	Group				
	A	B	C	D	E
No. Origin Nodes	800	800	800	100	100
No. Dest. Nodes	700	700	400	1000	1000
No. Arcs Per Origin	15-20	15-20	15-20	20-40	20-40
Cost Range	1-200	1-100	1-1000	1-100	1-100
Capacity Range	1-100	1-1000	1-1150	1-1000	1-1000
Multiplier Range	.98 - .70	.90 - .98	.90 - .98	1.5 - 3.0	.90 - .98
μ	.25	.65	.65 - .89	.25	.25

Table 1

Problem Data

	No. of Quasi-trees at Optimality		
	Group		
q	A	B	C
0.0	2	1	1
0.1	102	100	97
0.2	202	196	195
0.3	294	291	271
0.4	382	382	353
0.5	437	451	427
0.6	517	517	502
0.7	571	566	570
0.8	633	640	634
0.9	715	724	716

Table 2

Test Results

	Group D			Group E		
q	No. Q-trees at Opt.	Iterations	CPU Time	No. Q-trees at Opt.	Iterations	CPU Time
.00	2	6920	820	1	8273	994
.05	5	6155	515	5	6641	510
.10	13	4978	279	12	5119	273
.30	32	3922	101	31	3964	100
.50	48	3403	62	48	3450	61
.70	69	2995	44	69	3048	46
.90	91	2811	36	91	2856	38

Table 3

Test Results

4. Conclusions

We have developed a problem generator which allows the user a great deal of control over the number of quasi-trees in the optimal basis for a generalized transportation problem. The results presented indicate that the number of quasi-trees at optimality has a marked effect on the time required for solution by a sequential algorithm. These results may point the way to modification of real-world generalized network models so that decreased solution times result. This generator has also provided a useful set of test problems for the evaluation of a parallel version of the GRNET generalized network code.

References

(1) G. Brown and R. McBride, "Solving Generalized Networks," *Management Science* 30 (1984), 1497-1523.

(2) M. Chang and M. Engquist, "GTGEN: A Generator for Generalized Transportation Problems," Research Report CCS 540, Center for Cybernetic Studies, The University of Texas, Austin, 1986.

(3) M. Chang, M. Engquist, R. Meyer and R. Finkel, "A Parallel Simplex Algorithm for Generalized Networks," Technical Report 642, Department of Computer Sciences, University of Wisconsin, Madison, 1986.

(4) M. Engquist and M. Chang, "New Labeling Procedures for the Basis Graph in Generalized Networks," *Operations Research Letters* 4 (1985), 151-155.

(5) D. Klingman, A. Napier and J. Stutz, "NETGEN: A Program for Generating Large Scale Capacitated Assignment, Transportation, and Minimum Cost Flow Problems," *Management Science*, 20 (1974), 814-821.

(6) F. Glover, J. Hultz, D. Klingman and J. Stutz, "Generalized Networks: A Fundamental Computer Based Planning Tool," *Management Science*, 24 (1978), 1209-1220.

A NEW TEST FUNCTION FOR UNCONSTRAINED OPTIMIZATION

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RCA Laboratories
Princeton, NJ 08540

Testing unconstrained optimization routines means, for the most part, testing them on near-quadratic topographies. For example, Rosenbrock's function looks nearly quadratic after the function value is reduced two orders of magnitude from the value at the standard starting point. Below is the code for a simple 'descending curved valley' function that has no minimum and never becomes quadratic. Also included is code for the gradient. Both are defined everywhere but at the origin. The shape is that of a children's slide whose ramp is curved like a corkscrew. Some performance measures relevant to this family of functions are:

1. the long run average number of function evaluations per unit of decrease in the function value;
2. the dispersion of the iterates about the bottom of the valley; that is, the standard deviation (or interquartile range, etc.) of the $(\|x^i\| - R)$ values, where R is the corkscrew radius.

The circular form of the corkscrew can be distorted by changing 'PF' to a value other than 1. A value of 20 or more makes the trajectory appear back-and-forth rather than circular; the Hessian doesn't approximate this distortion well at the ends. This makes comparisons of quasi-Newton methods and pattern search methods like Nelder-Mead more interesting.

