Evidence accumulation in multiobjective data clustering

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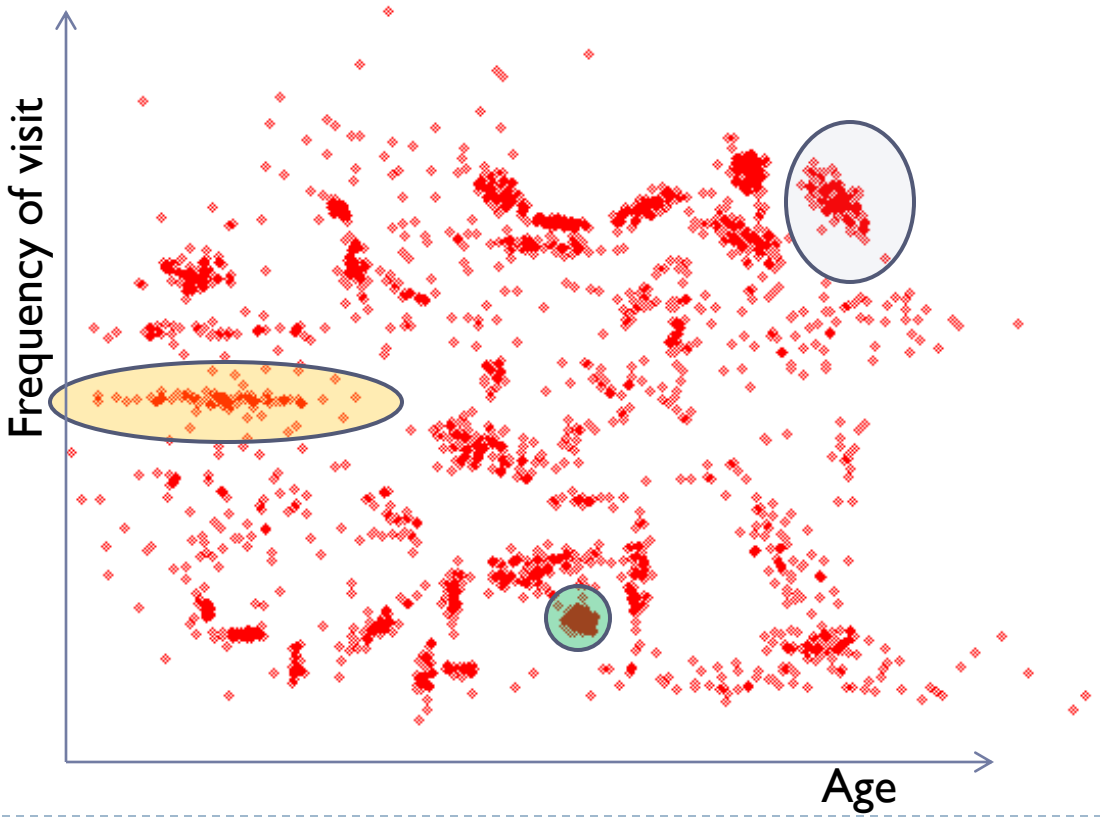
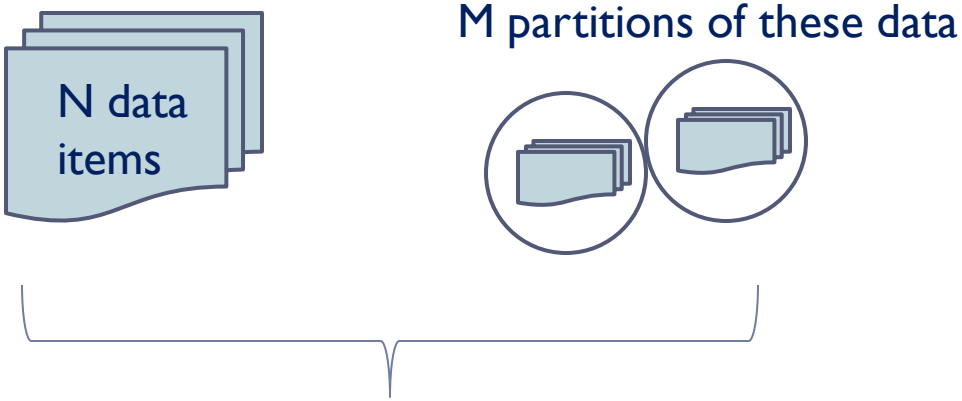
Data clustering

Unsupervised classification.
Finding groups of data items that are similar "in some sense".



