

Lecture 1

First Steps in Graph Theory

This lecture introduces Graph Theory, the main subject of the course, and includes some basic definitions as well as a number of standard examples.

Reading: Some of the material in today's lecture comes from the beginning of Chapter 1 in

Dieter Jungnickel (2008), *Graphs, Networks and Algorithms*, 3rd edition, which is available online via [SpringerLink](#).

If you are at the university, either physically or via the VPN, you can download the chapters of this book as PDFs.

1.1 The Königsberg Bridge Problem

Graph theory is usually said to have been invented in 1736 by the great Leonhard Euler, who used it to solve the Königsberg Bridge Problem. I used to find this hard to believe—the graph-theoretic graph is such a natural and useful abstraction that it's difficult to imagine that no one hit on it earlier—but Euler's paper about graphs¹ is generally acknowledged² as the first one and it certainly provides a satisfying solution to the bridge problem. The sketch in the left panel of Figure 1.1 comes from Euler's original paper and shows the main features of the problem. As one can see by comparing Figures 1.1 and 1.2, even this sketch is already a bit of an abstraction.

The question is, can one make a walking tour of the city that (a) starts and finishes in the same place and (b) crosses every bridge exactly once. The short answer to this question is “No” and the key idea behind proving this is illustrated in the right panel of Figure 1.1. It doesn't matter what route one takes while walking around on, say, the smaller island: all that really matters are the ways in which the bridges connect the four land masses. Thus we can shrink the small island to a

¹L. Euler (1736), *Solutio problematis ad geometriam situs pertinentis*, *Commentarii Academiae Scientiarum Imperialis Petropolitanae* **8**, pp. 128–140.

²See, for example, Robin Wilson and John J. Watkins (2013), *Combinatorics: Ancient & Modern*, OUP, ISBN 978-0-19-965659-2.

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Bin Xiong



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Model Theory, Computer Science, and Graph Polynomials Klaus Meer, Alexander Rabinovich, Elena Ravve, Andrés Villaveces, 2025-08-05 This festschrift honors Johann A Makowsky on the occasion of his 75th birthday Gathering 24 research articles authored by scientific companions friends and colleagues it covers a broad variety of areas to which Johann A Makowsky made significant contributions himself These include several areas of mathematical logic and its relevance for Computer Science including Graph polynomials Algorithms for graph invariants Algorithms and descriptive complexity theory complexity of real and algebraic computations Mathematical logic Model theory Design and theory of databases Logic in computer science and AI and Logic programming The volume is enriched with 4 biographical essays and two contributions by the celebrant himself Mathematical Olympiad in China (2009-2010) Bin Xiong, 2013 The International Mathematical Olympiad IMO is a competition for high school students China has taken part in the IMO 21 times since 1985 and has won the top ranking for countries 14 times with a multitude of golds for individual students The six students China has sent every year were selected from 20 to 30 students among approximately 130 students who took part in the annual China Mathematical Competition during the winter months This volume of comprises a collection of original problems with solutions that China used to train their Olympiad team in the years from 2009 to 2010 Mathematical Olympiad problems with solutions for the years 2002-2008 appear in an earlier volume Mathematical Olympiad in China **Towards an Information Theory of Complex Networks** Matthias Dehmer, Frank Emmert-Streib, Alexander Mehler, 2011-08-26 For over a decade complex networks have steadily grown as an important tool across a broad array of academic disciplines with applications ranging from physics to social media A tightly organized collection of carefully selected papers on the subject Towards an Information Theory of Complex Networks Statistical Methods and Applications presents theoretical and practical results about information theoretic and statistical models of complex networks in the natural sciences and humanities The book's major goal is to advocate and promote a combination of graph theoretic information theoretic and statistical methods as a way to better understand and characterize real world networks This volume is the first to present a self contained comprehensive overview of information theoretic models of complex networks with an emphasis on applications As such it marks a first step toward establishing advanced statistical information theory as a unified theoretical basis of complex networks for all scientific disciplines and can serve as a valuable resource for a diverse audience of advanced students and professional scientists While it is primarily intended as a reference for research the book could also be a useful supplemental graduate text in courses related to information science graph theory machine learning and computational biology among others Logic and Automata Jörg Flum, Erich Grädel, Thomas Wilke, 2008 Mathematical logic and automata theory are two scientific disciplines with a fundamentally close relationship The authors of Logic and Automata take the occasion of the sixtieth birthday of Wolfgang Thomas to present a tour d horizon of automata theory and logic The twenty papers in this

