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The Mathematics of Chip-Firing Caroline J. Klivans 2018-11-15 The Mathematics of Chip-firing is a solid introduction and overview of the growing field of chip-firing. It offers an appreciation for the richness and diversity of the subject. Chip-firing refers to a discrete dynamical system — a commodity is exchanged between sites of a network according to very simple local rules. Although governed by local rules, the long-term global behavior of the system reveals fascinating properties. The Fundamental properties of chip-firing are covered from a variety of perspectives. This gives the reader both a broad context of the field and concrete entry points from different backgrounds. Broken into two sections, the first examines the fundamentals of chip-firing, while the second half presents more general frameworks for chip-firing. Instructors and students will discover that this book provides a comprehensive background to approaching original sources. Features: Provides a broad introduction for researchers interested in the subject of chip-firing The text includes historical and current perspectives Exercises included at the end of each chapter About the Author: Caroline J. Klivans received a BA degree in mathematics from Cornell University and a PhD in applied mathematics from MIT. Currently, she is an Associate

Professor in the Division of Applied Mathematics at Brown University. She is also an Associate Director of ICERM (Institute for Computational and Experimental Research in Mathematics). Before coming to Brown she held positions at MSRI, Cornell and the University of Chicago. Her research is in algebraic, geometric and topological combinatorics.

Bounded Cohomology of Discrete Groups Roberto Frigerio 2017-11-21 The theory of bounded cohomology, introduced by Gromov in the late 1980s, has had powerful applications in geometric group theory and the geometry and topology of manifolds, and has been the topic of active research continuing to this day. This monograph provides a unified, self-contained introduction to the theory and its applications, making it accessible to a student who has completed a first course in algebraic topology and manifold theory. The book can be used as a source for research projects for master's students, as a thorough introduction to the field for graduate students, and as a valuable landmark text for researchers, providing both the details of the theory of bounded cohomology and links of the theory to other closely related areas. The first part of the book is devoted to settling the fundamental definitions of the theory, and to proving some of the (by now classical) results on low-dimensional bounded cohomology and on bounded cohomology of topological spaces. The second part describes applications of the theory to the study of the simplicial volume of manifolds, to the classification of circle actions, to the analysis of maximal representations of surface groups, and to the study of flat vector bundles with a particular emphasis on the possible use of bounded cohomology in relation with the Chern conjecture. Each chapter ends with a discussion of further reading that puts the presented results in a broader context.

The Shape of Inner Space Shing-Tung Yau 2010 Argues that geometry is fundamental to string theory--which posits that we live in a 10-dimensional existence--as well as the very nature of the universe, and explains where mathematics will take string theory next.

Trends in Commutative Algebra Luchezar L. Avramov 2004-12-13 In 2002, an introductory workshop was held at the Mathematical Sciences Research Institute in Berkeley to survey some of the many directions of the commutative algebra field. Six principal speakers each gave three lectures, accompanied by a help session, describing the interaction of commutative algebra with other areas of mathematics for a broad audience of graduate students and researchers. This book is based on those lectures, together with papers from contributing researchers. David Benson and Srikanth Iyengar present an introduction to the uses and concepts of commutative algebra in the cohomology of groups. Mark Haiman considers the commutative algebra of n points in the plane. Ezra Miller presents an introduction to the Hilbert scheme of points to complement Professor Haiman's paper. Further contributors include David Eisenbud and Jessica Sidman; Melvin Hochster; Graham Leuschke; Rob Lazarsfeld and Manuel Blickle; Bernard Teissier; and Ana Bravo.