Evidence accumulation

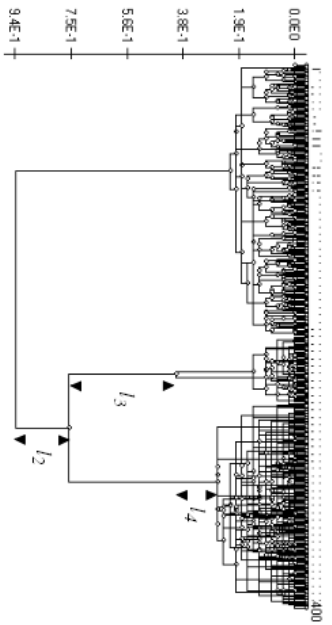


The $N \times N$ co-association matrix is then defined as $C(i, j) = \frac{m_{ij}}{M}$ where m_{ij} indicates the number of times data items i and j have been assigned to the same cluster, e.g.

$$\begin{pmatrix} 1 & \frac{m_{12}}{M} & \frac{m_{13}}{M} & \frac{m_{14}}{M} \\ \frac{m_{21}}{M} & 1 & \frac{m_{23}}{M} & \frac{m_{24}}{M} \\ \frac{m_{31}}{M} & \frac{m_{32}}{M} & 1 & \frac{m_{34}}{M} \\ \frac{m_{41}}{M} & \frac{m_{42}}{M} & \frac{m_{43}}{M} & 1 \end{pmatrix}$$

This can be used to construct a dissimilarity matrix for a further clustering step.

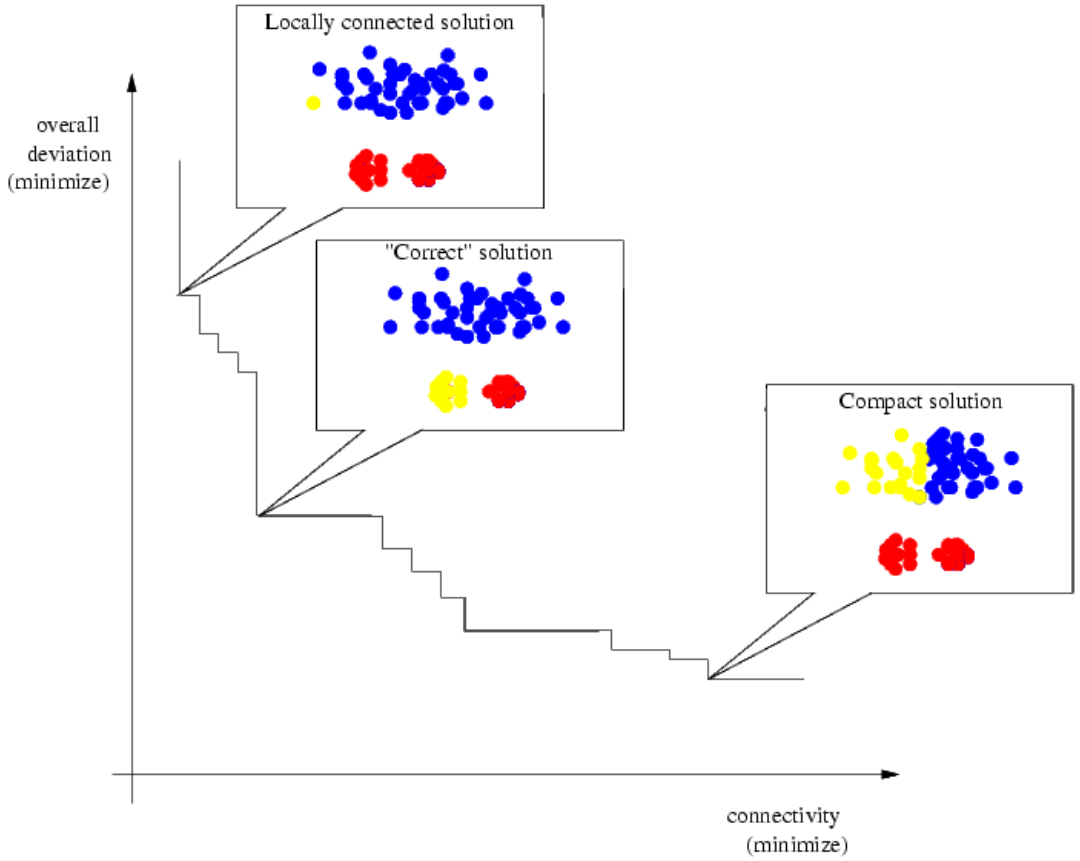
(Fred & Jain, 2005)



