OPTIMA

№ 28

MATHEMATICAL PROGRAMMING SOCIETY NEWSLETTER

November 1989

Chairman's Message

MY IMPRESSION of the Mathematical Programming Society, in comparison with, say, SIAM or ORSA, is that of a low key, internally directed organization. MPS publishes a prestigious journal of excellent quality and every three years holds a well-organized, scientifically stimulating meeting on theoretical and algorithmic developments in the field. We also have an informative newsletter and we award four prizes: Dantzig, Fulkerson, Orchard-Hays and Tucker.

Undoubtedly, our first priority is to maintain or improve the quality of these activities. I am confident that this will happen because of the people involved. The 1991 meeting, to be held in Amsterdam, is being co-chaired by Alexander Rinnooy Kan, Jan Karel Lenstra and Alexander Schrivjer. Our journal editors are Robert Bixby (replacing Michael Todd) and William Pulleyblank. From its inception, Donald Hearn has edited **OPTIMA**. The members of the new prize committees are announced elsewhere in this issue.

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Chairman's Message

What more, if anything, should we be doing? The status quo is comfortable and I am reluctant to depart from it. But I think there are some good reasons for becoming pro-active in promoting membership in the society and appreciation of the field.

Our past chairman, Michel Balinski, began a membership drive that revealed the need for geographical sections. Such groups could, for example, hold meetings in the years between the international symposia. We claim to be an international society, but our membership is disproportionally North American. Geographical sections could correct this imbalance. The Tokyo meeting in 1988 revealed the untapped potential for Asian membership. Peristroika should make membership accessible to math programmers from the Eastern Bloc countries where we have a group of scientists whose contributions to the field far exceed their membership in the society. Scandinavians, under the leadership of Stein Wallace, have begun to organize a geographical section. I would like to encourage others to do the same. Please contact me if you believe that it would be desirable to have a section in your region.

MPS should define itself broadly to encompass all areas of optimization. By chance, because I have no other explanation for it, in our last election nearly all of the officers elected work primarily in discrete optimization. For this reason, I have heard the conjecture that MPS may be narrowing its focus. Let me assure you that no such thing is happening. Our editorial boards, meetings, and prize committees will be balanced among the diverse areas of optimization. Moreover, we should make every effort to bring in new areas. For only through our collective strength can we influence our colleagues in other areas of the significance of mathematical programming. In other words, we must develop an identity that is understood beyond our community. This recognition is essential to the continued success of our field, which depends on our ability to attract bright students and adequate funding for research.

–G. L. Nemhauser

CALL FOR PROPOSALS

1994 International Mathematical Programming Symposium

Proposals are now being solicited for the location of the 1994 International Symposium on Mathematical Programming. A Symposium is held every three years under the auspices of the Mathematical Programming Society. The 1991 Symposium is scheduled to be held in Amsterdam. In keeping with the informal tradition of the Society, a site in North America will be preferred for the 1994 Symposium; however, other proposals will also be seriously considered. A preference is given to holding this meeting the first or second week of August 1994, due to the teaching schedule at American Universities.

The main criteria for selection of the location are:

1 Existence of mathematical programming researchers in the geographical area who are interested in organizing the Symposium.

2 Attendance open to prospective participants from all nations.

3 Availability of an attractive facility with a sufficient number of meeting rooms, standard lecture equipment, etc.

4 Availability of a sufficient supply of reasonably economical hotel and/or university dormitory rooms fairly near the meeting facility.

A copy of the Society's "Guidelines for Submission of Proposals" and further information can be obtained by contacting:

Clyde Monma
Combinatorics & Optimization Group
Bell Communications Research
445 South Street
Morristown, NJ 07960-1910 USA
Phone: (201) 829-4428
Email: clyde@bellcore.com
Fax: (201) 538-9093

The site selection committee consists of:

Clyde Monma, Chairperson
(Bell Communications Research)
William Cunningham
(Carleton University)
Jan Karel Lenstra
(Eindhoven University of Technology)
Robert Schnabel
(University of Colorado)

– C. Monma

CONFERENCE NOTES

Twelfth Symposium on Mathematical Programming with Data Perturbations

The George Washington University
Washington, DC
May 24-25, 1990

The Twelfth Symposium on Mathematical Programming with Data Perturbations will be held at George Washington University's Marvin Center on May 24-25, 1990. This symposium is designed to bring together practitioners who use mathematical programming optimization models which deal with questions of sensitivity analysis and researchers who are developing techniques applicable to these problems.

Contributed papers in mathematical programming are solicited in the following areas:

(1) Sensitivity and stability analysis results and their applications;

(2) Solution methods for problems involving implicitly defined problem functions;

(3) Solution methods for problems involving deterministic or stochastic parameter changes;

(4) Solution approximation techniques and error analysis.

