classes.

(a) *The problem is representative of a class of applications.* This allows for simplified versions of a real application, as well as for the original applications themselves. For example, problems such as the "minimum surface" problem [2], the "boundary value" problem [3] or the "clamped plate" problem [1] fall into this class.

(b) *The problem tests the behaviour of the code in specific situations.* Behaviour of the code under test when faced with badly scaled or otherwise ill-conditioned problems, nearly critical points, curving valleys, singularities, etc., is useful to analyze. It is tested by the problems in this class. Known examples include the "Rosenbrock" problem [3], the "Powell singular" problem [3], the "Woods" problem [3] and many others.

5. *The problem should be completely and unambiguously defined.* This requirement has many aspects, as shown by the following (nonexhaustive) list:

   - Generating the structure inherent to some problems is sometimes nontrivial. Sparsity patterns or partially separable decompositions should be specified in detail. To allow real duplication of numerical experiments, it is also important that no random process is involved in this definition, except if the procedure to generate it is also specified with the problem.
   - One or several starting point should be defined.
   - If the problem contains parameters that can be varied (for example to modify the degree of difficulty of the test), the allowed range for these parameters has to be precisely given.
   - Is there a known solution? Which one? Is it unique? This last point may be important because the results of different runs are clearly incomparable if the solutions found are different.

This list of desirable features is by no means complete. Even besides scientific value, things like a catchy name also help in making a test problem popular, and the very popularity of a problem can sometimes be of real interest, because it provides a very wide basis for subsequent comparison of the tested code with other software products.

3. A call for test problems

The reader is now probably convinced that adequate test problems are quite difficult to define. However, they are really a necessary step on the way to efficient and reliable

software for large-scale nonlinear problems.

As alluded to above, the main purpose of this note is to send a call to all readers to make their own (test) problems available to the community. If you have a large dimensional problem that qualifies as a test problem according to the criteria discussed above, please send it to the author at the following address:

Professor Ph. L. Toint
Department of Mathematics
Facultés Universitaires ND de la Paix
61, rue de Bruxelles
B-5100 Namur, Belgium

Since a short (2 pages) description is needed, there is no problem in using the ordinary mail. Please state your name and organization, so that proper acknowledgement can be made in due time.

The following categories of test problems will be considered for inclusion in the collection:

- unconstrained problems,
- problems with bounds on the variables,
- nonlinear network problems,
- problems with general linear constraints (excluding linear programming problems),
- problems with nonlinear constraints.

In each category, distinction will be made between problems for which derivative information is available and problem for which this is not the case.

The idea is to gather enough interesting test problems into a collection that will be subsequently published (hopefully) and made available to everyone interested. It is also planned to produce Fortran 77 software for the evaluation of the involved function and derivatives.

Thank you very much for your collaboration on this project!

References

[1] A. Dax, "Successive refinement of large multicell models", SIAM Journal on Numerical Analysis, vol. 22(5), pp. 865-887, 1985.

[2] A. Griewank and Ph. L. Toint, "On the unconstrained optimization of partially separable functions", In "Nonlinear Optimization 1981" (M.J.D. Powell, ed.), Academic Press, London, 1982.

[3] J. J. Moré, B. S. Garbow and K. E. Hillstrom, "Testing unconstrained optimization software", Transactions of the AMS on Mathematical Software, vol. 7, pp. 17-41, 1981.

[4] J. J. Moré, B. S. Garbow and K. E. Hillstrom, "Fortran subroutines for testing unconstrained optimization software", Transactions of the AMS on Mathematical Software, vol. 7, pp. 136-140, 1981.

[5] D. M. Himmelblau, "Applied nonlinear programming", McGraw-Hill, New York, 1972.

[6] W. Hock and K. Schittkowski, "Test examples for nonlinear programming codes", Lecture Notes in Economics and Mathematical Systems 187, Springer Verlag, Berlin, 1981.

