F. Winkler

Polynomial Algorithms in Computer Algebra

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V. Bykov,A. Kytmanov,M. Lazman,Mikael Passare

Polynomial Algorithms In Computer Algebra:

Polynomial Algorithms in Computer Algebra Franz Winkler,1996-08-02 For several years now I have been teaching courses in computer algebra at the Universitat Linz the University of Delaware and the Universidad de Alcala de Henares In the summers of 1990 and 1992 I have organized and taught summer schools in computer algebra at the Universitat Linz Gradually a set of course notes has emerged from these activities People have asked me for copies of the course notes and different versions of them have been circulating for a few years Finally I decided that I should really take the time to write the material up in a coherent way and make a book out of it Here now is the result of this work Over the years many students have been helpful in improving the quality of the notes and also several colleagues at Linz and elsewhere have contributed to it I want to thank them all for their effort in particular I want to thank B Buchberger who taught me the theory of Grabner bases nearly two decades ago B F Caviness and B D Saunders who first stimulated my interest in various problems in computer algebra G E Collins who showed me how to compute in algebraic domains and J R Sendra with whom I started to apply computer algebra methods to problems in algebraic geometry Several colleagues have suggested improvements in earlier versions of this book However I want to make it clear that I am responsible for all remaining mistakes **Algorithms for Computer Algebra** Keith O. Geddes,Stephen R. Czapor,George Labahn,2007-06-30 Algorithms for Computer Algebra is the first comprehensive textbook to be published on the topic of computational symbolic mathematics The book first develops the foundational material from modern algebra that is required for subsequent topics It then presents a thorough development of modern computational algorithms for such problems as multivariate polynomial arithmetic and greatest common divisor calculations factorization of multivariate polynomials symbolic solution of linear and polynomial systems of equations and analytic integration of elementary functions Numerous examples are integrated into the text as an aid to understanding the mathematical development The algorithms developed for each topic are presented in a Pascal like computer language An extensive set of exercises is presented at the end of each chapter Algorithms for Computer Algebra is suitable for use as a textbook for a course on algebraic algorithms at the third year fourth year or graduate level Although the mathematical development uses concepts from modern algebra the book is self contained in the sense that a one term undergraduate course introducing students to rings and fields is the only prerequisite assumed The book also serves well as a supplementary textbook for a traditional modern algebra course by presenting concrete applications to motivate the understanding of the theory of rings and fields *Polynomial Algorithms in Computer Algebra* Franz Winkler,2012-12-06 For several years now I have been teaching courses in computer algebra at the Universitat Linz the University of Delaware and the Universidad de Alcala de Henares In the summers of 1990 and 1992 I have organized and taught summer schools in computer algebra at the Universitat Linz Gradually a set of course notes has emerged from these activities People have asked me for copies of the course notes and different versions of them have been circulating for a few years Finally I decided that I

should really take the time to write the material up in a coherent way and make a book out of it Here now is the result of this work Over the years many students have been helpful in improving the quality of the notes and also several colleagues at Linz and elsewhere have contributed to it I want to thank them all for their effort in particular I want to thank B Buchberger who taught me the theory of Grabner bases nearly two decades ago B F Caviness and B D Saunders who first stimulated my interest in various problems in computer algebra G E Collins who showed me how to compute in algebraic domains and J R Sendra with whom I started to apply computer algebra methods to problems in algebraic geometry Several colleagues have suggested improvements in earlier versions of this book However I want to make it clear that I am responsible for all remaining mistakes **Computer Algebra and Polynomials** Jaime Gutierrez,Josef Schicho,Martin Weimann,2015-01-20 Algebra and number theory have always been counted among the most beautiful mathematical areas with deep proofs and elegant results However for a long time they were not considered that important in view of the lack of real life applications This has dramatically changed nowadays we find applications of algebra and number theory frequently in our daily life This book focuses on the theory and algorithms for polynomials over various coefficient domains such as a finite field or ring The operations on polynomials in the focus are factorization composition and decomposition basis computation for modules etc Algorithms for such operations on polynomials have always been a central interest in computer algebra as it combines formal the variables and algebraic or numeric the coefficients aspects The papers presented were selected from the Workshop on Computer Algebra and Polynomials which was held in Linz at the Johann Radon Institute for Computational and Applied Mathematics RICAM during November 25 29 2013 at the occasion of the Special Semester on Applications of Algebra and Number Theory *Computing in Algebraic Geometry* Wolfram Decker,Christoph Lossen,2006-05-01 This book provides a quick access to computational tools for algebraic geometry the mathematical discipline which handles solution sets of polynomial equations Originating from a number of intense one week schools taught by the authors the text is designed so as to provide a step by step introduction which enables the reader to get started with his own computational experiments right away The authors present the basic concepts and ideas in a compact way **Some Tapas of Computer Algebra** Arjeh M. Cohen,Hans Cuypers,Hans Sterk,2013-03-09 In the years 1994 1995 two EIDMA mini courses on Computer Algebra were given at the Eindhoven University of Technology by apart from ourselves various invited lecturers EIDMA is the Research School Euler Institute for Discrete Mathematics and its Applications The idea of the courses was to acquaint young mathematicians with algorithms and software for mathemat ical research and to enable them to incorporate algorithms in their research A collection of lecture notes was used at these courses When discussing these courses in comparison with other kinds of courses one might give in a week s time Joachim Neub ser referred to our courses as tapas This denomination underlined that the courses consisted of appe tizers for various parts of algorithmic algebra indeed we covered such spicy topics as the link between Gr bner bases and integer programming and the detection of algebraic solutions to differential

