# *Computational Complexity Analysis Of Simple Genetic*

New and classical results in computational complexity, including interactive proofs, PCP, derandomization, and quantum computation. Ideal for graduate students.
This volume contains the proceedings of the 7th European Performance En- neering Workshop (EPEW 2010), held in Bertinoro, Italy, on September 23–24, 2010. The purpose of this workshop series is to gather academic and industrial researchers working on all aspects of performance engineering. This year the workshop was structured around three main areas: system and network p- formance engineering, software performance engineering, and the modeling and evaluation techniques supporting them. This edition of the workshop attracted 38 submissions, whose authors we wish to thank for their interest in EPEW 2010. After a careful review process during which every paper was refereed by at least three reviewers, the Program Committee selected 16 papers for presentation at the workshop. We warmly thank all the members of the ProgramCommittee and all the reviewersfor their fair and constructive comments and discussions. The workshop program was enriched by two keynote talks given by Marco Roccetti and Ralf Reussner. We conclude by expressing our gratitude to all the people who contributed to the organization of EPEW 2010, in particular the sta? of the University Residential Center of Bertinoro. We are also grateful to the EasyChair team for having allowed us to use their conference system and Springer for the continued editorial support of this workshop series.
Computational ComplexityA Modern ApproachCambridge University Press
MPEG-4 is the multimedia standard for combining interactivity, natural and synthetic digital video, audio and computer-graphics. Typical applications are: internet, video conferencing, mobile videophones, multimedia cooperative work, teleteaching and games. With MPEG-4 the next step from block-based video (ISO/IEC MPEG-1, MPEG-2, CCITT H.261, ITU-T H.263) to arbitrarily-shaped visual objects is taken. This significant step demands a new methodology for system analysis and design to meet the considerably higher flexibility of MPEG-4. Motion estimation is a central part of MPEG-1/2/4 and H.261/H.263 video compression standards and has attracted much attention in research and industry, for the following reasons: it is computationally the most demanding algorithm of a video encoder (about 60-80% of the total computation time), it has a high impact on the visual quality of a video encoder, and it is not standardized, thus being open to competition. Algorithms, Complexity Analysis, and VLSI Architectures for MPEG-4 Motion Estimation covers in detail every single step in the design of a MPEG-1/2/4 or H.261/H.263 compliant video encoder: Fast motion estimation algorithms Complexity analysis tools Detailed complexity analysis of a software implementation of MPEG-4 video Complexity and visual quality analysis of fast motion estimation algorithms within MPEG-4 Design space on motion estimation VLSI

architectures Detailed VLSI design examples of (1) a high throughput and (2) a low-power MPEG-4 motion estimator. Algorithms, Complexity Analysis and VLSI Architectures for MPEG-4 Motion Estimation is an important introduction to numerous algorithmic, architectural and system design aspects of the multimedia standard MPEG-4. As such, all researchers, students and practitioners working in image processing, video coding or system and VLSI design will find this book of interest.

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.

Analytic Computational Complexity

Bioinspired Computation in Combinatorial Optimization

Cognitive Radio Oriented Wireless Networks

Algorithms and Their Computational Complexity

Computer Networks

International Conference, CIS 2006, Guangzhou, China, November 3-6, 2006, Revised Selected Papers

**This book presents a collection of computational intelligence algorithms that addresses issues in visual pattern recognition such as high computational complexity, abundance of pattern features, sensitivity to size and shape variations and poor performance against complex backgrounds. The book has 3 parts. Part 1 describes various research issues in the field with a survey of the related literature. Part 2 presents computational intelligence based algorithms for feature selection and classification. The algorithms are discriminative and fast. The main application area considered is hand posture recognition. The book also discusses utility of these algorithms in other visual as well as non-visual pattern recognition tasks including face recognition, general object recognition and cancer / tumor**

classification. Part 3 presents biologically inspired algorithms for feature extraction. The visual cortex model based features discussed have invariance with respect to appearance and size of the hand, and provide good inter class discrimination. A Bayesian model of visual attention is described which is effective in handling complex background problem in hand posture recognition. The book provides qualitative and quantitative performance comparisons for the algorithms outlined, with other standard methods in machine learning and computer vision. The book is self-contained with several figures, charts, tables and equations helping the reader to understand the material presented without instruction.

Lattices are geometric objects that can be pictorially described as the set of intersection points of an infinite, regular n-dimensional grid. De spite their apparent simplicity, lattices hide a rich combinatorial struc ture, which has attracted the attention of great mathematicians over the last two centuries. Not surprisingly, lattices have found numerous ap plications in mathematics and computer science, ranging from number theory and Diophantine approximation, to combinatorial optimization and cryptography. The study of lattices, specifically from a computational point of view, was marked by two major breakthroughs: the development of the LLL lattice reduction algorithm by Lenstra, Lenstra and Lovasz in the early 80's, and Ajtai's discovery of a connection between the worst-case and average-case hardness of certain lattice problems in the late 90's. The LLL algorithm, despite the relatively poor quality of the solution it gives in the worst case, allowed to devise polynomial time solutions to many classical problems in computer science. These include, solving integer programs in a fixed number of variables, factoring polynomials over the rationals, breaking knapsack based cryptosystems, and finding solutions to many other Diophantine and cryptanalysis problems.

This book constitutes the refereed proceedings of the 26th International Symposium on Algorithms and Computation, ISAAC 2015, held in Nagoya, Japan, in December 2015. The 65 revised full papers presented together with 3 invited talks were carefully reviewed and selected from 180 submissions for inclusion in the book. The focus of the volume is on the following topics: computational geometry; data structures; combinatorial optimization and approximation algorithms; randomized algorithms; graph algorithms and FPT; computational complexity; graph drawing and planar graphs; online and streaming algorithms; and string and DNA algorithms.

The two volume set LNCS 7491 and 7492 constitutes the refereed proceedings of the 12th International Conference on Parallel Problem Solving from Nature, PPSN 2012, held in Taormina, Sicily, Italy, in September 2012. The total of 105 revised full papers were carefully reviewed and selected from 226 submissions. The meeting began with 5 workshops which offered an ideal opportunity to explore specific topics in evolutionary computation, bio-inspired computing and metaheuristics. PPSN 2012 also included 8 tutorials. The papers are organized in topical sections on evolutionary computation; machine learning, classifier systems, image processing; experimental analysis, encoding, EDA, GP; multiobjective optimization; swarm intelligence, collective behavior, coevolution and robotics; memetic algorithms, hybridized techniques, meta and hyperheuristics; and applications.

