

# RESEARCH PROBLEMS IN DISCRETE GEOMETRY

Peter M. Gruber  
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# Research Problems In Discrete Geometry

**Karoly Bezdek, Zsolt Langi**



## Research Problems In Discrete Geometry:

**Research Problems in Discrete Geometry** Peter Brass, William O. J. Moser, János Pach, 2006-01-27 Although discrete geometry has a rich history extending more than 150 years it abounds in open problems that even a high school student can understand and appreciate Some of these problems are notoriously difficult and are intimately related to deep questions in other fields of mathematics But many problems even old ones can be solved by a clever undergraduate or a high school student equipped with an ingenious idea and the kinds of skills used in a mathematical olympiad **Research Problems in Discrete Geometry** is the result of a 25 year old project initiated by the late Leo Moser It is a collection of more than 500 attractive open problems in the field The largely self contained chapters provide a broad overview of discrete geometry along with historical details and the most important partial results related to these problems This book is intended as a source book for both professional mathematicians and graduate students who love beautiful mathematical questions are willing to spend sleepless nights thinking about them and who would like to get involved in mathematical research Important features include More than 500 open problems some old others new and never before published Each chapter divided into self contained sections each section ending with an extensive bibliography A great selection of research problems for graduate students looking for a dissertation topic A comprehensive survey of discrete geometry highlighting the frontiers and future of research More than 120 figures A preface to an earlier version written by the late Paul Erdos Peter Brass is Associate Professor of Computer Science at the City College of New York William O J Moser is Professor Emeritus at McGill University Janos Pach is Distinguished Professor at The City College of New York Research Professor at the Courant Institute NYU and Senior Research Fellow at the R nyi Institute Budapest

**Research Problems in Discrete Geometry** Peter Brass, William O. J. Moser, János Pach, 2008-11-01 This book is the result of a 25 year old project and comprises a collection of more than 500 attractive open problems in the field The largely self contained chapters provide a broad overview of discrete geometry along with historical details and the most important partial results related to these problems This book is intended as a source book for both professional mathematicians and graduate students who love beautiful mathematical questions are willing to spend sleepless nights thinking about them and who would like to get involved in mathematical research

**Research Problems in Discrete Geometry** W. O. J. Moser, 1985 □□□□□□□□□□ Peter Brass, W. O. J. Moser, János Pach, 2007 500 Research Problems in Discrete Geometry, 1981 Classical Topics in Discrete Geometry Károly Bezdek, 2010-06-23 Geometry is a classical core part of mathematics which with its birth marked the beginning of the mathematical sciences Thus not surprisingly geometry has played a key role in many important developments of mathematics in the past as well as in present times While focusing on modern mathematics one has to emphasize the increasing role of discrete mathematics or equivalently the broad movement to establish discrete analogues of major components of mathematics In this way the works of a number of outstanding mathematicians including H S M Coxeter Canada C A Rogers United Kingdom and L Fejes Th

Hungary led to the new and fast developing field called discrete geometry. One can briefly describe this branch of geometry as the study of discrete arrangements of geometric objects in Euclidean as well as in non-Euclidean spaces. This as a classical core part also includes the theory of polytopes and tilings in addition to the theory of packing and covering. Discrete geometry is driven by problems often featuring a very clear visual and applied character. The solutions use a variety of methods of modern mathematics including convex and combinatorial geometry, coding theory, calculus of variations, differential geometry, group theory and topology as well as geometric analysis and number theory.

*Surveys on Discrete and Computational Geometry* Jacob E. Goodman, 2008. This volume contains nineteen survey papers describing the state of current research in discrete and computational geometry as well as a set of open problems presented at the 2006 AMS/IMS/SIAM Summer Research Conference Discrete and Computational Geometry Twenty Years Later held in Snowbird, Utah, in June 2006. Topics surveyed include metric graph theory, lattice polytopes, the combinatorial complexity of unions of geometric objects, line and pseudoline arrangements, algorithmic semialgebraic geometry, persistent homology, unfolding polyhedra, pseudo-triangulations, nonlinear computational geometry,  $k$ -sets and the computational complexity of convex bodies.

