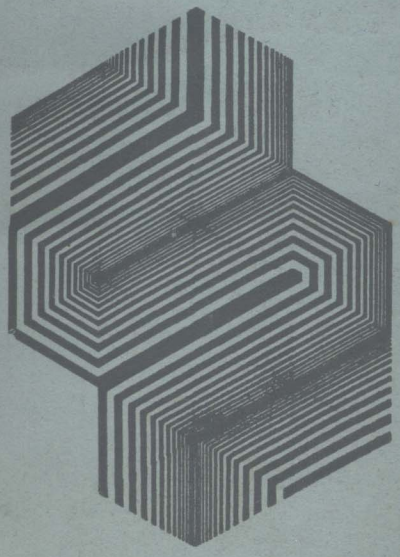
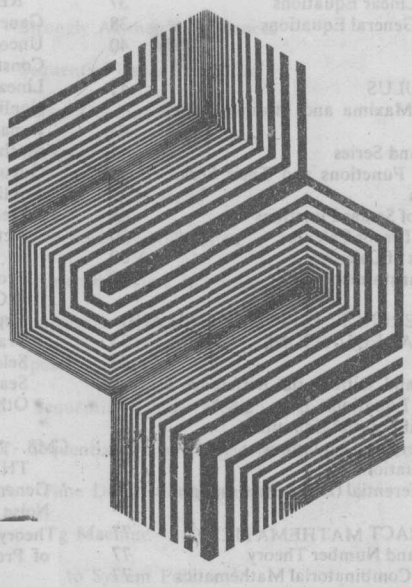
COMPUTER MATHEMATICS

SERIES II



COMPUTER MATHEMATICS

SERIES II



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GENERAL ACRONYM INDEX

ABLU - Almost Best Linear Unbiased

AFA - Abstract Family of Acceptors

AFL - Abstract Family of Languages

AFP - Abstract Family of Processors

AIRCOM - Air Communication Network

ADI - Alternating Direction

APT - Automatically Programmed Tools

ASIL - Asymptotic Stability in the Large

BCSOC - Binary Convolutional Self-Orthogonal Codes

BPRE - Branching Process with Random Environments

CCSOC - Correcting Convolutional Self-Orthogonal Codes

CFA - Cosmic Flying Apparatus

CG - Conjugate Gradients

CLP - Continuous Linear Part

CSDT - Continuous Space - Discrete Time

CTCA - Channel and Traffic Control Agency

CTCU - Channel and Traffic Control Units

CVSD - Continuous Variable Slope Delta

DCPM - Decision Critical Path Method

DFB - Delayed Feedback

DFP - Davidson-Fletcher-Powell

DFT - Discrete Fourier Transform

DLS - Delay Line Synthesizer

EFC - Extended Functional Calculus

ESS - Electronic Switching Systems

FDE - Functional Differential Equations

FFC - Feedforward Control

FFT - Fast Fourier Transform

FSM - Finite State Machine

FSK - Frequency Shift Keyed

GTO - Gate Turn-Off

ID - Iustantaneous Description

IDEA - Inductive Data Exploration and Analysis

IS - Inertial Subcircuits

KRC - Kendal Rank Correlations

LCA - Locally Compact Abelian (Group)

LOC - Line-of-Communication

MAD - Mathematical Analysis of Downtime

MLE - Maximum Likelihood Estimators

MLM - Membrane Light Modulator

MMSE - Minimum Mean Square Error

MRPAP - Markov Renewal Process with Auxiliary Paths

MST - Minimum Spanning Tree

MWAE - Minimum-Weighted-Absolute-Error

MWMSE - Minimum-Weighted-Mean-Square-Error

NDR - Nondeterministic Finite Automaton

OCR - Optimum Compression Ratio

PAQ - Position Analysis Questionnaire

PCM - Pulse Code Modulation

PCS - Probability of a Correct Selection

PFM - Pulse Frequency Modulation

PID - Proportional Integrations and Differentiation

PLL - Phase Locked Loops

PSK - Phase-Shift Keyed

RCN - Relay-Contact Network

RKHS - Reproducing Kernel Hilbert Space

SA - Stochastic Approximation

SAS - Strongly Asymetric Sequences

SBP - Sequential Bayes Procedure

SDF - Social Decision Function

SDT - System Down Time

SNR - Signal-to-Noise Ratio

SOR - Successive Overrelaxation

SPIF - Sequential Prime Implicant Form

SPRT - equential Probability Ratio Tests

SRC - Spearman Rank Correlation

SSMT - Sequential Sample Median Test

SUMT -Sequential Unconstrained Minimization Techniques

TDMA - Time Division Multiple Access

TM - Turing Machine

TSF - Time to System Failure

TSL - Tree Searching Language

ULP - Universal Logic Primitive

VLW - Variable-Length-Word

ZNL - Zero-Memory Nonlinear

SPECIFIC ACRONYM INDEX

CM1 - GENERAL: NUMERICAL AND SYMBOLIC ANALYSIS

CM1.0 - GENERAL

39736C ON THE ELEMENTARY TREATMENT OF INDEX NUMBERS by J. Craig (U. Hull); APPL. STAT., Vol. 18, No. 2, 1969, pp. 141-152

40751C FINITE DIFFERENCE SCHEME FOR CALCULATING PROBLEMS IN TWO SPACE DIMENSIONS AND TIME by M. L. Wilkins (Lawrence Radiation Lab., U. Calif., Livermore); J. COMP. PHYS., Vol. 5, No. 3, June 1979, pp. 406-414

The effectiveness of a finite difference scheme for solving problems in continuum mechanics is demonstrated by a series of problems ranging from elasticity theory to gas dynamics. All of the results shown were plotted directly by the high speed computer and permit an easy evauation of the technique.

41699C ON THE ONE HUNDREDTH ANNIVERSARY OF THE BIRTH OF V.I. LENIN: MATHEMATICS AND DIALECTICS by A.D. Lleksandrov SIBERIAN MATH. J., Vol. 11, No. 2, March-April 1970, pp. 185-197

41700C COMPUTER INTERVAL ARITHMETIC: DEFINITION AND PROOF OF CORRECT IMPLEMENTATION by D. I. Good; R. L. London (U. Wisc., Madison, Wisc.); J. ASSOC. COMP. MACHINERY, Vol. 17, No. 4, Oct. 1970, pp. 603-612

A definition is given of computer interval arithmetic suitable for implmentation on a digital computer. Some computational properties and simplifications are derived. An ALGOL code segment is proved to be a correct implementation of the definition on a specified machine environment.

42564C APPROXIMATIONS FOR THE ELLIPTIC INTEGRAL-FUNCTION K/ K' AND ALGORITHM FOR AN ARBITRARY IMPROVEMENT OF THEIR ACCURACY IN PARTICULAR FOR THE CALCULATION OF CHARACTERISTIC IMPEDANCE by W. Hilberg ARCH. ELEKTROTECH., Vol. 53, No. 5, 1979, pp. 290-298

Recursion formulae starting with approximations are derived for the function K/ K' and the converse function $[K/K]^{-1}$. The recursion converges very rapidly and comprises the whole range of definition. The first three approximations are given explicity. The first one has only a maximal relative error smaller than $2.4 \cdot 10^{-3}$, the second one smaller than $2.3 \cdot 10^{-6}$ and the third one smaller than 4.10^{-12}. As the recursion formulae contain only elementary functions and no integrals, they are adapted for futher general calculations as well as for practical use. The basic algorithms finally derived in (31, 34) and (35) are given in such a form that they are well suited for practical computations with digital computers.

43146C GENRALIZED ORDINAL NOTATION by F.S. Gass (Miami U., Oxford, Ohio); NOTRE DAME J. FORMAL LOGIC, Vol. 12, No. 1, Jan. 1971, pp. 104-114

The purpose of this paper is to explore a broad class of systems that generalize Kleene's notion of r-system. In a background section, following notation and terminology we describe some prominent results from ordinal notation theory. Then in section 1 we review some facts about r-systems and describe the generalized systems. Since the mathematical notation can easily become forbidding in such investigations, we have adopted a simplified notation that is often dependent upon context for its full meaning. Section 2 pursues the study of three particular systems that are noteworthy for their resemblence to Kleene's S_1, including a maximality property. In section 4, we identify the segment of ordinals for which these systems provide notations. Since the systems are maximal for only a proper sub-class of the generalized systems, we turn out attention in section 5 to a result about the remaining generalized systems; as a class, they admit no maximal system.

43147C A SHORT PROOF OF STONE'S THEOREM by A. Abian (Dept. of Math., Iowa St. U., Ames, Iowa); ACTA MATH. HUNGARY, Vol. 21, No. 1-2, 1970, pp. 225-226

43148C NORMAL STATES AND REPRESENTATIONS OF THE CANONICAL COMMUTATION RELATIONS by M. Courbage (Centre U., Marseille-Luminy); S. Miracle-Sole (CNRS Marzeille); D.W. Robinson (Centre U., Marseille-Luminy); ANN. INST. POINCARE, Vol. 14, No. 2, 1971, pp. 171-178

A characterization of all representations of the canonical commutation relations which are quasi-equivalent to the Fock representation is given and a characterization of all finite density states is subsequently derived.

43553C HYBRID COMPUTATION TECHNIQUES INFERRED FROM FUNCTIONAL ANALYSIS by C. K. Sanathanon; D. Ferfuson (Dept. Infor. Engrg., U. Ill., Chicago, Ill.); IEEE TRANS. COMPUTERS, Vol. C-20, No. 1, Jan. 1971, pp. 19-24

The research reported in this paper is concerned with the use of functional analysis and operator theory in providing insights into iterative computational methods. The computational methods are discussed in the context of obtaining the closed-loop response of a complex feedback system on a hybrid computer. The need for iterative solution arises in problems in which the feedback cannot be computer instantaneously, for instance, when there are partial differential equations, and/ or where there is a large number of arithmetic and logical operations. The tools of functional analysis are used to devise computational schemes with improved convergence properties.

43600C A MONTE CARLO PERT ANALYSIS SYSTEM UTILIZING THE GRAPHIC DISPLAY OF AN IBM 360 COMPUTER by R. A. Kottke, Jr. (Naval Postgrad. Sch., Monterey, Calif.); USGRDR, Vol. 70, No. 23, Dec. 1970, p. 93, AD-712 461

A system for PERT analysis using Monte Carlo method to estimate project completion times was designedusing a 2250 Display Unit operating on an IBM 360/ 67 computer. The user enters the PERT network and the distributions of activity times by using the light pen on the 2250 Display Unit. After the computer performs the analysis, the probability of being on the critical path is shown for each arc in the network and a histogram of project completion times is displayed. The used may then modify the network and run another analysis. A discussion of the difference between this Monte Carlo PERT analysis and the ussual PERT analysis and details of the implementation is included, along with operating instructions for the program. A user with no programming experience of the 2250 Display Unit can utilize the program by following the operating instructions.

CM1.1 - COMPUTER MATHEMATICS - GENERAL

44174C A METHOD OF RESOLVING NONLINEAR PROGRAMS WITHOUT CONVEX HYPOTHESIS(IN FRENCH) by J. Abadie, REV. FRAN. INFO. ET RECH. OP., Vol. 5, No. 1, Jan. 1971, pp. 23-38

The author has previously published a branch and bound method for solving mixed integer nonlinear programming problems. Proof of inite convegence rested upon some convexity or quasi-convexity hypothesis. A modification is proposed, which permits elimination of all hypotheses, and nevertheless

preserves the property of the previous method concerning the small number of groups of memories necessary for backtracking. Application is made to mixed integer quadratic programming and to polynomial Boolean programming, without any assumption other than those which are implied by these titles.

44175C LINEAR MIXED PROGRAMMING: VALIDITY CONDITIONS IN ABORESCENT METHOD (IN FRENCH(by J. Tergny; REV. FRAN. INFOR. ET RECH. OP., Vol. 5, No. 1, Jan. 1971, pp. 11-21

In branch and bound method for linear mixed-integer programming a simple analysis of the last tableau of the basis at each "terminal" subprogramme gives rise to a better solution than the ones already found. The necessary condltions or "validity conditions" take the form of linear constraints relating the integer variables. This tool has a classic application in partitioning procedures; the idea to apply it to tree-structure methods is more recent.

