Algorithmic Geometry

This book covers combinatorial data structures and algorithms, algebraic issues in geometric computing, approximation of curves and surfaces, and computational topology. Each chapter fully details and provides a tutorial introduction to important concepts and results. The focus is on methods which are both well founded mathematically and efficient in practice. Coverage includes references to open source software and discussion of potential applications of the presented techniques.

From the reviews: "This book offers a coherent treatment, at the graduate textbook level, of the field that has come to be known in the last decade or so as computational geometry. ... ... The book is well organized and lucidly written; a timely contribution by two founders of the field. It clearly demonstrates that computational geometry in the plane is now a fairly well-understood branch of computer science and mathematics. It also points the way to the solution of the more challenging problems in dimensions higher than two." #Mathematical Reviews#1 "... This remarkable book is a comprehensive and systematic study on research results obtained especially in the last ten years. The very clear presentation concentrates on basic ideas, fundamental combinatorial structures, and crucial algorithmic techniques. The plenty of results is clever organized following these guidelines and within the framework of some detailed case studies. A large number of figures and examples also aid the understanding of the material. Therefore, it can be highly recommended as an early graduate text but it should prove also to be essential to researchers and professionals in applied fields of computer-aided design, computer graphics, and robotics." #Biometrical Journal#2

This monograph presents a thorough geometrical investigation of practical and theoretical problems arising from NC pocket machining. Practical topics include selection of tool sizes and determination of optimal tool paths. A rigorous theoretical framework based on Voronoi diagrams is given.

This introduction to computational geometry focuses on algorithms. Motivation is provided from the application areas as all techniques are related to particular applications in robotics, graphics, CAD/CAM, and geographic information systems. Modern insights in computational geometry are used to provide solutions that are both efficient and easy to understand and implement.

This book constitutes the thoroughly refereed post-conference proceedings of the 16th Japanese Conference on Discrete and computational Geometry and Graphs, JDCDGG 2013, held in Tokyo, Japan, in September 2013. The total of 16 papers included in this volume was carefully reviewed and selected from 58 submissions. The papers feature advances made in the field of computational geometry and focus on emerging technologies, new methodology and applications, graph theory and dynamics.

The International Workshop CG '88 on "Computational Geometry" was held at the University of Würzburg, FRG, March 24-25, 1988. As the interest in the fascinating field of Computational Geometry and its Applications has grown very quickly in recent years the organizers felt the need to have a workshop, where a suitable number of invited participants could concentrate their efforts in this field to cover a broad spectrum of topics and to communicate in a stimulating atmosphere. This workshop was attended by some fifty invited scientists. The scientific program consisted of 22 contributions, of which 18 papers with one additional paper (M. Reichling) are contained in the present volume. The contributions covered important areas not only of fundamental aspects of Computational Geometry but a lot of interesting and most promising applications: Algorithmic Aspects of Geometry, Arrangements, Nearest-Neighbor-Problems and Abstract Voronoi-Diagrams, Data Structures for Geometric Objects, Geo-Relational Algebra, Geometric Modeling, Clustering and Visualizing Geometric Objects, Finite Element Methods, Triangulating in Parallel, Animation and Ray Tracing, Robotics: Motion

Planning, Collision Avoidance, Visibility, Smooth Surfaces, Basic Models of Geometric Computations, Automatizing Geometric Proofs and Constructions.

Polyhedral and Algebraic Methods in Computational Geometry provides a thorough introduction into algorithmic geometry and its applications. It presents its primary topics from the viewpoints of discrete, convex and elementary algebraic geometry. The first part of the book studies classical problems and techniques that refer to polyhedral structures. The authors include a study on algorithms for computing convex hulls as well as the construction of Voronoi diagrams and Delone triangulations. The second part of the book develops the primary concepts of (non-linear) computational algebraic geometry. Here, the book looks at Gröbner bases and solving systems of polynomial equations. The theory is illustrated by applications in computer graphics, curve reconstruction and robotics. Throughout the book, interconnections between computational geometry and other disciplines (such as algebraic geometry, optimization and numerical mathematics) are established. Polyhedral and Algebraic Methods in Computational Geometry is directed towards advanced undergraduates in mathematics and computer science, as well as towards engineering students who are interested in the applications of computational geometry.

