Membrane Computing An Introduction Natural Computing Series

Cartesian Genetic Programming Reservoir Computing Quantum Computing Introduction to Evolutionary Computing Contemporary Evolution Strategies Fundamentals of Natural Computing Introduction to Evolutionary Computing Bioinspired Computation in Combinatorial Optimization Algorithmic Aspects of Bioinformatics Evolvable Components Natural Computing Algorithms Self-organising Software Design by Evolution Sensitivity Analysis for Neural Networks An Introduction to Metaheuristics for Optimization Hyper-Heuristics: Theory and Applications Automating the Design of Data Mining Algorithms Natural Computing and Beyond The Art of Artificial Evolution Differential Evolution Foraging-Inspired Optimisation Algorithms Theory and Practice of Natural Computing Natural Computing in Computational Finance Designing Evolutionary Algorithms for Dynamic Environments Analyzing Evolutionary Algorithms Handbook of Natural Computing Computational Matter Membrane Computing Swarm Intelligence Design of Modern Heuristics Natural Computing in Computational Finance Spatially Structured Evolutionary Algorithms Theory of Evolutionary Computation Discrete and Topological Models in Molecular Biology Natural and Artificial Computation for Biomedicine and Neuroscience Evolution as Computation Computing Nature Quantum Computation and Quantum Information Automated Design of Machine Learning and Search Algorithms Natural Computing Algorithms

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Fundamentals of Natural Computing May 26 2022 Natural computing brings together nature and computing to develop new computational tools for problem solving; to synthesize natural patterns and behaviors in computers; and to potentially design novel types of computers. Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications presents a wide-ranging survey of novel techniques and important applications of nature-based computing. This book presents theoretical and philosophical discussions, pseudocodes for algorithms, and computing paradigms that illustrate how computational techniques can be used to solve complex problems, simulate nature, explain natural phenomena, and possibly allow the development of new computing technologies. The author features a consistent and approachable, textbook-style format that includes lucid figures, tables, real-world examples, and different types of exercises that complement the concepts while encouraging readers to apply the computational tools in each chapter. Building progressively upon core concepts of nature-inspired techniques, the topics include evolutionary computing, neurocomputing, swarm intelligence, immunocomputing, fractal geometry, artificial life, quantum computing, and DNA computing. Fundamentals of Natural Computing is a self-contained introduction and a practical guide to nature-based computational approaches that will find numerous applications in a variety of growing fields including engineering, computer science, biological modeling, and bioinformatics.

Computational Matter Aug 05 2020 This book is concerned with computing in materio: that is, unconventional computing performed by directly harnessing the physical properties of materials. It offers an overview of the field, covering four main areas of interest: theory, practice, applications and implications. Each chapter synthesizes current understanding by deliberately bringing together researchers across a collection of related research projects. The book is useful for graduate students, researchers in the field, and the general scientific reader who is interested in inherently interdisciplinary research at the intersections of computer science, biology, chemistry, physics, engineering and mathematics.

Designing Evolutionary Algorithms for Dynamic Environments Nov 07 2020 Details robustness, stability, and performance of Evolutionary Algorithms in dynamic environments

Natural Computing in Computational Finance Mar 31 2020 Recent years have seen the widespread application of Natural Computing algorithms (broadly defined in this context as computer algorithms whose design draws inspiration from phenomena in the natural world) for the purposes of financial modelling and optimisation. A related stream of work has also seen the application of learning mechanisms drawn from Natural Computing algorithms for the purposes of agent-based modelling in finance and economics. In this book we have collected a series of chapters which illustrate these two faces of Natural Computing. The first part of the book illustrates how algorithms inspired by the natural world can be used as problem solvers to uncover and optimise financial models. The second part of the book examines a number agent-based simulations of financial systems. This book follows on from Natural Computing in Computational Finance (Volume 100 in Springer's Studies in Computational Intelligence series) which in turn arose from the success of EvoFIN 2007, the very first European Workshop on Evolutionary Computation in Finance & Economics held in Valencia, Spain in April 2007.

