OPTIMA

Nº 21

MATHEMATICAL PROGRAMMING SOCIETY NEWSLETTER JUNE 1987

Martin Beale Memorial Symposium

The Programme of this symposium (which will be held at the Royal Society, London, from July 6-8, 1987) will include a reception, a dinner (speaker: S. Vajda), contributed talks (the deadline for submissions was March 1), and the following invited papers:

P. Hughes (Logica), "Martin Beale: A Personal Memory"

G. B. Dantzig (Stanford), "Solving Large Scale Mathematical Systems Is Becoming a Practical Reality"

K.C. Bowen (Royal Holloway and Bedford New College), "A Mathematician's Journey Through Operational Research"

P.J. Green (University of Durham), "Regression, Curvature and Weighted Least Squares"

R.D. Ripley (University of Strathclyde), "Uses and Abuses of Statistical Simulation"

J.A. Tomlin (Ketron), "Special Ordered Sets and an Application to Gas Supply Operations Planning"

A. Orden (University of Chicago), "The Assessment of OR Models"

B.R.R. Butler (British Petroleum), "Applications of OR in the Oil Industry."

Further information is available from Mrs. B.A. Peberdy, Scicon Limited, Wavendon Tower, Wavendon, Milton Keynes MK17 8LX, England.

OPTIMA
number twenty-one

List of contents

Conference Note

Symposium on Parallel Optimization

August 10 - 12, 1987
Computer Sciences Department
University of Wisconsin
Madison, Wisconsin
USA

Partial List of Invited Speakers:
D.P. Bertsekas, Y. Censor, M.D. Chang, G.B. Dantzig, R. DeLeone, R.S. Dembo, J.G. Ecker, L. Grandinetti, S.-P. Han, J.K. Ho, O.L. Mangasarian*, R.R. Meyer*, J.M. Mulvey, J.-S. Pang, A.H.G. Rinnooy Kan, K. Ritter, J.B. Rosen, R.B. Schnabel, D. Sorensen, S.A. Zenios

This symposium will address computational aspects of parallel algorithms for optimization. Emphasis will be on algorithms implementable on parallel and vector architectures. Further information may be obtained by writing to the SPO Secretary or to either of the symposium co-chairmen at the above address. The symposium will be supported by grants from the Air Force Office of Scientific Research and from the Office of Naval Research. The proceedings will be published as a Mathematical Programming Study.
**Symposium Co-chairmen*

Technical Reports & Working Papers

University of Missouri-Columbia
College of Engineering
Design Productivity Center
1080 Engineering Building
Columbia, Missouri

B.M.E. de Silva, *"Substructuring for Multilevel Structural Optimization,"* 86DPC005 ($2.42).

V. Bhatt and B.M.E. de Silva, *"Sensitivity of Optimum Designs to Problem Parameters,"* 86DPC015 ($2.70).

J.K. Blundell and B. Greenway, *"LBO - Line Balancing Optimization,"* 86DPCO17 ($1.38).

K.M. Ragsdell, *"State-of-the-Art In Parallel Nonlinear Optimization,"* 86DCP027 ($2.41).

Cornell University
School of Operations Research
and Industrial Engineering
Upson Hall
Ithaca, NY

R. Roundy, *"Efficient, Effective Lot-Sizing for Multi-Product Multi-Stage Production/Distribution Systems with Correlated Demands,"* TR 671.

L.J. Billera and K. Magurn, *"Balanced Subdivision and Enumeration in Balanced Spheres,"* TR 672.

M.Todd, *"Reformulations of Economic Equilibrium Problems for Solution by Quasi-Newton and Simplicial Algorithms,"* TR 673.

R.Roudy, *"94%-Effective Lot-Sizing in Multi-Stage Assembly Systems,"* TR 674.

J. Sand and P. Jackson, *"Operating Policies for Water-Supply Reservoirs in Parallel, I: The Single Demand System,"* TR 675.

M. Phelan, *"Estimating the Compensator from Poisson -Type Counting Processes,"* TR 676.

C. Jennison, *"On the Stochastic Minimization of Sample Size by the Bechhofer-Kulkarni Bernoulli Sequential Selection Procedure,"* TR 677.

R. Bechhofer and C. Dunnett, *"Two-Stage Selection of the Best Factor-Level Combination in Multi-Factor Experiments: Common Unknown Variance,"* TR 678.

R. Dalang, L.E. Trotter, Jr., and D. de Werra, *"On Randomized Stopping Points and Perfect Graphs,"* TR 679.

S. Tipnis, *"Integer Rounding and Combinatorial Max-Min Theorems,"* TR 680.

M.J. Todd and C. Ip, *"Conditioning in Rank 1 Quasi-Newton Updates,"* TR 681.

M.J. Todd, *"On Bounds in Anstreicher's Monotonic Projective Algorithm,"* TR 682.

R. Bechhofer and D. Goldsman, *"Truncation of the Bechhofer-Kiefer-Sobel Sequential Procedure for Selecting the Multinomial Event which has the Largest Probability (II): Extended Tables and an Improved Procedure,"* TR 683.

J.A. Muckstadt, P.L. Jackson, W.T. Martin, S.Bellantoni and R. Ferstenberg, *"Cornell Simulator of Manufacturing Operations,"* TR 684.

