OPTIMA

Nº 32

MATHEMATICAL PROGRAMMING SOCIETY NEWSLETTER March 1991

Amsterdam 1991

Beyond the bounds of the conference, visitors will be rewarded by a sampling from Amsterdam's overflowing agenda.

Symposium

THIS YEAR's **International Symposium on Mathematical Programming** is being held in Amsterdam, the capital of the Netherlands. The meeting runs from August 5 to 9, 1991 and is being jointly organized by CWI, the University of Amsterdam, Eindhoven University of Technology, Erasmus University Rotterdam, Free University Amsterdam, and Tilburg University.

The opening session is on Monday August 5 at 10 a.m. Here the Mathematical Programming Society will award the ***Fulkerson Prizes*** for outstanding papers in discrete mathematics (jointly with AMS), the ***George B. Dantzig Prize*** for original research with a major impact on mathematical programming (jointly with SIAM), the ***Beale–Orchard-Hayes Prize*** for excellence in computational mathematical programming, and the ***A.W. Tucker Prize*** for an outstanding paper by a student. The session will be completed with a plenary opening address by W.R. Pulleyblank (Yorktown Heights/Waterloo).

The remainder of the meeting is comprised of invited one-hour lectures as well as invited and contributed thirty-minute presentations. These will focus on theoretical, computational and practical aspects of mathematical programming. The committee has selected June 1, 1991 as the deadline for submission of abstracts so as to facilitate the presentation of current and ongoing research. In addition, there will be two special sessions in memory of Robert G. Jeroslow and Darwin Klingman.

The series of invited one-hour lectures will include E.H.L. Aarts (Eindhoven), R.E. Bixby (Houston), V. Chvátal (New Brunswick), A.R. Conn (Yorktown Heights/Waterloo), T.M. Cook (Dallas), J.E. Dennis, Jr. (Houston), C.C. Gonzaga (Rio de Janeiro), M. Grötschel (Augsburg), R.M. Karp (Berkeley), A.V. Karzanov (Moscow), K. Kennedy (Houston), L.G. Khachiyan (Moscow/New Brunswick), C. Lemaréchal (Rocquencourt), C.H. Papadimitriou (San Diego), D.F. Shanno (New Brunswick), and R.E. Tarjan (Princeton).

The official activities of the symposium take place in the heart of the city and thus enjoy as a backdrop the charm of its canals. Although the first settlements in Amsterdam date back to the 13th century, most of the early (wood) buildings have been

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NOTICE

Nominations invited for 1991 Elections

The Constitution of the Mathematical Programming Society sets the term of office for all officers of the Society at three years. Elections for all offices (Chairman, Treasurer, and four at-large members of the Council) are to be held four months prior to each triennial International Symposium. The fourteenth Symposium will be held in Amsterdam, August 5-9, 1991, so the next election will be held in April 1991. The new members-at-large of the Council will take office at the time of the Symposium, while the Chairman-elect and Treasurer-elect will take office one year later.

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Amsterdam 1991
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destroyed by fire. What exists now is a living museum of well-preserved 17th century architecture. This period of Dutch history was known as the Golden Age and witnessed the growing importance of Amsterdam as a center of international trade. The best mode of sightseeing is the stroll. Though first-time visitors can easily become lost (the streets and canals shift between polar and rectangular coordinates), this can also provide an interesting strategy for getting to know the environment. Along with being home to much of the business sector, the center also houses 300,000 inhabitants, and Amsterdam is rare in that first-level dwellers are eager to give the passerby a glimpse of their residences. A different perspective of the city is gained from one of the several boat tours (including an evening dinner cruise). The boats meander through the canals while a guide divulges an impressive amount of information in a handful of languages.

The Symposium, apart from the lectures themselves, has always been a time for informal discussions amongst colleagues and potentially for beginning new research directions. The meeting rooms of Amsterdam are its cafés and pubs, varying from the intimate two-table Belgian café to the art deco splendor of Café Americain. The facilities are extensive–approximately one establishment to each participant. There is also an admirable selection of restaurants for the evening meal. Depending on the mood, dinner may be the traditional Indonesian *rijsttafel*, French cuisine served in a post-modern atmosphere, or a meal at one of several vegetarian restaurants.

Beyond the bounds of the conference, visitors will be rewarded by sampling from Amsterdam's overflowing agenda. Possibilities range from the chaotic Waterlooplein flea market to the English theater or an evening in arguably the world's most famous concert hall, the Concertgebouw. Jazz aficionados will also not be disappointed, with a variety of venues that includes the reputed *Bimhuis* which has hosted such greats as Charles Mingus and Dexter Gordon. This is not to imply that pop, reggae, African, salsa or blues are overlooked. One need only check the local paper *De Uitkrant* for a list of performances, many of which are free.

