

# Two books for computer scientists. Can you afford to miss them? 

## THE STRUCTURE OF LANGUAGE - A NEW APPROACH

By Petr Beckmann

Natural languages, says the author (a professor of electrical engineering at the University of Colorado fluent in five languages), are structured like error-detecting codes. To prove his point, he has used a generative grammar based on this principle to write a program that will construct trillions of grammatical sentences from less than 100 unprocessed words. He has also worked out an information theory based on the meaning of a message rather than on its formal structure alone.
You can use the method for a hundred applications of linguistic processing and artificial intelligence. For example, make English a subroutine called by the main program, and get the output in English, not in pre-stored sentences, but in what the main program decides to construct.

Besides that, you can get enjoyable insight into the structure of Language. For example, what the "her" is doing in She shrugged her shoulders, and why it is absent from this sentence in German, French, Russian, and most other languages.


## ORTHOGONAL POLYNOMIALS FOR ENGINEERS AND PHYSICISTS

## By Petr Beckmann

Orthogonal polynomials are no longer the confusing labyrinth of systems that they used to be. The important properties of all classical systems can now be derived from their weighting functions alone - you can get the recurrent formulas, the Rodriguez relations, leading and second coefficients, norms, generating functions, integral representations and most other properties by substituting in general formulas, which are particularly well suited for digital computing. Look up both the method and the results in this book. Read the applications, not to 19th century antiques, but to numerical analysis, quantum mechanics, electromagnetics, systems theory, probability theory, and the other subjeets where today's action is. Find, for the first time, how to construct the two-dimensional density of a random process given only its onedimensional density (not necessarily normal) and its correlation function. Get a 50 -page appendix with several hundred integrals over orthogonal polynomials and interrelations among them.
280 pages, illustrated 6 by 9 clothbound $\$ 15$ postpaid
(Please recommend this book to your library! Libr. of Congr. No. 72-87318)

*     *         * 

Both books obtainable from:

## THE GOLEM PRESS

Box 1342
Boulder, Colorado 80302

## A new book series

## Selected Tables in Mathematical Statistics <br> Volume 1

Edited by the Institute of Mathematical blatistios
Each volume in this new series will contain several sets of extensive tables of interest to statisticians and users of statistical tables.

Volume 1 was first published in 1970 by the Markham Publishing Company. The AMS is now reprinting it with corrections. It contains five sets
 of tables, each with introductory material. Four of these sets were computed for the original edition, one was a reprint and extension of previously published material.

The contents:
Tables of the Cumulative Non-central Chi-square Distribution, by G. E. Haynam, Z. Govindarajulu, and F. C Leone (43 pages)
Tables of the Exact Sampling Distribution of the Two-sample Kolmogorov-Smirnov Criterion $D_{m, n}(m$ - $n$ ), by P. J. Kim and R. I. Jennrich ( 50 pages)
Critical Values and Probability Levels for the Wilcoxon Rank Sum Test and the Wilcoxon Signed Rank Test, by Frank Wilcoxon, S. K. Katti, and Roberta A. Wilcox ( 66 pages)
The Null Distribution of the First Three Product-Moment Statistics for Exponential, Half-Gamma, and Normal Scores, by P. A. W. Lewis and A. S. Goodman (55 pages)
Tables to Facilitate the Use of Orthogonal Polynomials for Two Types of Error Structures, by Kirkland B. Stewart (49 pages)

The tentative plans are for Volume 2 to contain five new sets of tables. These will deal with

> Probability Integral of the Doubly Noncentral $t$-distribution. Doubly Noncentral F-distribution.
> Expected Sample Size for Curtailed Fixed Sample Size Tests.
> Distribution of Some Product-moment Statistics Under a Null Permutation Hypothesis.
> Zonal Polynomials of Order 1-2.

Donald B. Owen is the chairman of the IMS Committee on Tables, James M. Davenport the managing editor, and H . Leon Harter the co-editor.

Publication of both volumes is expected in 1974. Standing orders for this series are being solicited.