M. Phelan, *"Nonparametric Inference from Poisson-Type Counting Processes,"* TR 685.

P. Domich, *"Residual Methods for Computing Hermite and Smith Normal Forms,"* TR 686.

M. Todd, *"The Symmetric Rank-One Quasi-Newton Method is a Space Dilation Subgradient Algorithm,"* TR 687.

I. Barany and Z. Furedi, *"Computing the Volume Is Difficult,"* TR 688.

I. Barany and Z. Furedi, *"Empty Simplices in Euclidean Space,"* TR 689.

W. Cook, *"Cutting-Plane Proofs in Polynomial Space,"* TR 690.

I. Barany and Z. Furedi, *"On the Convex Hull of Random Points,"* TR 691.

P. Jackson, W.L. Maxwell, J. Muckstadt and R. Roundy, *"The Interaction Between Design and Scheduling in Repetitive Manufacturing Environments,"* TR 692.

W.L. Maxwell, *"Scheduling the Factory of the Future—Results of a Research Planning Session,"* TR 693.

I. Barany, *"Rearrangement of Series in Infinite-Dimensional Spaces,"* TR 694.

H. Taylor, *"A Model for the Failure Process of Semi-Crystalline Polymer Materials Under Static Fatigue,"* TR 695.

R. Bland and D. Cho, *"Arranging Points in R^d: A Question of Balances,"* TR 696.

R. Sheldon, *"The Lot Scheduling Problem in the Hierarchy of Decision Models,"* TR 697.

T. Santner and S. Yamagami, *"A New System of Small Sample Confidence Intervals for the Difference of Two Success Probabilities,"* TR 698.

P. Jackson, *"The Simplex Method in Cyclic Scheduling,"* TR 699.

D. Joneja and W. Maxwell, *"Buffer Replacement in Sequential Production Lines: Considerations of Processing Time Variability,"* TR 700.

R. Dalang, *"On Infinite Perfect Graphs and Randomized Stopping Points on the Plane,"* TR 701.

Y. Herer, *"Buffer Placement in Sequential Production Lines: Further Studies,"* TR 702.

D. Duffy and T. Santner, *"Estimating Logistic Regression Probabilities,"* TR 703.

D. Goldsman and R. Bechhofer, *"Sequential Selection Procedures for Multi-Factor Experiments Involving Koopman-Darmois Populations with Additivity,"* TR 704.

R. Bechhofer and C. Dunnett, *"Percentage Points of Multivariate Student t Distributions,"* TR 705.

continues

M. Phelan, *"Nonparametric Estimation from a Censored Markov Renewal Process Observed over a Long Period of Time,"* TR 706.

M.J. Todd, *"Polynomial Algorithms for Linear Programming,"* TR 707.

M. Phelan, *"Life-Testing and Estimation with Arbitrary Distribution Function,"* TR 708.

M. Phelan, *"Nonparametric Estimation from Discrete-Time Nonhomogeneous Finite Markov Chains with Applications to Inference from Multiwave Panel Data,"* TR 709.

M. Hartman, *"An Improvement of Various Elimination Procedures,"* TR 710.

J. Ryan, *"Integral Monoid Duality Models,"* TR 711.

M. Kulldorff, *"Tandem Queueing Systems with Blocking,"* TR 712.

R. Bland and B. Dietrich, *"Abstract Duality,"* TR 713.

L. Schruben and S. Jacobson, *"A Frequency Selection Algorithm for Frequency Domain Experiments in Simulation,"* TR 714.

L. Schruben and S. Jacobson, *"Techniques for Simulation Optimization,"* TR 715.

R. Roundy, *"Rounding Off to Powers of Two in Continuous Relaxations of Capacitated Lot Sizing Problems,"* TR 716.

W. Morris, *"Oriented Matroids and the Linear Complementarity Problem,"* TR 717.

Charles University
Department of Applied Mathematics
KAM - Series
Malostranské nám. 25
11800 Praha 1
Czechoslovakia

J. Nesetril, and V. Rödl, *"Complexity of Diagrams."*

P. Sgall, *"From Expression through Meaning to Intention."*

I. Kríz, *"A Hypergraph-less Construction of Highly Chromatic Graphs without Short Cycles."*

M. Loebl and S. Poljak, *"On Matroids Induced by Packing Subgraphs."*

K. Zimmermann, *"One Optimization Problem with Max-Min Operations."*

R. Svarc, *"Some Combinatorial Results about the Operators with Jumping Nonlinearities."*

J. Matousek, *"A Few Colored Cuts or Cycles in Edge Colored Graphs."*

E. Hajicová, *"Machine Translation Research in Czechoslovakia."*

J. Nesetril and P. Pudlák, *"A Note on Boolean Dimension of Posets."*

L. Kucera, *"Greedy Coloring Is a Bad Probabilistic Algorithm."*

S. Poljak and M. Chrobak, *"On Common Edges in Optimal Solutions to Travelling Salesman and other Optimization Problems."*

R. Svarc, *"The Operators with Jumping Nonlinearities and Combinatorics."*

R. Thomas, *"A Counterexample to Wagner's Conjecture for Infinite Graphs."*

P. Sgall and J. Panevová, *"Dependency Syntax, Its Problems and Advantages."*

J. Kratochvíl and D. Zeps, *"On the Minimum Number of Hamiltonian Cycles in Triangulations."*

J. Nesetril, *"For Graphs There Are Only Four Types of Hereditary Ramsey Classes."*

S Poljak and Z. Tuza, *"Maximum Bipartite Subgraphs of Kneser Graphs."*

J. Nesetril and R. Thomas, *"Well Quasi Orderings, Long Games and a Combinatorial Study of Undecidability."*

M. Loebl and J. Matousek (x), *"On Undecidability of the Weakened Kruskal Theorem."*

M. Loebl and S. Poljak, *"Remark on Restricted and Strongly Unimodular Matrices and a Class between Them."*

E. Hajicová, *"Focusing - A Meeting Point of Linguistics and Artificial Intelligence."*

Mathematisches Institut
Universität zu Köln
Preprints in Optimization
Weyertal 86 - 90
D-5000 Köln 41, West Germany

A. Wanka, *"Matroiderweiterungen zur Existenz endlicher LP–Algorithmen, von Hahn-Banach-Sätzen und Polarität in Orientierten Matroiden,"* WP 86.24.

