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High-Dimensional Statistics Martin J. Wainwright 2019-02-21 Recent years have witnessed an explosion in the volume and variety of data collected in all scientific disciplines and industrial settings. Such massive data sets present a number of challenges to researchers in statistics and machine learning. This book provides a self-contained introduction to the area of high-dimensional statistics, aimed at the first-year graduate level. It includes chapters that are focused on core methodology and theory - including tail bounds, concentration inequalities, uniform laws and empirical process, and random matrices - as well as chapters devoted to in-depth exploration of particular model classes - including sparse linear models, matrix models with rank constraints, graphical models, and various types of non-parametric models. With hundreds of worked examples and exercises, this text is intended both for courses and for self-study by graduate students and researchers in statistics, machine learning, and related fields who must understand, apply, and adapt modern statistical methods suited to large-scale data. *Fundamentals of Computation Theory 2001*

Stochastic Parameterizing Manifolds and Non-Markovian Reduced Equations Mickaël D. Chekroun 2014-12-23 In this second volume, a general approach is developed to provide approximate parameterizations of the "small" scales by the "large" ones for a broad class of stochastic partial differential equations (SPDEs). This is accomplished via the concept of parameterizing manifolds (PMs), which are stochastic manifolds that improve, for a given realization of the noise, in mean square error the partial knowledge of the full SPDE solution when compared to its projection onto some resolved modes. Backward-forward systems are designed to give access to such PMs in practice. The key idea consists of representing the modes with high wave numbers as a pullback limit depending on the time-history of the modes with low wave numbers. Non-Markovian stochastic reduced systems are then derived based on such a PM approach. The reduced systems take the form of stochastic differential equations involving random coefficients that convey memory effects. The theory is illustrated on a stochastic Burgers-type equation.

Generalized Barycentric Coordinates in Computer Graphics and Computational Mechanics Kai Hormann 2017-10-30 In Generalized Barycentric Coordinates in Computer Graphics and Computational Mechanics, eminent computer graphics and computational mechanics researchers provide a state-of-the-art overview of generalized barycentric coordinates. Commonly used in cutting-edge applications such as mesh parameterization, image warping, mesh deformation, and finite as well as boundary element methods, the theory of barycentric coordinates is also fundamental for use in animation and in simulating the deformation of solid continua. Generalized Barycentric Coordinates is divided into three sections, with five chapters each, covering the theoretical background, as well as their use in computer graphics and computational mechanics. A vivid 16-page insert helps illustrating the stunning applications of this fascinating research area. Key Features: Provides an overview of the many different types of barycentric coordinates and their properties. Discusses diverse applications of barycentric coordinates in computer graphics and computational mechanics. The first book-length treatment on this topic

Geometric Partial Differential Equations - Part 2 Andrea Bonito 2021-01-26 Besides their intrinsic mathematical interest, geometric partial differential equations (PDEs) are ubiquitous in many scientific, engineering and industrial applications. They represent an intellectual challenge and have received a great deal of attention recently. The purpose of this volume is to provide a missing reference consisting of self-contained and comprehensive presentations. It includes basic ideas, analysis and applications of state-of-the-art fundamental algorithms for the approximation of geometric PDEs together with their impacts in a variety of fields within mathematics, science, and engineering. About every aspect of computational geometric PDEs is discussed in this and a companion volume. Topics in this volume include stationary and time-dependent surface PDEs for geometric flows, large deformations of nonlinearly geometric plates and rods, level set and phase field methods and applications, free boundary problems, discrete Riemannian calculus and morphing, fully nonlinear PDEs including Monge-Ampere equations, and PDE constrained optimization Each chapter is a complete essay at the research level but accessible to junior researchers and students. The intent is to provide a comprehensive description of algorithms and their analysis for a specific geometric PDE class, starting from basic concepts and concluding with interesting applications. Each chapter is thus useful as an introduction to a research area as well as a teaching resource, and provides numerous pointers to the literature for further reading The authors of each chapter are world leaders in their field of expertise and skillful writers. This book is thus meant to provide an invaluable, readable and enjoyable account of computational geometric PDEs

