

Review of¹
Essential Discrete Mathematics for Computer Science
By Harry Lewis and Rachel Zax
Published by Princeton University Press
408 Pages, \$38 on Amazon, Hardcover or \$45 on Kindle

Review by
William Gasarch gasarch@cs.umd.edu

Disclaimer: One of the authors of the book, Harry Lewis, was my Phd. thesis advisor.

1 Introduction

At various times representatives from book publishers come to my office and ask what kind of book do I want to see. I often say

I want to see a Discrete Math textbooks that costs \$38 and can leaves out some of the topics that nobody covers such as algorithms, finite automata, Bayes Theorem (more on that later).

Why do I say this? Because Discrete Math (henceforth DM) books (and in fact many textbooks) are expensive. In preparing this review I looked at DM textbooks on amazon to see if my complaint is still true.

Here is what I found (I also include what the first chapter is for reasons we will see later.)

1. Discrete Mathematics by Chartrand and Zhang. \$107 for the hardcover, \$70 for the eBook. First chapter is on logic.
2. Discrete Mathematics and its Applications by Kenneth Rosen. \$65 for the paperback, \$11 for the eBook. First chapter is on logic.
3. Discrete Mathematics: An Open Introduction by Oscar Levine. \$14 for the paperback. First chapter on Logic, Sets, Functions.
4. Discrete Mathematics by Richard Johnsonbaugh. \$154 hardcover, \$64 paperback. First chapter on Sets and Logic.
5. Discrete Mathematics by Susanna Epp. \$204 hardcover, \$149 e-book First chapter is on logic.

Most of the books are expensive, though some were not.

Caveat: Some of the books were available for rent at a cheaper price, but even the cheaper price seemed expensive.

Harry Lewis and Rachel Zax have written a book that is cheaply priced and, oddly enough, still has some of those chapters that I can't imagine many teachers getting to. This is not a complaint; however, it may mean that my notion that shorter books would be cheaper may not be correct.

¹©2020, William Gasarch

2 Format

Many discrete math books have (say) 5 parts (e.g., *Techniques of Proof*), and each part has (say) 4 chapters (e.g., (1) *Direct Proof*, (2) *Proof by contradiction*, (3) *Disproof by Counterexample*, (4) *Proof by Induction*). This book does not have any parts, 31 short chapters. The chapters length, and the fact that they are not part of a set of X chapters, makes the book more flexible and easier to read than other books.

3 The Book Does Not Begin With Logic!

Which of the following statements is interesting?

- If P is true and $P \rightarrow Q$ then Q is true.
- One can build an n -bit ADDER out of AND, OR, and NOT gates.
- $\sqrt{2}$ is irrational.
- $\prod_{i=1}^n (1 + \frac{1}{i}) = n + 1$. (Disclaimer: I might find this more interesting than you do since I didn't know it before I reviewed this book.)

This is of course a matter of opinion, so there is no right answer. **I am lying (hmmm, a paradox?)**. Of course the first one is not interesting and the rest are. The first one is about the *form* of a proof but does not have interesting content.

As noted above when I listed DM textbooks and their prices, most begin with logic. The book under review begins with a chapter on the Pigeonhole principle. They give *interesting* applications of it. They then do a chapter on basic proof techniques which includes the proof that $\sqrt{2}$ is irrational. Chapters 3 and 4 are on induction and strong induction, with many interesting examples. Hence the students *begin* with theorems of interest.

4 But There Have to Be Some Boring Parts

Chapter 6 is on sets, Chapter 7 is on Relations and Functions, Chapter 9 is on Prop Logic, Chapter 10 is on Normal Forms, Chapter 12 is on Quantification Logic. These chapters are mostly definitions. It is a challenge for any DM textbook to make these topics interesting. This book does the next best thing: the chapters are short.

5 And of Course Lots of DM IS Interesting

Chapter 7 is on uncountable sets. This was right after the chapter on functions, which makes sense.

Chapter 11 is on how to use AND, OR and NOT gates to build a computer (or at least and ADDER). This was just after the chapter on normal forms, which makes sense.

Chapters 22 and 23 are on combinatorics. Chapters 26-29 are on probability. It is a bit odd that the Pigeonhole principle (Chapter 1), Combinatorics (22 and 23) and Probability (26-29) are scattered in the book. However, since pigeonhole is there to whet their appetites, perhaps it is best to not then go whole-hog into combinatorics. As for the gap between combinatorics and probability,

the chapters between are on Series and Recurrences, which makes sense. **I am lying again**—I don't see why that makes sense at all. I checked to see if series or recurrences in the section on probability—they are not. This is odd its, but it is not a problem since a teacher can pick and choose as they see fit.

Chapter 30 is on Mod Arithmetic. I am surprised it is so late in the book since I usually use it to show numbers are irrational.

6 Why are These Chapters in a DM Textbook?

- Chapters 13, 14, 16, 17, 18 are on Graph Theory and Graph Algorithms.
- Chapter 15 is on States and Invariants which is about modeling programs as graphs and looking for invariants. It reminds me of proving-programs-correct, but it does not quite get there.
- Chapters 19,20 are on Finite Automata and Regular Languages.
- Chapter 21 is on Order Notation.
- Chapters 26-29 are on Probability, including Bayes Theorem.
- Chapter 31 is on RSA.

These are all topics that *when I first taught the DM in 1990* I did not cover. And I think I am not alone in this point of view for that time frame. I have since incorporated O-notation into the section on quantifiers, Bayes theorem (inspired by an early version of this book) into my section on probability, and RSA in my section on Number Theory, though only in the honors sections. RSA may well migrate to the standard sections at some point.

My original complaint to the publishers that they should *get rid of the material that nobody covers* is incorrect. (1) Who knows what the future may bring?, and (2) Page count is not the end-all and be-all of book pricing.

7 Opinion

The book is well written, has lots of exercises, and has all the topics (and more) that a teacher would want to cover. This is also true of other books I have used (Rosen's book and Epp's book).

So why is this book different from other books:

- The ordering of the chapters allows students to see interesting material early on.
- The book is well paced—the boring parts are shorter than in other books, and the interesting parts get to their point, make it, and shut up. Other books talk too much.
- The 31 chapters are somewhat independent making it easier for a teacher to pick-and-choose.
- The price for the hardcover edition is low. I expect that if there is a softcover version the price will be amazingly low.

Given all of the above, I highly recommend this book.