44176C REALIZATION OF OPTIMUM INTERLEAVERS by J. L. Ramsey (Standord Res. Inst. Menlo Pk, Calif.); IEEE TRANS., Vol. IT-16, No. 3, 1970, pp. 338-345

Four realizations of interleavers that reorder a sequence of symbols so that no contigous sequence of n_2 symbols that the reordered sequence contains any pair of symbols that were separated by fewer than n_1 symbols in the original ordering are introduced. For any n_1 and n_2 that satisfy an appropriate relative primeness conditon, these interleavers are optimum in the sence that of all possible interleavers providing the indicated symbol separation, on of these four realizations achieves both the minimum possible encoding delay and the minimum possible combined storage capacity for the interleaver and its unscrambler.

44177C SELF-IDENTIFICATION OF THE TRANSFER FUNCTION OF THE PID-CONTROL by G. Lefevre, P. Bertrand; F. N'Goulou; AUTOMATISME, Vol. 16, No. 2, Feb. 1971, pp. 111-115

The method set forth permits of deriving directly the transfer function of a P.I.D. control by considering the latter as a process. The various actions, i.e., proportional integral and derivative, are sequentially identified through an analogue computer to which is connected an online mathematical model of the control's kinematics; the values of each parameter of the transfer functions are automatically displayed on the computer. This short cut provides the interaction curve for the parameters.

44178C CORRECTION OF ERRORS IN ARITHMETIC DEVICES BASED ON ELEMENTS WITH MANY STABLE STATES by I. L. Yerosh; M. G. Karpovskiy; REFERATIVNYY-ZHURNAL-KYBERNETIKA, Vol. 1, Jan. 1971, Abst. No. IV408

The authors consider classes of q-nary codes which detect and correct arithmetic errors in different channels. Conditions are formulated for the existence of AN codes which correct isolated errors of varying depth in symmetric and asymmetric arithmetic channels. A method is proposed for selecting a code which corrects isolated errors of arbitrary depth in arithmetic devices which utilize the decimal system of notation, where the individual units are based on binary elements.

44179C THE CORRESPONDENCE BETWEEN METHOD OF DIGITAL DIVISION AND MULTIPLIER RECODING PROCEDURES by J. W. Robertson; IEEE TRANS. COMP., Vol. C-19, No. 8, Aug. 1970, pp. 692-701

This paper relates previous analyses or the binary SRT division to the theory of multiplier recoding. Since each binary quotient digit has three possible values, the quotient resulting from the SRT division is in recoded form; in this paper it is shown that the recoding is a function of the divisor, and the method for determining the characteristic Boolean function of the recoding is presented. The relationship between the division and the recording is established by scaling the division in such a way that the scaled "divisor" becomes a constant. Higher radix results are also discussed.

44180C A FORMALIZATION OF FLOATING-POINT NUMERIC BASE CONVERSION by D. W. Matula; IEEE TRANS., Vol. C-19, No. 8, Aug. 1970, pp. 681-691

45455C THE SUPER-VARIATIONAL TECHNIQUE REVISITED by P.J. Turinsky (Dept. Nucl. Engrg., U. Mich., Ann Arbor, Mich.); J. MATH. ANALYSIS AND APPL., Vol. 33, No. 3, March 1971, pp. 605-615

45456C ON THE DIVISIBILITY OF AN ODD PERFECT NUMBER OF THE SIXTH POWER OF A PRIME by W. L. McDaniel; MATH. COMPUTATION, Vol. 25, No. 114, April 1971, pp. 383-386

It is shown that any odd perfect number less than 109118 is divisible by the sixth power of some prime.

45457C RATIONAL APPROXIMATIONS TO μ, by K. Y. Choong, D. E. Daykin; (Computer Cntr., U. Malaya Kuala Lumpur, Malaysia); C. R. Rathbone (Math. Dept., U. Malaya Kuala Lumpur, Malaysia); MATH. COMPUTATION, Vol. 25, No. 114, April 1971, pp. 387-392

Using an IBM 1130 computer, we have generated the first 20,000 partial quotents in the ordinary continued fraction representation of μ.

45458C "ALGORITHMS IN GENERALIZED MATHEMATICAL THOUGHT" by S. I. Shapiro, KIBERNETIKA, No. 3, 1971

Using the example of a simple arithmetic problem, the relationship between the algorithm used for problem solving by students and the algorithm used for recognition of applicability of the solution method is discussed.

45459C THE ART OF COMPUTER PROGRAMMING ERRATA ET ADDENDA by D. E. Knuth (Stanford U., Calif., Dept. of Compute Sci.); GOV. REPTS. ANNOUNCEMENTS, Vol. 71, No. 12, June 1971, p. 119

The report lists about 100 changes which will be made to the next edition of the Art of Computer Programming, Volume 1, and about 140 changes for Volume 2. These changes attempt to keep the books "up-to-date" by correcting errors, providing additional historical information and literature references, incorporating recently discovered algorithms or solutions to previously unsolved problems. Some of the more interesting topics treated are recent results on high speed multiprecision multiplication and on the analysis of Euclid's algorithm.

45460C ON EFFECTIVE PROCEDURES FOR SPEEDING UP ALGORITHMS by M. Blum (Electron. Res. Lab., U. Calif., Berkeley, Calif.); J. ASSOC. FOR COMPUTING MACHINERY, Vol. 18, No. 2, April 1971, pp. 290-305

This paper is concerned with the nature of speedups. Let f by any recursive function. We show that there is no effective procedure for going form an algorithm for f to another algorithm for f that is significantly faster on all but a finite number of inputs. One the other hand, for a large class of functions f, one can go effectively from any algorithm for f to one that is faster on at least infinitely many integers.

CM1.3 - BASIC CONCEPTS OF NUMERICAL ANALYSIS

38384C STOCHASTIC OPTIMIZATION OF FEEDBACK CONTROL SYSTEMS FOR MEAN-SQUARE-ERROR MINIMIZATION WITH REFERENCE TO SINGLE-TIME-CONSTANT IDEAL by T. Rajagopalan; V. Seshadri (Indian Inst. Tech., Madras); INT. J. CONTROL, Vol. 10, Sept. 1969, pp. 263-270

It is generally known that the design of linear systems for stochastic optimization for mean-square-error minimization leads to optimal systems that are insufficiently damped to be of practical utility. It is shown here that a modified definiton of error, employing a properly chosen single-time-constant ideal, leads, on mean-square-error stochastic optimization, to systems which have much better damping characteristics. The procedure is illustrated by a typical gain-optimization problem in a servo system.

38385C ITERATIVE SOLUTIONS OF THE SCALAR HELMHOLTZ EQUATION IN LOSSY REGIONS by J. R. Molberg; D. K. Reynolds (Boeing and U. Seattle, Wash.); IEEE TRANS., Vol. MTT-17, Aug. 1969, pp. 460-464

Iterative solutions to the finite difference equaztions derived from the scalar Helmholtz equation are found to diverge for domains greater than a certain size. A transform method is presented which produces convergence in larger domains. The method is illustrated by solutions for one- and two-dimensional cases involving losy dielectric media.

38386C A NOTE ON COMPLEX RECURSIVE CHARACTERISTIC FUNCTIONS by E. M. McCreight (Carnegie-Mellon U., Pittsburgh, Pa., Dept. Computer Sci.); USGRDR, Vol. 69, Aug. 1969, p. 88, AD-688 841

There are 0-1 valued functions c(x) such that any program with index i computing c(x) takes a large number of steps except at log of i to the base 2 values of x.

38387C PROPERTIES OF BOUNDS ON COMPUTATION by A. R. Meyer; E. M. McCreight (Carnegie-Mellon U., Pittsburgh, Pa., Dept. Computer Sci.); U.S. GOV. RES. AND DEV. REPTS., Vol. 69, Aug. 10, 1969, p. 112, AD-688 241

Partial recursive functions which equal the amount of time or space required by computations have special properties which distinguish them from arbitrary partial recursive functions. Our main result illustrates a property of running times similar in interpretation to Borodin's gap theorem. The proof is based on the construction of difficult to comoute characteristic functions which take the value one very infrequently.

38518C SEQUENTIAL ESTIMATION FOR DISCRETE-TIME NONLINEAR SYSTEMS by J. S. Meditch (Boeing Sci. Res. Labs., Seattle, Washington, Info. Sci. Lab.); U.S. GOV. RES. AND DEV. DEPTS., Vol. 69, Aug. 10, 1969, p. 93, AD-688 244

The problem of state and parameter estimation for noisy discrete-time nonlinear dynamic systems is examined from the viewpoint of marginal maximum likelihood estimation. Approximate algorithms for sequential prediction, filtering, and smoothing are developed. The former two are in agreement with previous results; the latter is new. A technique for iterative-sequential filtering and smoothing using Newton's method is indicated. A numerical example is included to illustrate the results.

38568C ERROR-BOUNDS AND COMPUTER ARITHMETIC by K. Nickel (Karisruhe, Germany); INFO. PROC. 68 - PROC. IFIP CONG., Vol. 1, 1969, pp. 54-62

38571C ON THE CONVERGENCE OF A PRACTICAL QR ALGORITHM by B. N. Parlett (U. Calif., Berkeley); W. Kahan (Dept. Math., U. Toronto) INFO. PROC. 68, - PROC. IFIP CONG., Vol. 1, 1969, pp. 114-118

38572C GLOBAL CONVERGENCE OF QR ALGORITHM by J. H. Wilkinson (Natl. Phys. Lab., Teddington, Middlesex, U.K.); INFO. PROC. 68 - PROC. IFIP CONG., Vol. 1, 1969, pp. 130-133

38576C STARTING PROCEDURES FOR THE ITERATIVE CALCULATION OF RATIONAL TSCHEBYSCHEFF APPROXIMATIONS by H. K. E. Werner (U. Munster, Germany); INFO. PROC. 68 - PROC. IFIP CONG., Vol. 1, 1969, pp. 106-110

38589C CONSTRAINT THEORY, PART III: INEQUALITY AND DISCRETE RELATIONS by G. J. Friedman; C. T. Leondes (Sept. Engrg., U. Calif., Los Angeles); IEEE TRANS., Vol. SSC-5, July 1969, pp. 191-199

38712C SOLUTION OF A CERTAIN PROBLEM IN OPTIMUM CONTROL BY THE METHOD OF SUCCESSIVE APPROXIMATIONS by N. T. Band; AUTOMATION AND REMOTE CONTROL, June 1969, pp. 857-866

39455C NUMERICAL ANALYSIS AND DATA ANALYSIS IN SUPPORT OF SCIENTIFIC RESEARCH by R. W. Doherty, J. F. Russell, R. M. Ring; N. Grossbard (Boston Coll., Chestnut Hill, Mass.); U.S. GOV. RES. AND DEV. REPT., Vol. 69, Oct. 25, 1969, p. 108, AD-692 519

The report describes the data analysis, numerical analysis and programming performed in the solution of varied scientific problems during this year. These problems range in complexity from the numerical approximation of complicated double and triple integrals and numerical solutions for systems of non-homogeneous integral equations using integral approximations, to the classical solution of a system of non-homogeneous equations and the root solutions of cubic equations with varying coefficients. Each problem encountered is presented in capsule form and its solution is outlined.

39456C AN ERROR ANALYSIS FOR THE BIVARIATE INTERPOLATION OF ANALYTIC FUNCTIONS by R. E. Barnhill; J. A. Wixom (U. Utha, Weber State College); SIAM J. NUMER. ANAL., Vol. 6, Sept. 1969, pp. 450-457

39457C ON THE CONVERGENCE OF STOCHASTIC APPROXIMATION IDENTIFICATION ALGORITHMS by V. Panuska (Dept. EE, Sir George Williams U., Montreal); IEEE TRANS., Vol. AC-14, Oct. 1969, pp. 587-588

Some clarification concerning the convergence of one type of stochastic approximation identification algorithms is presented. A quick check for unbiasedness of such algorithms is given.

39458C A MULTIPOINT METHOD OF THIRD ORDER by W. E. Bosarge, Jr.; P. O. Falb; J. OPTIMIZATION THEORY AND APPL., Vol. 4, Sept. 1969, pp. 156-166

A convergence theorem for the iterative solution of $F(x) = 0$ is proved for the multipoint algorithm $x_{n+1} = x_n - \phi(x_n)$. The theorem guarantees that, under appropriate conditions on F, the multipoint sequence [xn] generated by ϕ converges cubically to a zero of F. The algorithm is applied to the nonlinear Chandraskhar integral equation.