Amsterdammers are understandably proud of their many museums, and a visit to the city should at least include time to enjoy the work of the Dutch Masters in the Rijksmuseum (home of Rembrandt's Nightwatch) and the collection in the Van Gogh Museum. The Rijksmuseum is also of interest in that the works on display provide a pictorial history of the streets through which you will wander. Today, the rich tradition of visual art in the Netherlands is continued by its many living artists, whose work can be viewed in a staggering abundance of small galleries located throughout the city. A high density of these is found in the Kerkstraat and Spiegelstraat where galleries are interspersed with exclusive antique shops.

For those extending their visit or travelling with family, there are a number of worthwhile day trips near Amsterdam. Destinations include Delft, Gouda, the medieval wall surrounding Naarden, as well as the coast, which is a thirty-minute journey by train. Another popular outing is to the Kröller-Müller museum. This is located in a wildlife reserve outside Arnhem and is well suited to being explored as a biking and picnic trip. The museum itself has a fine collection of many styles; two of the highlights are its sculpture garden and Theo Van Gogh's collection of his brother's work.

Flights to Amsterdam arrive at Schiphol Airport. Taxis to the center cost about fifty *gulden*, but there are also frequent connections to the Centraal Station using the excellent national train system. The train costs about five gulden and takes approximately twenty minutes; from Centraal Station one may then take a taxi or tram, or walk to the hotel. There is no need for a car during the conference as everything is within walking distance.

REGISTRATION MATERIAL FOR THE CONFERENCE CAN BE OBTAINED BY WRITING TO:

14th International Symposium on Mathematical Programming
c/o NOVEP, Paulus Potterstraat 40
1071 Amsterdam, The Netherlands
Telephone +31-20-6752120
fax +31-20-6628136
e-mail ismp@swi.psy.uva.n l.

The deadline for early registration is April 1.
Registration fees for members and non-members are, respectively, NLG 240 and NLG 300. These increase by NLG 100 after the deadline. The fees for non-members also include membership to the Mathematical Programming Society. Student fees are one half of the above rates.

On behalf of the organizers, I cordially invite you to attend the Symposium. I am certain that the participants will find the meeting productive and memorable.

–BRUCE SHEPHERD

1991 Nominations
CONTINUED

It further states that the Chairman is to invite nominations. Candidates must be members of the Society. They may be proposed either by Council or by any six members of the Society. No proper nomination may be refused, provided the candidate agrees to stand. The Chairman decides the form of the ballot. It also states that the Council shall pass by-laws governing elections designed to promote international representation on the Council.

Accordingly, the Council has agreed to the following procedure:

(1) *Nomination to any office is to be submitted to me by April 1, 1991.*

Such nomination is to be supported in writing by the nominator and at least five other members of the Society.

(2) *In keeping with what seems to have become a tradition, the membership is asked to give preference to nominees who are not from North America.*

(3) *When the ballots are counted, the four at-large candidates for Council receiving the highest number of votes will be elected, except that not more than two members having permanent residence in the same country may be elected.*

G. L. Nemhauser
Chairman 1989-1991
Department of Industrial and Systems Engineering
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Some Comments on Notation for Quasi-Newton Methods

W.C. Davidon, R.B. Mifflin and J.L. Nazareth†*

Abstract

In this informal note, we propose a notation and terminology for quasi-Newton methods for nonlinear minimization. We do not intend that our proposed notation be definitive. Rather, our aim is to provide a starting point for discussion by other researchers in the field in the hope that a more usable notation will evolve.

Introduction

A recent visit to Washington State University by Bill Davidon provided the opportunity for us to discuss the conflicting and sometimes confusing notation used to describe quasi-Newton methods for nonlinear minimization. For example, the symbol H is often used in the literature to denote the ***true*** Hessian matrix of second partial derivatives; at other times H is used to denote a quasi-Newton *approximation* to the Hessian, and on yet other occasions it is used to denote a quasi-Newton approximation to the *inverse* Hessian matrix. The symbol B is used by many to denote a quasi-Newton approximation to the Hessian matrix. This conflicts with H, and it also seems inappropriate to use an unsymmetric letter to denote a symmetric matrix. The terminology of quasi-Newton updates, for example, DFP-update, BFGS-update, PSB-update, has grown haphazardly to the point that Dennis and Schnabel [3] call it a form of "alphabet-soup" in the preface of their book.

