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Review of: Pearls Of Discrete Mathematics by Martin Erickson

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is an expression of the form

$$p(x) = c_n x^n + \cdots + c_0.\text{”}$$

Although mathematical strength is usually not necessary in the introduction of a book, it would be more precise to define p as a function of x, stating first from which set the coefficients $c_0, c_1, \ldots, c_n$ are taken and what the domain of p is. Throughout this book no period is printed after a formula at the end of a sentence. This is very unusual. What is even worse is the fact that formulas are numbered as usual within parentheses, e.g., (10); however, they are referred to without parentheses, e.g., 10. Furthermore, it is very annoying that in formulas and in the text variables are denoted using different typefaces. Also, the arrangement of the formulas is very often not carefully done; see, for example, page xiv, equations (4) and (5). Repeatedly, the notation is changed without warning. For example, on page xvi, in formula (17) the letter i denotes an iteration index. In formula (19), following only a couple of lines later, the letter i can take on only the integers between 1 and n and denotes the ith zero of an nth-degree polynomial. Also repeatedly, notations are used without any definitions. These and several other little flaws mean that the book is not a pleasure to read.

On the other hand, it contains a collection of material which cannot be found in any other book. In the introduction, the author says that he has compiled a bibliography containing over 8000 entries. Reading the book, one gets the impression that the author is more or less evaluating this bibliography. Many methods and ideas are merely mentioned without explanation. Also, the behavior of many methods is only reported from the original literature. In rare cases proofs are performed or indicated. Therefore, it is not surprising that occasionally results are not cited correctly or are incomplete. Take, for example, the relation (5.228), which only holds under additional assumptions on the derivative of the underlying function (which always hold for polynomials). As already mentioned, the book contains a lot of material. Therefore, everyone interested in computing approximations to the zeros of polynomials could use it to get an overview of existing methods. However, if one really needs an algorithm for computing zeros of polynomials (which is in my experience very seldom the case), it is not easy to find the appropriate method. Therefore, I look forward to what material is treated in Part II, only a few examples of which are mentioned in the introduction of Part I.

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Pearls of Discrete Mathematics. *By Martin Erickson.* CRC Press, Boca Raton, FL, 2009. $59.95. x+270 pp., softcover. ISBN 978-1-4398-1616-5.

If you were first attracted to mathematics by puzzles, games, elementary number theory, geometry, or basic graph theory (instead of, say, second-order semilinear partial differential equations), then this book will remind you why you think mathematics is fun. The twenty-four chapters are divided evenly between the eight parts. Each is relatively short and relatively disjoint from the others. No attempt is made to be systematic, and, in some cases, no attempt is made to be complete or rigorous. This is not criticism; it is the nature of the collection. Hit a new topic quickly, do something interesting, and move on. While suggested as appropriate for a topics course, I think the real strengths of this text would be as self-study for the motivated student (who can consult more careful references) or a source of interesting examples for a more traditional course in various areas of discrete mathematics. It might also serve as an enticing exposé of the many facets of mathematics captured under the umbrella term “discrete mathematics.”

Each chapter begins with one or two leading questions or startling results, which are eventually addressed in the chapter. For example, the number of ways to make change for a million dollars is

$$88{,}265{,}881{,}340{,}710{,}786{,}348{,}934{,}950{,}201,\\ 250{,}975{,}072{,}332{,}541{,}120{,}001$$

by using standard U.S. currency from a penny up to a $100 note. Or, in any group of six people there is either a group of three, all of whom knows each other, or a group of three, none of whom knows each other. The experienced discrete mathematician will recognize these as teasers for generating functions and Ramsey theory, respectively. As mentioned, some of the chapters are shorter than the seven-page average. For example, random tournaments takes three pages to explain and includes one page of questions. The first chapter is one page of narrative and one equally long page of exercises. So some topics are presented without all the details, given the space allowed, or a chapter may be longer but still contain many more new ideas than the space allows for careful explanation. For example, Chapter 10 covers discrete probability spaces, introducing random variables, expectation, variance, derangements, inclusion-exclusion, and a limit law in eleven pages. The next section includes a one-page description of the eigenvalues of a matrix and their role in diagonalizing the matrix, though there is no discussion of when this might be possible for the transition matrix of a Markov chain. An improvement to the book would be a clearer indication for the student of where to go to learn more about a topic, either to fill in details or to continue their study.

A small selection of the topics addressed, one from each of the eight parts, will give an indication of the range: Pascal's triangle, Fibonacci numbers, rook paths, Markov chains, partitions of integers, coding theory, higher-dimensional tic-tac-toe, and listing permutations in lexicographic order. Each chapter contains roughly ten to fifteen exercises, with some marked as "particularly difficult," or requiring a computing device, or "of theoretical importance." These are collectively another strength of the book, especially given the hints and/or solutions for *every* problem, which together comprise 58 of the 270 pages.

Motivated students will learn much new mathematics if they work through this book carefully. For a student curious about exactly which topics make up the field of "discrete mathematics," a more cursory trip through the book will do a good job of answering the question. For the library with a collection in recreational mathematics, this book will serve as a nice bridge to the "more serious" associated areas of mathematics. And finally, for the professional mathematician, using this book as bedtime reading just might remind you of why you found math fun in the first place.

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Mathematical Optimization and Economic Analysis. *By Mikulas Luptáčik.* Springer, New York, 2010. $99.00. xiv+294 pp., hardcover. ISBN 978-0-387-89551-2.

Some other books on mathematical optimization (or programming) and its applications present the mathematical theory and computational methods in detail, but include only fairly simple illustrative applications. In contrast, Luptáčik's book, which is reviewed here, places the emphasis on the economic applications. The mathematical theory is presented, though in less detail than a mathematician might desire, and with more attention paid to the rationale than the proofs. This reviewer, being a mathematician rather than an economist, cannot judge the depth of the economic presentation, but it appears clearly presented and relates to a number of significant economic questions.

By comparison, an older book by M. Intriligator (*Mathematical Optimization and Economic Theory*, Prentice-Hall, 1971; reprinted by SIAM in 2002) presents the mathematics in more detail, including other topics such as dynamic programming. Economics topics, such as theory of the firm, are analyzed with more emphasis on the mathematics.

Most mathematical optimization in economics is built on linear programming. This first became practicable in the 1950s with Dantzig's simplex method (although linear economic models were known much earlier). The calculations were first done by hand, for small models, and then for much bigger models when computers became available. (The word "computer" had previously meant a human being.) It is important to remember that systems in economics, or management planning, are not automatically linear. A cost, or profit, function is only linear over a limited range, outside