Book Reviews

C. A. Floudas and Panos M. Pardalos (eds.), *Recent Advances in Global Optimization*, Princeton Series in Computer Science, Princeton University Press, Princeton, NJ, 1992, x + 633 pp.

This excellent book covers a broad range of topics (all in the area of global optimization) which were presented at a recent conference held at Princeton University, Princeton, New Jersey, May 10–11, 1991. There has been a significant increase in research activity in global optimization during the past ten years, both in its theoretical basis and the development of new computational algorithms. This is especially true of constrained global optimization. A variety of topics, together with important applications, are well represented by the papers in this volume.

This volume would be a valuable addition to the library of all those doing active research in global optimization and its applications. In addition, the book is well suited as a reference for scientists working in related disciplines of optimization. For the reader's information the contents of the book are now presented.

Contents:

Zheng and Deming Zhuang, Integral global optimization of constrained problems in functional spaces with discontinuous penalty functions (298–320); Ramon Moore, Eldon Hansen and Anthony Leclerc, Rigorous methods for global optimization (321–342); Zelda B. Zabinsky, Douglas L. Graesser, Mark E. Tuttle and Gun-In Kim, Global optimization of composite laminates using improving hit and run (343–368); Regina Hunter Mladineo, Stochastic minimization of Lipschitz functions (369–383); Aimo Torn and Sami Viitanen, Topographical global optimization (384–398); Janos Pinter, Lipschitzian global optimization: some prospective applications (399–432); David Shalloway, Packet annealing: a deterministic method for global minimization. Application to molecular conformation (433–477); I. E. Grossmann, V. T. Voudouris and O. Ghattas, Mixed-integer linear programming reformulations for some nonlinear discrete design optimization problems (478–512); Soren S. Nielsen and Stavros A. Zenios, Mixed-integer nonlinear programming on generalized networks (513–542); Angelo Lucia and Jinxian Xu, Global minima in root finding (543–560); Amy C. Sun and Warren D. Seider, Homotopy-continuation algorithm for global optimization (561–592); Zhian Li, P. M. Pardalos and S. H. Levine, Space-covering approach and modified Frank-Wolfe algorithm for optimal nuclear reactor reload design (593–615); Roberto Barbagallo, Maria Cristina Recchioni and Francesco Zirilli, A global optimization approach to software testing (616–633).

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Richard K. Cottle, Jong-Shi Pang, and Richard E. Stone, *The Linear Complementarity Problem*, Academic Press, 1992, xxiv + 762 pp., Price $59.95.

It is nice to have this long awaited book out at last. It is a meticulous piece of work expertly done by three well known researchers in the area.

The linear complementarity problem (LCP) provides a framework that unifies the bimatrix game problem, and the system of KKT optimality conditions for linear and quadratic programming. The fascination of the subject stems from the fact that it exhibits enormous diversity. Depending on the properties of the data matrix, the LCP can be so nice at one end that it admits an extremely simple greedy algorithm for its solution, or be an intractable NP-hard problem at the other end.

Although instances of the problem have been studied more that 50 years ago in isolated publications, it has experienced explosive growth with the appearance of the paper of Lemke and Howson in 1964. All the current nomenclature in the subject has been devised since then.

Chapters 1 and 2 introduce the problem nicely, with several motivating examples, and establish connections to other areas of mathematical programming, and survey the background needed to study the subject.

When the data matrix defining an LCP is the unit matrix, the complementary cones are the orthants of the real n-dimensional space, and the LCP becomes the simple problem of finding an orthant containing a given point q. In general, complementary cones are direct generalizations of orthants, and the LCP is the problem of finding a complementary cone containing a given point q. Thus the LCP has a captivating geometric interpretation. Its geometry was the subject of my Ph.D. dissertation at Berkeley under the guidance of David Gale in 1968. It has been the object of enduring study in the literature ever since. The authors provide a systematic treatment of the geometric side of the LCP in Chapter 6.

The algebraic study of the LCP involves detailed investigation of the properties of the data matrix defining it. A variety of matrix classes characterizing certain properties of the LCP have been identified. The authors provide a thorough treatment of these matrix classes in Chapter 3 and in later chapters.

Most of the popular algorithms for the LCP belong to three main families. Two of them are the pivoting methods (discussed very completely in Chapter 4), and iterative methods (again discussed exhaustively in Chapter 5), both of which are mature subjects in a sense. The third important class of algorithms for the LCP are the interior point methods which are very active research topics at the moment with new developments occurring at a fast pace. The book has only a very simplified treatment of these algorithms, without any proofs of their polynomial complexity.

And finally, Chapter 7 presents the very elegant work on stability analysis for the LCP.

A nice feature of the book is the notes and reference section at the end of each chapter, containing comments relating to the history of the subjects treated, attributions for the results that are stated, and pointers to the relevant literature. There is a comprehensive bibliography at the back of the book and a very helpful glossary of notation in the front.

Thus, the book is a wonderful repository of material for learning linear complementarity from a mathematical programmer's perspective. But the literature on LCP is vast, and the authors had to draw a line somewhere. Because the general LCP is NP-hard, it provides a very convenient test bed for researchers in global optimization to try their algorithms, and there have been many computational experiments and publications reporting on their results in recent years. This topic is not discussed in the book. Readers of this journal in particular, may find this mildly disappointing.

I have shown this book to a colleague who works on applications of LCP in physical sciences. He told me that complementarity manifests itself very beautifully in many research problems in mechanics, electro-magnetism, quantum theory of physics and other physical sciences; and that none of this is covered in the book. He expressed the hope that the authors would now embark on a second volume to complete the task. I do share his hope.

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