The Bulletin of Mathematics Books 1992

Methods of Geometric Analysis in Extension and Trace Problems Alexander Brudnyi 2011-10-07 The book presents a comprehensive exposition of extension results for maps between different geometric objects and of extension-trace results for smooth functions on subsets with no a priori differential structure (Whitney problems). The account covers development of the area from the initial classical works of the first half of the 20th century to the flourishing period of the last decade. Seemingly very specific these problems have been from the very beginning a powerful source of ideas, concepts and methods that essentially influenced and in some cases even transformed considerable areas of analysis. Aside from the material linked by the aforementioned problems the book also is unified by geometric analysis approach used in the proofs of basic results. This requires a variety of geometric tools from convex and combinatorial geometry to geometry of metric space theory to Riemannian and coarse geometry and more. The necessary facts are presented mostly with detailed proofs to make the book accessible to a wide audience.

An Invitation to Analytic Combinatorics Stephen Melczer 2020-12-22 This book uses new mathematical tools to examine broad computability and complexity questions in enumerative combinatorics, with applications to other areas of mathematics, theoretical computer science, and physics. A focus on effective algorithms leads to the development of computer algebra software of use to researchers in these domains. After a survey of current results and open problems on decidability in enumerative combinatorics, the text shows how the cutting edge of this research is the new domain of Analytic Combinatorics in Several Variables (ACSV). The remaining chapters of the text alternate between a pedagogical development of the theory, applications (including the resolution by this author of conjectures in lattice path enumeration which resisted several other approaches), and the development of algorithms. The final chapters in the text show, through examples and general theory, how results from stratified Morse theory can help refine some of these computability questions. Complementing the written presentation are over 50 worksheets for the SageMath and Maple computer algebra systems working through examples in the text.

Variational Methods for Discontinuous Structures Rai Serapioni 1996-08-28 In recent years many researchers in material science have focused their attention on the study of composite materials, equilibrium of crystals and crack distribution in continua subject to loads. At the same time several new issues in computer vision and image processing have been studied in depth. The understanding of many of these problems has made significant progress thanks to new methods developed in calculus of variations, geometric measure theory and partial differential equations. In particular, new technical tools have been introduced and successfully applied. For example, in order to describe the geometrical complexity of unknown patterns, a new class of problems in calculus of variations has been introduced together with a suitable functional setting: the free-discontinuity problems and the special BV and BH functions. The conference held at Villa Olmo on Lake Como in September 1994 spawned successful discussion of these topics among mathematicians, experts in computer science and material scientists.

Fundamentals of Computation Theory Rusins Freivalds 2003-05-15 This book constitutes the refereed proceedings of the 13th International Symposium Fundamentals of Computation Theory, FCT 2001, as well as of the International Workshop on Efficient Algorithms, WEA 2001, held in Riga, Latvia, in August 2001. The 28 revised full FCT papers and 15 short papers presented together with six invited contributions and 8 revised full WEA papers as well as three invited WEA contributions have been carefully reviewed and selected. Among the topics addressed are a broad variety of topics from theoretical computer science, algorithmics and programming theory. The WEA papers deal with graph and network algorithms, flow and routing problems, scheduling and approximation algorithms, etc.

Sampling in Combinatorial and Geometric Set Systems Nabil H. Mustafa 2022-01-14 Understanding the behavior of basic sampling techniques and intrinsic geometric attributes of data is an invaluable skill that is in high demand for both graduate students and researchers in mathematics, machine learning, and theoretical computer science. The last ten years have seen significant progress in this area, with many open problems having been resolved during this time. These include optimal lower bounds for epsilon-nets for many geometric set systems, the use of shallow-cell complexity to unify proofs, simpler and more efficient algorithms, and the use of epsilon-approximations for construction of coresets, to name a few. This book presents a thorough treatment of these probabilistic, combinatorial, and geometric methods, as well as their combinatorial and algorithmic applications. It also revisits classical results, but with new and more elegant proofs. While mathematical maturity will certainly help in appreciating the ideas presented here, only a basic familiarity with discrete mathematics, probability, and combinatorics is required to understand the material.

