Abstracts

Listed are abstracts from recent papers by IBM authors. Inquiries should be directed to the publications cited.

Computer Methods of Network Analysis, F. H. Branin, Jr., *Proceedings of the IEEE* **55,** No. 11, 1787–1801 (November 1967). This tutorial paper highlights the influence of the computer not only on the modus operandi of circuit design but also on network theory itself. It reviews the topological properties of linear graphs and describes a matrix-topological formulation of the network problem. In addition to the classical mesh, node, and cutset methods, a mixed method of analysis is described which is applicable to d-c, a-c, and transient problems and underlies the so-called state-variable approach to network analysis. Numerical methods of solving the network problem are discussed in connection with linear and nonlinear d-c networks. A new approach to a-c analysis, using the mixed method and based on a numerical solution of the matrix eigenvalue problem, is described. The extension of this method to the transient analysis of linear networks is also explained. Finally, the problem of instability in the numerical integration of differential equations is discussed and several means of solving the problem are outlined.

Computers Applied to Routings, J. D. Mueller, *Preprints of papers, ASTME Manufacturing Systems Seminar,* No. MS68, p. 574 (March 6, 1968). It has become a common pratice in the past few years to store manufacturing routings on a computer system. This has provided the engineer with a powerful tool for projecting and planning both the needs of new products and their impact on the manufacturing facility. With this information he can determine the use of each machine tool, implement inventory systems for cutting tools, and have the capability to simulate the manufacturing processes, locate his problem areas, and resolve potential problems before they occur. These systems assume that an accurate manfacturing routing is available which can be used to calculate this specific information. The newest generation of computers offer large memories, tremendous speed, and large data banks. This paper describes how these computers generate the manufacturing information or routings which were previously written by the engineer. The many benefits of such a system, for example reduced lead time required to place a product into production and more detailed and accurate information for the manufacturing areas, are also discussed.

Decision Making in Markov Chains Applied to the Problem of Pattern Recognition, J. Raviv, *IEEE Transactions on Information Theory* **IT-3,** No. 4, 536-551 (October 1967). In many pattern-recognition problems there exist dependencies among the patterns to be recognized. In the past, these dependencies have not been introduced into the mathematical model when designing an optimal pattern-recognition system. In this paper the optimal decision rule is derived under the assumption of Markov dependence among the patterns to be recognized. Subsequently, this decision rule is applied to character-recognition problems. The main idea is to balance appropriately the information which is obtained from contextual considerations and the information from measurements on the character being recognized and thus arrive at a decision using both. Bayes' decision in Markov chains is presented and this mode of decision is adapted to character recognition. A look-ahead mode of decision is presented. The problem of estimation of transition probabilities is discussed. The experimental system is described and results of experiments on English legal text and names are presented.

Digital Sensors in Industry, J. A. Dickerson, *Computer Weekly,* pp. 6-7 (April 25, 1968). The list of possible applications for digital sensors is growing at an increasing rate. This brief description of current instrumentation trends is intended to introduce digital equipment to those who are interested in data collection, process, and display. Four basic phenomena require instrumentation prior to usage, whether by man or machine: pressure, temperature, position, and force. Several examples of how digital data can be applied to output devices are given. These devices may range from a simple decimal display to inputs to a large-scale digital computer.

An Experimental Investigation of a Nonsupervised Adaptive Algorithm, E. R. Ide and C. J. Tunis, *IEEE Transactions on Electronic Computers* **EC-16,** No. 6, 860-864 (December 1967). An unsupervised or nonsupervised adaptive algorithm for linear decision boundaries is applied to two pattern recognition problems: the classification of spoken words, and the classification of hand-printed characters. The term unsupervised indicates that the class identification of the input patterns is not continuously available to the adaptive system. The algorithm discussed offers two advantages for pattern recognition applications. First, the number of patterns which must be labeled with class identification is reduced. Second, the adaptive system can follow changes in the class distributions over time, due to data fluctuation or hardware degradation. These advantages are demonstrated for each of the two applications.