Dynamics and Randomness Alejandro Maass 2012-12-06 This book contains the lectures given at the Conference on

Dynamics and Randomness held at the Centro de Modelamiento Matemático of the Universidad de Chile from December 11th to 15th, 2000. This meeting brought together mathematicians, theoretical physicists and theoretical computer scientists, and graduate students interested in fields related to probability theory, ergodic theory, symbolic and topological dynamics. We would like to express our gratitude to all the participants of the conference and to the people who contributed to its organization. In particular, to Pierre Collet, Bernard Host and Mike Keane for their scientific advice. We want to thank especially the authors of each chapter for their well prepared manuscripts and the stimulating conferences they gave at Santiago. We are also indebted to our sponsors and supporting institutions, whose interest and help was essential to organize this meeting: ECOS-CONICYT, FONDAP Program in Applied Mathematics, French Cooperation, Fundación Andes, Presidential Fellowship and Universidad de Chile. We are grateful to Ms. Gladys Cavallone for their excellent work during the preparation of the meeting as well as for the considerable task of unifying the typography of the different chapters of this book.

Critical Issues in Mathematics Education Bharath Sriraman 2009-06-01 The word "critical" in the title of this collection has three meanings, all of which are relevant. One meaning, as applied to a situation or problem, is "at a point of crisis". A second meaning is "expressing adverse or disapproving comments or judgments". A third is related to the verb "to critique", meaning "to analyze the merits and faults of". The authors contributing to this book pose challenging questions, from multiple perspectives, about the roles of mathematics in society and the implications for education. Traditional reasons for teaching mathematics include: preparing a new generation of mathematics researchers and a cadre of technically competent users of mathematics; training students to think logically; and because mathematics is as much part of cultural heritage as literature or music. These reasons remain valid, though open to critique, but a deeper analysis is required that recognizes the roles of mathematics in framing many aspects of contemporary society, that will connect mathematics education to the lived experiences of students, their communities, and society in general, and that acknowledges the global ethical responsibilities of mathematicians and mathematics educators. The book is organized in four sections (1) Mathematics education: For what and why? (2) Globalization and cultural diversity, (3) Mathematics, education, and society and (4) Social justice in, and through, mathematics education The chapters address fundamental issues such as the relevance of school mathematics in people's lives; creating a sense of agency for the field of mathematics education, and redefining the relationship between mathematics as discipline, mathematics as school subject and mathematics as part of people's lives.

Introduction to Functional Equations Costas Efthimiou 2011-10-13 Functions and their properties have been part of the rigorous precollege curriculum for decades. And functional equations have been a favorite topic of the leading national

and international mathematical competitions. Yet the subject has not received equal attention by authors at an introductory level. The majority of the books on the topic remain unreachable to the curious and intelligent precollege student. The present book is an attempt to eliminate this disparity. The book opens with a review chapter on functions, which collects the relevant foundational information on functions, plus some material potentially new to the reader. The next chapter presents a working definition of functional equations and explains the difficulties in trying to systematize the theory. With each new chapter, the author presents methods for the solution of a particular group of equations. Each chapter is complemented with many solved examples, the majority of which are taken from mathematical competitions and professional journals. The book ends with a chapter of unsolved problems and some other auxiliary material. The book is an invaluable resource for precollege and college students who want to deepen their knowledge of functions and their properties, for teachers and instructors who wish to enrich their curricula, and for any lover of mathematical problem-solving techniques. In the interest of fostering a greater awareness and appreciation of mathematics and its connections to other disciplines and everyday life, MSRI and the AMS are publishing books in the Mathematical Circles Library series as a service to young people, their parents and teachers, and the mathematics profession.

Mathematical Writing Donald E. Knuth 1989 This book will help those wishing to teach a course in technical writing, or who wish to write themselves.

Tropical Algebraic Geometry Ilia Itenberg 2009-05-30 These notes present a polished introduction to tropical geometry and contain some applications of this rapidly developing and attractive subject. It consists of three chapters which complete each other and give a possibility for non-specialists to make the first steps in the subject which is not yet well represented in the literature. The notes are based on a seminar at the Mathematical Research Center in Oberwolfach in October 2004. The intended audience is graduate, post-graduate, and Ph.D. students as well as established researchers in mathematics.

Differential Geometry of Curves and Surfaces Victor Andreevich Toponogov 2006-09-10 Central topics covered include curves, surfaces, geodesics, intrinsic geometry, and the Alexandrov global angle comparison theorem Many nontrivial and original problems (some with hints and solutions) Standard theoretical material is combined with more difficult theorems and complex problems, while maintaining a clear distinction between the two levels

Algebraic Statistics for Computational Biology L. Pachter 2005-08-22 This book, first published in 2005, offers an introduction to the application of algebraic statistics to computational biology.

