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Book Reviews

RICHARD R. SHIVELY, *Book Reviews Editor*

In this section, the IEEE Computer Society publishes reviews of books in the computer field and related areas. Readers are invited to send comments on these reviews for possible publication in the Correspondence section of this TRANSACTIONS. Please address your comments and suggestions to the Book Reviews Editor: Richard P. Shively, Bell Laboratories, Whippany, N.J. 07981. The Computer Society does not necessarily endorse the opinions of the reviewers.

B74-1 Complexity of Computer Computations—R. E. Miller and J. W. Thatcher, Ed. (New York: Plenum, 1972, 225 pp., $16.50.)

This book is the proceedings of a symposium held at the IBM T. J. Watson Research Center in March 1972. It contains the 14 papers presented plus an account of the panel discussion session. There was considerable attention given in the panel discussion to the field of the symposium. There was no agreement on a suitable name although "computational complexity," "computability," "theory of algorithms," and "concrete computational complexity" were suggested. Neither was there good agreement on the content of the field, but the symposium (and this book) itself serve admirably to delineate the field. That is, the content of this field (whatever it is called) is that which the people in the field are doing.

There are two branches to the field, one numerical and the other combinatorial in nature. Space precludes presenting a review of each of the 14 papers, but, since, the nature of this field is a prime question at this time, a very short description is given for each paper. The order is that of the book.

NUMERICAL COMPUTATIONS

1) V. Strassen: Analysis of the number of arithmetic operations required to evaluate a rational function.

2) M. O. Rubin: Analysis of the effort to solve a system of n linear equations using only scalar product computations. At least $n(n + 1)/2$-1 inner products must be used.

3) E. M. Reingold and A. I. Stocks: New and more elementary proofs of the lower bounds on the number of arithmetic operations required to evaluate a polynomial.

4) C. M. Fiduccia: An analysis of fast matrix multiplication algorithms which involves a new representation/interpretation of the situation.

5) M. S. Paterson: Applies ideas from the study of the efficiency of solving a nonlinear equation to the problem of evaluating an algebraic number (solving a polynomial equation).

6) S. Winograd: An analysis of the behavior of parallel algorithms for solving a nonlinear equation. Parallelism does not pay off.

7) R. Brent: Analysis of local iterative methods (which use no derivatives) for the solution of systems of nonlinear equations. A conjecture is made about the optimum efficiency.

8) M. Schultz: Demonstration that, in a certain reasonable sense, the numerical solution of an elliptic partial differential equation is as efficient as the tabulation of the solution from a known closed-form formula.

COMBINATION COMPUTATIONS

9) R. M. Karp: Presentation of a systematic method of establishing the equivalence of problems in complexity. A large number are shown to be equivalent although their complexity is still unknown.

10) R. W. Floyd: Presents bounds on the work required to rearrange information (in pages and records) in a slow memory by bringing pairs of pages into a fast memory where records may be rearranged.

11) V. R. Pratt: Analysis of the effort in defining a computer library given the probability of accessing the ith program after the jth one. Results are given in some special cases.

12) D. C. VanVorrhis: Study of the smallest number of components required for constructing a sorting network.

13) J. E. Hopcroft and R. E. Tarjan: Presentation of an algorithm to determine if two planar graphs with n vertices are isomorphic. It uses $0(n \log n)$ operations.

14) M. J. Fisher: Proof of a new upper bound on the computation required to obtain the finest partition of a set consistent with a given set of equivalence relations.

The panel discussion centered on two questions: "Is there an emerging unity in this field?" and "Are real computations improved as a result of studies in this field?" There was some optimism and considerable doubt expressed about the unity of this field. The diversity in the field is underscored by the fact that few people will feel comfortable with all the papers presented. The case for stating that these studies have had an effect on real computation is weak. However, several people expressed the opinion that the effect will be felt in the future as this field provides the proper framework to think about computation. The reviewer agrees with this opinion and even with the one that this field and classical numerical analysis will merge at some future time.

In summary, this book provides a good snapshot of the "complexity of computer computations" field as of 1972. A number of significant research results are presented and the panel discussion transcript allows one to obtain a feel for the thinking of some of the leaders in this field. The book is overpriced in view of its length and the lack of typesetting or royalty expenses to the publisher.

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B74-2 Man and the Computer—J. G. Kemeny. (New York: Scribner, 1972, $6.95.)

This slim volume is a forward-looking speculation of the promise of computers for making further contributions to mankind. It is aimed at alerting the informed layman to the vast potential that lies ahead of us in the intelligent development of computer systems.