Multiobjective clustering

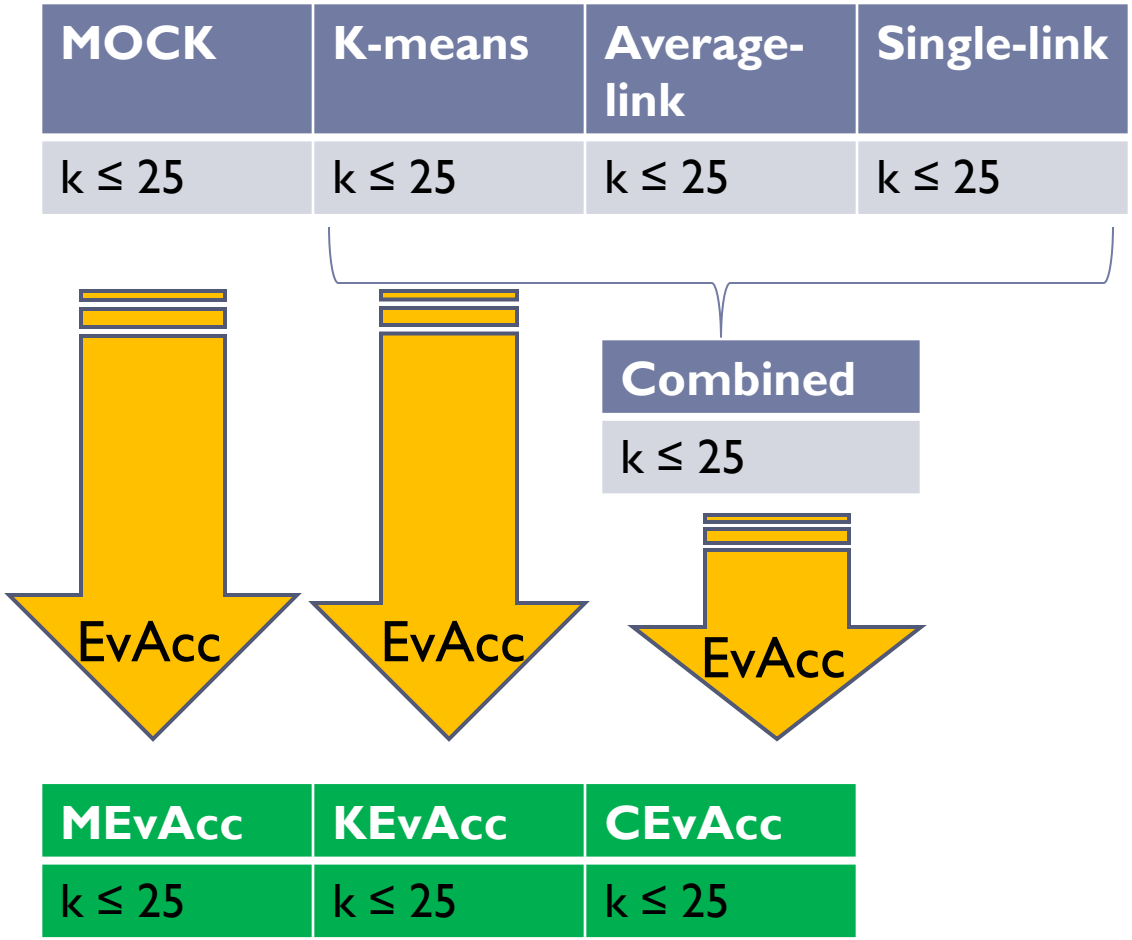
Use of an MOEA to optimize more than one clustering criterion simultaneously (MOCK).