**This two-volume set LNCS 12269 and LNCS 12270 constitutes the refereed proceedings of the 16th International Conference on Parallel Problem Solving from Nature, PPSN 2020, held in Leiden, The Netherlands, in September 2020. The 99 revised full papers were carefully reviewed and selected from 268 submissions. The topics cover classical subjects such as automated algorithm selection and configuration; Bayesian- and surrogate-assisted optimization; benchmarking and performance measures; combinatorial optimization; connection between nature-inspired optimization and artificial intelligence; genetic and evolutionary algorithms; genetic programming; landscape analysis; multiobjective optimization; real-world applications; reinforcement learning; and theoretical aspects of nature-inspired optimization.**

**Algorithms and Complexity**

**Parallel Problem Solving from Nature – PPSN XV**

**A Conceptual Perspective**

**Genetic Programming Theory and Practice IX**

**Computational Sensor Networks**

**Artificial Neural Networks and Machine Learning – ICANN 2016**

This book is an introductory textbook on the design and analysis of algorithms. The author uses a careful selection of a few topics to illustrate the tools for algorithm analysis. Recursive algorithms are illustrated by Quicksort, FFT, fast matrix multiplications, and others. Algorithms associated with the network flow problem are fundamental in many areas of graph connectivity, matching theory, etc. Algorithms in number theory are discussed with some applications to public key encryption. This second edition will differ from the present edition mainly in that solutions to most of the exercises will be included.

Foundations of Algorithms, Fifth Edition offers a well-balanced presentation of algorithm design, complexity analysis of algorithms, and computational complexity. Ideal for any computer science students with a background in college algebra and discrete structures, the text presents mathematical concepts using standard English and simple notation to maximize accessibility and user-friendliness. Concrete examples, appendices reviewing essential mathematical concepts, and a student-focused approach reinforce theoretical explanations and promote learning and retention. C++ and Java pseudocode help students better understand complex algorithms. A chapter on numerical algorithms includes a review of basic number theory, Euclid's Algorithm for finding the greatest common divisor, a review of modular arithmetic, an algorithm for solving modular linear equations, an algorithm for computing modular powers, and the new polynomial-time algorithm for determining whether a number is prime. The revised and updated Fifth Edition features an all-new chapter on genetic algorithms and genetic programming, including approximate solutions to the traveling salesperson problem, an algorithm for an artificial ant that navigates along a trail of food, and an application to financial trading. With fully updated exercises and examples throughout and improved instructor resources including complete solutions, an Instructor's Manual and PowerPoint lecture outlines, Foundations of Algorithms is an essential text for undergraduate and graduate courses in the design and analysis of algorithms. Key features include: • The only text of its kind with a chapter on genetic algorithms • Use of C++ and Java pseudocode to help students better understand complex algorithms • No calculus background required • Numerous clear and student-friendly examples throughout the text • Fully updated exercises and examples throughout • Improved instructor resources, including complete solutions, an Instructor's Manual, and PowerPoint lecture outlines

This thesis is concerned with analyzing the computational complexity of NP-hard problems related to data science. For most of the problems considered in this thesis, the computational complexity has not been intensively studied before. We focus on the complexity of computing exact problem solutions and conduct a detailed analysis identifying tractable special cases. To this end, we adopt a parameterized viewpoint in which we spot several parameters which describe properties of a specific problem instance that allow to solve the instance efficiently. We develop specialized algorithms whose running times are polynomial if the corresponding parameter value is constant. We also investigate in which cases the problems remain intractable even for small parameter values. We thereby chart the border between tractability and intractability for some practically motivated problems which yields a better understanding of their computational complexity. In particular, we consider the following problems. General Position Subset Selection is the problem to select a maximum number of points in general position from a given set of points in the plane. Point sets in general position are well-studied in geometry and play a role in data visualization. We prove several computational hardness results and show how polynomial-time data reduction can be applied to solve the problem if the sought number of points in general position is very small or very large. The Distinct Vectors problem asks to select a minimum number of columns in a given matrix such that all rows in the selected submatrix are pairwise distinct. This problem is motivated by combinatorial feature selection. We prove a complexity dichotomy with respect to combinations of the minimum and the maximum pairwise Hamming distance of the rows for binary input matrices, thus separating polynomial-time solvable from NP-hard cases. Co-Clustering is a well-known matrix clustering problem in data mining where the goal is to partition a matrix into homogenous submatrices. We conduct an extensive multivariate complexity analysis revealing several NP-hard and some polynomial-time solvable and fixed-parameter tractable cases. The generic F-free Editing problem is a graph modification problem in which a given graph has to be modified by a minimum number of edge modifications such that it does not contain any induced subgraph isomorphic to the graph F. We consider three special cases of this problem: The graph clustering problem Cluster Editing with applications in machine learning, the Triangle Deletion problem which is motivated by network cluster analysis, and Feedback Arc Set in Tournaments with applications in rank aggregation. We introduce a new parameterization by the number of edge modifications above a lower bound derived from a packing of induced forbidden subgraphs and show fixed-parameter tractability for all of the three above problems with respect to this parameter. Moreover, we prove several NP-hardness results for other variants of F-free Editing for a constant parameter value. The problem DTW-Mean is to compute a mean time series of a given sample of time series with respect to the dynamic time warping distance. This is a fundamental problem in time series analysis the complexity of which is unknown. We give an exact exponential-time algorithm for DTW-Mean and prove polynomial-time solvability for the special case of binary time series. Diese Dissertation befasst sich mit der Analyse der Berechnungskomplexität von NP-schweren Problemen aus dem Bereich Data Science. Für die meisten der hier betrachteten Probleme wurde die Berechnungskomplexität bisher nicht sehr detailliert untersucht. Wir führen daher eine genaue Komplexitätsanalyse dieser Probleme durch, mit dem Ziel, effizient lösbare Spezialfälle zu identifizieren. Zu diesem Zweck nehmen wir eine parametrisierte Perspektive ein, bei der wir bestimmte Parameter definieren, welche Eigenschaften einer konkreten Probleminstanz beschreiben, die es ermöglichen, diese Instanz effizient zu lösen. Wir entwickeln dabei spezielle Algorithmen, deren Laufzeit für konstante Parameterwerte polynomiell ist. Darüber hinaus untersuchen wir, in welchen Fällen die Probleme selbst bei kleinen Parameterwerten berechnungsschwer bleiben. Somit skizzieren wir die Grenze zwischen schweren und handhabbaren Probleminstanzen, um ein besseres Verständnis der Berechnungskomplexität für die folgenden praktisch motivierten Probleme zu erlangen. Beim

