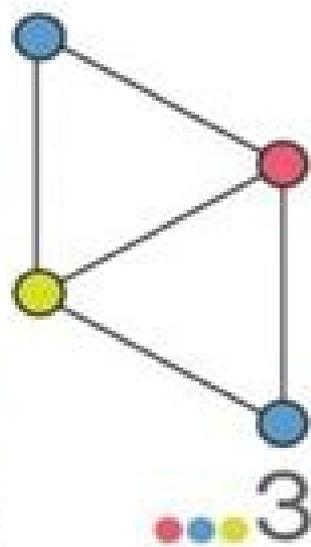
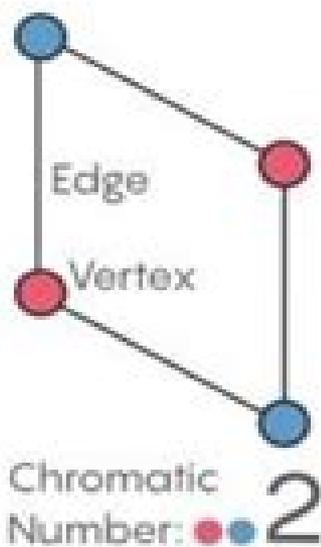


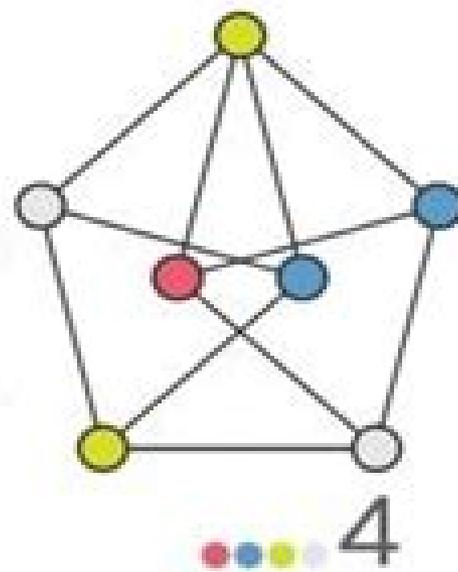
# The Graph Coloring Problem

Graphs are made of vertices connected by edges. If you color each vertex in a “unit graph” — where every edge is the same length — and require that connected vertices have different colors, what’s the minimum number of colors needed?

Simple graphs require two or three colors.



More complex graphs such as this “Moser spindle” need at least four.



Researchers have now found graphs that require at least five colors.

Mathematicians want to know if every graph — even those with an infinite number of vertices — can be colored with only five colors.

# Graph Coloring Problems

**CO Houle**



## **Graph Coloring Problems:**

**Graph Coloring Problems** Tommy R. Jensen, Bjarne Toft, 2011-10-24 Contains a wealth of information previously scattered in research journals conference proceedings and technical reports Identifies more than 200 unsolved problems Every problem is stated in a self contained extremely accessible format followed by comments on its history related results and literature The book will stimulate research and help avoid efforts on solving already settled problems Each chapter concludes with a comprehensive list of references which will lead readers to original sources important contributions and other surveys

**Graph Colorings** Marek Kubale, 2004 Graph coloring is one of the oldest and best known problems of graph theory Statistics show that graph coloring is one of the central issues in the collection of several hundred classical combinatorial problems This book covers the problems in graph coloring which can be viewed as one area of discrete optimization

**Graph Colouring and Applications** Pierre Hansen, Odile Marcotte, 1999 CRM stands for the Centre de Recherches Mathematiques Universite de Montreal created in 1968 to promote research in pure and applied math and related disciplines Ten papers from a May 1997 workshop address aspects of graph coloring having applications in mathematical models of the sciences including enumeration of colorings chromatic polynomials and graph coloring problems related to frequency assignment Six open problems suggested by the participants conclude the proceedings Lacks an index Annotation copyrighted by Book News Inc Portland OR