Computing Nature Sep 25 2019 This book is about nature considered as the totality of physical existence, the universe, and our present day attempts to understand it. If we see the universe as a network of networks of computational processes at many different levels of organization, what can we learn about physics, biology, cognition, social systems, and ecology expressed through interacting networks of elementary particles, atoms, molecules, cells, (and especially neurons when it comes to understanding of cognition and intelligence), organs, organisms and their ecologies? Regarding our computational models of natural phenomena Feynman famously wondered: "Why should it take an infinite amount of logic to figure out what one tiny piece of space/time is going to do?" Phenomena themselves occur so quickly and automatically in nature. Can we learn how to harness nature's computational power as we harness its energy and materials? This volume includes a selection of contributions from the Symposium on Natural Computing/Unconventional Computing and Its Philosophical Significance, organized during the AISB/IACAP World Congress 2012, held in Birmingham, UK, on July 2-6, on the occasion of the centenary of Alan Turing's birth. In this book, leading researchers investigated questions of computing nature by exploring various facets of computation as we find it in nature: relationships between different levels of computation, cognition with learning and intelligence, mathematical background, relationships to classical Turing computation and Turing's ideas about computing nature - unorganized machines and morphogenesis. It addresses questions of information, representation and computation, interaction as communication, concurrency and agent models; in short this book presents natural computing and unconventional computing as extension of the idea of computation as symbol manipulation.

Swarm Intelligence Jun 02 2020 The book's contributing authors are among the top researchers in swarm intelligence. The book is intended to provide an overview of the subject to novices, and to offer researchers an update on interesting recent developments. Introductory chapters deal with the biological foundations, optimization, swarm robotics, and applications in new-generation telecommunication networks, while the second part contains chapters on more specific topics of swarm intelligence research.

Foraging-Inspired Optimisation Algorithms Feb 08 2021 This book is an introduction to relevant aspects of the foraging literature for algorithmic design, and an overview of key families of optimization algorithms that stem from a foraging metaphor. The authors first offer perspectives on foraging and foraging-inspired algorithms for optimization, they then explain the techniques inspired by the behaviors of vertebrates, invertebrates, and non-neuronal organisms, and they then discuss algorithms based on formal models of foraging, how to evolve a foraging strategy, and likely future developments. No prior knowledge of natural computing is assumed. This book will be of particular interest to graduate students, academics and practitioners in computer science, informatics, data science, management science, and other application domains.

Handbook of Natural Computing Sep 05 2020 Natural Computing is the field of research that investigates both human-designed computing inspired by nature and computing taking place in nature, i.e., it investigates models and computational techniques inspired by nature and also it investigates phenomena taking place in nature in terms of information processing. Examples of the first strand of research covered by the handbook include neural computation inspired by the functioning of the brain; evolutionary computation inspired by Darwinian evolution of species; cellular automata inspired by intercellular communication; swarm intelligence inspired by the behavior of groups of organisms; artificial immune systems inspired by the natural immune system; artificial life systems inspired by the properties of natural life in general; membrane computing inspired by the compartmentalized ways in which cells process information; and amorphous computing inspired by morphogenesis. Other examples of natural-computing paradigms are molecular computing and quantum computing, where the goal is to replace traditional electronic hardware, e.g., by bioware in molecular computing. In molecular computing, data are encoded as biomolecules and then molecular biology tools are used to transform the data, thus performing computations. In quantum computing, one exploits quantum-mechanical phenomena to perform computations and secure communications more efficiently than classical physics and, hence, traditional hardware allows. The second strand of research covered by the handbook, computation taking place in nature, is represented by investigations into, among others, the computational nature of self-assembly, which lies at the core of nanoscience, the computational nature of developmental processes, the computational nature of biochemical reactions, the computational nature of bacterial communication, the computational nature of brain processes, and the systems biology approach to bionetworks where cellular processes are treated in terms of communication and interaction, and, hence, in terms of computation. We are now witnessing exciting interaction between computer science and the natural sciences. While the natural sciences are rapidly absorbing notions, techniques and methodologies intrinsic to information processing, computer science is adapting and extending its traditional notion of computation, and computational techniques, to account for computation taking place in nature around us. Natural Computing is an important catalyst for this two-way interaction, and this handbook is a major record of this important development.

