

## Distance Geometry Theory Methods And Applications

Numerical Geometry of Images examines computational methods and algorithms in image processing. It explores applications like shape from shading, color-image enhancement and segmentation, edge integration, offset curve computation, symmetry axis computation, path planning, minimal geodesic computation, and invariant signature calculation. In addition, it describes and utilizes tools from mathematical morphology, differential geometry, numerical analysis, and calculus of variations. Graduate students, professionals, and researchers with interests in computational geometry, image processing, computer graphics, and algorithms will find this new text / reference an indispensable source of insight of instruction.

Volume 45 of "Progress in Drug Research" contains eight reviews and the various indexes which facilitate its use and establish the connection with the previous volumes. The articles in this volume deal with neuro peptides as native immune modulators, with Calmodulin and with effects of cell stimuli and drugs on cellular activation, with recent advances in benzodiazepine receptor binding studies, with the medicinal chemistry and therapeutic potentials of ligands of the histamine H3 receptor, with Serotonin uptake inhibitors, with computer-aided drug design, with natri uretic hormones and with the recent developments in the chemotherapy of osteoporosis. In the 36 years that PDR has existed, the Editor has enjoyed the valuable help and advice of many colleagues. Readers, the authors of the reviews and, last but not least, the reviewers have all contributed greatly to the success of this series. Although the comments received so far have generally been favorable, it is nevertheless necessary to analyze and to reassess the current position and the future direction of such a series of monographs. So far, it has been the Editor's intention to help disseminate information on the vast domain of drug research, and to provide the reader with a tool with which to keep abreast of the latest developments and trends. The reviews in PDR are useful to the nonspecialist, who can obtain an overview of a particular field of drug research in a relatively short time.

This book provides a complete snapshot of various experimental approaches to structure-based and ligand-based drug design and is illustrated with more than 200 images.

The goal of the Encyclopedia of Optimization is to introduce the reader to a complete set of topics that show the spectrum of research, the richness of ideas, and the breadth of applications that has come from this field. The second edition builds on the success of the former edition with more than 150 completely new entries, designed to ensure that the reference addresses recent areas where optimization theories and techniques have advanced. Particularly heavy attention resulted in health science and transportation, with entries such as "Algorithms for Genomics", "Optimization and Radiotherapy Treatment Design", and "Crew Scheduling".

The third of three parts comprising Volume 54, the proceedings of the Summer Research Institute on Differential Geometry, held at the University of California, Los Angeles, July 1990 (ISBN for the set is 0-8218-1493-1). Part 3 begins with an overview by R.E. Greene of some recent trends in Riemannia

This volume presents articles by speakers and participants in two AMS special sessions, Geometric Group Theory and Geometric Methods in Group Theory, held respectively at Northeastern University (Boston, MA) and at Universidad de Sevilla (Spain). The expository and survey articles in the book cover a wide range of topics, making it suitable for researchers and graduate students interested in group theory.

This text traces developments in rational drug discovery and combinatorial library design with contributions from 50 leading scientists in academia and industry who offer coverage of basic principles, design strategies, methodologies, software tools and algorithms, and applications. It outlines the fundamentals of pharmacophore modelling and 3D Quantitative Structure-Activity Relationships (QSAR), classical QSAR, and target protein structure-based design methods.

Annual Reports in Medicinal Chemistry

Algebraic & geometry methods have constituted a basic background and tool for people working on classic block coding theory and cryptography. Nowadays, new paradigms on coding theory and cryptography have arisen such as: Network coding, S-Boxes, APN Functions, Steganography and decoding by linear programming. Again understanding the underlying procedure and symmetry of these topics needs a whole bunch of non trivial knowledge of algebra and geometry that will be used to both, evaluate those methods and search for new codes and cryptographic applications. This book shows those methods in a self-contained form.

Graph Theory (as a recognized discipline) is a relative newcomer to Mathematics. The first formal paper is found in the work of Leonhard Euler in 1736. In recent years the subject has grown so rapidly that in today's literature, graph theory papers abound with new mathematical developments and significant applications. As with any academic field, it is good to step back occasionally and ask Where is all this activity taking us?, What are the outstanding fundamental problems?, What are the next important steps to take?. In short, Quo Vadis, Graph Theory?. The contributors to this volume have together provided a comprehensive reference source for future directions and open questions in the field.

