

Admissible Solutions of Linear Systems with Not Sharply Defined Coefficients, W. Oettli, W. Prager,* and J. H. Wilkinson,** *Journal of SIAM, Numerical Analysis, Series B* 2, No. 2, 291-299 (1965). The compatibility of a complex vector ξ with the linear system $A\xi = b$ is discussed from the point of view of mathematical programming, when all that is known concerning the typical element of A is that it is represented in the complex plane by a point of a circular disc with given center a_{ij} and radius Δa_{ij} .

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Approximation in the Metric of $L^1(X, \mu)$, T. J. Rivlin and B. R. Kripke,* *Transactions of the American Mathematical Society* 119, No. 1, 101-122 (July 1965). This is a detailed study of least first power approximation with especial attention to the uniqueness problem. The presentation is unified by the systematic exploitation of a basic characterization result.

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Abstracts

from recent
papers by
IBM authors

"Autoindexing" and Indexing by Automatic Processes, P. B. Baxendale, *Special Libraries* 56, No. 10, 715-719 (December 1965). An index is, intrinsically, a lexicon of accepted vocabulary that is intended to fulfill three functions: (1) it condenses the information contained in a document collection, (2) it provides a bridge by which the language of the author and that of the searcher can be reconciled, and (3) it is the instrument that governs the searching strategy. This distinguishes what an index is from the output that results when an index is used. Various forms of "autoindexing" are examined on this basis and are differentiated by the extent to which each of the three indexing functions is performed by automatic processes.

Automatic Programs in Circuit Analysis and Design, S. R. Sedore, *Electronic Design* 14, No. 1, 96-99 (January 4, 1966). This article surveys the computer techniques used to perform *dc*, *ac*, and transient analysis of electronic circuits. Some problems currently being faced by the developers of analysis programs are mentioned.

Automatic Simplification of Mathematical Expressions—The FORMAC Algorithm, R. G. Tobey, R. J. Bobrow, S. N. Zilles, *AFIPS Conference Proceedings, Proceedings of the Fall Joint Computer Conference* 27, 37-53 (November 1965). The simplification of symbolic mathematical expressions is an essential process in the manipulation of such expressions. The role of simplification in the experimental FORMAC programming system is presented in this paper. In addition, the approach taken in implementing the FORMAC automatic simplification algorithm is described. Some possibilities for automatic simplification are explored, and a broad sketch of the techniques employed by the FORMAC algorithm for automatic simplification is presented.

Automatic Telephone Intercept System, G. F. Abbott and R. L. Bence*, *Telephone Engineering & Management* 69, No. 23, 43-49 (December 1965). The magnitude, complexity, and sophistication of the telephone system is largely taken for granted today. Direct-distance dialing places any one of 72 million telephones at the finger-tip of the customer. Although most telephone services are revenue-producing, one essential element which yields no income to a telephone company is its automatic intercept system. A mechanized intercept system developed through the collaboration of IBM and Southwestern Bell Telephone is described in this paper.

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A Business-Oriented Time-Sharing System, G. F. Duffy and W. D. Timberlake, *AFIPS Conference Proceedings, Proceedings of the Spring Joint Computer Conference* 28, 265-275 (April 1966). Two years of systems experience in planning, installing, and operating the IBM Administrative Terminal System (ATS) in a business environment has provided considerable knowledge of real-time applications. ATS is a multiprogrammed system that time-shares control of typewriter terminals and peripheral operations (tape-to-printer, etc.). The terminal operator can enter, retrieve, change, and store text or data. Text can be easily corrected, automatically formatted, and printed either on remote terminals or a high-speed printer. This paper describes how the concept of ATS was introduced to management; how specific application areas were selected; planning for installation; and training of personnel. Actual operating experience gained from the following applications is also described; text processing for proposals, specifications, and engineering instructions; file maintenance for status reports, library book processing, and manpower and schedule charts; direct data entry (keypunch simulation) for tape file update; and for miscellaneous uses as correspondence, form letters, and lists.