This 2005 book deals with interest topics in Discrete and Algorithmic aspects of Geometry.

This book presents state-of-the-art research and survey articles that highlight work done within the Priority Program SPP 1489 "Algorithmic and Experimental Methods in Algebra, Geometry and Number Theory", which was established and generously supported by the German Research Foundation (DFG) from 2010 to 2016. The goal of the program was to substantially advance algorithmic and experimental methods in the aforementioned disciplines, to combine the different methods where necessary, and to apply them to central questions in theory and practice. Of particular concern was the further development of freely available open source computer algebra systems and their interaction in order to create powerful new computational tools that transcend the boundaries of the individual disciplines involved. The book covers a broad range of topics addressing the design and theoretical foundations, implementation and the successful application of algebraic algorithms in order to solve mathematical research problems. It offers a valuable resource for all researchers, from graduate students through established experts, who are interested in the computational aspects of algebra, geometry, and/or number theory.

This is a fundamental analysis of the influence of woody plants on agricultural production, in relation to characteristics of these plants, with examples mostly from the Sahelian countries. The conclusions enable practitioners in the field of rural development in semi-arid tropical countries to identify proper conditions for using plants to improve and sustain agricultural production for specific agropastoral objectives.

An original motivation for algebraic geometry was to understand curves and surfaces in three dimensions. Recent theoretical and technological advances in areas such as robotics, computer vision, computer-aided geometric design and molecular biology, together with the increased availability of computational resources, have brought these original questions once more into the forefront of research. One particular challenge is to combine applicable methods from algebraic geometry with proven techniques from piecewise-linear computational geometry (such as Voronoi diagrams and hyperplane arrangements) to develop tools for treating curved objects. These research efforts may be summarized under the term nonlinear computational geometry. This volume grew out of an IMA workshop on Nonlinear Computational Geometry in May/June 2007 (organized by I.Z. Emiris, R. Goldman, F. Sottile, T. Theobald) which gathered leading experts in this emerging field. The research and expository articles in the volume are intended to provide an overview of nonlinear computational geometry. Since the topic involves computational geometry, algebraic geometry, and geometric modeling, the volume has contributions from all of these areas. By addressing a broad range of issues from purely

theoretical and algorithmic problems, to implementation and practical applications this volume conveys the spirit of the IMA workshop.

This book constitutes the thoroughly refereed post-proceedings of the Japanese Conference on Discrete Computational Geometry, JCDCG 2004, held in Tokyo, Japan in October 2004, to honor Janos Pach on his fiftieth year. The 20 revised full papers presented were carefully selected during two rounds of reviewing and improvement from over 60 talks at the conference. All current issues in discrete algorithmic geometry are addressed.

Radiocarbon After Four Decades: An Interdisciplinary Perspective commemorates the 40th anniversary of radiocarbon dating. The volume presents discussions of every aspect of this dating technique, as well as chronicles of its development and views of future advancements and applications. All of the 64 authors played major roles in establishment, development or application of this revolutionary scientific tool. The 35 chapters provide a solid foundation in the essential topics of radiocarbon dating: Historical Perspectives; The Natural Carbon Cycle; Instrumentation and Sample Preparation; Hydrology; Old World Archaeology; New World Archaeology; Earth Sciences; and Biomedical Applications.

This Festschrift volume is published in honor of Ferran Hurtado on the occasion of his 60th birthday; it contains extended versions of selected communications presented at the XIV Spanish Meeting on Computational Geometry, held at the University of Alcalá, Spain, in June 2011. Ferran Hurtado has played a central role in the Spanish community of Computational Geometry since its very beginning, and the quantity and quality of the international participants in the conference is an indisputable proof of his relevance in the international level. The 26 revised full papers were carefully reviewed and selected from numerous submissions. The papers present original research in computational geometry, in its broadest sense. Topics included are discrete and combinatorial geometry, linear programming applied to geometric problems, geometric algorithms and data structures, theoretical foundations of computational geometry, questions of interest in the implementation of geometric algorithms, and applications of computational geometry.

