains a selection of papers presented at the conference on High Performance Software for Nonlinear Optimization (HPSN097) which was held in Ischia, Italy, in June 1997. The rapid progress of computer technologies, including new parallel architec tures, has stimulated a large amount of research devoted to building software environments and defining algorithms able to fully exploit this new computa tional power. In some sense, numerical analysis has to conform itself to the new tools. The impact of parallel computing in nonlinear optimization, which had a slow start at the beginning, seems now to increase at a fast rate, and it is reasonable to expect an even greater acceleration in the future. As with the first HPSNO conference, the goal of the HPSN097 conference was to supply a broad overview of the more recent developments and trends in nonlinear optimization, emphasizing the algorithmic and high performance software aspects. Bringing together new computational methodologies with theoretical ad vances and new computer technologies is an exciting challenge that involves all scientists willing to develop high performance numerical software. This book contains several important contributions from different and com plementary standpoints. Obviously, the articles in the book do not cover all the areas of the conference topic or all the most recent developments, because of the large number of new theoretical and

computational ideas of the last few years.

High Performance Algorithms and Software in Nonlinear Optimization

Optimization has played a key role in the design, planning and operation of chemical and related processes, for several decades. Global optimization has been receiving considerable attention in the past two decades. Of the two types of techniques for global optimization, stochastic global optimization is applicable to any type of problems having non-differentiable functions, discrete variables and/or continuous variables. It, thus, shows significant promise and potential for process optimization. So far, there are no books focusing on stochastic global optimization and its applications in chemical engineering. Stochastic Global Optimization - a monograph with contributions by leading researchers in the area - bridges the gap in this subject, with the aim of highlighting and popularizing stochastic global optimization techniques for chemical engineering applications. The book, with 19 chapters in all, is broadly categorized into two sections that extensively cover the techniques and the chemical engineering applications.

Ant Colony Optimization and Swarm Intelligence

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.

Hybrid Metaheuristics

This two-volume set LNCS 6691 and 6692 constitutes the refereed proceedings of the 11th International Work-Conference on Artificial Neural Networks, IWANN 2011, held in Torremolinos-Málaga, Spain, in June 2011. The 154 revised papers were carefully reviewed and selected from 202 submissions for presentation in two volumes. The first volume includes 69 papers organized in topical sections on mathematical and theoretical methods in computational intelligence; learning and adaptation; bio-inspired systems and neuro-engineering; hybrid intelligent systems; applications of computational intelligence; new applications of brain-computer interfaces; optimization algorithms in graphic processing units; computing languages with bio-inspired devices and multi-agent systems; computational intelligence in multimedia processing; and biologically plausible spiking neural processing.

Advances in Biologically Inspired Information Systems

Optimization is a pivotal aspect of software design. The techniques treated in this text represent research as elucidated by the leaders in the field. The optimization methods are applied to real problems, such as hilllclimbing, simulated annealing, and tabu search.

Ant Colony Optimization and Swarm Intelligence

Evolutionary algorithms are general-purpose search procedures based on the mechanisms of natural selection and population genetics. They are appealing because they are simple, easy to interface, and easy to extend. This volume is concerned with applications of evolutionary algorithms and associated strategies in engineering. It will be useful for engineers, designers, developers, and researchers in any scientific discipline interested in the applications of evolutionary algorithms. The volume consists of five parts, each with four or five chapters. The topics are chosen to emphasize application areas in different fields of engineering. Each chapter can be used for self-study or as a reference by practitioners to help them apply evolutionary algorithms to problems in their engineering domains.

Orienteering Problems

This volume presents a collection of refereed papers reflecting the state of the art in the area of over-constrained systems. Besides 11 revised full papers, selected from the 24 submissions to the OCS workshop held in conjunction with the First International Conference on Principles and Practice of Constraint Programming, CP '95, held in Marseilles in September 1995, the book includes three comprehensive background papers of central importance for the workshop papers and the whole field. Also included is an introduction by one of the volume editors together with a bibliography listing 243 entries. All in all this is a very useful reference book relevant for all researchers and practitioners interested in hierarchical, partial, and over-constrained systems.

