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Gröbner Bases
and Convex Polytopes

Bernd Sturmfels

Grobner Bases And Convex Polytopes

Christodoulos A. Floudas,Panos M. Pardalos

Grobner Bases And Convex Polytopes:

Grobner Bases and Convex Polytopes Bernd Sturmfels,1996 This book is about the interplay of computational commutative algebra and the theory of convex polytopes It centres around a special class of ideals in a polynomial ring the class of toric ideals They are characterized as those prime ideals that are generated by monomial differences or as the defining ideals of toric varieties not necessarily normal The interdisciplinary nature of the study of Gr bner bases is reflected by the specific applications appearing in this book These applications lie in the domains of integer programming and computational statistics The mathematical tools presented in the volume are drawn from commutative algebra combinatorics and polyhedral geometry   **Gröbner Bases and Convex Polytopes** Bernd Sturmfels,1996 This work is about the interplay of computational commutative algebra and the theory of convex polytopes It centres around a special class of ideals in a polynomial ring the class of toric ideals They are characterized as those prime ideals that are generated by monomial differences or as the defining ideals of toric varieties not necessarily normal The interdisciplinary nature of the study of Grobner bases is reflected by the specific applications appearing in this book These applications lie in the domains of integer programming and computational statistics The mathematical tools presented in the volume are drawn from commutative algebra combinatorics and polyhedral geometry   *Gröbner Bases* Takayuki Hibi,2014-01-07 The idea of the Gr bner basis first appeared in a 1927 paper by F S Macaulay who succeeded in creating a combinatorial characterization of the Hilbert functions of homogeneous ideals of the polynomial ring Later the modern definition of the Gr bner basis was independently introduced by Heisuke Hironaka in 1964 and Bruno Buchberger in 1965 However after the discovery of the notion of the Gr bner basis by Hironaka and Buchberger it was not actively pursued for 20 years A breakthrough was made in the mid 1980s by David Bayer and Michael Stillman who created the Macaulay computer algebra system with the help of the Gr bner basis Since then rapid development on the Gr bner basis has been achieved by many researchers including Bernd Sturmfels This book serves as a standard bible of the Gr bner basis for which the harmony of theory application and computation are indispensable It provides all the fundamentals for graduate students to learn the ABC s of the Gr bner basis requiring no special knowledge to understand those basic points Starting from the introductory performance of the Gr bner basis Chapter 1 a trip around mathematical software follows Chapter 2 Then comes a deep discussion of how to compute the Gr bner basis Chapter 3 These three chapters may be regarded as the first act of a mathematical play The second act opens with topics on algebraic statistics Chapter 4 a fascinating research area where the Gr bner basis of a toric ideal is a fundamental tool of the Markov chain Monte Carlo method Moreover the Gr bner basis of a toric ideal has had a great influence on the study of convex polytopes Chapter 5 In addition the Gr bner basis of the ring of differential operators gives effective algorithms on holonomic functions Chapter 6 The third act Chapter 7 is a collection of concrete examples and problems for Chapters 4 5 and 6 emphasizing computation by using various software systems   *Applications of Computational Algebraic Geometry*

David A. Cox,Dinesh N. Manocha,1998 This book introduces readers to key ideas and applications of computational algebraic geometry Beginning with the discovery of Gr bner 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 Gr bner 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 **Polytopes and Graphs** Guillermo Pineda Villavicencio,2024-03-21 An introduction to convex polytopes and their graphs including both background material and cutting edge research

Software for Algebraic Geometry Michael E. Stillman,Nobuki Takayama,Jan Verschelde,2008-05-29 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 Gröbner Bases and Applications Bruno Buchberger,Franz Winkler,1998-02-26 Comprehensive account of theory and applications of Gr bner bases co edited by the subject s inventor Grobner Bases in Commutative Algebra Viviana Ene,J rgen Herzog,2011-12-01 This book provides a concise yet comprehensive and self contained introduction to Grobner basis theory and its applications to various current research topics in commutative algebra It especially aims to help young researchers become acquainted with fundamental tools and techniques related to Grobner bases which are used in commutative algebra and to arouse their interest in exploring further topics such as toric rings Koszul and Rees algebras determinantal ideal theory binomial edge ideals and their applications to statistics The book can be used for graduate courses and self study More than 100 problems will help the readers to better understand the main theoretical results and will inspire them to further investigate the topics studied in this book **Computer Algebra in Scientific Computing** Viktor G. Ganzha,Ernst W. Mayr,Evgenii V. Vorozhtsov,2012-12-06 Proceedings of the Third