[7] D. F. Shanno, "On variable metric methods for sparse Hessians", Mathematics of Computation, vol. 34, pp. 499-514, 1980.

[8] Ph. L. Toint, "Some numerical result using a sparse matrix updating formula in unconstrained optimization", Mathematics of Computation, vol. 32(143), pp. 839-851, 1978.

[9] Ph. L. Toint, "A view of nonlinear optimization in a large number of variables", in "Proceedings of the IMA Conference on Large Systems Optimization and Modelling", (D. J. Bell, ed.), Oxford University Press, 1987.

do not mean that smaller problems are not worth consideration, but they simply do not belong to the class discussed here. Note, however, that some of the classical large problems are built as some combination of small ones (see the "extended Rosenbrock" example again): such extensions are clearly of interest to us.

2. *The problem should be easily stated.* Unfortunately, many relevant problems involving a large number of variables also involve a large number of constants and/or a lengthy description of many subsystems or subfunctions. Despite the increasing use of computer networks and the resulting facility for exchanging long files (see NETLIB, as maintained by J. Dongarra and E. Grosse, for instance), many test problem users still rely on publication of the explicit statement of the problem. Therefore, the existence of a reasonably short problem statement (less than 2 typeset pages, say) is really crucial to ensure wide distribution, and hence standardization.

   Again, this is not obvious for many problems of reasonable size; it often happens that the computation of the objective function or the constraints involve a large amount of computation, as the solution of a partial differential equation on some domain, for example. However, since the proper use of test problems requires that they should be run over and over, the cost (in terms of dollars or any other currency) sometimes becomes a serious obstacle.

   Furthermore, in order to avoid nonstandard implementations, it is also necessary to specify the computational procedure for the objective function and the constraints quite precisely. Describing the minimum surface problem merely as "minimizing the surface satisfying such and such conditions on the boundary of the unit square, the surface being computed using a bilinear finite element discretization over square elements" is clearly not enough.

3. *The problem statement should be in the public domain.* This requirement is obvious for problems that, as discussed above, should be published in the open literature. Experience has, however, shown this to be a major difficulty. To avoid it, it is indeed often necessary to modify some parts of the problem statement in order not to give away proprietary information. These transformations are not always easy to design for nonlinear problems, for example, because solutions may fail to exist when some parameter ranges are modified.

4. *The problem should be interesting.* By this very general (and clearly desirable) requirement, we mainly mean that the problem should fall into one of the following

nonlinear programming ignore the ever famous Rosenbrock or "banana" function in two variables, for example. Collections of such test problems have been published, most notably in Himmelblau's book [5] and in landmark papers by Moré, Garbow and Hillstrom [3] [4] as far as unconstrained problems are concerned, and in the well-known computational study by Hock and Schittkowski [6] for constrained problems. The very fact that these collections have been published in the open literature has helped enormously in their recognition as standards, which in turn has been very useful as a *uniform* basis for comparison between software products.

However, until quite recently most of the efforts in algorithm development and software production for nonlinear minimization were geared to small dimensional problems, so a vast majority of the available test examples also consists of problems with a relatively small number of variables and/or constraints. As a consequence, very few test problems involving a large number of variables (> 250, say) are presently available in the open literature. Furthermore, many of the problems that are published are built as some kind of "stretching" of a small dimensional original. For instance, various extensions of the Rosenbrock test function have been designed, some of which consist of truly larger problems as in [7] or [8], and others being just the simple juxtaposition (without any kind of interrelation) of a number of copies of the original two variable function (see the "extended Rosenbrock" problem in [3]). Whether or not these stretchings produce interesting and useful test problems is clearly debatable.

It is the author's opinion that this lack of a *recognized* and *sufficient* collection of test problems for large scale problems is highly detrimental to the development of quality software in this area. This is especially unfortunate since concepts such as partial separability and related algorithms for large dimensional nonlinear problems are now available (see [9] for a recent survey of this field). Hence we propose the project of building such a collection, which constitutes the main motivation of the present note.

