OPTIMA

Nº 29

MATHEMATICAL PROGRAMMING SOCIETY NEWSLETTER

March 1990

Amsterdam 1991

AMSTERDAM, the capital of the Netherlands, will host the 14th International Symposium on Mathematical Programming from August 5 to 9, 1991. This is the triennial meeting of the Mathematical Programming Society, and we cordially invite you to participate in the meeting and to contribute to making it a success.

Amsterdam is known all over the world for a variety of reasons. Its historic center covers a wide area of, mainly 17th Century, buildings along "grachten" (canals). The cultural attractions include the Rijksmuseum, with several Rembrandts (Nachtwacht), Vermeers, Frans Hals, etc.; the Vincent van Gogh Museum, with a huge collection of van Goghs; the Stedelijk Museum, for modern art; the Royal Concertgebouw Orchestra, and the National Ballet. Moreover, we mention the liberal atmosphere, yielding a rich supply of pleasures of various kinds.

The Symposium will take place in the buildings of the University of Amsterdam in the city center, with several hotels and restaurants of diverse categories nearby. The meeting offers invited and contributed talks in parallel sessions, and we call for papers on all theoretical, computational, and practical aspects of our field. We have chosen a particularly late deadline for the submission of papers (June 1, 1991) so as to encourage the presentation of very recent results.

Last October we sent out the First Announcement to a large number of people, including all members of the Society. It contains some more information and is reprinted in this issue of OPTIMA. *The Second Announcement will appear this Fall and will be sent to all those who have returned the Preregistration Form in the First Announcement.*

We look forward to seeing you in Amsterdam and to offering you a pleasant and fruitful symposium.

JAN KAREL LENSTRA
ALEXANDER RINNOOY KAN
ALEXANDER SCHRIJVER

S Y M P O S I U M

Council Meets in the Black Forest

Bernhard Korte and Klaus Ritter were the organizers of the VIth Biennial Oberwolfach Conference on Mathematical Programming. Between 60 and 70 mathematical programmers met from January 7 to January 13 at the "Mathematisches Forschungsinstitut" in Oberwolfach. They attended more than 50 presentations on recent research; they enjoyed the informal atmosphere and the scenic surroundings; and many participated in the traditional hike on Wednesday afternoon.

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O P T I M A

14th International Symposium on Mathematical Programming

Amsterdam, The Netherlands, August 5-9, 1991

First Announcement

The International Symposium on Mathematical Programming is the triennial scientific meeting of the Mathematical Programming Society. The 14th Symposium will be held at the University of Amsterdam, August 5-9, 1991. It is jointly organized by the University of Amsterdam, the Centre for Mathematics and Computer Science (CWI) in Amsterdam, Eindhoven University of Technology, and the Erasmus University in Rotterdam.

Chairmen: J. K. Lenstra, A. H. G. Rinnooy Kan, A. Schrijver. **International Program Committee:** A. Auslender, M. Avriel, E. Balas, M. L. Balinski, C. Berge, R. E. Bixby, V. Chvátal, A. R. Conn, R. W. Cottle, G. B. Dantzig, J. E. Dennis, Jr., L. C. W. Dixon, A. M. Geoffrion, F. Giannessi, J.-L. Goffin, D. Goldfarb, E. G. Golshtein, R. L. Graham, M. Grötschel, P. L. Hammer, M. Held, A. J. Hoffman, K. L. Hoffman, T. Ibaraki, M. Iri, E. L. Johnson, P. Kall, R. Kannan, R. M. Karp, A. V. Karzanov, M. L. Kelmanson, V. Klee, K. O. Kortanek, B. Korte, J. Krarup, H. W. Kuhn, E. L. Lawler, C. Lemaréchal, F. A. Lootsma, L. Lovász, O. L. Mangasarian, G. P. McCormick, N. Megiddo, G. Mitra, B. Mond, G. L. Nemhauser, W. Oettli, M. W. Padberg, B. T. Polyak, M. J. D. Powell, A. Prékopa, W. R. Pulleyblank, M. R. Rao, K. Ritter, S. M. Robinson, R. T. Rockafellar, J. B. Rosen, H. E. Scarf, R. B. Schnabel, P. D. Seymour, J. Stoer, É. Tardos, M. J. Todd, A. W. Tucker, H. Tuy, A. F. Veinott, Jr., R. J.-B. Wets, A. P. Wierzbicki, P. Wolfe, L. A. Wolsey, M.-Y. Yue. **Organizing Committee:** O. J. Boxma, A. M. H. Gerards, J. L. de Jong, G. A. P. Kindervater, M. Labbé, B. J. Lageweg, G. de Leve, M. W. P. Savelsbergh, A. J. J. Talman, H. C. Tijms, L. N. van Wassenhove. **Advisory Committee:** M. Grötschel (chairman), H. Konno, R. B. Schnabel, M. J. Todd.

Call for papers. Papers on all theoretical, computational and practical aspects of mathematical programming are welcome. The presentation of very recent results is encouraged. For this reason, a particularly late deadline for the submission of titles and abstracts has been set.

