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## Applications of Computational Algebraic Geometry

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David A. Cox  
Bernd Sturmfels  
Editors



American Mathematical Society

# Applications Of Computational Algebraic Geometry

**Ciro Ciliberto, Friedrich  
Hirzebruch, Rick Miranda, Mina Teicher**

## **Applications Of Computational Algebraic Geometry:**

Applications of Computational Algebraic Geometry David A. Cox Dinesh N. Manocha Bernd Sturmfels, *Emerging Applications of Algebraic Geometry* Mihai Putinar, Seth Sullivant, 2008-12-10 Recent advances in both the theory and implementation of computational algebraic geometry have led to new striking applications to a variety of fields of research The articles in this volume highlight a range of these applications and provide introductory material for topics covered in the IMA workshops on Optimization and Control and Applications in Biology Dynamics and Statistics held during the IMA year on Applications of Algebraic Geometry The articles related to optimization and control focus on burgeoning use of semidefinite programming and moment matrix techniques in computational real algebraic geometry The new direction towards a systematic study of non commutative real algebraic geometry is well represented in the volume Other articles provide an overview of the way computational algebra is useful for analysis of contingency tables reconstruction of phylogenetic trees and in systems biology The contributions collected in this volume are accessible to non experts self contained and informative they quickly move towards cutting edge research in these areas and provide a wealth of open problems for future research

**Applications of Computational Algebraic Geometry** Dinesh Manocha, 2014-05-10 This work introduces readers to key ideas and applications of computational algebraic geometry Beginning with the discovery of Gr obner 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 impact in recent years At the same time the mathematics used in computational algebraic geometry is unusual and accessible which makes the subject easy to learn and easy to apply This book begins with an introduction to Gr obner 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 this book assume no previous acquaintance with the material

**Polyhedral and Algebraic Methods in Computational Geometry** Michael Joswig, Thorsten Theobald, 2013-01-04 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 Gr bner 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 Applications of Algebraic Geometry to Coding Theory, Physics and Computation Ciro Ciliberto, Friedrich Hirzebruch, Rick Miranda, Mina Teicher, 2012-12-06 An up to date report on the current status of important research topics in algebraic geometry and its applications such as computational algebra and geometry singularity theory algorithms numerical solutions of polynomial systems coding theory communication networks and computer vision Contributions on more fundamental aspects of algebraic geometry include expositions related to counting points on varieties over finite fields Mori theory linear systems Abelian varieties vector bundles on singular curves degenerations of surfaces and mirror symmetry of Calabi Yau manifolds

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**Emerging Applications of Algebraic Geometry** Mihai Putinar, Seth Sullivant, 2008-11-01 Recent advances in both the theory and implementation of computational algebraic geometry have led to new striking applications to a variety of fields of research The articles in this volume highlight a range of these applications and provide introductory material for topics covered in the IMA workshops on Optimization and Control and Applications in Biology Dynamics and Statistics held during the IMA year on Applications of Algebraic Geometry The articles related to optimization and control focus on burgeoning use of semidefinite programming and moment matrix techniques in computational real algebraic geometry The new direction towards a systematic study of non commutative real algebraic geometry is well represented in the volume Other articles provide an overview of the way computational algebra is useful for analysis of contingency tables reconstruction of phylogenetic trees and in systems biology The contributions collected in this volume are accessible to non experts self contained and informative they quickly move towards cutting edge research in these areas and provide a wealth of open problems for future research **Computational Algebraic Geometry** Richard Lanier Williams, 1995 *Applications of Computational Algebraic Geometry* David A. Cox, Bernd Sturmfels, 2025

**Ideals, Varieties, and Algorithms** David Cox, John Little, DONAL OSHEA, 2013-03-09 Algebraic Geometry is the study of

systems of polynomial equations in one or more variables asking such questions as Does the system have finitely many solutions and if so how can one find them And if there are infinitely many solutions how can they be described and manipulated The solutions of a system of polynomial equations form a geometric object called a variety the corresponding algebraic object is an ideal There is a close relationship between ideals and varieties which reveals the intimate link between algebra and geometry Written at a level appropriate to undergraduates this book covers such topics as the Hilbert Basis Theorem the Nullstellensatz invariant theory projective geometry and dimension theory The algorithms to answer questions such as those posed above are an important part of algebraic geometry This book bases its discussion of algorithms on a generalization of the division algorithm for polynomials in one variable that was only discovered in the 1960 s Although the algorithmic roots of algebraic geometry are old the computational aspects were neglected earlier in this century This has changed in recent years and new algorithms coupled with the power of fast computers have led to some interesting applications for example in robotics and in geometric theorem proving In preparing a new edition of *Ideals Varieties and Algorithms* the authors present an improved proof of the Buchberger Criterion as well as a proof of Bezout's Theorem Appendix C contains a new section on Axiom and an update about Maple Mathematica and REDUCE

