We may conclude that in general, for these surfaces, the bicubic spline interpolation method M2 is the most accurate if it can be applied, i.e. if the data are regularly spaced. Of the distance-weighted least-squares methods M7-M15, the method M10 recommended in the paper, using a quadratic polynomial with weighting function e^{-d^2}/d^2 appears satisfactory; although some others (e.g. M13) are slightly more accurate, this gain is not felt to justify the extra computing involved.

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Book review

The Art of Computer Programming, Volume 3, Sorting and Searching, by Donald Knuth, 1973; 722 pages. (*Addison-Wesley*, £9·30.)

This thick volume is the third of a projected series of seven. Like the two earlier volumes the exposition is heavily weighted towards mathematics, but there are perhaps fewer examples of results being introduced into the text solely for their mathematical interest. A better title to the series might have been 'A Mathematical Approach to Computer Programming'; certainly the title must not be taken as implying that the author considers that, in the common phrase, 'programming is more an art than a science'.

The first half of the book deals with sorting. This was the subject of much research in the period around 1960-65. With the results of this research scattered in the literature and requiring cross evaluation before they could be used, a compendium was much needed. Now anyone with a sorting problem to solve would be foolish not to look in this book first. As Dr. Knuth tells us: 'unfortunately there is no known "best" way to sort; there are *many* methods, depending on what is to be sorted on what machine for what purpose'.

Methods of internal sorting are dealt with first; by this is meant the sorting of information wholly contained within the high speed memory. Twenty-five different algorithms are described and evaluated. In each case an English language description of the algorithm is given, followed by a flow diagram and a program written in MIX, the author's synthetic assembly language. Finally there is an example of numbers sorted according to the algorithm. No use is made of high level languages for describing algorithms.

Methods discussed under the heading of internal sorting are, by themselves, virtually useless when the amount of information to be sorted is greater than can be held in the high speed memory. It is then that merging comes into its own and most of the section in the book on external sorting is concerned with variations on the theme of internal sorting followed by merging. People who are accustomed to use such methods in business data processing may, perhaps, be surprised to find how much theoretical discussion is necessary to evaluate the various alternatives.

The second half of the book is concerned with searching. The author remarks that this section might have been given the more pretentious title 'Storage and Retrieval of Information' or the less pretentious title 'Table Look-up'. The sub-headings are: sequential searching; searching by comparison of keys; digital searching; hashing; retrieval on secondary keys. The problem discussed is simply stated; it is how to find data that has been stored with a given identification. 'Searching is the most time consuming part of many programs and the substitution of a good search method for a bad one often leads to a substantial increase in speed'. The author was right in choosing a non-pretentious title for this part of the book, since he was concerned with the design of algorithms and not with database technology in any general sense. There is much more to the design of management information systems, for example, than is discussed here; in particular, the reader will find no reference to the work of the CODASYL Data Base Task Group or to relational data bases. A similar remark can be made about systems for information retrieval, as that subject is understood in the world of library and information science.

The book is liberally provided with exercises classified according to the amount of mathematical knowledge needed and according to difficulty. They are intended for self study as well as for classroom study and the author has devoted 130 pages at the end of the book to giving solutions. The book is to be strongly recommended to systems programmers and implementers of application packages. It will be indispensible to those who have to plan courses in computer science that cover the topics of which it treats. As a source of inspiration for lecturers and their abler students it could hardly be bettered.

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