Dates and deadlines
September, 1990: Second Announcement
April 1, 1991: Deadline for early registration
June 1, 1991: Deadline for submission of titles and abstracts
August 5-9, 1991: The Symposium

Topics. Sessions on the following topics are organized. Suggestions for further areas to be included are welcome.
- Linear, integer, mixed-integer programming
- Interior-point and path-following algorithms
- Nonlinear, nonconvex, nondifferential, global optimization
- Complementarity and fixed point theory
- Dynamic and stochastic programming, optimal control
- Game theory and multicriterion optimization
- Combinatorial optimization, graphs and networks, matroids
- Computational complexity
- Approximative methods, heuristics
- Computational geometry, VLSI-design
- Implementation and evaluation of algorithms and software
- Large-scale mathematical programming
- Parallel computing in mathematical computing
- Expert, interactive and decision support systems
- Mathematical programming on personal computers
- Teaching in mathematical programming
- Applications of mathematical programming in industry, government, economics, management, finance, transportation, engineering, energy, environment, agriculture, sciences and humanities

Structure of the meeting. The meeting will offer invited and contributed lectures in parallel sessions. In addition, computer demonstrations and survey lectures highlighting developments of current interest are planned. During the plenary opening session, the George B. Dantzig Prize (for original research with a major impact on mathematical programming), the Fulkerson Prizes (for outstanding papers in discrete mathematics), the Orchard-Hays Prize (for excellence in computational mathematical programming), and the A.W. Tucker Prize (for an outstanding paper by a student) will be awarded. The program also contains a reception and a banquet.

Site. The Symposium will take place in the Oudemanhuispoort building of the University of Amsterdam, located in the historic centre of Amsterdam, close to many attractions of various kinds. Amsterdam is easily reachable by all means of public transportation and has direct air connections with many cities all over the world.

Preregistration. The Second Announcement, which will appear in September 1990, will be sent to all those who return the Preregistration Form below. It will contain additional and more detailed information about the program, registration fees, social events, hotels, traveling, etc.

Mailing address
14th International Symposium on Mathematical Programming
Paulus Potterstraat 40
1071 DB Amsterdam
The Netherlands
Telephone: +31-20-752120
Telefax: +31-20-6628136
Telex: 10761 omega.nl
Electronic mail: ismp@swivax.uucp, ismp@swi.psy.uva.nl

Preregistration Form

Please keep me on the mailing list for further information about the 14th International Symposium on Mathematical Programming.

Last name: ______________________________

First name: ______________________________

Mailing address: ______________________________

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Institution (if not in mailing address): ______________________________

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☐ I plan to attend the Symposium.

☐ I intend to give a talk.

My talk may be on the following subject: ______________________________

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Please return this form to:

14th International Symposium on Mathematical Programming

Paulus Potterstraat 40

1071 DB Amsterdam

The Netherlands

CONFERENCE NOTES

Nato Advanced Study Institute on Combinatorial Optimization Bilkent University
Ankara, Turkey
July 16-28, 1990

NATO is sponsoring an ASI, "New Frontiers in the Theory and Practice of Combinatorial Optimization: Applications in VLSI Design," to be held at Bilkent University in Ankara, Turkey, July 16-28, 1990. The ASI is also sponsored by the University of Florida (S. Tufekci), Bilkent University (M. Akgul) and the University of Kaiserslautern (H. W. Hamacher). The objective of this institute is to disseminate the state-of-the-art knowledge on combinatorial optimization with a focus on the applications in VLSI design. This two-week institute will be primarily in the form of a workshop with lectures from prominent, internationally renowned scientists. It will be followed by an afternoon poster session where a limited number of papers on the theory and practice of combinatorial optimization will be discussed. Papers might be submitted for these poster sessions on network optimization, recent advances in linear programming, integer programming, traveling salesman problem, parallel algorithms, matroids, polyhedral combinatorics, and application of combinatorial optimization on manufacturing decision problems including VLSI design. There is a limited number of financial grants available for participants from the NATO countries. To be considered for a financial grant, applicants must provide background information and a letter of recommendation from their department head or from their dissertation advisor no later than March 15, 1990. The award notification will be mailed by May 5, 1990. Send applications and abstracts to DR. SULEYMAN TUFEKCI, Associate Director, Center for Optimization and Combinatorics (COCO), Department of Industrial and Systems Engineering, University of Florida, Gainesville, Florida, 32611, USA.

Nordic MPS Meeting and Formation of Geographical Section

Some MPS members from the Nordic countries will arrange a meeting on "Algorithms and Solution Procedures in Mathematical Programming" on August 25 and 26, 1990 in Copenhagen. The meeting is supported in part by The Nordic Council of Ministers and has two goals:

1. To increase contact between math programmers in the Nordic countries;

2. To discuss the formation of a Nordic section of MPS.

Applications for participation and abstracts must be sent to Stein W. Wallace, Haugesund Maritime College, Skåregaten 103, N-5500 Haugesund, Norway, by April 30, 1990. For more information, please contact him at the above address, or by phone (+47 4 721200) or FAX (+47 4 715906). (e-mail is not functioning properly at this time.) It is possible to apply for partial coverage of travel costs for those who do not have other sources.

STEIN W. WALLACE

COUNCIL *from page one:*

Among the attendants were all of the members of the Council of the Mathematical Programming Society: George Nemhauser (Chairman), Michel Balinski (Past Chairman), Les Trotter (Treasurer), Egon Balas, Bill Cunningham, Claude Lemarechal, and Alexander Schrijver (Council Members-at-Large). It was therefore decided to organize a rare event– a Council meeting in between the triennial international symposia. This meeting took place on January 10 and was also attended by Bob Meyer (Chairman of COAL), Clyde Monma (Chairman of the Advisory Committee for the 1994 Symposium), Bill Pulleyblank (Editor of Series B of the Journal), Mike Todd (Past Editor of Series A of the Journal), Laurence Wolsey (Chairman of the Publications Committee), and Jan Karel Lenstra (Chairman of the Executive Committee). I will summarize the issues that were discussed below.