Mathematical Reviews 2005

Quantifier Elimination and Cylindrical Algebraic Decomposition Bob F. Caviness 2012-12-06 George Collins' discovery of Cylindrical Algebraic Decomposition (CAD) as a method for Quantifier Elimination (QE) for the elementary theory of real closed fields brought a major breakthrough in automating mathematics with recent important applications in high-tech areas (e.g. robot motion), also stimulating fundamental research in computer algebra over the past three decades. This volume is a state-of-the-art collection of important papers on CAD and QE and on the related area of algorithmic aspects of real geometry. It contains papers from a symposium held in Linz in 1993, reprints of seminal papers from the area including Tarski's landmark paper as well as a survey outlining the developments in CAD based QE that have taken place in the last twenty years.

Tensor Numerical Methods in Scientific Computing Boris N. Khoromskij 2018-06-11 The most difficult computational problems nowadays are those of higher dimensions. This research monograph offers an introduction to tensor numerical methods designed for the solution of the multidimensional problems in scientific computing. These methods are based on the rank-structured approximation of multivariate functions and operators by using the appropriate tensor formats. The old and new rank-structured tensor formats are investigated. We discuss in detail the novel quantized tensor approximation method (QTT) which provides function-operator calculus in higher dimensions in logarithmic complexity rendering super-fast convolution, FFT and wavelet transforms. This book suggests the constructive recipes and computational schemes for a number of real life problems described by the multidimensional partial differential equations. We present the theory and algorithms for the sinc-based separable approximation of the analytic radial basis functions including Green's and Helmholtz kernels. The efficient tensor-based techniques for computational problems in electronic structure calculations and for the grid-based evaluation of long-range interaction potentials in multi-particle systems are considered. We also discuss the QTT numerical approach in many-particle dynamics, tensor techniques for stochastic/parametric PDEs as well as for the solution and homogenization of the elliptic equations with highly-oscillating coefficients. Contents Theory on separable approximation of multivariate functions Multilinear algebra and nonlinear tensor approximation Superfast computations via quantized tensor approximation Tensor approach to multidimensional integrodifferential equations **Complex Analysis and Dynamical Systems** Mark Agranovsky 2018-01-31 This book focuses on developments in complex dynamical systems and geometric function theory over the past decade, showing strong links with other areas of mathematics and the natural sciences. Traditional methods and approaches surface in physics and in the life and engineering sciences with increasing frequency – the Schramm-Loewner evolution, Laplacian growth, and quadratic differentials are just a few typical examples. This book provides a representative overview of these processes and collects open problems in the various areas, while at the same time showing where and how each particular topic evolves. This volume is dedicated to the memory of Alexander Vasiliev.

The Concrete Tetrahedron Manuel Kauers 2011-01-15 The book treats four mathematical concepts which play a fundamental role in many different areas of mathematics: symbolic sums, recurrence (difference) equations, generating functions, and asymptotic estimates. Their key features, in isolation or in combination, their mastery by paper and pencil or by computer programs, and their applications to problems in pure mathematics or to "real world problems" (e.g. the analysis of algorithms) are studied. The book is intended as an algorithmic supplement to the bestselling "Concrete Mathematics" by Graham, Knuth and Patashnik.

Algorithm Engineering Lasse Kliemann 2016-11-10 Algorithm Engineering is a methodology for algorithmic research that combines theory with implementation and experimentation in order to obtain better algorithms with high practical impact. Traditionally, the study of algorithms was dominated by mathematical (worst-case) analysis. In Algorithm Engineering, algorithms are also implemented and experiments conducted in a systematic way, sometimes resembling the experimentation processes known from fields such as biology, chemistry, or physics. This helps in counteracting an otherwise growing gap between theory and practice.