Clinical presentations that describe problems in sensitivity or stability analysis encountered in applications are also invited.

Abstracts should provide a good technical summary of key results, avoid the use of mathematical symbols and references, not exceed 500 words, and include a title and the name and full mailing address of each author. The deadline for submission of abstracts is March 9, 1990. Approximately 30 minutes will be allocated for the presentation of each paper. A blackboard and overhead projector will be available.

Abstracts of papers intended for presentation at the Symposium should be sent in triplicate to:

Professor Anthony V. Fiacco
The George Washington University
Department of Operations Research
Washington, DC 20052
Telephone: (202) 994-7511

- Anthony V. Fiacco

System Modelling and Optimization

Zurich, Switzerland
September 2-6, 1991

IFIP TC7 has decided to hold its 15th Conference on **System Modelling and Optimization** at the University of Zurich, September 2-6, 1991. According to the tradition of the well-established IFIP TC7 conference series, colleagues from all over the world are expected to get together to discuss theoretical and practical results contributing to the further success of systems analysis and optimization techniques.

For all questions concerning the conference, please contact:

Dr. Karl Frauendorfer
Institute for Operations Research
University of Zurich
Moussonstr. 15
CH-8044 Zurich, Switzerland
Phone +41-1-257 37 71
E-mail IFIP91 at CZHRZU1A (EARN or BITNET)
Telex 817 260 uniz ch

- Peter Kall

Technical Reports & Working Papers

RUTCOR

Rutgers Center for Operations Research
Hill Center, Busch Campus
Rutgers University
New Brunswick, New Jersey 08903

P. Hansen, B. Jaumard and S-H. Lu, *"Global Optimization of Univariate Lipschitz Functions: I. Survey and Properties,"* RRR 18-89.

S-R. Kim, F.S. Roberts and S. Seager, *"On 101-Clear (0,1) Matrices and the Double Competition Number of Bipartite Graphs,"* RRR 19-89.

S-R. Kim and F.S. Roberts, *"On Opsut's Conjecture about the Competition Number,"* RRR 20-89.

F.S. Roberts, *"Applications of Combinatorics and Graph Theory to the Biological and Social Sciences: Seven Fundamental Ideas,"* RRR 21-89.

E. Boros, Y. Crama and P.L. Hammer, *"Polynomial-Time Inference of All Valid Implications for Horn and Related Formulae,"* RRR 22-89.

P. Hansen, B. Jaumard and S-H. Lu, *"Global Optimization of Univariate Lipschitz Functions: II. New Algorithms and Computational Comparison,"* RRR 23-89.

A.C. Williams, *"Estimating the Numbers of Threshold Functions of Dimension n and Order m,"* RRR 24-89.

P. Hansen, M.V. Poggi de Aragão and C.C. Ribeiro, *"Hyperbolic 0 - 1 Programming and Queries Optimization in Classical Databases,"* RRR 25-89.

C.T. Hoàng, F. Maffray and M. Preissmann, *"New Properties of Perfectly Orderable Graphs and Strongly Perfect Graphs,"* RRR 26-89.
J-M. Bourjolly, P.L. Hammer, W.R. Pulleyblank and B. Simeone, *"Combinatorial Methods for Bounding Quadratic Pesudo-Boolean Functions,"* RRR 27-89.

Rice University Department of Mathematical Sciences P. O. Box 1892 *Houston, Texas*

R.A. Tapia and Y. Zhang, *"A Fast Optimal Basis Identification Technique for Interior Point Linear Programming Methods,"* TR89-1.
J. Chiang and R.A. Tapia, *"Convergence Rates for the Variable, the Multiplier, and the Pair in SQP Methods,"* TR89-2.
R.H. Byrd, R.A. Tapia and Y. Zhang, *"An SQP Secant Algorithm for Equality Constrained Optimization Using the Structure of the Augmented Lagrangian,"* TR89-4.
P. Tarazaga, *"More Estimates for Eigenvalues and Singular Values,"* TR89-6.
P. Tarazaga, *"A Quadratic Minimization Problem on Subsets of Symmetric Positive Semidefinite Matrices,"* TR89-7.
J. Dennis and R. Schnabel, *"A New Derivation of Symmetric Positive Definite Secant Updates,"* CU-CS 185-80 (Nonlinear Programming 4, Academic Press, pp. 167-199).
D. Scott, *"Nonparametric Probability Density Estimation by Optimization Theoretic Techniques,"* 476-131-1.
K. Kennedy, *"Automatic Translation of Fortran Programs to Vector Form,"* 476-029-4.

