Multiobjective Optimization Software

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  - Software specific for discrete/choice problems not listed here
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Motivation

- Solving MO problems requires implementations of MO methods.
- No need for everybody to make their own implementations.
- Especially for interactive methods, the role of graphical user interface crucial in communication with the DM.
Excercise

Find software for multiobjective optimization from the Internet

Time: 10 minutes
Surveys of MO software

- *Gets outdated quite fast!*
- List of software at the MCDM Society webpage, [http://www.mcdmsociety.org/soft.html](http://www.mcdmsociety.org/soft.html)

Nonlinear Multiobjective Optimization - Uppsala University 2013
Commercial MO Software


'total packages’ from modelling to optimization
"Multidisciplinary and multi-objective software written to allow easy coupling to any computer aided engineering (CAE) tool”

Designed to be multiobjective

"State-of-the-art” in MO software

Multiobjective genetic algorithm (MOGA-II), multiobjective simulated annealing (MOSA), NSGA-II, multiobjective game theory, multiobjective particle swarm (MOPSO),…
”Optimus is a Process Integration and Design Optimization software, which bundles a collection of design exploration and numerical optimization methods”

– Weighting method
– $\varepsilon$-constraint method
– lexicographic programming, …
"Software for sensitivity analysis, multiobjective and multidisciplinary optimization, robustness evaluation, reliability analysis and robust design optimization”

- Multiobjective evolutionary algorithm
- Fitness assignment using strength Pareto ranking
- Preservation of diversity by density estimation
- Dominance based constraint handling
BOSS quattro

"BOSS quattro is an open application manager for parametric analyses, design of experiments, multidisciplinary optimization and sensitivity analysis, statistic analyses and updating."

multiobjective problems with user-driven objective weights
iSIGHT

“the industry leading process automation and design optimization solution”

- AMGA,
- NSGA II,
- NCGA,
- Particle Swarm
EMO libraries/platforms (open source)

- NSGA-II (C/C++),
  [http://www.iitk.ac.in/kangal/codes.shtml](http://www.iitk.ac.in/kangal/codes.shtml)
- PISA (language independent),
- paradisEO (C++),
- jMetal (Java),
Software Developed at JyU

- **WWW-NIMBUS** – a free www-based implementation for teaching and academic purposes since 1995, [http://nimbus.it.jyu.fi/](http://nimbus.it.jyu.fi/)

- **IND-NIMBUS** multiobjective optimization framework, [http://ind-nimbus.it.jyu.fi/](http://ind-nimbus.it.jyu.fi/)
  - several interactive multiobjective optimization methods in the same platform
  - possibility to change method during the solution process if needed
IND-NIMBUS
Interactive Multiobjective Optimization System

- Can be connected with different simulators or modelling tools (e.g. Matlab, GAMS)
- Includes
  - the NIMBUS method
  - Pareto Navigator
  - Pareto Front Interpolation (PAINT)
- Stores all the solutions computed
- Offers various visualizations for illustrating and comparing the solutions obtained
- Easy-to-use GUI (?)
Visualizing PO solutions

- Visualization of PO solutions → DM evaluates and compares the solutions obtained
- Visualization of the PO set easy for 2 objectives
  - can be shown as points in a plane
Visualizing PO solutions

Can be done for 3 objectives but interpretation more difficult (PO set is a surface in 3D)
Visualizing PO solutions

- Visualization difficult for more than 3 objectives
  - approximation of PO set can’t be easily visualized
- Projections of PO set w.r.t. 2 or 3 objectives can be visualized
  - all PO points doesn’t seems to be PO

From Subramani, Hidajat & Ray: Computers and Chemical Engineering, 27, 2003
Visualizing PO solutions

- Typically, only a small set of PO solutions visualized at a time for more than 3 objectives
- Different ways of visualizing individual solutions are used
  - Best visualization depends on the DM!
- Aim is to enable comparison of PO solutions
Examples of visualization techniques

- **3D bars**
  - a solution is presented by one color
Examples of visualization techniques

- Valuepath: one solution is presented by one piecewise linear segment

free an... alkalin... blower/...
Examples of visualization techniques

- Petal diagram: one solution is presented by a disc
- The more color in a sector, the worse value for the corresponding objective
Examples of visualization techniques

- Whisker plot: one solution is presented by a disc
- The more color, the worse value for the corresponding objective
Thank You!

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