I would like to hear of other tests using this family of functions. I can be reached at the address above.

In Table 1, problem data other than q in each of five test problem groups are given. In Table 2, test results on the number of quasi-trees in an optimal basis are shown for the first three problem groups. In Table 3, test results for the last two problem groups are shown. In addition to the number of quasi-trees at optimality, the number of iterations and the solution time - exclusive of I/O - in CPU seconds are given for these two last groups. These solution statistics were obtained by GRNET using the f77 compiler on a VAX 11/750 computer. GRNET uses an artificial starting basis and a candidate list pivot strategy. We note that the number of iterations and the solution time both vary inversely with the number of basis quasi-trees at optimality. Further, as this number increases, the solution time decreases faster than the number of iterations. This can be explained by noting that as the quasi-trees become smaller, the length of the path on which the basis representation of an incoming arc is nonzero also becomes smaller. Hence, the calculation of this representation, the ratio test, and the flow updates execute faster. Also, the updating of the node functions used to maintain the basis quasi-trees can be done faster.

2. Problem Generator

GTGEN is a program that randomly generates generalized transportation problems with (approximately) a prespecified number of quasi-trees in an optimal basis. The program is written in FORTRAN and it allows the user to specify the number of origins and destinations and ranges for the other problem parameters. GTGEN creates a feasible flow as it generates a problem. As an arc is created, a flow on the arc is also created. This flow is set at μ times the arc capacity, where μ is user-specified fractional value. The supply for an origin node is set to the value obtained by summing these generated flows over the arcs emanating from the node. Similarly, the generated flows, after being transformed by the appropriate multiplier, are summed over the arcs entering a destination node to determine the demand. The underlying network for a problem generated by GTGEN is guaranteed to be connected.

After the supply and emanating arcs for an origin node are initially created, this problem data is modified with probability q, where q is another user-specified parameter. This modification includes 1) creation of a slack arc for the node and 2) creation of a new supply which is $1/\mu$ times the previous supply. The number of origin nodes times q gives the expected number of modified origin nodes. This expected value is used to predict the number of quasi-trees in the optimal basis. It is plausible that the number of modified origin nodes can be used for such a prediction since, relative to the original feasible flow generated, each modified origin node has increased supply which will likely force the associated slack into the optimal basis. It is conceivable, however, that the excess supply could result in flows at capacity on all arcs emanating from this origin node. The slack arc would then likely be nonbasic at zero flow in the optimal solution.

The random number generator used in GTGEN is portable. A set of solved problems along with further details concerning this code can be found in [2]. Persons wishing to obtain a copy of GTGEN should contact the authors.