Nuclear Magnetic Resonance (NMR) spectroscopy, a physical phenomenon based upon the magnetic properties of certain atomic nuclei, has found a wide range of applications in life sciences over recent decades. The dramatic advances in NMR techniques have led to corresponding advances in the ability of NMR to study structure, dynamics and interactions of biological macromolecules in solution under close to physiological conditions. This volume focuses on the use of NMR to study proteins. NMR can be used to determine detailed three-dimensional structures of proteins in solution. Furthermore, it provides information about conformational or chemical exchange, internal mobility and dynamics at timescales varying from picoseconds to seconds. It is the primary technique used to obtain information on intrinsically disordered (unfolded) proteins, since these proteins will not crystallize easily. NMR is also a very powerful method for the study of interactions of protein with other molecules, whether small molecules (including drugs), nuclear acids or other proteins. This up-to-date volume covers NMR techniques and their application to proteins, with a focus on practical details. This book will provide a newcomer to NMR with the practical guidance in order to carry out successful experiments with proteins and to analyze the resulting spectra. Those who are familiar with the chemical applications of NMR will also find it useful in understanding the special requirements of protein NMR.

Historical analysis reveals that perceptual theories and models are doomed to relatively short lives. The most popular contemporary theories in perceptual science do not have as wide an acceptance among researchers as do some of those in other sciences. To understand these difficulties, the authors of the present volume explore the conceptual and philosophical foundations of perceptual science. Based on logical analyses of various problems, theories, and models, they offer a number of reasons for the current weakness of perceptual explanations. New theoretical approaches are also proposed. At the end of each chapter, discussants contribute to the conclusions by critically examining the authors' ideas and analyses.

Invariant, or coordinate-free methods provide a natural framework for many geometric questions. Invariant Methods in Discrete and Computational Geometry provides a basic introduction to several aspects of invariant theory, including the supersymmetric algebra, the Grassmann-Cayley algebra, and Chow forms. It also presents a number of current research papers on invariant theory and its applications to problems in geometry, such as automated theorem proving and computer vision. Audience: Researchers studying mathematics, computers and robotics.

This volume is a collection of research surveys on the Distance Geometry Problem (DGP) and its applications. It will be divided into three parts: Theory, Methods and Applications. Each part will contain at least one survey and several research papers. The first part, Theory, will deal with theoretical aspects of the DGP, including a new class of problems and the study of its complexities as well as the relation between DGP and other related topics, such as: distance matrix theory, Euclidean distance matrix completion problem, multispherical structure of distance matrices, distance geometry and geometric algebra, algebraic distance geometry theory, visualization of K-dimensional structures in the plane, graph rigidity, and theory of discretizable DGP: symmetry and complexity. The second part, Methods, will discuss mathematical and computational properties of methods developed to the problems considered in the first chapter including continuous methods (based on Gaussian and hyperbolic smoothing, difference of convex functions, semidefinite programming, branch-and-bound), discrete methods (based on branch-and-prune, geometric build-up, graph rigidity), and also heuristics methods (based on simulated annealing, genetic algorithms, tabu search, variable neighborhood search). Applications will comprise the third part and will consider applications of DGP to NMR structure calculation, rational drug design, molecular dynamics simulations, graph drawing and sensor network localization. This volume will be the first edited book on distance geometry and applications. The editors are in correspondence with the major contributors to the field of distance geometry, including important research centers in molecular biology such as Institut Pasteur in Paris.

This textbook, the first of its kind, presents the fundamentals of distance geometry: theory, useful methodologies for obtaining solutions, and real world applications. Concise proofs are given and step-by-step algorithms for solving fundamental problems efficiently and precisely are presented in Mathematica®, enabling the reader to experiment with concepts and methods as they are introduced. Descriptive graphics, examples, and problems, accompany the real gems of the text, namely the applications in visualization of graphs, localization of sensor networks, protein conformation from distance data, clock synchronization protocols, robotics, and control of unmanned underwater vehicles, to name several. Aimed at intermediate undergraduates, beginning graduate students, researchers, and practitioners, the reader with a basic knowledge of linear algebra will gain an understanding of the basic theories of distance geometry and why they work in real life.