(Handl & Knowles, 2007)

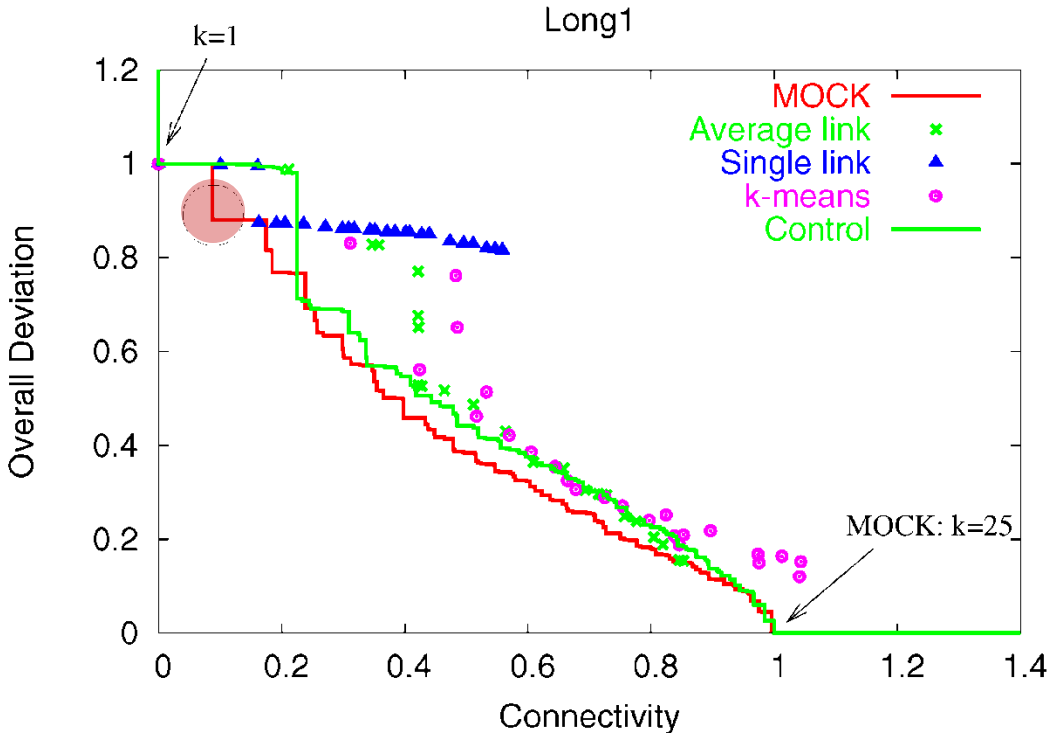


- Previously:
  - MOCK returns a set of solutions (Pareto front approximation)
  - A single preferred solution is selected from the front (model selection)
- Research question: Could we better exploit the information intrinsic to this "ensemble" of solutions?
  - Improved accuracy?
  - Support for model selection?
  - Insight into data?
- Use of Evidence Accumulation to "post-process" MOCK's clustering solutions

Methods to generate input partitions



Methods for model selection



Random control data	Minimum angle	Maximum branch length
MOCK	Any EvAcc	Any EvAccc

Model selection

Introduction

Research focus

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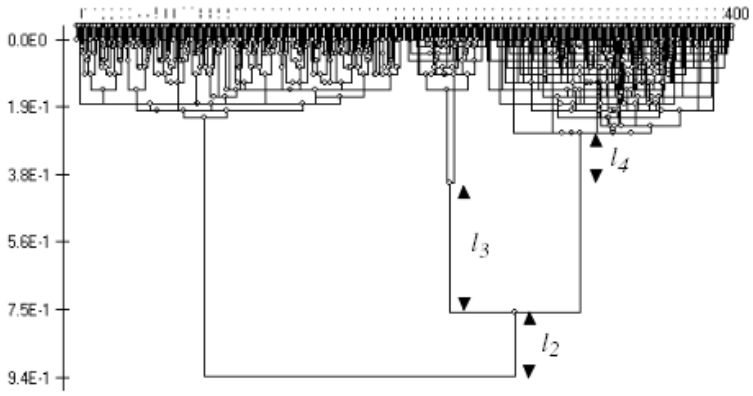
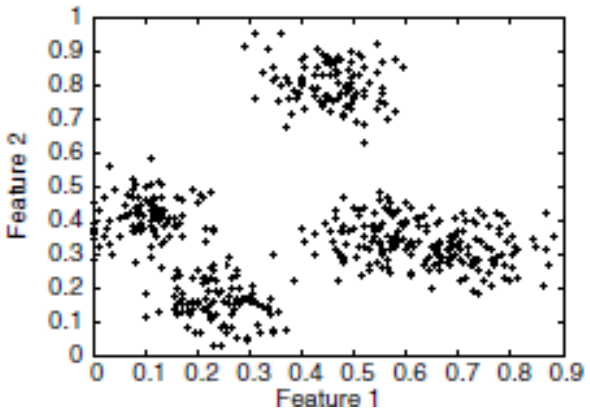
Conclusion