A. Bachem and A Wanka, *"Euclidean Intersection Properties,"* WP 86.25.

W. Kern, *"On the Rate of Convergence of Some Stochastic Processes,"* WP 86.26.

A. Bachem and A. Wanka, *"Matroids without Adjoint,"* WP 86.27.

W. Kern, *"A Probabilistic Analysis of the Switching Algorithm for the Euclidean TSP,"* WP 86.28.

J. Rieder, *" On k-Tuple-Colorings of Graphs,"* WP 86.29.

W. Kern and A. Wanka, *"On a Problem About Covering Lines by Squares,"* WP 86.31.

M. Leclerc, *"Slices of the Matching Polytope,"* WP 86.32.

W. Kern, *"On the Depth of Combinatorial Optimization Problems,"* WP 86.33.

M. Leclerc, *"Optimization Over a Slice of the Bipartite Matching Polytope,"* WP 86.34.

W. Kern, *"Optimization and Optimality Test for Weighted Max Cut,"* WP 86.35.
M. Leclerc, *"The 2-Matching Lattice of a Graph,"* WP 86.36.
W. Nettekoven, *"The Hyperbolic n-Space as a Graph in Euclidean (6n-6)–Space,"* WP 86.37.
C. Bold, *"Order-Degree Sequences,"* WP 86.38.

Technical University Graz
University Graz
Reports of the Mathematical Institutes
Kopernikusgasse 24
A-8010 Graz, Austria

R.E. Burkard and R.A. Cunninghame-Green, *"Saddle Points in Groups and Semigroup Minimization,"* No. 68.
G. Rote, *"On the Connection between Hexagonal and Undirectional Rectangular Systolic Arrays,"* No. 72.
G. Rote, *"A Proposal of a Heuristic for Decomposing Traffic Matrices in TDMA Satellite Communication,"* No. 73.
H. Edelsbrunner, G. Rote, and E. Welzl, *"Testing the Necklage Condition for the Shortest Tours and Optimal Factors in the Plane,"* No. 83.
M. Perusch, *"Simulated Annealing Applied to a Single Machine Scheduling Problem with Sequence Dependent Setup Times and Due Dates,"* No. 84.

Northwestern University
Department of Industrial Engineering
and Management Sciences
Evanston, Illinois 60201

G.B. Hazen, *"Differential Characterizations of Nonconical Dominance in Multiple Objective Decision Making,"* Report No. 86-14.
P.C. Jones, and R.R. Inman, *"Analytic Results for the Two-Product Fully-Loaded Economic Lot Scheduling Problem,"* Report No. 86.06.
P.C. Jones and R.R. Inman, *"When is the Economic Lot Scheduling Problem Easy?,"* Report No. 86-13.
J. Sun, *"Basic Theories and Selected Applications of Monotropic Piecewise Quadratic Programming,"* Report No. 86.09.
J. Sun, *"A Simplex-Active-Set Algorithm for Piecewise Quadratic Programming,"* Report No. 86-10.

Journals & Studies

Vol. 37, No. 1

L. Mathiesen, *"An Algorithm Based on a Sequence of Linear Complementarity Problems Applied to a Walrasian Equilibrium Model: an Example."*
A. R. Conn and N. I. M. Gould, *" An Exact Penalty Function for Semi-Infinite Programming."*
D. de Werra, *"Partitions into Odd Chains."*
M.A. Hanson and B. Mond, *"Necessary and Sufficient Conditions in Constrained Optimization."*
C.G.E. Boender and A.H.G. Rinnooy Kan, *"Bayesian Stopping Rules for Multistart Global Optimization Methods."*
D.M. Gay, *"A Variant of Karmarkar's Linear Programming Algorithm for Problems in Standard Form."*
S.M. Grzegorski, *"Multilevel Least-Change Newton-like Methods for Equality Constrained Optimization Problems."*
M.Fischetti and S. Martello, *"Worst-Case Analysis of the Differencing Method for the Partition Problem."*

Vol. 37, No. 2

M.-C. Noel and Y. Smeers, *"Nested Decomposition of Multistage Nonlinear Programs with Recourse."*
P. Kleinschmidt, C.W. Lee and H. Schannath, *"Transportation Problems Which Can Be Solved by the Use of Hirsch-Paths for the Dual Problems."*
S. Sen and H. D. Sherali, *"Nondifferential Reverse Convex Programs and Facetial Convexity Cuts via a Disjunctive Characterization."*
H.C.P. Berbee, C.G.E. Boender, A.H.G. Rinnooy Kan, C.L. Scheffer, R.L. Smith and J. Telgen , *"Hit-and-Run Algorithms for the Identification of Nonredundant Linear Inequalities."*
S.M. Robinson, *"Local Epi-Continuity and Local Optimization."*
M. Aganagic and R. W. Cottle, *"A Constructive Characterization of Q_0-Matrices with Nonnegative Principal Minors."*
S.J. Wright, *"Local Properties of Inexact Methods for Minimizing Nonsmooth Composite Functions."*