Cornell University School of Operations Research and Industrial Engineering Upson Hall *Ithaca, NY 14853-7501*

R. Roundy, W. Maxwell, Y. Herer, S. Tayur and A. Getzler, *"A Price-Directed Approach to Real-Time Scheduling of Production Operations,"* TR 823.
R.E. Bechhofer, A.J. Hayter and A.C. Tamhane, *"Designing Experiments for Selecting the Largest Normal Mean When the Variances are Known and Unequal: Optimal Sample Size Allocation,"* TR 825.
M. Kulldorff, *"Optimal Control of Favorable Games with a Time Limit,"* TR 826.
M.J. Todd, *"Recent Developments and New Directions in Linear Programming,"* TR 827.
L.E. Trotter, Jr. and S.K. Tipnis, *"Node-Packing Problems with Integer Rounding Properties,"* TR 828.
L.E. Trotter, Jr. and J. Ryan, *"Weyl-Minkowski Duality for Integral Monoids,"* TR 829.
D. Joneja, *"Multi-Item Production Planning with Joint Replenishment and Capacity Constraints: The Trucking Problem,"* TR 830.
J.S.B. Mitchell, L. Gewali, A. Meng, and S. Ntafos, *"Path Planning in 0/1/∞ Weighted Regions with Applications,"* TR 831.
J.S.B. Mitchell, *"A New Algorithm for Shortest Paths Among Obstacles in the Plane,"* TR 832.
J.S.B. Mitchell, *"On Maximum Flows in Polyhedral Domains,"* TR 833.
M.J. Todd, *"The Affine-Scaling Direction for Linear Programming is a Limit of Projective-Scaling Directions,"* TR 834.
M.J. Todd, *"Probabilistic Models for Linear Programming,"* TR 836.
E. Arkin, R. Connelly, and J. Mitchell, *"On Monotone Paths Among Obstacles with Applications to Planning Assemblies,"* TR 838.
L. Trotter and M. Hartmann, *"A Topological Characterization for Closed Sets Under Polar Duality in Q^n,"* TR 843.
S. Resnick and R. Roy, *"Multivariate Extremal Processes and Dynamic Choice Models,"* TR 844.
E.M. Arkin, L.P. Chew, D.P. Huttenlocher, K. Kedem, J.S.B. Mitchell, *"An Efficiently Computable Metric for Comparing Polygonal Shapes,"* TR 845.
M. Hariga, *"The Warehouse Scheduling Problem,"* TR 846.
A. Forbes, *"Proofs of the Asymptotic Properties of the Conditional Maximum Likelihood Estimator for Log Odds Ratio Regression,"* TR 848.
P.L. Jackson, *"The Cumulative Flow Plot: Understanding Basic Concepts in Material Flow,"* TR 852.
J. Renegar, *"On the Computational Complexity and Geometry of the First-Order Theory of the Reals, Part I,"* TR 853.
J. Renegar, *"On the Computational Complexity and Geometry of the First-Order Theory of the Reals, Part II,"* TR 854.
J. Muckstadt, P. McCrink and L. Denardis, *"An Application of a Hierarchical Modeling Framework to the Computer Maintenance Industry,"* TR 855.
J. Renegar, *"On the Computational Complexity and Geometry of the First-Order Theory of the Reals, Part III,"* TR 856.
M. Todd, *"The Effects of Sparsity, Degeneracy and Null and Unbounded Variables on Variants of Karmarkar's Linear Programming Algorithm,"* TR 857.
J. Renegar, *"On the Computational Complexity of Approximating Solutions for Real Algebraic Formulae,"* TR 858.

Georgia Institute of Technology School of Industrial and Systems Engineering *Atlanta, GA 30332*

F.A. Al-Khayyal and J. Kyparisis, *"Conditions for Finite Convergence of Algorithms for Nonlinear Programs and Variational Inequalities,"* PDRC 88-1.
F.A. Al-Khayyal, R. Horst and P.M. Pardalos, *"Global Optimization of Concave Functions Subject to Separable Quadratic Constraints and of All Quadratic Separable Problems,"* PDRC 88-4.
F.A. Al-Khayyal, *"On Characterizing Linear Complementarity Problems as Linear Programs,"* to appear in Optimization.
F.A. Al-Khayyal, *"Jointly Constrained Bilinear Programs and Related Problems: An Overview,"* to appear in Journal of Computers and Mathematics with Applications.
F.A. Al-Khayyal, *"Generalized Bilinear Programming."*
F.A. Al-Khayyal, *"On Solving Linear Complementarity Problems as Bilinear Programs."*
C. Alexopoulos and P.G. Griffin, *"Path Planning for a Mobile Robot,"* J-89-09.
S. Amiouny, J.J. Bartholdi, III, J.H. Vande-Vate and J. Zhang, *"The Balanced Packing Problem."*
E.R. Barnes, *"Some Results Concerning Convergence of the Affine Scaling Algorithm,"* to appear in Mathematical Developments Arising from Linear Programming.
E.R. Barnes, A.J. Hoffman, U.G. Rothblum, *"Optimal Partitions Having Disjoint Convex and Conic Hulls."*
E.R. Barnes, D. Jensen and S. Chopra, *"A Polynomial Time Version of the Affine Scaling Algorithm."*
C. Barnhart, *"A Decomposition Strategy for the Solution of Large-Scale Multi-Commodity Network Flow Problems."*
C. Barnhart, *"A Comparison of Primal-Dual and Dantzig-Wolfe Decomposition Techniques for the Multi-Commodity Flow Problem."*

