

The Probabilistic Method

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the leading reference on probabilistic methods in combinatorics now expanded and updated when it was first published in 1991 the probabilistic method became instantly the standard reference on one of the most powerful and widely used tools in combinatorics still without competition nearly a decade later this new edition brings you up to speed on recent developments while adding useful exercises and over 30 new material it continues to emphasize the basic elements of the methodology discussing in a remarkably clear and informal style both algorithmic and classical methods as well as modern applications the probabilistic method second edition begins with basic techniques that use expectation and variance as well as the more recent martingales and correlation inequalities then explores areas where probabilistic techniques proved successful including discrepancy and random graphs as well as cutting edge topics in theoretical computer science a series of proofs or probabilistic lenses are interspersed throughout the book offering added insight into the application of the probabilistic

approach new and revised coverage includes several improved as well as new results a continuous approach to discrete probabilistic problems talagrand's inequality and other novel concentration results a discussion of the connection between discrepancy and vc dimension several combinatorial applications of the entropy function and its properties a new section on the life and work of paul erdős the developer of the probabilistic method

this update of the 1987 title of the same name is an examination of what is currently known about the probabilistic method written by one of its principal developers based on the notes from spencer's 1986 series of ten lectures this new edition contains an additional lecture the janson inequalities these inequalities allow accurate approximation of extremely small probabilities a new algorithmic approach to the lovasz local lemma attributed to jozsef beck has been added to lecture 8 as well

over the past decade many major advances have been made in the field of graph colouring via the probabilistic method this monograph provides an accessible and unified treatment of these results using tools such as the lovasz local lemma and talagrand's concentration inequality the topics covered include kahn's proofs that the goldberg seymour and list colouring conjectures hold asymptotically a proof that for some absolute constant c every graph of maximum degree Δ has a Δ^c total colouring johansson's proof that a triangle free graph has a $O(\Delta / \log \Delta)$ colouring algorithmic variants of the local lemma which permit the efficient construction of many optimal and near optimal colourings this begins with a gentle introduction to the probabilistic method and will be useful to researchers and graduate students in graph theory discrete mathematics theoretical computer science and probability

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the stability of natural rock slopes is influenced by a wide spectrum of factors such as mechanical properties of bedrocks and spatial distribution of discontinuities their specific values are typically incomplete due mainly to the lack of effective and comprehensive methods to accurately characterize these factors especially those inside of the slopes the neutrosophic number is a useful tool to solve problems in indeterminate environment

leave nothing to chance this cliché embodies the common belief that randomness has no place in carefully planned methodologies every step should be spelled out each i dotted and each t crossed in discrete mathematics at least nothing could be further from the truth introducing random choices into algorithms can improve their

performance the application of probabilistic tools has led to the resolution of combinatorial problems which had resisted attack for decades the chapters in this volume explore and celebrate this fact our intention was to bring together for the first time accessible discussions of the disparate ways in which probabilistic ideas are enriching discrete mathematics these discussions are aimed at mathematicians with a good combinatorial background but require only a passing acquaintance with the basic definitions in probability e.g. expected value conditional probability a reader who already has a firm grasp on the area will be interested in the original research novel syntheses and discussions of ongoing developments scattered throughout the book some of the most convincing demonstrations of the power of these techniques are randomized algorithms for estimating quantities which are hard to compute exactly one example is the randomized algorithm of Dyer, Frieze and Kannan for estimating the volume of a polyhedron to illustrate these techniques we consider a simple related problem suppose S is some region of the unit square defined by a system of polynomial inequalities $p_i(x, y) \leq 0$

the book gives an accessible account of modern probabilistic methods for analyzing combinatorial structures and algorithms each topic is approached in a didactic manner but the most recent developments are linked to the basic material extensive lists of references and a detailed index will make this a useful guide for graduate students and researchers special features included a simple treatment of Talagrand inequalities and their applications an overview and many carefully worked out examples of the probabilistic analysis of combinatorial algorithms a discussion of the exact simulation algorithm in the context of Markov chain Monte Carlo methods a general method for finding asymptotically optimal or near optimal graph colouring showing how the probabilistic method may be fine tuned to exploit the structure of the underlying graph a succinct treatment of randomized algorithms and derandomization techniques