Meetings The 14th International Symposium on Mathematical Programming will be held in Amsterdam in 1991. You will find more about it elsewhere in this issue. In the meantime, a site for the 1994 symposium has to be selected. A call for proposals has already appeared in the previous issue of OPTIMA. Since then, the Symposium Advisory Committee has sent invitations to submit such a proposal to about 12 of our colleagues at American universities. The Council suggested that our triennial symposia might be held under co-sponsorship of SIAM; the Chairman will explore this idea.

The Society is a co-sponsor of the Conference on Integer Programming and Combinatorial Optimization that is being organized by Ravi Kannan and Bill Pulleyblank and will be held in Waterloo at the end of May 1990. The Council felt that the Society should be catalytic in this respect and encourage others who might want to organize similar meetings.

Publications Due to an overflow of papers that have been accepted for Series A of the Journal, it is difficult to avoid a large backlog for Series A while maintaining a regular publication schedule for Series B. The Council discussed several remedies. As a result, we have entered negotiations with our publisher, North-Holland. There will most likely be a substantial increase in the total annual volume of Series A over the next few years.

Committee on Stochastic Programming The Council approved of new membership of this committee: John Birge, Michael Dempster, Jitka Dupavcova (Secretary), Yuri Ermoliev, Kurt Marti, Andras Prekopa, Yves Smeers, Tomas Szantai, Roger Wets (Chair), and William Ziemba.

Membership The Council invited the Chairman to appoint a general **Membership Committee.** It will have the task of advising the Council on initiatives that could increase our membership, e.g., by the creation of geographical sections.

Egon Balas and Claude Lemarechal agreed to serve on an ad hoc **Committee for Special Membership Arrangements.** This committee will advise the Council on special arrangements for members from countries with non-convertible currencies. At present, we have an arrangement for non-paying Hungarian members, and we also received suggestions for a Soviet membership from Professors Golshtein and Levner. The Council prefers a uniform policy to arrangements on a country-by-country basis and feels that any arrangement of this kind should be financially reasonable for the Society and subject to periodic (e.g., triennial) review.

Prizes The Council decided to change the name of the **Orchard-Hays Prize** to the **Beale-Orchard-Hays Prize.** The membership of our four prize committees has already been announced in OPTIMA.

Administrative Issues The 1990 membership list will contain information (telephone and fax numbers, electronic addresses) that has recently been collected. The Council decided to give the members the option of paying their dues by credit card, but decided against the possibility of offering a three-year membership at a reduced fee.

Algorithms and the Law The Council expressed concern about the fact that the interior point approach for solving resource allocation problems has recently been patented in the U.S. and that some of these patents might misrepresent the history of our field. The Chairman was urged to appoint a **Committee on Algorithms and the Law.** This committee will be asked to investigate the situation and to advise the Council on possible courses of action.

JAN KAREL LENSTRA

Technical Reports & Working Papers

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

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.

G.L. Nemhauser, G. Sigismondi and P. Vance, *"A Characterization of the Coefficients in Facet-Defining Lifted Cover Inequalities,"* J-89-06.

G. Parker and M. Richey, *"A Cubic Algorithm for the Directed Eulerian Subgraph Problem,"* to appear in European Journal of Operations Research.

R. Rardin and C.A. Tovey, *"Test Travelling Salesman Problems of Intermediate Complexity."*

A.E. Roth and J.H. VandeVate, *"Decentralized Paths to Stability in Two-Sided Matching."*

D. Solow, R. Stone and C.A. Tovey, *"Solving LCP on Known P-Matrices is Probably not NP Hard."*

R. Stone and C.A. Tovey, *"The Simplex and Projective Scaling Algorithms as Iteratively Reweighted Least Squares Methods."*

C.A. Tovey, *"Asymmetric Probabilistic Prospects of Stackelberg Players."*

C.A. Tovey, *"The Value of Information and Cooperation in Bimatrix Games: An Average Case Analysis."*

C.A. Tovey, *"Simulated Simulated Annealing."*

C.A. Tovey, *"Simplified Anomalies and Reduction for Multiprocessor Precedence Constrained Scheduling."*

J.H. VandeVate and J. Wang, *"Question-Asking Strategies for Horn Clause Systems."*

J.H. VandeVate, *"Fractional Matroid Matchings."*

System Optimization Laboratory Operations Research Department
Stanford, CA 94305-4022

H. Hu, *"On the Feasibilty of a Generalized Linear Program,"* SOL 89-1.

H. Hu, *"Semi-Infinite Programming,"* SOL 89-2.

R.W. Cottle, *"The Principal Pivoting Method Revisited,"* SOL 89-3.

A.S. Krishna, *"Note on Degeneracy,"* SOL 89-4.

K. Zikan, *"An Efficient Exact Algorithm for the "LEAST SQUARES" Image Registration Problem,"* SOL 89-5.

A. Marxen, *"Primal Barrier Methods for Linear Programming,"* SOL 89-6.

Mathematisches Institut der Universität zu Köln Weyertal 86-90 D-5000 Köln 41
WEST GERMANY

B. Fassbender, *"A Sufficient Condition on Degree Sums of Independent Triples for Hamiltonian Cycles in 1-Tough Graphs,"* WP 89-78.

A. Bachem, A. Dress and W. Wenzel, *"Varieties on a Theme by J. Farkas,"* WP 89-73.

W. Kern, *"Verfahren der Kombinatorischen Optimierung und ihre Gültigkeitsbereiche,"* WP 89-71.

U. Faigle and W. Kern, *"A Note on the Communication Complexity of Totally Unimodular Matrices,"* WP 89-70.

A. Bachem and M. Niezborala, *"Numerische Erfahrungen bei der Vektorisierunglinearer Programmierungsalgorithmen,"* WP 89-68.

