

computer algebra

Unlocking the Power of Computer Algebra: A Comprehensive Guide

Introduction:

Are you intrigued by the possibility of solving complex mathematical problems with the speed and precision of a computer? Do you yearn to understand the intricate algorithms that power groundbreaking scientific discoveries and engineering feats? Then you've come to the right place! This comprehensive guide delves into the fascinating world of computer algebra, exploring its core concepts, applications, and the revolutionary impact it has on various fields. We'll journey from the fundamental definitions to advanced techniques, equipping you with a thorough understanding of this powerful computational tool. Get ready to unlock the power of computer algebra!

What is Computer Algebra?

Computer algebra, also known as symbolic computation, is a branch of computer science that deals with the manipulation of mathematical expressions in symbolic form. Unlike numerical computation, which deals with numerical approximations, computer algebra focuses on exact calculations and manipulations of algebraic expressions, equations, and formulas. This means it works with variables and symbols, not just numbers. Think of it as having a highly intelligent assistant capable of performing complex algebraic manipulations, simplifying equations, solving systems of equations, and even proving mathematical theorems – all automatically and with perfect accuracy.

Key Concepts and Techniques in Computer Algebra Systems (CAS):

Symbolic Differentiation and Integration: CAS excels at calculating derivatives and integrals, even for complex functions where traditional methods would be cumbersome or impossible. It can handle both indefinite and definite integrals, providing exact solutions whenever possible.

Polynomial Manipulation: CAS systems are adept at manipulating polynomials, including factorization, expansion, greatest common divisor (GCD) calculations, and resultant computations. This is crucial for solving polynomial equations and analyzing algebraic structures.

Equation Solving: Solving equations, from simple linear equations to complex systems of non-linear equations, is a core strength of CAS. They employ sophisticated algorithms to find both numerical and symbolic solutions.

Matrix Operations: CAS provides powerful tools for matrix algebra, including matrix multiplication, inversion, determinant calculation, eigenvalue and

eigenvector computation, and solving systems of linear equations using matrix methods.

Simplification and Transformation of Expressions: One of the most significant advantages of CAS is its ability to simplify complex mathematical expressions, reducing them to their most concise and understandable forms. This simplification is essential for solving problems and gaining insights.

Series Expansions: CAS can perform Taylor and Laurent series expansions, crucial for approximation and analysis of functions near specific points.

Calculus and Differential Equations: Beyond basic calculus operations, CAS can tackle differential equations, providing both analytical and numerical solutions depending on the nature of the equation.

Number Theory and Cryptography: Computer algebra plays a significant role in number theory, enabling calculations involving prime numbers, modular arithmetic, and other crucial aspects relevant to cryptography.

Applications of Computer Algebra Across Diverse Fields:

The applications of computer algebra are vast and span numerous scientific and engineering disciplines:

Physics: Solving complex equations in classical mechanics, electromagnetism, quantum mechanics, and general relativity. Simulating physical systems and analyzing their behavior.

Engineering: Designing and analyzing control systems, solving structural mechanics problems, optimizing engineering designs, and simulating complex processes.

Mathematics: Proving mathematical theorems, exploring new mathematical concepts, and conducting advanced research in various mathematical fields.

Chemistry: Modeling molecular structures and reactions, analyzing chemical kinetics, and predicting the properties of chemical compounds.

Economics: Building econometric models, analyzing financial markets, and forecasting economic trends.

Computer Graphics: Rendering complex 3D scenes, simulating physical phenomena in computer games, and developing advanced graphics algorithms.

Robotics: Controlling robot movements, planning robot trajectories, and simulating robot behavior in various environments.

Bioinformatics: Analyzing biological data, modeling biological systems, and discovering new biological insights.

Popular Computer Algebra Systems (CAS):

Several powerful CAS are available, each with its own strengths and weaknesses:

Maple: Known for its intuitive interface and strong symbolic computation capabilities. Widely used in education and research.

Mathematica: A comprehensive system with a vast range of functionalities, renowned for its power and versatility. Excellent for visualizations.

SageMath: A free and open-source CAS built on Python, offering a flexible and extensible environment. Ideal for collaborative projects and customization.

MATLAB (with Symbolic Math Toolbox): While primarily known for numerical computation, MATLAB's Symbolic Math Toolbox extends its capabilities to include symbolic calculations.

A Sample Textbook Outline: "Introduction to Computer Algebra"

Introduction: Defining computer algebra, historical context, and overview of applications.

