Algebraic Geometry A Problem Solving Approach Student Mathematical Library

An accessible introduction to convex algebraic geometry and semidefinite optimization. For graduate students and researchers in mathematics and computer science.
Algorithmic and quantitative aspects in real algebraic geometry are becoming increasingly important areas of research because of their roles in other areas of mathematics and computer science. The papers in this volume collectively span several different areas of current research. The articles are based on talks given at the DIMACS Workshop on "Algorithmic and Quantitative Aspects of Real Algebraic Geometry". Topics include deciding basic algebraic properties of real semi-algebraic sets, application of quantitative results in real algebraic geometry towards investigating the computational complexity of various problems, algorithmic and quantitative questions in real enumerative geometry, new approaches towards solving decision problems in semi-algebraic geometry, as well as computing algebraic certificates, and applications of real algebraic geometry to concrete problems arising in robotics and computer graphics. The book is intended for researchers interested in computational methods in algebra.
Recent advances in both the theory and implementation of computational algebraic geometry have led to new, striking applications to a variety of fields of research. The articles in this volume highlight a range of these applications and provide introductory material for topics covered in the IMA workshops on "Optimization and Control" and "Applications in Biology, Dynamics, and Statistics" held during the IMA year on Applications of Algebraic Geometry. The articles related to optimization and control focus on burgeoning use of semidefinite programming and moment matrix techniques in computational real algebraic geometry. The new direction towards a systematic study of non-commutative real algebraic geometry is well represented in the volume. Other articles provide an overview of the way computational algebra is useful for analysis of contingency tables, reconstruction of phylogenetic trees, and in systems biology. The contributions collected in this volume are accessible to non-experts, self-contained and informative; they quickly move towards cutting edge research in these areas, and provide a wealth of open problems for future research.
The math challenge curriculum textbook series is designed to help students learn the fundamental mathematical concepts and practice their in-depth problem solving skills with selected exercise problems. Ideally, these textbooks are used together with Areteem Institute's corresponding courses, either taken as live classes or as self-paced classes. According to the experience levels of the students in mathematics, the following courses are offered: Fun Math Problem Solving for Elementary School (grades 3-5) Algebra Readiness (grade 5; preparing for middle school) Math Challenge I-A Series (grades 6-8; intro to problem solving) Math Challenge I-B Series (grades 6-8; intro to math contests e.g. AMC 8, ZIML Div M) Math Challenge I-C Series (grades 6-8; topics bridging middle and high schools) Math Challenge II-A Series (grades 9+ or younger students preparing for AMC 10) Math Challenge II-B Series (grades 9+ or younger students preparing for AMC 12) Math Challenge III Series (preparing for AIME, ZIML Varsity, or equivalent contests) Math Challenge IV Series (Math Olympiad level problem solving) These courses are designed and developed by educational experts and industry professionals to bring real world applications into the STEM education. These programs are ideal for students who wish to win in Math Competitions (AMC, AIME, USAMO, IMO, ARML, MathCounts, Math League, Math Olympiad, ZIML, etc.), Science Fairs (County Science Fairs, State Science Fairs, national programs like Intel Science and Engineering Fair, etc.) and Science Olympiad, or purely want to enrich their academic lives by taking more challenges and developing outstanding analytical, logical thinking and creative problem solving skills. Math Challenge I-C is a four-part course designed to bridge the middle school and high school math materials. For students who participate in the American Math Competitions (AMC), there is a big gap in both the fundamental math concepts and the problem-solving techniques involved between the AMC 8 and AMC 10 contests. This course is developed to help students transition smoothly from middle school to high school, and prepare them for high school math competitions including the AMC 10 \& 12, ARML, and ZIML. The full course covers topics and introductory problem solving in algebra, geometry, and finite math. Algebraic topics include linear equations, systems of equations and inequalities, exponents and radicals, factoring polynomials, and solving quadratic equations. Geometric topics include angles in triangles, quadrilaterals, and polygons, congruent and similar polygons, calculating area, and algebraic geometry. Topics in finite math include logic, introductory number theory, and an introduction to probability and statistics. These topics serve as the fundamental knowledge needed for a more advanced problem solving course such as Math Challenge II-A. The course is divided into four terms: Summer, covering Algebra Fall, covering covering additional topics in Algebra Winter, covering Geometry Spring, covering Finite Math The book contains course materials for Math Challenge I-C: Additional topics in Algebra. We recommend that students take all four terms starting with the Summer, but students with the required background are welcome to join for later terms in the course, or select suitable terms for self-paced study. Students can sign up for the course at https: //classes.areteem.org for the live online version or at https: //www.edurila.com for the self-paced version.
This work focuses on the association of methods from topology, category and sheaf theory, algebraic geometry, noncommutative and homological algebras, quantum groups and spaces, rings of differential operation, Cech and sheaf cohomology theories, and dimension theories to create a blend of noncommutative algebraic geometry. It offers a scheme theory that sustains the duality between algebraic geometry and commutative algebra to the noncommutative level.
This book is a unique collection of challenging geometry problems and detailed solutions that will build students’ confidence in mathematics. By proposing several methods to approach each problem and emphasizing geometry’s connections with different fields of mathematics, Methods of Solving Complex Geometry Problems serves as a bridge to more advanced problem solving. Written by an accomplished female mathematician who struggled with geometry as a child, it does not intimidate, but instead fosters the reader’s ability to solve math problems through the direct application of theorems. Containing over 160 complex problems with hints and detailed solutions, Methods of Solving Complex Geometry Problems can be used as a self-study guide for mathematics competitions and for improving problem-solving skills in courses on plane geometry or the history of mathematics. It contains important and sometimes overlooked topics on triangles, quadrilaterals, and circles such as the Menelaus-Ceva theorem, Simson’s line, Heron’s formula, and the theorems of the three altitudes and medians. It can also be used by professors as a resource to stimulate the abstract thinking required to transcend the tedious and routine, bringing forth the original thought of which their students are capable. Methods of Solving Complex Geometry Problems will interest high school and college students needing to prepare for exams and competitions, as well as anyone who enjoys an intellectual challenge and