Flavors of Geometry Silvio Levy 1997-09-28 Lectures on hyperbolic geometry, dynamics in several complex variables,

convex geometry, and volume estimation.

Symmetry in Graph Theory Jose M. Rodriguez 2019-03-14 This book contains the successful invited submissions to a Special Issue of Symmetry on the subject of "Graph Theory". Although symmetry has always played an important role in Graph Theory, in recent years, this role has increased significantly in several branches of this field, including but not limited to Gromov hyperbolic graphs, the metric dimension of graphs, domination theory, and topological indices. This Special Issue includes contributions addressing new results on these topics, both from a theoretical and an applied point of view.

Combinatorial and Computational Geometry cob E. Goodman 2005-08-08 This 2005 book deals with interest topics in Discrete and Algorithmic aspects of Geometry.

Differential Geometry Loring W. Tu 2017-06-01 This text presents a graduate-level introduction to differential geometry for mathematics and physics students. The exposition follows the historical development of the concepts of connection and curvature with the goal of explaining the Chern–Weil theory of characteristic classes on a principal bundle. Along the way we encounter some of the high points in the history of differential geometry, for example, Gauss' Theorema Egregium and the Gauss–Bonnet theorem. Exercises throughout the book test the reader's understanding of the material and sometimes illustrate extensions of the theory. Initially, the prerequisites for the reader include a passing familiarity with manifolds. After the first chapter, it becomes necessary to understand and manipulate differential forms. A knowledge of de Rham cohomology is required for the last third of the text. Prerequisite material is contained in author's text An Introduction to Manifolds, and can be learned in one semester. For the benefit of the reader and to establish common notations, Appendix A recalls the basics of manifold theory. Additionally, in an attempt to make the exposition more self-contained, sections on algebraic constructions such as the tensor product and the exterior power are included. Differential geometry, as its name implies, is the study of geometry using differential calculus. It dates back to Newton and Leibniz in the seventeenth century, but it was not until the nineteenth century, with the work of Gauss on surfaces and Riemann on the curvature tensor, that differential geometry flourished and its modern foundation was laid. Over the past one hundred years, differential geometry has proven indispensable to an understanding of the physical world, in Einstein's general theory of relativity, in the theory of gravitation, in gauge theory, and now in string theory. Differential geometry is also useful in topology, several complex variables, algebraic geometry, complex manifolds, and dynamical systems, among other fields. The field has even found applications to group theory as in Gromov's work and to probability theory as in Diaconis's work. It is not too far-fetched to argue that differential geometry should be in every mathematician's arsenal.

Three-dimensional Geometry and Topology WILLIAM P AUTOR THURSTON 1997 Every mathematician should be

acquainted with the basic facts about the geometry of surfaces, of two-dimensional manifolds. The theory of three-dimensional manifolds is much more difficult and still only partly understood, although there is ample evidence that the theory of three-dimensional manifolds is one of the most beautiful in the whole of mathematics. This excellent introductory work makes this mathematical wonderland remained rather inaccessible to non-specialists. The author is both a leading researcher, with a formidable geometric intuition, and a gifted expositor. His vivid descriptions of what it might be like to live in this or that three-dimensional manifold bring the subject to life. Like Poincaré, he appeals to intuition, but his enthusiasm is infectious and should make many converts for this kind of mathematics. There are good pictures, plenty of exercises and problems, and the reader will find a selection of topics which are not found in the standard repertoire. This book contains a great deal of interesting mathematics.

Analytic Combinatorics Philippe Flajolet 2009-01-15 Analytic combinatorics aims to enable precise quantitative predictions of the properties of large combinatorial structures. The theory has emerged over recent decades as essential both for the analysis of algorithms and for the study of scientific models in many disciplines, including probability theory, statistical physics, computational biology, and information theory. With a careful combination of symbolic enumeration methods and complex analysis, drawing heavily on generating functions, results of sweeping generality emerge that can be applied in particular to fundamental structures such as permutations, sequences, strings, walks, paths, trees, graphs and maps. This account is the definitive treatment of the topic. The authors give full coverage of the underlying mathematics and a thorough treatment of both classical and modern applications of the theory. The text is complemented with exercises, examples, appendices and notes to aid understanding. The book can be used for an advanced undergraduate or a graduate course, or for self-study.