Ant Colony Optimization and Constraint Programming

The series of biannual international conferences "ANTS – International C- ference on Ant Colony Optimization and Swarm Intelligence", now in its sixth edition, was started ten years ago, with the organization of ANTS'98. As some readers might recall, the ?rst edition of ANTS was titled "ANTS'98 – From Ant Colonies to Arti?cial Ants: First International Workshop on Ant Colony Op- mization. " In fact, at that time the focus was mainly on ant colony optimization (ACO), the ?rst swarm intelligence algorithm to go beyond a pure scienti?c interest and to enter the realm of real-world applications. Interestingly, in the ten years after the ?rst edition there has been a gr- ing interest not only for ACO, but for a number of other studies that

belong more generally to the area of swarmintelligence. The rapid growth of the swarm intelligence ?eld is attested by a number of indicators. First, the number of s- missions and participants to the ANTS conferences has steadily increased over the years. Second, a number of international conferences in computational - telligence and related disciplines organize workshops on subjects such as swarm intelligence, ant algorithms, ant colony optimization, and particle swarm op- mization. Third, IEEE startedorganizing,in 2003,the IEEE SwarmIntelligence Symposium (in order to maintain unity in this growing ?eld, we are currently establishingacooperationagreementbetweenIEEE SISandANTSsoastohave 1 IEEE SIS in odd years and ANTS in even years). Last, the Swarm Intelligence journal was born.

Stochastic Global Optimization Methods and Applications to Chemical, Biochemical, Pharmaceutical and Environmental Processes

Ant colony optimization is a metaheuristic which has been successfully applied to a wide range of combinatorial optimization problems. The author describes this metaheuristic and studies its efficiency for solving some hard combinatorial problems, with a specific focus on constraint programming. The text is organized into three parts. The first part introduces constraint programming, which provides

high level features to declaratively model problems by means of constraints. It describes the main existing approaches for solving constraint satisfaction problems, including complete tree search approaches and metaheuristics, and shows how they can be integrated within constraint programming languages. The second part describes the ant colony optimization metaheuristic and illustrates its capabilities on different constraint satisfaction problems. The third part shows how the ant colony may be integrated within a constraint programming language, thus combining the expressive power of constraint programming languages, to describe problems in a declarative way, and the solving power of ant colony optimization to efficiently solve these problems.

Optimization

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.

Evolutionary Algorithms in Engineering Applications

This book constitutes the refereed proceedings of the International Conference on Intelligent Computing, ICIC 2006, held in Kunming, China, in August 2006. The book presents 165 revised full papers, carefully reviewed. Topics covered include ant colony optimization, particle swarm optimization, swarm intelligence, autonomy-oriented computing, quantum and molecular computations, biological and DNA computing, intelligent computing in bioinformatics, intelligent computing in computational biology and drug design, computational genomics and proteomics, and more.

Ant Colony Optimization

This book constitutes the refereed proceedings of the 10th International Conference on Hybrid Systems: Computation and Control, HSCC 2007, held in Pisa, Italy in April 2007. The 44 revised full papers and 39 revised short papers presented together with the abstracts of 3 keynote talks were carefully reviewed and selected from 167 submissions. Among the topics addressed are models of heterogeneous systems, computability and complexity issues, real-time computing

and control, embedded and resource-aware control, control and estimation over wireless networks, tools for analysis, verification, control, and design, programming languages support and implementation, applications, including automotive, communication networks, avionics, energy systems, transportation networks, biology and other sciences, manufacturing, and robotics.

Nature Inspired Cooperative Strategies for Optimization (NICSO 2008)

During the last decade, artificial ants have experienced rapid development in the research community, mainly for solving optimization problems. This book provides an overview of the situation ant colony algorithms reached. Artificial Ants encompasses solution methods of hard optimization problems and new trends for collective intelligence. Part 1 helps to understand the basis of ant colony algorithms, and to discover a panorama of applications in the field of optimization, particularly in the industrial world. Part 2 deals with broader issues and provides an overview of current research in the field of artificial ants.

Computational Intelligence and Bioinformatics

Choose the Correct Solution Method for Your Optimization ProblemOptimization:

Algorithms and Applications presents a variety of solution techniques for optimization problems, emphasizing concepts rather than rigorous mathematical details and proofs. The book covers both gradient and stochastic methods as solution techniques for unconstrained and co

Ant Colony Optimization and Swarm Intelligence

This book constitutes the refereed proceedings of the 5th International Workshop on Ant Colony Optimization and Swarm Intelligence, ANTS 2006, held in Brussels, Belgium, in September 2006. The 27 revised full papers, 23 revised short papers, and 12 extended abstracts presented were carefully reviewed and selected from 115 submissions.