General Position Subset Selection Problem ist eine Menge von Punkten in der Ebene gegeben und das Ziel ist es, möglichst viele Punkte in allgemeiner Lage davon auszuwählen. Punktmengen in allgemeiner Lage sind in der Geometrie gut untersucht und spielen unter anderem im Bereich der Datenvisualisierung eine Rolle. Wir beweisen etliche Härteergebnisse und zeigen, wie das Problem mittels Polynomzeitdatenreduktion gelöst werden kann, falls die Anzahl gesuchter Punkte in allgemeiner Lage sehr klein oder sehr groß ist. Distinct Vectors ist das Problem, möglichst wenige Spalten einer gegebenen Matrix so auszuwählen, dass in der verbleibenden Submatrix alle Zeilen paarweise verschieden sind. Dieses Problem hat Anwendungen im Bereich der kombinatorischen Merkmalsselektion. Wir betrachten Kombinationen aus maximalem und minimalem paarweisen Hamming-Abstand der Zeilenvektoren und beweisen eine Komplexitätsdichotomie für Binärmatrizen, welche die NP-schweren von den polynomzeitlösbaren Kombinationen unterscheidet. Co-Clustering ist ein bekanntes Matrix-Clustering-Problem aus dem Gebiet Data-Mining. Ziel ist es, eine Matrix in möglichst homogene Submatrizen zu partitionieren. Wir führen eine umfangreiche multivariate Komplexitätsanalyse durch, in der wir zahlreiche NP-schwere, sowie polynomzeitlösbare und festparameterhandhabbare Spezialfälle identifizieren. Bei F-free Editing handelt es sich um ein generisches Graphmodifikationsproblem, bei dem ein Graph durch möglichst wenige Kantenmodifikationen so abgeändert werden soll, dass er keinen induzierten Teilgraphen mehr enthält, der isomorph zum Graphen F ist. Wir betrachten die drei folgenden Spezialfälle dieses Problems: Das Graph-Clustering-Problem Cluster Editing aus dem Bereich des Maschinellen Lernens, das Triangle Deletion Problem aus der Netzwerk-Cluster-Analyse und das Problem Feedback Arc Set in Tournaments mit Anwendungen bei der Aggregation von Rankings. Wir betrachten eine neue Parametrisierung mittels der Differenz zwischen der maximalen Anzahl Kantenmodifikationen und einer unteren Schranke, welche durch eine Menge von induzierten Teilgraphen bestimmt ist. Wir zeigen Festparameterhandhabbarkeit der drei obigen Probleme bezüglich dieses Parameters. Darüber hinaus beweisen wir etliche NP-Schwereergebnisse für andere Problemvarianten von F-free Editing bei konstantem Parameterwert. DTW-Mean ist das Problem, eine Durchschnittszeitreihe bezüglich der Dynamic-Time-Warping-Distanz für eine Menge gegebener Zeitreihen zu berechnen. Hierbei handelt es sich um ein grundlegendes Problem der Zeitreihenanalyse, dessen Komplexität bisher unbekannt ist. Wir entwickeln einen exakten Exponentialzeitalgorithmus für DTW-Mean und zeigen, dass der Spezialfall binärer Zeitreihen in polynomieller Zeit lösbar ist.

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.

Going beyond the usual how-to guide, Lean Six Sigma Secrets for the CIO supplies proven tips and valuable case studies that illustrate how to combine Six Sigma’s rigorous quality principles with Lean methods for uncovering and eliminating waste in IT processes. Using these methods, the text explains how to take an approach that is all about improving IT performance, productivity, and security—as much as it is about cutting costs. Savvy IT veterans describe how to use Lean Six Sigma with IT governance frameworks such as COBIT and ITIL and warn why these frameworks should be considered starting points rather than destinations. This complete resource for CIOs and IT managers provides effective strategies to address the human element that is so fundamental to success and explains how to maximize the voice of your customers while keeping in touch with the needs of your staff. And perhaps most importantly—it provides the evidence needed to build your case to upper management. Supplying you with the tools to create methods that will bring out the best in your employees; Lean Six Sigma Secrets for the CIO provides the understanding required to manage your IT operations with unique effectiveness and efficiency in service of the bottom line.

Modeling Time in Computing

Theory of Evolutionary Computation

Fine-grained complexity analysis of some combinatorial data science problems
A Guide to Classical and Parameterized Complexity Analysis
Parallel Problem Solving from Nature - PPSN XII
Complexity and Real Computation

**Computer science and physics have been closely linked since the birth of modern computing. In recent years, an interdisciplinary area has blossomed at the junction of these fields, connecting insights from statistical physics with basic computational challenges. Researchers have successfully applied techniques from the study of phase transitions to analyze NP-complete problems such as satisfiability and graph coloring. This is leading to a new understanding of the structure of these problems, and of how algorithms perform on them. Computational Complexity and Statistical Physics will serve as a standard reference and pedagogical aid to statistical physics methods in computer science, with a particular focus on phase transitions in combinatorial problems. Addressed to a broad range of readers, the book includes substantial background material along with current research by leading computer scientists, mathematicians, and physicists. It will prepare students and researchers from all of these fields to contribute to this exciting area.**

**We also give algorithms for learning powerful concept classes under the uniform distribution, and give equivalences between natural models of efficient learnability. This thesis also includes detailed definitions and motivation for the distribution-free model, a chapter discussing past research in this model and related models, and a short list of important open problems."**

**The refereed post-proceedings of the International Conference on Computational Intelligence and Security are presented in this volume. The 116 papers were submitted to two rounds of careful review. Papers cover bio-inspired computing, evolutionary computation, learning systems and multi-agents, cryptography, information processing and intrusion detection, systems and security, image and signal processing, and pattern recognition.**

