

Are All Objectives Necessary?

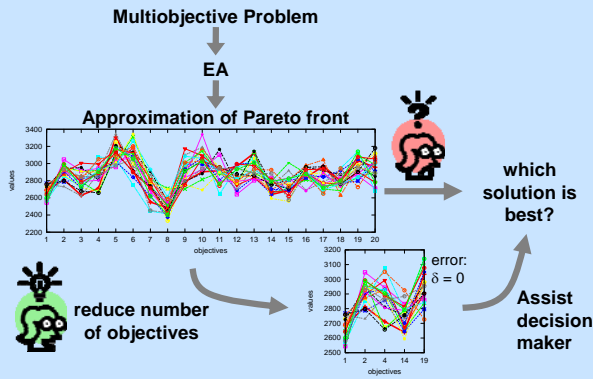
On Dimensionality Reduction in Evolutionary Multiobjective Optimization

1 Motivation

Problem: Decision making with many objectives is challenging

Questions:

- Can objectives be omitted while the dominance structure is preserved/only slightly changed?
- How to compute a minimum objective set?

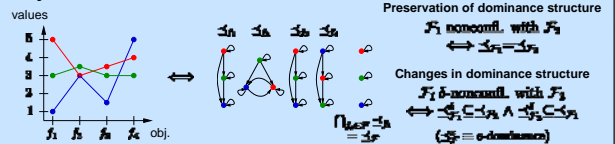


Drawbacks of known dimensionality reduction approaches:

- Not suitable for black-box optimization [Agrell 1997]
- No guarantee to preserve dominance structure [Deb and Saxena 2005]

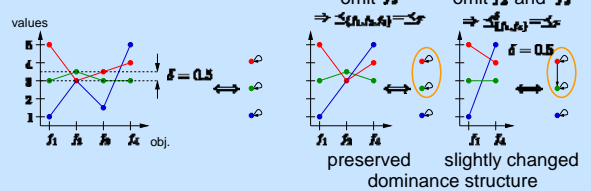
2 Approach

Objective Conflicts



- Pairwise objective conflicts \nrightarrow non-redundancy
- Omission of objectives \Rightarrow possibly additional edges

Dimensionality Reduction



The Minimum Objective Subset Problems

Given: Solution set A with objective values $f_1(x), \dots, f_k(x)$

δ -MOSS: Compute a minimum objective set, yielding a slightly changed relation with error $\leq \delta$

k-EMOSS: Compute an objective set with k objectives, changing the relation least

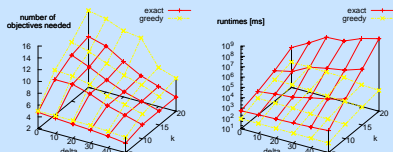
Algorithms

- exact**
- $\mathcal{O}(|A|^k \cdot k \cdot 2^k)$, and $\mathcal{O}(|A|^k \cdot 2^{k^2})$ resp., for δ -MOSS and k-EMOSS
- greedy**
- $\mathcal{O}(\min(|A|^k \cdot k^2, |A|^k \cdot k^2))$ for δ -MOSS
 - $\mathcal{O}(|A|^k \cdot k^2)$ for k-EMOSS

3 Results

Exact algorithm vs. heuristic

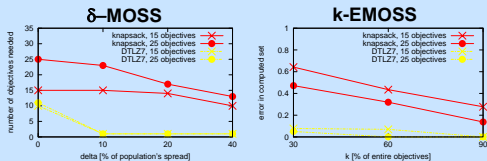
entire search space of 0-1-knapsack problem with 7 items



\Rightarrow heuristic slightly worse results, but clearly faster

Different problems act differently

Pareto front approximations for 0-1-knapsack and DTLZ7



\Rightarrow the smaller the objective set, the larger the error
 \Rightarrow general statements on redundancy impossible

4 Conclusions

Key Contributions:

- Generalization of conflict between objective sets
- Framework for objective reduction to assist the decision maker

Benefits of the Approach:

- Definition of conflict between objective sets can detect redundancy
- Objective reduction is adjustable by defining error threshold or largest allowed objective set size
- Approach guarantees maximal error in dominance structure change

Take Home Message: Given a set of solutions, objective reduction is possible by preserving or only slightly changing the dominance structure. The omission of redundant information can assist the decision maker.