3. Computational Testing

In this section we present a series of problems that were generated by GTGEN with various values of the parameters. Each of these problems was solved by the specialized primal simplex FORTRAN code GRNET [4], and the number N of quasi-trees at optimality was recorded. The results verify that qm, where m is the number of origins, yields a good prediction of N, although the predicted value is typically somewhat lower than the true value. However, when $q=0$ we expect a single quasi-tree at optimality.


```
C                          PSEUDO FORTRAN
C
C     THIS ROUTINE PROVIDES AN UNBOUNDED DESCENDING CURVED VALLEY
C TO TEST UNCONSTRAINED FUNCTION MINIMIZATION ROUTINES.
C
C THE SLOPE OF THE DESCENDING CHUTE IS CHANGED VIA 'SLOPE'.  THE SHAPE
C OF THE BELLY OF THE CHUTE IS CHANGED BY CHANGING 'UX'; IN PARTICULAR,
C 'PINCH' AND 'K'.  THE VALUE OF 'OLDANG' MUST BE SAVED BETWEEN CALLS;
C THIS IS DONE VIA THE 'SAVE' STATEMENT IN FORTRAN77.
C
C THE SEARCH TRAJECTORY IN TWO-SPACE SHOULD ROUGHLY FOLLOW A CIRCLE
C CENTERED AT THE ORIGIN WITH RADIUS 'RADIUS'.  TO MAKE THE TRAJECTORY
C OVAL, CHANGE PF TO A VALUE OTHER THAN 1.  THE ORIENTATION OF THE
C OVAL IS SET BY 'ROTANG'.
C
C                           - RUSSELL BARTON, RCA LABORATORIES
C
C======================================================================
C
      FUNCTION PSEUDO(X)
C
      INTEGER K
      REAL*8 X(2),RADIUS,SLOPE,PINCH,ROTANG,PF,A(2,2),AX(2),AXNORM,
     .      UX,SUMANG,NEWANG,OLDANG,DTHETA,PI,PSEUDO
      DATA OLDANG/0.D0/
C
      SAVE OLDANG
C
      K=2
      PI=3.14159265358979D0
      RADIUS=10.D0
      SLOPE=10.D0
      PINCH=10.D0
      ROTANG=0.D0
      PF=1.D0
      A(1,1)=COS(ROTANG)
      A(1,2)=-SIN(ROTANG)
      A(2,1)=SIN(ROTANG)*SQRT(PF)
      A(2,2)=COS(ROTANG)*SQRT(PF)
      AX(1)=A(1,1)*X(1)+A(1,2)*X(2)
      AX(2)=A(2,1)*X(1)+A(2,2)*X(2)
      AXNORM=SQRT(AX(1)**2+AX(2)**2)
C
      UX=PINCH*ABS(RADIUS-AXNORM)**K + 1.D0/AXNORM
C
      NEWANG=ATAN2(X(2),X(1))
      DTHETA=NEWANG-OLDANG
      IF(DTHETA.LT.-PI)DTHETA=DTHETA+2.D0*PI
      IF(DTHETA.GT.PI)DTHETA=DTHETA-2.D0*PI
      SUMANG=SUMANG+DTHETA
      OLDANG=NEWANG
C
C
      PSEUDO = UX + SLOPE*SUMANG
C
      RETURN
      END
```

```
------- -- -------- DPSEUD FORTRAN -------- -- --------

      SUBROUTINE DPSEUD(X,DX)
C
C    THIS SUBROUTINE CALCULATES THE GRADIENT OF 'FUNCTION PSEUDO',
C PROVIDED THAT THE VALUES OF RADIUS,SLOPE,PINCH,ROTANG, AND PF ARE
C SET TO MATCH THE VALUES IN 'FUNCTION PSEUDO'.  IF SEVERAL DIFFERENT
C VALUES ARE DESIRED, THESE PROGRAMS SHOUD BE MODIFIED, PLACING THE
C VARIABLES IN THE CALLING PARAMETER SET OR SETTING UP A LABELED COMMON
C BLOCK.
C
      REAL*8 X(2),RADIUS,SLOPE,PINCH,ROTANG,PF,A(2,2),AX(2),AXNORM,
     .       DX(2),ATAX(2)
      REAL*8 TERM1(2),TERM2(2),TERM3(2)
C
      K=2
      RADIUS=10.D0
      SLOPE=10.D0
      PINCH=10.D0
      ROTANG=0.D0
      PF=1.D0
      A(1,1)=COS(ROTANG)
      A(1,2)=-SIN(ROTANG)
      A(2,1)=SIN(ROTANG)*SQRT(PF)
      A(2,2)=COS(ROTANG)*SQRT(PF)
      AX(1)=A(1,1)*X(1)+A(1,2)*X(2)
      AX(2)=A(2,1)*X(1)+A(2,2)*X(2)
      AXNORM=SQRT(AX(1)**2+AX(2)**2)
      ATAX(1)=A(1,1)*AX(1)+A(2,1)*AX(2)
      ATAX(2)=A(1,2)*AX(1)+A(2,2)*AX(2)
C
      TERM1(1)=-(DBLE(K)*PINCH*ATAX(1)*(RADIUS-AXNORM)**(K-1))/
     .                    AXNORM
      TERM2(1)=-2.D0*ATAX(1)/AXNORM**3
      TERM3(1)=SLOPE*(-X(2)/(X(1)**2+X(2)**2))
      TERM1(2)=-(DBLE(K)*PINCH*ATAX(2)*(RADIUS-AXNORM)**(K-1))/
     .                    AXNORM
      TERM2(2)=-2.D0*ATAX(2)/AXNORM**3
      TERM3(2)=SLOPE*(X(1)/(X(1)**2+X(2)**2))
C
      DX(1)=TERM1(1)+TERM2(1)+TERM3(1)
      DX(2)=TERM1(2)+TERM2(2)+TERM3(2)
C
      RETURN
      END
```