**Lectures on Sphere Arrangements - the Discrete Geometric Side** Károly Bezdek, 2013-08-04. This monograph gives a short introduction to the relevant modern parts of discrete geometry in addition to leading the reader to the frontiers of geometric research on sphere arrangements. The readership is aimed at advanced undergraduate and early graduate students as well as interested researchers. It contains more than 40 open research problems ideal for graduate students and researchers in mathematics and computer science. Additionally, this book may be considered ideal for a one-semester advanced undergraduate or graduate level course. The core part of this book is based on three lectures given by the author at the Fields Institute during the thematic program on Discrete Geometry and Applications and contains four core topics. The first two topics surround active areas that have been outstanding from the birth of discrete geometry, namely dense sphere packings and tilings. Sphere packings and tilings have a very strong connection to number theory, coding groups, and mathematical programming. Extending the tradition of studying packings of spheres is the investigation of the monotonicity of volume under contractions of arbitrary arrangements of spheres. The third major topic of this book can be found under the sections on ball polyhedra that study the possibility of extending the theory of convex polytopes to the family of intersections of congruent balls. This section of the text is connected in many ways to the above-mentioned major topics and it is also connected to some other important research areas as the one on coverings by planks with close ties to geometric analysis. This fourth core topic is discussed under covering balls by cylinders.

*Volumetric Discrete Geometry* Károly Bezdek, Zoltán Langi, 2019-04-24. Volume of geometric objects plays an important role in applied and theoretical mathematics. This is particularly true in the relatively new branch of discrete geometry where volume is often used to find new topics for research. *Volumetric Discrete Geometry* demonstrates the recent aspects of volume, introduces problems related to it, and presents

methods to apply it to other geometric problems Part I of the text consists of survey chapters of selected topics on volume and is suitable for advanced undergraduate students Part II has chapters of selected proofs of theorems stated in Part I and is oriented for graduate level students wishing to learn about the latest research on the topic Chapters can be studied independently from each other Provides a list of 30 open problems to promote research Features more than 60 research exercises Ideally suited for researchers and students of combinatorics geometry and discrete mathematics

**Towards a Theory of Geometric Graphs** János Pach,2004 This volume contains a collection of papers on graph theory with the common theme that all the graph theoretical problems addressed are approached from a geometrical rather than an abstract point of view This is no accident the editor selected these papers not as a comprehensive literature review

Graph Theory, Combinatorics and Algorithms Martin Charles Golumbic,Irith Ben-Arroyo Hartman,2006-03-30 Graph Theory Combinatorics and Algorithms Interdisciplinary Applications focuses on discrete mathematics and combinatorial algorithms interacting with real world problems in computer science operations research applied mathematics and engineering The book contains eleven chapters written by experts in their respective fields and covers a wide spectrum of high interest problems across these discipline domains Among the contributing authors are Richard Karp of UC Berkeley and Robert Tarjan of Princeton both are at the pinnacle of research scholarship in Graph Theory and Combinatorics The chapters from the contributing authors focus on real world applications all of which will be of considerable interest across the areas of Operations Research Computer Science Applied Mathematics and Engineering These problems include Internet congestion control high speed communication networks multi object auctions resource allocation software testing data structures etc In sum this is a book focused on major contemporary problems written by the top research scholars in the field using cutting edge mathematical and computational techniques

