Imperial College London

Centre for Process Systems Engineering
2017 Seminar Series

UCL

New Developments in Flexibility Analysis and Global Optimization

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Abstract:

In this seminar we describe two new developments that are based on pioneering work by Chris Floudas. We first describe the relationship between flexibility analysis and robust optimization for linear systems. A historical perspective is given, which shows that some of the fundamental concepts in robust optimization have been developed in the area of flexibility analysis in the 1980s before the start of the era of robust optimization in the late 1990s. To compare the different approaches, we consider the three classical problems from flexibility analysis: the flexibility test problem, the flexibility index problem, and the design under uncertainty with flexibility constraints. The concepts that form the theoretical basis for the three different approaches are compared with adjustable robust optimization. It is shown that the latter can be seen as a special case of flexibility analysis that is more restrictive, and therefore may be overly conservative. For linear systems with a given general structure, two new solution approaches are proposed, where the first derives duality-based reformulations of the traditional active-set MILP formulations, and the second applies the concept of affinely adjustable robust optimization. We apply the three different approaches to several numerical examples, verifying some of the theoretical properties of the proposed formulations.

We next address the global optimization of nonconvex nonlinear generalized disjunctive programming (GDP) problems that include for instance bilinear, concave and linear fractional terms. In order to solve these nonconvex problems a *convex nonlinear GDP relaxation* is obtained by using suitable convex envelopes for the nonconvex terms. In order to predict tighter lower bounds to the global optimum we consider a sequence of basic steps for the convex relaxation that take a disjunctive set to another one with fewer conjuncts. Based on this procedure for strengthening lower bounds, we describe a solution method that relies on a logic-based outer-approximation algorithm that involves the solution of mixed-integer linear programming master problems and nonlinear programming subproblems for which new cuts are proposed, as well as a two-stage partition. A number of basic theoretical properties are proved, and we illustrate the application of this method in the global optimization of several process systems to demonstrate the computational savings that can be achieved with tighter lower bounds.

Bio:

Ignacio E. Grossmann is the R. R. Dean University Professor of Chemical Engineering, and former Department Head at Carnegie Mellon University. He obtained his B.S. degree at the Universidad Iberoamericana, Mexico City, in 1974, and his M.S. and Ph.D. at Imperial College in 1975 and 1977, respectively. He is a member and former director (2005-2015) of the "*Center for Advanced Process Decision-making*," an industrial consortium that involves about 20 petroleum, chemical, engineering and software companies. He is a member of the National Academy of Engineering, and associate editor of *AIChE Journal*. He has received the following AIChE awards, Computing in Chemical Engineering, William H. Walker for Excellence in Publications, Warren Lewis for Excellence in Education, and Research Excellence in Sustainable Engineering. In 2015 he was the first recipient of the Sargent Medal by the IChemE. He has honorary doctorates from Abo Akademi in Finland, University of Maribor in Slovenia, Technical University of Dortmund in Germany, University of Cantabria in Spain, and from the Russian Kazan National Research Technological University. He has been named Thomson Reuters Highly Cited Researcher in 2014-2016. His research interests are in the areas of mixed-integer, disjunctive and stochastic programming, energy systems including petroleum, shale gas and biofuels, water networks, and planning and scheduling for enterprise -wide optimization. He has authored more than 500 papers, several monographs on design cases studies, and the textbook "Systematic Methods of Chemical Process Design," which he co-authored with Larry Biegler and Art Westerberg. He has also organized the Virtual Library on Process Systems Engineering. Professor Grossmann has graduated 56 Ph.D. and 11 M.S. students.

24 February 2017, 11am
Lecture Theatre 3, RODH C333

Lecture Theatre 3, RODH C333, Roderic Hill Bldg, Chemical Engineering department, Imperial College London, SW7 2AZ;
Refreshments before the seminar in RODH C336 (opposite Lecture Theatre 3).
This event is free and open to the public. No registration is required.

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