State of the Art in Using Optimization

Andrés Ramos

Instituto de Investigación Tecnológica

"The technology improvements in algorithms, modeling languages, software, and hardware have made the methodology accessible, easy to use, and fast. So the *Age of Optimization* has arrived"

George L. Nemhauser

"In the last decade, new advances in algorithms have been as important as the impressive advances in computer technology"
George L. Nemhauser

Content

- System modeling
- Solution methods
- Implementation in an optimizer
- Control parameters
- Strategies
- Algorithms
- Current record

System modeling

- "The amount of time it takes to solve a mathematical model may depend dramatically on how the model is formulated"
  - NLP problems
  - MIP problems
- Trade-offs
  - constraints vs. variables vs. non zero elements
  - piecewise linear vs. non linear
  - NLP vs. QP
- Presolve

LP methods

- simplex
  - ↗ primal
  - ↗ dual
- interior point
  - ↗ primal-dual predictor-corrector
  - ↗ projective

NLP methods

- augmented Lagrangian
- generalized reduced gradient

Implementation in an optimizer

- Recent survey in OR/MS Today
- LP
  - CPLEX
  - OSL
  - LAMPS
  - LINDO
- NLP
  - MINOS
  - CONOPT

Implementation of a model

- Modeling languages
  - GAMS
  - AMPL
  - LINGO
  - AIMMS
- Computer languages
  - C
  - FORTRAN

Control parameters of the optimizer

- convergence tolerances in constraints and objective function
- factorization and numerical stability
- linesearch tolerance

Strategies

- Initial solution
- Initial basis (primal and dual information)

Algorithms

- Decomposition
  - ↗ functional (hydro vs. thermal, intro vs. inter-area)
  - ↗ mathematical (Benders, Dantzig-Wolfe, Lagrangian, Cross)

Current record

- Size of LP problem:

  96505 constraints, 132633 variables and 382213 non zero elements

- Solution time:

  -2 hours in a workstation
  (162 SPECfp92, 114 SPECint92)