(Fred & Jain, 2005)

Test suite of Gaussian clusters

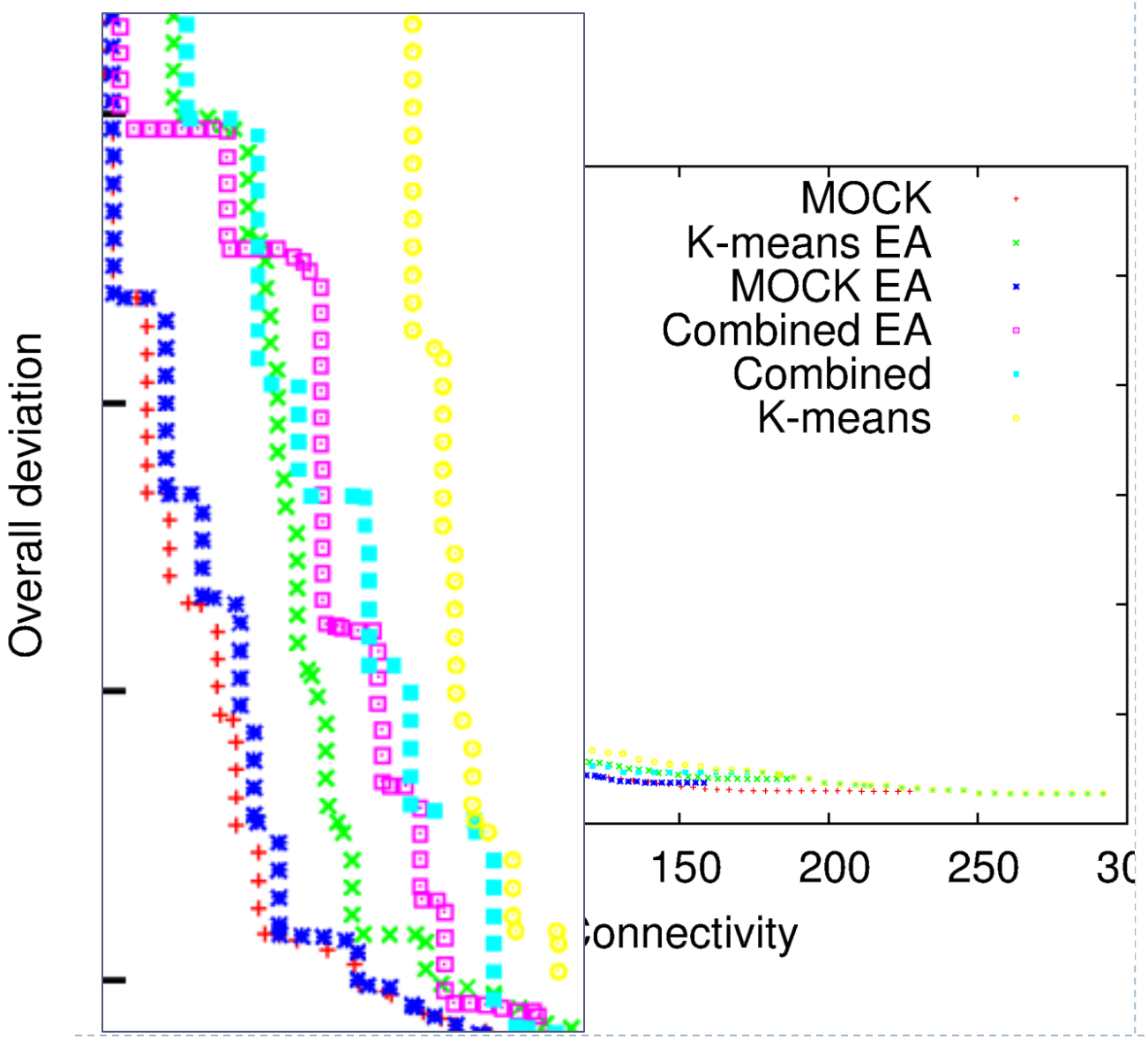


Generator available online; Parameters in paper; 21 runs per instance.