Vol. 37, No. 3

S. Hashizume, M. Fukushima, N. Katoh and T. Ibaraki, *"Approximation Algorithms for Combinatorial Fractional Programming Problems."*
E. R. Panier, *"An Active Set Method for Solving Linearly Constrained Nonsmooth Optimization Problems."*
M.J.M. Jansen and S.H. Tijs, *"Robustness and Nondegenerateness for Linear Complementarity Problems."*
E. Allen, R. Helgason and J. Kennington, *"A Generalization of Polyak's Convergence Result for Subgradient Optimization."*
D. Talman and T. Doup, *"A New Simplicial Variable Dimension Algorithm to Find Equilibria on the Product Space of Unit Simplices."*
S.H. Lu and A.C. Williams, *"Roof Duality for Polynomial 0-1 Optimization."*

Vol. 38, No. 1

G. van der Laan and A.J.J. Talman, *"Simplicial Approximation of Solutions to the Nonlinear Complementarity Problem with Lower and Upper Bounds."*
M. Conforti and M.R. Rao, *"Structural Properties and Recognition of Restricted and Strongly Unimodular Matrices."*
M.J.D. Powell, *"Update Conjugate Directions by the BFGS Method."*
R.M. Freund, *"Dual Gauge Programs, with Applications to Quadratic Programming and the Minimum-Norm Problem."*
M.H. Gerards and A. Sebo, *"Total Dual Integrality Implies Local Strong Unimodularity."*
P.H. Calamai and A.R. Conn, *"A Projected Newton Method for* l_p *Norm Location Problems."*

Vol. 38, No 2

E.M.L. Beale, FRS: *"Friend and Colleague,"* edited by G.B. Dantzig and J.A. Tomlin.
S.W. Wallace, *"A Piecewise Linear Upper Bound on the Network Recourse Function."*
A. Bouchet, *"Greedy Algorithm and Symmetric Matroids."*
M.N. Broadie and B. C. Eaves, *"A Variable Rate Refining Triangulation."*
J. Kyparisis, *"Sensitivity Analysis Framework for Variational Inequalities."*
S. -K. Sim, *"Clarification of Certain* (α, β) *–Polarity Results of Bachem and Grotschel."*
Z. Drezner, *"On the Complexity of the Exchange Algorithm for Minimax Optimization Problems."*

Vol. 38, No. 3

S. Chopra and E.L. Johnson, *"Dual Row Modules and Polyhedra of Blocking Group Problems."*
B. Betro and F. Schoen, *"Sequential Stopping Rules for the Multistart Algorithm in Global Optimisation."*
J.V. Burke, *"Second Order Necessary and Sufficient Conditions for Convex Composite NDO."*
P. Tseng and D.P. Bertsekas, *"Ralaxation Methods for Problems with Strictly Convex Separable Costs and Linear Constraints."*
P. Zencke and R. Hettich, *"Directional Derivatives for the Value-Function in Semi-Infinite Programming."*

Mathematical Programming Study 31

F.A. Al–Khayyal, *"An Implicit Enumeration Procedure for the General Linear Complementarity Problem."*
M.C. Bartholomew–Biggs, *"Recursive Quadratic Programming Methods Based on the Augmented Lagrangian."*
R.S. Dembo, *"A Primal Truncated Newton Algorithm with Application to Large-Scale Nonlinear Network Optimization."*
S.D. Flam, *"Approximating some Convex Programs in Terms of Borel Fields."*
H.J. Greenberg, *"Computer-Assisted Analysis for Diagnosing Infeasible or Unbounded Linear Programs."*
D.W. Hearn, S. Lawphongpanich and J.A. Ventura, *"Restricted Simplicial Decomposition: Computation and Extensions."*
J.K. Ho, *"Recent Advances in the Decomposition Approach to Linear Programming."*
M. Kupferschmid and J.G. Ecker, *"A Note on Solution of Nonlinear Programming Problems with Imprecise Function and Gradient Values."*
Z.A. Maany, *"A New Algorithm for Highly Curved Constrained Optimisation."*
R. Mifflin, *"An Implementation of an Algorithm for Univariate Minimization and an Application to Nested Optimization."*
W. Ogryczak, *"On Practical Stopping Rules for the Simplex Method."*
J.A. Tomlin, *"An Experimental Approach to Karmarkar's Projective Method for Linear Programming."*

BOOK REVIEWS

Finite Algorithms in Optimization and Data Analysis

By M.R. Osborne
Wiley, Chichester, 1985
ISBN 0-471-90539-9

While most optimization problems are computed by some version of the simplex method for linear programming, many nonlinear problems require different treatment. Some linear problems may be better approached by other methods which take into account the structure of the problems. This book analyses various finite algorithms, methods involving a strictly limited number of steps, both for linear and some nonlinear problems. The results presented will interest those who want better algorithms and who are interested in both mathematical and computational aspects. The emphasis is on problems of moderate size and some interesting structure, so sparseness is not a factor here. Questions of scaling, degeneracy, and stability are discussed at some length, not only for the simplex method but also for some rival methods arising in some applications. These include various data analysis problems and some statistical questions.

After an initial chapter on convex analysis, linear programming is extensively discussed, not only by the simplex method but also by descent methods (both reduced and projected gradient) and an exact penalty algorithm. Attention is paid to degeneracy and comparing the amount of computation required. The next chapter applies linear programming to questions of discrete approximation, which is related to linear programming using a polyhedral norm. Both primal and dual algorithms are discussed. Next, polyhedral convex functions are analysed; these are nondifferentiable functions obtained as the maximum of a finite number of affine functions. What is interesting here, as well as in other contexts of nondifferentiable convex programming, is finding tractable compact representations for the subdifferentials which arise. This theory is then applied to least squares and related methods. There is a considerable discussion of robustness and "resistance", the latter meaning insensitivity to a few large residuals. Several nonconvex problems are also analysed. The final chapter, on complexity and performance, discusses the number of iterations and amount of computing for various algorithms, including the ellipsoid method. There is a useful discussion, with some numerical data, on the various possibilities for randomly generated test problems. A great deal of interesting research on algorithms from very scattered sources in the literature, as well as the author's own considerable contributions, are summed up in these chapters.