This book constitutes the thoroughly refereed post-conference proceedings of the 18th Japanese Conference on Discrete and Computational Geometry and Graphs, JDCDGG 2015, held in Kyoto, Japan, in September 2015. The total of 25 papers included in this volume was carefully reviewed and selected from 64 submissions. The papers feature advances made in the field of computational geometry and focus on emerging technologies, new methodology and applications, graph theory and dynamics. This proceedings are dedicated to Naoki Katoh on the occasion of his retirement from Kyoto University.

This commemorative book contains the 28 major articles that appeared in the 2008 Twentieth Anniversary Issue of the journal Discrete & Computational Geometry, and presents a comprehensive picture of the current state of the field. The articles in this volume, a number of which solve long-outstanding problems in the field, were chosen by the editors of DCG for the importance of their results, for the breadth of their scope, and to show the intimate connections that have arisen between discrete and computational geometry and other areas of both computer science and mathematics. Apart from the articles, the editors present an expanded preface, along with a set of photographs of groups and individuals who have played a major role in the history of the field during the past twenty years.

An impressive collection of original research papers in discrete and computational geometry, contributed by many leading researchers in these fields, as a tribute to Jacob E. Goodman and Richard Pollack, two of the 'founding fathers' of the area, on the occasion of their 2/3 x 100 birthdays. The topics covered by the 41 papers provide professionals and graduate students with a comprehensive presentation of the state of the art in most aspects of discrete and computational geometry, including geometric algorithms, study of arrangements, geometric graph theory, quantitative and algorithmic real algebraic geometry, with important connections

to algebraic geometry, convexity, polyhedral combinatorics, the theory of packing, covering, and tiling. The book serves as an invaluable source of reference in this discipline.

This book, based on the authors' lecture series at a 2006 satellite meeting of the International Congress of Mathematicians, offers a comprehensive survey of core areas of combinatorial geometry. These lecture notes aptly describe both the history and the state of the art of these topics. These combinatorial techniques have found applications in areas of computer science ranging from graph drawing to frequency allocation in cellular networks.

This book constitutes the thoroughly refereed post-proceedings of the Japanese Conference on Discrete Computational Geometry, JCDCG 2004, held in Tokyo, Japan in October 2004, to honor János Pach on his fiftieth year. The 20 revised full papers presented were carefully selected during two rounds of reviewing and improvement from over 60 talks at the conference. All current issues in discrete algorithmic geometry are addressed.

In this project we do an algorithmic study of problems from computational geometry with countably infinite input, especially countable sets in R?n. To do so, we use the infinite time Blum-Shub-Smale (ITBSS) machine, which is capable to extend computations to infinite time. We present this framework, explained with several algorithms, some results on the ITBSS Machine, and a storage system capable of encoding, editing and extracting sequences of real numbers. We study different geometric problems, giving algorithmic solutions to several of them. The accumulation points problem in R?2 is presented and solved for countable sets with finitely many accumulation points. Also, the convex hull problem is studied. We show how to compute the closure of the convex hull of countable bounded sets in R?n. The non-crossing perfect matching problem with infinite input is addressed as well.

First published in 1987, the seven chapters that comprise this book review contemporary work on the geometric side of robotics. The first chapter defines the fundamental goal of robotics in very broad terms and outlines a research agenda each of whose items constitutes a substantial area for further research. The second chapter presents recently developed techniques that have begun to address the geometric side of this research agenda and the third reviews several applied geometric ideas central to contemporary work on the problem of motion planning. The use of Voronoi diagrams, a theme opened in these chapters, is explored further later in the book. The fourth chapter develops a theme in computational geometry having obvious significance for the simplification of practical robotics problems — the approximation or decomposition of complex geometric objects into simple ones. The final chapters treat two examples of a class of geometric 'reconstruction' problem that have immediate application to computer-aided geometric design systems.

Advanced textbook in computational geometry; algorithmic approach.