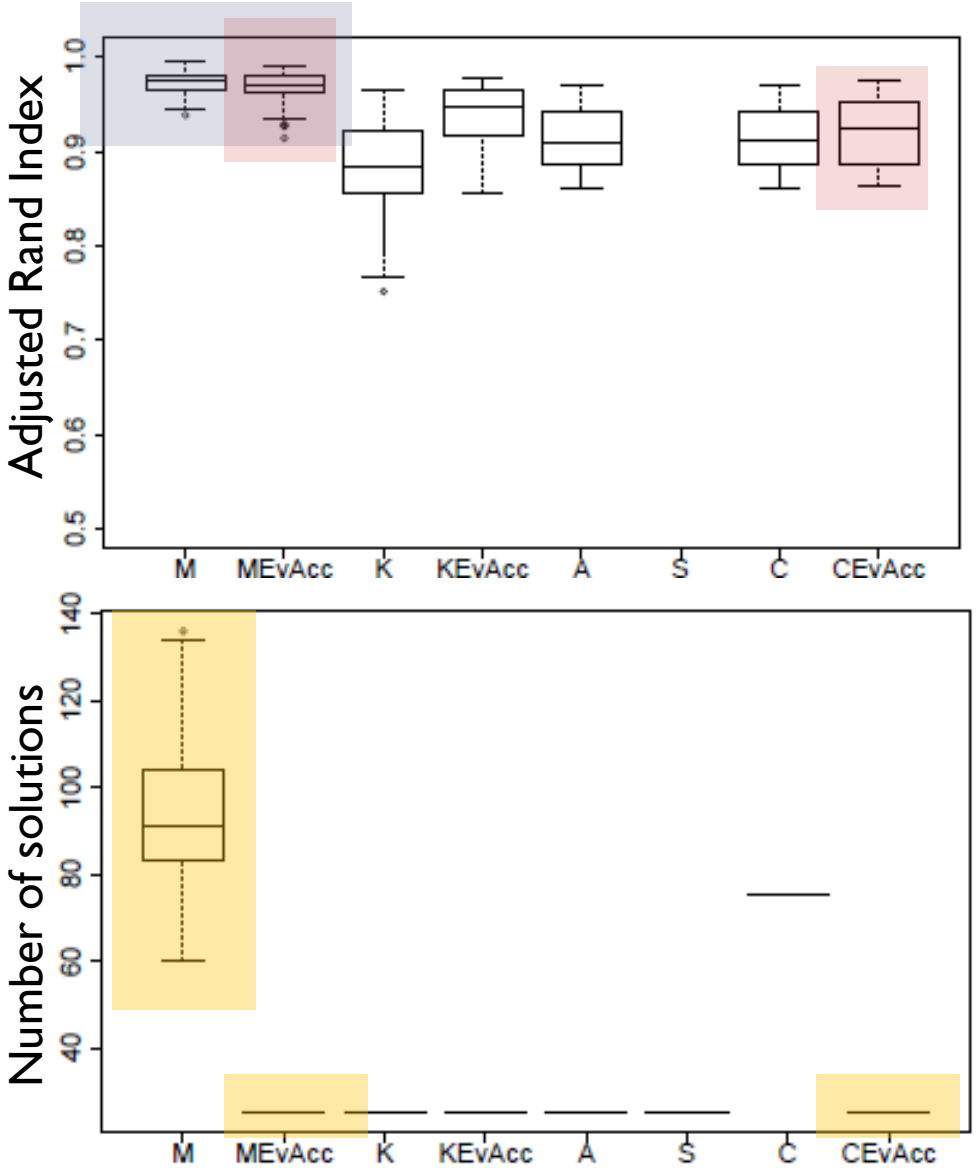
Name	Dimensionality	Number of clusters	Instances
3d-4c	3	4	10
3d-6c	3	6	10
3d-8c	3	8	10
10d-4c	10	4	10
10d-6c	10	6	10
10d-8c	10	8	10