Progress in medicinal chemistry and in drug design depends on our ability to understand the interactions of drugs with their biological targets. Classical QSAR studies describe biological activity in terms of physicochemical properties of substituents in certain positions of the drug molecules. The purpose of this book is twofold: On the one hand, both the novice and the experienced user will be introduced to the theory and application of 3D QSAR analyses, and on the other, a comprehensive overview of the scope and limitations of these methods is given. The detailed discussion of the present state of the art should enable scientists to further develop and improve these powerful new tools. The greater part of the book is dedicated to the theoretical background of 3D QSAR and to a discussion of CoMFA applications. In addition, various other 3D QSAR approaches and some CoMFA-related methods are described in detail. Thus, the book should be valuable for medicinal, agricultural and theoretical chemists, biochemists and biologists, as well as for other scientists interested in drug design. Its content, starting at a very elementary level and proceeding to the latest methodological results, the strengths and limitations of 3D QSAR approaches, makes the book also appropriate as a text for teaching and for graduate student courses.

This book brings together geometric tools and their applications for Information analysis. It collects current and many uses of in the interdisciplinary fields of Information Geometry Manifolds in Advanced Signal, Image & Video Processing, Complex Data Modeling and Analysis, Information Ranking and Retrieval, Coding, Cognitive Systems, Optimal Control, Statistics on Manifolds, Machine Learning, Speech/sound recognition and natural language treatment which are also substantially relevant for the industry.

The usual "implementation" of real numbers as floating point numbers on existing computers has the well-known disadvantage that most of the real numbers are not exactly representable in floating point. Also the four basic arithmetic operations can usually not be performed exactly. During the last years research in different areas has been intensified in order to overcome these problems. (LEDA-Library by K. Mehlhorn et al., "Exact arithmetic with real numbers" by A. Edalat et al., Symbolic algebraic methods, verification methods). The latest development is the combination of symbolic-algebraic methods and verification methods to so-called hybrid methods. – This book contains a collection of worked out talks on these subjects given during a Dagstuhl seminar at the Forschungszentrum für Informatik, Schloß Dagstuhl, Germany, presenting the state of the art.

The intention of this collection agrees with the purposes of the homonymous mini-symposium (MS) at ICIAM-2019, which were to overview the essentials of geometric calculus (GC) formalism, to report on state-of-the-art applications showcasing its advantages and to explore the bearing of GC in novel approaches to deep learning. The first three contributions, which correspond to lectures at the MS, offer

perspectives on recent advances in the application GC in the areas of robotics, molecular geometry, and medical imaging. The next three, especially invited, hone the expressiveness of GC in orientation measurements under different metrics, the treatment of contact elements, and the investigation of efficient computational methodologies. The last two, which also correspond to lectures at the MS, deal with two aspects of deep learning: a presentation of a concrete quaternionic convolutional neural network layer for image classification that features contrast invariance and a general overview of automatic learning aimed at steering the development of neural networks whose units process elements of a suitable algebra, such as a geometric algebra. The book fits, broadly speaking, within the realm of mathematical engineering, and consequently, it is intended for a wide spectrum of research profiles. In particular, it should bring inspiration and guidance to those looking for materials and problems that bridge GC with applications of great current interest, including the auspicious field of GC-based deep neural networks.

Cuts and metrics are well-known objects that arise - independently, but with many deep and fascinating connections - in diverse fields: in graph theory, combinatorial optimization, geometry of numbers, combinatorial matrix theory, statistical physics, VLSI design etc. This book presents a wealth of results, from different mathematical disciplines, in a unified comprehensive manner, and establishes new and old links, which cannot be found elsewhere. It provides a unique and invaluable source for researchers and graduate students. From the Reviews: "This book is definitely a milestone in the literature of integer programming and combinatorial optimization. It draws from the Interdisciplinarity of these fields [...]. With knowledge about the relevant terms, one can enjoy special subsections without being entirely familiar with the rest of the chapter. This makes it not only an interesting research book but even a dictionary. [...] The longer one works with it, the more beautiful it becomes." Optima 56, 1997.