39729C PATH INTEGRALS AND LYAPUNOV FUNCTIONALS by M. Gruber; IEEE TRANS., Vol. AC-14, Oct. 1969, pp. 365-475

A method for generating Lyapunov functionals for time-delay systems by means of path integrals in state space is given. The method is derived by making use of a new description of such systems in terms of convolution equations involving distributions with compact support. The important properties of these equations are discussed and it is shown that a suitable state space can be defined, and conditions for path independence are derived. With the aid of some results dealing with the spectral factorization of entire functions of exponential order, it is shown that these path integrals can be used to define Lyapunov functionals for time-delay systems. The method represents an extension to infinite dimensional systems of a technique developed by Brockett for systems described by ordinary differential equations. While the present approach differs fundamentally from that used for finite-dimensional systems, the results given here are similar to, and in the special case of finite-dimensional systems reduce to, the results given by Brockett. The method can be successfully applied even without a deep understanding of either distributions or distributional convolution equations. This is illustrated by a number of examples which show the application of the results to stability analysis as well as to a class of quadratic minimization problems.

39737C FORMALIZATION OF PROPERTIES OF RECURSIVELY DEFINED FUNCTIONS by Z. Manna; A. Pnueli (Stanford U., Calif. Dept. Computer Sci.); U.S. GOV. RES. AND DEV. REPT., Vol. 59, June 10, 1969, pp. 118-119

40755C CONVERGENCE OF SUMS TO A CONVOLUTION OF STABLE LAWS by J. D. Mason (U. of Georgia); ANNALS OF MATH STAT., Vol. 41, No. 3, 1970, pp. 1068-1070

30756C COMPUTATIONAL EXPERIENCE WITH QUADRATICALLY CONVERGENT MINIMISATION METHODS by B. A. Murtagh; R. W. H Sargent (Imperial. Coll. London. SW7); THE COMP. J., Vol. 13, No. 2, May 1970, pp. 185-194

A recently reported minimization method allows great flexibility in choosing successive steps without losing the property of quadratic convergence, but special precautions are necessary to ensure ultimate convergence from an arbitrary point for general functions. The paper makes an analysis of the required conditions, which give rise to several possible algorithms, and results of these for a number of problems are presented and discussed.

40757C ON THE RATE OF CONVERGENCE OF DIFFERENCE-SCHEMES WHICH APPROXIMATE PARABOLIC INITIAL-VALUE PROBLEMS by B. Nonien (Hamburg); COMPUTING, Vol. 5, No. 3, 1970, pp. 221-245

The rate of convergence of a difference-scheme depends on the differentiability of the solution of the differential equation. In parabolic initial value

problems this is determined by the initial function. We examine the changing of the rate of convergence in dependence on the initial function.

40758C THE CONVERGENCE OF PADE APPROXIMANTS OF MEROMORPHIC FUNCTIONS by J. Nuttall (Phys. Dept. Texas A and M U. coll. St.); J. MATH. ANALYSIS AND APPL., Vol. 31, 1970, pp. 147-153

40759C AN IMBEDDING METHOD OF ITERATION WITH GLOBAL CONVERGENCE by P. Laasonen (Otaniemi); COMPUTING, Vol. 5, No. 3, 1970, pp. 253-258

In the solution methods introduced by DACIDENKO AND GAVURIM the nonlinear equation is simulated by an initial value problem involving a differential equation. In this paper a related imbedding method has been produces a global convergence even without any knowledge of a first approximation.

40760C DERIVATION-FREE METHODS WITHOUT SOLVING LINEAR EQUATIONS (IN GERMAN) by J. W. Schmidt; D. Leder (Dresden); COMP., Vol. 5, No. 1, 1970, pp. 71-81

Iteration methods are given for the solution of nonlinear equations in normed spaces requiring function values and first-order divided differences. The latter may be replaced by derivation. The linear equations of each iteration step are solved only approximatively but this does not diminish the order of convergence.

40761C ALGEBRAIC AND METRIC STRUCTURES IN INTERVAL ARITHMETIC AND APPLICATIONS (IN GERMAN) by O. Mayer (Karlsruhe); COMPUTING, Vol. 5, No. 2, 1970, pp. 144-162

This paper deals with the structure and the characteristics of the spaces occurring in interval analysis and presents some applications. At first the algebraic structure of these spaces in abstractly described by the definition of the quasilinear space, a generalization of the linear space. Then metric structures in these spaces are treated. As for applications only metrics are apt, which have a certain compatibility with the algebraic structure, such properties are introduced and examined. For the interval arithmetic with matrices and vectors metrics are developed, which are compatible with the algebraic structure and so are apt to estimate with. With these results for certain equations existence and uniqueness of the solution are examined and tests of convergence deduced. Finally it is shown how these iteration methods are to be carried out on a computer.

40762C THE CLUSTER SET OF SEQUENCES OF SUCCESSIVE APPROXIMATIONS by F. T. Metcalf (U. Calif. Riverside); T. D. Rogers (U. Alberta, Edmonton, Can.); J. MATH ANALYSIS AND APPL., Vol. 31, 1970, pp. 206-212

40763C ITERATIVE SOLUTIONS FOR SYSTEMS OF NONLINEAR EQUATION AND DISCRETISATION OF ELLIPTIC DIFFERENTIAL EQUATIONS by Th. Meis; W. Tornig (Julich); COMPUTING, Vol. 5, No. 3, 1970, pp. 281-294

The theorems, known for systems of linear equations, on the convergence of "Successive overrelaxation methods (SOR)" and "Alternating direction methods (ADI)" are transferred to analogous methods for systems of nonlinear equations. In doing so, only so-called "local" convergence theorems can be proved, however, as it is the case with other iteration procedures for nonlinear problems.

41701C PARAMETER SELECTION FOR MODIFIED NEWTON METHODS FOR FUNCTION MINIMIZATION by D. F. Shanno (Graduate Sch. Business, U. of Chicago, Chicago, Illinois); SIAM J. NUMER. ANAL., Vol. 7, No. 3, Sept. 1970, pp. 366-372

The stability of Newton's methods for function minimization, or variants of it such as quasi-Newton or Newton-Raphson methods, can be improved by modifying the acceleration matrix by adding a scalar parameter to the diagonal elements. It can be further improved by optimizing the function in the direction of the search vector. This paper derives an algorithm for determining when to add these parameters, and how to determine their magnitude, by considering the function as a function of a single scalar parameter. Computational results are included to show the stability of the derived algorithm.

41702C ACCUMULATION OF ROUND-OFF ERROR IN FAST FOURIER TRANSFORMS by T. Kaneko; B. Liu (Princeton U., Princeton, N.J.); J. ASSOC. COMP. MACHINERY, Vol. 17, No. 4, Oct. 1970, pp. 637-654

The fast Fourier transform (FFT) is an algorithm to compute the discrete Fourier coefficients with a substantial time saving over conventional methods. The finite word length used in the computer causes an error in computing the Fourier coefficients. This paper derives explicit expressions for the mean square error in the FFT when floating-point arithmetics are used. Upper and lower bounds for the total relative mean square error in the FFT when floating-point arithmetics are used. Upper and lower bounds for the total relative mean square error are given. The theoretical results are in good agreement with the actual error observed by taking the FFT of data sequences.

41703C NATURAL NORMS IN ALGEBRAIC PROCESSES by D. K. Faddeev; V. N. Faddeeva (Math. Inst. Steklof Acad. of Sci., USSR, Fontanka 25, Leningrad, USSR); SIAM J. NUMER. ANAL., Vol. 7, No. 4, Dec. 1970, pp. 520-531

41704C CUTTING-PLANE METHODS WITHOUT NESTED CONSTRAINT SETS by D. M. Topkis (U. of Calif., Berkeley, Calif.); OPERATIONAL RES., Vol. 18, No. 3, May-June, 1970, pp. 404-413

This paper gives general conditions for the convergence of a class of cutting-plane algorithms without requiring that the constraint sets for the subproblem be sequentially nested. Conditions are given under which inactive constraints may be dropped after each subproblem. Procedures for generating cutting-planes include those of Kelley, Cheney and Goldstein, and a generalization of the one used by both ZOUTENDIJK and VEINOTT. For algorithms with nested constraint sets, these conditions reduce to a special case of those of ZANGWILL for such problems and include as special cases the algorithms of KELLEY, CHENEY and GOLDSTEIN, and VEINOTT. Finally, the paper gives an arithmetic convergence rate.

41705C A NEW ITERATIVE PROCEDURE FOR THE MINIMIZATION OF A QUADRATIC FORM ON A CONVEX SET by T. Pecsvaradi; S. Narendra (Dept. of Engrg. and Appl. Sci., Yale U., New Haven, Conn.); SIAM J. CONTROL, Vol. 8, No. 3, Aug. 1970, pp. 396-402

41706C SOME ITERATIVE METHODS FOR IMPROVING ORTHONORMALITY by Z. Kovarik (Toronto, Ont.); SIAM J. NUMER. ANAL., Vol. 7, No. 3, Setp. 1970, pp. 386-389

41707C DERIVATIVE-FREE ITERATION PROCESSES by J. Wimp (Midwest Res. Inst., Kansas City, Missouri); SIAM J. NUMER. ANAL., Vol. 7, No. 3, Sept. 1970, pp. 329-334

41708C RECURSIVE FUNCTION THEORY AND NUMERICAL ANALYSIS by W. Miller (comp. Sci. Dept., Penn St. U., University Pk., Pa.); J. OF COMP. AND SYS. SCI., Vol. 4, No. 5, Oct. 1970, pp. 465-472

We consider the role of subclasses of the recursive functions in proving nonexistence of certain numerical methods. In particular, an initial value problem is treated.

41771C A METHOD FOR SOLVING LARGE MATRIX EQUATIONS REDUCED FROM FREDHOLM INTEGRAL EQUATIONS OF THE SECOND KIND by M. Hashimoto (Osaka U., Toyonaka, Japan); J. ASSOC. C. MACH., Vol. 17, No. 4, Oct. 1970, pp. 629-636

The method of reducing a Fredholm integral equation of the second kind to a matrix equation and then inverting the matrix is well suited to a machine computation. The number of the dimension of the matrix equation is desired to be large for a well approximated solution. However, much computing time may be required to invert the matrix of the number of the elements of the matrix may exceed the memory capacity. A successive iterative method is suggested to avoid these difficulties.

43149C A STATISTICAL MODEL OF ROUNDOFF ERROR FOR VARYING LENGTH FLOATING-POINT ARITHMETIC by M. Tienari; BIT, Vol. 10, No. 3, 1970, pp. 355-365

A model is presented which explains the behavior of the roundoff error in a result quantity when computing precision is varied. A set of hypotheses concerning this a posteriori model is tested in a matrix inversion algorithm. The characteristics of the algorithms where the error model is valid are discussed. As an application of the model, the usual estimation procedure for roundoff error consisting of comparing the results computed in two different precisions is analyzed statistically.

43150C ERROR ANALYSIS OF THE ALGORITHM FOR SHIFTING THE ZEROS OF A POLYNOMIAL BY SYNTHETIC DIVISION by G. W. Stewart III (Computation Cntr., U. of Tex., Austin, Tex.); MATH COMP., Vol. 25, No. 113, Jan. 1971, pp. 135-139

An analysis is given of the role of rounding errors in the synthetic division algorithm for computing the coefficients of the polynomial $g(z) = f(z+s)$ from the coefficients of the polynomial f. It is shown that if $|z+s| \cong |z| + |s|$ then the value of the computed polynomial g (z) differs from g(z) by no more than a bound on the error made in computing $f(z+s)$ with rounding error. It may be concluded that well-conditioned zeros of f lying near s will not be seriously disturbed by the shift.

43151C ITERATIVE SOLUTION OF LARGE-SCALE SYSTEMS BY HYBRID TECHNIQUES by W. Chen; L. P. McNamee (General Precision Systems, Link Group, Sunnyvale, Calif.); (Dept. Computer Sci., U. Calif., L.A., Calif.); IEEE TRANS. ON COMPUTERS, Vol. C-19, No. 10, Oct. 1970, pp. 879-889

A hybrid computing technique is presented for improving the resolution of the discrete-space discrete-time (DSDT) resistive network method and the treatment of large scale systems encountered in the solution of partial differential equations.