On the Busy Period of a Facility Which Serves Customers of Several Types, P. D. Welch, *Journal of the Royal Statistical Society, Series B (Methodological)* 27, 361 (1965). Customers of a finite number of types are attended by a single server. The input for each type is Poisson and these inputs are mutually independent. The service times are general and a function of the customer type. The service discipline is subject only to minimal restrictions. This paper contains a discussion of the phenomenon of the busy period for the above queuing model. The main result obtained is the determination of the joint distribution of the length of the busy period and the number of each type of customer served during it.

Die charakteristische Matrix des gegengekoppelten Vierpols (The Characteristic Matrix of a Two-Port Network with Feedback), D. Seitzer, *Archiv der elektrischen Uebertragung* 20, No. 1, 19-26 (January 1966). It is shown that a two-port network with substantial feedback can be described by an illustrative equivalent model. The matrix belonging to that equivalent model is called the characteristic matrix of the two-port. The characteristic matrix of a two-port with feedback is calculated in a way which is valid, at the same time, for all types of feedback. The characteristic matrix is based on the impedance mismatch at the input and output of the two-port considered. Therefore, it is especially suitable for describing high-speed transistor circuits.

A Class of Nonlinear Recognition Procedures, C. K. Chow, *IEEE International Convention Record*, Part 6, 40-50 (March 1966). In statistical recognition, the functional form of the underlying probability distributions determines the structure of recognition networks. Two approaches toward deriving a hierarchy of recognition procedures are reviewed and their implications concerning realization and estimation of recognition weights are discussed. The approaches are based on approximating the probability distributions by (1) orthogonal expansion and (2) a product of low-order conditional probabilities. Only binary measurements are considered here. Rademacher-Walsh functions are used as the orthogonal basis. A notion of tree dependence is introduced to effect the approximation by the product of low-order conditional probabilities. The chain dependence and the two-dimensional neighbor (or mesh) dependence are two instances of the tree dependence.

Computer Assisted Instruction, E. N. Adams, *Computers and Automation* 15, No. 3, 12, 13, & 41 (March 1966). A general discussion is given of the way in which a computer may be made useful as a direct aid to instruction.

Cutting Complexities With Occam's Razor, A. D. Pratt, *Special Libraries* 57, No. 2, 91-95 (February 1966). A proposal is advanced consisting of four elements: (1) a simpler classification scheme—the DDC, (2) simplification of the Cutter numbering system, (3) a system of subject headings appropriate to the particular library, rather than a large universal list, and (4) use of a small digital computer to automatically prepare catalogs, shelf lists, indexes, and similar listings in lieu of a 3 × 5 card catalog. The advantages are, in addition to those accruing to any simplification process, that the intellectual effort of the library professionals is focused more directly on the needs of the specific library, and the results of this intellectual effort are more readily available to the library's patrons.

Data, Documentation, and Decision Tables, D. L. Fisher, *Communications of the ACM* 9, No. 1, 26-31 (January 1966). In business data processing systems, it is necessary to be able to define and document data, files, programs, and decision rules in a way that adequately represents both (1) their changing information content, and (2) their continuous interaction. Tabular description makes this possible, being notably objective, thorough and economical in cost and time when systems must be analyzed and programs prepared or modified. To show how quickly tabular techniques make an unfamiliar system manageable, a detailed example and a self-test are provided.

The Degree of Approximation of Certain Functions of Two Variables by a Sum of Functions of One Variable, T. J. Rivlin and R. J. Sibner,* *American Mathematical Monthly* 72, No. 10, 1101-1103 (December 1965). The degree of approximation to certain functions of several variables by sums of functions of one variable is obtained explicitly.