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Technical Reports & Working Papers

C. Barnhart, *"A Network-Based Primal-Dual Heuristic for the Solution of Multi-Commodity Network Flow Problems."*
M.B. Daya and C.M. Shetty, *"Polynomial Barrier Function Algorithms for Linear Programming,"* J-88-4.
M.B. Daya and C.M. Shetty, *"Polynomial Barrier Function Algorithms for Convex Quadratic Programming,"* J-88-05.
M.B. Daya and C.M. Shetty, *"A Barrier Function Algorithm for Linear Programming and Its Implementation,"* J-88-20.
M.B. Daya and C.M. Shetty, *"Underlying Concepts in Interior Point Methods for Linear Programming,"* J-89-10.
R. Borie, G. Parker and C. Tovey, *"Recursively Constructed Graphs: Decomposition and Linear Time Algorithm Generation."*
R. Borie, G. Parker and C. Tovey, *"Unambiguous Factorization of Recursive Graph Classes."*
R. Borie, G. Parker and C. Tovey, *"Automatic Generation of Linear Algorithms from Predicate Calculus Descriptions of Problems on Recursively Constructed Graph Families."*
R. Borie, G. Parker and C. Tovey, *"Generalized k-Jacknife Operations and Partial k-Trees,"* J-88-13.
M. Carter and C. A. Tovey, *"When Is the Classroom Assignment Problem Hard?"*
M. Goetschalckx and H.D. Ratliff, *"Shared Storage Policies Based on Duration of Stay."*
M. Goetschalckx and H.D. Ratliff, *"Determining Optimal Lane Depths for Single and Multiple Products in Block Stacking Operations."*
A. Iyer and H.D. Ratliff, *"Hierarchical Solution of Network Flow Problems."*
A. Iyer and H.D. Ratliff, *"Location Issues in Guaranteed Time Distribution Systems."*
A. Iyer, H.D. Ratliff and G. Vijayan, *"On an Edge Ranking Problem of Trees and Graphs."*
D.C. Llewellyn and T. Ryan, *"A Primal-Dual Integer Programming Algorithm."*
D.C. Llewellyn and C.A. Tovey, *"Dividing and Conquering the Square."*
G.L. Nemhauser and S. Park, *"A Polyhedral Approach to Edge Coloring,"* J-89-01.
G.L. Nemhauser and R. Rushmeier, *"Performance of Parallel Branch-and-Bound Algorithms for the Set Covering Problem,"* J-89-02.
G.L. Nemhauser and G. Sigismondi, *"A Strong Cutting Plane/Branch-and-Bound Algorithm for Node Packing,"* J-89-08.

Report on Stochastic Programming Meeting

ATTRACTING more people than any previous meeting on the subject, the Fifth International Conference on Stochastic Programming in Ann Arbor, Michigan, August 13-18, 1989, gave 123 participants from 31 countries and 6 continents both an introduction to the field and insight into current and future research. Organized by the Committee on Stochastic Programming (COSP) of the Society, this meeting was the first of its kind held in North America. The previous conferences were in Oxford in 1974, Koszeg, Hungary in 1981, Laxenburg, Austria in 1983, and Prague in 1986.

The meeting began with a day and a half of tutorial sessions that gave students, practitioners and researchers from other areas some background on stochastic programming and the fundamental techniques used in current work. Plenary lectures were given by R. Wets, R.T. Rockafellar, P. Käll, Y. Ermoliev, G. Dantzig and Y. Chang on work with A. Charnes. Participants attended 14 talks in morning and afternoon sessions as well as evening workshops which focussed on a variety of practical applications.

The meeting received financial support from the U.S. National Science Foundation, the College of Engineering and Department of Industrial and Operations Engineering of the University of Michigan, and corporate sponsors: IBM, AT&T, and General Motors. The Conference was jointly sponsored by the Mathematical Programming Society, ORSA, TIMS, and IFIP TC7.

Discussion of the next conference in 1992 was initiated by Andras Prekopa, Chair of COSP. No definite plans were made, but the COSP membership indicated a preference for Western Europe. The consensus was that this was the most exciting meeting in the field so far and that the committee was looking forward to continued growth in an area that offers challenges and rewards to both theoreticians and practitioners.