equations As a collection the not es turned out to have some appeal of their own which is the main reason why the idea came up of transforming them into book form We feIt however that the book should be distinguishable from a standard text book on computer algebra in that it retains its appetizing flavour by presenting a variety of topics at an accessible level with a view to recent developments Effective Polynomial Computation Richard Zippel,2012-12-06 Effective Polynomial Computation is an introduction to the algorithms of computer algebra It discusses the basic algorithms for manipulating polynomials including factoring polynomials These algorithms are discussed from both a theoretical and practical perspective Those cases where theoretically optimal algorithms are inappropriate are discussed and the practical alternatives are explained Effective Polynomial Computation provides much of the mathematical motivation of the algorithms discussed to help the reader appreciate the mathematical mechanisms underlying the algorithms and so that the algorithms will not appear to be constructed out of whole cloth Preparatory to the discussion of algorithms for polynomials the first third of this book discusses related issues in elementary number theory These results are either used in later algorithms e g the discussion of lattices and Diophantine approximation or analogs of the number theoretic algorithms are used for polynomial problems e g Euclidean algorithm and p adic numbers Among the unique features of Effective Polynomial Computation is the detailed material on greatest common divisor and factoring algorithms for sparse multivariate polynomials In addition both deterministic and probabilistic algorithms for irreducibility testing of polynomials are discussed *Ideals, Varieties, and Algorithms* David A. Cox,John Little,Donal O'Shea,2025-08-23 This text covers topics in algebraic geometry and commutative algebra with careful attention to their practical and computational aspects The first four chapters form the core of the book A comprehensive chart in the Preface illustrates a variety of ways to proceed with the material once these chapters are covered In addition to the fundamentals of algebraic geometry the elimination theorem the extension theorem the closure theorem and the Nullstellensatz there are 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 Gr bner 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 *Solving Polynomial Equations* Alicia Dickenstein,2005-04-27 This book provides a general introduction to modern mathematical aspects in computing with multivariate polynomials and in solving algebraic systems It presents the state of the art in several symbolic numeric and symbolic numeric techniques including effective and algorithmic methods in algebraic geometry and computational algebra complexity issues and applications ranging from statistics and geometric modelling to robotics and vision Graduate students as well as researchers in related areas will find an excellent introduction to currently interesting topics These cover Groebner and border bases multivariate resultants residues primary decomposition multivariate polynomial factorization homotopy continuation complexity issues and their applications **Elimination Methods in Polynomial Computer Algebra** Valeriĭ Ivanovich Bykov,A. M. Kytmanov,Mark Zakharovich Lazman,Mikael Passare,1998 This book presents a modified method based on multidimensionalresidue theory for the elimination of unknowns from a system ofnonlinear algebraic equations An algorithm is given for constructingthe resultant of the system and a computer implementation making useof formula manipulation software is carried out Programmes in MAPLEare available The algorithms and programmes are then applied toquestions from the theory of chemical kinetics such as the search forall stationary solutions of kinetic equations and the construction ofkinetic polynomials The subject of this book is closely connectedwith a wide range of current problems in the analysis of nonlinearsystems Audience This volume will be of interest to graduate studentsand researchers whose work involves multidimensional theory ofresidues mathematical kinetics computer algebra and symboliccomputation **Computer Algebra and Symbolic Computation** Joel S. Cohen,2002-07-19 This book provides a systematic approach for the algorithmic formulation and implementation of mathematical operations in computer algebra programming languages The viewpoint is that mathematical expressions represented by expression trees are the data objects of computer algebra programs and by using a few primitive operations that analyze and **Mathematics for Computer Algebra** Maurice Mignotte,2012-12-06 This book corresponds to a mathematical course given in 1986 87 at the University Louis Pasteur Strasbourg This work is primarily intended for graduate students The following are necessary prerequisites a few standard definitions in set theory the definition of rational integers some elementary facts in Combinatorics maybe only Newton s