Metaheuristics in Water, Geotechnical and Transport Engineering

This book presents recent advances on hybrid intelligent systems using soft computing techniques for intelligent control and robotics, pattern recognition, time series prediction and optimization of complex problems. Soft Computing (SC) consists of several intelligent computing paradigms, including fuzzy logic, neural networks, and bio-inspired optimization algorithms, which can be used to produce

powerful hybrid intelligent systems. The book is organized in five main parts, which contain groups of papers around a similar subject. The first part consists of papers with the main theme of hybrid intelligent systems for control and robotics, which are basically state of the art papers that propose new models and concepts, which can be the basis for achieving intelligent control and mobile robotics. The second part contains papers with the main theme of hybrid intelligent systems for pattern recognition and time series prediction, which are basically papers using nature-inspired techniques, like evolutionary algorithms, fuzzy logic and neural networks, for achieving efficient pattern recognition or time series prediction. The third part contains papers with the theme of bio-inspired and genetic optimization methods, which basically consider the proposal of new methods and applications of bio-inspired optimization to solve complex optimization of real problems. The fourth part contains papers that deal with the application of intelligent optimization techniques in real world problems in scheduling, planning and manufacturing. The fifth part contains papers with the theme of evolutionary methods and intelligent computing, which are papers considering soft computing methods for applications related to diverse areas, such as natural language processing, recommending systems and optimization.

Stochastic Global Optimization

The Second Symposium on Professional Practice in AI 2006 is a conference within

the IFIP World Computer Congress 2006, Santiago, Chile. The Symposium is organised by the IFIP Technical Committee on Artificial Intelligence (Technical Committee 12) and its Working Group 12.5 (Artificial Intelligence Applications). The First Symposium in this series was one of the conferences in the IFIP World Computer Congi-ess 2004, Toulouse France. The conference featured invited talks by Rose Dieng, John Atkinson, John Debenham and Max Bramer. The Symposium was a component of the IFIP AI 2006 conference, organised by Professor Max Bramer. I should like to thank the Symposium General Chair, Professor Bramer for his considerable assistance in making the Symposium happen within a very tight deadline. These proceedings are the result of a considerable amount of hard work. Beginning with the preparation of the submitted papers, the papers were each reviewed by at least two members of the international Program Committee. The authors of accepted papers then revised their manuscripts to produce their final copy. The hard work of the authors, the referees and the Program Committee is gratefully aclaiowledged. The IFIP AI 2006 conference and the Symposium are the latest in a series of conferences organised by IFIP Technical Committee 12 dedicated to the techniques of Aitificial Intelligence and their real-world applications. Further infoirmation about TC12 can be found on our website http;//www.ifiptcI2.org.

Project Scheduling under Resource Constraints

Ants communicate information by leaving pheromone tracks. A moving ant leaves, in varying quantities, some pheromone on the ground to mark its way. While an isolated ant moves essentially at random, an ant encountering a previously laid trail is able to detect it and decide with high probability to follow it, thus reinforcing the track with its own pheromone. The collective behavior that emerges is thus a positive feedback: where the more the ants following a track, the more attractive that track becomes for being followed; thus the probability with which an ant chooses a path increases with the number of ants that previously chose the same path. This elementary ant's behavior inspired the development of ant colony optimization by Marco Dorigo in 1992, constructing a meta-heuristic stochastic combinatorial computational methodology belonging to a family of related meta-heuristic methods such as simulated annealing, Tabu search and genetic algorithms. This book covers in twenty chapters state of the art methods and applications of utilizing ant colony optimization algorithms. New methods and theory such as multi colony ant algorithm based upon a new pheromone arithmetic crossover and a repulsive operator, new findings on ant colony convergence, and a diversity of engineering and science applications from transportation, water resources, electrical and computer science disciplines are presented.

Recent Advances on Hybrid Intelligent Systems

This book constitutes the refereed proceedings of the 4th International Workshop

on Ant Colony Optimization and Swarm Intelligence, ANTS 2004, held in Brussels, Belgium in September 2004. The 22 revised full papers, 19 revised short papers, and 9 poster abstracts presented were carefully reviewed and selected from 79 papers submitted. The papers are devoted to theoretical and foundational aspects of ant algorithms, ant colony optimization and swarm intelligence and deal with a broad variety of optimization applications in networking and operations research.