A Decade of the Berkeley Math Circle Zvezdelina Stankova 2008-11-26 Many mathematicians have been drawn to mathematics through their experience with math circles: extracurricular programs exposing teenage students to advanced mathematical topics and a myriad of problem solving techniques and inspiring in them a lifelong love for mathematics. Founded in 1998, the Berkeley Math Circle (BMC) is a pioneering model of a U.S. math circle, aspiring to prepare our best young minds for their future roles as mathematics leaders. Over the last decade, 50 instructors--from university professors to high school teachers to business tycoons--have shared their passion for mathematics by delivering more than 320 BMC sessions full of mathematical challenges and wonders. Based on a dozen of these sessions, this book encompasses a wide variety of enticing mathematical topics: from inversion in the plane to circle geometry; from combinatorics to Rubik's cube and abstract algebra; from number theory to mass point theory; from complex numbers to game theory via invariants and monovariants. The treatments of these subjects encompass every significant method of proof and emphasize ways of

thinking and reasoning via 100 problem solving techniques. Also featured are 300 problems, ranging from beginner to intermediate level, with occasional peaks of advanced problems and even some open questions. The book presents possible paths to studying mathematics and inevitably falling in love with it, via teaching two important skills: thinking creatively while still "obeying the rules," and making connections between problems, ideas, and theories. The book encourages you to apply the newly acquired knowledge to problems and guides you along the way, but rarely gives you ready answers. "Learning from our own mistakes" often occurs through discussions of non-proofs and common problem solving pitfalls. The reader has to commit to mastering the new theories and techniques by "getting your hands dirty" with the problems, going back and reviewing necessary problem solving techniques and theory, and persistently moving forward in the book. The mathematical world is huge: you'll never know everything, but you'll learn where to find things, how to connect and use them. The rewards will be substantial. In the interest of fostering a greater awareness and appreciation of mathematics and its connections to other disciplines and everyday life, MSRI and the AMS are publishing books in the Mathematical Circles Library series as a service to young people, their parents and teachers, and the mathematics profession.

Persistence Theory: From Quiver Representations to Data Analysis Steve Y. Oudot 2017-05-17 Persistence theory emerged in the early 2000s as a new theory in the area of applied and computational topology. This book provides a broad and modern view of the subject, including its algebraic, topological, and algorithmic aspects. It also elaborates on applications in data analysis. The level of detail of the exposition has been set so as to keep a survey style, while providing sufficient insights into the proofs so the reader can understand the mechanisms at work. The book is organized into three parts. The first part is dedicated to the foundations of persistence and emphasizes its connection to quiver representation theory. The second part focuses on its connection to applications through a few selected topics. The third part provides perspectives for both the theory and its applications. The book can be used as a text for a course on applied topology or data analysis.

Introduction to Tropical Geometry Diane Maclagan 2021-12-13 Tropical geometry is a combinatorial shadow of algebraic geometry, offering new polyhedral tools to compute invariants of algebraic varieties. It is based on tropical algebra, where the sum of two numbers is their minimum and the product is their sum. This turns polynomials into piecewise-linear functions, and their zero sets into polyhedral complexes. These tropical varieties retain a surprising amount of information about their classical counterparts. Tropical geometry is a young subject that has undergone a rapid development since the beginning of the 21st century. While establishing itself as an area in its own right, deep connections have been made to many branches of pure and applied mathematics. This book offers a self-contained introduction to tropical geometry,

suitable as a course text for beginning graduate students. Proofs are provided for the main results, such as the Fundamental Theorem and the Structure Theorem. Numerous examples and explicit computations illustrate the main concepts. Each of the six chapters concludes with problems that will help the readers to practice their tropical skills, and to gain access to the research literature. This wonderful book will appeal to students and researchers of all stripes: it begins at an undergraduate level and ends with deep connections to toric varieties, compactifications, and degenerations. In between, the authors provide the first complete proofs in book form of many fundamental results in the subject. The pages are sprinkled with illuminating examples, applications, and exercises, and the writing is lucid and meticulous throughout. It is that rare kind of book which will be used equally as an introductory text by students and as a reference for experts.