**The continuous and very intense development of IT has resulted in the fast development of computer networks. Computer networks, as well as the entire ?eldofIT,aresubjectto constantchangestriggeredbythegeneraltechnological advancement and the in?uence of new IT technologies.These methods and tools of designing and modeling computer networks are becoming more advanced. Above all, the scope of their application is growing thanks to, for example, the results of new research and because of new proposals of application, which not long ago were not even taken into consideration. These new applications stimulate the development of scienti?c research, as the broader application of system solutions based on computer networks results in a wide range of both theoretical and practical problems. This book proves that and the contents of its chapters concern a variety of topics and issues. Generally speaking, the contents can be divided into several subject groups. The ?rst group of contributions concerns new technologies applied in computer networks,particularlythoserelatedto nano,molecularandquantumtechnology.**

**In this thesis, we identify and develop simple combinatorial models for four natural team management tasks and identify tractable and intractable cases with respect to their computational complexity. To this end, we perform a multivariate complexity analysis of the underlying problems and test some of our algorithms on synthetic and empirical data. Our first task is to find a team that is accepted**

**by competing groups and also satisfies the agenda of some principal. Extending an approval balloting procedure by an agenda model, we formalize this task as a simple combinatorial model where potential team members are represented by a set of proposals and the competing groups are represented by voters with favorite ballots, that is, subsets of proposals. We show that the underlying problems UNANIMOUSLY ACCEPTED BALLOT and MAJORITYWISE ACCEPTED BALLOT are NP-hard even without an agenda for the principal. Herein, UNANIMOUSLY ACCEPTED BALLOT asks for a set of proposals that is accepted by all voters and MAJORITYWISE ACCEPTED BALLOT asks for a set of proposals that is accepted by a strict majority of the voters where acceptance means that each voter supports the majority of the proposals. On the positive side, we show fixed-parameter tractability with respect to the parameters "number of proposals" and "number of voters". With respect to the parameter "maximum size of the favorite ballots" we show fixed-parameter tractability for UNANIMOUSLY ACCEPTED BALLOT and W[1]-completeness for MAJORITYWISE ACCEPTED BALLOT. On the negative side, we show W[2]-hardness for the parameter "size of the solution" and NP-hardness for various special cases. Our second task is to partition a set of individuals into homogeneous groups. Using concepts from the combinatorial data anonymization model k-ANONYMITY, we develop a new model which formalizes this task. The information about the individuals is stored in a matrix where rows represent individuals and columns represent attributes of the individuals. The homogeneity requirement of each potential group is specified by a "pattern vector". We show that some special cases of the underlying problem HOMOGENEOUS TEAM FORMATION are NP-hard while others allow for (fixed-parameter) tractability results. We transfer our "pattern vector" concept back to combinatorial data anonymization and show that it may help to improve the usability of the anonymized data. We show that the underlying problem PATTERN-GUIDED k-ANONYMITY is NP-hard and complement this by a fixed-parameter tractability result based on a "homogeneity parameterization". Building on this, we develop an exact ILP-based solution method as well as a simple but very effective greedy heuristic. Experiments on several real-world datasets show that our heuristic easily matches up to the established "Mondrian" algorithm for k-ANONYMITY in terms of quality of the anonymization and outperforms it in terms of running time. Our third task is to effectively train team members in order to ensure that from a set of important skills each skill is covered by a majority of the team. We formalize this task by a natural binary matrix modification problem where team members are represented by rows and skills are represented by columns. The underlying problem is known as LOBBYING in the context of bribery in voting. We study how natural parameters such as "number of rows", "number of columns", "number of rows to modify", or the "maximum number of ones missing for any column to have a majority of ones" (referred to as "gap value") govern the computational complexity. On the negative side, we show NP-hardness even if each row contains at most three ones. On the positive side, for example, we prove fixed-parameter tractability for the parameter "number of columns" and provide a greedy logarithmic-factor approximation algorithm. We also show empirically that this greedy algorithm performs well on general instances. As a further key result, we prove LOGSNP-completeness for constant gap values. Our fourth task is to redistribute teams of equal size. More precisely, one asks to reduce the number of equal-size teams by dissolving some teams, distributing their team members to non-conflicting non-dissolved teams, and ensuring that all new teams are again of equal size. We**

**formalize this task by a new combinatorial graph model. We show relations to known graph models such as perfect matchings, flow networks, and star partitions. On the negative side, we show that the underlying problem is NP-hard even if the old team size and the team size increase are distinct constants. On the positive side, we show that even our two-party variant of the problem is polynomial-time solvable when there are no conflicts or when the districts to dissolve and the districts to win are known. Furthermore, we show fixed-parameter tractability with respect to treewidth when the old team size and the team size increase are constants. In dieser Dissertation identifizieren und entwickeln wir einfache kombinatorische Modelle für vier natürliche Teamverwaltungsaufgaben und untersuchen bezüglich Berechnungskomplexität handhabbare und nicht handhabbare Fälle. Hierzu analysieren wir die multivariate Komplexität der zu Grunde liegenden Probleme und testen manche unserer Algorithmen auf synthetischen und empirischen Daten. Unsere erste Aufgabe ist es ein Team zu finden, welches von einer Gemeinschaft akzeptiert wird und den Vorstellungen (im Folgenden „Agenda") eines Chefs entspricht. Wir formalisieren diese Aufgabe mit einem einfachen kombinatorischen Modell, indem wir ein bekanntes Verfahren aus dem Wahlkontext durch ein Agendamodell erweitern. In diesem Modell wird die Gemeinschaft durch Wähler mit je einer „Favoritenmenge" repräsentiert. Wir zeigen, dass die resultierenden Probleme UNANIMOUSLY ACCEPTED BALLOT und MAJORITYWISE ACCEPTED BALLOT NP-schwer sind, sogar wenn es keine Agenda des Chefs gibt. Hierbei fragt UNANIMOUSLY ACCEPTED BALLOT, ob es ein Team gibt, welches von allen Wählern akzeptiert wird. MAJORITYWISE ACCEPTED BALLOT fragt, ob es ein Team gibt, welches von einer strikten Mehrheit der Wähler akzeptiert wird. Akzeptanz bedeutet in diesem Zusammenhang, dass jeder Wähler die Mehrheit der Teammitglieder unterstützt. Auf der positiven Seite zeigen wir „fixed-parameter tractability" (FPT) für die Parameter „Anzahl an potentiellen Teammitgliedern" und „Anzahl an Wählern". Für den Parameter „maximale Größe der Favoritenmengen" zeigen wir ein FPT-Ergebnis für UNANIMOUSLY ACCEPTED BALLOT und W[1]-Vollständigkeit für MAJORITYWISE ACCEPTED BALLOT. Unsere zweite Aufgabe ist es eine Menge von Individuen in homogene Gruppen zu partitionieren. Unter Ausnutzung von Konzepten des kombinatorischen Datenanonymisierungsmodells k-ANONYMITY entwickeln wir ein neues Modell, welches diese Aufgabe formalisiert. Dabei werden die Homogenitätsanforderungen jeder potentiellen Gruppe durch einen „Mustervektor" spezifiziert. Die Informationen über die Individuen sind in einer Matrix gespeichert, wo Individuen durch Zeilen und ihre Attribute durch Spalten repräsentiert werden. Wir zeigen, dass einige Spezialfälle des sich ergebenden Problems HOMOGENEOUS TEAM FORMATION NP-schwer sind während andere FPT-Ergebnisse ermöglichen. Wir übertragen unser „Mustervektorkonzept" zurück in die Welt der kombinatorischen Datenanonymisierung und zeigen, dass es helfen kann die Nutzbarkeit der anonymisierten Daten zu verbessern. Wir zeigen, dass das zu Grunde liegende Problem NP-schwer ist und ergänzen dies durch ein FPT-Ergebnis bezüglich eines „Homogenitätsparameters". Aufbauend darauf entwickeln wir sowohl eine ILP-basierte exakte Lösungsmethode als auch eine Heuristik und testen diese in Experimenten mit empirischen Daten. Unsere dritte Aufgabe ist es ein Team effektiv auszubilden, um sicherzustellen, dass aus einer Menge von wichtigen Fähigkeiten jede jeweils von der Mehrheit der Teammitglieder beherrscht wird. Wir formalisieren diese Aufgabe durch ein natürliches Matrixmodifikationsproblem auf binären Matrizen, wobei Teammitglieder durch Zeilen und deren Fähigkeiten durch Spalten**