2. What is a good test problem?

Providing interesting test problems for large scale optimization is however not very easy. The main reason is that a good test problem in this area should satisfy a (sometimes contradictory) list of requirements:

1. *The problem should be large.* Problems involving less than 100 variables cannot be considered as "large", because they could be dealt with without any specific care for their structure, given the power and memory size of today's computing equipment. We

Calendar

1987

December 1-4: Third SIAM Conference on Parallel Processing for Scientific Computing, Los Angeles

December 31: Deadline for Orchard-Hays prize nominations

1988

January 15: Deadline for Fulkerson prize nominations

March 1: Deadline for paper titles, MPS XIII

April 25-27: TIMS/ORSA Joint National Meeting, Washington, D.C.

May 23-26: Third SIAM Conference on Linear Algebra, Madison, WI, U.S.A.

August 29-September 2: MPS XIII, Tokyo

ORCHARD-HAYS PRIZE

CALL FOR NOMINATIONS

Nominations are solicited for the 1988 Mathematical Programming Society Orchard-Hays Prize for Excellence in Computational Mathematical Programming. To be eligible a book or paper(s) should have appeared in 1985-1987 and:

(1) Be on computational MP with emphasis on (a) documented experimental evaluations of algorithms, (b) development of quality mathematical programming software, and/or (c) development of new methods for empirical testing of MP techniques.

(2) Have appeared in the open literature.

(3) Be written in a English or made available in English translation.

Nominations (together with supporting materials) should be sent by December 31, 1987 to the Orchard-Hays prize committee chairman:

J. A. Tomlin
Ketron Management Science, Inc.
201 San Antonio Circle, Suite 208
Mountain View, CA 94040

CALL FOR TEST PROBLEMS IN LARGE-SCALE NONLINEAR OPTIMIZATION

by Ph. L. Toint
Department of Mathematics
Facultés Universitaires ND de la Paix
B-5000 Namur, Belgium

April 7, 1987

Abstract. The need of a larger collection of test problems for large dimensional constrained and unconstrained nonlinear optimization is discussed, as well as some desirable properties of these test problems. A call for such problems is made.

Key Words: Nonlinear optimization, large problems, testing

1. Why test problems for large-scale nonlinear optimization?

In nonlinear optimization, as in many other areas of numerical computation, testing and asserting the quality of a given code is of great importance of both developers and prospective users.

It is necessary to the first group because it allows a meaningful comparison between different implementations of a given algorithm, and a rational selection of a robust and efficient one for distribution. Fine tuning of a particular piece of software also requires extensive testing. In a more indirect way, preliminary testing using an experimental code has often played an important role in the selection of fast and reliable algorithms.

Testing is important to prospective users of a code or subroutine too, because it provides some a priori guarantee of efficiency and measure of robustness. If they are found to be satisfactory, the decision may then be taken to invest time (and usually effort) in integrating the studies code as a tool into an existing application environment.

These considerations are clearly not new, and testing procedures have been discussed for a long time, especially in relation with optimization software. In particular, a wide collection of *test problems* has been used over a period of years. Very few researchers in

APPLICATION FOR MEMBERSHIP

Mail to: The Mathematical Programming Society, Inc.
c/o International Statistical Institute
428 Prinses Beatrixlaan, 2270 AZ Voorburg, The Netherlands

Checks or money orders should be made payable to The Mathematical Programming Society, Inc., in one of the currencies listed below.

Dues for 1987, covering subscription to volumes 37-39 of *Mathematical Programming*, are Dfl. 103.50 (or $ 45.00 or DM 95.00 or £ 30.00 or FF 300.00 or Sw.Fr. 75.00).

Subscription to volumes 30-31 of *Mathematical Programming Studies*, available to members only, is Dfl. 50.00 (or $ 22.00 or DM 44.50 or £ 15.00 or FF 145.00 or Sw.Fr. 36.00).

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

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Institution .....