Various authors, for example, Dennis and Tapia [4], Dennis and Schnabel [3], have tried to propose remedies for this unfortunate state of affairs. However, since their suggestions have not fully taken root, we begin afresh. We do not intend for our proposed notation to be definitive. Rather, we hope to provide a starting point for discussion in the hope that a more usable notation will evolve. In order to better the chances of acceptance, we have also focused on a few items and not sought to be comprehensive.

Proposed Terminology and Notation

We suggest the term *quasi-Newton* be used as a *generic* name for the entire class of methods that rely on the quasi-Newton (or secant) relation. The subset of methods for which *positive definite* approximations to the Hessian are made will be termed *variable metric* methods, because they provide a natural choice of preconditioner or metric. When the approximations are permitted to be *indefinite*, then the associated methods will be called *secant* methods. Thus, variable metric methods [2] are a subset of secant methods, and, collectively, variable metric and secant methods may be termed quasi-Newton methods.

Denote the step from the iterate $\mathbf{x}$ to the next iterate $\mathbf{x}_+$ by $\mathbf{s}$, i.e., $\mathbf{s} = \mathbf{x}_+ - \mathbf{x}$. Denote the gradients at the points $\mathbf{x}$ and $\mathbf{x}_+$ of the function $f(\mathbf{x})$ being minimized by $\mathbf{g}$ and $\mathbf{g}_+$, respectively. Denote the change of gradient corresponding to the step $\mathbf{s}$ by $\mathbf{y}$, i.e., $\mathbf{y} = \mathbf{g}_+ - \mathbf{g}$. Thus, for example, when the line search that determines step $\mathbf{s}$ is exact, we have $\mathbf{g}_+^T\mathbf{s} = 0$.

Denote the approximation to the Hessian matrix by M, and the approximation to the *inverse* Hessian matrix by W. Note that M is natural for Matrix and that the letter W is close to the symbol M inverted. Also, both M and W are symmetric letters, which is appropriate, because they denote symmetric matrices.

Define the three scalars,

$$a = \mathbf{s}^T M\mathbf{s}, \qquad b = \mathbf{y}^T\mathbf{s}, \qquad c = \mathbf{y}^T W\mathbf{y}. \tag{1}$$

Assuming a, b and c are nonzero, define the two vectors,

$$\mathbf{m} = \frac{\mathbf{y}}{b} - \frac{M\mathbf{s}}{a} \tag{2}$$

$$\mathbf{w} = \frac{\mathbf{s}}{b} - \frac{W\mathbf{y}}{c} \tag{3}$$

so that $\mathbf{m}^T\mathbf{s} = 0 = \mathbf{w}^T\mathbf{y}$.

Define the two matrices

$$M_+(0) = M - \frac{M\mathbf{s}\mathbf{s}^T M}{a} + \frac{\mathbf{y}\mathbf{y}^T}{b} \tag{4}$$

$$W_+(0) = W - \frac{W\mathbf{y}\mathbf{y}^T W}{c} + \frac{\mathbf{s}\mathbf{s}^T}{b}. \tag{5}$$

For each value of the parameters μ and ν, define the Broyden [1] family of updates,

$$M_+(\mu) = M_+(0) + \mu a\,\mathbf{m}\mathbf{m}^T, \tag{6}$$

$$W_+(\nu) = W_+(0) + \nu c\,\mathbf{w}\mathbf{w}^T. \tag{7}$$

Note that the matrices $M_+(\mu)$ and $W_+(\nu)$ satisfy the quasi-Newton equations $M_+(\mu)\mathbf{s} = \mathbf{y}$ and $W_+(\nu)\mathbf{y} = \mathbf{s}$ for all values of μ and ν.

The symbol $\mathbf{m}$ for the vector in (6) is very natural in association with M and the symbol μ is Greek for 'm'. The symbol $\mathbf{w}$ for the vector in (7) again goes naturally with W. The letter ν follows μ in the Greek alphabet and is, therefore, a natural and easily remembered choice for the parameter in the family of inverse updates (7). (So many conflicting symbols have been used in the literature for these two parameters that we feel a fresh choice is required.)