U. Faigle and W. Kern, *"Note on the Convergence of Simulated Annealing Algorithms,"* WP 89-67.

U. Faigle, W. Kern and T. György, *"On the Performance of On-Line Algorithms for Partition Problems,"* WP 89-66.

A. Bachem and A. Reinhold, *"On the Complexity of the Farkas-Property of Oriented Matroids,"* WP 89-65.

A. Bachem and W. Kern, *"A Guided Tour through Oriented Matroid Axioms,"* WP 89-64.

M. Hofmeister, *"Concrete Graph Covering Projections,"* WP 89-62.

Mathematical Sciences Technical Report Series Department of Mathematical Sciences Clemson University
Clemson, SC 29634-1907

R. Ringeisen and V. Rice, *"Cohesion Stability under Edge Destruction,"* TR 557.

R. Ringeisen and V. Rice, *"When is a Stable Graph not Stable or Are There Any Stable Graphs Out There?"* TR 557A.

E. Cockayne, B. Hartnell, S.T. Hedetniemi and R. Laskar, *"Efficient Domination in Graphs,"* TR 558.

R. Ringeisen and V. Rice, *"Cohesion Stable Edges,"* TR 559.

R. Ringeisen and C. Lovegrove, *"Crossing Numbers of Permutation Graphs,"* TR 560.

M. Kostreva, A. Aoun, N. Brown, S. Chattopadhyay, R. Guidry, T. Ordoyne and R. Zurovchak, *"Linear Complementarity Theory: 1st Generation,"* TR 561.

B. Piazza and R. Ringeisen, *"Connectivity Generalized Prisms over G,"* TR 562.

B. Piazza, R. Ringeisen and S. Stueckle, *"Properties of Non-Minimum Crossings for Some Classes of Graphs,"* TR 564.

B. Piazza, R. Ringeisen and S. Stueckle, *"On the Vulnerability of Cycle Permutation Graphs,"* TR 565.

J. Key and K. Mackenzie, *"An Upper Bound for the p-Rank of a Translation Plane,"* TR 566.

D. Shier and N. Chandrasekharan, *"Algorithms for Computing the Chromatic Polynomial,"* TR 567.

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Technical Reports & Working Papers

J. Key and K. Mackenzie, *"Ovals in the Design W(2m),"* TR 568.

P. Dearing, P. Hammer and B. Simeone, *"Boolean and Graph Theoretic Formulations of the Simple Plant Location Problem,"* TR 569.

M. Kostreva, M. Wiecek and T. Ordoyne, *"Multiple Objective Programming with Polynomial Objectives and Constraints,"* TR 571.

C. Williams, *"A Knowledge-Based Approach to Designing Experiments: Design Expert,"* TR 572.

V. Rice and R. Ringeisen, *"On Cohesion Stable Graphs,"* TR 573.

J. Boland, R. Laskar and C. Turner, *"On Mod Sum Graphs,"* TR 574.

R. Laskar, S. Stueckle and B. Piazza, *"On the Edge-Integrity of Some Graphs and Their Complements,"* TR 575.

R. Laskar, A. Majumdar, G. Domke and G. Fricke, *"A Fractional View of Graph Theory,"* TR 576.

J. Lalani, R. Laskar and S.T. Hedetniemi, *"Graphs and Posets: Some Common Parameters,"* TR 577.

M. Kostreva and M. Wiecek, *"Linear Complementarity Problems and Multiple Objective Programming,"* TR 578.

G. Isac and M. Kostreva, *"The Generalized Order Complementarity Problem,"* TR 579.

Research Initiative Program in Discrete Mathematics and Computational Analysis Clemson University

Clemson, SC 29634-1907

R. Laskar, R. Rowley, R. Jamison and C. Turner, *"The Edge Achromatic Number of Small Complete Graphs,"* URI-029.

T. Wimer, *"Linear Algorithms on k-Terminal Graphs,"* URI-030.

D.R. Shier, E.J. Valvo and R.E. Jamison, *"Generating the States of a Probabilistic System,"* URI-031.

D.R. Shier, *"The Monotonicity of Power Means Using Entropy,"* URI-032.

C. Jeffries, *"Fluid Dynamics with Pressure Diffusion,"* URI-033.

D.R. Shier and G.A. Vignaux, *"Adaptive Methods for Graphing Functions,"* URI-034.

P.J. Slater, *"A Summary of Results on Pair-Connected Reliability,"* URI-035.

C.L. Cox, *"Implementation of a Divide and Conquer Cyclic Reduction Algorithm on the FPS-T-20 Hypercube,"* URI-037.

R.E. Fennell, *"An Application of Eigenspace Methods to Symmetric Flutter Suppresion,"* URI-038.

J.A. Reneke and J.R. Brannan, *"Application of RKH Space Methods to the Filtering Problem for Linear Hereditary Systems,* URI-039.

J.A. Reneke and R.E. Fennell, *"Canonical Forms for Distributed Systems Control II,"* URI-040.

J.A. Reneke and R.E. Fennell, *"Convergence of RKH Space Simulations of Stochastic Linear Hereditary Systems,"* URI-041.

R.E. Fennell, R.E. Haymond and J.A. Reneke, *"RKH Space Simulation of Stochastic Linear Hereditary Systems,"* URI-042.