Graph Drawing Ulrik Brandes 2011-02-10 This volume constitutes the refereed proceedings of the 18th International Symposium on Graph Drawing, GD 2010, held in Konstanz, Germany, during September 2010. The 30 revised full papers presented together with 5 revised short and 8 poster papers were carefully reviewed and selected from 77 submissions. The volume also contains a detailed report about the 17th Annual Graph Drawing Contest, held as a satellite event of GD 2010. Devoted both to theoretical advances as well as to implemented solutions, the papers are concerned with the geometric representation of graphs and networks and are motivated by those applications where it is crucial to visualize structural information as graphs.

Algorithms and Data Structures Anna Lubiw 2021-07-30 This book constitutes the refereed proceedings of the 17th International Symposium on Algorithms and Data Structures, WADS 2021, held in virtually in August 2021. The 47 full papers, presented together with two invited lectures, were carefully reviewed and selected from a total of 123 submissions. They present original research on the theory, design and application of algorithms and data structures.

Digital and Discrete Geometry Li M. Chen 2014-12-12 This book provides comprehensive coverage of the modern methods for geometric problems in the computing sciences. It also covers concurrent topics in data sciences including geometric processing, manifold learning, Google search, cloud data, and R-tree for wireless networks and BigData. The author investigates digital geometry and its related constructive methods in discrete geometry, offering detailed methods and algorithms. The book is divided into five sections: basic geometry; digital curves, surfaces and manifolds; discretely represented objects; geometric computation and processing; and advanced topics. Chapters especially focus on the applications of these methods to other types of geometry, algebraic topology, image processing, computer vision and computer graphics. Digital and Discrete Geometry: Theory and

Algorithms targets researchers and professionals working in digital image processing analysis, medical imaging (such as CT and MRI) and informatics, computer graphics, computer vision, biometrics, and information theory. Advanced-level students in electrical engineering, mathematics, and computer science will also find this book useful as a secondary text book or reference. Praise for this book: This book does present a large collection of important concepts, of mathematical, geometrical, or algorithmical nature, that are frequently used in computer graphics and image processing. These concepts range from graphs through manifolds to homology. Of particular value are the sections dealing with discrete versions of classic continuous notions. The reader finds compact definitions and concise explanations that often appeal to intuition, avoiding finer, but then necessarily more complicated, arguments... As a first introduction, or as a reference for professionals working in computer graphics or image processing, this book should be of considerable value." - Prof. Dr. Rolf Klein, University of Bonn. **A Course in Convexity** Alexander Barvinok 2002-11-19 Convexity is a simple idea that manifests itself in a surprising variety of places. This fertile field has an immensely rich structure and numerous applications. Barvinok demonstrates that simplicity, intuitive appeal, and the universality of applications make teaching (and learning) convexity a gratifying experience. The book will benefit both teacher and student: It is easy to understand, entertaining to the reader, and includes many exercises that vary in degree of difficulty. Overall, the author demonstrates the power of a few simple unifying principles in a variety of pure and applied problems. The prerequisites are minimal amounts of linear algebra, analysis, and elementary topology, plus basic computational skills. Portions of the book could be used by advanced undergraduates. As a whole, it is designed for graduate students interested in mathematical methods, computer science, electrical engineering, and operations research. The book will also be of interest to research mathematicians, who will find some results that are recent, some that are new, and many known results that are discussed from a new perspective.