Note that the BFGS-update of M and W yields $M_+(0)$ and $W_+(1)$, respectively, and that the DFP-update of M and W yields $M_+(1)$ and $W_+(0)$, respectively. The foregoing notation makes it possible to dispense entirely with names that are mainly of historical interest. For instance, the BFGS and DFP updates could be termed the "M-zero" and "W-zero" updates, respectively. Also, based on personal taste, a researcher may prefer variants that retain some of the historical terminology, but remain within the general guidelines of the notation

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proposed here. For example, one could substitute M_+^B for $M_+(0)$ and W_+^D for $W_+(0)$. The inverses of these quantities can then be denoted by W_+^B and M_+^D, respectively. If $M_+(\mu)$ and $W_+(\nu)$ are found to be cumbersome, one could substitute M_+ and W_+, respectively. An iteration subscript can be attached to all symbols as needed, for example, M_k, $\mathbf{w}_k$, a_k, $M_{k+1}(\mu)$, $M_{k+1}(0)$, M^B_{k+1}. (Note that k+1 replaces + and k is used otherwise.) We have used bold-face letters in this note to distinguish vectors from scalars and matrices, but this convention can easily be dropped. It can prove to be a nusiance when word-processing an article, and some may not care for the appearance of bold-face letters in formulae. In addition to the commonly used symbols $\mathbf{x}$ (or x), $\mathbf{g}$ (or g), $\mathbf{s}$ (or s) and $\mathbf{y}$ (or y), the symbols M, W, $\mathbf{m}$ (or m), $\mathbf{w}$ (or w), μ, ν, a, b, and c form the mainstay of the notation proposed here, and it is these symbols that we hope researchers will choose to adopt.

We now give a few useful identities that also serve to illustrate the notation.

If M is positive definite with inverse W, then $b^2 < ac$ if and only if $\mathbf{y}$ and $M\mathbf{s}$ are linearly independent. If $ac=b^2$, then $\mathbf{m} = \mathbf{0}$ and the entire Broyden family for approximating the Hessian reduces to $M_+(0)$. Similarly, $\mathbf{w} = 0$, and the entire Broyden family for approximating the inverse Hessian matrix reduces to $W_+(0)$.

If $WM = I$, then

$$\mathbf{m}^T\mathbf{w} = (b/ac) - (1/b), \qquad (8)$$

$$M_+(\mu)\mathbf{w} = -(\mu\,(a/b)+(1-\mu)(b/c))\,\mathbf{m}, \qquad (9)$$

$$W_+(\nu)\,\mathbf{m} = -(\nu\,(c/b)+(1-\nu)(b/a))\,\mathbf{w}, \qquad (10)$$

and

$$W_+(\nu)M_+(\mu) = I+((1-\mu)(1-\nu)b - \mu\nu ac/b)\,\mathbf{w}\mathbf{m}^T. \qquad (11)$$

Thus, if $WM = I$, and $\mathbf{w}\mathbf{m}^T$ is nonzero,

$$W_+(\nu)M_+(\mu) = I \text{ if and only if } (1-\mu)(1-\nu)\,b^2 = \mu\nu ac. \qquad (12)$$

Also, under the same assumptions, the value of μ which makes $M_+(\mu)$ singular equals the value of ν which makes $W_+(\nu)$ singular, namely, $b^2/(b^2-ac)$.

Finally, we have the following two results concerning determinants:

$$\det(M_+(\mu))/\det(M) = \mu(c/b)+(1-\mu)(b/a), \qquad (13)$$

and

$$\det(W_+(\nu))/\det(W) = \nu(a/b)+(1-\nu)(b/c). \qquad (14)$$

The following chart gives specializations of these results:

Update	μ	ν	$\det(M_+(\mu))/\det(M)$	$\det(W_+(\nu))/\det(W)$
DFP	1	0	c/b	b/c
BFGS	0	1	b/a	a/b
SR1	$b/(b-a)$	$b/(b-c)$	$(c-b)/(b-a)$	$(b-a)/(c-b)$

(15)

where SR1 denotes the symmetric rank-1 update.

For a further illustration of the use of our proposed notation, see Nazareth and Mifflin [5].

References

[1] Broyden, C.G (1970), "The convergence of a class of double-rank minimization algorithms," Parts I and II, *J.I.M.A.*, Vol 6, pp. 76-90, 222-236.

[2] Davidon, W.C. (1959), "Variable metric methods for minimization," Research and Development Report ANL-5990 (Rev.), Argonne National Laboratory, Argonne, Illinois. (reprinted in *SIAM J. Optimization*, Vol. 1, No. 1, to appear, February, 1991).

[3] Dennis, J.E. and Schnabel, R.B. (1983), *Numerical Methods for Unconstrained Optimization and Nonlinear Equations*, Prentice-Hall, New Jersey.

