

Chapter 4

Induction, Recursion, and Recurrences

4.1 Mathematical Induction

Smallest Counter-Examples

In Section 3.3, we saw one way of proving statements about infinite universes: we considered a “generic” member of the universe and derived the desired statement about that generic member. When our universe is the universe of integers, or is in a one-to-one correspondence with the integers, there is a second technique we can use.

Recall our proof of Euclid’s Division Theorem (Theorem 2.12), which says that for each pair (m, n) of positive integers, there are nonnegative integers q and r such that $m = sq + r$ and $0 \leq r < n$. For the purpose of a proof by contradiction, we assumed that the statement was false. Then we said the following. “Among all pairs (m, n) that make it false, choose the smallest m that makes it false. We cannot have $m < n$ because then the statement would be true with $q = 0$ and $r = m$, and we cannot have $m = n$ because then the statement is true with $q = 1$ and $r = 0$. This means $m - n$ is a positive number smaller than m . We assumed that m was the smallest value that made the theorem false, and so the theorem must be true for the pair $(m - n, n)$. Therefore, there must exist a q' and r' such that

$$m - n = q'n + r', \text{ with } 0 \leq r' < n.$$

Thus $m = (q' + 1)n + r'$. Now, by setting $q = q' + 1$ and $r = r'$, we can satisfy the theorem for the pair (m, n) , contradicting the assumption that the statement is false. Thus the only possibility is that the statement is true.”

Focus on the sentences “This means $m - n$ is a positive number smaller than m . We assumed that m was the smallest value that made the theorem false, and so the theorem must be true for the pair $(m - n, n)$. Therefore, there must exist a q' and r' such that

$$m - n = q'n + r', \text{ with } 0 \leq r' < n.$$

Thus $m = (q' + 1)n + r'$.” To analyze these sentences, let $p(m, n)$ denote the statement “there are nonnegative integers q and r with $0 \leq r < n$ such that $m = sq + r$.” The quoted sentences

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Mark Steyvers



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Algorithm Design: A Methodological Approach - 150 problems and detailed solutions Patrick Bosc, Marc Guyomard, Laurent Miclet, 2023-01-31 A bestseller in its French edition this book is original in its construction and its success in the French market demonstrates its appeal It is based on three principles 1 An organization of the chapters by families of algorithms exhaustive search divide and conquer etc On the contrary there is no chapter devoted only to a systematic exposure of say algorithms on strings Some of these will be found in different chapters 2 For each family of algorithms an introduction is given to the mathematical principles and the issues of a rigorous design with one or two pedagogical examples 3 For the most part the book details 150 problems spanning seven families of algorithms For each problem a precise and progressive statement is given More importantly a complete solution is detailed with respect to the design principles that have been presented often some classical errors are pointed out Roughly speaking two thirds of the book is devoted to the detailed rational construction of the solutions

Foundations of Algorithms Richard E. Neapolitan, Kumarss Naimipour, 2011 Data Structures Theory of Computation Foundations of Algorithms Using Java Pseudocode Richard E. Neapolitan, 2004 *Python Algorithms* Magnus Lie Hetland, 2014-09-17 Python Algorithms Second Edition explains the Python approach to algorithm analysis and design Written by Magnus Lie Hetland author of Beginning Python this book is sharply focused on classical algorithms but it also gives a solid understanding of fundamental algorithmic problem solving techniques The book deals with some of the most important and challenging areas of programming and computer science in a highly readable manner It covers both algorithmic theory and programming practice demonstrating how theory is reflected in real Python programs Well known algorithms and data structures that are built into the Python language are explained and the user is shown how to implement and evaluate others

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Journal of the Physical Society of Japan, 1976 **Discrete Mathematics** Kenneth A. Ross, Charles R. B. Wright, 1992 This third edition offers an introduction to discrete mathematics covering relations induction counting techniques logic and graphs More advanced topics of Boolean algebra and permutation groups are included and there are numerous examples to reinforce the material *Discrete Mathematics with Applications* Susanna S. Epp, 2004 Susanna Epp's DISCRETE MATHEMATICS THIRD EDITION provides a clear introduction to discrete mathematics Renowned for her lucid accessible prose Epp explains complex abstract concepts with clarity and precision This book presents not only the major themes of discrete mathematics but also the reasoning that underlies mathematical thought Students develop the ability to think abstractly as they study the ideas of logic and proof While learning about such concepts as logic circuits and computer addition algorithm analysis recursive thinking computability automata cryptography and combinatorics students discover that the ideas of discrete mathematics underlie and are essential to the science and technology of the computer age Overall Epp's emphasis on reasoning provides students with a strong foundation for computer science and upper level mathematics courses *Data Structures and Abstractions with Java* Frank M. Carrano, 2007 This book Includes generic data types as well as enumerations for each loops the interface Iterable the class Scanner assert statements and autoboxing and unboxing Amazon **General Catalog** Orta Doğu Teknik Üniversitesi (Ankara, Turkey), 2002 **Study Guide, Discrete Mathematics, Second Edition**

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