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Design Considerations for a 25-nsec Tunnel Diode Memory, D. J. Crawford, R. L. Moore, J. A. Parisi, J. K. Picciano, and W. D. Pricer, *AFIPS Conference Proceedings, Proceedings of the Fall Joint Computer Conference* 27, Part 1, 627-636 (November 1965). The design factors for a practical ultra-high speed "scratch pad" memory are described. Information is stored in an array of tunnel diodes interconnected with driving and sensing circuits in a manner to specifically minimize cycle time. The design features modular construction of both the storage array and the associated circuits, practical component tolerances and compact construction. A fully populated system now under construction contains 64 words of 48 bits each complete with address circuits and I/O data circuits. The memory is designed to operate at a 25 nsec cycle time. Special features of interest are miniature printed circuit transformer construction, high speed driving techniques, and rapid regeneration of interrogated information.

Digital Computer Solutions for Excitable Membrane Models, J. Cooley, F. Dodge, and H. Cohen, *Journal of Cellular and Comparative Physiology* 66, Supplement 2, No. 3, 99-109 (December 1965). This report presents a discussion of computational results from two mathematical models which have been applied to various problems on the excitable nerve membrane. To both of these models, the electro-diffusion theory and the empirical Hodgkin-Huxley model, K. S. Cole has made important theoretical as well as experimental contributions. The report discusses numerical calculations from each of these models.

Ervaringen met de Computer in een Bibliotheek (Experiences with a Computer in a Library), J. F. C. Boomsma, *Tijdschrift voor Efficiency en Documentatie* 36, No. 1, 42-46 (January 1966). This paper describes a system called Computerized Document Information Transactions (CODIT), which makes use of an IBM 1410 for handling administrative data and for information processing. The output consists of records-checking data and KWIC hand-sorted index cards, catalogues, SDI, and Information Retrieval. The file can be adapted for use as a text-searching system.

An Experiment in Automatic Indexing, F. J. Damerau, *American Documentation* 16, No. 4, 283-289 (October 1965). This report describes a method of indexing documents which is based on the assumptions, (1) that a subset of the words in a document can be an effective index to that document and, (2) that this subject can be approximated by selecting those words from the document whose frequencies are statistically unexpectedly high. The results of the experiment are encouraging, although not definitive because any index-set chosen must be tested by using it for retrieval from a large collection.

Forecasts of Future Prices, Unbiased Markets, and "Martingale" Models, Benoit Mandelbrot, *Journal of Business (University of Chicago) Special Supplement on Security Prices* 39, No. 1, 242-255 (January 1966). Conditions are explored, under which a price series $z(t)$ constitutes a "martingale": this means that the expectation of the future price $Z(t + T)$, conditioned by the knowledge of the present price $Z(t)$ and by the knowledge of any set of past prices, is identical to the present price $Z(t)$. Knowledge of past prices is then unnecessary in forecasting the expectation of $E[Z(t + T)]$; but it is useful in forecasting the dispersion of $Z(t + T)$ around its expectation. It is shown that a price series generated by a martingale can have a variety of striking "patterns"; conversely, this finding gives additional support to the thesis (advanced in an earlier paper, "The Variation of Certain Speculative Prices," *J. Business* 36, 394-419) that the existence of perceptual patterns does not prove that prices cannot be represented by stochastic processes as being "fair games."

Higher-Speed Data Transmission, A. J. Weber, *Record of the Eleventh National Communications Symposium*, 23-26 (October 1965). With the advent of "real-time" teleprocessing systems, where much of the data is initiated or immediately interpreted by machines rather than people, both the data processing equipment manufacturers and the common carriers visualize a whole new area of higher-speed data transmission for satisfying customers' needs. This paper explores some of the requirements, configurations, and advantages of higher-speed data transmission systems. A review of the economics of higher-speed communications reveals that the bits per dollar of the various services offered by the common carriers clearly point to the advantage of utilizing the highest speed consistent with the application.

Image Information, Classification, and Coding, P. D. Dodd and F. B. Wood, *IEEE International Convention Record*, Part 7, 60-71 (March 1966). Since information content and redundancy vary in documents of different types, these variations must be measured to classify the images for efficient compression and transmission in an automatic document-handling system. Measuring the ϵ -entropy (where ϵ is the scanning resolution), we compared information content and redundancy in numerous examples of three major types of documents. We then plotted the relationships between classes identified and compression ratios reported (theoretical, simulated, and actual) to indicate the state of the art. Improved compression ratios may depend on adaptive scanning, which can identify each document by class and switch to an appropriate compression code.

