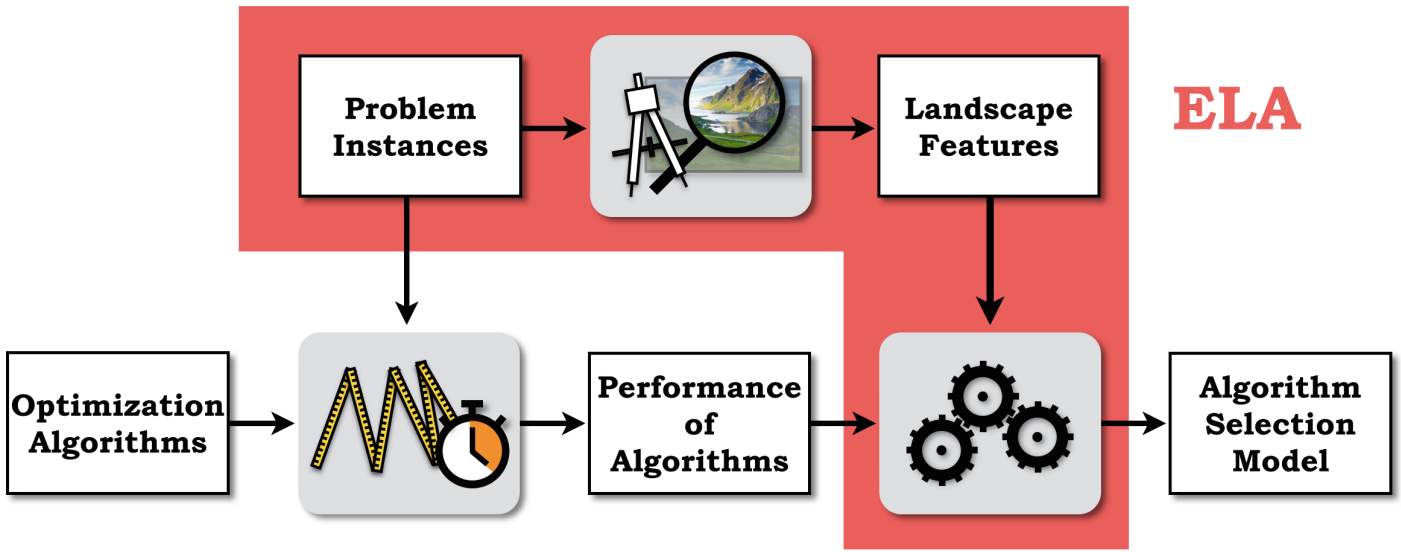
General Idea of Exploratory Landscape Analysis

Introduction

Goal:

- improve understanding of (continuous black-box) problems
- describe relationship between algorithm behavior and underlying problem
- ultimate goal for algorithm selection problem[1] (ASP): select the "best" algorithm



[1] Rice, J. (1976). *The Algorithm Selection Problem*. In: Advances in Computers (pp. 65 – 118).

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Idea of *Exploratory Landscape Analysis (ELA):*

- characterize black-box problems by numerical (and thus automatically computable) values
- start with very simple features without clear purpose
- match existing high-level features[2] with our ELA features

[2] high-level features = properties / characteristics of the problem landscape as categorized by an expert

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Notes I:

- functional relationships are unknown when designing features (usually one has a vague idea of what kind of property one would like to "measure")
- pure numbers of a single feature on a single problem are basically meaningless
  - $\rightsquigarrow$ look at combination of features and/or compare the values across problems

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Notes II:

- try to match the features to high-level characteristics[5] (multimodality, funnel structure, etc.) of optimization problems
- this enables recognizing important problem properties quickly (and without consulting an expert)

[5] usually via classification models, whose "class labels" are the problem properties

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Notes III:

- features are based on initial design of samples $x_{i1}, \ldots, x_{iD}$ and their corresponding fitness values y_i, $i = 1, \ldots, n$
- given an evaluated initial design[6], most ELA features are for free
  $\rightsquigarrow$ they don't need any further function evaluations
- multiple different feature sets already exist, and we will introduce some of them on the following slides[7]

[6] usually a well-spread sample (LHS, random uniform sample, etc.); however, using the initial population of an optimizer is also possible

[7] for further details, please attend "ELA Tutorial" at PPSN 2018 ;-)