A Fast, Reliable Iteration Method for D-C Analysis of Nonlinear Networks, F. H. Branin, Jr. and H. H. Wang, *Proceedings of the IEEE* **55,** No. 11, 1819-1826 (November 1967). A new iteration method for nonlinear D-C analysis is described which is based on Broyden's modification of the Newton-Raphson method. Broyden introduces a variable correction factor which is chosen so as to minimize, or at least reduce, the size of the error vector at each iteration. This completely precludes divergence of the algorithm. Broyden also develops a means for updating the inverse Jacobian matrix without ever having to compute or invert it explicity. Two algorithms are described, one for solving a single nonlinear problem and the other for solving a large number of neighboring problems such as are encountered in statistical (Monte Carlo) analysis. Timing measurements on these two algorithms are reported. Application of these algorithms to statistical A-C analysis and to frequency response calculations is proposed and a possible method of improving the basic algorithm by means of a sparse matrix technique is described.

A General Purpose Digital Traffic Simulator, A. M. Blum, *SAE Conference Proceedings* **P22,** 10-25 (January 1968). The vehicle traffic simulator decribed in this paper is designed to facilitate analysis of traffic flow and to experiment with postulated traffic control systems. It offers users a large amount of flexibility in specifying network, intersection, vehicle, and control parameters. The logical flow of vehicles, as well as much of the control system, is preprogrammed. Vehicles varying in size may change lanes, turn, change velocity (including reaction and acceleration delays), and merge. Inputs may be varied, turns may be eliminated, and vehicles may be routed through the network. The user supplies the geometrical characteristics and input information unique to his particular network in data cards for the program. Some applications to real traffic networks (including a validation procedure) and some simple control experiments are discussed. The model, programmed in a special version of GPSS II and in FAP for the IBM 7090/94 systems, can be used in the simulation of single intersections, arterial routes, grid networks, and throughways.

The Impact of Large Scale Integration on Small Data Processing Equipment, P. R. Low, *IEEE 1968 International Convention Digest,* p. 81 (March 18–21, 1968). It has been generally accepted that large scale integration will have its first application in large, high-speed digital data processors. Indeed, current efforts in the industry would support this premise. This paper attempts to show that a substantial market area for logic circuits exists in the I/O terminals and peripheral gear associated with all classes of data processing equipment. The peculiarities of this equipment and the requirements of the technology for them is discussed. It will be shown that large scale integration can play an important part in fulfilling the technology needs of this market area.

Large-Scale Integration of MOS Complex Logic: A Layout Method, A. Wienberger, *IEEE Journal of Solid-State Circuits* **SC-2**, No. 4 (December 1967). Large-scale integration of complex logic is generally assumed to be a compromise between two conflicting cost factors; i.e., reduced design time through layout standardization, and increased yield through high circuit density. A unique but rather simple layout method is described that combines layout standardization with high circuit density generally expected from customized layout. At the same time, the design of the "personality" (the desired interconnection pattern) is simplified, while using a single layer of metallization. The method has been applied to complex logic using MOS NOR circuits.

A Logical Approach to Documenting the Internal Logic of a Programming System, R. C. Billups and L. Gordon, *Proceedings of the 15th International Technical Communications Conference (STWP)*, Paper No. 1–20, 1–8 (May 8–11, 1968). This approach to documenting the internal logic of programming systems has been designed to satisfy the documentation requirements of support personnel responsible for their maintenance. The approach mirrors the logical development of a programming system, and recognizes that the design or method of operation is the reason for coding—not the result of coding. Since the method of operation is the underlying factor in the approach, the paper presents a technique for describing the method of operation, and relating it to (1) the organization of the programming system, (2) the detailed descriptions of constituent tables, and (3) the program listings.

Multitape Finite Automata with Rewind Instructions, A. L. Rosenberg, *Journal of Computer and System Sciences* **1**, No. 3, 299–315 (October 1967). The model of multitape finite automaton is generalized by allowing the automaton to rewind all its tapes simultaneously at any stage in its computation. This added capability is shown to yield the Boolean closure of the class of word relations defined by multitape automata. Several properties of this extended model are investigated. In particular it is shown that this model is incomparable to the nondeterministic multitape finite automata and is strictly weaker than two-way multitape finite automata.

