On Continuation Methods for Non-Linear Multi-Objective Optimization

Benjamin Martin, Alexandre Goldsztejn,
Laurent Granvilliers, and Christophe Jermann

Université de Nantes
LINA - UMR 6241

Abstract: Recent advances in Non-Linear Multi-Objective Optimization (NLMOO) have focused on the use of continuation methods that exploit the continuity of solutions satisfying the first order optimality conditions. Given a single solution, continuation methods allow the inexpensive computation of a full component of connected solutions. The growing interest in combining continuation with NLMOO methods is noticeable in the recent literature. For instance, in Schtze et al. (2008) and Harada et al. (2007), continuation is associated with metaheuristics (respectively a Particle Swarm Optimizer and a Genetic Algorithm) in order to build solutions well scattered upon the Pareto set.

With a similar goal, Pereyra et al. (2009-2011) propose a continuation coupled with global optimization techniques in the bi-objective case. Within a set-oriented framework, Schtze et al. (2005) use continuation to fasten the computation of new portions of the Pareto set, and to recover connected parts possibly missed by the algorithm. Lovison (2011-2012) proposes a deterministic approach, using Delaunay tessellations and continuation to cover sets of solutions satisfying optimality conditions. This approach is global provided the tessellation cuts every connected components of solutions.

We propose a comparative overview of such NLMOO methods using continuations with the objective of showing their potential and weaknesses. One discussion of special interest is their ability to handle constrained NLMOO. We also introduce a novel rigorous continuation method based on recent advances in Interval Analysis. Used for NLMOO, it can in principle reconstruct a certified enclosure of the whole Pareto-optimal set provided one solution in each component of this set is given, i.e., under assumptions similar to Lovison (2011). Finally, we discuss how such initial guesses could be obtained.

Keywords: Interval Analysis, Hybrid Approaches, Non-Linear Multi-Objective Optimization, Path-Following Methods