[4] Dennis, J.E. and Tapia, R.A. (1976), "Supplementary terminology for nonlinear iterative methods," *SIGNUM Newsletter*, Vol. 11, No 4, pp. 4-6.

[5] Nazareth, J.L. and Mifflin, R.B. (1991), "The least prior deviation quasi-Newton update," Technical Report 91-2, Department of Pure and Applied Mathematics, Washington State University, Pullman, WA.

New Code for Constrained Optimization

FSQP (Feasible SQP) Version 2.0, developed by J. Zhou and A. L. Tits, at the Systems Research Center at the University of Maryland, College Park, MD 20742, is now available. FSQP is a FORTRAN code for solving constrained optimization problems, including constrained minimax problems (but nonlinear equality constraints are not allowed). Its main feature is that all the iterates generated satisfy the constraints. This is of value in many engineering related problems. Extensive numerical tests show that FSQP's efficiency is comparable to that of the most popular (non-feasible) codes. A detailed User's Manual has been completed. FSQP is available free of charge to academic users but may not be redistributed without the author's approval. To obtain the code, please contact:

André Tits
Department of Electrical Engineering and Systems Research Center
University of Maryland
College Park, MD 20742
E-mail: (andre@src.umd.edu)

–ANDRÉ L. TITS

CONFERENCE NOTES

Thirteenth Symposium on Mathematical Programming with Data Perturbations

May 23-24, 1991

A Thirteenth Symposium on Mathematical Programming with Data Perturbations will be held at George Washington University's Marvin Center on May 23-24, 1991. This symposium is designed to bring practitioners, who use mathematical programming optimization models and who deal with questions of sensitivity analysis, together with researchers who are developing techniques applicable to these problems.

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

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

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

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

(4) Solution approximation techniques and error analysis.

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

ABSTRACTS of papers intended for presentation at the Symposium should provide a good technical summary of key results, avoid the use of mathematical symbols and references, not exceed 500 words, and include a title and the name and full mailing address of each author. The deadline for submission of abstracts is March 9, 1991. Abstracts should be sent in triplicate to:

PROFESSOR ANTHONY V. FIACCO
INSTITUTE FOR MANAGEMENT SCIENCE AND ENGINEERING
SCHOOL OF ENGINEERING AND APPLIED SCIENCE
THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC 20052
TELEPHONE: (202) 994-7511.

APPROXIMATELY 30 minutes will be allocated for the presentation of each paper. A blackboard and overhead projector will be available.

–ANTHONY V. FIACCO, ORGANIZER

Integer Programming/Combinatorial Optimization Conference

May 28-30, 1990
The University of Waterloo

The Mathematical Programming Society was a principal sponsor of a three day conference on integer programming and combinatorial optimization held at the University of Waterloo in May of 1990. Approximately 100 people participated in the meeting, the formal portion of which consisted of thirty-six papers, selected by a program committee on the basis of extended abstracts. The proceedings of the conference, consisting of full versions of all the papers presented, were provided to all participants at the meeting and may be ordered as described below.

In view of the success of the conference, the Society has decided to make it a regular event. It will be held the two out of every three years that there is not an International Mathematical Programming Symposium. The next IPCO conference will be held in 1992 at Carnegie Mellon University.

The proceedings (535 pages) are published by the University of Waterloo Press and may be ordered from them directly at the address below:

THE UNIVERSITY OF WATERLOO PRESS
UNIVERSITY OF WATERLOO
WATERLOO, ONTARIO, CANADA N2L 3G1
TELEPHONE (519) 885-1211 EXT. 3369
FAX (519) 747-4606

The purchase price is $48.00 (CDN) for orders within Canada and $48.00 (US) for non-Canadian sales.

–BILL PULLEYBLANK

FIRST CALL FOR PAPERS

2ND Stockholm Optimization Days

August 12-13, 1991, KTH
Stockholm, Sweden

A Workshop on Optimization is to be held in Stockholm, August 12-13, the week after the Mathematical Programming Symposium. The workshop will take place at KTH (the Royal Institute of Technology), Stockholm, and is organized by the Optimization Laboratory at the Division of Optimization and Systems Theory with financial support by the Goran Gustafsson Foundation and the Swedish National Board for Technical Development.

The main themes of the workshop will be dual optimization and nonlinear optimization respectively. We also welcome papers in other areas of mathematical programming as well as applications, however.

