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# Graph Theory Problems And Solutions

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50 years of Combinatorics, Graph Theory, and Computing  
Combinatorics and Graph Theory  
Graph Theory with Applications to Engineering and Computer Science  
Applied Combinatorics  
Second Edition  
Exact Solutions of Shortest-Path Problems Based on Mechanical Analogies  
A Discrete Approach  
Schaum's Outline of Graph Theory: Including Hundreds of Solved Problems  
Discrete Mathematics with Graph Theory (Classic Version)  
Introduction to Graph Theory  
Problems and Solutions in Structural Geology and Tectonics  
Graph Edge Coloring  
Theory, Solutions and Applications  
In Honor of Gregory Z. Gutin's 60th Birthday  
In Connection with Labyrinths, Mazes and Graph Theory  
Graph Theory and Computing  
Graph Theory and Its Applications to Problems of Society  
Problems and Solutions in Introductory and Advanced Matrix Calculus  
Optimization Problems in Graph Theory  
An Open Introduction  
Vizing's Theorem and Goldberg's Conjecture  
Introduction to Graph Theory  
Graphentheorie  
Solutions Manual  
Arc Routing  
Finite and Discrete Math Problem Solver

Discrete Mathematics  
Problems in Combinatorics and Graph Theory  
Concise Encyclopedia of Software Engineering  
Solutions Manual  
Handbook of Graph Theory, Combinatorial Optimization, and Algorithms  
A Concise Study Companion and Guide  
The Finite and Discrete Math Problem Solver  
Fundamentals of Graph Theory  
Graph Theory  
The William Lowell Putnam Mathematical Competition 2001–2016: Problems, Solutions, and Commentary  
Problems & Solutions in Theoretical & Mathematical Physics: Advanced level  
Mathematical Circle Diaries, Year 2: Complete Curriculum for Grades 6 to 8

*Graph Theory Problems  
And Solutions*

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## **ROLLINS KYLER**

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50 years of Combinatorics, Graph Theory,  
and Computing Springer Nature

Concisely written, gentle introduction to graph theory suitable as a textbook or for self-study Graph-theoretic applications from diverse fields (computer science, engineering, chemistry, management science) 2nd ed. includes new chapters on labeling and communications networks and small worlds, as well as expanded beginner's material Many additional changes, improvements, and corrections

resulting from classroom use  
*Combinatorics and Graph Theory* World Scientific

This book is a collection of problems with detailed solutions which will prove valuable to students and research workers in mathematics, physics, engineering and other sciences. The topics range in difficulty from elementary to advanced level. Almost all the problems are solved in detail and most of them are self-contained. All relevant definitions are given. Students can learn important principles and strategies required for problem solving. Teachers will find this text useful as a supplement, since

important concepts and techniques are developed through the problems. The material has been tested in the author's lectures given around the world. The book is divided into two volumes. Volume I presents the introductory problems, for undergraduate and advanced undergraduate students. In Volume II, the more advanced problems, together with detailed solutions, are collected, to meet the needs of graduate students and researchers. The problems included cover most of the new fields in theoretical and mathematical physics, such as Lax representation, Backlund transformation, soliton equations, Lie-algebra-valued

differential forms, the Hirota technique, the Painleve test, the Bethe ansatz, the Yang -- Baxter relation, chaos, fractals, complexity, etc.

### **Graph Theory with Applications to Engineering and Computer Science**

McGraw Hill Professional

In this book, approaches based on mechanical analogies are presented for the solutions of path finding problems and exact solutions of shortest path problems. Shortest path problems are of great importance not only in terms of theory but also in solutions of optimization problems in many different areas of real life. The fact that shortest path problems are spread over different areas makes it important that it is understandable, even to a certain level, by people of different branches and education levels in order to use the proposed solution methods effectively. In the preparation of this book, special attention was paid to this issue, and the familiar nature of mechanical behaviors was supported by visuals that could be easily understood by everyone, and the theory of the essence of the approach was made without allowing it to be lost due to detailed presentations of