**repräsentiert werden. Das resultierende Problem ist bekannt als LOBBYING im Kontext von Bestechung in Wahlen. Wir untersuchen wie natürliche Parameter wie „Anzahl an Zeilen", „Anzahl an Spalten" oder die „maximale Anzahl an fehlenden Einsen pro Spalte um eine Mehrheit an Einsen zu erhalten" (im Folgenden „Gap-Wert") die Berechnungskomplexität unseres Problems beeinflussen. Auf der negativen Seite zeigen wir NP-Schwere, sogar wenn jede Zeile höchstens drei Einsen enthält. Auf der positiven Seite zeigen wir zum Beipiel ein FPT-Ergebnis für den Parameter „Anzahl an Spalten" und entwickeln eine Heuristik mit logarithmischen Approximationsfaktort und testen diese auf empirischen Daten. Als weiteres Schlüsselergebnis zeigen wir, dass unser Problem LOGSNP-vollständig ist für konstante Gap-Werte. Unsere vierte Aufgabe ist es Teams gleicher Größe neu aufzuteilen. Genauer versucht man die Anzahl gleichgroßer Teams zu reduzieren indem man einige Teams auflöst, deren Mitglieder an nicht in Konflikt stehenden verbleibende Teams verteilt und dabei sicherstellt, dass alle neuen Teams wiederum gleich groß sind. Wir formalisieren diese Aufgabe durch ein neues kombinatorisches Graphmodell. Wir zeigen dessen Beziehungen zu bekannten Graphkonzepten wie Perfekten Matchings, Flussnetzwerken, und Sternpartitionen von Graphen. Auf der negativen Seite zeigen wir, dass das zu Grunde liegende Problem NP-schwer ist, sogar wenn die alte Teamgröße und der Teamgrößenanstieg voneinander verschiedene Konstanten sind. Auf der positiven Seite zeigen wir unter anderem, dass unser Problem in Polynomzeit lösbar ist, wenn es keine Konflikte gibt oder wenn die aufzulösenden und zu gewinnenden Teams bereits bekannt sind.**

**Complexity of Lattice Problems**

**Algorithms and Computation**

**Hand Posture and Face Recognition using Biologically Inspired Approaches**

**A Cryptographic Perspective**

**From a Layperson to a Programmer in 30 Steps**

**Advances in Computational Complexity Theory**

This thesis investigates the parameterized computational complexity of six classic graph problems lifted to a temporal setting. More specifically, we consider problems defined on temporal graphs, that is, a graph where the edge set may change over a discrete time interval, while the vertex set remains unchanged. Temporal graphs are well-suited to model dynamic data and hence they are naturally motivated in contexts where dynamic changes or time-dependent interactions play an important role, such as, for example, communication networks, social networks, or physical proximity networks. The most important selection criteria for our problems was that they are well-motivated in the context of dynamic data analysis. Since temporal graphs are mathematically more complex than static graphs, it is maybe not surprising that all problems we consider in this thesis are NP-hard. We focus on the development of exact algorithms, where our goal is to obtain fixed-parameter tractability results, and refined computational hardness reductions that either show NP-hardness for very restricted input instances or parameterized hardness with respect to " large " parameters. In the context of temporal graphs, we mostly consider structural parameters of the underlying graph, that is, the graph obtained by ignoring all time information. However, we also consider parameters of other types, such as ones trying to measure how fast the temporal graph changes over time. In the following we briefly discuss the problem setting and the main results. Restless Temporal Paths. A path in a temporal graph has to respect causality, or time, which means that the edges used by a temporal path have to appear at non-decreasing times. We investigate temporal paths that additionally have a maximum waiting time in every vertex of the temporal graph. Our main contributions are establishing NP-hardness for the problem of finding restless temporal paths even in very restricted cases, and showing W[1]-hardness with respect to the feedback vertex number of the underlying graph. Temporal Separators. A temporal separator is a vertex set that, when removed from the temporal graph, destroys all temporal paths between two dedicated vertices. Our contribution here is twofold: Firstly, we investigate the computational complexity of finding temporal separators in temporal unit interval graphs, a generalization of unit interval graphs to the temporal setting. We show that the problem is NP-hard on temporal unit interval graphs but we identify an additional restriction which makes the problem solvable in polynomial time. We use the latter result to develop a fixed-parameter algorithm with a "distance-to-triviality" parameterization. Secondly, we show that finding temporal separators that destroy all restless temporal paths is Σ-P-2-hard. Temporal Matchings. We introduce a model for matchings in temporal graphs, where, if two vertices are matched at some point in time, then they have to "recharge" afterwards, meaning that they cannot be matched again for a certain number of time steps. In our main result we employ temporal line graphs to show that finding matchings is NP-hard even on instances where the underlying graph is a path. Temporal Coloring. We lift the classic graph coloring problem to the temporal setting. In our model, every edge has to be colored properly (that is,the endpoints are colored differently) at least once in every time interval of a certain length. We show that this problem is NP-hard in very restricted cases, even if we only have two colors. We present simple exponential-time algorithms to solve this problem. As a main contribution, we show that these algorithms presumably cannot be improved significantly. Temporal Cliques and s-Plexes. We propose a model for temporal s-plexes that is a canonical generalization of an existing model for temporal cliques. Our main contribution is a fixed-parameter algorithm that enumerates all maximal temporal s-plexes in a given temporal graph, where we use a temporal adaptation of degeneracy as a parameter. Temporal Cluster Editing. We present a model for cluster editing in temporal graphs, where we want to edit all "layers" of a temporal graph into cluster graphs that are sufficiently similar. Our main contribution is a fixed-parameter algorithm with respect to the parameter "number of edge modifications" plus the "measure of similarity" of the resulting clusterings. We further show that there is an efficient preprocessing procedure that can provably reduce the size of the input instance to be independent of the number of vertices of the original input instance.