43152C APPROXIMATIONS FOR THE ELLIPTIC INTEGRAL-FUNCTION K/ K′ AND ALGORITHM FOR AN ARBITRARY IMPROVEMENT OF THEIR ACCURACY IN PARTICULAR FOR THE CALCULATION OF CHARACTERISTIC IMPEDANCE by W. Hiberg; ARCH. ELEKTROTECH, Vol. 53, No. 5, 1970, pp. 290-298

Recursion formulae starting with approximations are derived for the function K/ K′ and the converse function $[K/K]^{-1}$. The recursion converges very rapidly and comprises the whole range of definition. The first three approximations are given explicitly. The first one has only a maximal relative error smaller than $2.4 \cdot 10^{-3}$, the second one smaller than $2.3 \cdot 10^{-6}$ and the third one smaller than $4 \cdot 10^{-12}$. As the recursion formulae contain only elementary functions and no integrals, they are adapted for further general calculations as well as for practical use. The basic algorithms finally derived in (31, 34) and (35) are given in such a form, that they are well suited for practical computations with digital computers.

44181C COMPLEX POLYNOMIAL SPLINES ON THE UNIT CIRCLE by J. A. Ahlnery (Brown U., Providence, R.I.); E. N. Nilson (Pratt and Whitney Aircraft, East Hartford, Conn.); J. L. Walsh (U. Md., College Park, Md.); J. MATH. ANALYSIS AND APPL., Vol. 33, No. 2, Feb. 1971.

44182C A SIMPLIFIED DEFINITION OF WALSH FUNCTIONS by R. B. Lackey; D. Meltzer (Dept. Elec. Engrg., Ohio St. U., Columbus, Ohio); IEEE TRANS., Vol. X-20, No. 2, Feb. 1971, pp. 211-213

A simple method is presented which defines Walsh functions in terms of products of Rademacher functions, but which preserves the ordering of the Walsh functions necessary to retain the notion of increasing number of zero crossings, or sequency.

44183C HIERARCHIES OF NUMBER-THEORETIC FUNCTIONS II by M. H. Lob; S. S. Wainer (Herrn Prof. Dr. K. Schutte zum 60. Geburstag gewidmet); ARCH. MATH. LOGIK, Vol. 13, No. 3-4, Dec. 1970, pp. 97-113

In this section we shall consider initial segments of the hierarchies $[E_\alpha]$ obtained by restricting α to range over the constructive ordinals.

44184C ERROR-BOUNDS FOR FINITE ELEMENT METHOD by I. Babuska; NUMERISCHE METH., Vol. 16, No. 4, 1971, pp. 322-333

Different variational methods are used as a tool to approximate the solution and error-estimates are studied in different norms. The purpose of this contribution is to show a generalization which gives errors in different spaces and some special applications. As a concrete application we shall study the error of the finite element method for the Dirichlet problem for the Laplace equation on a Lipschitz domain.

44185C A SIMPLIFIED APPROACH TO THE EVALUATION OF LATTICE SUMS by J. R. Peverley (Catholic U. of Am., Wash., D.C.); J. COMP. PHYS., Vol. 7, No. 1, Feb. 1971, pp. 83-88

The calculation of the slowly converging lattice sums required in solid state physics has traditionally been rendered tractable by converting part of the sum into a sum over the reciprocal lattice. In this paper, the physical principles underlying that method have been used to justify a much simpler, yet equally effective approach which is well suited for numerical computation. The enhanced convergence rate, as compared with that of the so-called direct calculation, is illustrated by explicit computation in the case of a dipole sum.

44186C EMBEDDING THEOREMS FOR TWO-PARAMETER GROUPS OF FORMAL POWER SERIES AND RELATED PROBLEMS by A. Ran; ISRAEL J. MATH., Vol. 9, No. 1, 1971, pp. 73-92

The classical problem of analytic iteration is that of embedding analytic functions in one-parameter Lie groups of formal power series. The main purpose of the present paper is to consider similar problems for two parameter groups. These problems are closely related to problems concerning conjugate power series and conjugate one parameter groups of such series, to which the first sections of the paper are devoted. As an application of the conjugacy theorems and the embedding theorems we bring an algebraic characterization of the class of the two-parameter groups.

44187C ON DIVISION BY FUNCTIONAL ITERATION by M. J. Flynn; IEEE TRANS. COMP., Vol. C-19, No. 8, Aug. 1970, pp. 702-705

In order to avoid the time delays associated with linearly convergent division based on subtraction, other iterative schemes can be used. These are based on 1) series expansion of the reciprocal, 2) multiplicative sequence, or 3) additive sequence convergent to the quotient. These latter techniques are based on finding the root of an arbitrary function at either the quotient or reciprocal value. A Newton-Raphson iteration or root finding iteration can be used. The most useful tecniques are quadratically convergent (i.e., error $_{i+1} = 0$ (error $_i)^2$). These techniques generally require two arithmetic operations (add or multiply) to double the precision of the quotient.

44188C ON THE MAGNITUDE OF THE SUBGRID SCALE EDDY COEFFICIENT by J. W. Deardorff (Natl. Ctr. for Atmospheric Res., Boulder, Colo.); J. COMP. PHYS., Vol. 7, No. 1, Feb. 1971, pp. 120-133

Three-dimensional numerical integrations capable of resolving the energy containing motions at large Reynolds number have tested the nonlinear eddy-viscosity formulation in the two cases when the turbulence is generated by mean shear or by thermal instability. The proportionality constant suggested by Lilly is found to be applicable in the latter case, but a smaller value is found necessary in the preence of mean shear. Spectra of calculated velocity components are shown to deviate from a $k^{-5/3}$ law, as k approaches the grid cutoff wavenumber, in a manner consistent with the application of Reynolds-averaging over grid volumes.

44189C PRODUCT TYPE QUADRATURE FORMULAS by W. R. Boland; C. S. Duris (Dept. Math. Clemson, U. Clemson, S.C. and Dept. Math., Drexel U., Philadelphia, Pa.); BIT, Vol. 11, No. 2, 1971, pp. 139-158

This paper is concerned with the numberial approximation of integrals of the form $\int_a^b f(x)g(x)dx$ by means of a product type quadrature formula. In such a formula the function f(x) is sampled at a set of n+1 distinct points and the function g(x) at a possibly different set of m+1 distinct points. These formulas are a generalization of the classical (regular) numerical integration rules. A number of basic results for such formulas are stated and proved. The concept of a summetric quadrature formula is defined and the connection between such rules and regular quadrature formulas is discussed. Expressions for the error term are developed. These are applied to a specific example.

44190C A CLASSIFICATION OF THE ORDINAL RECURSIVE FUNCTIONS by S. S. Wainer; ARCH. MATH. LOGIK, Vol. 13, No. 3-4, Dec. 1970, pp. 136-153

In a previous work a framework was developed within which various

hierarchies of number-theoretic functions can be generated. Particular attention was paid to a hierarchy $[E_\alpha]$ obtained by restricting appropriately to the ordinals below ϵ_0, and it was conjectured that this hierarchy provides provides a classification of the ordinal recursive functions. The main purpose of this paper is to give an affirmative answer to this conjecture.

45423C CALCULATION METHOD FOR THE EVALUATION AND COMPENSATION OF ERRORS CAUSED BY SCATTERED IMPEDANCES OF MEASURING CIRCUITS by E. Toth (Dept. Inst. and Measurement Tech., Budapest Tech. U., Budapest); MERES ES AUTOMATICA,Vol. 18, No. 9, 1970, pp. 297-301

The author discusses the effects of errors in the measuring circuit on the measured impedance, the determination of the amplitude and phase error of the measuring circuits, and the compensation of the scattered impedances of the measuring circuits. The calculation methods employed permit the determination of the measurements errors in the real and imaginary portions of impedance from data on the phase and amplitude errors in cases of alternating-current measuring circuits.

45461C FINITE-DIMENSIONAL ANALOGUES OF VARIATIONAL PROBLEMS IN THE PLANE by R. S. Stepleman (Dept. Appl. Math. Computer Sci., U. Va., Charlottesvile, Va.); SIAM J. NUMER. ANAL., Vol. 8, No. 1, Mar. 1971, pp. 11-24

45462C THE NUMERICAL STABILITY OF THE SCHUR-COHN CRITERION by I. Gargantini (Comp ter Sci. Dept., U. Western Ont. London, and IBM Zurich Res. Lab., Ruschilkon, Switzerland); SIAM J. NUMER. ANAL., Vol. 8, No. 1, Mar. 1971, pp. 24-29

45463C AN INTRODUCTION TO AMBLIT/ L, A DIAGRAMMATIC LANGUAGE FOR LIST PROCESSING by C. Christensen (Mass. Computer Assoc. Inc., Wakefield); GOV. REPTS. ANNOUNCEMENTS, Vol. 71, No. 9, May 10, 1971, p. 104

AMBIT/ L is a list-processing programming system. It integrates the general use of recursive functions with a pattern-matching style of programming. Two-dimensional directed-graph diagrams are used to represent the data, and similar diagrams appear throughout the program as the 'patterns' of rules. The system has a simple core, but extends out to accomodate the always complicated requirements of input-output traps and interrupts, and storage management; it is a large system. The PDP-1 implementation of AMBIT/ L is described in this paper.

45464C QUANTITATIVE FUZZY SEMANTICS by L. A. Zadeh (Dept. Electrical Engrg., Computer Sci. and R Electron Res. Lab., U. Calif., Berkeley, Calif.); INFO. SCI., Vol. 3, No. 2, Apr. 1971, pp. 159-176

The point of departure in this paper is the definition of a language, L, as a fuzzy relation from a set of terms T=(x), to a universe of discourse, U=(y).

45465C A CONTEXT-FREE LANGUAGE WHICH IS NOT ACCEPTABLE BY A PROBABILISTIC AUTOMATION by Masakazu Nasu, N. Honda (Res. Inst. Eleectrical Comm., Tohoku U., Sendai, Japan) INFO AND CONTROL Vol. 18, No. 3, Apr. 1971, pp. 233-236.

A linear context-free language which is not acceptable by afinite probabilistic automation is given, and it is shown that the family of stochastic languages is not closed under concatenation and homomorphism.

45466C A GRAMMATICAL CHARACTERIZATION OF ONE-WAY NONDETERMINISTIC STACK LANGUAGES by M. A. Harrison; M. Schkolnick (U. Calif., Berkeley, Calif.); J. ASSOC. COMPUTING MACHINERY, Vol. 18, No. 2, Apr. 1971, pp. 148-173

A new family of grammars is introduced. A grammatical characterization of the one-way nondeterministic stack languages is obtained. Characterizations of the languages accepted by nonerasing stack automata and by checking automata are also derived.

45467C SOME CLOSURE PROPERTIES OF THE FAMILY OF STOCHASTIC LANGUAGES by P. Turakainen (Dept. Math., U. Turku, Finland); INFO. AND CONTROL, Vol. 18, No. 3, Apr. 1971, pp. 253-256

The purpose of the paper is to prove that the family of languages accepted by finite probabilistic automata is not closed under any of the operations catenation, catenation closure and homomorphism.

45468C AMBIT/ G AS AN IMPLEMENTATION LANGUAGE by C. Christensen; M. S. Wolfberg (Mass. Computer Assoc., Inc., Wakefield); GOV. REPTS. ANNOUNCEMENTS, Vol. 71, No. 9, May 10, 1971, p. 103

The AMBIT/ G programming system is, first of all, a high level system for the construction of software. The term 'high level' is often applied to a programming language to indicate the use of some combination of english and mathematical notation. One intends a more general use of the term. In the broader sense, a successful high level system provides a complete framework of concepts and techniques for programming in addition to a language; that is, it channels and supports the thoughts of the programmer as well as his utterances.

45469C PARALLEL IMPLEMENTATION OF A SINGLE ASSIGNMENT LANGUAGE by D. D. Chamberlin (Stanford U., Calif., Stanford Electron Labs.); GOV. REPTS. ANNOUNCEMENTS, Vol. 71, No. 9, Ma 10, 1971, p. 104

The thesis describes a high-level computer programming language, called SAMPLE, and a parallel processing system to implement the language. SAMPLE belongs to the class of single-assignment languages, which have the property that statements are not necessarily executed in their order of appearance in the program; rather, each statement is triggered by the readiness of the data on which it depends. Because of this property, single-assignment languages are well adapted for parallel processing.