Chapter 1: Fundamental Concepts: Basic algebraic structures, polynomials, rational functions, and their representations within a CAS.

Chapter 2: Symbolic Differentiation and Integration: Techniques, algorithms, and practical examples.

Chapter 3: Equation Solving: Linear and non-linear equations, systems of equations, and numerical methods.

Chapter 4: Matrix Algebra: Matrix operations, eigenvalues, eigenvectors, and applications.

Chapter 5: Series Expansions: Taylor and Laurent series, applications in approximation theory.

Chapter 6: Advanced Topics: Differential equations, number theory applications, and Gröbner bases.

Conclusion: Summary of key concepts, future directions of computer algebra, and resources for further learning.

(Detailed explanation of each chapter would require a separate, extensive document. The above is a skeletal outline to illustrate the structure of a potential textbook.)

Frequently Asked Questions (FAQs):

1. What is the difference between computer algebra and numerical computation? Computer algebra deals with symbolic manipulations, aiming for exact solutions, while numerical computation uses approximations and deals with numbers.
1. Is computer algebra programming-based? While many CAS have programming interfaces (e.g., using Python within SageMath), the core functionality is often accessed through a user-friendly interface.
1. Can computer algebra solve any mathematical problem? No, there are limitations. Some problems are computationally intractable, even for powerful CAS.
1. What are the learning resources available for computer algebra? Numerous textbooks, online courses (MOOCs), and tutorials are available for various skill levels.
1. Which CAS is best for beginners? Maple and SageMath offer relatively user-friendly interfaces suitable for beginners.
1. What are the career opportunities related to computer algebra? Careers exist in research, software development, and various scientific and engineering fields.
1. Is computer algebra only used in academia? No, it finds applications in industry, finance, and numerous other sectors.
1. How computationally intensive is computer algebra? The computational cost varies greatly depending on the complexity of the problem.

1. What is the future of computer algebra? Continued advancements in algorithms, increased computational power, and integration with other computational tools are expected.

Related Articles:

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7. SageMath for Beginners: Learning the basics of the free and open-source SageMath.
8. The History of Computer Algebra: Tracing the evolution of computer algebra from its origins.
9. Computer Algebra Applications in Robotics: Exploring the use of CAS in robotics control and simulation.

computer algebra: 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: Modern Computer Algebra Joachim von zur Gathen, Jürgen Gerhard, 2013-04-25 Now in its third edition, this highly successful textbook is widely regarded as the 'bible of computer algebra'.

computer algebra: Computer Algebra Systems Michael J. Wester, 1999-07-16 This thorough

overview of the major computer algebra (symbolic mathematical) systems compares and contrasts their strengths and weaknesses, and gives tutorial information for using these systems in various ways. * Compares different packages quantitatively using standard 'test suites' * Ideal for assessing the most appropriate package for a particular user or application * Examines the performance and future developments from a user's and developer's viewpoint Internationally recognized specialists overview both the general and special purpose systems and discuss issues such as denesting nested roots, complex number calculations, efficiently computing special polynomials, solving single equations and systems of polynomial equations, computing limits, multiple integration, solving ordinary differential and nonlinear evolution equations, code generation, evaluation and computer algebra in education. The historical origins, computer algebra resources and equivalents for many common operations in seven major packages are also covered. By providing such a comprehensive survey, the experienced user is able to make an informed decision on which system(s) he or she might like to use. It also allows a user new to computer algebra to form an idea of where to begin. Since each system looked at in this book uses a different language, many examples are included to aid the user in adapting to these language differences. These examples can be used as a guide to using the various systems once one understands the basic principles of one CAS. The book also includes contributions which look at the broad issues of the needs of various users and future developments, both from the user's and the developer's viewpoint. The author is a leading figure in the development and analysis of mathematical software and is well known through the 'Wester test suite' of problems which provide a bench mark for measuring the performance of mathematical software systems. The book will help develop our range of titles for applied mathematicians. The book will provide a unique, fully up-to-date and independent assessment of particular systems and will be of interest to users and purchasers of CAS's.