Conjugate Gradient Algorithms and Finite Element Methods Michal Krizek 2012-12-06 The position taken in this collection of pedagogically written essays is that conjugate gradient algorithms and finite element methods complement each other extremely well. Via their combinations practitioners have been able to solve complicated, direct and inverse, multidimensional problems modeled by ordinary or partial differential equations and inequalities, not necessarily linear, optimal control and optimal design being part of these problems. The aim of this book is to present both methods in the context of complicated problems modeled by linear and nonlinear partial differential equations, to provide an in-depth discussion on their implementation aspects. The authors show that conjugate gradient methods and finite element methods apply to the solution of real-life problems. They address graduate students as well as experts in scientific computing.

Fundamentals of Computation Theory Rusins Freivalds 2001-08-03 This book constitutes the refereed proceedings of the 13th International Symposium Fundamentals of Computation Theory, FCT 2001, as well as of the International Workshop on Efficient Algorithms, WEA 2001, held in Riga, Latvia, in August 2001. The 28 revised full FCT papers and 15 short papers presented together with six invited contributions and 8 revised full WEA papers as well as three invited WEA contributions have been carefully reviewed and selected. Among the topics addressed are a broad variety of topics from theoretical computer science, algorithmics and programming theory. The WEA papers deal with graph and network algorithms, flow and routing problems, scheduling and approximation algorithms, etc.

Proceedings of the Twelfth Annual ACM-SIAM Symposium on Discrete Algorithms SIAM Activity Group on Discrete Mathematics 2001-01-01 Contains 130 papers, which were selected based on originality, technical contribution, and relevance. Although the papers were not formally refereed, every attempt was made to verify the main claims. It is expected that most will appear in more complete form in scientific journals. The proceedings also includes the paper presented by invited plenary speaker Ronald Graham, as well as a portion of the papers presented by invited plenary speakers Udi Manber and Christos Papadimitriou.

Proceedings, 38th Annual Symposium on Foundations of Computer Science IEEE Computer Society 1997

Alice and Bob Meet Banach: The Interface of Asymptotic Geometric Analysis and Quantum Information Theory Guillaume Aubrun 2017-08-30 The quest to build a quantum computer is arguably one of the major scientific and technological challenges of the twenty-first century, and quantum information theory (QIT) provides the mathematical framework for that quest. Over the last dozen or so years, it has become clear that quantum information theory is closely linked to geometric functional analysis (Banach space theory, operator spaces, high-dimensional probability), a field also known as asymptotic geometric analysis (AGA). In a nutshell, asymptotic geometric analysis investigates quantitative properties of convex sets, or other geometric structures, and their approximate symmetries as the dimension becomes large. This makes it especially relevant to quantum theory, where systems consisting of just a few particles naturally lead to models whose dimension is in the thousands, or even in the billions. Alice and Bob Meet Banach is aimed at multiple audiences connected through their interest in the interface of QIT and AGA: at quantum information researchers who want to learn AGA or apply its tools; at mathematicians interested in learning QIT, or at least the part of QIT that is relevant to functional analysis/convex geometry/random matrix theory and related areas; and at beginning researchers in either field. Moreover, this user-friendly book contains numerous tables and explicit estimates, with reasonable constants when possible, which make it a useful reference even for established mathematicians generally familiar with the subject.

Abstracts of Papers Presented to the American Mathematical Society American Mathematical Society 1997

Shapes and Diffeomorphisms Laurent Younes 2010-05-17 Shapes are complex objects to apprehend, as mathematical entities, in terms that also are suitable for computerized analysis and interpretation. This volume provides the background that is required for this purpose, including different approaches that can be used to model shapes, and algorithms that are available to analyze them. It explores, in particular, the interesting connections between shapes and the objects that naturally act on them, diffeomorphisms. The book is, as far as possible, self-contained, with an appendix that describes a series of classical topics in mathematics (Hilbert spaces, differential equations, Riemannian manifolds) and sections that represent the state of the art in the analysis of shapes and their deformations. A direct application of what is presented in the book is a branch of the computerized analysis of medical images, called computational anatomy.

