Linear Algebra in Computer Science

Unlocking the Power of Algorithms

[Algorithms For Computer Algebra](#)

Franz Winkler

Algorithms For Computer Algebra:

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 **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 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 *Algorithms for Computer Algebra* K. O. Geddes,1992 **Some Tapas of Computer Algebra** Arjeh

M. Cohen,Hans Cuypers,Hans Sterk,1998-12-15 This book presents the basic concepts and algorithms of computer algebra using practical examples that illustrate their actual use in symbolic computation A wide range of topics are presented including Groebner bases real algebraic geometry lie algebras factorization of polynomials integer programming permutation groups differential equations coding theory automatic theorem proving and polyhedral geometry This book is a must read for anyone working in the area of computer algebra symbolic computation and computer science **Computer Algebra** James Harold Davenport,Y. Siret,E. Tournier,1993 This book still remains the best introduction to computer algebra catering to both the interested beginner and the experienced pure mathematician and computer scientist This updated Second Edition provides a comprehensive review and contains excellent references to fundamental papers and worked examples In addition to being a general text on the subject the book includes an appendix describing the use of one particular algebra system REDUCE *Computer Algebra Handbook* Johannes Grabmeier,2003 This Handbook gives a comprehensive snapshot of a field at the intersection of mathematics and computer science with applications in physics engineering and education Reviews 67 software systems and offers 100 pages on applications in physics mathematics computer science engineering chemistry and education *Computer Algebra* R. Albrecht,B. Buchberger,G.E. Collins,R. Loos,2013-06-29 The journal Computing has established a series of supplement volumes the fourth of which appears this year Its purpose is to provide a coherent presentation of a new topic in a single volume The previous subjects were Computer Arithmetic 1977 Fundamentals of Numerical Computation 1980 and Parallel Processes and Related Automata 1981 the topic of this 1982 Supplementum to Computing is Computer Algebra This subject which emerged in the early nineteen sixties has also been referred to as symbolic and algebraic computation or formula manipulation Algebraic algorithms have been receiving increasing interest as a result of the recognition of the central role of algorithms in computer science They can be easily specified in a formal and rigorous way and provide solutions to problems known and studied for a long time Whereas traditional algebra is concerned with constructive methods computer algebra is furthermore interested in efficiency in implementation and in hardware and software aspects of the algorithms It develops that in deciding effectiveness and determining efficiency of algebraic methods many other tools recursion theory logic analysis and combinatorics for example are necessary In the beginning of the use of computers for symbolic algebra it soon became apparent that the straightforward textbook methods were often very inefficient Instead of turning to numerical approximation methods computer algebra studies systematically the sources of the inefficiency and searches for alternative algebraic methods to improve or even replace the algorithms **The Computer Algebra System OSCAR** Wolfram Decker,Christian Eder,Claus Fieker,Max Horn,Michael Joswig,2025-01-30 This book presents version 1 0 of the new Computer Algebra System OSCAR Written in Julia OSCAR builds on and vastly extends four cornerstone systems ANTIC for number theory GAP for group and representation theory polymake for polyhedral and tropical geometry and Singular for commutative algebra and algebraic geometry It offers powerful computational tools that

transcend the boundaries of the individual disciplines involved It is freely available open source software The book is an invitation to use OSCAR With discussions of theoretical and algorithmic aspects included it offers a multitude of explicit code snippets These are valuable for interested researchers from graduate students through established experts **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 **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 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 **Computer Algebra** Wolfram Koepf,2021 This textbook offers an algorithmic introduction to the field of computer algebra A leading expert in the field the author guides readers through numerous hands on tutorials designed to build practical skills and algorithmic thinking This implementation oriented approach equips readers with versatile tools that can be used to enhance studies in mathematical theory applications or teaching Presented using Mathematica code the book is fully supported by downloadable sessions in Mathematica Maple and Maxima Opening with an introduction to computer algebra systems and the basics of programming mathematical algorithms the book goes on to explore integer arithmetic A chapter on modular arithmetic completes the number theoretic foundations which are then applied to coding theory and cryptography From here the focus shifts to polynomial arithmetic and algebraic numbers with modern algorithms allowing the efficient factorization of polynomials The final chapters offer extensions into more advanced topics simplification and

normal forms power series summation formulas and integration Computer Algebra is an indispensable resource for mathematics and computer science students new to the field Numerous examples illustrate algorithms and their implementation throughout with online support materials to encourage hands on exploration Prerequisites are minimal with only a knowledge of calculus and linear algebra assumed In addition to classroom use the elementary approach and detailed index make this book an ideal reference for algorithms in computer algebra   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   Computer Algebra Edmund A. Lamagna,2019-01-15 The goal of Computer Algebra Concepts and Techniques is to demystify computer algebra systems for a wide audience including students faculty and professionals in scientific fields such as computer science mathematics engineering and physics Unlike previous books the only prerequisites are knowledge of first year calculus and a little programming experience a background that can be assumed of the intended audience The book is written in a lean and lively style with numerous examples to illustrate the issues and techniques discussed It presents the principal algorithms and data structures while also discussing the inherent and practical limitations of these systems   **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 **Fundamental Problems of Algorithmic Algebra** *Fundamental Problems of Algorithmic Algebra* Chee-Keng Yap,2000 Popular computer algebra systems such as Maple Macsyma Mathematica and REDUCE are now basic tools on most computers Efficient algorithms for various algebraic operations underlie all these systems Computer algebra or algorithmic algebra studies these algorithms and their properties and represents a rich intersection of theoretical computer science with classical mathematics Fundamental Problems of Algorithmic Algebra provides a systematic and focused treatment of a collection of core problemsthe computational equivalents of the classical Fundamental Problem of Algebra and its derivatives Topics covered include the GCD subresultants modular techniques the fundamental theorem of algebra roots of polynomials Sturm theory Gaussian lattice reduction lattices and polynomial factorization linear systems elimination theory Grobner bases and more Features Presents algorithmic ideas in pseudo code based on mathematical concepts and can be used with any computer mathematics system Emphasizes the algorithmic aspects of problems without sacrificing mathematical rigor Aims to be self contained in its mathematical development Ideal for a first course in algorithmic or computer algebra for advanced undergraduates or beginning graduate students **Computer Algebra Methods for Equivariant Dynamical Systems** Karin Gatermann,2007-05-06 This book starts with an overview of the research of Gr bner bases which have many applications in various areas of mathematics since they are a general tool for the investigation of polynomial systems The next chapter describes algorithms in invariant theory including many examples and time tables These techniques are applied in the chapters on symmetric bifurcation theory and equivariant dynamics This combination of different areas of mathematics will be interesting to researchers in computational algebra and or dynamics **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 *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

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