Cartesian Genetic Programming Oct 31 2022 Cartesian Genetic Programming (CGP) is a highly effective and increasingly popular form of genetic programming. It represents programs in the form of directed graphs, and a particular characteristic is that it has a highly redundant genotype–phenotype mapping, in that genes can be noncoding. It has spawned a number of new forms, each improving on the efficiency, among them modular, or embedded, CGP, and self-modifying CGP. It has been applied to many problems in both computer science and applied sciences. This book contains chapters written by the leading figures in the development and application of CGP, and it will be essential reading for researchers in genetic programming and for engineers and scientists solving applications using these techniques. It will also be useful for advanced undergraduates and postgraduates seeking to understand and utilize a highly efficient form of genetic programming.

Introduction to Evolutionary Computing Jul 28 2022 The first complete overview of evolutionary computing, the collective name for a range of problem-solving techniques based on principles of biological evolution, such as natural selection and genetic inheritance. The text is aimed directly at lecturers and graduate and undergraduate students. It is also meant for those who wish to apply evolutionary computing to a particular problem or within a given application area. The book contains quick-reference information on the current state-of-the-art in a wide range of related topics, so it is of interest not just to evolutionary computing specialists but to researchers working in other fields.

Theory and Practice of Natural Computing Jan 10 2021 This book constitutes the refereed proceedings of the 7th International Conference on Theory and Practice of Natural Computing, TPNC 2017, held in Dublin, Ireland, in December 2018. The 35 full papers presented in this book, together with one invited talk, were carefully reviewed and selected from 69 submissions. The papers are organized around the following topical sections: applications of natural computing as algorithms, bioinformatics, control, cryptography, design, economics. The more theoretical contributions handle with artificial chemistry, artificial immune systems, artificial life, cellular automata, cognitive computing, cognitive engineering, cognitive robotics, collective behaviour, complex systems, computational intelligence, computational social science, computing with words, developmental systems, DNA computing, DNA nanotechnology, evolutionary algorithms, evolutionary computing, evolutionary game theory, fractal geometry, fuzzy control, fuzzy logic, fuzzy sets, fuzzy systems, genetic algorithms, genetic programming, granular computing, heuristics, intelligent agents, intelligent systems, machine intelligence, molecular programming, neural computing, neural networks, quantum communication, quantum computing, rough sets, self-assembly.

Algorithmic Aspects of Bioinformatics Feb 20 2022 This book introduces some key problems in bioinformatics, discusses the models used to formally describe these problems, and analyzes the algorithmic approaches used to solve them. After introducing the basics of molecular biology and algorithmics, Part I explains string algorithms and alignments; Part II details the field of physical mapping and DNA sequencing; and Part III examines the application of algorithmics to the analysis of biological data. Exciting application examples include predicting the spatial structure of proteins, and computing haplotypes from genotype data. Figures, chapter summaries, detailed derivations, and examples, are provided.

Automated Design of Machine Learning and Search Algorithms Jul 24 2019 This book presents recent advances in automated machine learning (AutoML) and automated algorithm design and indicates the future directions in this fast-developing area. Methods have been developed to automate the design of neural networks, heuristics and metaheuristics using techniques such as metaheuristics, statistical techniques, machine learning and hyper-heuristics. The book first defines the field of automated design, distinguishing it from the similar but different topics of automated algorithm configuration and automated algorithm selection. The chapters report on the current state of the art by experts in the field and include reviews of AutoML and automated design of search, theoretical analyses of automated algorithm design, automated design of control software for robot swarms, and overfitting as a benchmark and design tool. Also covered are automated generation of constructive and perturbative low-level heuristics, selection hyper-heuristics for automated design, automated design of deep-learning approaches using hyper-heuristics, genetic programming hyper-heuristics with transfer knowledge and automated design of classification algorithms. The book concludes by examining future research directions of this rapidly evolving field. The information presented here will especially interest researchers and practitioners in the fields of artificial intelligence, computational intelligence, evolutionary computation and optimisation.