–B.D. Craven

Mathematical Programming Essays in Honor of George B. Dantzig

Parts I and II
Edited by R.W. Cottle
North-Holland, Amsterdam, 1985

Two volumes of the series, Mathematical Programming Studies, comprise 28 papers dedicated to Professor George B. Dantzig on the occasion of his 70th birthday. Their topics cover a broad range of mathematical programming. A common feature of the majority of papers is presentation of a new algorithm or a new variant of a known method for solving either some classical optimization problem or its restriction to more specified data.

To this group belong papers which deal with linear programming problems having staircase or network structure. Other contributions treat nonlinear or stochastic programming. Furthermore, two papers present algorithms immediately motivated by practical applications: Circuit routing for design of VLSI chips and optimal balancing between expansion cost and security index in the location of reactive sources in electrical power planning. Most of the above papers report also on computational experience with the implementation of the suggested methods and present a comparison with another standard method in favour of the new one. On the other hand, the conclusion of one is that the use of "deep cuts" in ellipsoid algorithms does not provide any substantial decrease in the number of iterations. Many of the above papers use the decomposition technique. A general approach to decomposition algorithms for ordered structures is also presented.

The first two papers study sensitivity of linear programming. A further one shows that each pair of feasible primal and dual solutions gives a computable bound on some components of the optimal solution. Other papers survey results on faces of a convex polyhedron and on complementarity problems. Moreover, a principle of monotone likelihood is introduced that is related to an exponential family of distributions. Besides that, a new condition for a minimum of a concave function and a class of matrices allowing certain type of scaling is given.

A small portion of papers is of rather combinatorial character, namely, showing that any basis of a 2-connected greedoid can be obtained from any other by a finite sequence of pivots and a polyhedral approach to scheduling problems.

The editorial intention was to stress the connection of the included papers with the scope of G.B. Dantzig's own work. The contributions are organized into six groups: linear programming, large-scale linear programming, network optimization and integer linear programming, complementarity, nonlinear programming, and stochastic programming. Each of these groups is separately surveyed with references to the list of 15 selected publications by G.B. Dantzig.

–S. Poljak

continues

Combinatorial Optimization, Annotated Bibliographies

Edited by M. O'Eigeartaigh, J. K. Lenstra and A.H.G. Rinnooy Kan
Wiley, Chichester, 1985
ISBN 0-471-90490-2

The purpose of the book is to present annotated bibliographies for most of the rapidly developing subareas of combinatorial optimization. To this end, twelve well-known specialists have been asked to select main references and important new preprints and to provide brief annotations.

The presentation is such that the book is somewhere in the middle between a pure bibliography and a collection of surveys. This makes it extremely useful for readers who are only slightly familiar with some subarea and want a brief and to-the-point introduction to the main results and the main research development.

Naturally, due to the fast expansion of the field, it is almost impossible for such a book to cover all subareas. So the book concentrates on the following topics: polyhedral combinatorics, duality for integer optimization, packing and covering, submodular functions and polymatroids, computational complexity, probabilistic analysis, randomized algorithms, parallel algorithms, location and network design, vehicle routing, scheduling, and software. Personally, I would have liked to see also chapters on perfect graphs or algorithmic graph theory and to cover in greater detail topics such as oriented matroids, project scheduling and stochastic scheduling.

Altogether, the book represents a very valuable source of information and can be highly recommended as an up-to-date reference book for research and teaching in combinatorial optimization.

–Rolf H. Möhring

Analysis and Design of Algorithms for Combinatorial Problems

Edited by G. Ausiello and M. Lucertini
North Holland, Amsterdam, 1985
ISBN 0-444-87699-5

The continuously growing interest for fast and efficient algorithms for combinatorial problems has led to a large number of schools, specialized conferences and workshops on this subject in the last decade. This volume contains a selection of the contributions presented at one of these meetings, an international workshop held in September 1982, at CISM in Udine, Italy.

Quite often proceeding volumes of this kind suffer from an intrinsic uneveness. This is particularly true when the subject lies in the interface between different disciplinary areas as in the case of combinatorial algorithms. Although it contains many valuable papers, the volume we are considering is no exception. The reader finds contributions belonging to quite different sectors; while some are of rather general interest, others are very technical.

The 15 papers in this volume cover several subjects which can be grouped as follows.

Several contributions deal with graph theoretic concepts. Among them we would like to mention a quite interesting study of algorithms to detect the equivalence among directed hypergraphs (a problem arising in relational database theory) and an elegant characterization of the relations between the König-Egerváry properties for graphs and the consistency of Boolean quadratic equations.

One paper deals with abstract computational complexity of enumeration problems. The comparison among complexity classes with respect to Counting Turing Machines and Random Access Machines is investigated.

Another group of papers contains quite interesting results on the analysis of approximation algorithms for hard problems. Most of them are based on a probabilistic approach. Among the problems investigated in these papers are the weighted vertex cover, the dominating set, the maximum clique, the maximum set packing and the multiple edge cover. As an example, it is shown that for a certain class of random graphs, a randomly selected feasible solution is asymptotically optimal, almost surely for the dominating set problem. A nice generalization and unification of known results concerning the probabilistic analysis of the greedy algorithm for the maximum clique and the maximum set packing problems is provided in one of these papers. Several approximation techniques for the weighted vertex cover problem are presented in a paper based on a new "Local-Ratio" Theorem.