**On Various Graph Coloring Problems** Dimitri Lajou, 2021

**Extremal Problems on Variations of Graph Colorings**, 2014 *Extremal Problems on Induced Graph Colorings* James Hallas, 2020 Graph coloring is one of the most popular areas of graph theory no doubt due to its many fascinating problems and applications to modern society as well as the sheer mathematical beauty of the subject As far back as 1880 in an attempt to solve the famous Four Color Problem there have been numerous examples of certain types of graph colorings that have generated other graph colorings of interest These types of colorings only gained momentum a century later however when in the 1980s edge colorings were studied that led to vertex colorings of various types led by the introduction of the irregularity strength of a graph by Chartrand and the majestic chromatic index of a graph by Harary and Plantholt Since then the study of such graph colorings has become a popular area of research in graph theory Recently two set and number theoretic graph colorings were introduced namely royal colorings and rainbow mean colorings These two colorings as well as variations have extended some classical graph coloring concepts We investigate structural and extremal problems dealing with royal and rainbow mean colorings and explore relationships among the chromatic parameters resulting from these colorings and traditional chromatic parameters

**Various Coloring Problems on Plane Graphs** Ching-Man Li, [ ] [ ], 2017-01-27 This dissertation Various Coloring Problems on Plane Graphs by Ching man Li was obtained from The University of Hong Kong Pokfulam Hong Kong and is being sold pursuant to Creative Commons Attribution 3.0 Hong Kong License The content of this dissertation has not been altered in any way We have altered the formatting in order to facilitate

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Abstract Abstract of thesis entitled VARIOUS COLORING PROBLEMS ON PLANE GRAPHS submitted by LI Ching Man for the degree of Master of Philosophy at The University of Hong Kong in July 2007 Partitioning a set of objects into classes according to certain rules is a fundamental process in mathematics A conceptually simple set of rules tells us for each pair of objects whether or not they are allowed in the same class The theory of graph coloring deals with exactly this situation Graph coloring has a long history and from the very beginning it has been closely tied to the famous Four Color conjecture which asserts that every plane map can be colored with four colors so that no two regions with common boundary segment receive the same color In addition to its great theoretical interest graph coloring can be found in many important real world applications time tabling sequencing scheduling problems and so on in their many forms are essentially graph coloring problems Since the graph coloring problem is NP hard in general there is no polynomial time algorithm for solving it exactly unless NP = P So a common practice is to restrict our attention to some special classes of graphs Motivated by the Four Color conjecture plane graphs have received tremendous research efforts The present thesis is devoted to the graph coloring problem and its variations on plane graphs To be specific the proofs of the following theorems have been presented

- 1 Every plane graph containing at most three triangles is 3 colorable
- 2 Every plane graph is 5 choosable
- 3 Every plane graph with girth at least 5 is 3 choosable
- 4 Every plane graph with maximum degree 9 is edge colorable

The proofs of the theorems are all constructive and yield polynomial time algorithms for solving the corresponding graph coloring problems DOI 10.5353/th\_b3900654 Subjects Graph coloring [Problems in Graph Coloring and Graph Structure](#) Seog-Jin Kim, 2003 [The Graph Coloring Problem](#) Jeremiah W. James, 1993 **Random Instances of a Graph Coloring Problem are Hard** Boston University. Dept. of Computer Science, Ramarathnam Venkatesan, Leonid A. Levin, 1987 **Variations on a Graph Coloring Theme** Bryan Phinezy, 2012 Historically the subject of graph colorings has been the most popular research area in graph theory There are many problems in mathematics and in real life that can be represented by a graph and whose solution involves finding a specific coloring of this graph Our research consists of two parts

- 1 combinatorial problems and vertex colorings and
- 2 distance defined colorings

In this research we show that certain combinatorial puzzles and problems can be placed in a graph coloring setting and graph colorings can be defined in terms of distance in graphs that are useful in applications **Proof Techniques in Graph Theory** Frank Harary, 1969 *Computational Complexity of Generalized Graph Coloring Problems* Vladislav Rutenburg, 1988 **Distributed Graph Coloring** Leonid Barenboim, Michael Elkin, 2022-06-01 The focus of this monograph is on symmetry breaking problems in the message passing model of distributed computing In this model a communication network is represented by a  $n$  vertex graph  $G = (V, E)$  whose vertices host autonomous processors The processors communicate over the edges of  $G$  in discrete rounds The goal is to devise algorithms that use as few rounds as possible A typical symmetry breaking problem is the problem of graph coloring