Discrete geometry is a relatively new development in pure mathematics, while computational geometry is an emerging area in applications-driven computer science. Their intermingling has yielded exciting advances in recent years, yet what has been lacking until now is an undergraduate textbook that bridges the gap between the two. Discrete and Computational Geometry offers a comprehensive yet accessible introduction to this cutting-edge frontier of mathematics and computer science. This book covers traditional topics such as convex hulls, triangulations, and Voronoi diagrams, as well as more recent subjects like pseudotriangulations, curve reconstruction, and locked chains. It also touches on more advanced material, including Dehn invariants, associahedra, quasigeodesics, Morse theory, and the recent resolution of the Poincaré conjecture. Connections to real-world applications are made throughout, and algorithms are presented independently of any programming

language. This richly illustrated textbook also features numerous exercises and unsolved problems. The essential introduction to discrete and computational geometry Covers traditional topics as well as new and advanced material Features numerous full-color illustrations, exercises, and unsolved problems Suitable for sophomores in mathematics, computer science, engineering, or physics Rigorous but accessible An online solutions manual is available (for teachers only). To obtain access, please e-mail: Vickie_Kearn@press.princeton.edu

This book constitutes the thoroughly refereed post-proceedings of the Japanese Conference on Discrete Computational Geometry, JCDCG 2002, held in Tokyo, Japan, in December 2002. The 29 revised full papers presented were carefully selected during two rounds of reviewing and improvement. All current issues in discrete algorithmic geometry are addressed.

This book constitutes the thoroughly refereed post-conference proceedings of the China-Japan Joint Conference on Computational Geometry, Graphs and Applications, CGGA 2010, held in Dalian, China, in November 2010. The 23 revised full papers presented were carefully selected during two rounds of reviewing and improvement from numerous submissions. All aspects of computational and discrete geometry, graph theory, graph algorithms, and their applications are covered.

This book introduces readers to key ideas and applications of computational algebraic geometry. Beginning with the discovery of Grobner bases and fueled by the advent of modern computers and the rediscovery of resultants, computational algebraic geometry has grown rapidly in importance. The fact that 'crunching equations' is now as easy as 'crunching numbers' has had a profound impact in recent years. At the same time, the mathematics used in computational algebraic geometry is unusually elegant and accessible, which makes the subject easy to learn and easy to apply. This book begins with an introduction to Grobner bases and resultants, then discusses some of the more recent methods for solving systems of polynomial equations. A sampler of possible applications follows, including computer-aided geometric design, complex information systems, integer programming, and algebraic coding theory. The lectures in the book assume no previous acquaintance with the material.

This book constitutes the thoroughly refereed post-proceedings of the 11th International Workshop on Theoretical Foundations of Computer Vision, held in Dagstuhl Castle, Germany in April 2002. The 27 revised full papers presented went through two rounds of reviewing and improvement and assess the state of the art in geometry, morphology, and computational imaging. The papers are organized in sections on geometry - models and algorithms; property measurement in the grid and on finite samples; features, shape, and morphology; and computer vision and scene analysis.

This book reviews the algorithms for processing geometric data, with a practical focus on important techniques not covered by traditional courses on computer

vision and computer graphics. Features: presents an overview of the underlying mathematical theory, covering vector spaces, metric space, affine spaces, differential geometry, and finite difference methods for derivatives and differential equations; reviews geometry representations, including polygonal meshes, splines, and subdivision surfaces; examines techniques for computing curvature from polygonal meshes; describes algorithms for mesh smoothing, mesh parametrization, and mesh optimization and simplification; discusses point location databases and convex hulls of point sets; investigates the reconstruction of triangle meshes from point clouds, including methods for registration of point clouds and surface reconstruction; provides additional material at a supplementary website; includes self-study exercises throughout the text.

Computational geometry emerged from the field of algorithms design and anal ysis in the late 1970s. It has grown into a recognized discipline with its own journals, conferences, and a large community of active researchers. The suc cess of the field as a research discipline can on the one hand be explained from the beauty of the problems studied and the solutions obtained, and, on the other hand, by the many application domains--computer graphics, geographic in formation systems (GIS), robotics, and others-in which geometric algorithms play a fundamental role. For many geometric problems the early algorithmic solutions were either slow or difficult to understand and implement. In recent years a number of new algorithmic techniques have been developed that improved and simplified many of the previous approaches. In this textbook we have tried to make these modem algorithmic solutions accessible to a large audience. The book has been written as a textbook for a course in computational geometry, but it can also be used for self-study.

Content Description #Anthology selected from contributions to the First ACM Workshop on Applied Computational Geometry.#Includes bibliographical references and index.