Theory of Evolutionary Computation Jan 28 2020 This edited book reports on recent developments in the theory of evolutionary computation, or more generally the domain of randomized search heuristics. It starts with two chapters on mathematical methods that are often used in the analysis of randomized search heuristics, followed by three chapters on how to measure the complexity of a search heuristic: black-box complexity, a counterpart of classical complexity theory in black-box optimization; parameterized complexity, aimed at a more fine-grained view of the difficulty of problems; and the fixed-budget perspective, which answers the question of how good a solution will be after investing a certain computational budget. The book then describes theoretical results on three important questions in evolutionary computation: how to profit from changing the parameters during the run of an algorithm; how evolutionary algorithms cope with dynamically changing or stochastic environments; and how population diversity influences performance. Finally, the book looks at three algorithm classes that have only recently become the focus of theoretical work: estimation-of-distribution algorithms; artificial immune systems; and genetic programming. Throughout the book the contributing authors try to develop an understanding for how these methods work, and why they are so successful in many applications. The book will be useful for students and researchers in theoretical computer science and evolutionary computing.

Sensitivity Analysis for Neural Networks Sep 17 2021 Artificial neural networks are used to model systems that receive inputs and produce outputs. The relationships between the inputs and outputs and the representation parameters are critical issues in the design of related engineering systems, and sensitivity analysis concerns methods for analyzing these relationships. Perturbations of neural networks are caused by machine imprecision, and they can be simulated by embedding disturbances in the original inputs or connection weights, allowing us to study the characteristics of a function under small perturbations of its parameters. This is the first book to present a systematic description of sensitivity analysis methods for artificial neural networks. It covers sensitivity analysis of multilayer perceptron neural networks and radial basis function neural networks, two widely used models in the machine learning field. The authors examine the applications of such analysis in tasks such as feature selection, sample reduction, and network optimization. The book will be useful for engineers applying neural network sensitivity analysis to solve practical problems, and for researchers interested in foundational problems in neural networks.

Differential Evolution Mar 12 2021 Problems demanding globally optimal solutions are ubiquitous, yet many are intractable when they involve constrained functions having many local optima and interacting, mixed-type variables. The differential evolution (DE) algorithm is a practical approach to global numerical optimization which is easy to understand, simple to implement, reliable, and fast. Packed with illustrations, computer code, new insights, and practical advice, this volume explores DE in both principle and practice. It is a valuable resource for professionals needing a proven optimizer and for students wanting an evolutionary perspective on global numerical optimization.

Natural and Artificial Computation for Biomedicine and Neuroscience Nov 27 2019 The two volumes LNCS 10337 and 10338 constitute the proceedings of the International Work-Conference on the Interplay Between Natural and Artificial Computation, IWINAC 2017, held in Corunna, Spain, in June 2017. The total of 102 full papers was carefully reviewed and selected from 194 submissions during two rounds of reviewing and improvement. The papers are organized in two volumes, one on natural and artificial computation for biomedicine and neuroscience, addressing topics such as theoretical neural computation; models; natural computing in bioinformatics; physiological computing in affective smart environments; emotions; as well as signal processing and machine learning applied to biomedical and neuroscience applications. The second volume deals with biomedical applications, based on natural and artificial computing and addresses topics such as biomedical applications; mobile brain computer interaction; human robot interaction; deep learning; machine learning applied to big data analysis; computational intelligence in data coding and transmission; and applications.

Natural Computing in Computational Finance Dec 09 2020 The chapters in this book illustrate the application of a range of cutting-edge natural computing and agent-based methodologies in computational finance and economics. The eleven chapters were selected following a rigorous, peer-reviewed, selection process.

Bioinspired Computation in Combinatorial Optimization Mar 24 2022 Bioinspired computation methods such as evolutionary algorithms and ant colony optimization are being applied successfully to complex engineering problems and to problems from combinatorial optimization, and with this comes the requirement to more fully understand the computational complexity of these search heuristics. This is the first textbook covering the most important results achieved in this area. The authors study the computational complexity of bioinspired computation and show how runtime behavior can be analyzed in a rigorous way using some of the best-known combinatorial optimization problems -- minimum spanning trees, shortest paths, maximum matching, covering and scheduling problems. A feature of the book is the separate treatment of single- and multiobjective problems, the latter a domain where the development of the underlying theory seems to be lagging practical successes. This book will be very valuable for teaching courses on bioinspired computation and combinatorial optimization. Researchers will also benefit as the presentation of the theory covers the most important developments in the field over the last 10 years. Finally, with a focus on well-studied combinatorial optimization problems rather than toy problems, the book will also be very valuable for practitioners in this field.