- Performance evaluation
  - Visualization in bi-objective space (attainment fronts)
  - External validation (Adjusted Rand Index)
    - Best ***generated***
    - Best ***selected***
  - Size of solutions sets

Median attainment fronts (3d-8c-no0)



Best generated & Solution Set Size



(10d-8c)

Results

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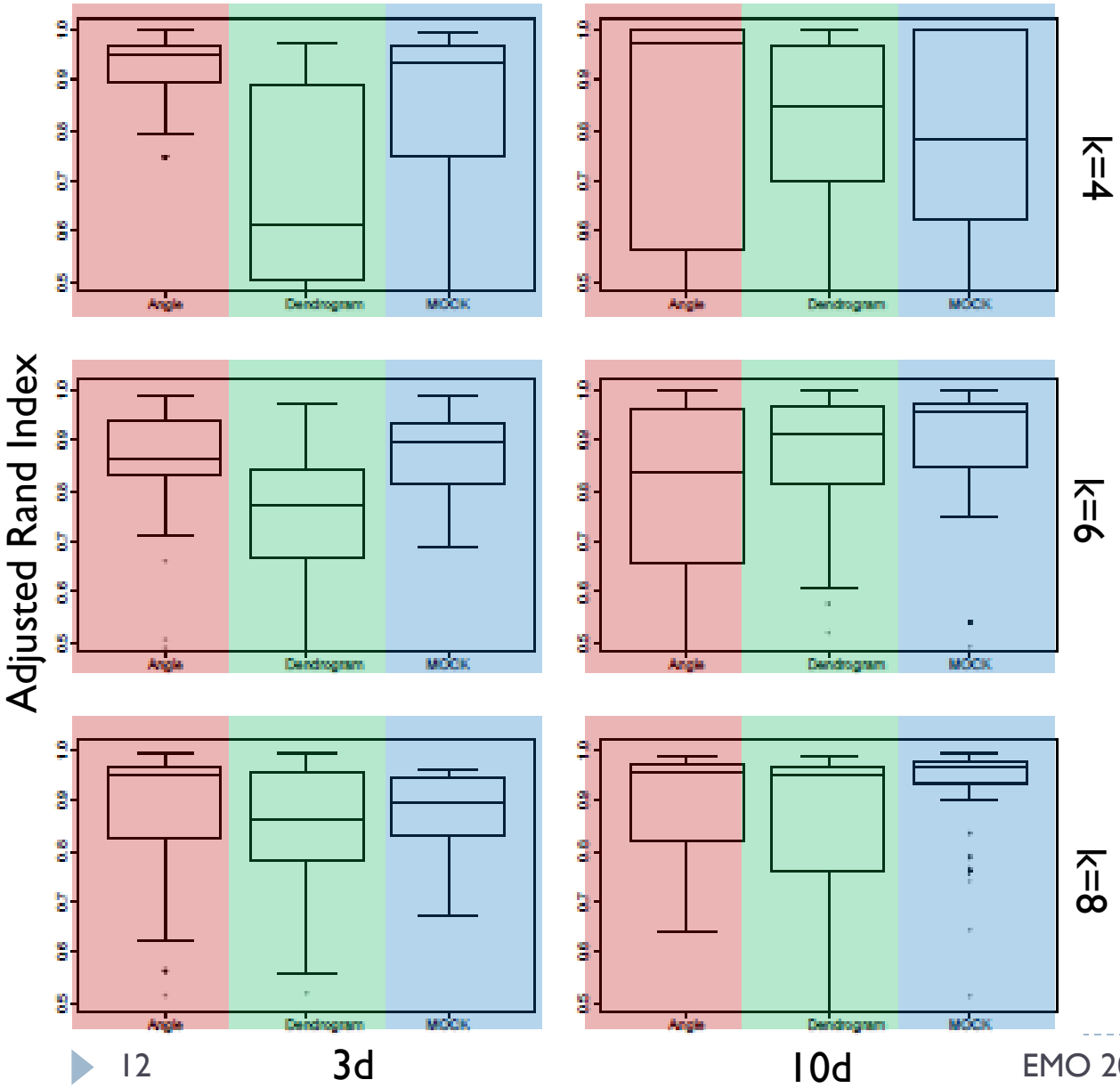
- Best selected