45470C THE GENERATIVE CAPACITY OF TRANSFORMATIONAL GRAMMARS OF GINSBURG AND PARTREE by A. Salomaa (Math. Dept., U. Turku, Finland); INFO. AND CONTROL, Vol. 18, No. 3, Apr. 1, 1971, pp. 227-232

Any recursively enumerable language is generated by a transformational grammar with a type 3 base of trees with no ordering or control device for the transformations. Furthermore, the set of transformation rules depends on the alphabet alone.

45471C ROAD ACCIDENT TABULATION LANGUAGE (RATTEL) BY P. Harris (Roads Res. Lab., Crowthorne (ng.)); GOV. REPTS. ANNOUNCEMENTS, Vol. 71, No. 12, June 25, 1971, p. 119

A suite of programs has been written for ICL System 4 computers to enable tabular reports from the annual road accident statistics files to be extracted with a minimum of effort. Requests for analysis are written in the form of simple language statement and punched onto cards. The system is designed for use by people with little computer experience and the time between inception and satisfaction of requests for information has been greatly improved. The project has been extended to provide a general purpose report from analysis method using the language elements and techniques from RATTLE.

45472C CONVERGENCE OF A DISCRETIZATION FOR CONSTRAINED SPLINE FUNCTION PROBLEMS by J. W. Daniel (Computer Sci. Dept., U. Wis., Madison, Wisc.); SIAM J. CONTROL, Vol. 9, No. 1, Feb. 1971, pp. 83-96

45473C AN UPPER BOUND FOR PROBABILITY OF ERROR RELATED TO A GIVEN DECISION REGION IN N-DIMENSIONAL SIGNAL SET by G. M. Poscetti (Inst. of Electron, Faculty of Engrg., U. of Rome, Rome, Italy); TRANS. INFO. THEORY, Vol. IT-17, No. 2, Mar. 1971, pp. 203-206

An upper bound for the probability of error related to a given decision region, in an arbitrary N-dimensional signal set transmitted over a coherent Gaussian white noise channel, is described here. This bound is valid for any number of dimensions and for any closed decision region that satisfies a very weak condition.

45474C UNIFORM COMPUTATION OF THE ERROR FUNCTION AND OTHER RELATED FUNCTIONS by F. Matta; A. Reichel (Dept. Appl.

Math., U. Sydney, Sydney, Australia); MATH. COMPUTATION, Vol. 25, No. 114, Apr. 1971, pp. 339-344

Uniform methods of computation, to any required degree of accuracy, for the error and other closely related functions are given.

45475C COMBINING OVERLAPPING INFORMATION by R. Zeckhauser (Harvad U.); J. AMER. STATISTICAL ASSOC., Vol. 66, No. 333, pp. 91-92

It is frequently necessary to combine the information provided by summary statistics for different observation sets, particularly in the context of group decision processes. Problems arise when there are unidentified observations that overlap, that is, belong to more than one set. This article discusses the handling of these problems in relation to a normal example when the exact extent of overlap is known.

45476C A SIMPLE SIMULTANEOUS TEST PROCEDURE FOR QUASI-INDEPENDENCE IN CONTINGENCY TABLES by L. A. Goodman (U. of Chicago); APPL. STATIST., Vol. 20, No. 2, 1971, pp. 165-177

This paper presents a simple procedure for testing simultaneously a series of hypotheses pertaining to whether or not the row and column classifications of an R x C cross-classification table are "quasi-independent." Applied to a given table, this procedure will limit the chances of rejecting any hypotheses about quasiindependence that are actually true.

45477C ON THE DISTRIBUTION OF A LINEAR COMBINATION OF INDEPENDENT CHI SQUARES by J. L. Fleiss (Biometrics Res. Unit, N.Y. State Dept. of Mental Hygiene and Columbia U., School of Mental Health); J. AM. STATISTICAL ASSOC., Vol. 66, No. 333, Mar. 1971, pp. 142-144

In several models of the analysis of variance, inferences can be made using the statistics of the analysis of variance table only by taking linear combinations of mean squares. A form for the exact distribution function of such a linear combination is given. While not new, this form does not seem to have been sufficiently exploited. Its use is illustrated in finding, by numerical integration, exact robabilities associated with two methods of assigning approximate confidence limits to a positive linear combination of variance components.

45478C EQUICONVERGENCE OF MARTINGALES by E. S. Boylan (Rutgers State U.); ANNALS MATH. STATISTICS, Vol. 42, No. 2, Apr. 1971, pp. 552-559

45479C ON THE REDUCTION OF A PROBLEM OF MINIMIZATION OF n+1 VARIABLES TO A PROBLEM OF ONE VARIABLE by A. Bacopoulos; B. Gaff (Dept. d'Infor., U. Montreal, Montreal, Canada); SIAM J. NUMER. ANAL., Vol. 8, No. 1, Mar. 1971, pp. 97-103

45480C ON THE ESTIMATION OF EQUIVALENT NUMBER OF REPETITIONS (IN FRENCH) by R. Sneyers (Inst. Royal Meteorologique de Belgique); REV. STATIST. APPL., Vol. 19, No. 2, 1971, p. 35

45481C SOME EXTENSIONS OF WEAKLY MIXING FLOWS by R. Peleg (Hebrew U. Jerusalem); ISRAEL J. MATH., Vol. 9, No. 3, 1971, pp. 330-336

Using a technique of R. Ellis we prove the existence of many weakly mixing (w.m) flows which are distal extensions of a given w. m. flow. Then we indicate two w.m. minimal flows whose product has a minimal non-w.m. subflow.

45482C A NOTE ON THE DISTRIBUTION OF HOTELLING'S GENERALIZED T_0^2 by M. L. Tiku (McMaster U., Canada); BIOMETRIKA, Vol. 58, No. 1, Apr. 1971, pp. 237-241

T_0^2 are obtained. These are easy to compute and provide accurate approximations for the values of the probability integral and the percentage points of the distribution of T_0^2.

45483C A COMPUTATIONAL APPROACH TO THE MAXIMUM PRINCIPLE by A. V. Balakrishnan (System Sci. Dept. U. of Calif., Los Angeles, Calif.); J. COMPUTER AND SYSTEM SCI., Vol. 5, No. 2, Apr. 1971, pp. 163-192

45484C SIGNIFICANCE TESTS BASED ON RESIDUALS by D. F. Andrews (Bell Telephone Labs., Murray Hill, N. J.; Princeton U.); BIOMETRIKA, Vol. 58, No. 1, Apr. 1971, pp. 139-148

The known distribution of residuals from linear regression models may be used to construct exact tests of significance. New tests for the presence of one or more outliers are considered in detail. Applications of the theory to other tests are discussed. Exact results are worked out for the normal and exponential error distributions; formulae are given for other nonormal cases.

CM1.4 - COMPUTATION (EXPANSION) OF FUNCTIONS

38389C ON THE APPROXIMATION OF FUNCTIONS BY FOURIER-JACOBI SUMS by S. Z. Rafalson; U.S. GOV. RES. AND DEV. REPTS., Vol. 69, Aug. 10, 1969, p. 113, AD-688 283

The result of G.V. Zhidkov is carried over the the case of approximations by Fourier-Jacobi sums in the ultraspherical polynomials (Pn) superscript (alpha,alpha) x, alpha > 0.

38390C A COMPUTER OPTIMIZATION OF THE RAYLEIGH-RITZ METHOD by A. S. V. Vorst, A. A. Laloux; R. J. M. Govaerts (Catholic U., Louvain, Belgium); IEEE TRANS., Vol. MTT-17, Aug. 1969, pp. 454-460

A method has been developed to improve the use of the Rayleigh-Ritz method. A criterion is established, which is a measure of the cumulative improvement due to the addition of more and more terms in the series expansion. Without calculating the exact roots of determinantal equations, the convergence is accelerated by skipping unnecessary intermediate steps. The computation time is drastically reduced because the final result is obtained after only a few (not more than 5 to 7) values of determinants of increasing order. Inhomogeneously loaded waveguides are chosen as an application because the exact solution is available to check the validity of the method. The results obtained with the method described in this paper are compared with other approximate procedures. The comparison shows a definite advantage for the suggested technique.

38569C PROBLEMS OF BINARY REPRESENTATION OF FUNCTIONS by G. G. Menshikov (Ledningrad Electrical Comm. 1st.); INFO. PROC. 68-PROC. IFIP CONG., Vol. 1, 1969, pp. 90-94

38570C A SURVEY OF SOME RESULTS IN THE FIELD OF DISCRETE MATHEMATICS by S. V. Tablonski (USSR); INFO. PROC. 68-PROC. IFIP CONG., Vol. 1, 1969, pp. 80-85

39360C ENVIRONMENTAL DATA FORMAT STUDY (Wyoming U., Laramie); U.S. GOV. RES. AND DEV. REPTS., Vol. 69, Nov. 25, 1969, p. 15, PB-185 892

An analysis of the basic characteristics of all kinds of environmentally-dependent, or Earth-centered "Geospheric" operations is presented in order to help provide a sound basis for: Establishing and implementing a viable ENDEX (or Environmental Data Index) for all kinds of environmental data; and Initiating those developments of equipments and procedures with which improved formats of environmental data could better be acquired, processed and utilized. The satisfaction of this dual purpose has been found to consist necessarily of a continual trial-and-error or postulate-and-test interplay between: An analytical identification of successively more detailed elements and interrelationships of the overall field of "Geospheric Operations"; and Particular ways in which particular detailed elements of such "Geospheric Operations" might well be synthesized.

39459C L^2-APPROXIMATION THEORY OF EVEN ORDER MULTIVARIATE SPLINES by M. H. Schultz (Calif. Inst. Tech.); SIAM J. NUMER. ANAL., Vol. 6, Sept. 1969, pp. 467-475

39460C THE LOCAL DEPENDENCE OF LEAST SQUARES CUBIC SPLINES by M. J. D. Powell (AERE, U.K.); SIAM J. NUMER. ANAL., Vol. 6, Sept. 1969, pp. 398-413

39461C FORTRAN SUBROUTINES TO EVALUATE, IN SINGLE PRECISION, BESSEL FUNCTIONS OF THE FIRST AND SECOND KINDS FOR INTEGER OF FRACTIONAL ORDERS AND POSITIVE

REAL ARGUMENTS by J. P. Mason; R. V. Baier (Naval Res. Lab.); U.S. GOV. RES. AND DEV. REPT., Vol. 69, Sept. 10, 1969, p. 86, AD-690 458

Subroutines have been written in Fortran for the CDC 3600/ 3800 Computer to evaluate in single precision, Bessel Functions of the first and second kinds for integer of fractional orders and positive arguments.

39462C A FORTRAN SUBROUTINE TO EVALUATE, IN DOUBLE PRECISION, BESSEL FUNCTIONS OF THE FIRST AND SECOND KINDS FOR ORDERS ZERO AND ONE, USING POSITIVE REAL ARGUMENTS by J. P. Mason (Naval Res.); U.S. GOV. RES. AND DEV. REPT., Vol. 69, Sept. 1969, p. 86, AD-690 457

A subroutine has been written in Fortran for the CDC 3600/ 3800 Computer to evaluate, in double precision, Bessel Functions of the first and second kinds for orders zero and one, for positive real arguments.

39463C FORTRAN SUBROUTINES TO EVALUATE, IN DOUBLE PRECISION, BESSEL FUNCTIONS OF THE FIRST AND SECOND KINDS FOR INTEGER OR FRACTIONAL ORDERS AND POSITIVE REAL ARGUMENTS by J. P. Mason (Naval Res.); U.S. GOV. RES. AND DEV. REPT., Vol. 69, Setp. 10, 1969, p. 86

Subroutines have been written in Fortran for the CDC 3600/ 3800 Computer to evaluate, in double precision; Bessel Functions of the first and second kinds for integer of fractional orders and positive real arguments.

39464C BESSEL FUNCTIONS FOR ORDERS ZERO AND ONE, USING POSITIVE REAL ARGUMENTS by J. P. Mason (Naval Res. Lab.); U.S. GOV. RES. AND DEV. REPT., Vol. 69, Sept. 10, 1969, p. 86, AD-690 456

A subroutine has been written in Fortran for the CDC 3600/ 3800 Computer to evaluate, in single precision, Bessel Functions of the first and second kinds for orders zero and one, for positive real arguments.