has a special love of geometry. It will also appeal to instructors of geometry, history of mathematics, and math education courses.
This book provides an introduction to abstract algebraic geometry. It includes more than 400 exercises that offer specific examples as well as more specialized topics. From the reviews: "Enables the reader to make the drastic transition between the basic, intuitive questions about affine and projective varieties with which the subject begins, and the elaborate general methodology of schemes and cohomology employed currently to answer these questions." --MATHEMATICAL REVIEWS
Maxwell's equations have led to many important mathematical discoveries. This text introduces mathematics students to some of their wonders.
Based on lectures given at an advanced course on integrable systems at the Centre de Recerca Matemàtica in Barcelona, these lecture notes address three major aspects of integrable systems: obstructions to integrability from differential Galois theory; the description of singularities of integrable systems on the basis of their relation to bi-Hamiltonian systems; and the generalization of integrable systems to the non-Hamiltonian settings. All three sections were written by top experts in their respective fields. Native to actual problem-solving challenges in mechanics, the topic of integrable systems is currently at the crossroads of several disciplines in pure and applied mathematics, and also has important interactions with physics. The study of integrable systems also actively employs methods from differential geometry. Moreover, it is extremely important in symplectic geometry and Hamiltonian dynamics, and has strong correlations with mathematical physics, Lie theory and algebraic geometry (including mirror symmetry). As such, the book will appeal to experts with a wide range of backgrounds.
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.
Excerpt from a review in the "Mathematics Teacher." A Mathematical Mosaic is a collection of wonderful topics from nmber theory through combinatorics to game theory, presented in a fashion that seventh- and eighth- grade students can handle yet high school students will find challenging." John Cocharo, Saint Mark's School of Texas, Dallas, TX
Mathematical algorithms are a fundamental component of Computer Aided Design and Manufacturing (CAD/CAM) systems. This book provides a bridge between algebraic geometry and geometric modelling algorithms, formulated within a computer science framework. Apart from the algebraic geometry topics covered, the entire book is based on the unifying concept of using algebraic techniques – properly specialized to solve geometric problems – to seriously improve accuracy, robustness and efficiency of CAD-systems. It provides new approaches as well as industrial applications to deform surfaces when animating virtual characters, to automatically compare images of handwritten signatures and to improve control of NC machines. This book further introduces a noteworthy representation based on 2D contours, which is essential to model the metal sheet in industrial processes. It additionally reviews applications of numerical algebraic geometry to differential equations systems with multiple solutions and bifurcations. Future Vision and Trends on Shapes, Geometry and Algebra is aimed specialists in the area of mathematics and computer science on the one hand and on the other hand at those who want to become familiar with the practical application of algebraic geometry and geometric modelling such as students, researchers and doctorates.
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Every New Copy of Precalculus: A Functional Approach to Graphing and Problem Solving Includes Access to the Student Companion Website! Precalculus: A Functional Approach to Graphing and Problem Solving prepares students for the concepts and applications they will encounter in future calculus courses. In far too many texts, process is stressed over insight and understanding, and students move on to calculus ill equipped to think conceptually about its essential ideas. This text provides sound development of the important mathematical