numerical methods that are already well known. The numerical methods in the book are utilized in the programs commonly used in calculations and simulations of the engineering and the gaming industry. Faster progress can be made in multidisciplinary working groups on the adaptation of the finite element method (FEM) based programs or rigid body dynamics (RBD) based motion engines to presented approaches. In this book, not even an equation was required to present topics and approaches. Because once the fiction of mechanical behaviors is designed with a natural imagination, the only thing left for the solution of the problem is the introduction of the designed model into software created on the basis of well-known numerical methods. In the study, the terms maze and labyrinth are frequently used. Although these two terms historically refer to some geometric forms, Graph Theory and topology also express certain definitions. It is important to understand the "labyrinth-path finding" and "maze-shortest path" relationship, especially for those who will use the methods to be presented with their

engineering approach, in connection with these broadly detailed definitions in the study. This book is organized into four chapters. The articles in each chapter are prepared independently of each other. Although the articles are independent from each other, since the approach in each chapter covers the approach in the previous chapter, reading articles in order facilitates their understanding. In Chapter 1 and 2, each path finding problem is addressed with different mechanical analogies, and there are important differences between approaches in terms of both computational cost and criteria used in the solutions. Chapter 3 provides highly detailed information and linked solutions for situations that need attention when it comes to implementing mechanical modeling and numerical methods. In Chapter 4, a very effective and simplified method based on the displacement criteria that can be used in the exact solution of the shortest path problems constructed in the light of the warnings mentioned in Chapter 3 is presented. FEM, which engineers and scientists are quite familiar with, has been widely used in presenting approaches and

simulations, but RBD-based calculations also have significant advantages such as computational cost. The main reason for the predominant use of FEM as a numerical method in the examples is the fact that FEM has many parameters that allow it to be adapted to different problem types easily and is more effective in understanding the approaches. The topics in the book are quite different from my routine academic work, and the writing of the book has been a long process due to ongoing projects, studies and contributions to education. The covid19 pandemic provided the time for me to finish this book. I hope this book will contribute to the work of researchers interested in the subject and serve as an additional toolbox that can be used in the exact solution of shortest problems.

Academic Press  
 Problems and Solutions in Structural Geology and Tectonics, Volume 5, in the series Developments in Structural Geology and Tectonics, presents students, researchers and practitioners with an all-new set of problems and solutions that structural geologists and tectonics researchers commonly face. Topics

covered include ductile deformation (such as strain analyses), brittle deformation (such as rock fracturing), brittle-ductile deformation, collisional and shortening tectonics, thrust-related exercises, rift and extensional tectonics, strike slip tectonics, and cross-section balancing exercises. The book provides a how-to guide for students of structural geology and geologists working in the oil, gas and mining industries. Provides practical solutions to industry-related issues, such as well bore stability Allows for self-study and includes background information and explanation of research and industry jargon Includes full color diagrams to explain 3D issues

*Applied Combinatorics* Elsevier  
 This is a companion to the book Introduction to Graph Theory (World Scientific, 2006). The student who has worked on the problems will find the solutions presented useful as a check and also as a model for rigorous mathematical writing. For ease of reference, each chapter recaps some of the important concepts and/or formulae from the earlier book.

Second Edition Wiley-Interscience  
 Because of its inherent simplicity, graph

theory has a wide range of applications in engineering, and in physical sciences. It has of course uses in social sciences, in linguistics and in numerous other areas. In fact, a graph can be used to represent almost any physical situation involving discrete objects and the relationship among them. Now with the solutions to engineering and other problems becoming so complex leading to larger graphs, it is virtually difficult to analyze without the use of computers. This book is recommended in IIT Kharagpur, West Bengal for B.Tech Computer Science, NIT Arunachal Pradesh, NIT Nagaland, NIT Agartala, NIT Silchar, Gauhati University, Dibrugarh University, North Eastern Regional Institute of Management, Assam Engineering College, West Bengal University of Technology (WBUT) for B.Tech, M.Tech Computer Science, University of Burdwan, West Bengal for B.Tech. Computer Science, Jadavpur University, West Bengal for M.Sc. Computer Science, Kalyani College of Engineering, West Bengal for B.Tech. Computer Science. Key Features: This book provides a rigorous yet informal treatment of graph theory with an

emphasis on computational aspects of graph theory and graph-theoretic algorithms. Numerous applications to actual engineering problems are incorporated with software design and optimization topics.