39738C THE NUMBER OF MULTIPLICATIONS INVOLVED IN COMPUTING CERTAIN FUNCTIONS by S. Winograd (IBM Yorktown Hts., N.Y.); INFO. PROC. 68-IFIP CONG. PROC., Vol. 1, 1969, pp. 276-279

39739C SYSTEMATIC DESIGN FOR MODULAR REALIZATION OF CONTROL FUNCTIONS by S. M. Altman; A. W. Lo (Princeton U.); AFIPS CONF. PROC., Vol. 34, May 1969, pp. 587-595

39740C MORE ZEROS OF BESSEL FUNCTION CROSS PRODUCTS by H. E. Fettis; J. C. Caslin (Aerospace Res. Labs., Wright-Patterson AFB, Ohio); U.S. GOV. RES. AND DEV. REPT., Vol. 69, June 10, 1969, pp. 115-116, AD-685 235

39741C COMPLEX INVERSION FOR THE GENERALIZED HANKEL CONVOLUTION TRANSFORMATION by J. N. Pandey (Carleton U., Ottawa); SIAM J. APPL. MATH., Vol. 17, No. 5, Sept. 1969, pp. 835-84[illegible]

39742C THE AUTOMATIC NUMERICAL EVALUATION OF DEFINITE INTEGRALS by R. Cranley; T. N. L. Patterson (Southwest Ctr. Adv. Studies, Dallas Tex.); U.S. GOV. RES. AND DEV. REPT., Vol. 69, June 10, 1969, p. 119, AD-685 623

39743C COMPUTATION OF THE BI-VARIATE NORMAL INTEGRAL by R. R. Sowden; J. R. Ashford (U. Exter); APPL. STAT., Vol. 18, No. 2, 1969, pp. 169-180

40764C ON NIELSEN'S GENERALIZED POLYLOGARITHMS AND THEIR NUMERICAL CALCULATION by K. S. Kolbid, J. A. Mignaco; E. Remiddi; BIT, Vol. 10, No. 1, 1970, pp. 38-74

The generalized polylogarithms of Nielsen are studied, in particular their functional relations. New integral expressions are obtained, and relations for function values of particular arguments are given. An algol procedure for calculating 10 functions of lowest order is presented. The numerical values of the Chebyshev coefficients used in this procedure are tabulated. A table of the real zeros of these functions is also given.

40765C DEVELOPMENTS IN TECHNIQUES FOR COMPUTATION OF BESSEL FUNCTION BY DIGITAL COMPUTERS by R. D. Halbegewachs (Sandi Lab., Albuquerque, N. Mex.); USRDR* Vol. 70, No. 12, Jun. 1970, NSA 24 08.

40766C THE ANALYTICAL AND RECURSIVE EVALUATION OF TWO-CENTRE INTEGRALS by R. Shakeshaft (Inst. of Comp. Sci., U. of Nebraska, Lincoln); J. COMP. PHYS., Vol. 5, No. 2, Apr. 1970, pp. 354-349

30767C COMPARISON OF SEVERAL ADAPTIVE NEWTON-COTES QUADRATURE ROUTINES IN EVALUATING DEFINITE INTEGRALS WITH PEAKED INTEGRANS by K. E. Hillstron (Argonne Natl. Lab., Argonne, Ill.); COMM. OF THE ACM Vol. 13, No. 6, June 1970, pp. 362-365

This report compares the performance of five different adaptive quadrature schemes, based on Newton-Cotes (2N 1) point rules (N= 1,2,3,4,5), in approximating the set of definite integrals $\int_{-1}^{1}(x^2+\cdot^2)^{\cdot}\,dx$ with relative accuracy.

41710C THE APPROXIMATING PROPERTIES OF CERTAIN ALGORITHMS OF THE POTENTIAL FUNCTIONS METHOD by B. M. Litvakov; AUTO. AND REMOTE CONTROL, No. 3, Mary. 1970, pp. 433-442

Recurrent algorithms of the potential functions method are usually considered as algorithms for the recovery (in some sense) of some objectively existing function y(x). In the present article, the sequence of functions set up in the functioning of the algorithm is considered as approximating with respect to y(x); such an approach also covers the case where y(x) cannot be recovered by means of an algorithm. Theorems are proved on the convergence of approximating sequences and on the coarseness of the algorithm with respect to small variations of the function y(x).

41711C CALCULATION OF BEST RESTRICTED APPROXIMATIONS by G. D. Taylor; M. J. Winter (Dept. Math., Michigan St. U., East Lansing, Mich.); SIAM J. NUMER. ANAL., Vol. 7, No. 2, June 1970

43155C DISCRETE INTERACTION PROCESSES by J. Winkowski; ALGORYTMY, Vol. 7, No. 13, 1970, pp. 9-16

The paper defines a certain relation between machines and families of machines using it to describe some interaction processes.

43156C ON THE REPRESENTATION OF ARBITRARY FUNCTIONS AND THEIR GENERATION by I. Korn (Mich. St. U., East Lansing, Mich.); A. Mathan (U. Rochester, Rochester, N.Y.); IEEE TRANS. COMPUTERS, Vol. C-19, No. 6, June 1970, pp. 483-486

43158C WHITAKER'S CARDINAL FUNCTION IN RETROSPECT by J. McNamee (Canadian Math. Congress, Montreal, Quebec, Canada); F. Stenger; E. L. Whitney (Dept. of Math., U. of Utah, Salt Lake City, Utah); MATH. COMP., Vol. 25, No. 113, Jan. 1971, pp. 141-154

This paper exposes properties of the Whittaker cardinal function and illustrates the use of this function as a mathematical tool. The cardinal function is derived using the Paley-Wiener theorem. The cardinal function and the central-difference expansions are linked through their similarities. A bound is obtained on the difference between the cardinal function and the function which it interpolates. Several cardinal functions of a number of special functions are examined. It is shown how the cardinal function provides a link between Fourier series and Fourier transforms, and how the cardinal function may be used to solve integral equations.

44096C A NOTE ON OBERHETTINGER'S SOLUTION FOR THE SCALAR DIFFRACTION BY A WEDGE by A. Mohsen (Antenna Lab., Dept. Elec. Engrg., U. Manitoba, Winnipeg, Manitoba, Canada); IEEE TRANS., Vol. E-13, No. 2, Aug. 1970, p. 122

A recursion relation for the expansion coefficients appearing in Oberhettinger's asymptotic solution of the diffraction of plane waves by wedges is derived. This relation reduces the effort in deriving the higher order asymptotic terms.

44191C TREE-SEARCH ALGORITHMS FOR QUADRATIC ASSIGNMENT PROBLEMS by J. F. Pierce (Mgmt. Decisions Devpt. Corp., Cincinnati, Ohio); W. B. Crowston (Sloan Sch. of Mgmt., M.I.T., Cambridge, Mass.); NAVAL RES. LOGISTICS Q., Vol. 18, No. 1, Mar. 1971, pp. 1-36

Problems having the mathematical structure of a quadratic assignment problem are found in a diversity of contexts: by the economist in assigning a number of plants or indivisible operations to a number of different geographical locations; by the architect or industrial engineer in laying out activities, offices, or departments in a building; by the human engineer in arranging the indicators and controls in an operators control room by the electronics engineer in laying out components on a backboard; by the computer systems engineer in arranging information in drum and disc storage; by the production scheduler in sequencing work through a production facility; and so on. In this paper we discuss general types of algorithms for solving such problems, presenting a unifying framework for some of existing algorithms, and describing some new algorithms. All of the algorithms discussed proceed first to a feasible solution and then to better and better feasible solutions, until ultimately one is discovered which is shown to be optimal.

44192C HIGH-SPEED COMPUTER MULTIPLICATION USING A MULTIPLE-BIT DECODING ALGORITHM by H. Ling; IEEE TRANS. COMP., Vol. C-19, No. 8, Aug. 1970, pp. 706-709

This paper presents a method of performing the binary multiplication beyond the scheme of multiple ADD and SHIFT. The binary multiplication algorithm will be discussed first, followed by block decoding method, logic implementation, hardware consideration, and two examples which are at the end of the discussion.

44193C A MODIFIED REGULA FALSI METHOD FOR COMPUTING THE ROOT OF AN EQUATION by M. Dowell; P. Jarratt (Computing Lab., U. Bradford Eng.); BIT, Vol. 11, No. 2, 1971, pp. 168-174

The Illinois method is briefly described and the asymptotic convergence of the method investigated. Numerical examples are also given including comparisons with other similar robust methods.

44194C ZEROS OF THE MODIFIED HANKEL FUNCTION by E. M. Ferreira; J. Sesma; NUMER. MATH., Vol. 16, No. 3, 1970, pp. 278-284

The roots of the modified Hankel function $K_\nu(z)$ for imaginary index and positive real values of the variable are discussed in this paper. That is, we are interested in the solutions of the equation

$$K = iq(x) = 0$$

with q and x real, and $x > 0$. This equation occurs in certain physical problems, such as in the determination of the bound states for an inverse square potential with hard core in Schrodinger equation.

44195C (0,1) HYPERBOLIC PROGRAMMING PROBLEMS by P. Robillard (Dept. d'Info. U. Montreal); NAVAL RES. LOGISTICS Q., Vol. 17, No. 1, Mar. 1971, pp. 47-58

In the first part of this paper we study the unconstrained [0,1] hyperbolic programming problem treated in a previous paper. We describe a new algorithm for this problem which produces an optimal solution by scanning just once the set of fractions to be analyzed. This algorithm shows better computing performance than the one described in the other paper. In the second part we study the [0,1] hyperbolic programming problem with constraints given by inequalities on nondecreasing pseudo-boolean functions. We describe a "branch and bound" type algorithm for this problem.

44196C ON THE SUM $\sum d_{n-1} d^{-1}$ by P. Erdos; ISRAEL J. MATH., Vol. 9, No. 1, 1971, pp. 43-48

Let (n) be the sum of divisors of n. In this paper we prove $\sigma(2^n - 1) < c(2^n - 1) \log \log n$.

44197C EXPONENTS AND INTERMEDIATE FIELDS OF PURELY INSEPARABLE EXTENSIONS by J. N. Mordeson (Creighton U.); B. Vinograde (Iowa St. U.); J. ALG., Vol. 17, No. 2, Feb. 1971, pp. 238-242

44198C FURTHER NOTE ON FAST GENERATION OF SPHERICAL BESSEL FUNCTIONS WITH COMPLEX ARGUMENTS by R. C. Boston (Comp. Ctr. U. Melbourne, Parkville, Victoria 3052, Australia); ELECTRON. LETT., Vol. 7, No. 2, Jan. 28, 1972, p. 34

The author discusses two extensions to previous work which may speed up, and render more accurate, the evaluation of the Bessel function. These extensions are real recursion for complex argument and the suppression of overflows.

44199C INVESTIGATION AND ANALYSIS OF CERTAIN METHODS OF COMPUTING CORRELATION FUNCTIONS AND CORRELATION COEFFICIENTS by V. A. Khomyakov; AUTOMATION AND REMOTE CONTROL, Vol. 32, No. 1, Pt. 1, Jan. 1971, pp. 43-49

It is shown that, in contrast to polar correlators, there exists in relay correlators an optimal width, not equal to zero, for the insensitivity region of the circuit relay elements, for which the accuracy of the estimates obtained in maximal. An analysis is made of an existing type of device used for computing correlation functions.

44200C AN EIGHTH ORDER RUNGE-KUTTA PROCESS WITH ELEVEN FUNCTION EVALUATIONS PER STEP by A. R. Curtis (Div. of Numer. and Appl. Math., Natl. Phys. Lab., Teddington, Middlesex, G.B.); NUMERISCHE. MATH., Vol. 16, No. 3, 1970, pp. 268-277

The system of algebraic equations whose solution defines an eighth order Runge-Kutta process is examined. A solution is found involving only eleven stages, and stated explicitly. Some results of test solutions of a system of differential equations using a program incorporating the coefficients given by the above solution are presented.

44201C ON THE SUM OF A PRIME AND OF TWO POWERS OF TWO by R. Crocker (John Carroll U.); PACIFIC J. MATH., Vol. 36, No. 1, Jan. 1971, pp. 103-107

It has been shown by different methods that there is an infinity of positive odd integers not representable as the sum of a prime and a (positive) power of 2, thus disproving a conjecture to the contrary which had been made in the nineteenth century.