-J. Birge

MPS Prize Committees

Dantzig Prize: Awarded for original research, which by its originality, breadth and depth, is having a major impact on the field of mathematical programming (jointly sponsored by SIAM). Thomas Magnanti, Massachusetts Institute of Technology (Chairman); Manfred Padberg, New York University; R. Tyrrell Rockafellar, University of Washington; Michael Todd, Cornell University.

Fulkerson Prize: Awarded for outstanding papers in the area of discrete mathematics (jointly sponsored by the AMS). Martin Grötschel, University of Augsburg (Chairman); Louis Billera, Cornell University; Robert Tarjan, Princeton University.

Orchard-Hays Prize: Awarded for contributions to computational mathematical programming. Robert Meyer, University of Wisconsin (Chairman); Jorge More, Argonne National Laboratory; John Tomlin, IBM; Laurence Wolsey, University of Louvain.

Tucker Prize: Awarded for an outstanding paper authored by a student. Richard Cottle, Stanford University (Chairman); Thomas Liebling, École Polytechnique Federale de Lausanne; Richard Tapia, Rice University; Alan Tucker, SUNY at Stony Brook.

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BOOK REVIEWS

Graph Theory

by Ronald Gould
The Benjamin/Cummings Publishing Company, Menlo Park, California, 1988
ISBN 0-8053-6030-1

This text is an introduction to modern graph theory for beginners as well as a reference book. The standard topics are presented in a lucid style as a perfect blend of theory and algorithms including complexity aspects. Recent results are incorporated, e.g. Fraisse's sufficient condition for a graph to be Hamiltonian. Every chapter contains a collection of exercises and an extensive list of references. The last chapter concerning extremal graph theory is intended for graduate students.

Unfortunately, there are some inaccuracies in the text which are vexatious, e.g. the reconstruction procedure of a graph from its intermediate degree sequences does not work as described. Too many misprints are a grievance, no matter who the typist and the typesetter are that are blamed by the author himself in the preface.

- M. Hofmeister

Algorithms in Combinatorial Geometry

by Herbert Edelsbrunner
Springer, Berlin, 1987
ISBN 3-540-13722-X

Computational geometry is a relatively young discipline which combines problems, methods and results from geometry—particularly combinatorial geometry–and computer science. A typical well-known problem in this area is the task of computing the convex hull of a given point set in R^n. In the past decade this field has attracted many people and much research. The area is still a rich source of interesting research problems. However, the results have grown together to form a theory.

Edelsbrunner's book reflects this fact by stressing unifying structures and basic (i.e. more generally applicable) techniques. A few quotes from the book show where the author sees unifying structures in his field and where he places the emphasis in his book. "... geometric transforms played an important role as they reveal connections between seemingly unrelated problems and thus help to structure the field. These transforms led me to believe that arrangements of hyperplanes are at the very heart of computational geometry - and this is my belief now more than ever," (p. vii) or "A more appropriate but longer title for this chapter would be 'Problems formulated for configurations and solved for arrangements.' In fact, many problems formulated for configurations, whether combinatorial or algorithmic, are easier to approach in dual space where an arrangement of hyperplanes represents the configuration" (p. 271).

Arrangements of hyperplanes are geometric cell complexes whose cells are the (relatively open) convex regions which are associated with a dissection of R^n by finitely many hyperplanes. According to the above quote, arrangements of hyperplanes are the central structure studied in this book, and transformations are used to relate various other problems to those for arrangements of hyperplanes.

Let us point out that, as mentioned in Chapter 1, arrangements of hyperplanes correspond to zonotopes in one dimension higher. These zonotopes are special polytopes which are given as the Minkowski sum of finitely many line segments. So, as well as arrangements of hyperplanes, zonotopes could be regarded as underlying unifying structure for many problems considered in Edelsbrunner's book.

The book consists of three parts, entitled Combinatorial Geometry, Fundamental Geometric Algorithms, and Geometric and Algorithmic Applications. This structure is used by the author in order to demonstrate that computational and combinatorial issues of geometry are very closely related. After all, there are many geometric ingredients to the design of an efficient algorithm that specify the structure of the problem and in particular cut down the number of candidates for a solution. In addition, computational questions stimulate some research in combinatorial geometry.

Roughly speaking, the relation of various chapters in different parts of the book is as follows: respective chapters study related concepts and provide, first, the theoretical background, then, in the second part, (state-of-the-art) algorithms and, finally, they give applications.

In the first part Edelsbrunner introduces concepts of combinatorial geometry and gives results that on one hand are important for

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their own but on the other hand are relevant for the design of algorithms that solve respective combinatorial problems from a computational point of view. The chapter headings of the Combinatorial Geometry part are as follows: Fundamental Concepts in Combinatorial Geometry, Permutation Tables, Semispaces of Configurations, Dissections of Point Sets, Zones in Arrangements, and The Complexity of Families of Cells.

