Preface

This book has been designed to serve as an introduction to the subject of discrete mathematics. Discrete mathematics is a gateway course for both mathematics and computer science students that covers key elements of logical reasoning, algorithms, and relevant mathematical structures. There are many interesting examples, applications, and exercises that have been carefully designed to foster understanding and to generate enthusiasm for students.

The author has had many years of experience teaching students of mathematics, computer science, and engineering at a variety of schools. He has taught courses at the University of Michigan-Ann Arbor, the University of Hawaii, the University of Guam, the University of Missouri-Columbia, Stanford University, and Renmin National University in China. The author has published another book on the subject [Sta-11] that is about twice the size as this one and contains much more material than was typically needed in a single introductory course of the subject. Material from the larger book has been carefully curated and revised to create this one. Feedback from students who learned from and colleagues who taught out of the earlier book was carefully synthesized in the creation of this book. Areas and concepts that are difficult for students have been carefully revised with improved explanations. Many worked examples have been added to every chapter. Careful consideration was made in deciding what material to keep from the larger book. There will inevitably be certain topics left out of this new book that some professors might miss. So, while it is impossible to meet everyone's preferences, we feel that the selection here should allow planning a large variety excellent courses that should meet the needs of most professors looking for a suitable textbook. There is an adequate amount of material to plan a variety of different semester courses; indeed, there is enough material to give two consecutive semester courses.

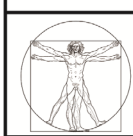
Main Features of the Book

This book is about half the size of the earlier book [Sta-11] and under 25% of the cost. The book is written for students, and many of the explanations and suggestions have been carefully worded to foster solid understanding and (we hope) motivate students to get the most out of their course and this book. The layout of the book is designed to facilitate quickly locating key items: definitions, theoretical results, algorithms, and examples. The topics that are covered were chosen by checking with recommendations of the MAA on suggested outlines of introductory courses in discrete mathematics and by discussing with other professors who regularly teach such a course (and by checking numerous syllabi for discrete mathematics courses online).

Examples of some topics that were covered in the author's larger book but omitted in this one include probability and public-key cryptography. Probability is typically learned in a separate course. Public-key cryptography is quite an interesting application area of number theory (which is covered), but time constraints imposed on all the things that need to be covered in an introductory course typically make it difficult to spend an adequate amount of time on this very interesting topic. The goal was to provide an introductory book written for students rather than a tome or encyclopedia on the subject.

Since the book contains much more material than can be covered in a one-semester course, there is a lot of flexibility in planning courses. The book consists of 18 chapters. A chapter dependency chart is included after this preface to help instructors and readers better plan how to give a course or to read the book. The following chart shows the icons that are used in the left margins of the text to indicate key items. Additionally, every definition, theoretical result (theorem, proposition, corollary, or lemma)[1] and algorithm is presented in boxed text.

Explanation of Navigational Icons Used in each Chapter:

ICON	MEANING
	Helicoptor Tour: At the beginning of each chapter a helicopter tour is given that will preview the material to be covered.
	Indicator for the start of a new section. Each chapter is naturally separated into smaller sections focusing on a single topic.
D	Definition: All definitions are individually numbered within each chapter and boxed.
T	Indicates a theoretical result (theorem, proposition, corollary, or lemma) . These are also boxed.
E	Example: Each chapter contains many worked examples to illustrate the various concepts.
A	Algorithm: When convenient algorithms are written using an intuitive pseudocode (an Appendix explains this). Algorithms are also boxed.
	Indicator for the start of end-of-chapter exercise sets. There are many exercises and doing them is an important part of learning discrete mathematics.