Index Register Allocation, L. P. Horwitz, R. M. Karp, R. E. Miller, and S. Winograd, *Journal of the Association for Computing Machinery* 13, No. 1, 43-61 (January 1966). A procedure for index register allocation is described. The rules of this procedure are shown to yield an optimal allocation for "straight line" programs.

On an Inequality for Modified Bessel Functions, R. P. Soni, *Journal of Mathematics and Physics* 44, No. 4, 406-407 (December 1965). A method is presented that establishes an inequality without resorting to expressions for the derivative of the function. The rather complicated expressions involving higher transcendental functions are avoided.

Iterative Procedure for Analyzing Certain Networks by Digital Computer, B. A. M. Willcox* and R. C. V. Macario,** *Proceedings of I.E.E.* 112, No. 12, 2243-2253 (December 1965). This paper describes and illustrates a method of analyzing linear electrical networks which can be viewed as a set of interconnected 4-terminal networks. The iterative nature of the method makes it very suitable for programming on a digital computer. Further, it is often very economical in computer time because one can use the results of previously analyzed 4-terminal networks. The paper also outlines a program which has been written for the method.

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Linearly Separable Codes for Adaptive Threshold Networks, C. E. Kiessling and C. J. Tunis, *IEEE Transactions on Electronic Computers* EC-14, No. 6, 935-936 (December 1965). This article describes the significance of the coding assignment in linear threshold networks used for pattern recognition. In particular, codes more dense than the 1-out-of- n are presented. The performance of these codes is comparable to the 1-out-of- n code, but more optimum codes exist.

Maintenance Strategy Diagramming, D. C. Burnstein and W. H. Eppard, *Proceedings of the 1966 Annual Symposium on Reliability*, p. 497, (January 1966). This paper discusses a disciplined approach to the problem of maintainability trade-offs and downtime prediction. The method involves analysis of the equipment reliability, support items, maintenance facility effectiveness and priority of use, symptoms of malfunction, and the strategy required to go from symptom to repair. It accounts for the time per maintenance task and probability of task occurrence. The resulting maintenance strategy is simulated using an IBM 7094 computer. The result of the simulation is examined and the maintenance strategy model is modified to see the effect of changes in any of the items originally analyzed. In this fashion, a prediction of unscheduled downtime is performed and the impact of changes in maintainability parameters on that predicted downtime is seen. The paper will include examples of the strategy, diagramming approach, simulation results, and will discuss the types of trade-offs that can be performed and correlation results.

A Model of Pulse Generation in the Peripheral Nervous System, W. L. Miranker, *Kybernetik* 3, No. 1, 13-17 (January 1966). A model of pulse generation in the peripheral nervous system is discussed in this paper. The model uses no nonlinear circuit analogues of cellular membrane but rather a direct piecewise linear characterization of the membrane permeability changes and related ionic transport which accompany pulse generation. The relative simplicity of the model notwithstanding, predictions of pulse frequency versus generator potential amplitude relationship and pulse frequency versus pulse amplitude relationship, as well as the threshold property of the process, are correctly furnished by straightforward calculations.

Nondestructive Readout Coupled Film Memory Device, C. H. Sie, *Journal of Applied Physics* 37, No. 3, 1375-1378 (March 1966). By magnetostatically coupling a soft film and a hard film with their easy axes orthogonal to each other, an NDRO memory device with fast read-cycle speed has been achieved. This device differs from the previously investigated NDRO devices as follows: (1) the partially magnetized state of the hard film is utilized for information storage; (2) since the device is read and sensed along the transverse axis of the soft film, low read current can be used. The calculated results of possible combination of the soft and hard film characteristics that will result in a device with this mode of operation are presented. A 10-kÅ NiFe (80-20) film and a 10-kÅ CoFe film (50-50) each evaporated on a polymer substrate are used respectively as the soft and hard films of the device. The insensitivity of this device to bit disturb pulses is established by measuring the pulse hysteresis of the CoFe film's partially magnetized state. It is interesting to note that as long as the CoFe film is switched into these partially magnetized states not by time limited process, these are stable states. Finally, the feasibility of this device for memory operation is evaluated experimentally in terms of driver current tolerances and signal-to-noise ratio.