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: *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: *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

computer algebra: *Computer Algebra and Differential Equations* E. Tournier, 1994-03-03

Selected papers from the Computer Algebra and Differential Equations meeting held in France in June 1992.

computer algebra: Computer Algebra with SymbolicC++ Yorick Hardy, Kiat Shi Tan, W.-H. Steeb, 2008 First published in 1973 Professor Akenzone's book traces the series of religious and political controversies which have battered the state schools of Northern Ireland. After the government's admirably intentioned, but muddled, attempt to create a non-sectarian school system in the early 1920s, the educational system was progressively manipulated by sectarianism. The way in which the author describes how children are schooled reveals a great deal about the attitudes and values of the parental generation and also helps to explain the actions of later generations.

computer algebra: Computer Algebra Wolfram Koepf, 2021-08-12 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: 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

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: *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: *Geometric Algebra for Computer Science* Leo Dorst, Daniel Fontijne, Stephen Mann, 2010-07-26 Until recently, almost all of the interactions between objects in virtual 3D worlds have been based on calculations performed using linear algebra. Linear algebra relies heavily on coordinates, however, which can make many geometric programming tasks very specific and complex-often a lot of effort is required to bring about even modest performance enhancements. Although linear algebra is an efficient way to specify low-level computations, it is not a suitable high-level language for geometric programming. Geometric Algebra for Computer Science presents a compelling alternative to the limitations of linear algebra. Geometric algebra, or GA, is a compact, time-effective, and performance-enhancing way to represent the geometry of 3D objects in computer programs. In this book you will find an introduction to GA that will give you a strong grasp of its relationship to linear algebra and its significance for your work. You will learn how to use GA to represent objects and perform geometric operations on them. And you will begin mastering proven techniques for making GA an integral part of your applications in a way that simplifies your code without slowing it down. * The first book on Geometric Algebra for programmers in computer graphics and entertainment computing * Written by leaders in the field providing essential information on this new technique for 3D graphics * This full colour book includes a website with GAViewer, a program to experiment with GA

computer algebra: *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.

computer algebra: *Computer Algebra in Quantum Field Theory* Carsten Schneider, Johannes Blümlein, 2013-10-05 The book focuses on advanced computer algebra methods and special functions that have striking applications in the context of quantum field theory. It presents the state of the art and new methods for (infinite) multiple sums, multiple integrals, in particular Feynman

integrals, difference and differential equations in the format of survey articles. The presented techniques emerge from interdisciplinary fields: mathematics, computer science and theoretical physics; the articles are written by mathematicians and physicists with the goal that both groups can learn from the other field, including most recent developments. Besides that, the collection of articles also serves as an up-to-date handbook of available algorithms/software that are commonly used or might be useful in the fields of mathematics, physics or other sciences.

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 Gr bner 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: 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 F rderung der wissenschaftlichen Forschung (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 Neub iser, J. : Computing with Groups and Their Character Tables. 45 Norman, A. C. : Integration in Finite Terms.

computer algebra: Computer Simulation and Computer Algebra Dietrich Stauffer, Friedrich W Hehl, Volker Winkelmann, John G. Zabolitzky, 2012-12-06 The chapter on statistical-physics simulations has been enlarged, mainly by a discussion of multispin coding techniques for the Ising model (bit-by-bit parallel operations). In the chapter about Reduce, some details of the presentation have been corrected or clarified. The new operator MATEIGEN for the computation of eigenvectors of matrices is explained. The first chapter and the appendix remain unchanged. Needless to say, the field of computational science is advancing so quickly, for example with the development of parallel, as opposed to vectorized, algorithms, that it will not be too long before a further edition is called for. Cologne, March 1989 The authors Preface to the First Edition

Computers play an increasingly important role in many of today's activities, and correspondingly physicists find employment after graduation in computer related jobs, often quite remote from their physics education. The present lectures, on the other hand, emphasize how we can use computers for the purposes of fundamental research in physics. Thus we do not deal with programs designed for newspapers, banks, or travel agencies, i.e., word processing and storage of large amounts of data.

computer algebra: 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.

computer algebra: Computer Algebra in Scientific Computing François Boulier, Matthew England, Timur M. Sadykov, Evgenii V. Vorozhtsov, 2021-08-16 This book constitutes the proceedings of the 23rd International Workshop on Computer Algebra in Scientific Computing, CASC 2021, held in Sochi, Russia, in September 2021. The 24 full papers presented together with 1 invited talk were carefully reviewed and selected from 40 submissions. The papers cover theoretical computer algebra and its applications in scientific computing.

computer algebra: Boolean Algebra and Its Applications J. Eldon Whitesitt, 2012-05-24 Introductory treatment begins with set theory and fundamentals of Boolean algebra, proceeding to concise accounts of applications to symbolic logic, switching circuits, relay circuits, binary arithmetic, and probability theory. 1961 edition.