The study of Euclidean distance matrices (EDMs) fundamentally asks what can be known geometrically given only distance information between points in Euclidean space. Each point may represent simply location or, abstractly, any entity expressible as a vector in finite-dimensional Euclidean space. The answer to the question posed is that very much can be known about the points; the mathematics of this combined study of geometry and optimization is rich and deep. Throughout we cite beacons of historical accomplishment. The application of EDMs has already proven invaluable in discerning biological molecular conformation. The emerging practice of localization in wireless sensor networks, the global positioning system (GPS), and distance-based pattern recognition will certainly simplify and benefit from this theory. We study the pervasive convex Euclidean bodies and their various representations. In particular, we make convex polyhedra, cones, and dual cones more visceral through illustration, and we study the geometric relation of polyhedral cones to nonorthogonal bases biorthogonal expansion. We explain conversion between halfspace- and vertex-descriptions of convex cones, we provide formulae for determining dual cones, and we show how classic alternative systems of linear inequalities or linear matrix inequalities and optimality conditions can be explained by generalized inequalities in terms of convex cones and their duals. The conic analogue to linear independence, called conic independence, is introduced as a new tool in the study of classical cone theory; the logical next step in the progression: linear, affine, conic. Any convex optimization problem has geometric interpretation. This is a powerful attraction: the ability to visualize geometry of an optimization problem. We provide tools to make visualization easier. The concept of faces, extreme points, and extreme directions of convex Euclidean bodies is explained here, crucial to understanding convex optimization. The convex cone of positive semidefinite matrices, in particular, is studied in depth. We mathematically interpret, for example, its inverse image under affine transformation, and we explain how higher-rank subsets of its boundary united with its interior are convex. The Chapter on "Geometry of convex functions", observes analogies between convex sets and functions: The set of all vector-valued convex functions is a closed convex cone. Included among the examples in this chapter, we show how the real affine function relates to convex functions as the hyperplane relates to convex sets. Here, also, pertinent results for multidimensional convex functions are presented that are largely ignored in the literature; tricks and tips for determining their convexity and discerning their geometry, particularly with regard to matrix calculus which remains largely unsystematized when compared with the traditional practice of ordinary calculus. Consequently, we collect some results of matrix differentiation in the appendices. The Euclidean distance matrix (EDM) is studied, its properties and relationship to both positive semidefinite and Gram matrices. We relate the EDM to the four classical axioms of the Euclidean metric; thereby, observing the existence of an infinity of axioms of the Euclidean metric beyond the triangle inequality. We proceed by deriving the fifth Euclidean axiom and then explain why furthering this endeavor is inefficient because the ensuing criteria (while describing polyhedra) grow linearly in complexity and number. Some geometrical problems solvable via EDMs, EDM problems posed as convex optimization, and methods of solution are presented; e.g., we generate a recognizable isotonic map of the United States using only comparative distance information (no distance information, only distance inequalities). We offer a new proof of the classic Schoenberg criterion, that determines whether a candidate matrix is an EDM. Our proof relies on fundamental geometry; assuming, any EDM must correspond to a list of points contained in some polyhedron (possibly at its vertices) and vice versa. It is not widely known that the Schoenberg criterion implies nonnegativity of the EDM entries; proved here. We characterize the eigenvalues of an EDM matrix and then devise a polyhedral cone required for determining membership of a candidate matrix (in Cayley-Menger form) to the convex cone of Euclidean distance matrices (EDM cone); i.e., a candidate is an EDM if and only if its eigenspectrum belongs to a spectral cone for  $EDM^N$ . We will see spectral cones are not unique. In the chapter "EDM cone", we explain the geometric relationship between the EDM cone, two positive semidefinite cones, and the ellipsope. We illustrate geometric requirements, in particular, for projection of a candidate matrix on a positive semidefinite cone that establish its membership to the EDM cone. The faces of the EDM cone are described, but still open is the question whether all its faces are exposed as they are for the positive semidefinite cone. The classic Schoenberg criterion, relating EDM and positive semidefinite cones, is revealed to be a discretized membership relation (a generalized inequality, a new Farkas-like lemma) between the EDM cone and its ordinary dual. A matrix criterion for membership to the dual EDM cone is derived that is simpler than the Schoenberg criterion. We derive a new concise expression for the EDM cone and its dual involving two subspaces and a positive semidefinite cone. "Semidefinite programming" is reviewed with particular attention to optimality conditions of prototypical primal and dual conic programs, their interplay, and the perturbation method of rank reduction of optimal solutions (extant but not well-known). We show how to solve a ubiquitous platonic combinatorial optimization problem from linear algebra (the optimal Boolean solution  $x$  to  $Ax=b$ ) via semidefinite program relaxation. A three-dimensional polyhedral analogue for the positive semidefinite cone of  $3 \times 3$  symmetric matrices is introduced; a tool for visualizing in 6 dimensions. In "EDM proximity" we explore methods of solution to a few fundamental and prevalent Euclidean distance matrix proximity problems; the problem of finding that Euclidean distance matrix closest to a given matrix in the Euclidean sense. We pay particular attention to the problem when compounded with rank minimization. We offer a new geometrical proof of a famous result discovered by Eckart & Young in 1936 regarding Euclidean projection of a point on a subset of the positive semidefinite cone comprising all positive semidefinite matrices having rank not exceeding a prescribed limit  $\rho$ . We explain how this problem is transformed to a convex optimization for any rank  $\rho$ .