—Matt Baker, Georgia Institute of Technology Tropical geometry is an exciting new field, which requires tools from various parts of mathematics and has connections with many areas. A short definition is given by Maclagan and Sturmfels:

“Tropical geometry is a marriage between algebraic and polyhedral geometry”. This wonderful book is a pleasant and rewarding journey through different landscapes, inviting the readers from a day at a beach to the hills of modern algebraic geometry. The authors present building blocks, examples and exercises as well as recent results in tropical geometry, with ingredients from algebra, combinatorics, symbolic computation, polyhedral geometry and algebraic geometry. The volume will appeal both to beginning graduate students willing to enter the field and to researchers, including experts.

—Alicia Dickenstein, University of Buenos Aires, Argentina

Random Surfaces Scott Sheffield 2005 The author develops a general theory of discrete and continuous height models governed by Gibbs potentials that depend only on height differences. He characterizes the gradient phases of a given slope as minimizers of specific free energy and gives large deviation principles for surface shapes and empirical measures. For convex, nearest neighbor Gibbs potentials, he shows that gradient phases are characterized by their slopes and, in higher dimensional discrete settings, by one additional parameter. For standard $2+1$ dimensional crystal surface models, he shows that all smooth phases (crystal facets) lie in the dual of the lattice of translation invariance.

Math from Three to Seven Aleksandr Kalmanovich Zvonkin 2011 This book is a captivating account of a professional mathematician's experiences conducting a math circle for preschoolers in his apartment in Moscow in the 1980s. As anyone who has taught or raised young children knows, mathematical education for little kids is a real mystery. What are they capable of? What should they learn first? How hard should they work? Should they even "work" at all? Should we push them, or just let them be? There are no correct answers to these questions, and the author deals with them in classic math-circle style: he doesn't ask and then answer a question, but shows us a problem--be it mathematical or pedagogical--and describes to us what happened. His book is a narrative about what he did, what he tried, what worked, what failed,

but most important, what the kids experienced. This book does not purport to show you how to create precocious high achievers. It is just one person's story about things he tried with a half-dozen young children. Mathematicians, psychologists, educators, parents, and everybody interested in the intellectual development in young children will find this book to be an invaluable, inspiring resource. In the interest of fostering a greater awareness and appreciation of mathematics and its connections to other disciplines and everyday life, MSRI and the AMS are publishing books in the Mathematical Circles Library series as a service to young people, their parents and teachers, and the mathematics profession. Titles in this series are co-published with the Mathematical Sciences Research Institute (MSRI).

Tensor Categories Pavel Etingof 2016-08-05 Is there a vector space whose dimension is the golden ratio? Of course not—the golden ratio is not an integer! But this can happen for generalizations of vector spaces—objects of a tensor category. The theory of tensor categories is a relatively new field of mathematics that generalizes the theory of group representations. It has deep connections with many other fields, including representation theory, Hopf algebras, operator algebras, low-dimensional topology (in particular, knot theory), homotopy theory, quantum mechanics and field theory, quantum computation, theory of motives, etc. This book gives a systematic introduction to this theory and a review of its applications. While giving a detailed overview of general tensor categories, it focuses especially on the theory of finite tensor categories and fusion categories (in particular, braided and modular ones), and discusses the main results about them with proofs. In particular, it shows how the main properties of finite-dimensional Hopf algebras may be derived from the theory of tensor categories. Many important results are presented as a sequence of exercises, which makes the book valuable for students and suitable for graduate courses. Many applications, connections to other areas, additional results, and references are discussed at the end of each chapter.