Workshop on Computer Algebra in Scientific Computing Samarkand Octobe5r 5 9 2000 **Advances in Algebra** Jörg Feldvoss,Lauren Grimley,Drew Lewis,Andrei Pavelescu,Cornelius Pillen,2019-02-27 This proceedings volume covers a range of research topics in algebra from the Southern Regional Algebra Conference SRAC that took place in March 2017 Presenting theory as well as computational methods featured survey articles and research papers focus on ongoing research in algebraic geometry ring theory group theory and associative algebras Topics include algebraic groups combinatorial commutative algebra computational methods for representations of groups and algebras group theory Hopf Galois theory hypergroups Lie superalgebras matrix analysis spherical and algebraic spaces and tropical algebraic geometry Since 1988 SRAC has been an important event for the algebra research community in the Gulf Coast Region and surrounding states building a strong network of algebraists that fosters collaboration in research and education This volume is suitable for graduate students and researchers interested in recent findings in computational and theoretical methods in algebra and representation theory *Partitions, Hypergeometric Systems, and Dirichlet Processes in Statistics* Shuhei Mano,2018-07-12 This book focuses on statistical inferences related to various combinatorial stochastic processes Specifically it discusses the intersection of three subjects that are generally studied independently of each other partitions hypergeometric systems and Dirichlet processes The Gibbs partition is a family of measures on integer partition and several prior processes such as the Dirichlet process naturally appear in connection with infinite exchangeable Gibbs partitions Examples include the distribution on a contingency table with fixed marginal sums and the conditional distribution of Gibbs partition given the length The A hypergeometric distribution is a class of discrete exponential families and appears as the conditional distribution of a multinomial sample from log affine models The normalizing constant is the A hypergeometric polynomial which is a solution of a system of linear differential equations of multiple variables determined by a matrix A called A hypergeometric system The book presents inference methods based on the algebraic nature of the A hypergeometric system and introduces the holonomic gradient methods which numerically solve holonomic systems without combinatorial enumeration to compute the normalizing constant Furher it discusses Markov chain Monte Carlo and direct samplers from A hypergeometric distribution as well as the maximum likelihood estimation of the A hypergeometric distribution of two row matrix using properties of polytopes and information geometry The topics discussed are simple problems but the interdisciplinary approach of this book appeals to a wide audience with an interest in statistical inference on combinatorial stochastic processes including statisticians who are developing statistical theories and methodologies mathematicians wanting to discover applications of their theoretical results and researchers working in various fields of data sciences **Handbook of Discrete and Computational Geometry** Csaba D. Toth,Joseph O'Rourke,Jacob E. Goodman,2017-11-22 The Handbook of Discrete and Computational Geometry is intended as a reference book fully accessible to nonspecialists as well as specialists covering all major aspects of both fields The book offers the most important results and methods in

discrete and computational geometry to those who use them in their work both in the academic world as researchers in mathematics and computer science and in the professional world as practitioners in fields as diverse as operations research molecular biology and robotics Discrete geometry has contributed significantly to the growth of discrete mathematics in recent years This has been fueled partly by the advent of powerful computers and by the recent explosion of activity in the relatively young field of computational geometry This synthesis between discrete and computational geometry lies at the heart of this Handbook A growing list of application fields includes combinatorial optimization computer aided design computer graphics crystallography data analysis error correcting codes geographic information systems motion planning operations research pattern recognition robotics solid modeling and tomography **Solving Polynomial Equation Systems II** Teo Mora,2003 The second volume of this comprehensive treatise focusses on Buchberger theory and its application to the algorithmic view of commutative algebra In distinction to other works the presentation here is based on the intrinsic linear algebra structure of Groebner bases and thus elementary considerations lead easily to the state of the art in issues of implementation Aiming to be a complete survey on Groebner bases and their applications the book will be essential for all workers in commutative algebra computational algebra and algebraic geometry **Computational Commutative Algebra 2** Martin Kreuzer,Lorenzo Robbiano,2005-11-04 Hofstadter s Law It always takes longer than you think it will take even if you take into account Hofstadter s Law Douglas R Hofstadter Dear Reader why did we begin the foreword of this second volume with the same quote as the rst There we wrote that it took three years of intense work just to ll three centimeters of your bookshelf The completion of this volume took four years and it is about four centimeters thick Thus we have a con rmed invariant which governs our writing our velocity is one centimeter per year after all e ects due to Hofstadter s Law have been taken into account When westartedthisprojectinthelastmillennium weplannedabookforlearning teaching reading and most of all enjoying the topic at hand Surely there is no law which says that a mathematical book has to be dull boring dry or tedious But how do you make it enjoyable Our approach has been to ll it with amusing quotes varied jokes funny word games owery metaphors and occasional literarye orts There are two possible drawbacks of this method Firstly not everyone has the same sense of humour and not every metaphor works as intended For instance it is easy to joke about certain politicians but what happens if they read this book And when we wrote of a small boat sailing slowly into the Brazilian sunset it was pointed out to us that this entails a geographical problem Secondly it is very di cult to write humorously in a foreign language