This series is reviewing advances in the rapidly growing and evolving field of computational chemistry. It was established to keep track of the many new developments and is therefore providing a valuable service to the scientific community.

After several decades of reduced contact, the interaction between physicists and mathematicians in the front-line research of both fields recently became deep and fruitful again. Many of the leading specialists of both fields became involved in this development. This process even led to the discovery of previously unsuspected connections between various subfields of physics and mathematics. In mathematics this concerns in particular knots von Neumann algebras, Kac-Moody algebras, integrable non-linear partial differential equations, and differential geometry in low dimensions, most importantly in

three and four dimensional spaces. In physics it concerns gravity, string theory, integrable classical and quantum field theories, solitons and the statistical mechanics of surfaces. New discoveries in these fields are made at a rapid pace. This conference brought together active researchers in these areas, reporting their results and discussing with other participants to further develop thoughts in future new directions. The conference was attended by 50 participants from 15 nations. These proceedings document the program and the talks at the conference. This conference was preceded by a two-week summer school. Ten lecturers gave extended lectures on related topics. The proceedings of the school will also be published in the NATO-ASI volume by Plenum. The Editors vii ACKNOWLEDGMENTS We would like to thank the many people who have made the conference a success. Furthermore, we appreciate the excellent talks. The active participation of everyone present made the conference lively and stimulating. All of this made our efforts worth while.

The concept of CAST, computer aided systems Theory, was introduced by F. Pichler of Linz in the late 1980s to include those computer theoretical and practical developments used as tools to solve problems in system science. It was considered as the third component (the other two being CAD and CAM) that would provide for a complete picture of the path from computer and systems sciences to practical developments in science and engineering. The University of Linz organized the first CAST workshop in April 1988, which demonstrated the acceptance of the concepts by the scientific and technical community. Next, the University of Las Palmas de Gran Canaria joined the University of Linz to organize the first international meeting on CAST (Las Palmas February 1989), under the name EUROCAST 1989, a very successful gathering of systems theorists, computer scientists and engineers from most European countries, North America and Japan. It was agreed that EUROCAST international conferences would be organized every two years. Thus, the following EUROCAST meetings took place in Krems (1991), Las Palmas (1993), Innsbruck (1995), Las Palmas (1997), Vienna (1999), Las Palmas (2001) and Las Palmas (2003) in addition to an extra-European CAST conference in Ottawa in 1994. Selected papers from those meetings were published as Springer Lecture Notes in Computer Science vols. 410, 585, 763, 1030, 1333, 1728, 2178 and 2809 and in several special issues of *Cybernetics and Systems: an International Journal*.

This book constitutes the thoroughly refereed post-proceedings of the 4th International Workshop on Automated Deduction in Geometry, ADG 2002, held at Hagenberg Castle, Austria in September 2002. The 13 revised full papers presented were carefully selected during two rounds of reviewing and improvement. Among the issues addressed are theoretical and methodological topics, such as the resolution of singularities, algebraic geometry and computer algebra; various geometric theorem proving systems are explored; and applications of automated deduction in geometry are demonstrated in fields like computer-aided design and robotics.

Proceedings of the Tenth Course of the International School of Pure and Applied Biostructure (Erice, Italy, June 1989). Knowledge of protein structure and of design and manufacture methods has made it possible to produce proteins of any desired sequence, but progress is limited by inability to predict

This textbook, the first of its kind, presents the fundamentals of distance geometry: theory, useful methodologies for obtaining solutions, and real world applications. Concise proofs are given and step-by-step algorithms for solving fundamental problems efficiently and precisely are presented in Mathematica(R), enabling the reader to experiment with concepts and methods as they are introduced. Descriptive graphics, examples, and problems, accompany the real gems of the text, namely the applications in visualization of graphs, localization of sensor networks, protein conformation from distance data, clock synchronization protocols, robotics, and control of unmanned underwater vehicles, to name several. Aimed at intermediate undergraduates, beginning graduate students, researchers, and practitioners, the reader with a basic knowledge of linear algebra will gain an understanding of the basic theories of distance geometry and why they work in real life.