This text looks at: complexity classes; algebraic complexity; interactive proof systems; circuits and other concrete computational models; Kolmogorov complexity; reducibility; complexity and logic; nonapproximability; cryptographic complexity; complexity and learning; quantum computation.

The two volume set, LNCS 9886 + 9887, constitutes the proceedings of the 25th International Conference on Artificial Neural Networks, ICANN 2016, held in Barcelona, Spain, in September 2016. The 121 full papers included in this volume were carefully reviewed and selected from 227 submissions. They were organized in topical sections named: from neurons to networks; networks and dynamics; higher nervous functions; neuronal hardware; learning foundations; deep learning; classifications and forecasting; and recognition and navigation. There are 47 short paper abstracts that are included in the back matter of the volume.

This book constitutes the thoroughly refereed post-conference proceedings of the 10th International Conference on Cognitive Radio Oriented Wireless Networks, CROWNCOM 2015, held in Doha, Qatar, in April 2015. The 66 revised full papers presented were carefully reviewed and selected from 110 submissions and cover the evolution of cognitive radio technology pertaining to 5G networks. The papers are clustered to topics on dynamic spectrum access/management, networking protocols for CR, modeling and theory, HW architecture and implementations, next generation of cognitive networks, standards and business models, and emerging applications for cognitive networks.

This two-volume set LNCS 11101 and 11102 constitutes the refereed proceedings of the 15th International Conference on Parallel Problem Solving from Nature, PPSN 2018, held in Coimbra, Portugal, in September 2018. The 79 revised full papers were carefully reviewed and selected from 205 submissions. The papers cover a wide range of topics in natural computing including evolutionary computation, artificial neural networks, artificial life, swarm intelligence, artificial immune systems, self-organizing systems, emergent behavior, molecular computing, evolutionary robotics, evolvable hardware, parallel implementations and applications to real-world problems. The papers are organized in the following topical sections: numerical optimization; combinatorial optimization; genetic programming; multi-objective optimization; parallel and distributed frameworks; runtime analysis and approximation results; fitness landscape modeling and analysis; algorithm configuration, selection, and benchmarking; machine learning and evolutionary algorithms; and applications. Also included are the descriptions of 23 tutorials and 6 workshops which took place in the framework of PPSN XV.

Computational Complexity and Statistical Physics

Multivariate Complexity Analysis of Team Management Problems

Parallel Problem Solving from Nature – PPSN XVI

A Modern Approach

Computational Intelligence in Multi-Feature Visual Pattern Recognition

Algorithms, Complexity Analysis and VLSI Architectures for MPEG-4 Motion Estimation

**A model-based approach to the design and implementation of Computational Sensor Networks (CSNs) is proposed. This high-level paradigm for the development and application of sensor device networks provides a strong scientific computing foundation, as well as the basis for robust software engineering practice. The three major components of this approach include (1) models of phenomena to be monitored, (2) models of sensors and actuators, and (3) models of the sensor network computation. We propose guiding principles to identify the state or structure of the phenomenon being sensed, or of the sensor network itself. This is called computational modeling. These methods are then incorporated into the operational system of the sensor network and adapted to system performance requirements to produce a mapping of the computation onto the system architecture. This is called real-time computational mapping and allows modification of system parameters according to real-time performance measures. This book deals with the development of a mathematical and modular software development framework to achieve computational sensor networks.**

**The two-volume proceedings LNCS 9916 and 9917, constitute the proceedings of the 17th Pacific-Rim Conference on Multimedia, PCM 2016, held in Xi`an, China, in September 2016. The total of 128 papers presented in these proceedings was carefully reviewed and selected from 202 submissions. The focus of the conference was as follows in multimedia content analysis, multimedia signal processing and communications, and multimedia applications and services.**

**This book constitutes the proceedings of the 26th International Conference on Computer Aided Verification, CAV 2014, held as part of the Vienna Summer of Logic, VSL 2014, in Vienna, Austria, in July 2014. The 46 regular papers and 11 short papers presented in this volume were carefully reviewed and selected from a total of 175 regular and 54 short paper submissions. The contributions are organized in topical sections named: software verification; automata; model checking and testing; biology and hybrid systems; games and synthesis; concurrency; SMT and theorem proving; bounds and termination; and abstraction.**

**The classical theory of computation has its origins in the work of Goedel, Turing, Church, and Kleene and has been an extraordinarily successful framework for theoretical computer science. The thesis of this book, however, is that it provides an inadequate foundation for modern scientific computation where most of the algorithms are real number algorithms. The goal of this book is to develop a formal theory of computation which integrates major themes of the classical theory and which is more directly applicable to problems in mathematics, numerical analysis, and scientific computing. Along the way, the authors consider such fundamental problems as: * Is the Mandelbrot set decidable? * For simple quadratic maps, is the Julia set a halting set? * What is the real complexity of Newton's method? * Is there an algorithm for deciding the knapsack problem in a ploynomial number of steps? * Is the Hilbert Nullstellensatz intractable? * Is the problem of locating a real zero of a degree four polynomial intractable? * Is linear programming tractable over the reals? The book is divided into three parts: The first part provides an extensive introduction and then proves the fundamental NP-completeness theorems of Cook-Karp and their extensions to more general number fields as the real and complex numbers. The later parts of the book develop a formal theory of computation which integrates major themes of the classical theory and which is more directly applicable to problems in mathematics, numerical analysis, and scientific computing.**