At present, the following invited speakers have agreed to participate in the workshop:

Don Hearn, U Florida, Gainesville
Philip Gill, UC San Diego
Jean Louis Goffin, McGill U, Montreal
Walter Murray, Stanford University
Panos Pardalos, Penn State U.

We have some limited funds for partial coverage of transportation and housing of participants.

Abstracts, not exceeding 200 words, should be sent by e-mail to P O Lindberg at the address pol@math.kth.se (on internet) or at pol@sekth.bitnet (on bitnet). Please use the format given below. Deadline for abstracts is June 1, 1991.

Applications for support as well as requests for additional information may also be sent to the above address.

–FOR THE ORGANIZING COMMITTEE, P O LINDBERG

Abstract format:

(If you use mathematical formulas, please write them so that they can be processed by LaTeX directly.)

AUTHOR(S) AND AFFILIATION(S): ____________________

____

TITLE: ____________________

ABSTRACT (NOT EXCEEDING 200 WORDS): ____________________

____

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OPTIMA

Technical Reports & WORKING PAPERS

Mathematical Sciences Clemson University

Clemson, SC 29634-1907

R. Ringeisen and S. Stueckle, *"Crossing Unique Graphs and Other Range Properties of Drawings,"* #580.

M.C. Golumbic and R.C. Laskar, *"Irredundancy in Circular Arc Graphs,"* #582.

E. Bibelnieks and P.M. Dearing, *"Neighborhood Subtree Tolerance Graphs,"* #585.

M. Kostreva and K.B. Jennings, *"Nurse Scheduling on a Microcomputer,"* #587.

J. Boland and R. Ringeisen, *"Inclusive Connectivity: An Introduction to a Local Parameter,"* #588.

R.D. Ringeisen, S.K. Stueckle and B.L. Piazza, *"Subgraphs and Bounds on Maximum Crossings,"* #589.

R. Laskar and J. Dunbar, *"Universal and Global Irredundancy in Graphs,"* #591.

R.D. Ringeisen, B.L. Piazza and S.K. Stueckle, *"Subthrackleable Graphs and Four Graphs,"* #592.

R.D. Ringeisen and J.W. Boland, *"Relationships Between i-Connectivity Parameters,"* #593.

K.L. Dunlap and M.M. Kostreva, *"More with Murty's Bard-Type Algorithm,"* #594.

A.A. Ebiefung and M.M. Kostreva, *"Global Solvability of Generalized Linear Complementarity Problems and a Related Class of Polynomial Complementarity Problems,"* #595.

Technische Universität Graz Institut für Mathematik B

Kopernikusgasse 24
8010 Graz, Austria

F. Rendl and G. Woeginger, *"Reconstructing Sets of Orthogonal Line Segments in the Plane,"* No. 160.

R.E. Burkard and J.A.A. van der Veen, *"Universal Conditions for Algebraic Traveling Salesman Problems to be Efficiently Solvable,"* No. 163.

H.A. Eiselt and R.E. Burkard, *"Reshipments and Overshipments in Transportation Problems with Minmax Objective,"* No. 165.

H. Kellerer and G. Woeginger, *"On the Euclidean Two Paths Problem,"* No. 166 (a).

G. Woeginger, *"A Simple Solution to the Two Paths Problem in Planar Graphs,"* No. 166 (b).

H. Tuy, *"The Complementary Convex Structure in Global Optimization,"* No. 167.

F. Rendl and H. Wolkowicz, *"A Projection Technique for Partitioning the Nodes of a Graph,"* No. 169.

H. Kellerer and G. Woeginger, *"A Tight Bound for Three-Partitioning,"* No. 170.

System Optimization Laboratory Operations Research Department Stanford University

Stanford, CA 94305-4022

A.L. Forsgren and W. Murray, *"Newton Methods for Large-Scale Linear Equality-Constrained Minimization,"* SOL 90-6.

J-C. Yao, *"A Monotone Complementarity Problem in Hilbert Space,"* SOL 90-7.

P.E. Gill, W. Murray, D.B. Ponceleón and M.A. Saunders, *"Preconditioners for Indefinite Systems Arising in Optimization,"* SOL 90-8.

R.W. Cottle and Y-Y. Chang, *"Least-Index Resolution of Degeneracy in Linear Complementarity Problems with Sufficient Matrices,"* SOL 90-9.

R.W. Cottle and J-C. Yao, *"Pseudo-monotone Complementarity Problems in Hilbert Space,"* SOL 90-10.