Algorithms and Data Structures Frank Dehne 2011-07-18 This book constitutes the refereed proceedings of the 12th Algorithms and Data Structures Symposium, WADS 2011, held in New York, NY, USA, in August 2011. The Algorithms and Data Structures Symposium - WADS (formerly "Workshop on Algorithms and Data Structures") is intended as a forum for researchers in the area of design and analysis of algorithms and data structures. The 59 revised full papers presented in this volume were carefully reviewed and selected from 141 submissions. The papers present original research on the theory and application of algorithms and data structures in all areas, including combinatorics, computational geometry, databases, graphics, parallel and distributed computing.

Approximation, Randomization, and Combinatorial Optimization. Algorithms and Techniques Leslie Ann Goldberg 2011-08-05 This book constitutes the joint refereed proceedings of the 14th International Workshop on Approximation Algorithms for Combinatorial Optimization Problems, APPROX 2011, and the 15th International Workshop on Randomization and Computation, RANDOM 2011, held in Princeton, New Jersey, USA, in August 2011. The volume presents 29 revised full papers of the APPROX 2011 workshop, selected from the 66 submissions, and 29 revised full papers of the RANDOM 2011 workshop, selected from 64 submissions. They were carefully reviewed and selected for inclusion in the book. In addition two abstracts of invited talks are included. APPROX focuses on algorithmic and complexity issues surrounding the development of efficient approximate solutions to computationally difficult problems. RANDOM is concerned with applications of randomness to computational and combinatorial problems.

Surveys on Discrete and Computational Geometry Jacob E. Goodman 2008 This volume contains nineteen survey papers describing the state of current research in discrete and computational geometry as well as a set of open problems presented at the 2006 AMS-IMS-SIAM Summer Research Conference Discrete and Computational Geometry--Twenty Years Later, held in Snowbird, Utah, in June 2006. Topics surveyed include metric graph theory, lattice polytopes, the combinatorial complexity of unions of geometric objects, line and pseudoline arrangements, algorithmic semialgebraic geometry, persistent homology, unfolding polyhedra, pseudo-triangulations, nonlinear computational geometry, \$k\$S-sets, and the computational complexity of convex bodies.

The Christoffel-Darboux Kernel for Data Analysis Jean Bernard Lasserre 2022-04-07 The Christoffel-Darboux kernel, a central object in approximation theory, is shown to have many potential uses in modern data analysis, including applications in machine learning. This is the first book to offer a rapid introduction to the subject, illustrating the surprising effectiveness of a simple tool. Bridging the gap between classical mathematics and current evolving research, the authors present the topic in detail and follow a heuristic, example-based approach, assuming only a basic background in functional analysis, probability and some elementary notions of algebraic geometry. They cover new results in both pure and applied mathematics and introduce techniques that have a wide range of potential impacts on modern quantitative and qualitative science. Comprehensive notes provide historical background, discuss advanced concepts and give detailed bibliographical references. Researchers and graduate students in mathematics, statistics, engineering or economics will find new perspectives on traditional themes, along with challenging open problems.

Proceedings Of The International Congress Of Mathematicians 2018 (Icm 2018) (In 4 Volumes) Sirakov Boyan 2019-02-27 The Proceedings of the ICM publishes the talks, by invited speakers, at the conference organized by the International Mathematical Union every 4 years. It covers several areas of Mathematics and it includes the Fields Medal and Nevanlinna, Gauss and Leelavati Prizes and the Chern Medal laudatios.