The author, Dr. J. G. Kemeny, is now the President of Dartmouth College. He is credited with being the father of time sharing and is a pioneer in introducing education on the use of computers on a university-wide basis in all disciplines. He looks at a number of the ways that computer systems could be developed to serve society in the fields of communications, education, libraries, management, the home, and solving the problems of society. The possibilities are a challenge to those in the computer field.

The author starts by correctly emphasizing the importance of man-machine symbiosis and goes on to predict further spectacular reductions in the cost per computation. These are the two technical factors which will make the dreams feasible. Dr. Kemeny sees a world where information is freely exchanged, and education is vastly improved and openly available throughout life. He forecasts a time when the information and simulation capabilities of computers will help provide the basis for rational solutions to social problems. But he also foresees some of the problems and limitations. Man must make the ultimate decisions. To make these dreams come true will require changes in the behavior of people and political and financial support. Hopefully, through the understanding that can be generated by works of this type, backing can be more easily obtained.

This excellent and thought-provoking volume is marred by an unfortunate historical blunder. Dr. Kemeny mistakenly attributes the work of J. P. Eckert, Jr., J. W. Mauchly, and others on the Eniac project to Dr. J. von Neumann. For example, Dr. Kemeny presents the idea of an all electronic computer as a von Neumann "proposal" in 1946. Actually, the idea was due to Eckert and Mauchly and in 1946 the Eniac was completed and operating. Eckert and Mauchly had not only conceived the idea but had demonstrated the feasibility in spite of expert opinion to the contrary.

This reviewer hopes that the historical errors are corrected in future editions.

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B74-3 Design Automation of Digital Systems—Volume 1, Theory and Techniques—M. A. Breuer, Ed. (Englewood Cliffs, N.J.: Prentice-Hall, 1972, 420 pp., $15.00.)

This book deals with a very important topic in computer engineering techniques, i.e., the use of digital computers as design tools in the development of digital systems. The use of design automation has been rapidly gaining wide acceptance, especially in recent years, in the computer industry due to the rapid pace of changing technologies and the desirability of shortening design and manufacturing intervals. While a number of significant results in design automation have been realized, most are either scattered in various literatures or are not readily obtainable. This book, written by eight authors, represents a body of information where several phases of design automation techniques, i.e., logic synthesis, logic simulation, testing, and physical implementation (partitioning, placement, and routing) are discussed.

The book is divided into seven chapters. Chapter 1 introduces the general concept of computer-aided design of digital systems. It also provides a very interesting summary of the evolution of design automation from the 1950's to the current techniques.

Chapter 2 deals with logic synthesis techniques with substantial emphasis on logic simplification and factorization methods. Regretfully, almost all the techniques presented are centered around gate-level combinational circuits; the suitability of applying these techniques to practical problems in present-day technologies appears to be quite limited. It is also unfortunate that the author uses a complex notation in presenting the material, which makes the text rather difficult to follow.

Chapter 3 is concerned with gate-level logic simulation techniques. Simulation is useful for logic design verification and for evaluation of fault-test procedures. Treatment of the commonly used simulation models (compiled-code model, table-driven model, and equation-simulation model) and description of major features of simulation algorithms such as the three-value simulation, next-event techniques and time-mapping technique for handling of asynchronous (delay) elements are clearly presented. The objective of fault simulation and a brief discussion of the simulation model using parallel fault-insertion techniques are also described. The chapter is concluded with a detailed simulation example and a discussion of the relationship between the data base and the simulation algorithm. This should be a very important consideration for those who are planning to implement a simulation system. The annoted bibliography is comprehensive; it would be useful for those interested in further study.

Chapter 4 deals with partitioning and card selection, a process commonly regarded as the first phase in physical implementation after a logic design has been completed. As both the partitioning (optimal assignment of circuits to replaceable modules) and the selection (choosing the minimum number of standard modules) problems are of a combinatorial nature, a considerable amount of discussion is on the tradeoff of the various parameters involved. On the partitioning problems, many of the known techniques by Gamblin *et al.*, Haspel, Kernighan, and Lin are reviewed. As all the algorithms described have shortcomings, the authors concluded their discussion by giving a critique comparing the pros and cons of the various approaches. The selection problems are briefly treated as integer linear programming problems and as restricted minimal cost-flow problems. Although it would be desirable to include some discussion on program implementation techniques and experimental data comparing the various approaches, this reviewer finds the treatment of partitioning and card selection techniques quite comprehensive and well presented.

Chapter 5 discusses the techniques of placing modules onto boards with respect to some predefined goals, such as minimal wire length, minimal crosstalk, preservation of heat dissipation levels, etc. All of the techniques described are based on heuristic rationales because of the complexity and magnitude of most practical problems. The placement techniques are classified either interative (i.e., placement improved by repeated modification) or constructive (i.e., placement produced