C.R. Johnson and T.A. Summers, *"The Potentially Stable Tree Sign Patterns for Dimensions Less than Five,"* URI-043.

M.E. Lundquist, *"An Implementation of the Preconditioned Conjugate Gradient Algorithm on the FPS-T-20 Hypercube,"* URI-044.

S.T. Hedetniemi, R. Laskar, E.J. Cockayne and B.L. Hartnell, *"Efficient Domination in Graphs,"* URI-045.

S.T. Hedetniemi, M.O. Albertson, R.E. Jamison and S.C. Locke, *"The Subchromatic Number of a Graph,"* URI-046.

K.R. Driessel, *"On Isospectral Surfaces in the Space of Symmetric Tridiagonal Matrices,"* URI-047.

P.J. Slater and D.L. Grinstead, *"On Minimum Dominating Sets with Minimum Intersection,"* URI-048.

W.H. Ruckle, *"Abstract of the Linearizing Projection, Local Theories,"* URI-049.

W.H. Ruckle, *"On Win-Lose Draw Games,"* URI-050.

W.H. Ruckle, *"Computer Studies of Coalition Formation Under Varying Dynamics,"* URI-051.

R.J. Lakin, *"State Space Approximation of a Multimode-Component System,"* URI-052.

E.O. Hare, S.T. Hedetniemi, R.C. Laskar and G.A. Cheston, *"Simplicial Graphs,"* URI-053.

G.S. Domke, S.T. Hedetniemi and R.C. Laskar, *"Fractional Packings, Coverings, and Irredundance in Graphs,"* URI-054.

M.M. Kostreva, *"Recent Results on Complimentarity Models for Engineering and Economics,"* URI-055.

S.T. Hedetniemi, G.A. Cheston, A. Farley and A. Proskurowski, *"Spanning Trees with Specified Centers in Biconnected Graphs,"* URI-056.

J.D. Trout, Jr., *"Vectorization of Morphological Image Processing Algorithms,"* URI-057.

J.P. Jarvis, D.E. Whited and D.R. Shier, *"Discrete Structures and Reliability Computations,"* URI-058.

C.L. Cox, *"On Least Squares Approximations to First Order Elliptic Systems in Three-Dimension,"* URI-059.

G.S. Domke, S.T. Hedeniemi, R. Laskar and G. Fricke, *"Relationships Between Integer and Fractional Parameters of Graphs,"* URI-060.

W.P. Adams and P.M. Dearing, *"On the Equivalence Between Roof Duality and Lagrangian Duality for Unconstrained 0-1 Quadratic Programming Problems,"* URI-061.

J.A. Reneke and M. Artzrouni, *"Stochastic Differential Equations in Mathematical Demography: A Review,"* URI-062.

S.T. Hedetniemi and N. Chandrasekharan, *"Fast Parallel Algorithms for Tree Decomposing and Parsing Partial k-Trees,"* URI-063.

B.B. King, *"The Dynamics of the Motion of a Filament: A Survey of the Literature,"* URI-064.

W.H. Ruckle, *"A Discrete Game of Infiltration,"* URI-065.

R. Geist and S. Hedetniemi, *"Disk Scheduling Analysis via Random Walks on Spiders,"* URI-066.

BOOK REVIEWS

Theory of Suboptimal Decisions

By A. A. Pervozvanskii and V. G. Gaitsgori
Kluwer, Dordrecht 1988
ISBN 90-277-2401-6

This is a research monograph concerned with large and complex optimization systems, too large to deal with analytically or numerically. For such systems the notion of optimality is often dubious, and it is usually furnished by the systems analyst or the decision maker rather than the mathematician. In these situations, insisting by all means on "optimality" may not be justified. An alternative is to use a more realistic and "relaxed" approach by exploiting the inner structure of the system, such as the "strong" and "weak" bonds between its various subsystems. It appears that in many practical models, after neglecting the weak bonds, the strong ones recover a simpler system that can be solved by, e.g., aggregation or decomposition. These solutions are the "suboptimal decisions." Their theory, and the ways of calculating and improving them in relation to the unknown "optimal" solution of the original complex problem, is the main theme of this book. A method for improving suboptimal solutions is the "perturbation method."

Let us illustrate the method in a simple and ideal situation. Consider a linear program $(L, \varepsilon) : Max\ \{c^{\circ} + \varepsilon c^{1} : (A^{\circ} + \varepsilon A^{1})x = b^{\circ} + \varepsilon b^{1}, x \geq 0\}$ for some $\varepsilon > 0$. Suppose that the program is large and complex, so we do not know its optimal solution $x(\varepsilon)$ and its optimal value $f(\varepsilon)$. However, suppose that its "reduced" program (L,0) is easy to solve for $x(0)$. If this suboptimal $x(0)$ is a unique and nondegenerate basic solution, and if the solution $\lambda(0)$ of dual of (L,0) is also unique, then for all "sufficiently small" $\varepsilon > 0$ we have the expansion

$$x(\varepsilon) = x(0) + \varepsilon x^{(1)} + \ldots + \varepsilon^{m} x^{(m)} + O(\varepsilon^{m+1}).$$

Here the basic components of $x^{(k)}$ are given recursively by

$$x_B^{(1)} = -(A_B)^{-1}(A^1 x(0) - b^1)$$
$$x_B^{(k+1)} = -(A_B)^{-1} A^1 x^{(k)}, \quad k = 1,2,\ldots,m-1$$

while all nonbasic components are zero. (Here A_B is a submatrix of A° consisting of the basic vectors.) Also

$$f(\varepsilon) = f(0) + \varepsilon[x^T(0)c^1 + \lambda^T(0)b^1 - \lambda^T(0)A^1 x(0)] + O(\varepsilon^2).$$