Programmed Algorithms to Compute Tests to Detect and Distinguish Between Failures in Logic Circuits, J. P. Roth, W. G. Bouricius, and P. R. Schneider, *IEEE Transactions on Electronic Computors* **EC-16**, No. 5, 567–580 (October 1967). Two algorithms are presented: one, DALG-II, computes a test to detect a failure in acyclic logic circuits; the other, TEST-DETECT, ascertains all failures detected by a given test. Both are based upon the utilization of a "calculus of D-cubes" that provides the means for effectively performing the necessary computations for very large logic circuits. Strategies for combining the two algorithms into an efficient diagnostic test generation procedure are given. APL specifications of the algorithms are given in an Appendix.

The Role of the Computer in Expendable Tool Supplies, R. A. Gaio, *Proceedings of the ASTME Annual Engineering Conference*, No. MS-68, p. 124 (April 29, 1968). A computer can be an effective aid in controlling expendable tool supplies. The computer program described controls all the commercially available items carried in stock. It provides a printout showing the three phases of inventory: past, present, and future. In the paper, different types of inventory transactions are presented with regard to computer updating. Emphasis is placed on the dollar value of the inventory in total as well as subtotal. Yearly turnover ratio, weekly dollar usage, and all aspects of inventory dollar control are discussed. An explanation of the ordering process is also given. The process is based on yearly contracts, purchase order releases, and a data phone system. It minimizes internal paper work and reduces replacement lead time.

Small-Card Wiring Changes on a Graphic Console, J. M. Lafuente and S. C. Plumb, *IEEE International Convention Digest*, p. 51 (1968). A set of experimental programs was written for an IBM 7044 prototype system to experiment with man/machine communication through a graphic console. The subject of these programs is small-card wiring changes (small volume input to a large-volume file of data), and the principal medium at the graphic console is the light pen. The aim of the programs is to provide a full picture of the card wiring layout on a CRT and to allow the user to select a subgroup (net) of interest and manipulate it. The available options include deletion of an entire net, deletion of selected wires, and drawing of new wires and nets. The user can work from prepared input notes or from visual identification at the CRT, composing the changes on-line. Features of the programs include rule checking, and interlocks which prevent uncorrected errors. Output of the programs consists of coded engineering change records which serve as input to the standard file update routines. In typical situations the user would examine a drawing of the subject card(s) and note the changes, execute the changes with CRT and light pen while seated at the console, then dispatch an output tape to the file updating process.

Systems Implications of Microprogramming, W. J. Patzer and G. C. Vandling, *Computer Design* **6,** No. 12, 62–66 (December 1967). The microprogrammed computer is first characterized as a system component. Then it is shown qualitatively that: (1) a microprogrammed computer organization is well suited to applications where very specialized operations and routines require a significant percentage of total execution time, which permits computer optimization through addition of application-dependent instructions; (2) the ease with which computer architecture can be restructured via microprogramming is a significant consideration in applications where system problems are not completely defined during initial program phases, requirements change during the development phase, and where system characteristics and emphasis change as a function of time; and (3) the unique capability for efficient simulation inherent in microprogrammed computers permits a significant reduction in development time and overall cost in many applications.

The Utility of Coded Multilevel Communications Systems, R. F. Filipowsky, *Proceedings of the Fifth Space Congress* **1,** 5.4.1–5.4.17 (March 11–14, 1968). The paper compares the various methods of coded multilevel communications systems with the help of the utility chart. "Coded communications," a term introduced by Viterbi in 1959, is generally used to designate all kinds of digital communications systems that translate a set of input messages into a set of transmission messages. Multilevel systems, also called quantized pulse amplitude modulation systems, are systems with transmission signals appearing in more than two levels (or states). This characteristic makes the multilevel systems members of the much larger class of nonbinary systems. Binary systems will appear as a special case using only two levels. In a more general sense the paper deals primarily with one-dimensional nonbinary systems; i.e., with systems using more than two members in the set of transmission messages and modulating only one parameter of the corresponding transmission signals.