underpinnings of calculus, stimulating problems and exercises, and a well-developed, engaging pedagogy. Students will leave with a clear understanding of what lies ahead in their future calculus courses. Instructors will find that Smith's straightforward, student-friendly presentation provides exactly what they have been looking for in a text!

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 Gröbner 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 MapleTM, 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. 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

Algebraic & geometry methods have constituted a basic background and tool for people working on classic block coding theory and cryptography. Nowadays, new paradigms on coding theory and cryptography have arisen such as: Network coding, S-Boxes, APN Functions, Steganography and decoding by linear programming. Again understanding the underlying procedure and symmetry of these topics needs a whole bunch of non trivial knowledge of algebra and geometry that will be used to both, evaluate those methods and search for new codes and cryptographic applications. This book shows those methods in a self-contained form.

Fill in any gaps in your knowledge with this overview of key topics in undergraduate mathematics, now with four new chapters.

Algebraic GeometryA Problem Solving ApproachAmerican Mathematical Soc.

It has been estimated that, at the present stage of our knowledge, one could give a 200 semester course on commutative algebra and algebraic geometry without ever repeating himself. So any introduction to this subject must be highly selective. I first want to indicate what point of view guided the selection of material for this book. This introduction arose from lectures for students who had taken a basic course in algebra and could therefore be presumed to have a knowledge of linear algebra, ring and field theory, and Galois theory. The present text shouldn't require much more. In the lectures and in this text I have undertaken with the fewest possible auxiliary means to lead up to some recent results of commutative algebra and algebraic geometry concerning the representation of algebraic varieties as in tersections of the least possible number of hypersurfaces and- a closely related problem-with the most economical generation of ideals in Noetherian rings. The question of the equations needed to describe an algebraic variety was addressed by Kronecker in 1882. In the 1940s it was chiefly Perron who was interested in this question; his discussions with Severi made the problem known and contributed to sharpening the rei event concepts. Thanks to the general progress of commutative algebra many beautiful results in this circle of questions have been obtained, mainly after the solution of Serre's problem on projective modules. Because of their relatively elementary character they are especially suitable for an introduction to commutative algebra.

This book is a true introduction to the basic concepts and techniques of algebraic geometry. The language is purposefully kept on an elementary level, avoiding sheaf theory and cohomology theory. The introduction of new algebraic concepts is always motivated by a discussion of the corresponding geometric ideas. The main point of the book is to illustrate the interplay between abstract theory and specific examples. The book contains numerous problems that illustrate the general theory. The text is suitable for advanced undergraduates and beginning graduate students. It contains sufficient material for a one-semester course. The reader should be familiar with the basic concepts of modern algebra. A course in one complex variable would be helpful, but is not necessary.