Why Johnny Can't Add Morris Kline 1974 Briefly discusses the traditional mathematics formerly taught in American schools and views the language and weaknesses of the modern math curriculum

Mathematics of Surfaces England) Ima Conference on the Mathematics of Surfaces 2003 (Leeds 2003-09-09 This book constitutes the refereed proceedings of the 10th IMA International Conference on the Mathematics of Surfaces, held in Leeds, UK in September 2003. The 25 revised full papers presented were carefully reviewed and selected from numerous submissions. Among the topics addressed are triangulated surface parameterization, bifurcation structures, control vertex computation, polyhedral surfaces, watermarking 3D polygonal meshed, subdivision surfaces, surface reconstruction, vector transport, shape from shading, surface height recovery, algebraic surfaces, box splines, the Plateau-Bezier problem, spline geometry, generative geometry, manifold representation, affine arithmetic, and PDE surfaces.

Experimental Mathematics V. I. Arnold 2015-07-14 One of the traditional ways mathematical ideas and even new areas of

mathematics are created is from experiments. One of the best-known examples is that of the Fermat hypothesis, which was conjectured by Fermat in his attempts to find integer solutions for the famous Fermat equation. This hypothesis led to the creation of a whole field of knowledge, but it was proved only after several hundred years. This book, based on the author's lectures, presents several new directions of mathematical research. All of these directions are based on numerical experiments conducted by the author, which led to new hypotheses that currently remain open, i.e., are neither proved nor disproved. The hypotheses range from geometry and topology (statistics of plane curves and smooth functions) to combinatorics (combinatorial complexity and random permutations) to algebra and number theory (continuous fractions and Galois groups). For each subject, the author describes the problem and presents numerical results that led him to a particular conjecture. In the majority of cases there is an indication of how the readers can approach the formulated conjectures (at least by conducting more numerical experiments). Written in Arnold's unique style, the book is intended for a wide range of mathematicians, from high school students interested in exploring unusual areas of mathematics on their own, to college and graduate students, to researchers interested in gaining a new, somewhat nontraditional perspective on doing mathematics. In the interest of fostering a greater awareness and appreciation of mathematics and its connections to other disciplines and everyday life, MSRI and the AMS are publishing books in the Mathematical Circles Library series as a service to young people, their parents and teachers, and the mathematics profession. Titles in this series are co-published with the Mathematical Sciences Research Institute (MSRI).

Exterior Differential Systems Robert L. Bryant 2013-06-29 This book gives a treatment of exterior differential systems. It will include both the general theory and various applications. An exterior differential system is a system of equations on a manifold defined by equating to zero a number of exterior differential forms. When all the forms are linear, it is called a pfaffian system. Our object is to study its integral manifolds, i. e. , submanifolds satisfying all the equations of the system. A fundamental fact is that every equation implies the one obtained by exterior differentiation, so that the complete set of equations associated to an exterior differential system constitutes a differential ideal in the algebra of all smooth forms. Thus the theory is coordinate-free and computations typically have an algebraic character; however, even when coordinates are used in intermediate steps, the use of exterior algebra helps to efficiently guide the computations, and as a consequence the treatment adapts well to geometrical and physical problems. A system of partial differential equations, with any number of independent and dependent variables and involving partial derivatives of any order, can be written as an exterior differential system. In this case we are interested in integral manifolds on which certain coordinates remain independent. The corresponding notion in exterior differential systems is the independence condition: certain pfaffian forms remain linearly independent. Partial differential equations and exterior differential systems with an independence

condition are essentially the same object.

Birational Geometry and Moduli Spaces Elisabetta Colombo 2020-02-25 This volume collects contributions from speakers at the INdAM Workshop “Birational Geometry and Moduli Spaces”, which was held in Rome on 11–15 June 2018. The workshop was devoted to the interplay between birational geometry and moduli spaces and the contributions of the volume reflect the same idea, focusing on both these areas and their interaction. In particular, the book includes both surveys and original papers on irreducible holomorphic symplectic manifolds, Severi varieties, degenerations of Calabi-Yau varieties, uniruled threefolds, toric Fano threefolds, mirror symmetry, canonical bundle formula, the Lefschetz principle, birational transformations, and deformations of diagrams of algebras. The intention is to disseminate the knowledge of advanced results and key techniques used to solve open problems. The book is intended for all advanced graduate students and researchers interested in the new research frontiers of birational geometry and moduli spaces.