computer algebra: Universal Algebra for Computer Scientists Wolfgang Wechler, 2012-12-06 A new model-theoretic approach to universal algebra is offered in this book. Written for computer scientists, it presents a systematic development of the methods and results of universal algebra that are useful in a variety of applications in computer science. The notation is simple and the concepts are clearly presented. The book concerns the algebraic characterization of axiomatic classes of algebras (equational, implicational, and universal Horn classes) by closure operators generalizing the famous Birkhoff Variety Theorem, and the algebraic characterization of the related theories. The book also presents a thorough study of term rewriting systems. Besides basic notions, the Knuth-Bendix completion procedure and termination proof methods are considered. A third main topic is that of fixpoint techniques and complete ordered algebras. Algebraic specifications of abstract data types and algebraic semantics of recursive program schemes are treated as applications. The book is self-contained and suitable both as a textbook for graduate courses and as a reference for researchers.

computer algebra: Rational Algebraic Curves J. Rafael Sendra, Franz Winkler, Sonia Pérez-Díaz, 2007-12-10 The central problem considered in this introduction for graduate students is the determination of rational parametrizability of an algebraic curve and, in the positive case, the computation of a good rational parametrization. This amounts to determining the genus of a curve: its complete singularity structure, computing regular points of the curve in small coordinate fields,

and constructing linear systems of curves with prescribed intersection multiplicities. The book discusses various optimality criteria for rational parametrizations of algebraic curves.

computer algebra: Computer Algebra Systems in Secondary School Mathematics Education James Taylor Fey, 2003

computer algebra: Computer Algebra Recipes Richard Enns, George C. McGuire, 2013-03-07 Computer algebra systems allow students to work on mathematical models more efficiently than in the case of pencil and paper. The use of such systems also leads to fewer errors and enables students to work on complex and computationally intensive models. Aimed at undergraduates in their second or third year, this book is filled with examples from a wide variety of disciplines, including biology, economics, medicine, engineering, game theory, physics, and chemistry. The text includes a large number of Maple(R) recipes.

computer algebra: Applications of Computer Algebra Richard Pavelle, 2012-12-06 Today, certain computer software systems exist which surpass the computational ability of researchers when their mathematical techniques are applied to many areas of science and engineering. These computer systems can perform a large portion of the calculations seen in mathematical analysis. Despite this massive power, thousands of people use these systems as a routine resource for everyday calculations. These software programs are commonly called Computer Algebra systems. They have names such as MACSYMA, MAPLE, muMATH, REDUCE and SMP. They are receiving credit as a computational aid with increasing regularity in articles in the scientific and engineering literature. When most people think about computers and scientific research these days, they imagine a machine grinding away, processing numbers arithmetically. It is not generally realized that, for a number of years, computers have been performing non-numeric computations. This means, for example, that one inputs an equation and obtains a closed form analytic answer. It is these Computer Algebra systems, their capabilities, and applications which are the subject of the papers in this volume.

computer algebra: Applications of Computer Algebra Ilias S. Kotsireas, Edgar Martínez-Moro, 2017-07-26 The Applications of Computer Algebra (ACA) conference covers a wide range of topics from Coding Theory to Differential Algebra to Quantum Computing, focusing on the interactions of these and other areas with the discipline of Computer Algebra. This volume provides the latest developments in the field as well as its applications in various domains, including communications, modelling, and theoretical physics. The book will appeal to researchers and professors of computer algebra, applied mathematics, and computer science, as well as to engineers and computer scientists engaged in research and development.

computer algebra: Computer Algebra with LISP and REDUCE F. Brackx, D. Constaes, 1991-11-30 One service mathematics has rendered the TEL moi, si j'avait su comment en revenir. je n'y serais point allé.' human race. It has put common sense back Jules Verne where it belongs, on the topmost shelf next to the dusty canister labelled 'discarded non sense', The series is divergent; therefore we may be Eric T. Bell able to do something with it. O. Heaviside Mathematics is a tool for thought. A highly necessary tool in a world where both feedback and non linearities abound. Similarly, all kinds of parts of mathematics serve as tools for other parts and for other sciences. Applying a simple rewriting rule to the quote on the right above one finds such statements as: 'One service topology has rendered mathematical physics ...'; 'One service logic has rendered computer science ...'; 'One service category theory has rendered mathematics ...'. All arguably true. And all statements obtainable this way form part of the raison d'être of this series.