The second part gives geometric algorithms which are regarded as fundamental since they deal with basic problems, and the techniques are of paradigmatic character. To deal with these algorithms one must pay attention to the fact that usually a computational problem falls into several parts depending on how one evaluates the importance of efficiency issues related to preprocessing, storage, time-complexity, etc. The chapter headings of Part II are as follows: Constructing Arrangements, Constructing Convex Hulls, Skeletons in Arrangements, Linear Programming, and Planar Point Location Search.

The third part, where the techniques and results of the first two parts flow together, deals with geometric and algorithmic applications. The chapter headings are: Problems for Configurations and Arrangements, Voronoi Diagrams, Separation and Intersection in the Plane, and Paradigmatic Design of Algorithms.

As it turns out, various computational problems of geometry are closely related to certain problems in mathematical programming. Of course, in computational geometry often configurations of points or arrangements of hyperplanes are central rather than convex polytopes. Furthermore, considerations tend to keep the dimension fixed, and in many problems there is no objective function that is optimized.

However, there are interesting connections between these fields, and Edelsbrunner pays attention to that. He uses, for instance, perturbation techniques for arrangements which are essentially the same as the approach which led to the lexicographical variant of the simplex algorithm. He also discusses contributions of techniques from computational geometry to the minimum-spanning-tree problem, and he devotes a whole chapter to linear programming. In fact, fast routines for linear programming problems are the heart of various algorithms in computational geometry. Edelsbrunner describes an approach (developed independently by Dyer and Megiddo in the plane and subsequently extended to arbitrary dimensions by Megiddo) which leads to a linear time algorithm for linear programming in fixed dimension.

As indicated before and as confirmed by the choice of topics in Edelsbrunner's book, computational geometry is more precisely a computational combinatorial geometry since the problems which are usually dealt with are very combinatorial in nature. Let us point out, however, that there are interesting results concerning algorithmic aspects of convex bodies which are usually not dealt with under the heading Computational Geometry but which might be regarded as belonging to an area which should be called Computational Convexity.

As intended by the author, the book serves the purpose very well of emphasizing "that computational and combinatorial investigations in geometry are doomed to profit from each other" (p. vii). The book is well written and gives an excellent and unifying treatment of fundamental results in computational (combinatorial) geometry.

I think this book is attractive and very valuable for everyone who is interested in (pure or applied) aspects of computational geometry.

- P. Gritzmann

The Theory of Algorithms
by A. A. Markov and M. M. Nagorny
Kluwer, Dordrecht, 1988
ISBN 90-277-2773-2

The Russian mathematician Markov died in 1979, and the current book was completed posthumously by colleagues and former students. An eloquent preface recognizes Markov's contributions to dynamical systems and topological groups (his father is famous in probability) as well as to the subject of the current book.

The primary focus is an extremely careful presentation of one approach to the concept of a recursive function, often known in the West as "Markov algorithms." There is motivational and philosophical discussion including numerous critical remarks about a set-theoretic foundation for mathematics as being unacceptably vague. (Markov's coauthor writes, "These views provoked a stormy reaction on the part of many of his set-theoretically inclined colleagues. Traces of the prolonged discussions which took place around A. A. Markov's conceptions can be found in this book, but they are merely pale shadows.")

Markov algorithms are formally equivalent to Turing machines and other methods of defining recursive functions. They were developed in order to show that certain problems in the theory of semigroups are undecidable. This result of Markov's was arguably the first example of an undecidable problem from outside of mathematical logic.

It is unfortunate that most of this book will probably be somewhat outside the range of interests of Mathematical Programming Society members, since the emphasis is on problems that cannot be decided by any alogrithm, rather than on those which can be solved but may require a long time. There is a brief section (number 52) dealing with complexity issues. The final chapter is a first glimpse of the problems that arise when one tries to develop a constructive theory of real numbers. Some of this material deals with issues similar to those considered by Grötschel, Lovász, and Schrijver in their recent book on geometric approaches to combinatorial optimization.

- C. Blair

Integer and Combinatorial Optimization
by G. L. Nemhauser and L. A. Wolsey
John Wiley, New York, 1988
ISBN 0-471-82819-X

During the last four decades combinatorial optimization has been one of the "hottest" and most active fields within mathematics. It began in 1947 with Dantzig's invention of the brilliant simplex method, and since then it has been a rich field of theories, deep theorems, many effective algorithms and an infinite variety of applications. Our desks are flooded with piles of relevant and stimulating publications. So it's necessary to refresh and update the textbooks used from time to time. To that end an indeed impressive and astonishing achievement of completeness is provided in this book of more than 700 pages. One can find old and very recent results. Numerous examples and model formulations are extensively used by the authors to illustrate the crucial points of the underlying subject more clearly. Everything is carefully developed with splendid clarity and the book is well organized. It provides a comprehensive treatment of the main topics leading up to the frontiers of current research. Unfortunately, I can't follow the authors' decision to present DeGhellinck and Vial's approach to linear programming instead of Karmarkar's.