A Nonlinear Eigenvalue Problem for Rotating Rods, F. Odeh and I. Tadjbakhsh, *Archive for Rational Mechanics and Analysis* 20, No. 2, 81-94 (1965). This paper is concerned with a nonlinear eigenvalue problem which arises in connection with the possible equilibrium states of a rotating rod. We prove the existence of nontrivial solutions for velocities of rotation which are greater than certain characteristic values. Some of the methods used are applicable to bifurcation problems in elliptic partial differential equations and difference equations.

On the Nonsingularity of Real Matrices, A. J. Hoffman, *Mathematics of Computation* 19, No. 89, 56-61 (January 1965). By exploiting the theory of linear inequalities, new bounds for the real eigenvalues of a real matrix are derived, along with sufficient conditions for matrix games to be completely mixed, for determinants to be positive, etc. The simple observation on which the derivation of new results and the unification of old results are based is that the typical conditions of diagonal dominance, which insure the nonsingularity of matrices, are essentially systems of linear inequalities on the rows of matrices.

On the Nonsingularity of Real Partitioned Matrices, A. J. Hoffman, *ICC Bulletin* 4, No. 1, 7-17 (January-March 1965). New criteria for the nonsingularity of real matrices are given in which the concept of partitioned matrix plays a forward role. The principal tool is a characterization of all systems of strong homogeneous linear inequalities on the entries of a matrix which imply that the matrix is nonsingular. Corollaries of these results include new bounds for real eigenvalues of real matrices.

Optimum Allocation in Stratified Sampling with Replacement,* S. P. Ghosh, *Metrika* 9, No. 3, 212-221, (1965). In a stratified sample, when sampling is done with replacement in each stratum, a better estimate of the population mean can be achieved by considering the distinct units only. An explicit expression for the variance for the mean of a stratified sample based on the distinct units only is obtained. Then the optimum allocation for the different strata are obtained by minimizing this variance subject to (1) total sample size being fixed, or (2) the expected number of distinct units being fixed. Neyman's solutions are obtained as special cases. The solutions finally arrived at are algebraically complex, hence, numerical methods are applied. In all examples, the variance of the estimates obtained by this method are smaller than the variances obtained by Neyman's allocation.

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Pilot Plant Puts DDC to the Test, P. E. A. Cowley, *Control Engineering* 13, No. 2, 53-56 (February 1966). A pilot plant, based on the distillation process, was built at San Jose for the development and evaluation of direct digital control. Both hardware and software are under development. The main features of the plant are the process itself, the instrumentation, and the control computer.

The Problem of Too Many Measurements in Pattern Recognition and Prediction, D. C. Allais, *IEEE International Convention Record*, Part 7, 124-130 (March 1966). Investigators in the field of pattern recognition have shown that the performance of a recognition system sometimes deteriorates when additional measurements are included in the pattern analysis. This strange phenomenon is explained theoretically for the related problem of normal prediction in which the parameters must be estimated. A practical method is proposed for making the predictor more accurate by reducing the number of measurements. The effectiveness of this technique is shown by experiments with artificial data. The measurement selection procedure is then extended to the two-class pattern recognition problem, which is illustrated by experiments in weather forecasting and character recognition.

Queuing with Nonpreemptive and Preemptive-Resume Priorities, W. Chang, *Operations Research* 13, No. 6, 1020-1022 (November-December 1965). This paper considers a special queue situation, one in which a single facility serves two major priority classes of customers. Within each class, there are several levels of priorities. The first class has the higher priority. On arrival, a customer of the first class immediately replaces any customer of lower priority being served. The second class has the lower priority, as compared to the first class. On its arrival, a customer of the second class cannot interrupt the current service of a lower priority customer in the system; it must wait until the service is completed. The first class is the preemptive priority, and the second class is the nonpreemptive priority. This paper formulates a theoretical solution for this queuing system, which has a wide range of application in the computer industry. The real-time control program under the multi-programming environment is an analog of this priority queuing model.