Another paper deals with a particular type of binary tree structure called "trie". A systematic way to obtain estimates of trie parameters, such as size, pathlength, height, etc., as a function of the number of elements on which the trie is built, is presented.

A couple of papers are in the area of parallel algorithms. In particular, a collection of algorithms is presented to store and process relational databases on VLSI mesh-of-trees structures. Unfortunately this interesting contribution is quite hard to follow since the figures, which the authors refer to in the text, for some mysterious reason, have not been printed.

Finally, two application oriented papers are concerned with particular network design problems. One problem is to set the arc capacities in a network where the flow demand is not known in advance. An approximation algorithm is proposed for the case in which the demand vector must belong to a polyhedron, and the objective is to maximize the subset of satisfied demand vectors under a budget constraint. The other problem, which arises in the design of electrical circuits, is to connect sets of terminals lying on the border of a grid by means of "wire-trees" in order to minimize the number of used rows ("tracks") of the grid. An optimal algorithm to solve this problem, known as the "multiterminal channel routing" problem, is presented.

In summary, this volume contains enough valuable contributions to be recommended to all scientists working in the Combinatorial Optimization area.

–Alan A. Bertossi
–Giorgio Gallo

A General Theory of Optimal Algorithms

By J.F. Traub and H. Wozniakowski
Academic Press, New York
ISBN 0-12-697650-3

The authors develop a framework for discussing optimality of algorithms, the emphasis lying on approximation questions. Major topics treated are interpolation, integration, approximation and partial differential equations. The book is essentially based on the fundamental work of Kiefer, Sard, Nikolski, Golumb, Weinberger, Michelli, Rivlin and many other mathematicians in the field of approximation theory. Given this background, the monograph stresses as a newly introduced basic instrument a notion of general information. As it turns out, this notion is intimately connected with classical concepts in approximation theory (like Gelfand-and Kolmogorov-n-width). The translation and interpretation of classical results into the present framework is a major aspect of the book. Consequently, a reader should not expect a treatment of the computational aspects of, e.g., combinatorial optimization (centering around NP-completeness and, in fact, not even the (explicit) treatment of Kashian's or Karmarkar's polynomial time algorithms for linear (and certain nonlinear) optimization problems.

Instead, in its main part (Part A up to chapter 6) the book is concerned with studying the worst case behaviour of non-iterative approximation algorithms for so-called linear problems, such as numerical integration. The (usually) available linear information for such problems consists, e.g., of function values at certain points. This means, in the author's terminology, that the information operator is linear. As a measure of the "size" of information the rank of the information operator (called the cardinality of information) is introduced.

The best information operator with a certain cardinality is asked for, and complete characterizations are given, e.g., for the Hilbert case. General - perhaps surprising - results obtained in this framework are the following:

- There are linear problems, for which there is no ε-approximation possible using any finite number of linear functionals as information operator (no matter how large ε is chosen).
- In the linear context, adaptive information is not superior to nonadaptive.

Interesting features from the complexity point of view are the observations that every linear algorithm with error less than ε is a nearly optimal complexity algorithm for this error rate. On the other side, the complexity of linear problems can be arbitrarily high with no complexity gap existing (essentially any decreasing real function on the positive reals is a complexity function for some suitable linear problem). As already mentioned, these principal insights are enriched with a wide variety of details from classical problem solutions, reformulated in the present framework. Aspects of symbolic integration are briefly addressed. Also, improved results on the treatment of differential equations are among the subjects covered, as is the critical role of the chosen norms.

Part A, chapters 8 to 10, deals with the case of nonlinear problems. As a particular central result it is established that nonlinear information operators with cardinality one are sufficient in this case. A good example for the ideas followed in this section is the treatment of the maximization of unimodular functions, where a result of Keifer is discussed and improved in a certain sense. As is to be expected, the use of non-adaptive techniques proves very favourable in the non-linear context. Quite a number of complexity results are included. In certain cases, the algorithmic complexity for ε-approximation is proportional to $1/\varepsilon$, i.e., not polynomial any more in the usual sense.

As was mentioned above, the results so far are subject to a worst-case analysis. Average case models, relative models, perturbed models and asymptotic models are then briefly discussed. Two interesting observations are the following:

- Contrary to many combinatorial optimization problems, the worst case and the average case complexity for linear problems with linear and non-adaptive information seem to be nearly the same.
- In a certain sense, studying perturbations (sensitivity analysis) seems not necessarily to lead to a really higher degree of correspondence between mathematical models and real life applications in the given framework. For instance, in a certain sense, the occurring models can have the nasty property of model-inherent instabilities. The authors themselves point out this deficiency of their treatment of stability aspects and ask for further research on this important question.

Part B of the book, strongly separated from Part A, is a comparatively small (50 pages) review of the situation for iterative approaches with a restriction to linear information. To mention one of the main results, the authors discuss the conjecture that essentially only (non)linear equations can be solved by iteration.

To summarize, given a basic knowledge in approximation theory, the book is useful as a unifying approach to a scattered variety of algorithmic and computational problems in this area. An outstanding feature of the monograph is its excellent bibliography with many comments.

–K. Donner
–F.J. Radermacher

Graphs (Vol. 6, Part 1)

By Claude Berge
North Holland, Amsterdam, 1985

This is in fact the third edition of Part One of the English translation of *Graphes et Hypergraphes* (1970) and may thus be regarded as a legitimate descendant of the author's classic *Théorie des Graphes et ses Applications* (1958), even though focuses and setup of the presentation have changed and, naturally, the volume of material has grown considerably.