Protein engineering has had considerable impact on basic and applied research in biochemistry and molecular biology. It is already in use as a tool in molecular biology, but it is beginning to strongly influence the planning of experiments in biology everywhere, and, with even further-reaching consequences, the appointment politics in research institutions and industries. Protein engineering, perhaps more than any other methods of protein analysis and peptide synthesis, has shown that proteins are organic molecules governed by the universal laws of chemistry and physics. However, as was the case with other new powerful methods and techniques, protein engineering tempts to an exploration of its limitations and thus generates more questions than it answers. The 39th Mosbacher Colloquium on Protein Structure and Protein Engineering is not the first conference on this topic and it will not be the last. The important issues are obviously techniques of protein engineering, examples of application, and the basic framework of protein structure and stability within which reasonable experiments can be designed; conversely also, what we can learn about protein structure, dynamics, and folding from such experiments. Experiments in this direction aim at elucidating the folding code in the long run, but help to exploit the role of individual amino acid residues in catalysis, protein stability, and binding specificity in selected proteins now.

The *Geometry of Musical Rhythm: What Makes a "Good" Rhythm Good?* is the first book to provide a systematic and accessible computational geometric analysis of the musical rhythms of the world. It explains how the study of the mathematical properties of musical rhythm generates common mathematical problems that arise in a variety of seemingly disparate

This volume is a comprehensive collection of extended contributions from the Workshop on Computational Optimization 2014, held at Warsaw, Poland, September 7-10, 2014. The book presents recent advances in computational optimization. The volume includes important real problems like parameter settings for controlling processes in bioreactor and other processes, resource constrained project scheduling, infection distribution, molecule distance geometry, quantum computing, real-time management and optimal control, bin packing, medical image processing, localization the abrupt atmospheric contamination source and so on. It shows how to develop algorithms for them based on new metaheuristic methods like evolutionary computation, ant colony optimization, constraint programming and others. This research demonstrates how some real-world problems arising in engineering, economics, medicine and other domains can be formulated as optimization tasks.

This book is a pedagogical presentation aimed at advanced undergraduate students, beginning graduate students and professionals who are looking for an introductory text to

the field of Distance Geometry, and some of its applications. This version profits from feedback acquired at undergraduate/graduate courses in seminars and a number of workshops.

Molecular similarity searching is fast becoming a key tool in organic chemistry. In this book, the editor has brought together an international team of authors, each working at the forefront of this technology, providing a timely and concise overview of current research. The chapters focus principally on those methods which have reached sufficient maturity to be of immediate practical use in molecular design.

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.

The demand for more reliable geometric computing in robotics, computer vision and graphics has revitalized many venerable algebraic subjects in mathematics. Among them, Grassmann-Cayley algebra and Geometric Algebra. Nowadays, they are used as powerful languages for projective, Euclidean and other classical geometries. This book contains the author and his collaborators' most recent, original development of Grassmann-Cayley algebra and Geometric Algebra and their applications in automated reasoning of classical geometries. It includes two of the three advanced invariant algebras: Cayley bracket algebra, conformal geometric algebra, and null bracket algebra for highly efficient geometric computing. They form the theory of advanced invariants, and capture the intrinsic beauty of geometric languages and geometric computing. Apart from their applications in discrete and computational geometry, the new languages are currently being used in computer vision, graphics and robotics by many researchers worldwide. Sample Chapter(s). Chapter 1: Introduction (252 KB). Contents: Projective Space, Bracket Algebra and Grassmann-Cayley Algebra; Projective Incidence Geometry with Cayley Bracket Algebra; Projective Conic Geometry with Bracket Algebra and Quadratic Grassmann-Cayley Algebra; Inner-product Bracket Algebra and Clifford Algebra; Geometric Algebra; Euclidean Geometry and Conformal Grassmann-Cayley Algebra; Conformal Clifford Algebra and Classical Geometries. Readership: Graduate students in discrete and computational geometry, and computer mathematics; mathematicians and computer scientists.

This book offers a gentle introduction to key elements of Geometric Algebra, along with their applications in Physics, Robotics and Molecular Geometry. Major applications covered are the physics of space-time, including Maxwell electromagnetism and the Dirac equation; robotics, including formulations for the forward and inverse kinematics and an overview of the singularity problem for serial robots; and molecular geometry, with 3D-protein structure calculations using NMR data. The book is primarily intended for graduate students and advanced undergraduates in related fields, but can also benefit professionals in search of a pedagogical presentation of these subjects.

This book constitutes the proceedings of the 23rd International Workshop on Computer Algebra in Scientific Computing, CASC 2021, held in Sochi, Russia, in September 2021. The 24 full papers presented together with 1 invited talk were carefully reviewed and selected from 40 submissions. The papers cover theoretical computer algebra and its applications in scientific computing.

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