Recognition of Printed Chinese Characters, R. Casey and G. Nagy, *IEEE Transactions on Electronic Computers* **EC-15**, No. 1, 91-101 (February 1966). The problem of recognizing a large alphabet (1,000 different characters) is approached using a two stage process. In the first stage of design, the data is partitioned into groups of similar characters by means of heuristic and iterative algorithms. In the second stage, peephole templates are generated for each character in such a way as to guarantee discrimination against other characters in the same similarity class. Recognition is preceded by establishing an order of search through the groups with a relatively small number of "group masks." The character is then identified by means of the "individual masks" through a threshold criterion. The effects on the error and reject rates of varying the several parameters in the design and test procedures are described on the basis of computer simulation experiments on a 20,000 character data set. An error rate of 1%, with 7% rejects, is obtained on new data.

On a Relation Between Two-Dimensional Fourier Integrals and Series of Hankel Transforms, J. V. Cornacchio and R. P. Soni, *Journal of Research of the National Bureau of Standards* **69B**, No. 3, 173-174 (July-September 1965). Procedures are developed for expressing two-dimensional Fourier transforms in terms of tabulated one-dimensional transforms.

The Stationary Waiting Time Distribution for a Single-Server Queue, A. G. Konheim, *Journal of the Society for Industrial and Applied Mathematics* **13**, No. 4, 966-976 (December 1965). The objective of this paper is to give a simple procedure for obtaining the stationary waiting time distribution in a single server queue (with queue discipline "first-come, first-served"). Our procedure consists of studying the Wiener-Hopf equation for discrete queues. Employing a result of Calderon-Spitzer-Widom, the solution for the discrete system is obtained, and the general result obtained by approximation.

Talking with Computers, E. Paris, *Science Journal* **2**, No. 3, 68-73 (March 1966). This paper summarizes some recent work in voice communication with computers.

Toward a Documentless System of Inventory Control and Material Accounting, W. J. Schroeder, Jr., *Management Accounting*, 41-49 (December 1965). The system presented in this article is illustrative of a new approach made possible through knowledgeable use of modern data processing equipment. Its internal control aspects and far-reaching implications regarding other areas of accounting are also discussed.

Two-Configuration, Self-Consistent Field Theory, A. Veillard,* *Theoretica Chimica Acta* **4**, No. 1, 22-29 (1966). The Hartree-Fock pseudoeigenvalues equations have been derived for configuration interaction in the case of two atomic configurations ns^2np^N and np^{N+2} . A special case of investigation is the interaction between the nearly-degenerate configurations $1s^22s^22p^N$ and $1s^22p^{N+2}$. The LCAO form of the equations has also been established.

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The Use of an Adaptive Threshold Element to Design a Linear Optimal Pattern Classifier, J. S. Koford and G. F. Goner,* *IEEE Transactions on Information Theory* IT-12, No. 1, 42-51 (January 1966). This paper develops a relationship between two traditional statistical methods of pattern classifier design, and an adaption technique involving minimization of the mean-square error in the output of a linear threshold device. It is shown that the two-category classifier derived by least-mean-square-error adaption using an equal number of sample patterns from each category is equivalent to the optimal statistical classifier if the patterns are equivalent to the optimal statistical classifier and if the patterns are multivariate Gaussian random variables having the same covariance matrix for both pattern categories. It is also shown that the classifier is always equivalent to the classifier derived by R. A. Fisher. A simple modification of the least-mean-square-error adaption procedure enables the adaptive structure to converge to a nearly-optimal classifier, even though the numbers of sample patterns are not equal for the two categories. The use of minimization of mean-square error as a technique for designing classifiers has the added advantage that it leads to the optimal classifier for patterns even when the covariance matrix is singular.

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