ON THE NUMBER OF QUASI-TREES IN AN OPTIMAL GENERALIZED NETWORK BASIS

by

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Michael Engquist

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1. Introduction

The solution of generalized networks by means of the primal simplex algorithm has been studied by a number of authors including Brown and McBride [1], Engquist and Chang [4], and Glover et al. [6]. Bases for these problems can be represented as a collection of quasi-trees, where a quasi-tree is a tree plus an additional arc. Specialized generalized network codes are about fifty times faster in solving these problems than general purpose linear programming codes [4], [6].

For pure networks, the problem generator NETGEN of Klingman, Napier and Stutz [5] has been widely used. NETGEN has been extended to generate generalized network problems and this extension is known as NETGENG [6]. In computational tests conducted using problems generated by NETGENG as described in [4], we found that the number of quasi-trees in the optimal basis was typically one or two. In order to test the effects of the number of quasi-trees at optimality on solution times, we developed a new generalized network generator, GTGEN, which is described in Section 2. We also note that problems having a large number of basic quasi-trees at optimality are more amenable to solution by a parallel version of the primal simplex algorithm as described by Chang, et al. [3]. The test problems used in [3] were generated by GTGEN.

Martin remained at the forefront of mathematical programming from the mid 1950's right up to his death. Since mathematics is supposed to be a young person's subject this perhaps gives us an insight into his character. With his exuberance, his impishness, his gentle teasing and his profound thirst for understanding, Martin was always a young person in spirit.

My most permanent memory of him will be of his attendance at conferences. Always sitting at the very front, he never missed even the driest and most theoretical paper. At the end of a hard day he would be alert, encouraging the speaker and putting the paper into a more general setting. But the greatest joy came at the after-hours social events. It really was fun to be with Martin and his wife Betty, talking over dinner or dancing enthusiastically in the evening.

Chairman of the Mathematical Programming Society, Silver Medallist of the Operational Research Society, Vice President of the Royal Statistical Society and the Institute of Mathematics and its Applications, Non-Executive Chairman of Beale International Technology Limited, Martin was an eminent public mathematician. However, he will be remembered best for his commitment to the application of theory to solving important problems and his dedication to improving the professionalism and enthusiasm of his co-workers.

Professor R. C. Daniel
The University College of Buckingham

CALENDAR OF MEETINGS

September 16-19, 1986: EURO VIII, Lisbon, Portugal

October 27-29, 1986: TIMS/ORSA Joint National Meeting, Miami, USA

May 4-6, 1987: TIMS/ORSA Joint National Meeting, New Orleans, USA

May 17-20, 1987, 2nd SIAM Conference on Numerical Optimization, Houston, USA

June 15-20, 1987: COAL ARW on Computational and Modelling Aspects of Mathematical Programming, Bergen, Norway (tentative - see page 14)

August 10-15, 1987: IFORS '87, Buenos Aires, Argentina (see page 15)

THE 1987 CONFERENCE OF THE COMMITTEE ON ALGORITHMS

The Committtee on Algorithms has decided to arrange its next meeting at Chr. Michelsen Institute, Bergen, Norway on June 15-20, 1987. We are planning for an advanced research workshop with approximately 40 participants. The main goal of the workshop will be to discuss the present state and future avenues for the research in linear programming and combinatorial optimization. This will be achieved by letting the morning sessions be plenary discussions with key-note speakers. The afternoon sessions will be used for presentations of technical paper. The conference is still pending upon financial support.

The organizing committee consists of

Professor Martin Grötschel, Universitatät Augsburg, Germany F. R.

Dr. Jan Telgen, Van Dien+Co, Utrecht, The Netherlands.

