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Book Review

Handbook of Test Problems in Local and Global Optimization by C.A. Floudas, P.M. Pardalos et al. In Noncovex Optimization and Its Applications, volume 33, Kluwer Academic Publishers, 1999

From the beginning of the field of global optimization, there has been a recognized need for standard test problems to facilitate comparisons between algorithms. In 1975, in preparation for a conference entitled *Towards Global Optimization*, L. Dixon and G. Szego developed a small set of unconstrained test problems and asked the conference participants to use them. They also provided a standard way for comparing computation times. This provided the first objective way to compare algorithms with respect to their ability to find the global optimum and with respect to computation time. The Dixon–Szego problems were all low-dimensional, unconstrained, and fairly easy. Hence, they were not an ideal set of test problems. In 1981, Hock and Schittkowski published a comprehensive set of problems for testing nonlinear programming codes, but these were fundamentally local (not global) optimization problems. As a result, an important gap remained in the literature.

Floudas and Pardalos were the first to address this gap with their publication, in 1990, of the book *A Collection of Test Problems for Constrained Global Optimization*. While there has been additional work in test-problem development for global optimization since then, the current book by Floudas and Pardalos is the most comprehensive of these efforts. It includes the following classes of problems: quadratic programming; quadratically constrained problems; univariate polynomial problems; bilinear problems; biconvex and difference-of-convex problems; generalized geometric programming (i.e., problems with polynomial objective and constraints); twice-continuously-differentiable, non-linear programming problems; bilevel programming problems; complementarity problems; semidefinite programming problems; mixed-integer nonlinear problems; combinatorial optimization problems; nonlinear systems of equations; and dynamic optimization problems (including optimal control problems).

In each chapter, the authors discuss one of these problem classes and give a collection of test problems. All of the problems can be downloaded from the web site http://titan.princeton.edu/TestProblems in either the GAMS or MINOPT modeling languages. (MINOPT is a special modeling language developed at Princeton, and documentation on it can be found by following a link on the web site). For some problems, such as the Traveling Salesman Problem, the authors discuss the problem and solution algorithms, but point the user to other web sites where good collections of test problems already exist.

Most of the test problems come from the field of chemical engineering, which is natural considering that a great deal of the authors' work — as well as that of the global optimization community in general — is motivated by problems from this field. However, the book also contains problems from other fields: operations research (trim loss problems, traffic equilibrium), engineering (stability of a spark ignition engine), game theory (Nash equilibrium in 5-firm non-cooperative game), and even educational testing (estimating the reliability of a test). Of course, many standard test problems are also included. The authors usually give references to papers containing the major solution methodologies and occasionally comment on whether a problem is easy, especially challenging, or causes odd behavior for some algorithms (e.g., cycling). Finally, for each problem the global optimum, or best known solution, is given.

The book does not cover black-box global optimization problems (i.e., problems that can not be expressed in closed form), nor does it give computation-time comparisons for different algorithms. Nevertheless, the book and the accompanying web site will be a boon to developers of algorithms for the included problem types. Hopefully, the problems presented here will become standards and facilitate performance comparisons among new and existing algorithms.

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