The book consists of three parts. In the first one, the foundations of combinatorial optimization are presented. In addition to some general model formulation schemes, this part addresses linear programming, graphs and networks, complexity theory and integer lattices. In linear programming, for instance, the book covers the associated theory, the simplex algorithm, Khachian's ellipsoidal method, DeGhellinck and Vial's projective algorithm and Tardos' contribution to a strongly polynomial linear programming algorithm. The emphasis in integer lattices lies in the solution of linear equations in integers.

Part II deals with general discrete optimization problems which, in most cases, are hard to solve. The topics discussed are: duality, relaxations, cutting planes and branch and bound. There is also a section of special purpose routines where methods like simulated annealing are briefly introduced. Finally, part III covers rather highly structured discrete optimization problems for which elegant proofs and algorithms are known. Very recent results about totally balanced, balanced and perfect matrices are included in a portion entitled Integer Polyhedra. In addition, there are extensive contributions on matchings and matroids.

The authors concentrate on theoretical properties and underlying ideas. Consequently, nothing is said about implementation aspects or parallel complexity. Also the probabilistic and amortized analysis has not been established seriously. I think that nowadays textbooks should have more details of real-world applications and implementations. On one hand, that's what we are looking for when we solve real-world problems, and on the other, real applications are rather convincing and motivating for students.

Summarizing, this book provides an excellent introduction and survey of traditional fields of combinatorial optimization. It should serve well as a textbook for students, and I'm convinced that it is going to be a standard reference. It is indeed one of the best and most complete texts on combinatorial optimization for students now available. In the preface the authors suggest different ways to incorporate the covered material into the curricula. Most sections are concluded with exercises and further readings. For experts the book contains some interesting and stimulating material as well. Even though it is impossible to include all important references in such an active field of research, this book with more than 700 entries, has quite an exhaustive reference list.

- A. Wanka

Combinatorial Designs
by W. D. Wallis
Marcel Dekker, Basel, 1988
ISBN 0-8247-7942-8

As the author states in the introduction, the book under review is intended for use as a text in a course in combinatorial designs at the senior/graduate level. His aims included giving "a good groundwork in the classical areas of design theory: block designs, finite geometries, and Latin squares," introducing "some modern extensions of design theory" and leading "students to the current boundaries of the subject." In spite of some recent texts on designs, such a textbook was still missing. The present book fills this gap quite nicely, and the author

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BOOK REVIEWS

has on the whole succeeded admirably. A very valuable feature of the book is the wealth of exercises (with solutions or hints).

Let me briefly summarize the contents of the book. There are 14 chapters: 1. Basic Concepts (first definitions and examples, including systems of distinct representatives); 2. Balanced Designs (PBD's, BIBD's, t-designs, including Fisher's inequality and a first discussion of symmetric designs); 3. Some Finite Algebra (auxiliary results on finite fields and sums of integer squares); 4. Difference Sets and Difference Methods (basic facts and construction of Hadamard difference sets, but no algebraic theory); 5. Finite Geometries (affine and projective geometries as designs, Singer difference sets, ovals); 6. More About Block Designs (residual designs, the Bruck-Ryser-Chowla thoerem, resolvability); 7. t-Designs (extensions, Cameron's theorem, affine t-designs); 8. Hadamard Matrices; 9. The Variability of Hadamard Matrices (a rather extensive treatment, including Hadamard designs, Williamson's method, regular Hadamard matrices, conference matrices and equivalence); 10. Latin Squares (again quite extensive, including proofs of the existence theorems for 2 and 3 MOLS); 11. One-Factors and One-Factorizations (including starter techniques); 12. Triple Systems (including the existence theorems for Steiner and Kirikman triple systems); 13. Room Squares (including starters, subsquares and the existence theorem); 14. Asymptotic Results on Balanced Incomplete Block Designs (presenting Wilson's asymptotic existence theory).

As this list indicates, the "classical" results have been adequately covered. The selection of advanced topics for such a book reflects, of course, the tastes of the author but seems to me, though my personal preferences would have been somewhat different, quite reasonable. At several points, some contact is made to the frontier of current research; necessarily, a text such as this cannot provide an overview of all the many different areas being studied now. Still, the student who has worked through the material presented here should be well prepared to go on to more specialized work.