Ant Colony Optimization

This book presents recent advances on the design of intelligent systems based on fuzzy logic, neural networks and nature-inspired optimization and their application in areas such as, intelligent control and robotics, pattern recognition, time series prediction and optimization of complex problems. The book is organized in eight main parts, which contain a group of papers around a similar subject. The first part consists of papers with the main theme of theoretical aspects of fuzzy logic, which basically consists of papers that propose new concepts and algorithms based on fuzzy systems. The second part contains papers with the main theme of neural networks theory, which are basically papers dealing with new concepts and algorithms in neural networks. The third part contains papers describing applications of neural networks in diverse areas, such as time series prediction and pattern recognition. The fourth part contains papers describing new nature-inspired optimization algorithms. The fifth part presents diverse applications of

nature-inspired optimization algorithms. The sixth part contains papers describing new optimization algorithms. The seventh part contains papers describing applications of fuzzy logic in diverse areas, such as time series prediction and pattern recognition. Finally, the eighth part contains papers that present enhancements to meta-heuristics based on fuzzy logic techniques.

Advances in Computational Intelligence

The inspiration from Biology and the Natural Evolution process has become a research area within computer science. For instance, the description of the arti?cial neuron given by McCulloch and Pitts was inspired from biological observations of neural mechanisms; the power of evolution in nature in the diverse species that make up our world has been related to a particular form of problem solving based on the idea of survival of the ?ttest; similarly, - ti?cial immune systems, ant colony optimisation, automated self-assembling programming, membrane computing, etc. also have their roots in natural phenomena. The ?rst and second editions of the International Workshop on Nature Inspired Cooperative Strategies for Optimization (NICSO), were held in Granada, Spain, 2006, and in Acireale, Italy, 2007, respectively. As in these two previous editions, the aim of NICSO 2008, held in Tenerife, Spain, was to provide a forum were the latest ideas and state of the art research related to nature inspired cooperative strategies for problem solving were discussed. The contributions collected in this book were strictly peer reviewed by

at least three members of the international programme committee, to whom we are indebted for their support and assistance. The topics covered by the contributionsincludenature-inspiredtechniqueslikeGeneticAlgorithms,Ant Colonies, Amorphous Computing, Arti?cial Immune Systems, Evolutionary Robotics, Evolvable Systems, Membrane Computing, Quantum Computing, Software Self Assembly, Swarm Intelligence, etc.

New Ideas in Optimization

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

Hybrid Systems: Computation and Control

The Pacific Rim International Conference on Artificial Intelligence (PRICAI) is a biennial international event which focuses on Artificial Intelligence (AI) theories and technologies, and their applications which are of social and economic importance for countries in the Pacific Rim region. Seven earlier conferences were held in: Nagoya, Japan (1990); Seoul, Korea (1992); Beijing, China (1994); Cairns, Australia (1996); Singapore (1998); Melbourne, Australia (2000); and Tokyo, Japan (2002). PRICAI 2004 was the eigth in the series and was held in Auckland, New Zealand in August 2004. PRICAI 2004 had attracted a historical record number of submissions, a total of 356 papers. After careful reviews by at least two international Program

Committee members or referees, 94 papers were accepted as full papers (27%) and 54 papers (15%) were accepted as posters. Authors of accepted papers came from 27 countries. This volume of the proceedings contains all the 94 full papers but only a 2-page - tended abstract of each of the accepted posters. The full papers were categorized into four sections, namely: AI foundations, computational intelligence, AI technologies and systems, and AI specific application areas. Among the papers submitted, we found "Agent Technology" to be the area having the most papers submitted. This was followed by "Evolutionary Computing", "Computational Learning", and "Image Processing".

Artificial Ants

This book introduces the field of resource-constrained project scheduling. State-of-the-art reviews of optimal and heuristic procedures are provided for classical project scheduling models. Furthermore, new models which are relevant for practical problem settings, are introduced. The main emphasis is on newly developed competitive heuristic methods. Contents: Introduction. - Description of the Problems.- Classification of Schedules.- Characterisation and Generation of Instances.- The Single-Mode Project Scheduling Problem.- The Multi-Mode Project Scheduling Problem.- Project Scheduling with Given Deadline.- Project Scheduling with Setup Times.- Applications to Production Management.- Concluding Remarks.- List of Notations.- List of Abbreviations.