Prerequisites: The prerequisites of the book are to have completed a course in precalculus. The course provides a solid logical foundation and introduces many of the topics that are needed to study higher-level mathematics courses and computer science courses. There is a very short list of (optional) passages of the book that use some additional math. Here is the complete list: There is an optional

[1] These terms are defined and explained in Chatper 1.

section in Chapter 16 (Section 6) that uses matrix multiplication (and this prerequisite is clearly marked at the beginning of the section). Many students at this level will already know how to multiply matrices (or can quickly learn by watching a free online video), but, in any case this section can be skipped without loss of continuity. A few (clearly marked) examples in Chapter 14 use some basic ideas of probability. A brief appendix is provided at the end of the book to provide the needed information about probability. But the details of the examples can be skipped. An important point to make is that computer coding skill is not assumed in this book. Algorithms will be sometimes written in an easy-to-understand pseudocode. Another brief appendix provides an explanation of the pseudocode that is used to state algorithms. This is intended for students who have no coding experience (those that do should find the pseudocode self-explanatory). There are only two places in the whole book (as optional footnotes; one each in Chapters 2 and 14 where calculus is mentioned as a more efficient alternate method. There is one exercise in Chapter 2 that introduces the definition of the limit. This is a caculus topic, but no prior knowledge of calculus is needed for this exercise.

The Exercises: Each chapter contains an extensive set of exercises. There are basic-level exerices that reinforce the student's understanding of the concepts. There are intermediate-level exercises that further sharpen the student's skills and understanding. Finally, there more advanced exercises that are either of a higher level of difficulty, or that explore new areas not covered in the text so as to allow students extend the theory and concepts of the text and to make their own discoveries. After reading the text, conscientiously working through the exercises is the best way to learn (discrete) mathematics.

The Exercise Solutions: An appendix includes answers and, in many cases, quite detailed solutions to most all of the odd-numbered exerices.

Message to Students: These solutions can be a valuable learning tool if used correctly. It is important not to rush or to panic when doing the exercises! When in doubt or if you get stuck with a certain exercise, please do not get in the habit of immediately looking at the solution. This will get you to the answer quickly but you might only have a superficial understanding You would be forfeiting yourself of the valuable experience of solving the problem on your own. Also, if you look too quickly at the solutions you probably would not be ready to solve a problem of similar difficulty that you do not have an answer to (for example an exam question). When you get stuck on a problem, you should go back to review the relevant portions and examples of the text (and class notes). If it is a proof or true/false question, and you do not know how to proceed, you should do what all scientists do to help them make discoveries: perform some experiments. You may have some ideas that do not pan out (i.e., lead to dead ends)—but this is OK and part of the scientific discovery process. It is not a waste of time since in the future you will remember along with the things that do work, things that do not work and why. It is also a good idea to get into regular discussion groups with some of your classmates to share ideas on some of the more difficult exercises and concepts of the book. Having a group with mixed backgrounds and majors can be very beneficial so that different viewpoints can be shared and learned.

The Book's Webpage: A dedicated webpage for this book is maintained by the author:

`http://stanoyevitch.net/discretemath.html`

The webpage will contain some supplementary material. Initially it will have an extensive set of computer exercises that can be downloaded for students with coding experience who wish to learn get some more experience coding with the topics of this course. There will also be a sampling of downloadable sample programs for some of the algorithms.

Plans are underway to provide some additional online chapters to supplement the chapters in the book that can be downloaded in pdf form.

Acknowledgements: This book has evolved over many years of the author teaching and learning about many different areas of discrete mathematics. The main hope is that readers will have as much joy learning as the author has enjoyed learning and teaching the topics. Feedback from many students, colleagues (both local and remote) who have read or used the authors larger book, friends and family, and reviewers of the earlier book [Sta-11] have been very helpful in making many improvements in the book. There are too many people to thank here, but I am truly grateful to all who have provided help.

About the Author

Alexander Stanoyevitch completed his doctorate in mathematical analysis at the University of Michigan–Ann Arbor. He has many years experience teaching students of mathematics, computer science, and engineering at a variety of universities including the University of Michigan, the University of Hawaii, the University of Guam, Stanford University, and Renmin National University in China. He is presently a professor at California State University–Dominguez Hills. Dr. Stanoyevitch has published several articles in leading mathematical journals and has been an invited speaker at numerous lectures and conferences in the United States, Europe, and Asia. His research interests include areas of pure and applied mathematics as well as statistics and machine learning.

Dependency Chart

The following chart should be helpful to readers or instructors aiming to plan courses with this book. Major dependencies are indicated with solid arrows, minor ones with dashed arrows. The dependencies on Chapter 5 (*) pertain only to the material on equivalence relations. The single dependence on Chapter 9 does not require the materials on base b arithmetic.