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chapters on polynomial and rational functions between varieties robotics and geometric theorem proving invariant theory of finite groups projective algebraic geometry dimension theory and progress made over the last decades in computing Gröbner bases The fifth edition builds on the fourth edition in two main ways First a number of typographical errors found by readers and by the authors since 2018 have been corrected Second new material on toric varieties monomial curves and other topics of current interest in algebraic geometry has been added This enhances the opportunities for active learning through new examples new exercises and new projects in Appendix D all supplemented by additional references The book also includes updated computer algebra material in Appendix C The book may be used for a first or second course in undergraduate abstract algebra and with some augmentation perhaps for beginning graduate courses in algebraic geometry or computational commutative algebra Prerequisites for the reader include linear algebra and a proof oriented course It is assumed that the reader has access to a computer algebra system Appendix C describes features of Maple Mathematica and SageMath as well as other systems that are most relevant to the text Pseudocode is used in the text Appendix B carefully describes the pseudocode used From the reviews of previous editions The book gives an introduction to Buchberger's algorithm with applications to syzygies Hilbert polynomials primary decompositions There is an introduction to classical algebraic geometry with applications to the ideal membership problem solving polynomial equations and elimination theory The book is well written The reviewer is sure that it will be an excellent guide to introduce further undergraduates in the algorithmic aspect of commutative algebra and algebraic geometry Peter Schenzel zbMATH 2007 I consider the book to be wonderful The exposition is very clear there are many helpful pictures and there are a great many instructive exercises some quite challenging offers the heart and soul of modern commutative and algebraic geometry The American Mathematical Monthly

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Software for Algebraic Geometry Michael E. Stillman, Nobuki Takayama, Jan Verschelde, 2008-11-01 Algorithms in algebraic geometry go hand in hand with software packages that implement them Together they have established the modern field of computational algebraic geometry which has come to play a major role in both theoretical advances and applications

Over the past fifteen years several excellent general purpose packages for computations in algebraic geometry have been developed such as CoCoA Singular and Macaulay 2 While these packages evolve continuously incorporating new mathematical advances they both motivate and demand the creation of new mathematics and smarter algorithms This volume reflects the workshop Software for Algebraic Geometry held in the week from 23 to 27 October 2006 as the second workshop in the thematic year on Applications of Algebraic Geometry at the IMA The papers in this volume describe the software packages Bertini PHClab Gfan DEMiCs SYNAPS TrIm Gambit ApaTools and the application of Risa Asir to a conjecture on multiple zeta values They offer the reader a broad view of current trends in computational algebraic geometry through software development and applications

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*Computational Methods in Commutative Algebra and Algebraic Geometry* Wolmer V. Vasconcelos, David Eisenbud, 1998 This ACM volume in computational algebra deals with methods and techniques to tackle problems that can be represented by data structures which are essentially matrices with polynomial entries mediated by the disciplines of commutative algebra and algebraic geometry It relates discoveries by a growing interdisciplinary group of researchers in the past decade It highlights the use of advanced techniques to bring down the cost of computation The book includes concrete algorithms written in MACAULAY It is intended for advanced students and researchers with interests both in algebra and computation Many parts of it can be read by anyone with a basic abstract algebra course

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chapter ten which presents some of the essentials of progress made over the last decades in computing Gröbner bases The book also includes current computer algebra material in Appendix C and updated independent projects Appendix D The book may serve as a first or second course in undergraduate abstract algebra and with some supplementation perhaps for beginning graduate level courses in algebraic geometry or computational algebra Prerequisites for the reader include linear algebra and a proof oriented course It is assumed that the reader has access to a computer algebra system Appendix C describes features of Maple™ Mathematica and Sage as well as other systems that are most relevant to the text Pseudocode is used in the text Appendix B carefully describes the pseudocode used From the reviews of previous editions The book gives an introduction to Buchberger's algorithm with applications to syzygies Hilbert polynomials primary decompositions There is an introduction to classical algebraic geometry with applications to the ideal membership problem solving polynomial equations and elimination theory The book is well written The reviewer is sure that it will be an excellent guide to introduce further undergraduates in the algorithmic aspect of commutative algebra and algebraic geometry Peter Schenzel zbMATH 2007 I consider the book to be wonderful The exposition is very clear there are many helpful pictures and there are a great many instructive exercises some quite challenging offers the heart and soul of modern commutative and algebraic geometry The American Mathematical Monthly

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**Computational Algebra: Course And Exercises With Solutions** Ihsen Yengui, 2021-05-17 This book intends to provide material for a graduate course on computational commutative algebra and algebraic geometry highlighting potential applications in cryptography Also the topics in this book could form the basis of a graduate course that acts as a segue between an introductory algebra course and the more technical topics of commutative algebra and algebraic geometry This book contains a total of 124 exercises with detailed solutions as well as an important number of examples that illustrate definitions theorems and methods This is very important for students or researchers who are not familiar with the topics discussed Experience has shown that beginners who want to take their first steps in algebraic geometry are usually discouraged by the difficulty of the proposed exercises and the absence of detailed

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white cheese similar to feta old cheese kaşar peyniri black and or green olives zeytin butter thick cream kaymak honey jam an omelet or boiled eggs yumurta are regular players of the game the surprise ingredients are sucuklu yumurta and börek these two are the most common dishes served to spoil the guests

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