*Exact Solutions of Shortest-Path Problems Based on Mechanical Analogies* Elsevier

This text offers the most comprehensive and up-to-date presentation available on the fundamental topics in graph theory. It develops a thorough understanding of the structure of graphs, the techniques used to analyze problems in graph theory and the uses of graph theoretical algorithms in mathematics, engineering and computer science. There are many new topics in this book that have not appeared before in print: new proofs of various classical theorems, signed degree sequences, criteria for graphical sequences, eccentric sequences, matching and decomposition of planar graphs into trees. Scores in digraphs appear for the first time and include new results due to Pirzada. The climax of the book is a new proof of the famous four colour theorem due to Dharwadker.

**A Discrete Approach** Pearson

Graph theory is a fascinating and inviting branch of mathematics. Many problems are easy to state and have natural visual representations, inviting exploration by new students and professional mathematicians. The goal of this textbook is to present the fundamentals of graph theory to a wide range of readers. The book contains many significant recent results in graph theory, presented using up-to-date notation. The author included the shortest, most elegant, most intuitive proofs for modern and classic results while frequently presenting them in new ways. Major topics are introduced with practical applications that motivate their development, and which are illustrated with examples that show how to apply major theorems in practice. This includes the process of finding a brute force solution (case-checking) when an elegant solution is not apparent. With over 1200 exercises, internet resources (e.g., the OEIS for counting problems), helpful appendices, and a detailed guide to different course outlines, this book provides a versatile and convenient tool for the needs of instructors at a large variety of institutions.

Schaum's Outline of Graph Theory: Including Hundreds of Solved Problems  
Research & Education Assn  
h Problem Solver is an insightful and essential study and solution guide chock-full of clear, concise problem-solving gems. All your questions can be found in one convenient source from one of the most trusted names in reference solution guides. More useful, more practical, and more informative, these study aids are the best review books and textbook companions available. Nothing remotely as comprehensive or as helpful exists in their subject anywhere. Perfect for undergraduate and graduate studies. Here in this highly useful reference is the finest overview of finite and discrete math currently available, with hundreds of finite and discrete math problems that cover everything from graph theory and statistics to probability and Boolean algebra. Each problem is clearly solved with step-by-step detailed solutions.  
DETAILS - The PROBLEM SOLVERS are unique - the ultimate in study guides. - They are ideal for helping students cope with the toughest subjects. - They greatly simplify study and learning tasks. - They

enable students to come to grips with difficult problems by showing them the way, step-by-step, toward solving problems. As a result, they save hours of frustration and time spent on groping for answers and understanding. - They cover material ranging from the elementary to the advanced in each subject. - They work exceptionally well with any text in its field. - PROBLEM SOLVERS are available in 41 subjects. - Each PROBLEM SOLVER is prepared by supremely knowledgeable experts. - Most are over 1000 pages. - PROBLEM SOLVERS are not meant to be read cover to cover. They offer whatever may be needed at a given time. An excellent index helps to locate specific problems rapidly. TABLE OF CONTENTS Introduction Chapter 1: Logic Statements, Negations, Conjunctions, and Disjunctions Truth Table and Proposition Calculus Conditional and Biconditional Statements Mathematical Induction Chapter 2: Set Theory Sets and Subsets Set Operations Venn Diagram Cartesian Product Applications Chapter 3: Relations Relations and Graphs Inverse Relations and Composition of Relations Properties of Relations Equivalence Relations Chapter 4:

Functions Functions and Graphs Surjective, Injective, and Bijective Functions Chapter 5: Vectors and Matrices Vectors Matrix Arithmetic The Inverse and Rank of a Matrix Determinants Matrices and Systems of Equations, Cramer's Rule Special Kinds of Matrices Chapter 6: Graph Theory Graphs and Directed Graphs Matrices and Graphs Isomorphic and Homeomorphic Graphs Planar Graphs and Colorations Trees Shortest Path(s) Maximum Flow Chapter 7: Counting and Binomial Theorem Factorial Notation Counting Principles Permutations Combinations The Binomial Theorem Chapter 8: Probability Probability Conditional Probability and Bayes' Theorem Chapter 9: Statistics Descriptive Statistics Probability Distributions The Binomial and Joint Distributions Functions of Random Variables Expected Value Moment Generating Function Special Discrete Distributions Normal Distributions Special Continuous Distributions Sampling Theory Confidence Intervals Point Estimation Hypothesis Testing Regression and Correlation Analysis Non-Parametric Methods Chi-Square and Contingency Tables Miscellaneous Applications Chapter