Call for Nominations for the D. R. Fulkerson Prize

This is a call for nomination for the D. Ray Fulkerson Prize which will be awarded at the XIIIth International Symposium on Mathematical Programming to be held in Tokyo, Japan, August 29-September 2, 1988.

The specifications for the Fulkerson Prize read:

"Papers to be eligible for the Fulkerson Prize should have been published in a recognized journal during the six calendar years preceding the year of the Congress. This extended period is in recognition of the fact that the value of fundamental work cannot always be immediately assessed. The prizes will be given for single papers, not series of papers or books, and in the event of joint authorship the prize will be divided.

The term "discrete mathematics" is intended to include graph theory, networks, mathematical programming, applied combinatorics, and related subjects. While research work in these areas is usually not far removed from practical applications, the judging of papers will be based on their mathematical quality and significance."

The nominations for the award will be presented by the Fulkerson Prize Committee (Manfred Padberg, Chairman, Martin Grotschel and Gian-Carlo Rota) to the Mathematical Programming Society and the American Mathematical Society.

Please send your nominations by January 15, 1988 to

Prof. Manfred Padberg
Tisch Hall, Room 517
New York University
40 West 4th Street
New York, N.Y. 10003
U.S.A.

M. Padberg

CALL FOR PAPERS

13th International Symposium on Mathematical Programming

The International Symposium on Mathematical Programming is the triennial scientific meeting of the mathematical Programming Society. The 13th symposium will be held on August 29 - September 2, 1988, at Chuo University, Tokyo, Japan. Participation is open. Those who want to present a paper are invited to submit the title of the paper by March 1, 1988, and the abstract by May 1, 1988. Acceptance of papers will be notified by July 1, 1988. For further information, please contact the Organizing Committee for the 13th International Symposium on Mathematical Programming, c/o The Operations Research Society of Japan, Gakkai Center Bldg., 2-4-16 Yayoi, Bunkyo-ku, Tokyo 113, Japan.

Notes from the U.S. Co-Editor

Congratulations are in order for Stein Wallace, Jan Telgen, Roger Wets and colleagues at the Chr. Michelsen Institute for successfully organizing the NATO ARW "Algorithms and Problem Formulations in Mathematical Programming" which also played the role of the 1987 COAL meeting. This ARW was held at CMI in Bergen, Norway, June 15-19, and had an attendance of forty-three, which is about the upper limit recommended by NATO for ARW's. There were participants from fourteen countries, and thirty-two papers were presented. Proceedings are to be published by Springer-Verlag. Besides the extensive schedule of talks, the conference organizers kindly arranged a full social schedule for the "off-hours", including a reception graciously hosted by the mayor of Bergen.

The small size and international character of the NATO meetings that have been organized with the assistance of COAL in recent years afford an unusual opportunity for interaction with colleagues in diverse areas of mathematical programming. With the continued support of NATO and COAL, we hope to continue this tradition.

R. R. Meyer

Future activities:

- The next COAL business meeting will be in Tokyo during the MP Symposium.
- The COAL meeting after that (1990 winter or summer) should be planned soon: Jan will contact Bill Stewart to see if he is interested in organizing this meeting.

The future of COAL:

Although a number of COAL objectives have come closer to being realized in the past several years there are many reasons why COAL should continue its work. Mentioned were:

- not all objectives are realized (in fact, most not)
- COAL bridges the gap between theory and practice
- COAL meetings are the best ones (small, attractive)
- COAL is a meetingplace for subdisciplines within MP.

Other business:

- There is some concern about the lack of practical and computational papers in "Mathematical Programming". As the flagship of the Society, the Journal should not reflect this image of the Society. Jan will draft a letter to Council to start discussion and thinking on this strategical issue.

Officers:

- Bob indicates his plan to step down as editor of the Newsletter after the Tokyo meeting;
- Jan indicates his plan to step down as chairman of COAL after the Tokyo meeting: the suggestion that the custom of having the former editor appointed as the new chairman might be used is not unfavourably received by Bob.