**This textbook introduces quantum computing to readers who do not have much background in linear algebra. The author targets undergraduate and master students, as well as non-CS and non-EE students who are willing to spend about 60 -90 hours seriously learning quantum computing. Readers will be able to write their program to simulate quantum computing algorithms and run on real quantum computers on IBM-Q. Moreover, unlike the books that only give superficial, "hand-waving" explanations, this book uses exact formalism so readers can continue to pursue more advanced topics based on what they learn from this book. Encourages students to embrace uncertainty over the daily classical experience, when encountering quantum phenomena; Uses narrative to start each section with analogies that help students to grasp the critical concept quickly; Uses numerical substitutions, accompanied by Python programming and IBM-Q quantum computer programming, as examples in teaching all critical concepts.**

**Computational Intelligence and Security**

**7th European Performance Engineering Workshop, EPEW 2010, Bertinoro, Italy, September 23-24, 2010, Proceedings**

**10th International Conference, CROWNCOM 2015, Doha, Qatar, April 21-23, 2015, Revised Selected Papers**

**26th International Conference, CAV 2014, Held as Part of the Vienna Summer of Logic, VSL 2014, Vienna, Austria, July 18-22, 2014, Proceedings**

**Introduction to Quantum Computing**

**17th Pacific-Rim Conference on Multimedia, Xi´ an, China, September 15-16, 2016, Proceedings, Part II**

**Analytic Computational Complexity contains the proceedings of the Symposium on Analytic Computational Complexity held by the Computer Science Department, Carnegie-Mellon University, Pittsburgh, Pennsylvania, on April 7-8, 1975. The symposium provided a forum for assessing progress made in analytic computational complexity and covered topics ranging from strict lower and upper bounds on iterative computational complexity to numerical stability of iterations for solution of nonlinear equations and large linear systems. Comprised of 14 chapters, this book begins with an introduction to analytic computational complexity before turning to proof techniques used in analytic complexity. Subsequent chapters focus on the complexity of obtaining starting points for solving operator equations by Newton's method; maximal order of multipoint iterations using n evaluations; the use of integrals in the solution of nonlinear equations in N dimensions; and the complexity of differential equations. Algebraic constructions in an analytic setting are also discussed, along with the computational complexity of approximation operators. This monograph will be of interest to students and practitioners in the fields of applied mathematics and computer science.**

**The third edition of this handbook is designed to provide a broad coverage of the concepts, implementations, and applications in metaheuristics. The book ' s chapters serve as stand-alone presentations giving both the necessary underpinnings as well as practical guides for implementation. The nature of metaheuristics invites an analyst to**

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

Provides an accessible introduction to computational complexity analysis and its application to questions of intractability in cognitive science.

Scalability is a fundamental problem in computer science. Computer scientists often describe the scalability of algorithms in the language of theoretical computational complexity, bounding the number of operations an algorithm performs as a function of the size of its input. The main contribution of this dissertation is to provide an analogous description of the scalability of actual software implementations run on realistic workloads. We propose a method for describing the asymptotic behavior of programs in practice by measuring their empirical computational complexity. Our method involves running a program on workloads spanning several orders of magnitude in size, measuring their performance, and fitting these observations to a model that predicts performance as a function of workload size. Comparing these models to the programmer's expectations or to theoretical asymptotic bounds can reveal performance bugs or confirm that a program's performance scales as expected. We develop our methodology for constructing these models of empirical complexity as we describe and evaluate two techniques. Our first technique, BB-TrendProf, constructs models that predict how many times each basic block runs as a linear (y = a + b*x) or a powerlaw (y = a*x^b) function of user-specified features of the program's workloads. To present output succinctly and focus attention on scalability-critical code, BB-TrendProf groups and ranks program locations based on these models. We demonstrate the power of BB-TrendProf compared to existing tools by running it on several large programs and reporting cases where its models show (1) an implementation of a complex algorithm scaling as expected, (2) two complex algorithms beating their worst-case theoretical complexity bounds when run on realistic inputs, and (3) a performance bug. Our second technique, CF-TrendProf, models performance of loops and functions both per-function-invocation and per-workload. It improves upon the precision of BB-TrendProf's models by using control flow to generate candidates from a richer family of models and a novel model selection criteria to select among these candidates. We show that CF-TrendProf's improvements to model generation and selection allow it to correctly characterize or closely approximate the empirical scalability of several well-known algorithms and data structures and to diagnose several synthetic, but realistic, scalability problems without observing an egregiously expensive workload. We also show that CF-TrendProf deals with multiple workload features better than BB-TrendProf. We qualitatively compare the output of BB-TrendProf and CF-TrendProf and discuss their relative strengths and weaknesses.

Simple games are a fundamental class of cooperative games. They have a huge relevance in several areas of computer science, social sciences and discrete applied mathematics. The algorithmic and computational complexity aspects of simple games have been gaining notoriety in the recent years. In this thesis we review different computational problems related to properties, parameters, and solution concepts of simple games. We consider different forms of representation of simple games, regular games and weighted games, and we analyze the computational complexity required to transform a game from one representation to another. We also analyze the complexity of several open problems under different forms of representation. In this scenario, we prove that the problem of deciding whether a simple game in minimal winning form is decisive (a problem that is associated to the duality problem of hypergraphs and monotone Boolean functions) can be solved in quasi-polynomial time, and that this problem can be polynomially reduced to the same problem but restricted to regular games in shift-minimal winning form. We also prove that the problem of deciding wheter a regular game is strong in shift-minimal winning form is coNP-complete. Further, for the width, one of the parameters of simple games, we prove that for simple games in minimal winning form it can be computed in polynomial time. Regardless of the form of representation, we also analyze counting and enumeration problems for several subfamilies of these games. We also introduce influence games, which are a new approach to study simple games based on a model of spread of influence in a social network, where influence spreads according to the linear threshold model. We show that influence games capture the whole class of simple games. Moreover, we study for influence games the complexity of the problems related to parameters, properties and solution concepts