For example: $Max\{1.3x_1 - x_2 : 1.1x_1 + 0.2x_2 = 1, x_1 \geq 0, x_2 \geq 0\}$ is a realization of $Max\{(1 + 3\varepsilon)x_1 - x_2 : (1 + \varepsilon)x_1 + 2\varepsilon x_2 = 1, x_1 \geq 0, x_2 \geq 0)$ at $\varepsilon = 0.1$. The basic part of the exact solution, for small $\varepsilon > 0$, is (for $m = 2$) : $x_B(\varepsilon) = 1 - \varepsilon + \varepsilon^2 + 0(\varepsilon^3) = 0.90909.\ldots$ Here the basic part of the suboptimal solution $x_B(0.1) = 0.91$ is obtained from the above recursive formulae after solving the simple reduced program: $Max\{x_1 - x_2 : x_1 = 1, x_2 \geq 0\}$.

If the primal or the dual are not unique, then the expansions are made around particular optimal solutions obtained after solving "auxiliary" programs such as $Max\ x^T(0)(c^1 - (A^1)^T\lambda(0))$ over all optimal solutions $x(0)$ of $(L,0)$. Of course, the above ideas work only if the reduced program is relatively simple to solve and if the original program (L,ε) is locally stable at $\varepsilon = 0$ relative to $\varepsilon > 0$. The perturbation method is formulated for linear and then extended to convex programs. By "stability" the authors mean continuity of the optimal value function $f(\varepsilon) \to f(0)$ and (in the case of uniqueness) $x(\varepsilon) \to x(0)$ as $\varepsilon \to +0$. If this fails, then the programs are "singularly perturbed." For such convex models

$$Min\{f^0(x) + \varepsilon f^1(x) : g^0(x) + \varepsilon g^1(x) \leq 0\} = f(\varepsilon)$$

another "auxiliary" program is constructed by adding constraints of the type $v^T g^1(x) \leq 0$, where v is an extreme ray of the unbounded set of Lagrange multipliers. The new feasible set is now smaller but, since some "badly behaved" constraints are replaced by "nice" perturbations, one may still obtain convergence $f(\varepsilon) \to f^*(0)$ and $x(\varepsilon) \to x^*(0)$ as $\varepsilon \to +0$ and reformulate the perturbation method. (The asterisk refers to the optimal value and the optimal solution of the reduced auxiliary program.)

The book has six chapters. The first four deal with the sûboptimal decisions and the perturbation method for finite-dimensional programs. In the last two, the ideas are extended to models that include differential equations in the constraints. Although the optimal solution is now often available (say in linear-quadratic problems of optimal control), the perturbation method, in addition to providing information about the robustness of optimal solutions, allows one to obtain simpler control designs which are, as a rule, more reliable. The method also shows how to avoid numerical difficulties if the algebraic Riccati equation is large. Particularly interesting is a study of the relationship between singularity and loss of controllability and/or observability.

This reviewer has partly used the book in a graduate course on optimization attended by mathematicians and operations researchers. Although the evidence of efficiency of the perturbation method for nonlinear programs was not convincing after three months of numerical experimentation, the students have found the topics provocative and intriguing. (The difficult question of how far one can stretch $\varepsilon > 0$ from $\varepsilon = 0$ to retain stability has cropped up repeatedly and, typically, it could not be answered.) The selection of applications of both stable and singularly perturbed programs is nonstandard, original and, in fact, remarkable. It ranges from optimization problems in input - output analysis, interregional transportation problems and Markov programming (here we find examples of "real life" singularly

CONTINUES

perturbed programs) to the engineering examples of suboptimal regulator syntheses including linear models for continuous technological control problem and ecological system control.

The book is a revision of a Russian text that was published in 1979. During the last 10 years there has been significant progress made in parametric optimization that does not appear to have been closely followed by the authors. No reference has been made in the book to the school of parametric optimization from and around von Humboldt University (Nozicka, Bank, Guddat, Klatte, Kummer, Tammer), and no recent results on sensitivity by several other important contributors (e.g., Fiacco, Gal or Robinson) are mentioned. Had the authors used point-to-set mappings and lower semicontinuity of the feasible-set mapping in the definition of stability, their presentation would have been more unified and smoother. Indeed, many of their results can be readily extended to vector perturbations over "regions of stability." The English translation is not always precise, and this occasionally creates ambiguities (e.g., the claim: "For convex programs the existence of a Lagrange vector appears to be sufficient condition of optimality" or "... there exists an interior point of the feasible domain, i.e., the Slater conditions are fulfilled ..." on p. 38; the former is a sufficient condition for optimality and the latter claims are not equivalent).

Prerequisites for reading most of the book are standard undergraduate courses in real analysis and linear algebra, plus the essentials of linear and nonlinear programming. The last two chapters require some familiarity with control theory. The book is of interest to applied mathematicians, operations researchers, and electrical engineers, to both the students and the researchers. In summary, this is an original and interesting book with many fresh ideas that excite the reader and reassure him that one can still do useful and mathematically sound, but not too technical, research in optimization.

The book appears in the new "Soviet Series" Mathematics and Its Applications program and comes from the IIASA group. This program is devoted to new emerging (sub) disciplines and their interrelationships. The idea is to publish books "which are stimulating rather than definitive, intriguing rather than encyclopedic". The editor Hazewinkel could not have made a better choice than including this book in the series.