E. Schweitzer, *"Modifying MINOS for Solving the Dual of a Linear Program,"* SOL 90-11.

W. Murray and F.J. Prieto, *"A Sequential Quadratic Programming Algorithm Using an Incomplete Solution of the Subproblem,"* SOL 90-12.

W. Murray and F.J. Prieto, *"A Second-Derivative Method for Nonlinearly Constrained Optimization,"* SOL 90-13.

B.C. Eaves and A.J. Hoffman, *"Covers by Polars of Arrangements,"* SOL 90-14.

B.C. Eaves and U.G. Rothblum, *"A Discounted-Cost Continuous-Time Flexible Manufacturing and Operator Scheduling Model Solved by Deconvexification Over Time,"* SOL 90-15.

F. Jarre, *"Interior-Point Methods for Convex Programming,"* SOL 90-16.

R.W. Cottle and S-M. Guu, "Two Characterizations of Sufficient Matrices," SOL 90-17.

BOOK REVIEWS

Applications of Discrete Mathematics

Edited by
Richard D. Ringeisen
and Fred S. Roberts
SIAM Philadelphia 1988
ISBN 0-89871-219-x

This book forms Proceedings of the Third Conference on Discrete Mathematics, held at Clemson University, Clemson, South Carolina, May 14-16, 1986.

As the first such conference under the direct sponsorship of the SIAM Activity Group (SIAG) on Discrete Mathematics, the conference brought together mathematicians from business, industry and government with those from academia to express their common interest in discrete mathematics and its applications.

This volume consists of papers from invited speakers at the plenary sessions and the minisymposia. The last part of the volume is a summary of the problems presented in the problem session. The papers reflect the wide range of topics covered at the meeting, and they are grouped by type of presentation at the conference rather than by topic.

The reader finds articles by invited speakers in cryptography (Ernest F. Brickell, Don Coppersmith), combinatorial geometry (Paul Erdös), probability (Peter Winkler) and perfect graphs (W.T. Trotter Jr.), as well as applications such as the use of discrete mathematics in airline scheduling (Kevin K. Gillette).

The Part II (Minisymposia) contains research articles on combinatorial aspects of network reliability (Daniel Bienstock, William T. McCullers and R. Kevin Wood, J. Scott Provan and Michael O. Ball, Douglas R. Shier), chemical graph theory (Gerry Ray Rias, R. Bruce King, Dennis H. Rouvay) and topics on domination in graphs (D.W. Bange, A.E. Barkauskas and P.J. Slater, C. Berge and P. Duchet, S.T. Hedetniemi and R. Laskar).

The selected papers are clearly written, providing both surveys of research areas and the new achievements.

The volume focuses on intensively growing branches of discrete mathematics with the aim to contribute to interaction between pure discrete mathematics and users of discrete mathematics. The reader also gets an impression about the spirit governing the SIAM conferences on Discrete Mathematics.

The volume is recommended to researchers and graduate students in discrete mathematics and computer science.

-MARTIN LOEBL

Introduction to the Mathematics of Operations Research

by Kevin J. Hastings
Dekker, 1989

Operations Research (in short, O.R.) is a recent but fast-growing branch of applied mathematics and has become an important part of so-called industrial mathematics. Models and methods of O.R. are the core of many industrial processes. Some of these, including production, inventory, transportation, and telecommunications, are now classical applications. However, in the last two decades, methods of O.R. have been shown to be instrumental in several fields which seemed far away when O.R. was young. Some instances are design problems, which come especially from elastoplasticity and structural engineering, computer networks, and aerospace engineering, just to mention a few.

Rapid growth of a discipline requires continuous renovation of the teaching. The present book can be considered in this category. It is addressed to students of O.R. at the university or postgraduate level, as well as to those scientists who want to become familiar with the basic methods of O.R. The exposition aims to acquaint them with the basic ideas.

The book begins appropriately with Graph Theory and Network Analysis. In fact, this topic has become one of the most essential parts of the mathematical machinery of computer science, of the language of discrete mathematics, and of the organization of ideas. The penetration of mathematical methods into science and technology takes place to a significant degree by means of graph theory.

Then the book is concerned with Linear Programming, the study of optimization of linear functions of several variables subject to linear constraints. The importance of this topic goes beyond O.R.; it has become a fundamental tool in most mathematical applications.

Special attention is then devoted to the study of systems moving in a nondeterministic way as time progresses, by analyzing some stochastic processes, like Markov Chains. Deterministic and stochastic Dynamic Programming, the study of optimization of randomly evolving systems, concludes this part, which is becoming more and more important.