randomization and probabilistic techniques play an important role in modern computer science with applications ranging from combinatorial optimization and machine learning to communication networks and secure protocols this 2005 textbook is designed to accompany a one or two semester course for advanced undergraduates or beginning graduate students in computer science and applied mathematics it gives an excellent introduction to the probabilistic techniques and paradigms used in the development of probabilistic algorithms and analyses it assumes only an elementary background in discrete mathematics and gives a rigorous yet accessible treatment of the material with numerous examples and applications the first half of the book covers core material including random sampling expectations Markov's inequality Chebyshev's inequality Chernoff bounds the probabilistic method and Markov chains the second half covers more advanced topics such as continuous probability applications of limited independence entropy Markov chain Monte Carlo methods and balanced allocations with its comprehensive selection of topics along with many examples and exercises this book is an indispensable teaching tool

the probabilistic method is the art of introducing probability to prove results that often do not involve randomness to begin with in this thesis we present four applications of this powerful technique which has become one of the cornerstones of modern combinatorics first we prove a new lower bound for online Ramsey numbers giving for the first time an exponential separation between the lower bounds for classical and online Ramsey numbers informally this means that it is quite difficult to adaptively find a monochromatic clique in an edge coloring of a large complete graph next we determine the growth rate of a certain off diagonal hypergraph Ramsey number

answering a question of Erdős and Hajnal from 1972 this is the first nontrivial hypergraph Ramsey number whose exponential order has been determined the proof introduces a new random model for hypergraphs and relies heavily on the entropy method third we apply the entropy method to extremal graph theory proving Tomescu's graph coloring conjecture from 1971 this determines the maximum number of proper k colorings of any graph with chromatic number k and n vertices in the proof we use an entropy inequality related to sequential importance sampling an estimation technique from statistics finally we present a result in probabilistic combinatorics outside graph theory an n permutation is called k universal if it contains every k permutation as a pattern and it is known that the shortest k universal permutation has length $O(k^2)$ it was suggested by Alon that actually almost all n permutations are k universal for some $n = O(k^2)$ and he proved that a random permutation of length $O(k^2 \log k)$ is k universal with high probability using a structure versus randomness approach we improve this bound to $O(k^2 \log \log k)$ almost closing the gap to the conjecture

We are pleased to present this global edition which has been developed specifically to meet the needs of international students of discrete mathematics in addition to great depth in key areas and a broad range of real world applications across multiple disciplines we have added new material to make the content more relevant and improve learning outcomes for the international student this global edition includes an entire new chapter on algebraic structures and coding theory new and expanded sections within chapters covering foundations basic structures and advanced counting techniques special online only chapters on boolean algebra and modeling computation new and revised problems for the international student integrating alternative methods and solutions this global edition has been adapted to meet the needs of courses outside of the United States and does not align with the instructor and student resources available with the US edition

This third edition of the Probabilistic Method reflects the most recent developments in the field while maintaining the standard of excellence that established this book as the leading reference on probabilistic methods in combinatorics maintaining its clear writing style illustrative examples and practical exercises this new edition emphasizes methodology enabling readers to use probabilistic techniques for solving problems in such fields as theoretical computer science mathematics and statistical physics this book begins with a description of tools applied in probabilistic arguments including basic techniques that use expectation and variance as well as the more recent applications of martingales and correlation inequalities next the authors examine where probabilistic techniques have been applied successfully exploring such topics as discrepancy and random graphs circuit complexity computational geometry and derandomization of randomized algorithms sections labeled the Probabilistic Lens offer additional insights into the application of the probabilistic approach and the appendix has been updated to include methodologies for finding lower bounds for large deviations the third edition also features a new chapter on graph property testing which is a current topic that incorporates combinatorial probabilistic and algorithmic techniques an elementary approach using probabilistic techniques to the powerful Szemerédi regularity lemma and its applications new sections devoted to percolation and liar games and a new chapter that provides a modern treatment of the Erdős-Rényi phase transition in the random graph process written by two leading authorities in the field the Probabilistic Method third edition is an ideal reference for researchers in combinatorics and algorithm design who would like to better understand the use of probabilistic methods the book's numerous exercises and examples also make it an excellent textbook for graduate level courses in mathematics and computer science

the present book presents an in depth report on probabilistic methods used to study fatigue and fracture of engineering materials it is divided into three sections fatigue reliability modeling and statistical methods the book will serve as a useful new reference on probabilistic methods in fatigue and fracture it should be of interest to researchers and engineers in industry and academia

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