S. ZLOBEC

Theoretical and Computational Aspects of Simulated Annealing

By P. J. M. van Laarhoven
CWI Tract 51, Amsterdam, 1988

During the last several years, simulated annealing (a certain kind of randomized local search procedure) has become a popular tool for approximately solving large scale discrete optimization problems. The present book on simulated annealing is, to my knowledge, the second one that has been written on that topic. The first one, *Simulated Annealing: Theory and Applications*, was written by the author of the present book, together with E. L. Aarts, and published by D. Reidel Publishing Company in 1987, only one year before the second one. Thus one may ask whether it was necessary to present a new book on this subject after such a short period of time. To answer this question, of course, one has to compare the two.

Firstly, the present tract is a slightly revised version of the author's doctoral thesis (supervised by J. K. Lenstra and A. Rinnooy Kan), whereas the first one is a monograph on simulated annealing, written for a much more general audience (including physisists, electrical engineers, but not biologists, according to what the authors state in the preface). As a consequence, the present book by Laarhoven concentrates on his own results rather than presenting a survey of what has been done in the field by other researchers. The basic theory of simulated annealing (conditions for convergence to optimality) is not treated in depth in either of the two books. Proofs are omitted except for the simplest version of the convergence theorem in the homogeneous case. The main concern of the present tract is the (theoretical) analysis of cooling schedules which do not satisfy the theoretical conditions for convergence to optimality but are likely to yield good results in practice. Rules for choosing the cooling schedule are obtained by estimating certain parameters of the optimization problem at hand, using Bayes' Theorem and rather involved mathematical machinery. Applications and computational results are presented in order to compare different cooling schedules and to support the theoretical estimates.

WALTER KERN

Biological Delay Systems: Linear Stability Theory

Cambridge Studies in Biology: 8
by N. MacDonald
Cambridge University Press, Cambridge, 1989
ISBN 0-521-34084-5

This excellent book gives a survey on the most important methods and results of the theory of delay equations arising from biological control systems. The special structure of the considered delayed differential equations is very well motivated by striking examples. A large part of the book is dedicated to mathematical modelling and description of the following biological systems: neurophysiology of the retina, insect maturation times, maturation of blood cells, population models, incubation times in the epidemiology, Neuron interaction, chemostat models like the Monod model and others. These models are not an a-posteriori justification for the development of an abstract "oversized" theory but the a-priori motivation for the development of mathematical tools that work in the concrete situations arising from mathematical biology. The concept of the book is influenced by the work of K. L. Cooke. The intended application in biological control does not require the embedding of delay equations in the wider class of general functional differential equations that one finds in the work of J. K. Hale.

The book is essentially concerned with local, or linear, stability analysis. This requires the linearization about a fixed point and the study of the roots of a certain algebraic equation, the so-called characteristic equation of the system, which is analogous to the characteristic equation in ordinary differential equations. The stability analysis requires the localization of roots with negative real parts. This motivates the intensive study of Hurwitz polynomials. In the field of discrete delay, where the change of the state of the system at time t is affected by terms depending on t-T, the book treats first- and second-order systems as well as higher-order systems and systems with two delays. Moreover, one finds an extended section on distributed delay where the present state of the system at time t is affected by an integral over all past states of the system. One also should mention the independent and commensurate delays as well as reducible delays and the role of linear subsystems.

The motivation and the presentation of the mathematical topics are of excellent clarity. Every chapter is followed by many informative exercises, with solutions given in an appendix. Thus, this volume will be an excellent textbook for any graduate course on delay equations, and it easily can be used for private studies. In general, this outstanding book can be recommended strongly for students at the graduate level and for research workers in mathematical biology and control theory.

J. WEYER

Algorithms–The Construction, Proof, and Analysis of Programs
by P. Berlioux and P. Bizard
Wiley, Chichester, 1987

The concern of this book is to help the reader to write correct programs. In every science, it is well known that any number of examples will never prove a theory; testing a program may show that it contains bugs, never that it is correct. There is a unique way to guarantee the value of a program, to prove that it is correct from its text (it will remain to guarantee that no typing error has been made when entering it in the computer).

The first chapter gives the theoretical foundations of formal program proofs, using Floyd's inductive assertions and Hoare's formalization. The authors emphasize the fact that the result is not really satisfactory, a lot of derivations for a very short and trivial program! The proof could be simplified using less formal tools, as it is usually done in mathematics. But even with less convincing proofs, the problem remains to discover a loop invariant to start the proof.

The answer is well known; instead of proving a program once it has been written, start its design from its proof. The construction of a loop begins with the proposal of a loop invariant. Several classical examples are proposed to illustrate this method. The resulting programs are analyzed and, in some cases, improved along the line suggested by the analysis. The authors give a good bibliography of previous works on this programming method.

The effect of assignments are discussed, introducing the concepts of weakest preconditions or strongest postconditions. The effects of indexing and pointers are discussed. Procedure calls are taken into account. This is a very deep review of essential programming features.

In the second part of the book recursion is considered. Induction is the keyword. The authors show how a recursive procedure can be proven to be correct by induction and how it can be analyzed, the recursive procedure giving an inductive or implicit definition of the number of operations which can be solved using ordinary mathematical ways. We have here the same situation as with iterative programming. It is better to start with the proof of the program (an inductive relation on the function to compute, a special case of explicit definition) to build the program rather than first writing it, then trying to prove it. Pertinent nontrivial examples are given to illustrate this method.

Finally, the authors consider one of the methods which have been proposed to transform recursion into iteration and its use to derive iterative programs from recursive definitions, with some efficiency concerns.