Image Processing and Analysis Tony F. Chan 2005-09-01 This book develops the mathematical foundation of modern image processing and low-level computer vision, bridging contemporary mathematics with state-of-the-art methodologies in modern image processing, whilst organizing contemporary literature into a coherent and logical structure. The authors have integrated the diversity of modern image processing approaches by revealing the few common threads that connect them to Fourier and spectral analysis, the machinery that image processing has been traditionally built on. The text is systematic and well organized: the geometric, functional, and atomic structures of images are investigated, before moving to a rigorous development and analysis of several image processors. The book is comprehensive and integrative, covering the four most powerful classes of mathematical tools in contemporary image analysis and processing while exploring their intrinsic connections and integration. The material is balanced in theory and computation, following a solid theoretical analysis of model building and performance with computational implementation and numerical examples.

Tropical Geometry and Mirror Symmetry Mark Gross 2011-01-20 Tropical geometry provides an explanation for the remarkable power of mirror symmetry to connect complex and symplectic geometry. The main theme of this book is the interplay between tropical geometry and mirror symmetry, culminating in a description of the recent work of Gross and Siebert using log geometry to understand how the tropical world relates the A- and B-models in mirror symmetry. The text starts with a detailed introduction to the notions of tropical curves and manifolds, and then gives a thorough description of both sides of mirror symmetry for projective space, bringing together material which so far can only be found scattered throughout the literature. Next follows an introduction to the log geometry of Fontaine-Illusie and Kato, as needed for Nishinou and Siebert's proof of Mikhalkin's tropical curve counting formulas. This latter proof is given in the fourth chapter. The fifth chapter considers the mirror, B-model side, giving recent results of the author showing how tropical geometry can

be used to evaluate the oscillatory integrals appearing. The final chapter surveys reconstruction results of the author and Siebert for "integral tropical manifolds." A complete version of the argument is given in two dimensions.

Steps in Commutative Algebra R. Y. Sharp 2000 Introductory account of commutative algebra, aimed at students with a background in basic algebra.

Testimonios: Stories of Latinx and Hispanic Mathematicians Pamela E. Harris 2021-08-16 Testimonios brings together first-person narratives from the vibrant, diverse, and complex Latinx and Hispanic mathematical community. Starting with childhood and family, the authors recount their own individual stories, highlighting their upbringing, education, and career paths. Their particular stories, told in their own voices, from their own perspectives, give visibility to some of the experiences of Latinx/Hispanic mathematicians. Testimonios seeks to inspire the next generation of Latinx and Hispanic mathematicians by featuring the stories of people like them, holding a mirror up to our own community. It also aims to provide a window for mathematicians (and aspiring mathematicians) from all ethnicities, with the hope of inspiring a better understanding of the diversity of the mathematical community.

Current Developments in Algebraic Geometry Lucia Caporaso 2012-03-19 This volume, based on a workshop by the MSRI, offers an overview of the state of the art in many areas of algebraic geometry.

Differential and Symplectic Topology of Knots and Curves Serge Tabachnikov 1999 This book presents a collection of papers on two related topics: topology of knots and knot-like objects (such as curves on surfaces) and topology of Legendrian knots and links in 3-dimensional contact manifolds. Featured is the work of international experts in knot theory (quantum knot invariants, knot invariants of finite type), in symplectic and contact topology, and in singularity theory. The interplay of diverse methods from these fields makes this volume unique in the study of Legendrian knots and knot-like objects such as wave fronts. A particularly enticing feature of the volume is its international significance. The volume successfully embodies a fine collaborative effort by worldwide experts from Belgium, France, Germany, Israel, Japan, Poland, Russia, Sweden, the U.K., and the U.S.