Dr. Stein W. Wallace, Chairman, Chr. Michelsen Institute, Bergen, Norway.

Professor Roger J-B. Wets, University of California at Davis.

Mailing addresss for the Conference

COAL-87 v/ Secretary Laila Fjeld

Chr. Michelsen Institute

N-5036 FANTOFT, Bergen

Norway

PROFESSOR MARTIN BEALE, FRS

The sadness of Martin Beale's death in Cornwall on December 23, 1985 is perhaps mitigated for his friends and colleagues by the knowledge that at the end he was surrounded by the three most important things in his life - his family, his Christianity and his mathematics.

His richly deserved Fellowship of the Royal Society was primarily awarded in 1979 for his applications of mathematical and statistical techniques to industrial problems, and for his contributions to the theory of mathematical programming. With his Chair at Imperial College and his leading technical role at Scicon Limited, Martin was in a unique position to develop these techniques, and then to apply them to the hardest problems that industry could generate.

Martin used this blend of theory and state-of-the-art practice to encourage several generations of young mathematicians and computer scientists, both as research students and as co-workers at Scicon. Many of them have gone on to apply the theory and techniques that Martin developed in a variety of large scale mathematical programming computer codes.

Martin inspired his students and co-workers by his total intellectual commitment and honesty, his clarity of thinking, the richness of his ideas and, above all, by his supreme professionalism. It was exhausting working with him, keeping up with the constant flow of creativity and watching him strive to render the mathematics usable and efficient. This attention to detail was astounding until one realized that it all fitted into a coherent view of how things ought to be done.

In his teaching, too, Martin strived for succinctness and clarity. He was not the sort of mathematician who seeks to impress by obscurity. Ideas were to be expressed only, criticism received and improvements welcomed. He worked ceaselessly to improve even his elementary introductory lecture notes, fitting the new theoretical developments into his broad perspectives on the subject.

NOTES FROM THE CHAIRMAN

Guidelines: Karla Hoffman submitted a motion to MPS council with the following wording:

"Council appoints Richard H. F. Jackson, Susan Powell, Steve Nash and Paul Boggs as an ad-hoc committee to revise the guidelines for reporting computational experiments in mathematical programming. They are instructed to consult with Michael Todd, Richard Cottle and Jan Karel Lenstra. The committee is expected to present a written report to MPS Council. Once MPS Council accepts the revised guidelines, they will be used by the Society for all of its publications. As such, the guidelines will be included in the "Instructions to Authors" and "Notes for referees".

This motion was approved by the council.

COAL Meeting: As the site for the next meeting of COAL we selected Bergen (Norway). The meeting is scheduled for June 15-20, 1987; please note these dates.

The meeting will be an Advanced Research Workshop focussed on problem formulation and algorithms for mathematical programming.

The announcement (on p. 14) contains more information. Of course the whole thing is still pending financial support.

EURO VIII: At this meeting to be held in Lisbon, Portugal from September 16-19, 1986 a COAL session "Comparison and evaluation of Mathematical Programming Algorithms" is scheduled. I am the organizer; so far 7 papers are registered.

Meeting on Modelling: Gautam Mitra is one of the organizers of a (proposed) NATO ASI on "Modelling Aspects of Mathematical Programming". The meeting is scheduled for the summer of 1987 but neither the place nor the date have been selected yet. This is not the official COAL meeting, but I have expressed my support for this meeting on behalf of COAL, since it is certainly a very interesting topic. For more information contact Gautam.

Jan Telgen

I.F.O.R.S.

INTERNATIONAL FEDERATION OF OPERATIONAL RESEARCH SOCIETIES

INTO THE SOUTHERN HEMISPHERE

In three years time I.F.O.R.S. will be thirty years old. When I.F.O.R.S. was formed in 1959, its initial membership consisted of the Operations Research Societies of America, The United Kingdom and the Societè Francaise de Rechereche Operationnelle

Today, I.F.O.R.S. has thirty-four national societies with a toal membership of 32,000. The geographical spread of Operations Research can be charted by the locations of our I.F.O.R.S. triennial conferences. Six in Europe, three in North American and one in Asia.