Starting in the middle of the 80s, there has been a growing and fruitful interaction between algebraic geometry and certain areas of theoretical high-energy physics, especially the various versions of string theory. Physical heuristics have provided inspiration for new mathematical definitions (such as that of Gromov-Witten invariants) leading in turn to the solution of problems in enumerative geometry. Conversely, the availability of mathematically rigorous definitions and theorems has benefited the physics research by providing the required evidence in fields where experimental testing seems problematic. The aim of this volume, a result of the CIME Summer School held in Cetraro, Italy, in 2005, is to cover part of the most recent and interesting findings in this subject.

"Analytic and algebraic geometers often study the same geometric structures but bring different methods to bear on them. While this dual approach has been spectacularly successful at solving problems, the language differences between algebra and analysis also represent a difficulty for students and researchers in geometry, particularly complex geometry. The PCMI program was designed to partially address this language gulf, by presenting some of the active developments in algebraic and analytic geometry in a form suitable for students on the 'other side' of the analysis-algebra language divide. One focal point of the summer school was multiplier ideals, a subject of wide current interest in both subjects. The present volume is based on a series of lectures at the PCMI summer school on analytic and algebraic geometry. The series is designed to give a high-level introduction to the advanced techniques behind some recent developments in algebraic and analytic geometry. The lectures contain many illustrative examples, detailed computations, and new perspectives on the topics presented, in order to enhance

access of this material to non-specialists."--Publisher's description.

One cannot be an expert in Autonomous Vehicle Navigation Systems without a proper understanding of the preliminary visual concepts being covered in this book. It is a COMPENDIUM of the intermediate level books in the Visual Mathematics Series. They cover topics of - Elementary (introductory solved visual problems) - Pre-algebra - Geometry - AlgebraThis book intends to test the mathematical concepts taught in intermediate school with an emphasis on the visual skills. The problems are based on middle school curriculum but they are meant to be challenging, and meant for visual learners and high achievers. The use of diagrams and color coding scheme allows enhancing the description of the problems presented in this book and to lead the problem solver towards the solution.The problems presented in this book are in FULL COLOR and they create a visual dimension to the underlying mathematical concepts. It intends to appeal to both sides of the brain - the left and the right. It requires understanding the problem presented in a visual manner, but requires solving the problems using a combination of visual insight and mathematical discipline.This book provides a wide variety of problems, albeit a very limited number of each type. The main goal is to maintain the student's interest. The first eighteen pages include solved examples of visual math problems and should provide the necessary background. Many of the problems in the Pre-Algebra section will remind you of logic based grid puzzles, but the problems in this book have a variety of graph as well as grid representations. The problems in the Geometry section require thinking in relative terms and many of the problems have a certain artistic flavor. The algebra section is also about geometry problems that require algebraic problem solving.

Affine geometry and quadrics are fascinating subjects alone, but they are also important applications of linear algebra. They give a first glimpse into the world of algebraic geometry yet they are equally relevant to a wide range of disciplines such as engineering. This text discusses and classifies affinities and Euclidean motions culminating in classification results for quadrics. A high level of detail and generality is a key feature unmatched by other books available. Such intricacy makes this a particularly accessible teaching resource as it requires no extra time in deconstructing the author’s reasoning. The provision of a large number of exercises with hints will help students to develop their problem solving skills and will also be a useful resource for lecturers when setting work for independent study. Affinities, Euclidean Motions and Quadrics takes rudimentary, and often taken-for-granted, knowledge and presents it in a new, comprehensive form. Standard and non-standard examples are demonstrated throughout and an appendix provides the reader with a summary of advanced linear algebra facts for quick reference to the text. All factors combined, this is a self-contained book ideal for self-study that is not only foundational but unique in its approach.’ This text will be of use to lecturers in linear algebra and its applications to geometry as well as advanced undergraduate and beginning graduate students.

"Presents the structure of algebras appearing in representation theory of groups and algebras with general ring theoretic methods related to representation theory. Covers affine algebraic sets and the nullstellensatz, polynomial and rational functions, projective algebraic sets. Groebner basis, dimension of algebraic sets, local theory, curves and elliptic curves, and more."