The price for Volume One is $\$ 8.60$ list; $\$ 6.45$ for members.
American Mathematical Society
P. O. Box 6248 Providence, R. I. 02904

## REVIEW VOLUMES

Classification of Simple and Nonsolvable Groups;
Some Unrelated Structural Problems;
Nilpotent Groups;
Solvable Groups;
Characterizations of Solvable Groups;
$\pi$-Structure of Groups;
Some Internal Properties of Groups;
Automorphisms of Groups;
Arithmetic and Combinatorial Problems;
Cohomology of Groups;
Miscellaneous Problems related to Rings.

Reviews of Papers in Number Theory, Compiled, edited and classified by William J. LeVeque.

6 volumes appearing during 1974.
Volume 1, 640 pages, February 1974:
Congruences, Arithmetical functions, Primes and factorization, Continued fractions, Other expansions;
Sequences and sets;
Polynomials and matrices.
Volume 2, 736 pages, April 1974:
Diophantine equations;
Forms and linear algebraic groups;
Discontinuous groups and automorphic forms;
Diophantine geometry.
Volume 3, 424 pages, May 1974:
Geometry of numbers;
Diophantine approximation;
Distribution modulo 1,
Metric theory of algorithms.

Volume 4, 672 pages, June 1974:
Exponential and Character sums;
Zeta functions and L-functions,
Analysis related to multiplicative and additive number theory;
Multiplicative number theory;
Additive number theory,
Lattice point problems;
Miscellaneous arithmetic-analytic questions.
Volume 5, 480 pages, June 1974:
Algebraic number theory - global fields;
Algebraic number theory-local and p-adic fields; Finite fields and finite commutative rings;
Connections with logic.
Volume 6, 424 pages, February 1974:
General;
Subject index;
Author index.

Orders are now being accepted for these three sets of review volumes. It should be noted that the two collections on group theory can be purchased as a set, and that the number theory volumes may be purchased individually, although it is suggested that those purchasing single volumes of the number theory set also purchase Volume 6 which contains the indexes.

|  | List | Institutional <br> Member | Individual <br> Member | Student |
| :--- | ---: | ---: | ---: | ---: |
| Reviews of Papers on Infinite Groups |  |  |  |  |
| Volumes 1 and 2 | $\$ 70$ | $\$ 49$ | $\$ 28$ | $\$ 14$ |
| Reviews of Papers on Finite Groups | 50 | 35 | 20 | 10 |
| Combined set of above three volumes | 100 | 70 | 40 | 20 |
| Reviews of Papers in Number Theory |  |  |  |  |
| Volume 1 | $\$ 50$ | $\$ 35$ | $\$ 20$ | $\$ 10$ |
| Volume 2 | 50 | 35 | 20 | 10 |
| Volume 3 | 40 | 28 | 16 | 8 |
| Volume 4 | 50 | 35 | 20 | 10 |
| Volume 5 | 40 | 28 | 16 | 8 |
| Volume 6 | 40 | 28 | 16 | 8 |
| Complete set of Volumes 1-6 | 190 | 133 | 76 | 38 |

Classification of Simple and Nonsolvable Groups;
Some Unrelated Structural Problems;
Nilpotent Groups;
Solvable Groups;
Characterizations of Solvable Groups;
$\pi$-Structure of Groups;
Some Internal Properties of Groups;
Automorphisms of Groups;
Arithmetic and Combinatorial Problems;
Cohomology of Groups;
Miscellaneous Problems related to Rings.

## Reviews of Papers in Number Theory, Compiled, edited and classified by William J. LeVeque.

6 volumes appearing during 1974.
Volume 1, 640 pages, February 1974:
Congruences, Arithmetical functions,
Primes and factorization, Continued
fractions, Other expansions;
Sequences and sets;
Polynomials and matrices.
Volume 2, 736 pages, April 1974:
Diophantine equations;
Forms and linear algebraic groups;
Discontinuous groups and automorphic forms;
Diophantine geometry.
Volume 3, 424 pages, May 1974:
Geometry of numbers;
Diophantine approximation;
Distribution modulo 1,
Metric theory of algorithms.