**Encyclopedia of Computer Science and Technology** Phillip A. Laplante,2017-10-02 With breadth and depth of coverage the Encyclopedia of Computer Science and Technology Second Edition has a multi disciplinary scope drawing together comprehensive coverage of the inter related aspects of computer science and technology The topics covered in this encyclopedia include General and reference Hardware Computer systems organization Networks Software and its engineering Theory of computation Mathematics of computing Information systems Security and privacy Human centered computing Computing methodologies Applied computing Professional issues Leading figures in the history of computer science The encyclopedia is structured according to the ACM Computing Classification System CCS first published in 1988 but subsequently revised in 2012 This classification system is the most comprehensive and is considered the de facto ontological framework for the computing field The encyclopedia brings together the information and historical context that students practicing professionals researchers and academicians need to have a strong and solid foundation in all aspects of computer science and technology

*Convexity from the Geometric Point of View* Vitor Balestro,Horst Martini,Ralph Teixeira,2024-07-14 This text gives a comprehensive introduction to the common core of convex geometry

Basic concepts and tools which are present in all branches of that field are presented with a highly didactic approach. Mainly directed to graduate and advanced undergraduates, the book is self-contained in such a way that it can be read by anyone who has standard undergraduate knowledge of analysis and of linear algebra. Additionally, it can be used as a single reference for a complete introduction to convex geometry, and the content coverage is sufficiently broad that the reader may gain a glimpse of the entire breadth of the field and various subfields. The book is suitable as a primary text for courses in convex geometry and also in discrete geometry including polytopes. It is also appropriate for survey-type courses in Banach space theory, convex analysis, differential geometry, and applications of measure theory. Solutions to all exercises are available to instructors who adopt the text for coursework. Most chapters use the same structure, with the first part presenting theory and the next containing a healthy range of exercises. Some of the exercises may even be considered as short introductions to ideas which are not covered in the theory portion. Each chapter has a notes section offering a rich narrative to accompany the theory, illuminating the development of ideas and providing overviews to the literature concerning the covered topics. In most cases, these notes bring the reader to the research front. The text includes many figures that illustrate concepts and some parts of the proofs, enabling the reader to have a better understanding of the geometric meaning of the ideas. An appendix containing basic and geometric measure theory collects useful information for convex geometers.

*Algorithms - ESA 2007* Lars Arge, Michael Hoffmann, Emo Welzl, 2007-09-17. This book constitutes the refereed proceedings of the 15th Annual European Symposium on Algorithms ESA 2007, held in Eilat, Israel, in October 2007, in the context of the combined conference ALGO 2007. The 63 revised full papers presented together with abstracts of three invited lectures address all current subjects in algorithmics, reaching from design and analysis issues of algorithms over to real-world applications and engineering of algorithms in various fields.

**Convexity and Discrete Geometry Including Graph Theory** Karim Adiprasito, Imre Bárány, Costin Vilcu, 2016-05-02. This volume presents easy-to-understand yet surprising properties obtained using topological, geometric, and graph-theoretic tools in the areas covered by the Geometry Conference that took place in Mulhouse, France, from September 7-11, 2014, in honour of Tudor Zamfirescu on the occasion of his 70th anniversary. The contributions address subjects in convexity and discrete geometry in distance geometry or with geometrical flavor in combinatorics, graph theory, or non-linear analysis. Written by top experts, these papers highlight the close connections between these fields as well as ties to other domains of geometry and their reciprocal influence. They offer an overview on recent developments in geometry and its border with discrete mathematics and provide answers to several open questions. The volume addresses a large audience in mathematics, including researchers and graduate students interested in geometry and geometrical problems.

Incidence Problems in Discrete Geometry Charles Wolf, 2017. Over the past decade, discrete geometry research has flourished with clever uses of algebraic methods. The polynomial method has had a deep impact on a wide collection of results in combinatorics, such as tight asymptotic lower bounds on finite field Kakeya and Nikodym sets, near-optimal lower bound for