Design by Evolution Oct 19 2021 Evolution is Nature's design process. The natural world is full of wonderful examples of its successes, from engineering design feats such as powered flight, to the design of complex optical systems such as the mammalian eye, to the merely stunningly beautiful designs of orchids or birds of paradise. With increasing computational power, we are now able to simulate this process with greater fidelity, combining complex simulations with high-performance evolutionary algorithms to tackle problems that used to be impractical. This book showcases the state of the art in evolutionary algorithms for design. The chapters are organized by experts in the following fields: evolutionary design and "intelligent design" in biology, art, computational embryogeny, and engineering. The book will be of interest to researchers, practitioners and graduate students in natural computing, engineering design, biology and the creative arts.

Discrete and Topological Models in Molecular Biology Dec 29 2019 Theoretical tools and insights from discrete mathematics, theoretical computer science, and topology now play essential roles in our understanding of vital biomolecular processes. The related methods are now employed in various fields of mathematical biology as instruments to "zoom in" on processes at a molecular level. This book contains expository chapters on how contemporary models from discrete mathematics – in domains such as algebra, combinatorics, and graph and knot theories – can provide perspective on biomolecular problems ranging from data analysis, molecular and gene arrangements and structures, and knotted DNA embeddings via spatial graph models to the dynamics and kinetics of molecular interactions. The contributing authors are among the leading scientists in this field and the book is a reference for researchers in mathematics and theoretical computer science who are engaged with modeling molecular and biological phenomena using discrete methods. It may also serve as a guide and supplement for graduate courses in mathematical biology or bioinformatics, introducing nontraditional aspects of mathematical biology.

Automating the Design of Data Mining Algorithms Jun 14 2021 Data mining is a very active research area with many successful real-world app- cations. It consists of a set of concepts and methods used to extract interesting or useful knowledge (or patterns) from real-world datasets, providing valuable support for decision making in industry, business, government, and science. Although there are already many types of data mining algorithms available in the literature, it is still dif cult for users to choose the best possible data mining algorithm for their particular data mining problem. In addition, data mining al- rithms have been manually designed; therefore they incorporate human biases and preferences. This book proposes a new approach to the design of data mining algorithms. - stead of relying on the slow and ad hoc process of manual algorithm design, this book proposes systematically automating the design of data mining algorithms with an evolutionary computation approach. More precisely, we propose a genetic p- gramming system (a type of evolutionary computation method that evolves c- puter programs) to automate the design of rule induction algorithms, a type of cl- si cation method that discovers a set of classi cation rules from data. We focus on genetic programming in this book because it is the paradigmatic type of machine learning method for automating the generation of programs and because it has the advantage of performing a global search in the space of candidate solutions (data mining algorithms in our case), but in principle other types of search methods for this task could be investigated in the future.

The Art of Artificial Evolution Apr 12 2021 Art is the Queen of all sciences communicating knowledge to all the generations of the world. Leonardo da Vinci Artistic behavior is one of the most valued qualities of the human mind. Although artistic manifestations vary from culture to culture, dedication to artistic tasks is common to all. In other words, artistic behavior is a universal trait of the human species. The current, Western de?nition of art is relatively new. However, a d- ication to artistic endeavors — such as the embellishment of tools, body - namentation, or gathering of unusual, arguably aesthetic, objects — can be traced back to the origins of humanity. That is, art is ever-present in human history and prehistory. Artandsciencesharealongandenduringrelationship.Thebest-known- ample of the explorationof this relationship is probably the work of Leonardo da Vinci. Somewhere in the 19th century art and science grew apart, but the cross-transfer of concepts between the two domains continued to exist. Currently, albeit the need for specialization, there is a growing interest in the exploration of the connections between art and science. Focusingoncomputerscience,itisinterestingtonoticethatearlypioneers of this discipline such as Ada Byron and Alan Turing showed an interest in using computational devices for art-making purposes. Oddly, in spite of this early interest and the ubiquity of art, it has received relatively little attention fromthe computersciencecommunityingeneral,and,moresurprisingly,from the arti?cial intelligence community.

Introduction to Evolutionary Computing Apr 24 2022 The first complete overview of evolutionary computing, the collective name for a range of problem-solving techniques based on principles of biological evolution, such as natural selection and genetic inheritance. The text is aimed directly at lecturers and graduate and undergraduate students. It is also meant for those who wish to apply evolutionary computing to a particular problem or within a given application area. The book contains quick-reference information on the current state-of-the-art in a wide range of related topics, so it is of interest not just to evolutionary computing specialists but to researchers working in other fields.

