

This Week's Citation Classic®

Knuth D E. *The art of computer programming, Volume 1. Fundamental algorithms.* Reading, MA: Addison-Wesley, (1968) 1973. 634 p. *Volume 2. Seminumerical algorithms.* Reading, MA: Addison-Wesley, (1969) 1981. 688 p. *Volume 3. Sorting and searching.* Reading, MA: Addison-Wesley, 1973. 723 p.
[California Institute of Technology, Pasadena, CA, and Stanford University, CA]

These books are the first volumes of a projected seven-volume series that surveys the most important techniques of computer programming—basic methods that are being applied to the solutions of many different kinds of problems. Each method is accompanied where possible by a quantitative analysis of its efficiency. [The SC® indicates that the combined volumes and editions of this book have been cited in more than 4,345 publications.]

Artistic Programming

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On my 24th birthday, a representative of Addison-Wesley asked me whether I'd like to write a book about software creation. At that time (1962) I was a grad student in mathematics at Caltech. I had no idea that a new discipline called computer science would soon begin to spring up at numerous campuses, nor did I realize that "deep down" I was really a computer scientist, not a mathematician; computer scientists hadn't discovered each other yet. But I'd been writing computer programs to help support my education, and the book project was immediately appealing.

By the time I reached home that day I had planned the book in my mind, and I quickly jotted down the titles of 12 chapters. But I had almost no time to work on the manuscript until after receiving my PhD in June 1963; I spent the summer of 1962 writing a FORTRAN compiler for UNIVAC. I did take one day off to investigate the statistical properties of "linear probing," an important way to locate data,¹ and I happened to discover a trick that made a mathematical analysis possible. This experience profoundly changed my book-writing plans; I decided that a quantitative rather than qualitative approach would be the best way to

organize and present the techniques of computing. I also decided to emphasize aesthetics, the creation of programs that are beautiful.²

I worked feverishly during the next years and finally finished the first draft in June 1965. By then I had accumulated 3,000 pages of handwritten manuscript. I typed up chapter 1 and sent it to the publishers as sort of a progress report, and they said, "Whoa, Don! If all 12 chapters are like the first, your book will be more than 2,000 pages long." My estimate of manuscript pages per printed page was off by a factor of three.

After hectic conferences we agreed to change the original book to a series of seven volumes. If I had continued to type the other chapters as they existed in 1965, all seven books would have been published by 1970; but computer science continued its explosive growth, and I decided to try keeping up with current developments. Thus I was lucky to finish volume 3 by 1973. By 1977 I had completed part of volume 4, but the subject of that volume—combinatorial algorithms—had become such a hot topic that more than half of all articles in computer science journals were being devoted to it. So I tried to gain efficiency by taking a year off to develop computer tools for typography. Alas, that project took 11 years.³

Meanwhile people do seem to like the published volumes,⁴ for which I received the Turing award in 1974 and the National Medal of Science in 1979. The books have been translated into Russian, Chinese, Japanese, Spanish, Romanian, and Hungarian; more than 475,000 copies have been sold in English. They probably became *Citation Classics*⁶ because they discuss classic principles of computing. I'm now working full time on volumes 4A, 4B, and 4C, which should be completed in 2003.

1. Knuth D E. Algorithms. *Sci. Amer.* 236:63-80, 1977.

2. Computer programming as an art. *Commun. ACM* 17:667-73, 1974.

3. The errors of T_EX. *Software—Pract. Exp.* 19:607-85, 1989.

4. Weiss E A. In the art of programming, Knuth is first; there is no second. *Abacus* 1:41-8, 1984.

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