44202C A GENERALIZATION OF A LEMMA OF BIHARI AND APPLICATIONS TO POINTWISE ESTIMATES FOR INTEGRAL EQUATIONS by G. Butler; T. Rogers (Dept. Math. U. Alberta, Alberta, Can.); J. MATH. ANALYSIS AND APPL., Vol. 33, No. 1, Jan. 1971, pp. 77-81

44203C AN OSCILLATION PROBLEM IN ELASTODYNAMICS AND FREDHOLM'S INTEGRAL EQUATION by S. M. Sharfuddin (Rajshahi Govt. Coll. Rajshahi); NUCLEUS, Vol. 8, No. 1-2, Jan. 1971, pp. 56-62

Torsional oscillations set up in an elastic stratum, one face of which is rigidly secured by a rigid circular disc which is attached to the free surface of the material and which performs simple harmonic oscillations about its axis. The problem has been solved after conversion into a Fredholm integral equation of the second kind.

44204C TWO INTEGRAL INEQUALITIES by J. R. Blum; M. Reichaw; ISRAEL J. MATH., Vol. 9, No. 1, 1971, pp. 20-26

Let (X,S,μ) and (Y,T ν) be two measure spaces $K9g) = \int yk(x,y)g(y)dv(y)\zeta = \max)\zeta,0)$, and $\delta(K) = \sup y(k(x,y) - k(x,y)\, dv(y)$. Two integral inequalities (the first of which has a simple geometrical interpretation involving $\delta(K)$ are proved. Generalizations of theorems about infinite stochastic matrices and convergence of superpositions of sequences of integral operators are obtained.

44205C A CRITERION FOR n CONVEXITY by P. S. Bullen (U. Brit. Columbia); PACIFIC J. MATH., Vol. 36, No. 1, Jan. 1971, pp. 81-98

The development of the F^n-integral of R. D. James and W. H. Gage is based on certain properties of n-convex functions. In order to develop this integral systematically a more detailed study of n-convex functions is needed. In the second section of this paper various derivatives are defined and some of their properties given; in the third and last sections properties of n-convex functions are developed.

44206C THE CENTROID METHOD OF NUMERICAL INTEGRATION by I. J. Good; R. A. Gaskins; NUMRISCHE MATH., Vol. 16, No. 4, 1971, pp. 343-359

The midpoint method of integration of a function of one variable is perhaps

the simplest method of numerical integration, although it is often not mentioned in textbooks. It is here generalized to any number of dimensions and the generalization is called the centroid method. This again is a very simple method and it can be conveniently used, for example for the integration of a function of several variables over any non-pathological region. The numerical examples include the integration of multinormal integrands.

44207C BIOLOGICAL PROBLEMS IN SOLVING SUMS OF EXPONENT L FUNCTIONS OF TIME: AN IMPROVED METHOD OF CALCULTION by D. H. Parsons (Dept. Math. U. Reading, Berkshire, Eng.); MATH. BIOSC., Vol. 9, 1970, pp. 37-47

A method was recently described for the analysis of experimental readings that are known to be sums of positive, decreasing exponential functions of time. By this method the unknown number of functions, the exponents, and the coefficients are determined simultaneously, from readings that may be taken in the early stages of the experiment. This process has great advantage over the conventional "peel-off" method since there is no need for asymptotic estimation, and experimental time can be greatly reduced.

44208C COMPUTATION OF GAMMA FUNCTIONS WITH COMPLEX ARGUMENT by R. A. Kinney; J. L. Hilburn (Dept. Elec. Engrg. L. S. T., Baton Rouge, La.); IEEE TRANS., Vol. E-14, Aug. 1970, pp. 117-118

A FORTRAN IV program for computing gamma functions with complex argument is discussed.

45481C SOME EXTENSIONS OF WEAKLY MIXING FLOWS by R. Peleg (Hebrew U. Jerusalem); ISRAEL J. MATH., Vol. 9, No. 3, 1971, pp. 330-336

Using a technique of R. Ellis we prove the existence of many weakly mixing (w.m.) flows which are distal extensions of a given w. m. flow. Then we indicate two w.m. minimal flows whose product has a minimal non-w.m. subflow.

45482C A NOTE ON THE DISTRIBUTION OF HOTELLING'S GENERALIZED T^2 by M. L. Tiku (McMaster U., Canada); BIOMETRIKA, Vol. 58, No. 1, Apr. 1971, pp. 237-241

Chi-squared approximations for the distribution of Hotelling's generalized T^2 are obtained. These are easy to compute and provide accurate approximations for the values of the probability integral and the percentage points of the distribution of T^2.

45483C A COMPUTATIONAL APPROACH TO THE MAXIMUM PRINCIPLE by A. V. Balakrishnan (System Sci. Dept. U. of Calif., Los Angeles, Calif.); J. COMPUTER AND SYSTEM SCI., Vol. 5, No. 2, Apr. 1971, pp. 163-191

45484C SIGNIFICANCE TESTS BASED ON RESIDUALS by D. F. Andrews (Bell Telephone Labs., Murray Hill, N.J.; Princeton U.); BIOMETRIKA, Vol. 58, No. 1, Apr. 1971, pp. 139-148

The known distribution of residuals from linear regression models may be used to construct exact tests of significance. New tests for the presence of one or more outliers are considered in detail. Applications of the theory to other tests are discussed. Exact results are worked out for the normal and exponential error distributions; formulae are given for other nonnormal cases.

45485C BIVARIATE FAILURE RATE by A.P. Basu, (Dept. Indust. Engrg., and Mgmnt. Sci, Northwestern U.); J. AM. STATISTICAL ASSOC., Vol. 66, No. 333, Mar 1971, pp. 103-104

In this article bivariate failure rate is defined, and it is shown that noabsolutely continuous bivariate distribution with constant failure rate exists except in the special case when the marginals are independently distributed.

45486C IMPROVED NEWTON ITERATION FOR INTEGRAL ROOTS by R.F. King (Dept. Math. U. Dundee Dundee, Scotland) MATH. COMPUTATION, Vol. 25, No. 114, Apr 1971, pp. 299-304

An improved Newton iteration procedure for computing pth roots from best Chebyshev or Moursund initial approximations is developed. It differs from the usual Newton method by a multiplicative factor at each step. This multiplier halves the relative error by translating the usual one-sided curve into a two-sided one, and then adjusting to make a Moursund-like fit. The generalized logarithmic error is used in determining this set of factors.

45487C A QUADRATIC FORMULA FOR FINDING THE ROOT OF AN EQUATION by L. G. Chambers (Math. Dept. U. College of North Wales Bangor, Caernarfonshire Wales) MATH. COMPUTATION, Vol. 25, No. 114, Apr 1971, pp. 305-308

An extension is made to Reguli Falsi involving a parabolic approximation. Formulae are derived which have convergence exponen s 2, 2.414, 3.732 respectively.

45488C A GENERAL SYSTEM OF DISCRIMINANTS OF CHARACTERISTIC EQUATIONS by Jarominek Wladyslaw, ARCHIWUM AUTOMATYKI I TELEMECHANIKI, Vol. 15, No. 4, 1970, pp. 383-401

The article develops a general system of discriminants for finding the roots to characteristic equations. The relation between the roots and power series is analyzed on the basis of the theory of determinants. The principal and any discriminant of a characteristic polynomial are defined in terms of symmetrical determinants.

45489C RATES OF CONVERGENCE FOR A CLASS OF ITERATIVE PROCEDURES by R. G. Voigh+ (Computer Sci. Cntr. U. of Md, College Pk., Maryland); SIAM J. NUMER. ANAL., Vol. 8, No. 1, Mar 1971, pp. 127-134

In this paper we shall give an extension of Ostrowski's point of attraction theorem to multistep iterative procedures for finding a zero of a nonlinear function defined on R . We shall also obtain a rate of convergence statement in terms of the spectral radius of certain matrices. These results will then be applied to a class of procedures obtained by composing one-dimensional iterative methods with the Jacobi and successive-overrelaxation processes. The rate of convergence of these procedures will be shown to be independent of the rate of convergence of the one-dimensional methods.

45490C THE LOGARITHM OF THE SUM OF TWO CORRELATED LOG-NORMAL VARIATES by M.A. Hamdan (Dept. Statistics, Va. Polytech. Inst. and State U.); J. AM. STATISTICAL ASSOC., Vol. 66, No. 333, Mar 1971, pp. 105-106

Naus derived the moment generating function of the logarithm of the sum of two variates whose logarithms are independent normal variates with equal variances. The present article generalized the results of Naus to the case when the logarithms of the variates have a bivariate normal distribution with unequal variances and correlation coefficient p.

45491C NUMERICAL SOLUTION OF MATHIEU'S EQUATION by J. Canasa (IBM Sci. Cntr., Palo Alto, Calif.); J. COMP. PHYS., Vol. 7, No. 2, Apr 1971, pp. 255-272

A method is presented for the numerical solution of Mathieu's equation. The power of the method lies in the fact that it can be used equally for ordinary and extremely asymptotic problems, making possible the computation of Mathieu functions for large values of the parameter with an accuracy heretofore unattainable.

45492C CONTRACTIVE DIFFERENCE SCHEMES FOR SYMMETRIC HYPERBOLIC SYSTEMS by P. Brenner, V. Thomee (Dept. Math. Chalmers U. Tech. Goteborg, Sweden; Dept. of Math.); MATH COMPUTATION, Vol. 25, No. 114, Apr 1971, pp. 205-218

Consider the initial-value problem for a constant-coefficient symmetric hyperbolic system with initial-values vanishing in a half-space. Consider also a finite difference operator consistent with the system. Conditions are given in terms of the orders of dissipation and accuracy which ensure that the solution of the discrete problem tends to zero exponentially with the mesh-width in half-spaces when the solution of the continuous problem vanishes.

45493C THIRD AND FOURTH ORDER ACCURATE SCHEMES FOR HYPERBOLIC EQUATIONS OF CONSERVATION LAW FORM by G. Zwas, S. Abarbanel (Tel-Aviv U., Tel-Aviv Israel); MATH COMPUTATION, Vol. 25, No. 114, Apr 1971, pp. 229-236

It is shown that for quasi-linear hyperbolic systems of the conservation form $W_t - -F_x - - AW_x$, it is possible to build up relatively simple finite-difference numerical schemes accurate to 3rd and 4th order provided that the matrix A

satisfies commutativity relations with its partial-derivative-matrices. Numerical calculations were made with a 3rd order and a 4th order scheme for scalar equations with continuous and discontinuous solutions. The results are compared with analytic solutions and the predicted improvement is verified. The computation reported on here was carried out on the CDC-3400 computer at the Tel Aviv University computation center.

45494C SYNTHESIS OF MICROPROGRAMS, USING THE BLOCK-CIRCUIT METHOD by F. Atstopas, R. Chomskis (Foreign Tech. Div. Wright-Patterson AFB Ohio) GOV. REPTS. ANNOUNCEMENTS, Vol. 71, No. 12, June 1971, p. 116

An improved Wilks, Stringer, Barty method for the design of digital computer flow charts is described. The method means for description of the structural elements of the functional diagram, functional structure, and dynamics of the computer in the form of rough and exact microprograms. The rough microprogram is an algorithm for completion of instructions using the given functional structure.

45495C DIFFERENCE ANALOGUES OF QUASI-LINEAR ELLIPTIC DIRICHLET PROBLEMS WITH MIXED DERIVATIVES by R.S. Stepleman (Dept. Appl. Math. and Computer Sci. U. of Va., Charlottesville, Va.); MATH COMPUTATION, Vol. 25, No. 114, Apr 1971, pp. 257-270

In this paper we consider a class of difference approximations to the Dirichlet problem for second-order quasilinear elliptic operators with mixed derivative terms. The main result is that for this class of discretizations and bounded g (the right-hand side) a solution to the difference equations exists. We also explicitly exhibit a discretization of this type for a class of operators.

45496C CALCULATION OF THE GAMMA FUNCTION BY STIRLING'S FORMULA by R. Spira (Math Dept. Mich. State U., East Lansing, Mich); MATH COMPUTATION, Vol. 25, No. 114, Apr 1971, pp. 317-322

In this paper, we derive a simple error estimate for the stirling formula and also give numerical coefficients.