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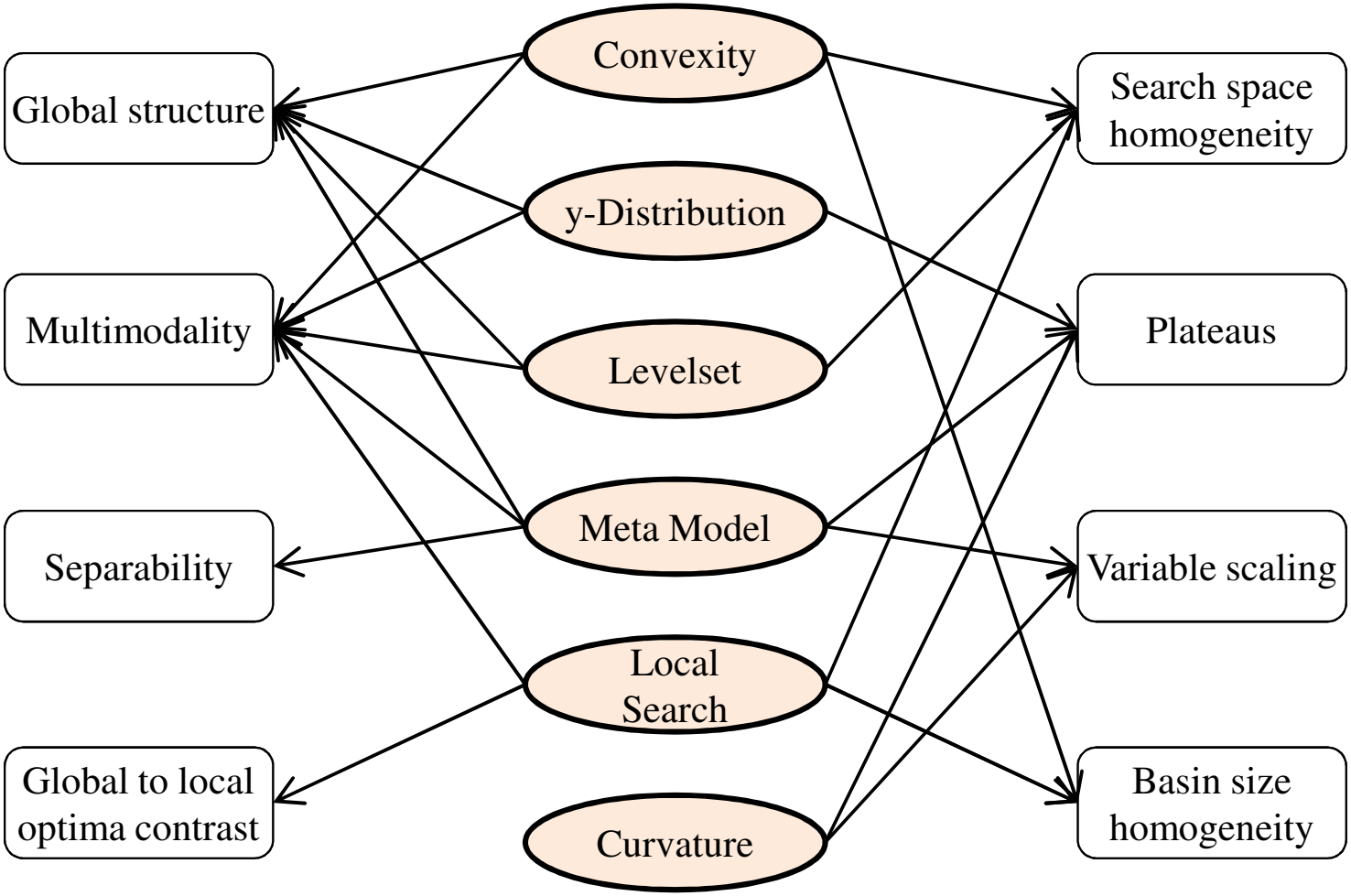


Mersmann, O., Preuss, M. & Trautmann, H. (2010). *Benchmarking Evolutionary Algorithms: Towards Exploratory Landscape Analysis*. In: Proceedings of PPSN XI (pp. 71 - 80).

