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Global optimization and its applications

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This special issue is devoted to selected invited papers presented at the Workshop on Global Optimization held at Imperial College London, 15–17 December 2007 (http://gow2007.ps.ic.ac.uk/). The Special Issue contains eight papers ranging from algorithms and methodology to applications in engineering and finance.

Methodological developments are considered by four papers. Floudas and Gounaris present a review of recent research in deterministic global optimization. It covers twice continuously differentiable nonlinear optimization, mixed-integer nonlinear optimization, optimization with differential-algebraic models, semi-infinite programming, optimization with grey box/nonfactorable models, and bilevel nonlinear optimization. Further methodological issues are discussed by Lasserre in relation to moments and sums of squares for polynomial optimization and related problems. The duality between moment problems and sums of squares representations of positive polynomials is central. Subsequently, the paper discusses how such results are used to define convergent semidefinite programming relaxations in polynomial optimization as well as computing the convex envelope of a rational function and finding all zeros of a system of polynomial equations. Mitsos, Chachuat, Barton consider global bilevel dynamic optimization. A deterministic algorithm for bilevel programs with nonconvex functions is given, followed by a summary of deterministic algorithms for the global solution of optimization problems with nonlinear ordinary differential equations embedded. Parpas and Rustem present a stochastic global optimization algorithm for general non-convex, smooth functions. The algorithm follows the trajectory of an appropriately defined stochastic differential equation (SDE). In order to achieve feasibility of the trajectory information from the Lagrange multipliers is introduced into the SDE. The convergence analysis is provided.

Two mixed-integer linear programming (MILP)-related papers are included. The first, by McAllister, DiMaggio, Floudas, presents a computational study for solving the distance-

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dependent rearrangement clustering problem using MILP. To address sparse data sets, an objective function is presented for evaluating the pair-wise interactions between two elements as a function of the distance between them in the final ordering. The physical permutations of the rows and columns of the data matrix can be modeled using MILP. Performance is compared for three distinct re-ordering problems corresponding to glass transition temperature data for polymers and two drug inhibition data matrices. The second, by Faísca, Kosmidis, Rustem, Pistikopoulos addresses global optimization of multi-parametric (mp) MILP problems. The optimization procedure iterates between a (master) mixed integer nonlinear program and a (slave) multi-parametric program. The authors explain how to overcome the presence of bilinearities, responsible for the non-convexity of the multi-parametric program, in two classes of mp-MILPs.

The applications focus is provided by two papers discussing finance and engineering problems. Kane, Bartholomew-Biggs, Cross, Dewar consider the global optimization of the Omega function which is a performance evaluation measure for comparison between financial assets. When the Omega function is used as a basis for portfolio selection, the problem of choosing invested fractions to maximize Omega typically has many local solutions. Some computational experience is discussed using a global optimization technique from the NAG library. Balendra and Bogle discuss modular/black box global optimization in chemical engineering where design and analysis is dominated by the use of modular computational systems restricting the use of rigorous global optimization techniques. By casting modules in a generic form such systems could be recast to incorporate interval based methods. This paper explores the use of five interval contraction methods to improve the performance of interval based optimization of modular process design systems: consistency methods, constraint propagation, interval Gaussian elimination, interval Newton, and LP.

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