GECCO 2021 Tutorial on Benchmarking Multiobjective Optimizers 2.0

Teaser slides only

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The final slides will be made available at
http://www.cmap.polytechnique.fr/~dimo.brockhoff/

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Isn't Benchmarking Trivial?

- Choose some algorithms
- Choose some test functions
- Discuss the results

Isn't Benchmarking Trivial?

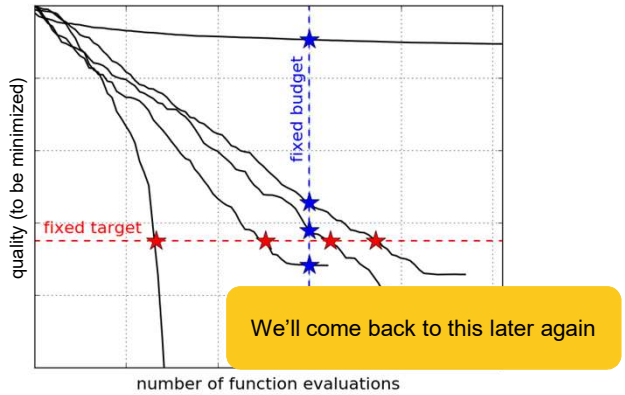
In principle: yes

But many details and pitfalls

and in addition
- we compare sets of solutions
- which might be random (in size, position, dimension, …)
- …

We Typically Start with Convergence Graphs

(…in single-objective optimization)



We'll come back to this later again

Overview

Our plan

Discuss history, present and future of multiobjective benchmarking

With respect to different topics

- performance assessment / methodology
- test functions

Finally, recommendations on good algorithms

Disclaimer

This is not an introductory tutorial to multiobjective optimization!

We assume you know basic definitions like

- Objective function
- Pareto dominance/Pareto front/Pareto set
- Ideal/Nadir points

Disclaimer II

We only consider continuous search spaces

We only consider unconstrained problems

What we present is highly subjective & selective

- how important do we find each milestone?
- use version numbering and branches
- what have we learned from the past?

Overview

❶ Performance Assessment
❷ Test Problems and Their Visualizations
❸ Recommendations from Numerical Results

Overview Performance Assessment

Performance Assessment

- **v0.0.1alpha:** visual performance assessment
- **v0.1beta:** tabular performance assessment
- **v1.0:** status of 2005 tutorial by Knowles, Thiele and Zitzler
  - the empirical attainment function
  - v1.0.1 – v1.0.100: indicator based performance assessment
- **v2.0:** anytime performance assessment (horizontal vs. vertical, ECDFs)
  - suggestions of what to look at, which questions to ask, …
  - general recommendations for performance assessment

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Overview Test Problems

Test Problems

Artificial problems

- **v0.1:** individual problems
- **v0.2:** MOP suite (unscalable problems)
- **v0.5:** ZDT suite (scalable number of variables)
- **v1.0:** DTLZ suite (scalable number of variables and objectives)
- **v1.2:** WFG suite
- **v1.3:** CEC suites
- **v1.3.5:** other DTLZ-like suites
- **v1.5:** suites of distance-based problems
- **v2.0:** bbob-biobj(-ext) suite

Real-world problems

- **v0.1:** individual problems
- **v0.5:** suites of unscalable problems
- **v1.0:** suites of scalable problems

Overview Problem Visualizations

Visualization of multiobjective landscapes

Low-dimensional search spaces

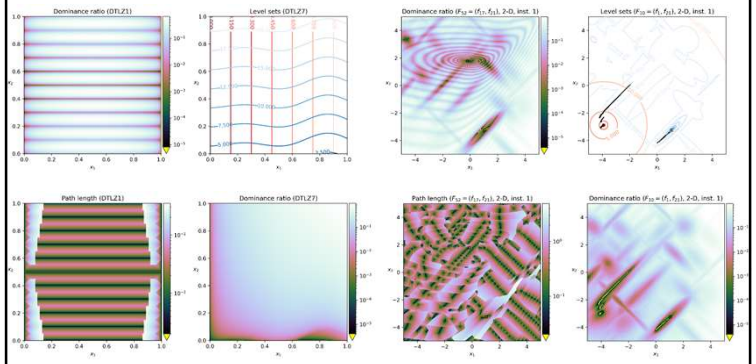
- Dominance ratio
- Local dominance
- (Cumulative) gradient

Any-dimensional search spaces

- Line cuts
- Optima network

Visual Comparison of Test Problems

Version 1.0 **DTLZ 1** and **DTLZ 7** vs. Version 2.0 **bbob-biobj F52** and **F10**