This book has been written for people having some experience in programming. It emphasizes the fact that program construction starts with the proposal of what can be called "a recurrence hypothesis" (loop invariant for iterative programming, recurrence relation for recursive programming). It does not consider where this hypothesis comes from. Like most programming books, building a program starts with something like, "Assume that we have been able to do that...." The questions remain: Why such a choice? Are you sure it is the best? How did you find it? This is especially clear with towers of Hanoi, "If n> 1, we begin by transferring a tower of height n-1 from rod A to rod C, using B as an intermediary." Why do you do that? Without an answer to this question, it is not clear that the resulting program is the best possible one.

Nevertheless, it is clear that the most difficult disk to move is the biggest one. It can be moved only if there is no other disk on it, so the n-1 other disks must be somewhere else, on the two other rods. If so, we can take this disk off of its rod, but we can put it on another rod only if this rod is empty. Thus the n-1 other disks must be on the third rod, and there is no other possible solution. A slightly different presentation gives a quite different result. The same remark is true for some other programs of the book. For instance, the binary search can be written in a simpler way, without extra tests before entering the loop.

CONTINUES

This book is not a book on how to invent a new program. It is a good textbook on some methods now available to construct correct and efficient programs, assuming that you have some idea of the method to be implemented. It is clear, well-written, well-documented and deep enough. There are many examples which are not all toy examples. This book is certainly worthwhile for any programmer or informatics student who wishes to know what is meant by program correctness, program efficiency or transformation of recursion into iteration without going into a lot of unnecessary details. It will not provide all the ways presently available to build, analyze, transform, or improve a program, but it will introduce the reader to this wide new area, the science of programming.

JACQUES ARSAC

Introduction to Optimization

by E. M. L. Beale
Edited by L. Mackley
Wiley, Chichester, 1988
ISBN 0-471-91760-5

"The book is based upon a series of lecture notes written by Professor E. M. L. Beale for his undergraduate course 'Introduction to Optimization,' given at Imperial College where he was a Visiting Professor in Mathematics from 1967 until his death in December 1985." /Lynne Mackley./

In this book the emphasis is put more on methods, algorithms and the practical problems of why and how methods succeed or fail, rather than on deep theory and rigorous proofs. As it contains different applications of optimization in industry and many suggestions for choosing efficient numerical procedures for solving concrete optimization problems, this book could be highly recommended to engineers having to solve practical optimization problems. Moreover, it would be a very good introduction for beginners in this area.

The book is divided into three parts. The first part, "Unconstrained Optimization" (chapters 2-4), is concerned with the main techniques for solving problems both for functions of one-variable and multivariable. Chapter 2 starts with considering the unconstrained optimization of functions of continuous variables and reviews iterative and valley-descending methods. Chapter 3, One-dimensional Optimization, describes a popular approach to solving this problem, i.e. Newton's method, the bisection, the method of false position and its modification. A Wijngaarden's method which uses both linear interpolation and bisection is recommended. Finally, some insight into the sort of ideas that go into development of optimization algorithms is given. Chapter 4 is about multi-dimensional optimization. It clearly explains why there is no single method which is effective for all problems of this type, resulting in a vast literature on numerical methods for unconstrained optimization of functions of n variables. Most of this chapter applies to finding local optima of functions that are twice differentiable.

The methods used to solve linear programming problems and applications of linear programming in industry are treated in the second part "Constrained Optimization: Linear Programming" (chapters 5-9). Chapters 5 and 6 describe the simplex method for linear programming and give the basic steps of the revised simplex method (also known as the inverse matrix method). The efficient modelling and systematic documentation of linear programming problems are reviewed here. Duality and its applications, dual simplex method and examples are studied in detail in Chapter 7. This chapter also deals with parametric programming in two basic forms, variation of the objective function and variation of the right-hand side. Chapters 8 and 9 answer the question of how to apply linear programming problems in industry.

Nonlinear, discrete and dynamic programming are the topics of the third part (chapters 10-12). Chapter 10 is concerned with nonlinear programming. It starts by reviewing the basic theory of optimization, i.e. Lagrange multipliers and the Kuhn-Tucker conditions and then presents two methods which are in practical use. The first is based on the concept of separable programming and the other on the reduced gradient method. Classical approaches to integer programming and its potential difficulties are discussed in Chapter 11. The cutting plane method and the branch and bound methods are discussed as general strategies, and a simple example makes the presentations clear. Chapter 12 discusses dynamic programming as an alternative to integer programming for some problems in combinatorial optimization. The art of dynamic programming formulation is illustrated with a shortest-route problem. In general, this part shows how the techniques of linear programming can be applied to solve nonlinear and discrete optimization problems.

ANNA RYCERZ

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CONTRIBUTIONS for a Mixed Integer Programming library of test examples are invited by Peter Conrad and Prof. R.C. Daniel, Univ. of Buckingham, Buckingham, MK18 1EG, England, Telephone: (0280) 81408. ¶Prof. Dr. Reiner Horst, Universität Trier, Postfach 3825, 5500 Trier, FRG, has issued a call for papers for a new Journal of Global Optimization to be published beginning in 1991. ¶AIRO'90, the annual Conference of the Operational Research Society of Italy, will be held in Sorrento, Oct. 3-5, 1990. Contact Prof. Antonio Sforza or the Secretariat, Instituto di Fisica, Matematica e Informatica, Facoltà di Ingegneria, Università di Salerno–84084 Fisciano (Salerno), Tel. +39-89-822233/822424. ¶Deadline for the next OPTIMA is June 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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