10: Boolean Algebra Boolean Algebra and Boolean Functions Minimization Switching Circuits Chapter 11: Linear Programming and the Theory of Games Systems of Linear Inequalities Geometric Solutions and Dual of Linear Programming Problems The Simplex Method Linear Programming - Advanced Methods Integer Programming The Theory of Games Index WHAT THIS BOOK IS FOR Students have generally found finite and discrete math difficult subjects to understand and learn. Despite the publication of hundreds of textbooks in this field, each one intended to provide an improvement over previous textbooks, students of finite and discrete math continue to remain perplexed as a result of numerous subject areas that must be remembered and correlated when solving problems. Various interpretations of finite and discrete math terms also contribute to the difficulties of mastering the subject. In a study of finite and discrete math, REA found the following basic reasons underlying the inherent difficulties of finite and discrete math: No systematic rules of analysis were ever developed to follow in a step-by-step manner to solve typically encountered problems. This results from

numerous different conditions and principles involved in a problem that leads to many possible different solution methods. To prescribe a set of rules for each of the possible variations would involve an enormous number of additional steps, making this task more burdensome than solving the problem directly due to the expectation of much trial and error. Current textbooks normally explain a given principle in a few pages written by a finite and discrete math professional who has insight into the subject matter not shared by others. These explanations are often written in an abstract manner that causes confusion as to the principle's use and application. Explanations then are often not sufficiently detailed or extensive enough to make the reader aware of the wide range of applications and different aspects of the principle being studied. The numerous possible variations of principles and their applications are usually not discussed, and it is left to the reader to discover this while doing exercises. Accordingly, the average student is expected to rediscover that which has long been established and practiced, but not always published or adequately explained.

The examples typically following the explanation of a topic are too few in number and too simple to enable the student to obtain a thorough grasp of the involved principles. The explanations do not provide sufficient basis to solve problems that may be assigned for homework or given on examinations. Poorly solved examples such as these can be presented in abbreviated form which leaves out much explanatory material between steps, and as a result requires the reader to figure out the missing information. This leaves the reader with an impression that the problems and even the subject are hard to learn - completely the opposite of what an example is supposed to do. Poor examples are often worded in a confusing or obscure way. They might not state the nature of the problem or they present a solution, which appears to have no direct relation to the problem. These problems usually offer an overly general discussion - never revealing how or what is to be solved. Many examples do not include accompanying diagrams or graphs, denying the reader the exposure necessary for drawing good diagrams and graphs. Such practice only

strengthens understanding by simplifying and organizing finite and discrete math processes. Students can learn the subject only by doing the exercises themselves and reviewing them in class, obtaining experience in applying the principles with their different ramifications. In doing the exercises by themselves, students find that they are required to devote considerable more time to finite and discrete math than to other subjects, because they are uncertain with regard to the selection and application of the theorems and principles involved. It is also often necessary for students to discover those "tricks" not revealed in their texts (or review books) that make it possible to solve problems easily. Students must usually resort to methods of trial and error to discover these "tricks," therefore finding out that they may sometimes spend several hours to solve a single problem. When reviewing the exercises in classrooms, instructors usually request students to take turns in writing solutions on the boards and explaining them to the class. Students often find it difficult to explain in a manner that holds the interest of the class, and enables the remaining

students to follow the material written on the boards. The remaining students in the class are thus too occupied with copying the material off the boards to follow the professor's explanations. This book is intended to aid students in finite and discrete math overcome the difficulties described by supplying detailed illustrations of the solution methods that are usually not apparent to students. Solution methods are illustrated by problems that have been selected from those most often assigned for class work and given on examinations. The problems are arranged in order of complexity to enable students to learn and understand a particular topic by reviewing the problems in sequence. The problems are illustrated with detailed, step-by-step explanations, to save the students large amounts of time that is often needed to fill in the gaps that are usually found between steps of illustrations in textbooks or review/outline books. The staff of REA considers finite and discrete math a subject that is best learned by allowing students to view the methods of analysis and solution techniques. This learning approach is similar to that practiced in various

scientific laboratories, particularly in the medical fields. In using this book, students may review and study the illustrated problems at their own pace; students are not limited to the time such problems receive in the classroom. When students want to look up a particular type of problem and solution, they can readily locate it in the book by referring to the index that has been extensively prepared. It is also possible to locate a particular type of problem by glancing at just the material within the boxed portions. Each problem is numbered and surrounded by a heavy black border for speedy identification.

