

TOPICS IN COMPUTATIONAL ALGEBRA

by

G.M. Piacentini Cattaneo

and

E. Strickland

Department of Mathematics,
University of Bath, Bath, England, UK

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Topics In Computational Algebra

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Topics in Computational Algebra Giulia Maria Piacentini Cattaneo, Elisabetta Strickland, 1991-01-31

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 answers Therefore exercises and their solutions as well as examples occupy a prominent place in this course This book is not designed as a comprehensive reference work but rather as a selective textbook The many exercises with detailed answers make it suitable for use in both a math or computer science course

Algorithms for Computer Algebra Keith O. Geddes, Stephen R. Czapor, George Labahn, 1992-09-30 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

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

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

Special Issue on Topics in Computational Algebra G. M. Piacentini Cattaneo, Elisabetta Strickland, 1990

Ideals, Varieties, and Algorithms David A. Cox, John Little, Donal O'Shea, 2015-04-30 This text covers topics in algebraic geometry and commutative algebra with a strong perspective toward 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 this new edition incorporates several substantial changes all of which are listed in the Preface The largest revision incorporates a new Chapter ten which presents some of the essentials of progress made over the last decades in computing Groebner 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 Readers who are teaching from *Ideals Varieties and Algorithms* or are studying the book on their own may obtain a copy of the solutions manual by sending an email to jlittle@holycross.edu 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

Topics in Computational Algebra G.M. Piacentini Cattaneo, Elisabetta Strickland, 1991-01-31 The main purpose of these lectures is first to briefly survey the fundamental connection between the representation theory of the symmetric group S_n and the theory of symmetric functions and second to show how combinatorial methods that arise naturally in the theory of symmetric functions lead to efficient algorithms to express various products of representations of S_n in terms of sums of irreducible representations That is there is a basic isometry which maps the center of the group algebra of S_n $\mathbb{Z}[S_n]$ to the space of homogeneous symmetric functions of degree n A_n This basic isometry is known as the Frobenius map F The Frobenius map allows us to reduce calculations involving characters of the symmetric group to calculations involving Schur functions Now there is a very rich and beautiful theory of the combinatorics of symmetric functions that has been developed in recent years The combinatorics of symmetric functions then leads to a number of very efficient algorithms for expanding various products of Schur functions into a sum of Schur functions Such expansions of products of Schur functions correspond via the Frobenius map to decomposing various products of irreducible representations of S_n into their irreducible components In addition the Schur functions are also the characters of the irreducible polynomial representations of the general linear group over the complex numbers $GL_n(\mathbb{C})$

Computers and Mathematics Erich Kaltofen, Stephen M. Watt, 2012-12-06 Advances in computer technology have had a tremendous impact on mathematics in the last two decades In June of 1989 an international conference was held at MIT bringing together mathematicians and computer scientists to survey the work that has been done in computational mathematics to report recent results in this field and to discuss research directions as well as educational issues This book presents a fascinating collection of contributions on topics ranging from computational algebra and parallel computing to mathematics education Mathematicians interested in the computational aspects of their discipline as well as computer scientists interested in mathematical applications will enjoy the integrative view provided by this book

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
Wolfram Koepf, 2021-07-11. 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.

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 polynomials.

Computer Algebra Handbook
Johannes Grabmeier, Erich Kaltofen, Volker Weispfenning, 2012-12-06. Two ideas lie gleaming on the jeweler's velvet. The first is the calculus, the second the algorithm. The calculus and the rich body of mathematical analysis to which it gave rise made modern science possible, but it has been the algorithm that has made possible the modern world. David Berlinski, *The Advent of the Algorithm*. First there was the concept of integers, then there were symbols for integers: I, II, III, 1, 11, 111, 1111, f, t, t, t, what might be called a sticks-and-stones representation: I, II, III, IV, V, Roman numerals, 1, 2, 3, 4, 5, Arabic numerals, etc. Then there were other concepts with symbols for them and algorithms, sometimes for manipulating the new symbols. Then

came collections of mathematical knowledge tables of mathematical computations theorems of general results Soon after algorithms came devices that provided assistance for carrying out computations Then mathematical knowledge was organized and structured into several related concepts and symbols logic algebra analysis topology algebraic geometry number theory combinatorics etc This organization and abstraction lead to new algorithms and new fields like universal algebra But always our symbol systems reflected and influenced our thinking our concepts and our algorithms

Algorithmic Algebra Bhubaneswar Mishra, 2012-12-06 Algorithmic Algebra studies some of the main algorithmic tools of computer algebra covering such topics as Gröbner 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 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 problems the 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 Gröbner 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

Ideals, Varieties, and Algorithms David A. Cox, John Little, Donal O'Shea, 2015 This text covers topics in algebraic geometry and commutative algebra with a strong perspective toward 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

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Aspects of Complexity Rod Downey, Denis R. Hirschfeldt, 2011-05-02 The book contains 8 detailed expositions of the lectures given at the Kaikoura 2000 Workshop on Computability Complexity and Computational Algebra Topics covered include basic models and questions of complexity theory the Blum Shub Smale model of computation probability theory applied to algorithmics randomized algorithms parametric complexity Kolmogorov complexity of finite strings computational group theory counting problems and canonical models of ZFC providing a solution to continuum hypothesis The text addresses students in computer science or mathematics and professionals in these areas who seek a complete but gentle introduction to a wide range of techniques concepts and research horizons in the area of computational complexity in a broad

sense **Computer Algebra in Scientific Computing** ,2005

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