Overview

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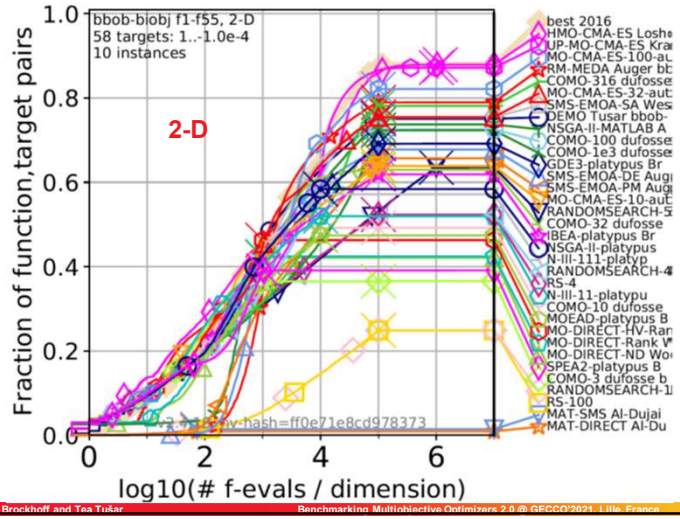
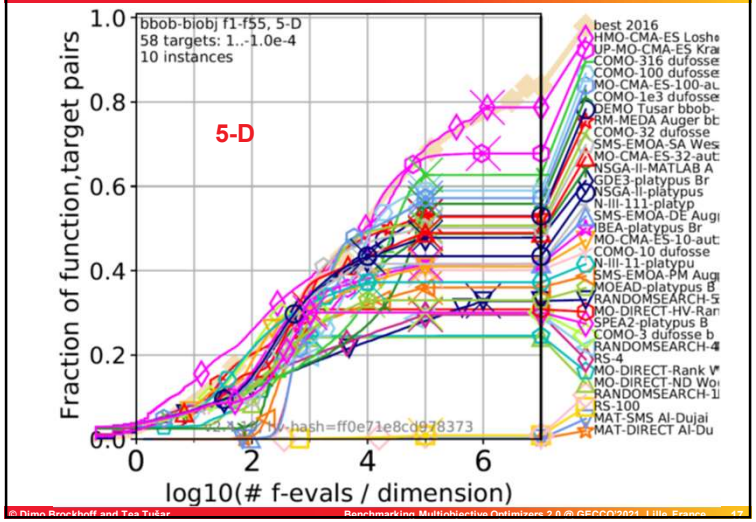
```
python -m cocopp bbob-biobj*
```

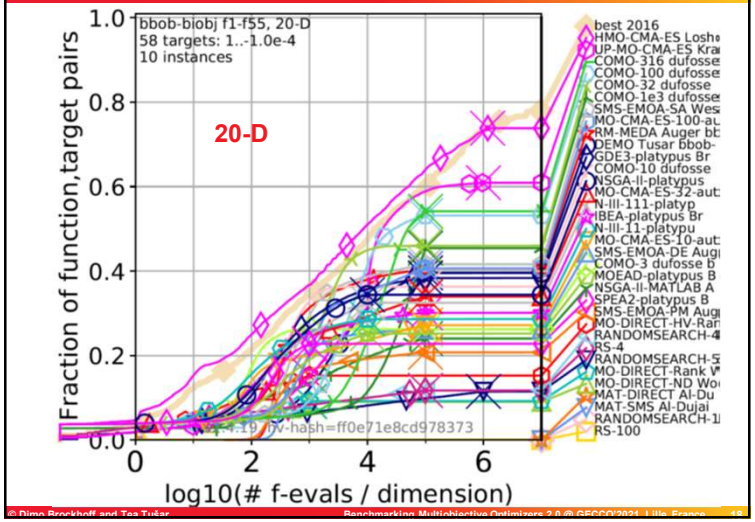

Aggregated Results Over All 55 Functions



Aggregated Results Over All 55 Functions



Aggregated Results Over All 55 Functions



Instructor Biography: Dimo Brockhoff

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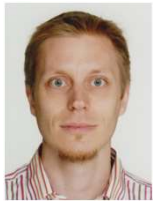

After obtaining his diploma in computer science (Dipl.-Inform.) from University of Dortmund, Germany in 2005, Dimo Brockhoff received his PhD (Dr. sc. ETH) from ETH Zurich, Switzerland in 2009. After postdoctoral research positions at Inria Saclay Ile-de-France in Orsay and at Ecole Polytechnique in Palaiseau, both in France, Dimo has been a permanent researcher at Inria: from 2011 till 2016 with the Inria Lille - Nord Europe research center and since October 2016 with the Saclay - Ile-de-France research center, co-located with CMAP, Ecole Polytechnique, IP Paris. His most recent research interests are focused on evolutionary multiobjective optimization (EMO) and other (single-objective) blackbox optimization techniques, in particular with respect to benchmarking, theoretical aspects, and expensive optimization.

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Tea Tušar is a research fellow at the Department of Intelligent Systems of the Jožef Stefan Institute in Ljubljana, Slovenia. She was awarded the PhD degree in Information and Communication Technologies by the Jožef Stefan International Postgraduate School for her work on visualizing solution sets in multiobjective optimization. She has completed a one-year postdoctoral fellowship at Inria Lille in France where she worked on benchmarking multiobjective optimizers. Her research interests include evolutionary algorithms for singleobjective and multiobjective optimization with emphasis on visualizing and benchmarking their results and applying them to real-world problems.