Meta-Heuristics

Ant Colony Optimization (ACO) is the best example of how studies aimed at understanding and modeling the behavior of ants and other social insects can provide inspiration for the development of computational algorithms for the solution of difficult mathematical problems. Introduced by Marco Dorigo in his PhD thesis (1992) and initially applied to the travelling salesman problem, the ACO field has experienced a tremendous growth, standing today as an important nature-inspired stochastic metaheuristic for hard optimization problems. This book presents state-of-the-art ACO methods and is divided into two parts: (I) Techniques, which includes parallel implementations, and (II) Applications, where recent contributions of ACO to diverse fields, such as traffic congestion and control, structural optimization, manufacturing, and genomics are presented.

Logic, Language, Information and Computation

This book constitutes the joint refereed proceedings of six workshops, EvoWorkshops 2003, held together with EuroGP 2003 in Essex, UK in April 2003. The 63 revised full papers presented were carefully reviewed and selected from a total of 109 submissions. In accordance with the six workshops covered , the papers are organized in topical sections on bioinformatics, combinatorial

optimization, image analysis and signal processing, evolutionary music and art, evolutionary robotics, and scheduling and timetabling.

Professional Practice in Artificial Intelligence

Stochastic global optimization methods and applications to chemical, biochemical, pharmaceutical and environmental processes presents various algorithms that include the genetic algorithm, simulated annealing, differential evolution, ant colony optimization, tabu search, particle swarm optimization, artificial bee colony optimization, and cuckoo search algorithm. The design and analysis of these algorithms is studied by applying them to solve various base case and complex optimization problems concerning chemical, biochemical, pharmaceutical, and environmental engineering processes. Design and implementation of various classical and advanced optimization strategies to solve a wide variety of optimization problems makes this book beneficial to graduate students, researchers, and practicing engineers working in multiple domains. This book mainly focuses on stochastic, evolutionary, and artificial intelligence optimization algorithms with a special emphasis on their design, analysis, and implementation to solve complex optimization problems and includes a number of real applications concerning chemical, biochemical, pharmaceutical, and environmental engineering processes. Presents various classical, stochastic, evolutionary, and artificial intelligence optimization algorithms for the benefit of the audience in different

domains Outlines design, analysis, and implementation of optimization strategies to solve complex optimization problems of different domains Highlights numerous real applications concerning chemical, biochemical, pharmaceutical, and environmental engineering processes

Harmony Search Algorithm

Technology is taking us to a world where myriads of heavily networked devices interact with the physical world in multiple ways and at multiple scales, from the global Internet down to micro and nano devices. Many of these devices are highly mobile and must adapt to the surrounding environment in a totally unsupervised way. A fundamental research challenge is the design of robust decentralized computing systems that are capable of operating under changing environments and noisy input, and yet exhibit the desired behavior and response time, under constraints such as energy consumption, size, and processing power. Biological systems are able to handle many of these challenges with an elegance and efficiency still far beyond current human artifacts. The goal is to obtain methods on how to engineer technical systems, which have similar high stability and efficiency. With this book, we present a comprehensive overview of the most promising research directions in the area of bio-inspired computing. According to the broad spectrum addressed by the different book chapters, a rich variety of biological principles and their application to ICT systems are presented.

Over-Constrained Systems

The quadratic assignment problem (QAP) was introduced in 1957 by Koopmans and Beckmann to model a plant location problem. Since then the QAP has been object of numerous investigations by mathematicians, computers scientists, opetions researchers and practitioners. Nowadays the QAP is widely considered as a classical combinatorial optimization problem which is (still) attractive from many points of view. In our opinion there are at last three main reasons which make the QAP a popular problem in combinatorial optimization. First, the number of re- life problems which are mathematically modeled by QAPs has been continuously increasing and the variety of the fields they belong to is astonishing. To recall just a restricted number among the applications of the QAP let us mention placement problems, scheduling, manufacturing, VLSI design, statistical data analysis, and parallel and distributed computing. Secondly, a number of other well known c- binatorial optimization problems can be formulated as QAPs. Typical examples are the traveling salesman problem and a large number of optimization problems in graphs such as the maximum clique problem, the graph partitioning problem and the minimum feedback arc set problem. Finally, from a computational point of view the QAP is a very difficult problem. The QAP is not only NP-hard and - hard to approximate, but it is also practically intractable: it is generally considered as impossible to solve (to optimality) QAP instances of size larger than 20 within reasonable time limits.