Erdos distinct distances problem and improved bounds for cap sets Spectral methods and rank bounds for matrices have shed new light on improved bounds for point line incidences subspace intersections and graph rigidity This thesis is focused on developing new ways to improve on these techniques and applying them in a few discrete geometry settings 1 Techniques such as matrix scaling and rank bounds for design matrices have recently found beautiful applications for understanding configurations of points and lines over the complex numbers In particular they give a different proof of Kelly s Theorem which says that any configuration of points in complex space must either be contained in a plane or have a line passing through exactly 2 of those points called an ordinary line We expand on these techniques to prove the first quantitative bounds for the number of ordinary lines in a non planar configuration of points in complex space 2 In 2008 showed in a breakthrough result that a Kakeya set over finite fields has an asymptotically tight lower bound using the polynomial method Later in 2008 Saraf and Sudan improved on the polynomial method by interpolating a polynomial that vanishes with high multiplicity on points of the Kakeya set We further enhance the polynomial method by introducing the notion of fractional multiplicity and use this improvement to obtain a better lower bound for finite field Kakeya sets in 3 dimensions 3 While studying these 3 dimensional finite field Kakeya sets we considered the related 3 dimensional finite field Nikodym sets Previously the lower bound for a 3 dimensional finite field Nikodym sets was also obtained using the polynomial method and had the same lower bound as for a Kakeya set We achieve a better lower bound for 3 dimensional finite field Nikodym sets thus separating it from the Kakeya set lower bound

**Discrete and Computational Geometry** Boris Aronov, Saugata Basu, Janos Pach, Micha Sharir, 2003-06-23 An impressive collection of original research papers in discrete and computational geometry contributed by many leading researchers in these fields as a tribute to Jacob E Goodman and Richard Pollack two of the founding fathers of the area on the occasion of their 2 3 x 100 birthdays The topics covered by the 41 papers provide professionals and graduate students with a comprehensive presentation of the state of the art in most aspects of discrete and computational geometry including geometric algorithms study of arrangements geometric graph theory quantitative and algorithmic real algebraic geometry with important connections to algebraic geometry convexity polyhedral combinatorics the theory of packing covering and tiling The book serves as an invaluable source of reference in this discipline [Annals of the New York Academy of Sciences](#) Thomas Lincoln Casey, Gilbert Van Ingen, Charles Lane Poor, Edmund Otis Hovey, Ralph Winfred Tower, 1985

**Lectures on Discrete Geometry**, *Discrete Geometry and Symmetry* Marston D. E. Conder, Antoine Deza, Asia Ivić Weiss, 2018-06-11 This book consists of contributions from experts presenting a fruitful interplay between different approaches to discrete geometry Most of the chapters were collected at the conference Geometry and Symmetry in Veszprém Hungary from 29 June to 3 July 2015 The conference was dedicated to Károly Bezdek and Egon Schulte on the occasion of their 60th birthdays acknowledging their highly regarded contributions in these fields While the classical problems of discrete geometry have a strong connection to geometric analysis coding theory symmetry groups and

number theory their connection to combinatorics and optimization has become of particular importance The last decades have seen a revival of interest in discrete geometric structures and their symmetry The rapid development of abstract polytope theory has resulted in a rich theory featuring an attractive interplay of methods and tools from discrete geometry group theory and geometry combinatorial group theory and hyperbolic geometry and topology This book contains papers on new developments in these areas including convex and abstract polytopes and their recent generalizations tiling and packing zonotopes isoperimetric inequalities and on the geometric and combinatorial aspects of linear optimization The book is a valuable resource for researchers both junior and senior in the field of discrete geometry combinatorics or discrete optimization Graduate students find state of the art surveys and an open problem collection

This book delves into Research Problems In Discrete Geometry. Research Problems In Discrete Geometry is an essential topic that must be grasped by everyone, ranging from students and scholars to the general public. The book will furnish comprehensive and in-depth insights into Research Problems In Discrete Geometry, encompassing both the fundamentals and more intricate discussions.

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- This book is crafted in an easy-to-understand language and is complemented by engaging illustrations. It is highly recommended for anyone seeking to gain a comprehensive understanding of Research Problems In Discrete Geometry.

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