Volume 4, 672 pages, June 1974:
Exponential and Character sums; Zeta functions and $L$-functions, Analysis related to multiplicative and additive number theory;
Multiplicative number theory;
Additive number theory,
Lattice point problems;
Miscellaneous arithmetic-analytic questions.
Volume 5, 480 pages, June 1974:
Algebraic number theory-global fields;
Algebraic number theory-local and p-adic fields;
Finite fields and finite commutative rings;
Connections with logic.
Volume 6, 424 pages, February 1974:
General;
Subject index;
Author index.

Orders are now being accepted for these three sets of review volumes. It should be noted that the two collections on group theory can be purchased as a set, and that the number theory volumes may be purchased individually, although it is suggested that those purchasing single volumes of the number theory set also purchase Volume 6 which contains the indexes.

|  | List | Instirutional <br> Member | Individual <br> Member | Student |
| :--- | ---: | ---: | ---: | ---: |
| Reviews of Papers on Infinite Groups | $\$ 70$ | $\$ 49$ | $\$ 28$ | $\$ 14$ |
| Volumes 1 and 2 | 50 | 35 | 20 | 10 |
| Reviews of Papers on Finite Groups | 100 | 70 | 40 | 20 |
| Combined set of above three volumes |  |  |  |  |
| Reviews of Papers in Number Theory | $\$ 50$ | $\$ 35$ | $\$ 20$ | $\$ 10$ |
| Volume 1 | 50 | 35 | 20 | 10 |
| Volume 2 | 40 | 28 | 16 | 8 |
| Volume 3 | 50 | 35 | 20 | 10 |
| Volume 4 | 40 | 28 | 16 | 8 |
| Volume 5 | 40 | 28 | 16 | 8 |
| Volume 6 | 190 | 133 | 76 | 38 |
| Complete set of Volumes 1-6 |  |  |  |  |

## Cumulative Index to Mathematics of Computation

The CUMULATIVE INDEX TO MATHEMATICS OF COMPUTATION is a compilation, by author and subject, of all material which has appeared in Mathematics of Computation and its predecessor, Mathematical Tables and Other Aids to Computation, during the years 1943 through 1969 (twentythree published volumes). The INDEX contains over 7,000 entries.

This is an unusual publication since the character of the journal is unique, not only publishing research papers, but also reviews of material on mathematics of computation and a table errata section which covers a number of other publications. In addition an unpublished mathematical tables' file is maintained.

The new classification system developed in 1969 is used in the SUBJECT INDEX to classify all research papers, tables, reviews, table errata, queries and replies, and microfiche. The AUTHOR INDEX gives bibliographical information on all of the items published in the journal.
462 pages; list price $\$ 19.95$; institutional member price $\$ 14.96$; individual member price $\$ 9.98$;
ISBN 0-8218-4000-2; to order, please specify MCOMIN/1
Please send orders to
american mathematical society
P. O. Box 6248

Providence, Rhode Island 02904
New Approximations to Familiar Functions
J. E. Dutt, T. K. Lin \& L. C. Tao ..... 939
A Search Procedure and Lower Bound for Odd Perfect Numbers Bryant Tuckerman ..... 943
A Lower Bound for the Set of Odd Perfect Numbers . . Peter Hagis, Jr. ..... 951
On the Largest Prime Divisor of an Odd Perfect Number
Peter Hagis, Jr. \& Wayne L. McDaniel ..... 955
The First Occurrence of Large Gaps Between Successive Primes
Richard P. Brent ..... 959
Computational Problems in $S$-Function Theory P. A. Morris ..... 965
A Note on Dirichlet Characters Richard H. Hudson ..... 973
Primitive Binary Polynomials Wayne Stahnke ..... 977
The Determination of Galois Groups Richard Stauduhar ..... 981
Reviews and Descriptions of Tables and Books ..... 997
Bulington 43, Cherkasova 45, Day 55, Fettis, Caslin \& Cramer49, Fettis \& Caslin 50, Hagis 53, Jacoby, Kowalik \& Pizzo 46,Karmazina 48, Morris 54, Robinson 44, Schatz 42, Tuckerman 51,Tuckerman 52, Young 47.
Table Errata ..... 1009Fletcher, Miller, Rosenhead \& Comrie 506, Slavic 507.
Corrigenda ..... 1011
Chorin, te Riele, Shanks \& Serafin
Microfiche SupplementIntegration Formulas and Schemes Based on $g$-SplinesGeorge D. Andria, George D. Byrne \& David R. Hill
Indices to Volume XXVII ..... 1013