Hyper-Heuristics: Theory and Applications Jul 16 2021 This introduction to the field of hyper-heuristics presents the required foundations and tools and illustrates some of their applications. The authors organized the 13 chapters into three parts. The first, hyper-heuristic fundamentals and theory, provides an overview of selection constructive, selection perturbative, generation constructive and generation perturbative hyper-heuristics, and then a formal definition of hyper-heuristics. The chapters in the second part of the book examine applications of hyper-heuristics in vehicle routing, nurse rostering, packing and examination timetabling. The third part of the book presents advanced topics and then a summary of the field and future research directions. Finally the appendices offer details of the HyFlex framework and the EvoHyp toolkit, and then the definition, problem model and constraints for the most tested combinatorial optimization problems. The book will be of value to graduate students, researchers, and practitioners.

Natural Computing and Beyond May 14 2021 This book contains the joint proceedings of the Winter School of Hakodate (WSH) 2011 held in Hakodate, Japan, March 15–16, 2011, and the 6th International Workshop on Natural Computing (6th IWNC) held in Tokyo, Japan, March 28–30, 2012, organized by the Special Interest Group of Natural Computing (SIG-NAC), the Japanese Society for Artificial Intelligence (JSAI). This volume compiles refereed contributions to various aspects of natural computing, ranging from computing with slime mold, artificial chemistry, eco-physics, and synthetic biology, to computational aesthetics.

Membrane Computing Jul 04 2020 Membrane computing is an unconventional model of computation associated with a new computing paradigm. The field of membrane computing was initiated in 1998 by the author of this book; it is a branch of natural computing inspired by the structure and functioning of the living cell and devises distributed parallel computing models in the form of membrane systems. This book is the first monograph surveying the new field in a systematic and coherent way. It presents the central notions and results: the main classes of P systems, the main results about their computational power and efficiency, a complete bibliography, and a series of open problems and research topics.

An Introduction to Metaheuristics for Optimization Aug 17 2021 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.

Quantum Computation and Quantum Information Aug 24 2019 First-ever comprehensive introduction to the major new subject of quantum computing and quantum information.

Reservoir Computing Sep 29 2022 This book is the first comprehensive book about reservoir computing (RC). RC is a powerful and broadly applicable computational framework based on recurrent neural networks. Its advantages lie in small training data set requirements, fast training, inherent memory and high flexibility for various hardware implementations. It originated from computational neuroscience and machine learning but has, in recent years, spread dramatically, and has been introduced into a wide variety of fields, including complex systems science, physics, material science, biological science, quantum machine learning, optical communication systems, and robotics. Reviewing the current state of the art and providing a concise guide to the field, this book introduces readers to its basic concepts, theory, techniques, physical implementations and applications. The book is sub-structured into two major parts: theory and physical implementations. Both parts consist of a compilation of chapters, authored by leading experts in their respective fields. The first part is devoted to theoretical developments of RC, extending the framework from the conventional recurrent neural network context to a more general dynamical systems context. With this broadened perspective, RC is not restricted to the area of machine learning but is being connected to a much wider class of systems. The second part of the book focuses on the utilization of physical dynamical systems as reservoirs, a framework referred to as physical reservoir computing. A variety of physical systems and substrates have already been suggested and used for the implementation of reservoir computing. Among these physical systems which cover a wide range of spatial and temporal scales, are mechanical and optical systems, nanomaterials, spintronics, and quantum many body systems. This book offers a valuable resource for researchers (Ph.D. students and experts alike) and practitioners working in the field of machine learning, artificial intelligence, robotics, neuromorphic computing, complex systems, and physics.

Evolvable Components Jan 22 2022 At the beginning of the 1990s research started in how to combine soft comput ing with reconfigurable hardware in a quite unique way. One of the methods that was developed has been called evolvable hardware. Thanks to evolution ary algorithms researchers have started to evolve electronic circuits routinely. A number of interesting circuits - with features unreachable by means of con ventional techniques - have been developed. Evolvable hardware is quite pop ular right now; more than fifty research groups are spread out over the world. Evolvable hardware has become a part of the curriculum at some universi ties. Evolvable hardware is being commercialized and there are specialized conferences devoted to evolvable hardware. On the other hand, surprisingly, we can feel the lack of a theoretical background and consistent design methodology in the area. Furthermore, it is quite difficult to implement really innovative and practically successful evolvable systems using contemporary digital reconfigurable technology.