Closing:

The meeting is adjourned after 1 hr., 10 min.

Jan Telgen

COMPETITION FOR YOUNG STATISTICIANS FROM DEVELOPING COUNTRIES

1989

The International Statistical Institute (ISI) announces the Fourth Competition among young statisticians from developing countries who are invited to submit a paper on any topic within the broad field of statistics, for possible presentation at the 47th Session of ISI to be held in Paris, France, in 1989.

Participation in the competition is open to nationals of developing countries who are living in a developing country, who will not be older than 32 years of age in the year during which the Session is to be held.

Papers submitted must be unpublished, original works which may include university theses.

The papers submitted will be examined by an international Jury of distinguished statisticians who are to select the three best papers presented in the competition. Their decision will be final.

The authors of the winning papers will be invited to present personally their papers at the Session of ISI concerned with all expenses paid (i.e. round trip airline ticket from his/her place of residence to Paris plus a lump sum to cover living expenses).

Manuscripts for the Competition should be submitted in time to reach the ISI not later than November 1, 1988.

The rules governing the preparation of papers, application forms and full details are available on request from the ISI Permanent Office to which interested individuals should write for further information. The address is as follows:

The Director
Permanent Office
International Statistical Institute
428 Prinses Beatrixlaan
2270 AZ Voorburg
The Netherlands

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.

Minutes of the COAL Business Meeting on June 18, 1987 in Bergen, Norway

Present: David Gay, Bob Meyer, Jan Telgen (Chairman), Stein Wallace, and four other interested MPS members.

Opening: Jan opened by expressing his gratitude towards the organizers of the NATO ARW on "Model Formulations and Algorithms", for setting up this nice workshop as a regular COAL meeting and thus creating the possibility of having a business meeting too.

Since the last business meeting:

- Some COAL members have given up membership, others have joined COAL, including David Gay (see opposite page for COAL membership).
- The Orchard-Hays prize for excellence in computational mathematical Programming is now a prize of the Society as a whole, with only minor COAL involvement in the appointment of the prize committee.
- The ad-hoc committee, which is to revise the guidelines for reporting computational evidence, has been accepted by Council. No activities could be reported yet. COAL members present expressed their willingness to comment on any drafts the ad-hoc committee might produce.
- Bob reports that within ACM a SIG on Computational Mathematical Programming may be realized. He will keep in close contact with Jerry Kreuser on this issue.
- The MP Study that grew out of the COAL meeting in Bad Windsheim is with the editor-in-chief now. Publication seems to be delayed because of a long list of MP studies awaiting publication.

COAL Newsletter:

- Bob gives some reasons for putting out the December 1986 issue in June 1987. He hopes to publish the next Newsletters in September 1987 and January 1988 to be back on schedule in 1988.
- The last Newsletter contains one advertisement; also 1 or 2 people who are not MPS members pay for getting the Newsletter.
- The editors are always on the hunt for good material; please think of Bob or Jens Clausen if you have something appropriate.

COMMITTEE ON ALGORITHMS OF THE MATHEMATICAL PROGRAMMING SOCIETY

ROBERT R. MEYER
UNIVERSITY OF WISCONSIN-MADISON
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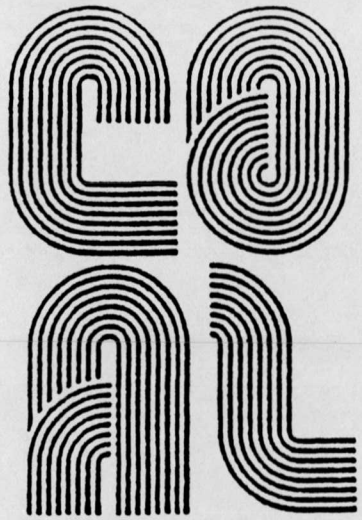

Mathematical Programming Society

Committee on Algorithms Newsletter

NO. 16 JUNE 1987

JENS CLAUSEN
ROBERT R. MEYER
EDITORS

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