computer algebra: Computer Algebra in Scientific Computing François Boulier, Matthew England, Timur M. Sadykov, Evgenii V. Vorozhtsov, 2020-10-17 This book constitutes the refereed proceedings of the 22nd International Workshop on Computer Algebra in Scientific Computing, CASC 2020, held in Linz, Austria, in September 2020. The conference was held virtually due to the COVID-19 pandemic. The 34 full papers presented together with 2 invited talks were carefully reviewed and selected from 41 submissions. They deal with cutting-edge research in all major disciplines of computer algebra. The papers cover topics such as polynomial algebra, symbolic and

symbolic-numerical computation, applications of symbolic computation for investigating and solving ordinary differential equations, applications of CAS in the investigation and solution of celestial mechanics problems, and in mechanics, physics, and robotics.

computer algebra: Perturbation Methods, Bifurcation Theory and Computer Algebra

Richard H. Rand, Dieter Armbruster, 2012-12-06 Perturbation methods have always been an important tool for treating nonlinear differential equations. Now the drudgery associated with them has been eliminated! This book offers computer algebra (MACSYMA) programs which implement the most popular perturbation methods. Not only does this avoid the errors associated with hand computation, but the increase in efficiency permits more complicated problems to be tackled. This book is useful both for the beginner learning perturbation methods for the first time, as well as for the researcher. Methods covered include: Lindstedt's method, center manifolds, normal forms, two variable expansion method (method of multiple scales), averaging, Lie transforms and Liapunov-Schmidt reduction. For each method the book includes an introduction and some example problems solved both by hand and by machine. The examples feature common bifurcations such as the pitchfork and the Hopf. The MACSYMA code for each method is given and suggested exercises are provided at the end of each Chapter. An Appendix offers a brief introduction to MACSYMA.

computer algebra: Quantum Mechanics Using Computer Algebra Willi-Hans Steeb, 1994

Solving problems in quantum mechanics is an essential skill and research activity for scientists, engineers and others. Nowadays the labor of scientific computation has been greatly eased by the advent of computer algebra packages. These do not merely perform number-crunching tasks, but enable users to manipulate algebraic expressions and equations symbolically. For example, differentiation and integration can now be carried out algebraically by the computer. This book collects standard and advanced methods in quantum mechanics and implements them using REDUCE, a popular computer algebra package. Throughout, sample programs and their output have been displayed alongside explanatory text, making the book easy to follow. Selected problems have also been implemented using two other popular packages, MATHEMATICA and MAPLE, and in the object-oriented programming language C++. Besides standard quantum mechanical techniques, modern developments in quantum theory are also covered. These include Fermi and Bose Operators, coherent states, gauge theory and quantum groups. All the special functions relevant to quantum mechanics (Hermite, Chebyshev, Legendre and more) are implemented. The level of presentation is such that one can get a sound grasp of computational techniques early on in one's scientific education. A careful balance is struck between practical computation and the underlying mathematical concepts, making the book well-suited for use with quantum mechanics courses.

computer algebra: Algebra for Computer Science Lars Garding, Torbjörn Tambour,

2012-12-06 The aim of this book is to teach the reader the topics in algebra which are useful in the study of computer science. In a clear, concise style, the author presents the basic algebraic structures, and their applications to such topics as the finite Fourier transform, coding, complexity, and automata theory. The book can also be read profitably as a course in applied algebra for mathematics students.

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1989-03-30 Numerical Modeling in Science and Engineering Myron B. Allen, George F. Pinder, and Ismael Herrera Emphasizing applications, this treatment combines three traditionally distinct disciplines—continuum mechanics, differential equations, and numerical analysis—to provide a unified treatment of numerical modeling of physical systems. Covers basic equations of macroscopic systems, numerical methods, steady state systems, dissipative systems, nondissipative systems, and high order, nonlinear, and coupled systems. 1988 (0 471-80635-8) 418 pp. Mathematical Modeling and Digital Simulation for Engineers and Scientists Second Edition Jon M. Smith Totally updated, this Second Edition reflects the many developments in simulation and computer modeling theory and practice that have occurred over the past decade. It includes a new section on the use of modern numerical methods for generating chaos and simulating random processes, a section on simulator verification, and provides applications of these methods for personal computers. Readers will find a

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computer algebra: 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 Gr bner 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.

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