binomial formula some theorems of Analysis at the level of high schools and some elementary Algebra basic results about groups rings fields and linear algebra An important place is given to exercises These exercises are only rarely direct applications of the course More often they constitute complements to the text Mostly hints or references are given so that the reader should be able to find solutions Chapters one and two deal with elementary results of Number Theory for example the euclidean algorithm the Chinese remainder theorem and Fermat s little theorem These results are useful by themselves but they also constitute a concrete introduction to some notions in abstract algebra for example euclidean rings principal rings Algorithms are given for arithmetical operations with long integers The rest of the book chapters 3 through 7 deals with polynomials We give general results on polynomials over arbitrary rings Then polynomials with complex coefficients are studied in chapter 4 including many estimates on the complex roots of polynomials Some of these estimates are very useful in the subsequent chapters 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 let 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 *Computer Algebra* R. Albrecht,B. Buchberger,G.E. Collins,R. Loos,2012-12-06 this gap In sixteen survey articles the most important theoretical results algorithms and software methods of computer algebra are covered together with systematic references to literature In addition some new results are presented Thus the volume should be a valuable source for obtaining a first impression of computer algebra as well as for preparing a computer algebra course or for complementary reading The preparation of some papers contained in this volume has been supported by grants from the Austrian Fonds zur Forderung der wissenschaftlichen For schung Project No 3877 the Austrian Ministry of Science and Research Department 12 Dr S Hollinger the United States National Science Foundation Grant MCS 8009357 and the Deutsche Forschungsgemeinschaft Lo

23 1 2 The work on the volume was greatly facilitated by the opportunity for the editors to stay as visitors at the Department of Computer and Information Sciences University of Delaware at the General Electric Company Research and Development Center Schenectady N Y and at the Mathematical Sciences Department Rensselaer Polytechnic Institute Troy N Y respectively Our thanks go to all these institutions The patient and experienced guidance and collaboration of the Springer Verlag Wien during all the stages of production are warmly appreciated The editors of the Cooperative editor of Supplementum Computing B Buchberger R Albrecht G Collins R Loos Contents Loos R Introduction 1 Buchberger B Loos R Algebraic Simplification 11 Neubiiser J Computing with Groups and Their Character Tables 45 Norman A C Integration in Finite Terms **Computer Algebra and Symbolic Computation** Joel S. Cohen,2003-01-03 Mathematica Maple and similar software packages provide programs that carry out sophisticated mathematical operations Applying the ideas introduced in Computer Algebra and Symbolic Computation Elementary Algorithms this book explores the application of algorithms to such methods as automatic simplification polynomial decomposition and polyno Computer Algebra and Geometric Algebra with Applications Hongbo Li,Peter J. Olver,Gerald Sommer,2005-06-20 MathematicsMechanization consistsoftheory softwareandapplicationofc puterized mathematical activities such as computing reasoning and discovering ItsuniquefeaturecanbesuccinctlydescribedasAAA Algebraization Algori mization Application The name Mathematics Mechanization has its origin in the work of Hao Wang 1960s one of the pioneers in using computers to do research in mathematics particularly in automated theorem proving Since the 1970s this research direction has been actively pursued and extensively dev oped by Prof Wen tsun Wu and his followers It di ers from the closely related disciplines like Computer Mathematics Symbolic Computation and Automated Reasoning in that its goal is to make algorithmic studies and applications of mathematics the major trend of mathematics development in the information age The International Workshop on Mathematics Mechanization IWMM was initiated by Prof Wu in 1992 and has ever since been held by the Key L oratory of Mathematics Mechanization KLMM of the Chinese Academy of Sciences There have been seven workshops of the series up to now At each workshop several experts are invited to deliver plenary lectures on cutting edge methods and algorithms of the selected theme The workshop is also a forum for people working on related subjects to meet collaborate and exchange ideas