Computational Topology Herbert Edelsbrunner 2010 Combining concepts from topology and algorithms, this book delivers what its title promises: an introduction to the field of computational topology. Starting with motivating problems in both mathematics and computer science and building up from classic topics in geometric and algebraic topology, the third part of the text advances to persistent homology. This point of view is critically important in turning a mostly theoretical field of mathematics into one that is relevant to a multitude of disciplines in the sciences and engineering. The main approach is the discovery of topology through algorithms. The book is ideal for teaching a graduate or advanced undergraduate course in computational topology, as it develops all the background of both the mathematical and algorithmic aspects of

the subject from first principles. Thus the text could serve equally well in a course taught in a mathematics department or computer science department.

Rational Points on Modular Elliptic Curves Henri Darmon 2004 The book surveys some recent developments in the arithmetic of modular elliptic curves. It places a special emphasis on the construction of rational points on elliptic curves, the Birch and Swinnerton-Dyer conjecture, and the crucial role played by modularity in shedding light on these two closely related issues. The main theme of the book is the theory of complex multiplication, Heegner points, and some conjectural variants. The first three chapters introduce the background and prerequisites: elliptic curves, modular forms and the Shimura-Taniyama-Weil conjecture, complex multiplication and the Heegner point construction. The next three chapters introduce variants of modular parametrizations in which modular curves are replaced by Shimura curves attached to certain indefinite quaternion algebras. The main new contributions are found in Chapters 7-9, which survey the author's attempts to extend the theory of Heegner points and complex multiplication to situations where the base field is not a CM field. Chapter 10 explains the proof of Kolyvagin's theorem, which relates Heegner points to the arithmetic of elliptic curves and leads to the so-far best evidence for the Birch and Swinnerton-Dyer conjecture.

The Mathematics of Data Michael W. Mahoney 2018-11-15 Nothing provided

Lectures on Spaces of Nonpositive Curvature Werner Ballmann 1995-09-01 Singular spaces with upper curvature bounds and, in particular, spaces of nonpositive curvature, have been of interest in many fields, including geometric (and combinatorial) group theory, topology, dynamical systems and probability theory. In the first two chapters of the book, a concise introduction into these spaces is given, culminating in the Hadamard-Cartan theorem and the discussion of the ideal boundary at infinity for simply connected complete spaces of nonpositive curvature. In the third chapter, qualitative properties of the geodesic flow on geodesically complete spaces of nonpositive curvature are discussed, as are random walks on groups of isometries of nonpositively curved spaces. The main class of spaces considered should be precisely complementary to symmetric spaces of higher rank and Euclidean buildings of dimension at least two (Rank Rigidity conjecture). In the smooth case, this is known and is the content of the Rank Rigidity theorem. An updated version of the proof of the latter theorem (in the smooth case) is presented in Chapter IV of the book. This chapter contains also a short introduction into the geometry of the unit tangent bundle of a Riemannian manifold and the basic facts about the geodesic flow. In an appendix by Misha Brin, a self-contained and short proof of the ergodicity of the geodesic flow of a compact Riemannian manifold of negative curvature is given. The proof is elementary and should be accessible to the non-specialist. Some of the essential features and problems of the ergodic theory of smooth dynamical systems are discussed,

and the appendix can serve as an introduction into this theory.

Computations in Algebraic Geometry with Macaulay 2 David Eisenbud 2013-03-14 This book presents algorithmic tools for algebraic geometry, with experimental applications. It also introduces Macaulay 2, a computer algebra system supporting research in algebraic geometry, commutative algebra, and their applications. The algorithmic tools presented here are designed to serve readers wishing to bring such tools to bear on their own problems. The first part of the book covers Macaulay 2 using concrete applications; the second emphasizes details of the mathematics.

Complex Algebraic Curves Frances Clare Kirwan 1992-02-20 This development of the theory of complex algebraic curves was one of the peaks of nineteenth century mathematics. They have many fascinating properties and arise in various areas of mathematics, from number theory to theoretical physics, and are the subject of much research. By using only the basic techniques acquired in most undergraduate courses in mathematics, Dr. Kirwan introduces the theory, observes the algebraic and topological properties of complex algebraic curves, and shows how they are related to complex analysis.