[^0]Mathematics of Computation
TABLE OF CONTENTS
OCTOBER 1973
Generalized Local Maximum Principles for Finite-Difference Operators
Achi Brandt ..... 685
Convergence for a Vortex Method for Solving Euler's Equation
Theodore E. Dushane ..... 719
Symmetrization of the Fluid Dynamic Matrices with Applications
Eli Turkel ..... 729
Stability and Convergence of Difference Approximations to Pseudo-Parabolic Partial Differential Equations . ..... William H. Ford \& T. W. Ting ..... 737
Mesh Refinements for Parabolic Equations of Second Order
Stewart Venit ..... 745
Eigenfrequencies of an Elliptic Membrane
B. A. Troesch \& H. R. Troesch ..... 755
Elliptical Membranes with Smallest Second Eigenvalue
B. Andreas Troesch ..... 767
A Posteriori Error Bounds for Numerical Solutions of the Neutron Transport Equation Niel K. Madsen ..... 773
A Modified Bairstow Method for Multiple Zeros of a Polynomial
F. M. Carrano ..... 781
The Order of Numerical Methods for Ordinary Differential Equations
J. C. Butcher ..... 793
Approximate Solution of the Differential Equation $y^{\prime \prime}=f(x, y)$ with Spline Functions ..... 807
Polynomial Approximation of a Function and Its First Derivative in Near Minimax Norms Edgar A. Cohen, Jr. ..... 817
Boundary Expansions for Spline Interpolation W. D. Hoskins ..... 829
Integration Formulas and Schemes Based on $g$-Splines
George D. Andria, George D. Byrne \& David R. Hill ..... 831
An Elliptic Integral Identity H. S. Wrigge ..... 839
Rational Approximants Defined from Double Power Series
J. S. R. Chisholm ..... 841
Error Analysis for Direct Linear Integral Equation Methods
James L. Phillips ..... 849
Numerical Construction of Gaussian Quadrature Formulas for
$\int_{0}{ }^{1}(-\log x) \cdot x^{\alpha} \cdot f(x) \cdot d x$ and $\int_{0}{ }^{\infty} E_{m}(x) \cdot f(x) \cdot d x \ldots$ Bernard Danloy ..... 861
A Note on the Computation of Integrals Involving Products of Trigonometric and Bessel Functions Peter Linz \& T. E. Kropp ..... 871
Self-Scaling Variable Metric Algorithms Without Line Search for Uncon- strained Minimization Shmuel S. Oren ..... 873
An Algorithm for the Exact Reduction of a Matrix to Frobenius Form Using Modular Arithmetic. I ..... 887
An Algorithm for the Exact Reduction of a Matrix to Frobenius Form Using Modular Arithmetic. II Jo Ann Howell ..... 905
An Extrapolated Gauss-Seidel Iteration for Hessenberg Matrices
L. J. Lardy ..... 921
Extensions of Forsythe's Method for Random Sampling from the Normal Distribution J. H. Ahrens \& U. Dieter ..... 927


[^0]:    The editorial committee would welcome readers' comments about this microfiche feature. Please send comments to Professor Eugene Isaacson, MATHEMATICS OF COMPUTATION, Courant Institute of Mathematical Sciences, New York University, 251 Mercer Street, New York, New York 10012.