Polytopes, Rings, and K-Theory Winfried Bruns,Joseph Gubeladze,2009-06-12 This book examines interactions of polyhedral discrete geometry and algebra What makes this book unique is the presentation of several central results in all three areas of the exposition from discrete geometry to commutative algebra and K theory *Convexity from the Geometric Point of View* Vitor Balestro,Horst Martini,Ralph Teixeira,2024-07-14 This text gives a comprehensive introduction to the common core of convex geometry Basic concepts and tools which are present in all branches of that field are presented with

a highly didactic approach Mainly directed to graduate and advanced undergraduates the book is self contained in such a way that it can be read by anyone who has standard undergraduate knowledge of analysis and of linear algebra Additionally it can be used as a single reference for a complete introduction to convex geometry and the content coverage is sufficiently broad that the reader may gain a glimpse of the entire breadth of the field and various subfields The book is suitable as a primary text for courses in convex geometry and also in discrete geometry including polytopes It is also appropriate for survey type courses in Banach space theory convex analysis differential geometry and applications of measure theory Solutions to all exercises are available to instructors who adopt the text for coursework Most chapters use the same structure with the first part presenting theory and the next containing a healthy range of exercises Some of the exercises may even be considered as short introductions to ideas which are not covered in the theory portion Each chapter has a notes section offering a rich narrative to accompany the theory illuminating the development of ideas and providing overviews to the literature concerning the covered topics In most cases these notes bring the reader to the research front The text includes many figures that illustrate concepts and some parts of the proofs enabling the reader to have a better understanding of the geometric meaning of the ideas An appendix containing basic and geometric measure theory collects useful information for convex geometers **Encyclopedia of Optimization** Christodoulos A. Floudas,Panos M. Pardalos,2008-09-04 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 **Mathematical Software – ICMS 2018** James H. Davenport,Manuel Kauers,George Labahn,Josef Urban,2018-07-17 This book constitutes the proceedings of the 6th International Conference on Mathematical Software ICMS 2018 held in South Bend IN USA in July 2018 The 59 papers included in this volume were carefully reviewed and selected from numerous submissions The program of the 2018 meeting consisted of 20 topical sessions each of which providing an overview of the challenges achievements and progress in a subeld of mathematical software research development and use **Discrete and Computational Geometry** Jin Akiyama,Mikio Kano,Masatsugu Urabe,2001-06-20 TheJapanConferenceonDiscreteandComputationalGeometry JCDCG has beenheldannuallysince1997 Oneofthegoalsofthisconferenceseriesistobring togetherJapaneseresearchersfrombothacademiaandindustrywithresearchers inthese eldsfromabroadtosharetheirrecentresults JCDCG2000washeld22 25November2000atTokaiUniversityinTokyo inconjunctionwiththecelebrationofWorldMathematicsYear2000 Atotalof 120participantsfrom20countriesattended Thisvolumeconsistsofthepapers presentedatJCDCG2000 whichhavebeenrefereedandrevised Somepapers

whichappearinshortforminthisvolumealsoappearinfullerexpandedversions injournalsdedicatedtocomputationalgeometry Theorganizersoftheconferencethanktheprincipalspeakersfortheir terestandsupport ImreBarany ErikD Demaine GregN Fredrickson Gyula Karolyi NaokiKatoh DavidKirkpatrick JosephO Rourke JanosPach Jozsef Solymosi WilliamSteiger JorgeUrrutia andAllanWilks   *Binomial Ideals* Jürgen Herzog,Takayuki Hibi,Hidefumi Ohsugi,2018-09-28 This textbook provides an introduction to the combinatorial and statistical aspects of commutative algebra with an emphasis on binomial ideals In addition to thorough coverage of the basic concepts and theory it explores current trends results and applications of binomial ideals to other areas of mathematics The book begins with a brief self contained overview of the modern theory of Gr bner bases and the necessary algebraic and homological concepts from commutative algebra Binomials and binomial ideals are then considered in detail along with a short introduction to convex polytopes Chapters in the remainder of the text can be read independently and explore specific aspects of the theory of binomial ideals including edge rings and edge polytopes join meet ideals of finite lattices binomial edge ideals ideals generated by 2 minors and binomial ideals arising from statistics Each chapter concludes with a set of exercises and a list of related topics and results that will complement and offer a better understanding of the material presented Binomial Ideals is suitable for graduate students in courses on commutative algebra algebraic combinatorics and statistics Additionally researchers interested in any of these areas but familiar with only the basic facts of commutative algebra will find it to be a valuable resource

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