The present edition is divided into chapters as follows: Basic Concepts; Cyclomatic Number; Trees and Arborescences; Paths, Centers and Diameters; Flow Problems; Degrees and Demi-degrees; Matchings; c-Matchings; Connectivity; Hamiltonian Cycles; Covering Edges with Chains; Chromatic Index; Stability Number; Kernels and Grundy Functions; Chromatic Number; and Perfect Graphs. As compared to Part One of the second English edition (1976) which shows the same titles of chapters, the following changes are worth mentioning: Updating and/or revision of the sections on edge con-

continues

nectivity, Hamiltonian circuits and cycles, bounds for the chromatic index, the stability number, vertex colourings, triangulated graphs, addition of new sections on the correlation of maximal path length and vertex colouring (Gallai-Roy theorem) and Lovász's perfect graph theorem.

Occasional confusion in theorem numbering and referencing caused by these changes should not blur their positive impact. They do confirm the role of the book as one of the leading accounts of modern graph theory.

The discussion of planarity has been reduced, the author renewing his promise to write a monograph on topological aspects of graph theory. Part Two of the previous editions (hypergraph theory) will also be re-published separately.

An unusual defect hinders the use of this prominent text as a reference book: There is no subject index. The useful English-French-German index of definitions of the previous editions has disappeared.

–M. Armbrust

Multiple-Criteria Decision Making

By Po Lung Yu
Plenum, London, 1985
ISBN 0-306-41965-3

Po Lung Yu is a very intelligent, inscrutable, and funny man. His book entitled Multiple-Criteria Decision Making (Concepts, Techniques, and Extensions) is a reflection of Professor Yu. He is also a friend and colleague. According to the dust cover, Professor Yu "...offers the reader an integral and systematic introduction to a number of concepts and techniques of MCDM (Multiple-Criteria Decision Making) and an exploration of some extensions and applications at the frontiers of the field." It does this, according to the preface, "...at an 'introductory' level ... (for a student having) ... the mathematical maturity equivalent to a course in operations research or optimization theory....The book is an outgrowth of formal graduate courses in ... (MCDM) that the author has taught...."

In spite of the author's professing the book to be an introductory text, I regard the book as a monograph of the author's own work with a smattering of other material added. The book is very much a no-nonsense presentation of Professor Yu's work in a Theorem-Proof style with remarks and examples that illustrate the mathematical concepts thrown in to help the student. It appears to be well done, though I do not think it as introductory as the author makes it out to be. In the preface, the author counsels those interested in applications to concentrate on Chapters 3 through 6. A reader might expect those chapters to discuss applications and to offer advice to those wishing to apply MCDM techniques. Not so, as a brief review of those chapters reveals! The titles of Chapters 3 through 6 are: Pareto Optimal or Efficient Solutions; Goal Setting and Compromise Solutions; Value Function; and Some Basic Techniques for Constructing Value Functions. These chapters contain lemmas, proofs, and remarks and would not be regarded as application material by most readers. Professor Yu apparently regards Chapter 7 as a heavy chapter, because he invites readers having sophisticated mathematical training to study it carefully and "... (hopefully) make a breakthrough in the area of local analysis of preference and domination structures." That chapter draws heavily on Yu's work on domination structures.

Chapter 8 presents methods for finding all nondominated solutions to multiobjective linear programming problems and an approach for solving a multiobjective, multiple right-hand-side linear programming problem.

The book is not large, weighing in at less that 400 pages. Chapter 8 ends on page 270, and the bibliography begins on page 361.

What I found particularly interesting was Chapter 9, "Behavioral Bases and Habitual Domains of Decision Making," also based very much on Professor Yu's own research. This is presented as "(filling in).... the gap between the technical concepts and the application arts by presenting the basic mechanism of human behavior and decision making in a larger scope than just mathematical optimization." Though my knowledge of behavioral science is less than vast, it is not zero. My impression is that Yu covers the material from his own point of view from what a behavioral scientist would call a nonstandard but valid perspective. He introduces and discusses extensively the concept of habitual domain, "the collection of ideas and actions that can be activated at (a) time." Then with a little bit of mathematical development (section 9.3), the author turns to "some observations in social psychology" (section 9.4) where he draws on his theory and deduces numerous behavioral effects, such as the "halo" effect and proximity theory. Then in the next section (section 9.5) the author presents some applications. These applications are essentially what the author calls common wisdom, and he discusses such topics as self-awareness, happiness, success, decision making, persuasion, negotiation, gaming, and career management. I particularly liked his section on career management (9.5.4) in which he reproduced someone else's "ground rules for business success." They are common sense and useful. Some of these applications are tied into the behavioral hierarchy set up by the author. Though I found this chapter rather interesting, I decided to ask some of my behavioral science colleagues for their interpretation of what was covered in Chapter 9. Though their review was not thorough, they provided support to my assessment above.

Chapter 10, "Further Topics," is a brief synopsis of the rest of the field. From my perspective it is too brief. It constitutes roughly ten percent of the entire volume. What it does cover, it covers correctly but tersely. Many readers may find it too terse. Further, I would have liked to see other approaches included.

As stated above, I regard the book as a monograph of Yu's work. A colleague and I regularly teach a seminar on multiple criteria decision making (mathematically oriented) at the State University of New York at Buffalo. Every time we conduct the seminar, we use a different format. We have used several different books, generally supplemented by current articles, as well as a rather overweight working paper that I have written for such courses, also supplemented by current articles. In spite of our optimistic feelings at the beginning of the seminar, we always have felt disappointed as we wend our way through the chosen book. Yu's volume appears to be a first-class piece of work: We are seriously considering using it in our next MCDM seminar. However, to provide the breadth that we believe is necessary, we will have to supplement the book substantially with papers.