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This book is the result of a meeting that took place at the University of Ghent (Belgium) on the relations between Hilbert's tenth problem, arithmetic, and algebraic geometry.

Included are written articles detailing the lectures that were given as well as contributed papers on current topics of interest. The following areas are addressed: an historical overview of Hilbert's tenth problem, Hilbert's tenth problem for various rings and fields, model theory and local-global principles, including relations between model theory and algebraic groups and analytic geometry, conjectures in arithmetic geometry and the structure of diophantine sets, for example with Mazur's conjecture, Lang's conjecture, and Bucchi's problem, and results on the complexity of diophantine geometry, highlighting the relation to the theory of computation.The volume allows the reader to learn and compare different approaches (arithmetical, geometrical, topological, model-theoretical, and computational) to the general structural analysis of the set of solutions of polynomial equations. It would make a nice contribution to graduate and advanced graduate courses on logic, algebraic geometry, and number theory.

The series is aimed specifically at publishing peer reviewed reviews and contributions presented at workshops and conferences. Each volume is associated with a particular conference, symposium or workshop. These events cover various topics within pure and applied mathematics and provide up-to-date coverage of new developments, methods and applications.

This volume contains the proceedings of the CIMPA Research School and Conference on Algebra for Secure and Reliable Communication Modeling, held from October 1-13, 2012, in Morelia, State of Michoacán, Mexico. The papers cover several aspects of the theory of coding theory and are gathered into three categories: general theory of linear codes, algebraic geometry and coding theory, and constacyclic codes over rings. The aim of this volume is to fill the gap between the theoretical part of algebraic geometry and the applications to problem solving and computational modeling in engineering, signal processing and information theory. This book is published in cooperation with Real Sociedad Matemática Española (RSME).

This ACM volume deals with tackling problems that can be represented by data structures which are essentially matrices with polynomial entries, mediated by the disciplines of commutative algebra and algebraic geometry. The discoveries stem from an interdisciplinary branch of research which has been growing steadily over the past decade. The author covers a wide range, from showing how to obtain deep heuristics in a computation of a ring, a module or a morphism, to developing means of solving nonlinear systems of equations - highlighting the use of advanced techniques to bring down the cost of computation. Although intended for advanced students and researchers with interests both in algebra and computation, many parts may be read by anyone with a basic abstract algebra course.

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This book develops the Weyr matrix canonical form, a largely unknown cousin of the Jordan form. It explores novel applications, including include matrix commutativity problems, approximate simultaneous diagonalization, and algebraic geometry. Module theory and algebraic geometry are employed but with self-contained accounts.

Algebraic Geometry has been at the center of much of mathematics for hundreds of years. It is not an easy field to break into, despite its humble beginnings in the study of circles, ellipses,

hyperbolas, and parabolas. This text consists of a series of ex

This book introduces the reader to modern algebraic geometry. It presents Grothendieck's technically demanding language of schemes that is the basis of the most important developments in the last fifty years within this area. A systematic treatment and motivation of the theory is emphasized, using concrete examples to illustrate its usefulness. Several examples from the realm of Hilbert modular surfaces and of determinantal varieties are used methodically to discuss the covered techniques. Thus the reader experiences that the further development of the theory yields an ever better understanding of these fascinating objects. The text is complemented by many exercises that serve to check the comprehension of the text, treat further examples, or give an outlook on further results. The volume at hand is an introduction to schemes. To get startet, it requires only basic knowledge in abstract algebra and topology. Essential facts from commutative algebra are assembled in an appendix. It will be complemented by a second volume on the cohomology of schemes.

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This book spans the distance between algebraic descriptions of geometric objects and the rendering of digital geometric shapes based on algebraic models. These contrasting points of view inspire a thorough analysis of the key challenges and how they are met. The articles focus on important classes of problems: implicitization, classification, and intersection. Combining illustrative graphics, computations and review articles this book helps the reader gain a firm practical grasp of these subjects.