Journal of Computational Mathematics 1997

Navier-Stokes Equations Roger Temam 2001-04-10 Originally published in 1977, the book is devoted to the theory and numerical analysis of the Navier-Stokes equations for viscous incompressible fluid. On the theoretical side, results related to the existence, the uniqueness, and, in some cases, the regularity of solutions are presented. On the numerical side, various approaches to the approximation of Navier-Stokes problems by discretization are considered, such as the finite difference method, the finite element method, and the fractional steps method. The problems of stability and convergence for numerical methods are treated as completely as possible. The new material in the present book (as compared to the preceding 1984 edition) is an appendix reproducing a survey article written in 1998. This appendix touches upon a few aspects not addressed in the earlier editions, in particular a short derivation of the Navier-Stokes equations from the basic conservation principles in continuum mechanics, further historical perspectives, and indications on new developments in the area. The appendix also surveys some aspects of the related Euler equations and the compressible Navier-Stokes equations. The book is written in the style of a textbook and the author has attempted to make the treatment self-contained. It can be used as a textbook or a reference book for researchers. Prerequisites for reading the book include some familiarity with the Navier-Stokes equations and some knowledge of functional analysis and Sololev spaces.

Algorithms and Data Structures Faith Ellen 2017-07-04 This book constitutes the refereed proceedings of the 15th Algorithms and Data Structures Symposium, WADS 2017, held in St. John's, NL, Canada, in July/August 2017. The 49 full papers presented together with 3 abstracts of invited talks were carefully reviewed and selected from 109 submissions. They present original research on the theory and application of algorithms and data structures in many areas, including combinatorics, computational geometry, databases, graphics, and parallel and distributed computing. The WADS Symposium, which alternates with the Scandinavian Symposium and Workshops on Algorithm Theory, SWAT, is intended as a forum for researchers in the area of design and analysis of algorithms and data structures. Papers presenting original research on the theory and application of algorithms and data structures

Fractals in Probability and Analysis Christopher J. Bishop 2016-12-22 This is a mathematically rigorous introduction to fractals which emphasizes examples and fundamental ideas. Building up from basic techniques of geometric measure theory and probability, central topics such as Hausdorff dimension, self-similar sets and Brownian motion are introduced, as are more specialized topics, including Keakeya sets, capacity, percolation on trees and the traveling salesman theorem. The broad range of techniques presented enables key ideas to be highlighted, without the distraction of excessive technicalities. The authors incorporate some novel proofs which are simpler than those available elsewhere. Where possible, chapters are designed to be read independently so the book can be used to teach a variety of courses, with the clear structure offering students an accessible route into the topic.

Bibliographic Index 2002

Algorithms for Hard Problems Juraj Hromkovič 2013-03-14 Algorithmic design, especially for hard problems, is more essential for success in solving them than any standard improvement of current computer tech nologies. Because of this, the design of algorithms for solving hard problems is the core of current algorithmic research from the theoretical point of view as well as from the practical point of view. There are many general text books on algorithmics, and several specialized books devoted to particular approaches such as local search, randomization, approximation algorithms, or heuristics. But there is no textbook that focuses on the design of algorithms for hard computing tasks, and that systematically explains, combines, and compares the main possibilities for attacking hard algorithmic problems. As this topic is fundamental for computer science, this book tries to close this gap. Another motivation, and probably the main reason for writing this book, is connected to education. The considered area has developed very dynami cally in recent years and the research on this topic discovered several profound results, new concepts, and new methods. Some of the achieved contributions are so fundamental that one can speak about paradigms which should be in cluded in the education of every computer science student. Unfortunately, this is very far from reality. This is because these paradigms are not sufficiently known in the computer science community, and so they are insufficiently com municated to students and practitioners. *Geometric Approximation Algorithms* Sariel Har-Peled 2011 Exact algorithms for dealing with geometric objects are complicated, hard to implement in practice, and slow. Over the last 20 years a theory of geometric approximation algorithms has emerged. These algorithms tend to be simple, fast, and more robust than their exact counterparts. This book is the first to cover geometric approximation algorithms in detail. In addition, more traditional computational geometry techniques that are widely used in developing such algorithms, like sampling, linear programming, etc., are also surveyed. Other topics covered include approximate nearest-neighbor search, shape approximation, coresets, dimension reduction, and embeddings. The topics covered are relatively independent and are supplemented by exercises. Close to 200 color figures are included in the text to illustrate proofs and ideas.