–Stanley Zionts

continues

Model Building in Mathematical Programming

2nd Edition
By H.P. Williams
John Wiley, Chichester, 1985

This book addresses the needs of students who desire practical experience with mixed-integer programming (MIP) problem formulations at a greater depth than is possible even with the best texts at the introductory level.

A large number of challenging formulations are given which are between "mini-cases" and cases in difficulty. These are first stated in words; then formulated in a following chapter; then solution output is given in a third chapter. In this manner, the text allows the students to obtain a good deal of realistic experience on small to medium-sized MIPs.

H.P. Williams has been among the earlier researchers to recognize the importance of MIP formulation techniques and to systematically study these techniques. Formulation has been, until recent years, a much neglected mathematical subject. It has unfortunately been associated with ad hoc "practitioners' tricks," a fact which has delayed a more rigorous development.

For nontechnical students, in the introductory course of mathematical programming I use the text by G. Eppen and F.J. Gould, *Quantitative Concepts for Management Decision Making Without Algorithms*. This text contains far more formulation exercises than is typical of most other introductory texts.

The easier program formulations in H.P. Williams' text are at the harder end of the formulations of Eppen and Gould. The discussions of MIP formulations are the core of his book, and consequently this matter is studied at far greater length than in introductory texts, which have a broader scope.

This book is a good choice as a text for a second and more advanced course. I used it partially in this manner in a graduate seminar which also touched on some research issues in MIP.

The author emphasized the importance of obtaining a good (i.e. small or "tight") linear relaxation (LR) in an MIP formulation. This has been recognized to be a crucial factor in computational success since at least the 1970s, dating from the discovery of the importance of "disaggregated constraints" in a flow setting by A. Geoffion and G. Graves and in a logical implication setting by Williams. The importance of an appropriate partitioning strategy is also emphasized both in the discussion of the SOS sets of Beale and Tomlin and in terms of adding new integer variables which represent better branching alternatives in highly symmetric MIPs. Total unimodularity and network structures are briefly treated. The "standard list" of specially-structured MIPs (e.g., knapsack, travelling salesman, quadratic assignment, covering, packing, and partitioning problems) is briefly developed, with the apt remark (p. 184) that "most practical IP models do not fall into any of these categories...."

The text does not systematically use the best MIP formulation, in the sense of the LR, to derive the MIP formulations given (as either best or a specific consequence of a best formulation). However, such derivations are recent developments, and in general many developments in IP and MIP formulation of the last five or so years are not treated.

Inclusion of Lagrangian relaxation, the ability to use special combinatorial structures when they occur as subprograms, and a more systematic use of best LRs, represent potential additional material for future texts, for a somewhat more advanced audience than the present text addresses. The present text provides a good means for familiarizing students with the use of MIP, and in this way, of having MIP more widely used. –Robert G. Jeroslow

Application for Membership

Mail to:
THE MATHEMATICAL PROGRAMMING SOCIETY, INC.
c/o International Statistical Institute
428 Prinses Beatrixlaan, 2270 AZ Voorburg, The Netherlands

Checks or money orders should be made payable to
THE MATHEMATICAL PROGRAMMING SOCIETY, INC.
in one of the currencies listed below.

Dues for 1987, covering subscription to volumes 37-39 of *Mathematical Programming*, are Dfl.103.50 (or $45.00 or DM95.00 or £30.00 or FF300.00 or Sw.Fr.75.00).

Subscription to volumes 30-31 of *Mathematical Programming Studies*, available to members only, is Dfl.50.00 (or $22.00 or DM44.50 or £15.00 or FF145 or Sw.Fr.36.00).

Student applications: Dues are one-half the above rates. Subscription to the *Studies* is at full rates. Have a faculty member verify your student status and send application with dues to above address.

I wish to enroll as a member of the Society.
My subscription(s) is (are) for my personal use and not for the benefit of any library or institution. I enclose payment as follows:

Dues for 1987 ____________

Subscription to *Studies* 30-31 ____________

Total ____________

Name (please print) ____________

Mailing Address (please print) ____________

____

____

Signature ____________

Faculty verifying status ____________

Institution ____________

Gallimaufry

The 13th International Symposium on Mathematical Programming will be held at Chuo University, Tokyo, Japan, August 29 - September 2, 1987. See OPTIMA Number 20 for details... In preparation for the Symposium, MPS Council Chairman **Michel L. Balinski** will visit organizers **Iri, Kone** and **Tone** in November... **David Shanno**, formerly of University of California, Davis has joined MPS Treasurer **A.C. Williams** at Rutgers University... **Michael Held** is retiring from IBM to accept a position in the School of Business Administration at Columbia University... There were over 300 attendees at the May 17-20 SIAM Conference on Optimization in Houston. Featured were many sessions on the Karmarkar LP Algorithm... **Richard Karp** is giving ten lectures on Probabilistic Analysis of Algorithms at Johns Hopkins, June 15-19, 1987... **Ashok Idnani** offers OPTPAK optimization software through 3i Corporation, 49 Oak Avernue, Box 144, Park Ridge, NJ 07656.

Deadline for the next OPTIMA is September 15, 1987.

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.

Journal contents are subject to change by the publisher.

Donald W. Hearn, Editor
Achim Bachem, Associate Editor
Published by the Mathematical Programming Society and
Publication Services of the
College of Engineering,
University of Florida.
Composition by Lessie McKoy,
Graphics by Lise Drake.

OPTIMA
MATHEMATICAL PROGRAMMING SOCIETY

303 Weil Hall
College of Engineering
University of Florida
Gainesville, Florida 32611

FIRST CLASS MAIL