Elimination Methods in Polynomial Computer Algebra V. Bykov,A. Kytmanov,M. Lazman,Mikael Passare,2012-12-06 The subject of this book is connected with a new direction in mathematics which has been actively developed over the last few years namely the field of polynomial computer algebra which lies at the intersection point of algebra mathematical analysis and programming There were several incentives to write the book First of all there has lately been a considerable interest in applied nonlinear problems characterized by multiple sta tionary states Practical needs have then in their turn led to the appearance of new theoretical results in the analysis of systems of nonlinear algebraic equations And finally the introduction of various computer packages for analytic manipulations has made it possible to use complicated elimination

theoretical algorithms in prac tical research The structure of the book is accordingly represented by three main parts Mathematical results driven to constructive algorithms computer algebra realizations of these algorithms and applications Nonlinear systems of algebraic equations arise in diverse fields of science In particular for processes described by systems of differential equations with a poly nomial right hand side one is faced with the problem of determining the number and location of the stationary states in certain sets Algorithmic Algebra Bhubaneswar Mishra,2012-12-06 Algorithmic Algebra studies some of the main algorithmic tools of computer algebra covering such topics as Gr bner bases characteristic sets resultants and semialgebraic sets The main purpose of the book is to acquaint advanced undergraduate and graduate students in computer science engineering and mathematics with the algorithmic ideas in computer algebra so that they could do research in computational algebra or understand the algorithms underlying many popular symbolic computational systems Mathematica Maple or Axiom for instance Also researchers in robotics solid modeling computational geometry and automated theorem proving community may find it useful as symbolic algebraic techniques have begun to play an important role in these areas The book while being self contained is written at an advanced level and deals with the subject at an appropriate depth The book is accessible to computer science students with no previous algebraic training Some mathematical readers on the other hand may find it interesting to see how algorithmic constructions have been used to provide fresh proofs for some classical theorems The book also contains a large number of exercises with solutions to selected exercises thus making it ideal as a textbook or for self study *Algorithms and Techniques in Computer Algebra* Pasquale De Marco,2025-07-15 Algorithms and Techniques in Computer Algebra provides a comprehensive introduction to this rapidly developing field covering the basic concepts core algorithms and practical applications of computer algebra Suitable for both undergraduate and graduate students in computer science mathematics and engineering this book is an essential resource for anyone looking to master the essential concepts and techniques of computer algebra With in depth explanations illustrative examples and comprehensive exercises this book covers a wide range of topics from the basic concepts of field theory and ring theory to advanced topics such as Gr bner bases and analytic integration It also includes a chapter dedicated to recent developments and open problems in computer algebra keeping readers abreast of the latest advancements in the field One of the key strengths of Algorithms and Techniques in Computer Algebra is its focus on practical applications It demonstrates how computer algebra can be used to solve real world problems in various fields including cryptography coding theory robotics computer graphics and artificial intelligence This makes the book not only a valuable resource for students but also a practical guide for professionals seeking to apply computer algebra to their work Whether you are a seasoned professional looking to expand your knowledge or a beginner seeking to understand the fundamentals of computer algebra Algorithms and Techniques in Computer Algebra is the perfect resource for you With its clear and concise explanations illustrative examples and comprehensive exercises this book will help you master the essential

concepts and techniques of this exciting field If you like this book write a review **Elimination Methods in Polynomial Computer Algebra** V. Bykov,Alexander M. Kytmanov,M. Lazman,Mikael Passare,2012-10-13 The subject of this book is connected with a new direction in mathematics which has been actively developed over the last few years namely the field of polynomial computer algebra which lies at the intersection point of algebra mathematical analysis and programming There were several incentives to write the book First of all there has lately been a considerable interest in applied nonlinear problems characterized by multiple sta tionary states Practical needs have then in their turn led to the appearance of new theoretical results in the analysis of systems of nonlinear algebraic equations And finally the introduction of various computer packages for analytic manipulations has made it possible to use complicated elimination theoretical algorithms in prac tical research The structure of the book is accordingly represented by three main parts Mathematical results driven to constructive algorithms computer algebra realizations of these algorithms and applications Nonlinear systems of algebraic equations arise in diverse fields of science In particular for processes described by systems of differential equations with a poly nomial right hand side one is faced with the problem of determining the number and location of the stationary states in certain sets

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Table of Contents Polynomial Algorithms In Computer Algebra

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