Applications of Evolutionary Computing

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.

Design of Intelligent Systems Based on Fuzzy Logic, Neural Networks and Nature-Inspired Optimization

This book presents state-of-the-art technical contributions based around one of the most successful evolutionary optimization algorithms published to date: Harmony Search. Contributions span from novel technical derivations of this algorithm to applications in the broad fields of civil engineering, energy, transportation & mobility and health, among many others and focus not only on its cross-domain applicability, but also on its core evolutionary operators, including elements inspired from other meta-heuristics. The global scientific community is witnessing an upsurge in groundbreaking, new advances in all areas of computational intelligence, with a particular flurry of research focusing on evolutionary computation and bio-inspired optimization. Observed processes in nature and sociology have provided the basis for innovative algorithmic developments aimed at leveraging the inherent capability to adapt characterized by various animals, including ants, fireflies, wolves and humans. However, it is the behavioral patterns observed in music composition that motivated the advent of the Harmony Search algorithm, a meta-heuristic optimization algorithm that over the last decade has been shown to dominate other solvers in a plethora of application scenarios. The book consists of a selection of the best contributions presented at ICHSA, a major biannual event where leading global experts on meta-heuristic optimization

present their latest findings and discuss the past, present, and future of the exciting field of Harmony Search optimization. It provides a valuable reference resource for researchers working in the field of optimization meta-heuristics, and a solid technical base for frontline investigations around this algorithm.

Handbook of Heuristics

From real to artificial ants - The ant colony optimization metaheuristic - Ant colony optimization algorithms for the traveling salesman problem - Ant colony optimization theory - Ant colony optimization for NP-Hard problems - AntNet : an ACO algorithm for data network routing - Conclusions and prospects for the future.

Handbook of Approximation Algorithms and Metaheuristics

This book is the result of a special session on constraint-handling techniques used in evolutionary algorithms within the Congress on Evolutionary Computation (CEC) in 2007. It presents recent research in constraint-handling in evolutionary optimization.

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

This book provides both the research and practitioner communities with a comprehensive coverage of the metaheuristic methodologies that have proven to be successful in a wide variety of real-world problem settings. Moreover, it is these metaheuristic strategies that hold particular promise for success in the future. The various chapters serve as stand alone presentations giving both the necessary background underpinnings as well as practical guides for implementation.

Ant Colony Optimization

Nature-based algorithms play an important role among artificial intelligence algorithms. Among them are global optimization algorithms called swarm intelligence algorithms. These algorithms that use the behavior of simple agents and various ways of cooperation between them, are used to solve specific problems that are defined by the so-called objective function. Swarm intelligence algorithms are inspired by the social behavior of various animal species, e.g. ant colonies, bird flocks, bee swarms, schools of fish, etc. The family of these algorithms is very large and additionally includes various types of modifications to enable swarm intelligence algorithms to solve problems dealing with areas other than those for which they were originally developed. This book presents 24 swarm algorithms together with their modifications and practical applications. Each chapter is devoted to one algorithm. It contains a short description along with a

pseudo-code showing the various stages of its operation. In addition, each chapter contains a description of selected modifications of the algorithm and shows how it can be used to solve a selected practical problem. This book should also be useful for undergraduate and postgraduate students studying nature-based optimization algorithms, and can be a helpful tool for learning these algorithms, along with their modifications and practical applications. In addition, it can be a useful source of knowledge for scientists working in the field of artificial intelligence, as well as for engineers interested in using this type of algorithms in their work. If the reader wishes to expand his knowledge beyond the basics of swarm intelligence algorithms presented in this book and is interested in more detailed information, we recommend the book "Swarm Intelligence Algorithms: A Tutorial" (Edited by A. Slowik, CRC Press, 2020). It contains a detailed explanation of how each algorithm works, along with relevant program codes in Matlab and the C ++ programming language, as well as numerical examples illustrating step-by-step how individual algorithms work.

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