*Discrete Mathematics with Graph Theory (Classic Version)* Research & Education Assoc.

In its second edition, expanded with new chapters on domination in graphs and on the spectral properties of graphs, this book offers a solid background in the basics of graph theory. Introduces such topics as Dirac's theorem on  $k$ -connected graphs and more.

American Mathematical Soc.

h Problem Solver is an insightful and essential study and solution guide chock-

full of clear, concise problem-solving gems. All your questions can be found in one convenient source from one of the most trusted names in reference solution guides. More useful, more practical, and more informative, these study aids are the best review books and textbook companions available. Nothing remotely as comprehensive or as helpful exists in their subject anywhere. Perfect for undergraduate and graduate studies. Here in this highly useful reference is the finest overview of finite and discrete math currently available, with hundreds of finite and discrete math problems that cover everything from graph theory and statistics to probability and Boolean algebra. Each problem is clearly solved with step-by-step detailed solutions. DETAILS - The PROBLEM SOLVERS are unique - the ultimate in study guides. - They are ideal for helping students cope with the toughest subjects. - They greatly simplify study and learning tasks. - They enable students to come to grips with difficult problems by showing them the way, step-by-step, toward solving problems. As a result, they save hours of frustration and time spent on groping for

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*Introduction to Graph Theory* CRC Press  
Originally published in 2006, reissued as part of Pearson's modern classic series.

Problems and Solutions in Structural Geology and Tectonics CRC Press

This book provides an extensive collection of problems with detailed solutions in introductory and advanced matrix calculus. Supplementary problems in each chapter will challenge and excite the reader, ideal for both graduate and undergraduate mathematics and theoretical physics students. The coverage includes systems of linear equations, linear differential equations, integration and matrices, Kronecker product and vector operation as well as functions of matrices. Furthermore, specialized topics such as

spectral theorem, nonnormal matrices and mutually unbiased bases are included. Many of the problems are related to applications for group theory, Lie algebra theory, wavelets, graph theory and matrix-valued differential forms, benefitting physics and engineering students and researchers alike. It also branches out to problems with tensors and the hyperdeterminant. Computer algebra programs in Maxima and SymbolicC++ have also been provided.

*Graph Edge Coloring* Springer-Verlag, Heidelberg

This book presents open optimization problems in graph theory and networks. Each chapter reflects developments in theory and applications based on Gregory Gutin's fundamental contributions to advanced methods and techniques in combinatorial optimization. Researchers, students, and engineers in computer science, big data, applied mathematics, operations research, algorithm design, artificial intelligence, software engineering, data analysis, industrial and systems engineering will benefit from the state-of-the-art results presented in modern graph theory and its applications

to the design of efficient algorithms for optimization problems. Topics covered in this work include:

- Algorithmic aspects of problems with disjoint cycles in graphs
- Graphs where maximal cliques and stable sets intersect
- The maximum independent set problem with special classes
- A general technique for heuristic algorithms for optimization problems
- The network design problem with cut constraints
- Algorithms for computing the frustration index of a signed graph
- A heuristic approach for studying the patrol problem on a graph
- Minimum possible sum and product of the proper connection number
- Structural and algorithmic results on branchings in digraphs
- Improved upper bounds for Korkel--Ghosh benchmark SPLP instances