45497C A NEW METHOD OF EVALUATION OF HOWLAND INTEGRALS by Chig-Bing Ling; Jung Lin, (Dept. Math. Va. Polytech. Inst. and State U., Blacksburg, Va.); MATH COMPUTATION, Vol. 25, No. 114, Apr 1971, pp. 331-338

In this paper, two Howland integrals are evaluated to 25D when the index is an odd integer. Those Howland integrals when the index is an even integer have been evaluated to 18D by Nelson. A new method of evaluation is used.

45498C THE NUMERICAL SOLUTION OF ELLIPTIC EQUATIONS by G. Birkhoff (Harvard U.) REGIONAL CONFERENCE SERIES IN APPLIED MATH., SIAM, 1971, pp. 1-82

45499C SOLUTIONS OF RELATIVISTIC DYNAMICAL INTEGRAL EQUATIONS by A. Pagnamenta (Rutgers-the State U. New Brunswick, N.J. Dept. of Phys.); GOV. REPTS. ANNOUNCEMENTS, Vol. 71, No. 12, May 25, 1971, p. 157

The report describes research under the contract in the area of numerical solutions to integral equations that arise in elementary particle theory.

45500C MINATURIZED TABLES OF BESSEL FUNCTIONS by Y.L. Luke (Midwest Res. Inst. Kans. City, Mo.); MATH. COMPUTATION, Vol. 25, No. 114, Apr 1971, pp. 323-330

In this report, we discuss the representation of bivariate functions in double series of Chebyshev polynomials.

45501C INTEGRATION OF THE PLANETARY VORTICITY EQUATION ON A PARABOLIC CIRCULAR GRID by R.C. Beardsley (Dept. Meteorology, Mass. Inst. Tech., Cambridge, Mass.); J. COMP. PHYS., Vol. 7, No. 2, Apr 1971, pp. 273-288

A nonuniform circular grid is defined based on equal azimuthal spacing and parabolic radial spacing for increased spatial resolution near the boundary. A conservative numerical scheme is devised to integrate the barotropic condivergent potential vorticity equation. Examination of the truncation errors associated with the Jacobian and Laplacian approximations and trial integrations using linearized Rossby waves as exact solutions both indicate the parabolic scheme predicts linear fields poorly in a small annular region near the basin's center. Improved integrations are obtained with a modified numerical scheme.

45502C THE APPROXIMATE SOLUTION OF THE DIRICHLET PROBLEM BY MEANS OF INTEGRAL EQUATIONS by G.A. Costello (Dept. Theoret. and Appl. Mech. U. Ill. Urbana, Ill.); SIAM J. NUMER. ANAL., Vol. 8, No. 1, Mar 1971, pp. 135-136

The Dirichlet problem is formulated in terms of an integral equation. The integral equation is solved in an approximate manner and a system of linear algebraic equations is obtained. It is shown that an iteration process converges if any tangent to the boundary comes in contact with the boundary at only one point.

CM1.5 - APPROXIMATIONS; CURVE FITTING

CM1.5.0 - GENERAL

38391C ADAPTIVE PLANS OPTIMAL FOR PAYOFF-ONLY ENVIRONMENTS by J. H. Holland (Mich. U., Ann Arbor, Logic Computers Groups); U.S. GOV. RES. AND DEV. REPTS., Vol. 69, Aug 10,1969, p. 88, AD-688 839

The paper characterizes a class of adaptive algorithms, the reproductive plans, which produce optimal performance in conditions where the information fed back to the algorithm consists only of a payoff at each instant of time. The payoff function can be any bounded (nonlinear) function of the algorithm's output space. The reproductive plans have the advantage that they achieve a global optimum (over the whole time course) via a local step-by-step optimization of well-defined quantities. The theorem guaranteeing optimal performance is a modification of the Kuhn-Tucker fixed point theorem closely related to Gale's work in mathematical economics.

38610C STATISTICAL LINEARIZATION OF NONLINEAR STOCHASTIC TRANSFORMATIONS WITH MEMORY by Y.V. Panich, AUTOMATION AND REMOTE CONTROL, Apr. 1969, pp. 512-521

38698C USE OF THE METHOD OF EXTRACTING THE MAIN PART FOR ANALYZING THE ACCURACY OF COMPLEX SYSTEMS by A.A. Gorskii; AUTOMATION AND REMOTE CONTROL, Mar 1969, pp. 347-356

41712C ON UNSUPERVISED ESTIMATION ALGORITHMS by E.A. Patrick, J.P. Costello (Dept. Elec. Engrg. Purdue U. Lafayette, Inc. and Electronics Lab. G.E. Co., Syracuse, N.Y.); IEEE TRANS., Vol. IT-16, No. 5, Sept. 1970

There are several approaches to unsupervised estimation that have application to problems of communications, control, and pattern recognition. This paper presents properties of several different digitally implemented algorithms suitable for unsupervised estimation. One result is the rate of convergence in mean square of the Bayes solution for a discretized parameter space. A regression function that is the expected value of the natural logarithm of the mixture probability density function naturally arises from the Bayes approach. This regression function can be used to devise unsupervised estimation algorithms of the stochastic approximation form. Also, the asymptotic solution and rates of convergence in mean square of a class of minimum-integral-square-difference algorithms are determined. Two other estimators that use a 'net' on the parameter space are also presented.

44209C ESTIMATING BY VARIABLE METHODS WITH THE AID OF DUALISTIC THEORIES II (In German) by L. Bittner; NUMERISCHE MATH., Vol. 16, No. 4, 1971, pp. 285-303

45503C PROBLEM OF APPROXIMATING FUNCTIONS OF MANY VARIABLES by V. Ya. Katkovnk; AUTOMATION AND REMOTE CONTROL, Vol. 32, No. 2, Pt. 2, Feb 1971, pp. 336-340

A procedure is presented for constructing the smoothing operator of a function of many variables. For the derivation of the operator's weight function use is made of orthonormalized polynomials of many variables, these polynomials being the analogs of the classical polynomials of Lengendre, laguerre, Chebyshev, and Hermite.

CM1.5.1 - PRINCIPLES AND BASIC CONCEPTS OF APPROXIMATION THEORY

43154C MODULATION TRANSFER FUNCTION OF THE FOCAL SPOT OF X-RAY TUBES by K. Kiviniitty (Dept. of Radiology, U. of Oulu, Finland); COMMENT. PHYS.-MATH., Vol. 40, No. 1, June 1970, pp. 9-40

Thirteen focuses of various diagnostic x-ray tubes have been examined by using pinhole pictures that have been analyzed microdensitometrically and mathematically, The modulation transfer functions have been calculated from the microdensitometric curves. It is possible with the aid of the modulation transfer functions calculated to standardize the information obtained from the focus. It is also possible to compare various focuses with each other as well as the information about the focus obtained with different exposure values.

44210C ALGORITHMIC APPROXIMATIONS by E. Engeler (Sch. Math., U. Minn., Minneapolis, Minn.); J. COMP. AND SYST. SCI., Vol. 5, No. 1, Feb 1971, pp. 67-82

The notions of approximation studied in this paper are motivated by the following two intuitive questions: (1) In what sense do the results of arbitrary numerical computations approximate the true result when the accuracy of the individual operations are increased? (2) Can one approximate the action of a more powerful machine by a weaker machine simply by replacing the individual operations of the strong machine by increasingly more accurate programs of the weaker one?

44211C THE DIOPHANTINE APPROXIMATION OF ROOTS OF POSITIVE INTEGERS by C.F. Osgood, J. RES. N.B.S. - B. MATH. SCI., Vol. 74B, No. 4, Oct/ Dec. 1970, pp. 241-244

45505C SOME NOTES ON TABLES TO FACILITATE FITTING S CURVES by N.L. Honson, J.O. Kitchen (U. N.C. Chapel Hill); BIOMETRIKA, Vol. 59, No. 1, Apr 1971, pp. 223-226

Construction of tables for fitting S distributions, using four moments, is described. Some extracts from the tables are given.

45505C ON THE OPTIMAL APPROXIMATION OF LINEAR FUNCTIONS IN SPACES OF BIVARIATE FUNCTIONS by L.E. Mansfield (Dept. Computer Sci., Purdue U., Lafayette, Ind.); siam j. numer. anal., Vol. 8, No. 1, Mar 1971, pp. 115-126

CM1.5.2 - INTERPOLATION AND EXTRAPOLATION

38573C A COMPARISON OF SPLINE APPROXIMATIONS WITH CLASSICAL INTERPOLATION METHODS by M.J.D. Powell (A.e.R.E., Berkshire, U.K.); INFO. PROC. 68, - PROC. IFIP CONG., Vol. 1, 1969, pp. 95-98

38574C ON THE NUMERICAL CONSTRUCTION AND THE PRACTICAL USE OF INTERPOLATING SPLINE-FUNCTIONS by C. Carasso and P.J. Laurent (Grenoble U., France); INFO. PROC. 68 - PROC. IFIP CONG., Vol. 1, 1969, pp. 86-89

40768C ON MONOTONICITY PRESERVING LINEAR EXTRAPOLATION SEQUENCES by G. Opfer (Bloomington); COMPUTING, Vol. 5, No. 3, 1970, pp. 259-266

40769C EXTRAPOLATION WHEN VERY LITTLE IS KNOWN ABOUT THE SOURCE by T. Fine (Sch. Electr. Engrg., Cornell U., Ithaca, N.Y.); INF. AND CONT., Vol. 16, No. 4, June 1970, pp. 331-359

Prompted by the inadequacies of the now traditional characterization of chance and uncertainty through the Kolmogoroc axioms for probability and the relative frequency interpretation of probability, we propose and examine a nonstatistical approach to extrapolation. The basic problem is the association of a real number y to a sequence of real numbers x in such a manner that the pair (x,y) conforms with a set of data sequences $D=(x_i, y_i)$, $i=1,M$) our prior knowledge of the data source, and our objectives. Our aim is to so define extrapolations with only minimal assumptions about the data source. While we are free to define the human activity of extrapolation to suit ourselves, the data sources functions independently of our wishful or metaphysical thinking.

The basic principle we adhere to is that the extra polation of x is a function of only those y ; extrapolate the output of a system by examination of the outputs of similar systems. This vague sentiment is clafiried and formalized through ten axions and leads to an optimal extrapolation function $\pi(x;D)$. The performance of π is then studied, both for very large and vary small sample sized (M), when the sequences (x,y), (x_i, y_i) are, in fact, independent and identically distributed random vectors.

43159C PRATICAL THROW-BACK INTERPOLATION by F. D. Burgoyne (Dept. of Math. U. of London King's Coll. Strand. London, W. C. 2, England) MATH. COMP., Vol. 25, No. 113, Jan 1971, pp. 113-117.

Precise conditions are determined for the validity of some frequently-used throw-back interpolation formulae.

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43161C EXTRAPOLATION AND INTERPOLATION OF STATIONARY GAUSSIAN PROCESSES by H. Dym, H. P. McKean (The City Coll. CUNY The Roc Rockefeller U.) ANNALS MATH STATISTICS, Vol. 41, No. 6, 1970, pp. 1817-1844.

44212C INTERPOLATION WITH PR FUNCTIONS BASED ON F. FENYVES' METHOD by J. Solymosi (Dept. Wire-Bound Telecommunication, Tech. U. Budapest); PERIOD. POLYTECH. ELEC. ENGRG. Vol. 15, No. 1, 1971, pp. 71-76.

44213C BOUNDS FOR A CLASS OF LINEAR FUNCTIONAL WITH APPLICATIONS TO HERMITE INTERPOLATION by J. H. Bramble and S. R. Hilbert MUMERISCHE MATH.Vol. 16, No. 4, 1971, pp. 262-268.

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It is shown that if x C^4 (a,b) is approximated by a natural cubic spline, then the error is $O(h^4)$ in a closed interval which is asymptotic to (a,b) as h, the maximum interval length, decreases to zero.

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45509C OPTIMAL DESIGNS FOR MULTIVARIATE POLYNORIAL EXTRAPOLATION by W. J. Studden (Purdue U.) ANNALS MATH. STATISTICS, Vol. 42, No. 2, Apr. 1971, pp. 828-832.

CM1.5.3 - MINIMAX (CHEBYSHEV) APPROXIMATION

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