Of course, there are some parts of the text which I think could have been improved. For instance, it seems a pity to talk about affine 2-designs without mentioning that they are the case of equality in Bose's classical inequality on resolvable designs, and without stating the connection to nets. Also, I think that the vast theory of difference sets would have merited a more detailed treatment, at least have included some material on Marshall Hall's classical multiplier theory. A little should have been said about base block constructions for t-designs with larger t, in particular since they provide practically all the known interesting examples! When discussing the existence of cyclic Steiner triple systems, the beautiful result of Colbourn and Colbourn determining the spectrum of cyclic triple systems in general should have been stated. A minor point: The Bruck-Ryser-Chowla theorem, which clearly is a non-existence result, should not be called the "main existence theorem." Also, I am not always happy with the references given. For instance, the author quotes three texts on difference sets, but the most important text available now—the book by E. S. Lander; *"Symmetric Designs: An Algebraic Approach,"* Cambridge University Press, 1983—is not referenced. Another missing reference: In Chapter 6, the author includes his beautiful 1973 result contructing symmetric designs from affine designs, but he does not give a reference for the simple proof he presents (which is not his).

In spite of these small misgivings, I still think that this is not only the best book for a first (but non-trivial) course on combinatorial designs now available, but really a good text for preparing the reader for more difficult monographs and research papers. However, for a deeper and more detailed study for students who are specialzing in this area, there is the book coauthored by the reviewer (T. Beth, D. Jungnickel and H. Lenz: *Design Theory*, Cambridge University Press, 1986) which is neither intended nor particularly suitable as a text for a first course.

- D. Jungnickel

Numerical Optimization Techniques
by Yurij G. Evtushenko
Optimization Software, Inc., Publications Division, New York, 1985

This is a highly theoretical view of a selected set of methods to solve a variety of numerical optimization problems. The book contains seven chapters, and an examination of these subjects provides a good picture of the scope of the topics covered. These topics are an introduction to optimization theory, convergence theorems and their application to numerical methods, the penalty function method, numerical methods for solving nonlinear programming problems using modified Lagrangians, relaxation methods for solving nonlinear programming problems, numerical methods for solving optimal control problems, and the search for global solutions.

The latter two topics are seldom covered in books on nonlinear optimization. Control theory is generally viewed as a topic of sufficient additional complexity as to merit separate treatment. Global optimization is sufficiently difficult that few numerical methods have proved to have general applicability, and hence the topic is generally omitted from books attempting to provide a comprehensive unified view of the subject. Thus a major strength of the book is the inclusion of these topics.

Also, imbedded in several of the chapters whose topics are listed above is substantial discussion of the theory and methods for solving minimax problems. There is substantial literature on these methods, but unfortunately this literature is seldom included in nonlinear optimization books.

A further nice feature of the book is the inclusion of methods little used in the West to analyze methods. For example, Lyapunov functions are used to prove convergence of numerical methods arising from the solution of differential equations. In general, continuous trajectories arising from the solution of differential equations are much better analyzed than is usual in nonlinear optimization texts. These differences point out markedly the different emphasis of much of the Russian analysis of numerical optimization. It is this different viewpoint, sometimes giving rise to different methods, that is the point of major interest to researchers unaware of this literature.

The book requires a sophisticated mathematical background and a fair knowledge of numerical optimization methods. The mathematics is advanced and very terse. Little motivation is given for methods, and there are virtually no geometric examples. Only the chapter on control theory has any graphic illustrations. There are few numerical examples and no problems. All of the above suggest that the book is not appropriate as a textbook. It could, however, serve as a valuable reference for a graduate course.

As a reference, it would not in itself be adequate for a standard course in numerical methods as they are currently taught in the United States. This stems from the fact that topics considered central here are sometimes completely omitted. Thus the main value of the book is as an interesting and useful addition to the reference library of researchers for the new viewpoints and methods presented and the wide scope of topics covered.

- D. F. Shanno

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OPTIMA

Gallimaufry

We note with sadness the recent deaths of two prominent researchers in computational mathematical programming: **William Orchard-Hays** who worked on the original development of a Simplex code for the IBM 704 and **Darwin Klingman** who made many contributions in network optimization.

Optimization Days 1990 will be held May 3-4 at the University of Montreal. Abstract deadline is January 31. Contact Michel Gendreau and Patrice Marcotte, Centre de recherche sur les transports, Univ. de Montreal, C. P. 6128 Succursale A, Montreal, Quebec, Canada H3C 3J7. Tel: (514) 343-7435...A conference on **Computer-Aided Scheduling of Public Transport** will also be held in Montreal August 19-23. Contact Martin Desrochers at the above address. The first ORSA conference on **OR in Telecommunications** will be held March 12-14, 1990 in Boca Raton, Florida. Contact Clyde Monma, Bell Communications Research, 445 South Street, Morristown NJ 07690-1910. Tel: (201) 829-4428; E-mail: clyde@bellcore.com.

Deadline for the next **OPTIMA** is February 1, 1990.

Books for review should be sent to the Book Review Editor, Prof. Dr. Achim Bachem, Mathematiches Institute der Universität zu Köln, Weyertal 86-90, D-5000 Köln, West Germany.

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