INDUSTRIAL OPTIMIZATION GROUP



The Industrial Optimization Group developes theory, methodology and computer implementations for solving real-world decision-making problems. Most of the research concentrates on multiobjective optimization (MO) in which multiple conflicting objectives are optimized simultaneously and a decision maker (DM) is supported in finding a preferred compromise.

Interactive Multiobjective Optimization

Interactive MO actively supports DMs in finding a preferred solution by continuously involving them in the solution process to guide the search. Continuous involvement enables DMs to learn about their preferences and the problem/phenomenon considered as well as interdependencies between the objectives. In addition to the NIMBUS method utilized in solving many practical MO problems, recent methods concentrate on computationally demanding problems (Pareto Navigator) and avoiding the anchoring effect often encountered in MO (Nautilus).



Approaching the solution set in the Nautilus method



Sofware implementation

Optimization

The Group designs and implements MO software tools for DMs based on the methods developed. Interactive MO methods and hybrid EMO algorithms are of interest. The research addresses the most intuitive and efficient interaction techniques for the users, support for DMs in exploring multidimensional data, and reduction of user's cognitive burden. Usability plays an important role.



UNIVERSITY OF JYVÄSKYLÄ DEPT. OF MATHEMATICAL INFORMATION TECHNOLOGY

Evolutionary Multiobjective Optimization (EMO)

EMO aims at finding a representation of the solution set for MO problems by utilizing evolutionary principles. Hybrid EMO algorithms with better convergence and computational efficiency have been developed. In addition, the Group is actively developing novel algorithms, e.g. with unrestricted population size, and evolutionary operators for improved performance.

Applications

- Optimal control for continuous casting of steel
- Paper machine design
- Ultasonic transducer design
- Chemical process design for paper production
- Optimization of chemical separation processes
- Exhaust pipe design for two-stroke engines
- Intensity modulated radiotherapy treatment and brachytherapy planning
- Wastewater treatment plant design
- Heat exchanger network synthesis

Collaboration e.g. with

Carnegie Mellon University, USA Clemson University, USA ETH, Switzerland IIT Kanpur, India Poznan University of Technology, Poland Russian Academy of Sciences University of Catania, Italy University of Malaga, Spain University of Malaga, Spain University of Manchester, UK University of Wuppertal, Germany Aalto University, Finland Tampere University of Technology, Finland VTT Technical Research Centre of Finland

Software

- WWW-NIMBUS
- IND-NIMBUS

Approximation in Optimization

Approximation of objectives or solution sets in optimization is often utilized for computationally challenging problems. The use of meta-models as well as approximation and representation of solution sets of MO problems are being studied. The main research questions involve the quality of approximation and its usefulness and applicability for decision-making.



Meta-model approximation of an objective (CaCO3 fraction in a solid phase)

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"The essence of successful human actions is decision-making. The Industrial Optimization Group at the University of Jyväskylä uses mathematics, economics, and computer science to promote decision-making BY the people and FOR the people. Can sciences support our lives better?"

Prof. Margaret Wiecek, Clemson University, USA