This is the revised and expanded 1998 edition of a popular introduction to the design and implementation of geometry algorithms arising in areas such as computer graphics, robotics, and engineering design. The basic techniques used in computational geometry are all covered: polygon triangulations, convex hulls, Voronoi diagrams, arrangements, geometric searching, and motion planning. The self-contained treatment presumes only an elementary knowledge of mathematics, but reaches topics on the frontier of current research, making it a useful reference for practitioners at all levels. The second edition contains material on several new topics, such as randomized algorithms for polygon triangulation, planar point location, 3D convex hull construction, intersection algorithms for ray-segment and ray-triangle, and point-in-polyhedron. The code in this edition is significantly improved from the first edition (more efficient and more robust), and four new routines are included. Java versions for this new edition are also available. All code is accessible from the book's Web site (http://cs.smith.edu/~orourke/) or by anonymous ftp.

Discrete and computational geometry are two fields which in recent years have benefitted from the interaction between mathematics and computer science. The results are applicable in areas such as motion planning, robotics, scene analysis, and computer aided design. The book consists of twelve chapters summarizing the most recent results and methods in discrete and computational geometry. All authors are well-known experts in these fields. They give concise and self-contained surveys of the most efficient combinatorical, probabilistic and topological methods that can be used to design effective geometric algorithms for the applications mentioned above. Most of the methods and results discussed in the book have not appeared in any previously published monograph. In particular, this book contains the first systematic treatment of epsilon-nets, geometric tranversal theory, partitions of Euclidean

spaces and a general method for the analysis of randomized geometric algorithms. Apart from mathematicians working in discrete and computational geometry this book will also be of great use to computer scientists and engineers, who would like to learn about the most recent results.

While high-quality books and journals in this field continue to proliferate, none has yet come close to matching the Handbook of Discrete and Computational Geometry, which in its first edition, quickly became the definitive reference work in its field. But with the rapid growth of the discipline and the many advances made over the past seven years, it's time to bring this standard-setting reference up to date. Editors Jacob E. Goodman and Joseph O'Rourke reassembled their stellar panel of contributors, added manymore, and together thoroughly revised their work to make the most important results and methods, both classic and cutting-edge, accessible in one convenient volume. Now over more then 1500 pages, the Handbook of Discrete and Computational Geometry, Second Edition once again provides unparalleled, authoritative coverage of theory, methods, and applications. Highlights of the Second Edition: Thirteen new chapters: Five on applications and others on collision detection, nearest neighbors in high-dimensional spaces, curve and surface reconstruction, embeddings of finite metric spaces, polygonal linkages, the discrepancy method, and geometric graph theory Thorough revisions of all remaining chapters Extended coverage of computational geometry software, now comprising two chapters: one on the LEDA and CGAL libraries, the other on additional software Two indices: An Index of Defined Terms and an Index of Cited Authors Greatly expanded bibliographies

Computational Geometry: Curve and Surface Modeling provides information pertinent to the fundamental aspects of computational geometry. This book discusses the geometric properties of parametric polynomial curves by using the theory of affine invariants for algebraic curves. Organized into eight chapters, this book begins with an overview of the objects studies in computational geometry, namely surfaces and curves. This text then explores the developments in the theory and application of spline functions, which began with cubic spline functions. Other chapters consider the mechanical background of the cubic spline functions, which is the wooden spline with small deflection. This book discusses as well that in mathematical lofting the information of a geometric shape is given by a set of data points, while in geometric design other ways of representations are available. The final chapter deals with the concepts in the theory of algebraic curves. This book is a valuable resource for mathematicians.

Computational geometry is a branch of computer science devoted to the study of algorithms which can be stated in terms of geometry. Some purely geometrical problems arise out of the study of computational geometric algorithms, and such problems are also considered to be part of computational geometry. While modern computational geometry is a recent development, it is one of the oldest fields of computing with history stretching back to antiquity. The main impetus for the development of computational geometry as a discipline was progress in computer graphics and computer-aided design and manufacturing (CAD/CAM), but many problems in computational geometry are classical in nature, and may come from mathematical visualization. Other important applications of computational geometry include robotics, geographic information systems, integrated circuit design, computer-aided engineering, and computer vision. Polyhedral and Algebraic Methods in Computational Geometry provides a thorough introduction into algorithmic geometry and its applications. This book is directed towards advanced undergraduates in mathematics and computer science, as well as towards engineering students who are interested in the applications of computational geometry.