Mathematical Program with complementarity constraints

Filter method in nonlinear optimization

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Identification

- Graduation (1990) - Informatic and Systems Engineering (University of Minho)
- MSc (1996) - Computational Mathematics - Optimization area (University of Minho)
- PhD (2001) - Production Engineering (Numerical Methods and Statistics) - Optimization area (University of Minho)

- Interests - nonlinear optimization, numerical methods, numerical modeling, biomedical optimization, ...

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MPCC - Motivation

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Mathematical Program with complementarity constraints

complementarity concept

$\Leftrightarrow$

system equilibrium

MPCC applications

- **Engineering problems**
  - contact and structural mechanic
  - obstacle problems
  - elastohydrodynamic lubrification
  - traffic equilibrium
- **Economic problems**
  - balance between supply and demand
  - Walsarian law of competitive equilibrium
  - games theory - Stackelberg games
- **Ecologic problems**
  - Quioto protocol

State of art - our experience, tools

- Interior point methods
- Relaxation approaches
- Penalty techniques
- Regularization schemes
- Nonlinear reformulation
  - electric power market
  - Stackelberg game

- Nonlinear solvers in NEOS server
- Programming in MATLAB language
- Using Optimization toolbox from MATLAB
- Interface with AMPL modeling language

Filter method

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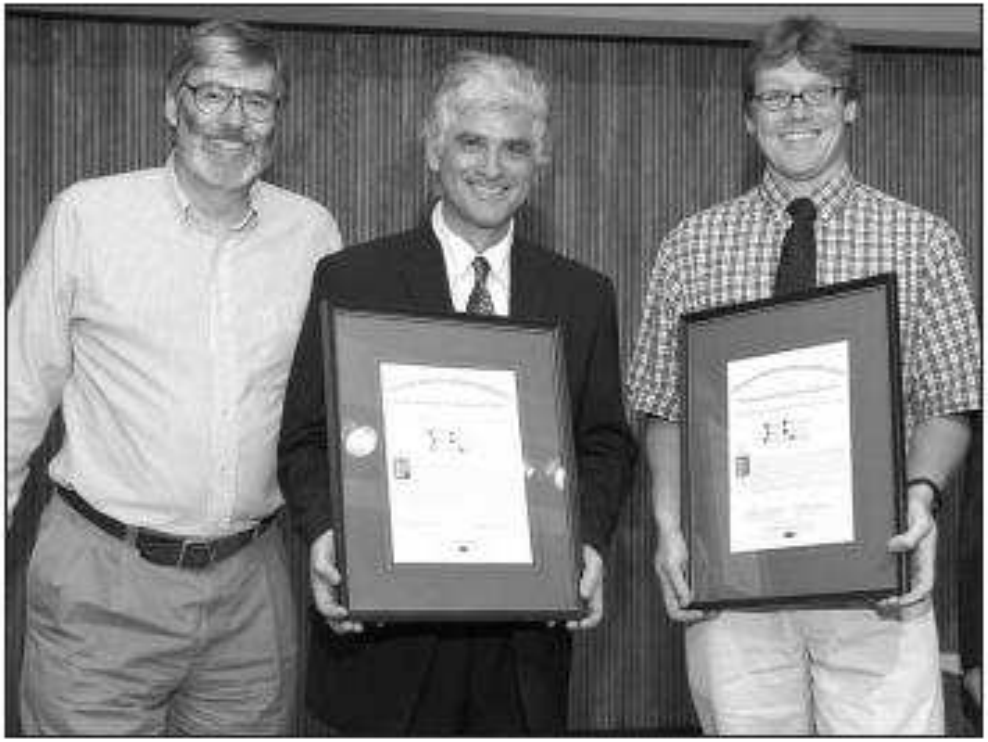
- SIAM recognizes outstanding achievement in Optimization



The Lagrange Prize for Continuous Optimization, established in 2003 as a joint prize of the Mathematical Programming Society and SIAM, was awarded in Boston to Roger Fletcher (University of Dundee), Sven Leyffer (Argonne National Laboratory), and Philippe Toint (University of Namur, Belgium). On hand to present the prize was selection committee chair Michael Todd (left), who is shown here with Toint (center) and Leyffer.

*The three researchers were honored for the following papers: "Nonlinear Programming Without a Penalty Function," by Roger Fletcher and Sven Leyffer (*Mathematical Programming, *91 (2), 239–269, 2002) and "On the Global Convergence of a Filter–SQP Algorithm," by Roger Fletcher, Sven Leyffer, and Philippe L. Toint (*SIAM Journal on Optimization, *Volume 13, 44–59, 2002).*

"In the development of nonlinear programming over the last decade," according to the prize citation, "an outstanding new idea has been the introduction of the filter. This new approach to balancing feasibility and optimality has been quickly picked up by other researchers, spurring the analysis and development of a number of optimization algorithms in such diverse contexts as constrained and unconstrained nonlinear optimization, solving systems of nonlinear equations, and derivative-free optimization. The generality of the filter idea allows its use, for example, in trust region and line search methods, as well as in active set and interior point frameworks.

"Currently, some of the most effective nonlinear optimization codes are based on filter methods. The importance of the work cited here will continue to grow as more algorithms and codes are developed.

"The filter sequential quadratic programming (SQP) method is proposed in the first of the two cited papers. Many of the key ideas that form the

Filter method - our experience, tools

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- filter method in Sequential Quadratic Programming (SQP)
- filter method in Inexact Restoration approach (IR)
- filter method to solve MPCC

- Programming in C language
- Interface with AMPL modeling language

Team, output and future work

Team

- António Manuel Sanches Antunes (PhD student)
- Cândida Elisa Pereira da Silva (Master degree)
- Helena Sofia Ferreira Rodrigues (Master degree)
- José Filipe Pedra Meira (MSc student)

Output

- 14 conference presentations, 9 papers
- 2 test problems in web public database (http://www-unix.mcs.anl.gov/ leyffer/MacMPEC/)
- 1^o prize in Poster Competition: 12th French-German-Spanish Conference on Optimization (FGS2004) Avignon, France, 20-24 Setembro, 2004.

Future work

- To find MPCC real applications
- To apply MPCC to semi-infinite programming
- To use filter method solving MPCC

The End

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