Denote by the maximum degree of  $G$  While coloring  $G$  with 1 colors is trivial in the centralized setting the problem becomes much more challenging in the distributed one One can also compromise on the number of colors if this allows for more efficient algorithms Other typical symmetry breaking problems are the problems of computing a maximal independent set MIS and a maximal matching MM The study of these problems dates back to the very early days of distributed computing The founding fathers of distributed computing laid firm foundations for the area of distributed symmetry breaking already in the eighties In particular they showed that all these problems can be solved in randomized logarithmic time Also Linial showed that an  $O(2)$  coloring can be solved very efficiently deterministically However fundamental questions were left open for decades In particular it is not known if the MIS or the 1 coloring can be solved in deterministic polylogarithmic time Moreover until recently it was not known if in deterministic polylogarithmic time one can color a graph with significantly fewer than 2 colors Additionally it was open and still open to some extent if one can have sublogarithmic randomized algorithms for the symmetry breaking problems Recently significant progress was achieved in the study of these questions More efficient deterministic and randomized 1 coloring algorithms were achieved Deterministic  $O(1)$  coloring algorithms with polylogarithmic running time were devised Improved and often sublogarithmic time randomized algorithms were devised Drastically improved lower bounds were given Wide families of graphs in which these problems are solvable much faster than on general graphs were identified The objective of our monograph is to cover most of these developments and as a result to provide a treatise on theoretical foundations of distributed symmetry breaking in the message passing model We hope that our monograph will stimulate further progress in this exciting area

*Competitive Algorithms for On-line Paging and Graph Coloring* Sandra Shireen Irani, 1991

**Coloring Mixed Hypergraphs: Theory, Algorithms and Applications** Vitaly Ivanovich Voloshin, 2002 The theory of graph coloring has existed for more than 150 years Historically graph coloring involved finding the minimum number of colors to be assigned to the vertices so that adjacent vertices would have different colors From this modest beginning the theory has become central in discrete mathematics with many contemporary generalizations and applications Generalization of graph coloring type problems to mixed hypergraphs brings many new dimensions to the theory of colorings A main feature of this book is that in the case of hypergraphs there exist problems on both the minimum and the maximum number of colors This feature pervades the theory methods algorithms and applications of mixed hypergraph coloring The book has broad appeal It will be of interest to both pure and applied mathematicians particularly those in the areas of discrete mathematics combinatorial optimization operations research computer science software engineering molecular biology and related businesses and industries It also makes a nice supplementary text for courses in graph theory and discrete mathematics This is especially useful for students in combinatorics and optimization Since the area is new students will have the chance at this stage to obtain results that may become classic in the future

**Chromatic Polynomials and Other Graph Coloring Problems** Rebecca Lucille Moore Long, 1989 [An Iterative](#)

Process to Solve the Graph-coloring Problem Dennis Spencer Read, 1969 The intent of this paper is to describe a method of coloring a map and to present an algorithm for the solution of this problem A computer program was developed to provide solutions to the problem of coloring a map which consists of a finite number of areas This algorithm may also be applied to problems other than map coloring Author

**Heuristic Algorithms for Graph Coloring Problems** Wen Sun, 2018 This thesis concerns four NP hard graph coloring problems namely graph coloring GCP equitable coloring ECP weighted vertex coloring WVCP and k vertex critical subgraphs k VCS These problems are extensively studied in the literature not only for their theoretical intractability but also for their real world applications in many domains Given that they belong to the class of NP hard problems it is computationally difficult to solve them exactly in the general case For this reason this thesis is devoted to developing effective heuristic approaches to tackle these challenging problems We develop a reduction memetic algorithm RMA for the graph coloring problem a feasible and infeasible search algorithm FISA for the equitable coloring problem an adaptive feasible and infeasible search algorithm AFISA for the weighted vertex coloring problem and an iterated backtrack based removal IBR algorithm for the k VCS problem All these algorithms were experimentally evaluated and compared with state of the art methods

*A Guide to Graph Colouring* R.M.R. Lewis, 2015-10-26 This book treats graph colouring as an algorithmic problem with a strong emphasis on practical applications The author describes and analyses some of the best known algorithms for colouring arbitrary graphs focusing on whether these heuristics can provide optimal solutions in some cases how they perform on graphs where the chromatic number is unknown and whether they can produce better solutions than other algorithms for certain types of graphs and why The introductory chapters explain graph colouring and bounds and constructive algorithms The author then shows how advanced modern techniques can be applied to classic real world operational research problems such as seating plans sports scheduling and university timetabling He includes many examples suggestions for further reading and historical notes and the book is supplemented by a website with an online suite of downloadable code The book will be of value to researchers graduate students and practitioners in the areas of operations research theoretical computer science optimization and computational intelligence The reader should have elementary knowledge of sets matrices and enumerative combinatorics

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