Natural Computing Algorithms Jun 22 2019 The field of natural computing has been the focus of a substantial research effort in recent decades. One particular strand of this research concerns the development of computational algorithms using metaphorical inspiration from systems and phenomena that occur in the natural world. These naturally inspired computing algorithms have proven to be successful problem-solvers across domains as diverse as management science, bioinformatics, finance, marketing, engineering, architecture and design. This book is a comprehensive introduction to natural computing algorithms, suitable for academic and industrial researchers and for undergraduate and graduate courses on natural computing in computer science, engineering and management science.

Self-organising Software Nov 19 2021 Self-organisation, self-regulation, self-repair and self-maintenance are promising conceptual approaches for dealing with complex distributed interactive software and information-handling systems. Self-organising applications dynamically change their functionality and structure without direct user intervention, responding to changes in requirements and the environment. This is the first book to offer an integrated view of self-organisation technologies applied to distributed systems, particularly focusing on multiagent systems. The editors developed this integrated book with three aims: to explain self-organisation concepts and principles, using clear definitions and a strong theoretical background; to examine how self-organising behaviour can be modelled, analysed and systematically engineered into agent behaviour; and to assess the types of problems that can be solved using self-organising multiagent systems. The book comprises chapters covering all three dimensions, synthesising up-to-date research work and the latest technologies and applications. The book offers dedicated chapters on concepts such as self-organisation, emergence in natural systems, software agents, stigmergy, gossip, cooperation and immune systems. The book then explains how to engineer artificial self-organising software, in particular it examines methodologies and middleware infrastructures. Finally, the book presents diverse applications of self-organising software, such as constraint satisfaction, trust management, image recognition and networking. The book will be of interest to researchers working on emergent phenomena and adaptive systems. It will also be suitable for use as a graduate textbook, with chapter summaries and exercises, and an accompanying website that includes teaching slides, exercise solutions and research project outlines. Self-organisation, self-regulation, self-repair and self-maintenance are promising conceptual approaches for dealing with complex distributed interactive software and information-handling systems. Self-organising applications dynamically change their functionality and structure without direct user intervention, responding to changes in requirements and the environment. This is the first book to offer an integrated view of self-organisation technologies applied to distributed systems, particularly focusing on multiagent systems. The editors developed this integrated book with three aims: to explain self-organisation concepts and principles, using clear definitions and a strong theoretical background; to examine how self-organising behaviour can be modelled, analysed and systematically engineered into agent behaviour; and to assess the types of problems that can be solved using self-organising multiagent systems. The book comprises chapters covering all three dimensions, synthesising up-to-date research work and the latest technologies and applications. The book offers dedicated chapters on concepts such as self-organisation, emergence in natural systems, software agents, stigmergy, gossip, cooperation and immune systems. The book then explains how to engineer artificial self-organising software, in particular it examines methodologies and middleware infrastructures. Finally, the book presents diverse applications of self-organising software, such as constraint satisfaction, trust management, image recognition and networking. The book will be of interest to researchers working on emergent phenomena and adaptive systems. It will also be suitable for use as a graduate textbook, with chapter summaries and exercises, and an accompanying website that includes teaching slides, exercise solutions and research project outlines.

Analyzing Evolutionary Algorithms Oct 07 2020 Evolutionary algorithms is a class of randomized heuristics inspired by natural evolution. They are applied in many different contexts, in particular in optimization, and analysis of such algorithms has seen tremendous advances in recent years. In this book the author provides an introduction to the methods used to analyze evolutionary algorithms and other randomized search heuristics. He starts with an algorithmic and modular perspective and gives guidelines for the design of evolutionary algorithms. He then places the approach in the broader research context with a chapter on theoretical perspectives. By adopting a complexity-theoretical perspective, he derives general limitations for black-box optimization, yielding lower bounds on the performance of evolutionary algorithms, and then develops general methods for deriving upper and lower bounds step by step. This main part is followed by a chapter covering practical applications of these methods. The notational and mathematical basics are covered in an appendix, the results presented are derived in detail, and each chapter ends with detailed comments and pointers to further reading. So the book is a useful reference for both graduate students and researchers engaged with the theoretical analysis of such algorithms.