volume cover many different facets of logic and automata theory emphasizing the connections to other disciplines such as games algorithms and semigroup theory as well as discussing current challenges in the field **Algorithms -- ESA 2004** Susanne Albers,2004-09 This book constitutes the refereed proceedings of the 12th Annual European Symposium on Algorithms ESA 2004 held in Bergen Norway in September 2004 The 70 revised full papers presented were carefully reviewed from 208 submissions The scope of the papers spans the entire range of algorithmics from design and mathematical issues to real world applications in various fields and engineering and analysis of algorithms **Their Footprints Remain** Alex McKay,2007 By the end of the 19th century British imperial medical officers and Christian medical missionaries had introduced Western medicine to Tibet Sikkim and Bhutan Their Footprints Remain uses archival sources personal letters diaries and oral sources in order to tell the fascinating story of how this once new medical system became imbedded in the Himalayas Of interest to anyone with an interest in medical history and anthropology as well as the Himalayan world this volume not only identifies the individuals involved and describes how they helped to spread this form of imperialist medicine but also discusses its reception by a local people whose own medical practices were based on an entirely different understanding of the world **Lectures on Particles' and Field Theory** Brandeis University. Summer Institute in Theoretical Physics,1966 **Proceedings of the ...ACM Symposium on Theory of Computing** ,2003 **Discrete Encounters** Craig Bauer,2020-05-14 Eschewing the often standard dry and static writing style of traditional textbooks Discrete Encounters provides a refreshing approach to discrete mathematics The author blends traditional course topics and applications with historical context pop culture references and open problems This book focuses on the historical development of the subject and provides fascinating details of the people behind the mathematics along with their motivations deepening readers appreciation of mathematics This unique book covers many of the same topics found in traditional textbooks but does so in an alternative entertaining style that better captures readers attention In addition to standard discrete mathematics material the author shows the interplay between the discrete and the continuous and includes high interest topics such as fractals chaos theory cellular automata money saving financial mathematics and much more Not only will readers gain a greater understanding of mathematics and its culture they will also be encouraged to further explore the subject Long lists of references at the end of each chapter make this easy Highlights Features fascinating historical context to motivate readers Text includes numerous pop culture references throughout to provide a more engaging reading experience Its unique topic structure presents a fresh approach The text s narrative style is that of a popular book not a dry textbook Includes the work of many living mathematicians Its multidisciplinary approach makes it ideal for liberal arts mathematics classes leisure reading or as a reference for professors looking to supplement traditional courses Contains many open problems Profusely illustrated [SIAM Journal on Algebraic and Discrete Methods](#) Society for Industrial and Applied Mathematics,1982 [Algorithms](#) ,2004 **Lectures in Theoretical Physics** Brandeis University Summer Institute in

Theoretical Physics,1966 Graph Coloring Problems Tommy R. Jensen,Bjarne Toft,1995 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 Theory Newsletter* ,1974 **Monographic Series** Library of Congress,1981 *The British National Bibliography* Arthur James Wells,2000 **Science** John Michels (Journalist),1890 Vols for 1911 13 contain the Proceedings of the Helminothological Society of Washington ISSN 0018 0120 1st 15th meeting Illinois Technograph ,1953 **Graph Theory Bibliography with Two Level Key-word Index** Gerald Berman,1983 *Optical Age. ...* ,1910

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