A good mixture of exercises of several levels of difficulty and problems illustrating possible applications complete the book.

-F. GIANNESSI

BOOK REVIEWS

Theory of Vector Optimization

by Dinh The Luc
Springer Verlag, Berlin
Monograph 319

The book is concerned with the important field of vector optimization, namely constrained extremum problems where the objective function is vector-valued. In the finite dimensional case such problems are referred to as multiobjective programming.

Great progress in optimization techniques has made multiobjective programming a reality. Several problems, which had been formulated as scalar optimization, have been restudied and recognized to have a vector nature. As a consequence, in the last two decades there has been a rapid growth of both theory and methods for vector optimization.

The book presents a study of the most important topics in the field. The reader, even if unfamiliar with vector optimization, is brought quickly and smoothly to the most advanced topics, such as nondifferentiable problems and duality. This has been made possible by the successful attempt of the author to give a unified approach to vector optimization by exploiting theorems of the alternative and an axiomatic theory of duality, as well as classical arguments such as Lagrangian and conjugate duality.

–F. GIANNESSI

Journals

Vol.49, No. 3

R.H. Byrd and J. Nocedal, *"An Analysis of Reduced Hessian Methods for Constrained Optimization."*

D. Goldfarb and S. Liu, *"An O(n^3L) Primal Interior Point Algorithm for Convex Quadratic Programming."*

F. Jarre, *"On the Convergence of the Method of Analytic Centers when Applied to Convex Quadratic Programs."*

S. Kim, H.-S. Ahn and S.-C. Cho, *"Variable Target Value Subgradient Method."*

C. Herrero and J.A. Silva, *"On the Equivalence between Strong Solvability and Strict Semimononicity for Some Systems."*

H.D. Sherali, *"Capacitated, Balanced, Sequential Location-Allocation Problems on Chains and Trees."*

J.J. More and S.A. Vavasis, *"On the Solution of Concave Knapsack Problems."*

R.H.F. Jackson, P.T. Boggs, S.G. Nash and S. Powell, *"Guidelines for Reporting Results of Computational Experiments. Report of the Ad-Hoc Committee."*

F.E. Torres, *"Linearization of Mixed Integer Products."*

Vol. 50, No. 1

J.C. Gilbert, *"Maintaining the Positive Definiteness of the Matrices in Reduced Secant Methods for Equality Constrained Optimization."*

I. Adler and R.D.C. Monteiro, *"Limiting Behavior of the Affine Scaling Continuous Trajectories for Linear Programming Problems."*

A.B. Gamble, A.R. Conn and W.R. Pulleyblank, *"A Network Penalty Problem."*

S. Kim and H. Ahn, *"Convergence of a Generalized Subgradient Method for Nondifferentiable Convex Optimization."*

S. Mehrotra and J. Sun, *"On Computing the Center of a Convex Quadratically Constrained Set."*

C.C.Y. Dorea, *"Effort Associated with a Class of Random Optimization Methods."*

D.T. Luc, *"Contingent Derivatives of Set-Valued Maps and Applications to Vector Optimization."*

U. Derigs and A. Metz, *"Solving (large scale) Matching Problems Combinatorially."*

A. Tamir, *"On the Core of Network Synthesis Games."*

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Gallimaufry

Stein W. Wallace has moved to The University of Trondheim (Norway) to become a professor of Operations Research. ¶The *Wall Street Journal*, Oct. 19, 1990, featured a story on **Ron Dembo**'s development of algorithms for trading "synthetic" securities. ¶AIRO '91 will be held Sept. 18-19, 1991, at Riva del Garda, Italy. Contact **Prof. Franco Molinari**, Universita Delgi Studi di Trento, Phone +39 461 882118, Fax +39 461 882144, Email molinari@itncisti.bitnet. ¶Deadline for the next OPTIMA is June 1, 1991.

Mathematical Programming Backlog Crisis Over

I am happy to report that Mathematical Programming Series A backlog, which had grown to an almost three year waiting period, has now been substantially reduced. Papers currently accepted can expect to wait about one year before being published. The waiting period should be reduced even further in 1991.

Several measures were undertaken to achieve the backlog reduction. The most significant was to renegotiate the Journal's contract with North-Holland, increasing the number of issues per year from 6 to 9, effective in 1991. That increased the number of pages per year from 720 to 1080. In addition, the sizes of the volumes published in 1990 were increased and one issue from 1991, volume 49, was shifted back into 1990. The result is that over 1300 pages were published in 1990.

–ROBERT E. BIXBY

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.

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