Knuth, Donald E.
Selected papers on analysis of algorithms. (English) Zbl 0966.68082

As the title indicates, this book is a self-selected collection of 34 papers by Donald E. Knuth, the pioneer of the field of algorithm analysis. They were published between 1963 (“Length of strings for a merge sort”) and 1998 (“Linear probings and graphs”). As the author noted at the end of the preface of this book, this is the fourth of an eight-volume series of collection of Knuth’s papers. This book is also published by the Cambridge University Press.

Just as demonstrated in his other writings, the papers included in this paper are thoughtful, thorough, and inspiring. They are very well written, and contain very few typos. (The only typo I have found after reading it is radically for about a month is the duplication of the word “of” in the first sentence in pp. 502.)

T. H. McNicholl has written an excellent review [ACM SIGACT News 32, No. 1, 5-8 (2001)] of this book, which I highly recommend. He categorizes these 34 papers into three classes: Historical essays, which includes papers on the evolution, and the finalization, of standard terminologies in this field such as $O$, $\Theta$, $\Omega$, and NP-Hard; Philosophical essays; and Methodological essays, which contains many case studies regarding the practice of algorithm analysis. This is certainly one way to look at it.

On the other hand, the author himself categorizes the collection into two classes: local algorithm analysis and global complexity study. The former studies particular algorithms intended to solve a problem to answer such questions as What is the best, worst, and the average time(space) requirement of this algorithm? Among a set of algorithms, which provides the “best” solution to this problem? The latter studies the complexity of a problem in general to answer such questions as How hard is this problem? How much time(space) does any algorithm have to take to solve it?

Most of these papers, although excellent in every sense of this word, are quite technical, and I certainly don’t recommend them for “easy reading”.

After reading through all the papers, I believe most of those methodological papers share a common theme: Present a problem, characterize it mathematically, study it carefully, generalize it, and finally, reduce it to other problems. I once tried to dissect a short paper to demonstrate this theme. But, I eventually gave it up, because of the limit of space, and the fear that I would ruin something beautiful during the process. McNicholl, on the other hand, did briefly look into three papers in his review. Those interested can certainly check that out to get a feeling.

As a teacher and practitioner of algorithm analysis myself, I have been studying books and papers by Knuth for many years. I have been really enjoying reading them, and benefiting greatly from doing it. I find this book no exception. I would whole-heartedly recommend this book to my colleagues who have some time to spare, and would like to get into one of the greatest minds in computer science.

Reviewer: Zhizhang Shen (Plymouth/New Hampshire)

MSC:

68Wxx Algorithms in computer science
68-02 Research exposition (monographs, survey articles) pertaining to computer science
00B60 Collections of reprinted articles
68Q25 Analysis of algorithms
01A75 Collected or selected works; reprints of translations of classics
68W40 Analysis of algorithms and problem complexity

Keywords:
local algorithm analysis; global complexity study