FLACCO + GUI

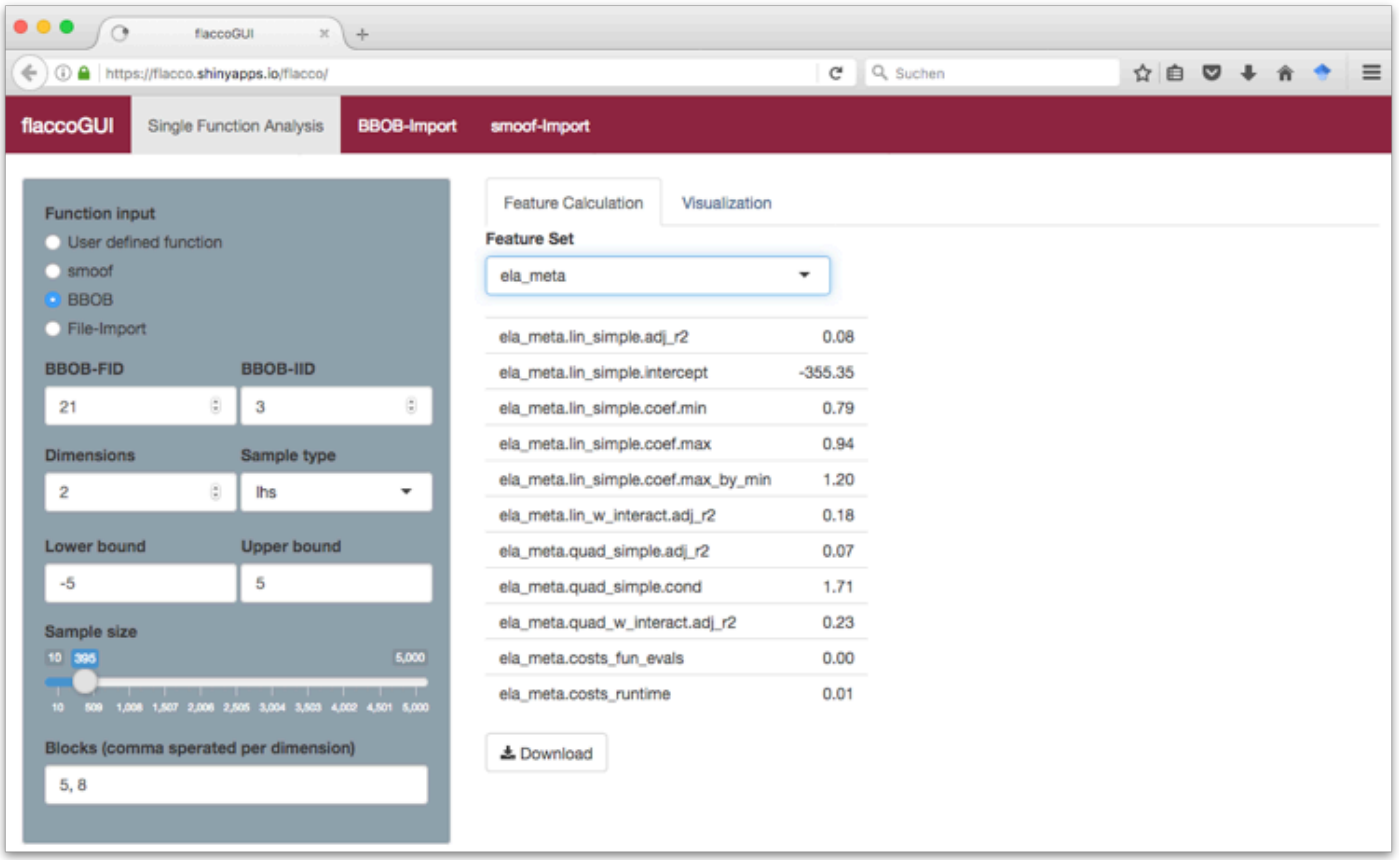
Notes I:

- `flacco`: **F**eature-Based **L**andscape **A**nalysis of **C**ontinuous and **C**onstraint **O**ptimization Problems
- unified interface for multiple (single-objective) sets of configurable features
- stable release on CRAN / developers version on GitHub
- multiple vizualisation techniques (partially shown on these slides)

FLACCO + GUI

Notes II:

- `flacco` also comes with a platform-independent web-application



[8]

[8] Link to GUI: `https://flacco.shinyapps.io/flacco/`

FLACCO + GUI

Notes III:

- tracks # of function evaluations and run time - per feature set
- `FLACCO` is described in our CEC paper:

  Kerschke, P. & Trautmann, H. (2016). *The R-Package FLACCO for Exploratory Landscape Analysis with Applications to Multi-Objective Optimization Problems*. In: Proceedings of CEC 2016.

- further information on `FLACCO`, its GUI, or the contained feature sets can be found here:

  Kerschke, P. (2017). *Comprehensive Feature-Based Landscape Analysis of Continuous and Constrained Optimization Problems Using the R-Package flacco*.
  In: `https://arxiv.org/abs/1708.05258`.