### **Theory, Solutions and Applications**

John Wiley & Sons

Now with solutions to selected problems, *Applied Combinatorics, Second Edition* presents the tools of combinatorics from an applied point of view. This bestselling textbook offers numerous references to the literature of combinatorics and its applications that enable readers to delve more deeply into the topics. After

introducing fundamental counting *In Honor of Gregory Z. Gutin's 60th Birthday* Institute of Mathematics  
 Note: This is the 3rd edition. If you need the 2nd edition for a course you are taking, it can be found as a "other format" on amazon, or by searching its isbn: 1534970746 This gentle introduction to discrete mathematics is written for first and second year math majors, especially those who intend to teach. The text began as a set of lecture notes for the discrete mathematics course at the University of Northern Colorado. This course serves both as an introduction to topics in discrete math and as the "introduction to proof" course for math majors. The course is usually taught with a large amount of student inquiry, and this text is written to help facilitate this. Four main topics are covered: counting, sequences, logic, and graph theory. Along the way proofs are introduced, including proofs by contradiction, proofs by induction, and combinatorial proofs. The book contains over 470 exercises, including 275 with solutions and over 100 with hints. There are also Investigate! activities throughout the text to support active, inquiry based

learning. While there are many fine discrete math textbooks available, this text has the following advantages: It is written to be used in an inquiry rich course. It is written to be used in a course for future math teachers. It is open source, with low cost print editions and free electronic editions. This third edition brings improved exposition, a new section on trees, and a bunch of new and improved exercises. For a complete list of changes, and to view the free electronic version of the text, visit the book's website at [discrete.openmathbooks.org](http://discrete.openmathbooks.org)

[In Connection with Labyrinths, Mazes and Graph Theory](#) Springer Science & Business Media

Binary Digital Image Processing is aimed at faculty, postgraduate students and industry specialists. It is both a text reference and a textbook that reviews and analyses the research output in this field of binary image processing. It is aimed at both advanced researchers as well as educating the novice to this area. The theoretical part of this book includes the basic principles required for binary digital image analysis. The practical part which will take an algorithmic approach

addresses problems which find applications beyond binary digital line image processing. The book first outlines the theoretical framework underpinning the study of digital image processing with particular reference to those needed for line image processing. The theoretical tools in the first part of the book set the stage for the second and third parts, where low-level binary image processing is addressed and then intermediate level processing of binary line images is studied. The book concludes with some practical applications of this work by reviewing some industrial and software applications (engineering drawing storage and primitive extraction, fingerprint compression). Outlines the theoretical framework underpinning the study of digital image processing with particular reference to binary line image processing

Addresses low-level binary image processing, reviewing a number of essential characteristics of binary digital images and providing solution procedures and algorithms Includes detailed reviews of topics in binary digital image processing with up-to-date research references in relation to each of the problems under

study Includes some practical applications of this work by reviewing some common applications Covers a range of topics, organised by theoretical field rather than being driven by problem definitions

**Graph Theory and Computing** Courier Corporation

This Concise Encyclopedia of Software Engineering is intended to provide compact coverage of the knowledge relevant to the practicing software engineer. The content has been chosen to provide an introduction to the theory and techniques relevant to the software of a broad class of computer applications. It is supported by examples of particular applications and their enabling technologies. This Encyclopedia will be of value to new practitioners who need a concise overview and established practitioners who need to read about the "penumbra" surrounding their own specialities. It will also be useful to professionals from other disciplines who need to gain some understanding of the various aspects of software engineering which underpin complex information and control systems, and the thinking behind them.

**Graph Theory and Its Applications to Problems of Society** Springer Science & Business Media

The ever-expanding field of extremal graph theory encompasses a diverse array of problem-solving methods, including applications to economics, computer science, and optimization theory. This volume, based on a series of lectures delivered to graduate students at the University of Cambridge, presents a concise yet comprehensive treatment of extremal graph theory. Unlike most graph theory treatises, this text features complete proofs for almost all of its results. Further insights into theory are provided by the numerous exercises of varying degrees of difficulty that accompany each chapter. Although geared toward mathematicians and research students, much of Extremal Graph Theory is accessible even to undergraduate students of mathematics. Pure mathematicians will find this text a valuable resource in terms of its unusually large collection of results and proofs, and professionals in other fields with an interest in the applications of graph theory will also appreciate its precision and

scope.

Problems and Solutions in Introductory and

Advanced Matrix Calculus World Scientific  
Revised throughout Includes new chapters  
on the network simplex algorithm and a

section on the five color theorem Recent  
developments are discussed

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