This success in spreading Operations Research has a specific catalyst, namely, the triennial conference.

In 1987, the I.F.O.R.S. triennial conference moves for the first time into the Southern Hemisphere. It moves to an Hispanic speaking continent with a population of 200 million. The August 10-14 1987 conference in Buenos Aires will indeed be an important milestone for I.F.O.R.S., for by its 30th birthday I.F.O.R.S. will have supported development of Operations Research, not alone across the Northern Hemisphere, from Washington to Tokyo, but also south of the equator.

For many individual members, travel to Argentina will represent a major problem. In preparing a case to justify such a trip, perhaps it is as well to remember that the I.F.O.R.S. conference offers an ideal forum for establishing professional and business relationships with key figures in the South American Economy.

1987 will, for many, be a once in a lifetime chance of visiting South America. 1986 is the year when member societies select their national contributions (deadline 1st September 1986). Perhaps this selection of a national contribution could be combined with a vigorous campaign to promote the first I.F.O.R.S. conference in the Southern Hemisphere.

Fred Ridgway
Vice President, I.F.O.R.S.
Bank of Ireland
Lower Baggot Street
Dublin 2, Ireland

GLOBAL OPTIMIZATION STUDY

A computational study of algorithms for global optimization will be carried out in accordance with guidelines discussed during a recent SDS-IIASA workshop in this area.

As a first step, appropriate test problems are being assembled featuring arbitrary objective functions and constraints. (Test problems for the special case of concave functions subject to linear constraints are available from J. B. Rosen, 136 Lind Hall, Minneapolis, MN 55455, U.S.A.).

Those interested in contributing to the computational study are invited to contact C. G. E. Boender and A. H. G. Rinnooy Kan, Econometric Institute, Erasmus University Rotterdam, P.O. Box 1738, 3000 DR Rotterdam, The Netherlands.

NOTES FROM THE U.S. CO-EDITOR

This issue contains two technical papers. The first, by M. Chang and M. Enquist of the University of Texas, describes a test problem generator for (linear) generalized network optimization problems that provides control over the number of quasi-trees in the optimal solution, and it also reports that solution times are inversely proportional to this parameter. The second paper, authored by R. R. Barton of RCA Laboratories, provides code for a family of difficult two-variable unconstrained optimization problems.

Jerry Kreuser, reporting on the establishment of SIGCMP as the successor to SIGMAP, notes that, due to complex ACM distribution requirements, a few more signatures of ACM members are required. He anticipates no problems in collecting these, and is optimistic that final approval of SIGCMP will be possible at the October ACM meeting in Dallas.

The Executive Committee of the Mathematical Programming Society has authorized the acceptance of a limited amount of appropriate advertising for publication in the COAL Newsletter. Ads will be sold by the page only, at a rate of $100 US per page. Ad copy may be sent to either co-editor, but checks should be made payable to "University of Wisconsin". The MPS mailing list need to distribute the COAL Newsletter contains approximately 700 names.

Robert R. Meyer

COMMITTEE ON ALGORITHMS OF THE MATHEMATICAL PROGRAMMING SOCIETY

COAL OBJECTIVES

The Committee on Algorithms is involved in computational developments in mathematical programming. There are three major goals: (1) ensuring a suitable basis for comparing algorithms, (2) acting as a focal point for computer programs that are available for general calculations and for test problems, and (3) encouraging those who distribute programs to meet certain standards of portability, testing, ease of use and documentation.

NEWSLETTER OBJECTIVES

The newsletter's primary objective is to provide a vehicle for the rapid dissemination of new results in computational mathematical programming. To date, our profession has not developed a clear understanding of the issues of how computational tests should be carried out, how the results of these tests should be presented in the literature, or how mathematical programming algorithms should be properly evaluated and compared. These issues will be addressed in the newsletter.

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Trond Steihaug

Mathematical Programming Society

Committee on Algorithms Newsletter

NO. 14 — ROBERT R. MEYER, JENS CLAUSEN — EDITORS

JUNE 1986

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