**considered for simple games. We consider extremal cases with respect to demand of influence, and we show that, for these subfamilies, several problems become polynomial. We finish with some applications inspired on influence games. The first set of results concerns to the definition of collective choice models. For mediation systems, several of the problems of properties mentioned above are polynomial-time solvable. For influence systems, we prove that computing the satisfaction (a measure equivalent to the Rae index and similar to the Banzhaf value) is hard unless we consider some restrictions in the model. For OLFM systems, a generalization of OLF systems (van den Brink et al. 2011, 2012) we provide an axiomatization of satisfaction. The second set of results concerns to social network analysis. We define new centrality measures of social networks that we compare on real networks with some classical centrality measures.**

**Computer Aided Verification**

**Recent Developments in Discrete Optimization**

**Computational Intelligence in Flow Shop and Job Shop Scheduling**

**26th International Symposium, ISAAC 2015, Nagoya, Japan, December 9-11, 2015, Proceedings**

**Classic graph problems made temporal – a parameterized complexity analysis**

**Computational Complexity**

For over fifty years now, the famous problem of flow shop and job shop scheduling has been receiving the attention of researchers in operations research, engineering, and computer science. Over the past several years, there has been a spurt of interest in computational intelligence heuristics and metaheuristics for solving this problem. This book seeks to present a study of the state of the art in this field and also directions for future research.

This book offers a comprehensive perspective to modern topics in complexity theory, which is a central field of the theoretical foundations of computer science. It addresses the looming question of what can be achieved within a limited amount of time with or without other limited natural computational resources. Can be used as an introduction for advanced undergraduate and graduate students as either a textbook or for self-study, or to experts, since it provides expositions of the various sub-areas of complexity theory such as hardness amplification, pseudorandomness and probabilistic proof systems.

Models that include a notion of time are ubiquitous in disciplines such as the natural sciences, engineering, philosophy, and linguistics, but in computing the abstractions provided by the traditional models are problematic and the discipline has spawned many novel models. This book is a systematic thorough presentation of the results of several decades of research on developing, analyzing, and applying time models to computing and engineering. After an opening motivation introducing the topics, structure and goals, the authors introduce the notions of formalism and model in general terms along with some of their fundamental classification criteria. In doing so they present the fundamentals of propositional and predicate logic, and essential issues that arise when modeling time across all types of system. Part I is a summary of the models that are traditional in engineering and the natural sciences, including fundamental computer science: dynamical systems and control theory; hardware design; and software algorithmic and complexity analysis. Part II covers advanced and specialized formalisms dealing with time modeling in heterogeneous software-intensive systems: formalisms that share finite state machines as common " ancestors " ; Petri nets in many variants; notations based on mathematical logic, such as temporal logic; process algebras; and " dual-language approaches " combining two notations with different characteristics to model and verify complex systems, e.g., model-checking frameworks. Finally, the book concludes with summarizing remarks and hints towards future developments and open challenges. The presentation uses a rigorous, yet not overly technical, style, appropriate for readers with heterogeneous backgrounds, and each chapter is supplemented with detailed bibliographic remarks and carefully chosen exercises of varying difficulty and scope. The book is aimed at graduate students and researchers in computer science, while researchers and practitioners in other scientific and engineering disciplines interested in time modeling with a computational flavor will also find the book of value, and the comparative and conceptual approach makes this a valuable introduction for non-experts. The authors assume a basic knowledge of calculus, probability theory, algorithms, and programming, while a more advanced knowledge of automata, formal languages, and mathematical logic is useful.

These contributions, written by the foremost international researchers and practitioners of Genetic Programming (GP), explore the synergy between theoretical and empirical results on real-world problems, producing a comprehensive view of the state of the art in GP. Topics include: modularity and scalability; evolvability; human-competitive results; the need for important high-impact GP-solvable problems;; the risks of search stagnation and of cutting off paths to solutions; the need for novelty; empowering GP search with expert knowledge; In addition, GP symbolic regression is thoroughly discussed, addressing such topics as guaranteed reproducibility of SR; validating SR results, measuring and controlling genotypic complexity; controlling phenotypic complexity; identifying, monitoring, and avoiding over-fitting; finding a comprehensive collection of SR benchmarks, comparing SR to machine learning. This text is for all GP explorers. Readers will discover large-scale, real-world applications of GP to a variety of problem domains via in-depth presentations of the latest and most significant results.

Many machine learning tasks involve solving complex optimization problems, such as working on non-differentiable, non-continuous, and non-unique objective functions; in some cases it can prove difficult to even define an explicit objective function. Evolutionary learning applies evolutionary algorithms to address optimization problems in machine learning, and has yielded encouraging outcomes in many applications. However, due to the heuristic nature of evolutionary optimization, most outcomes to date have been empirical and lack theoretical support. This shortcoming has kept evolutionary learning from being well received in the machine learning community, which favors solid theoretical approaches. Recently there have been considerable efforts to address this issue. This book presents a range of those efforts, divided into four parts. Part I briefly introduces readers to evolutionary learning and provides some preliminaries, while Part II presents general theoretical tools for the analysis of running time and approximation performance in evolutionary algorithms. Based on these general tools, Part III presents a number of theoretical findings on major factors in evolutionary optimization, such as recombination, representation, inaccurate fitness evaluation, and population. In closing, Part IV addresses the development of evolutionary learning algorithms with provable theoretical guarantees for several representative tasks, in which evolutionary learning offers excellent performance.

Structural and Computational Aspects of Simple and Influence Games

Advances in Multimedia Information Processing - PCM 2016

Cognition and Intractability

The Computational Complexity of Machine Learning

Proceedings : 16th IEEE Conference on Computational Complexity : June 18-21, 2001, Chicago, Illinois

Evolutionary Learning: Advances in Theories and Algorithms

* Recent papers on computational complexity theory * Contributions by some of the leading experts in the field This book will prove to be of lasting value in this fast-moving field as it provides expositions not found elsewhere. The book touches on some of the major topics in complexity theory and thus sheds light on this burgeoning area of research.

15th International Conference, Coimbra, Portugal, September 8–12, 2018, Proceedings, Part II

Handbook of Metaheuristics

16th Conference, CN 2009, Wisla, Poland, June 16-20, 2009. Proceedings

25th International Conference on Artificial Neural Networks, Barcelona, Spain, September 6-9, 2016, Proceedings, Part II

12th International Conference, Taormina, Italy, September 1-5, 2012, Proceedings, Part I