Evolution as Computation Oct 26 2019 The study of the genetic basis for evolution has flourished in this century, as well as our understanding of the evolvability and programmability of biological systems. Genetic algorithms meanwhile grew out of the realization that a computer program could use the biologically-inspired processes of mutation, recombination, and selection to solve hard optimization problems. Genetic and evolutionary programming provide further approaches to a wide variety of computational problems. A synthesis of these experiences reveals fundamental insights into both the computational nature of biological evolution and processes of importance to computer science. Topics include biological models of nucleic acid information processing and genome evolution; molecules, cells, and metabolic circuits that compute logical relationships; the origin and evolution of the genetic code; and the interface with genetic algorithms and genetic and evolutionary programming.

Quantum Computing Aug 29 2022 Mika Hirvensalo maps out the new multidisciplinary research area of quantum computing. The text contains an introduction to quantum computing as well as the most important recent results on the topic. The presentation is uniform and computer science-oriented. Thus, the book differs from most of the previous ones which are mainly physics-oriented. The special style of presentation makes the theory of quantum computing accessible to a larger audience. Many examples and exercises ease the understanding. In this second edition, a new chapter on quantum information has been added and numerous corrections, amendments, and extensions have been incorporated throughout the entire text.

Design of Modern Heuristics May 02 2020 Most textbooks on modern heuristics provide the reader with detailed descriptions of the functionality of single examples like genetic algorithms, genetic programming, tabu search, simulated annealing, and others, but fail to teach the underlying concepts behind these different approaches. The author takes a different approach in this textbook by focusing on the users' needs and answering three fundamental questions: First, he tells us which problems modern heuristics are expected to perform well on, and which should be left to traditional optimization methods. Second, he teaches us to systematically design the "right" modern heuristic for a particular problem by providing a coherent view on design elements and working principles. Third, he shows how we can make use of problem-specific knowledge for the design of efficient and effective modern heuristics that solve not only small toy problems but also perform well on large real-world problems. This book is written in an easy-to-read style and it is aimed at students and practitioners in computer science, operations research and information systems who want to understand modern heuristics and are interested in a guide to their systematic design and use. This book is written in an easy-to-read style and it is aimed at students and practitioners in computer science, operations research and information systems who want to understand modern heuristics and are interested in a guide to their systematic design and use. This book is written in an easy-to-read style and it is aimed at students and practitioners in computer science, operations research and information systems who want to understand modern heuristics and are interested in a guide to their systematic design and use.

Natural Computing Algorithms Dec 21 2021 The field of natural computing has been the focus of a substantial research effort in recent decades. One particular strand of this research concerns the development of computational algorithms using metaphorical inspiration from systems and phenomena that occur in the natural world. These naturally inspired computing algorithms have proven to be successful problem-solvers across domains as diverse as management science, bioinformatics, finance, marketing, engineering, architecture and design. This book is a comprehensive introduction to natural computing algorithms, suitable for academic and industrial researchers and for undergraduate and graduate courses on natural computing in computer science, engineering and management science.

Contemporary Evolution Strategies Jun 26 2022 This book surveys key algorithm developments between 1990 and 2012, with brief descriptions, a unified pseudocode for each algorithm and downloadable program code. Provides a taxonomy to clarify similarities and differences as well as historical relationships.

Spatially Structured Evolutionary Algorithms Feb 29 2020 Evolutionary algorithms (EAs) is now a mature problem-solving family of heuristics that has found its way into many important real-life problems and into leading-edge scientific research. Spatially structured EAs have different properties than standard, mixing EAs. By virtue of the structured disposition of the population members they bring about new dynamical features that can be harnessed to solve difficult problems faster and more efficiently. This book describes the state of the art in spatially structured EAs by using graph concepts as a unifying theme. The models, their analysis, and their empirical behavior are presented in detail. Moreover, there is new material on non-standard networked population structures such as small-world networks. The book should be of interest to advanced undergraduate and graduate students working in evolutionary computation, machine learning, and optimization. It should also be useful to researchers and professionals working in fields where the topological structures of populations and their evolution plays a role.