Results

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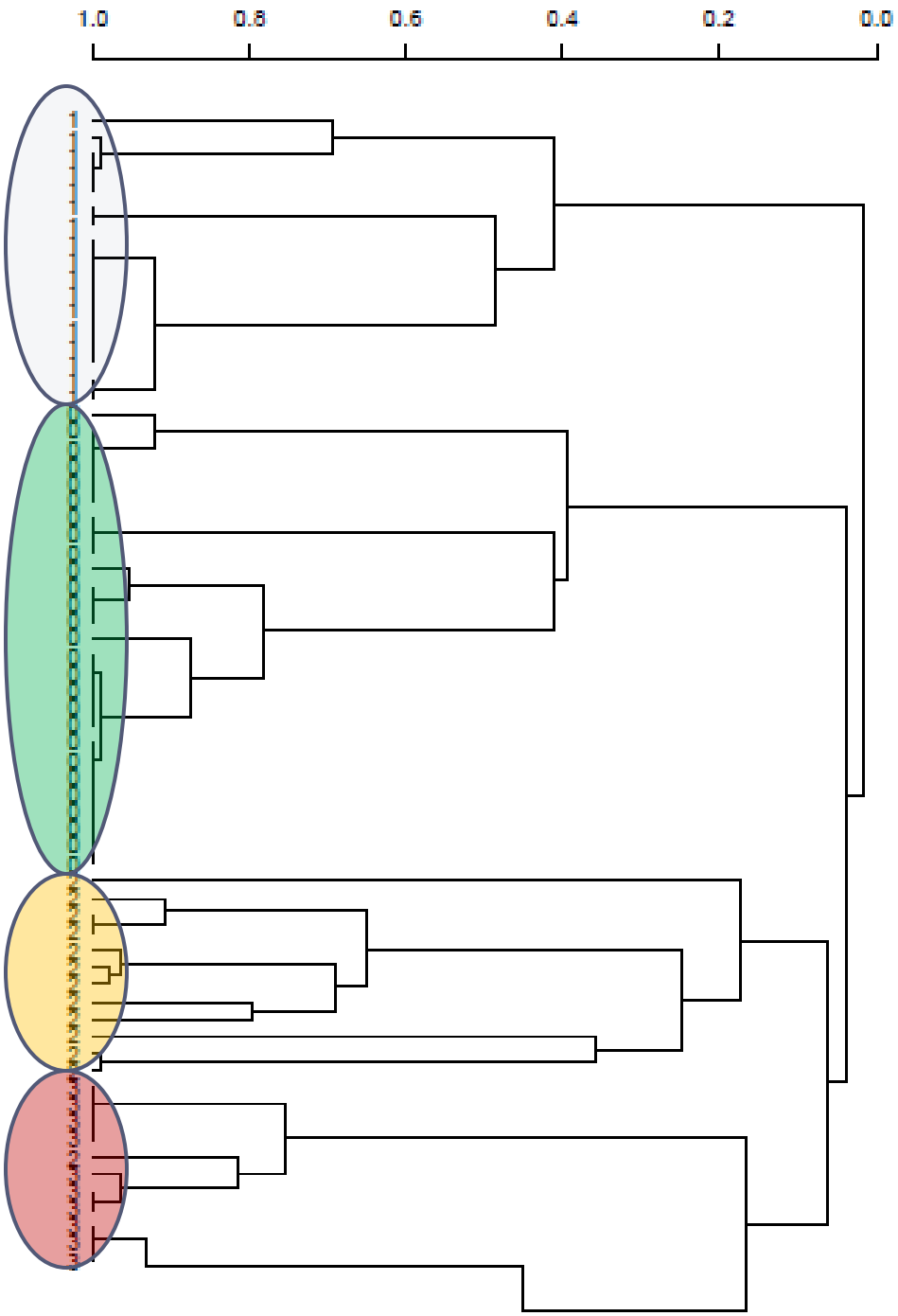
Legend:
Minimum angle
Maximum branch length
Random control data

Key findings

- MOCK with Evidence Accumulation:
  - Small decrease in average optimization performance and external validity
  - Significant reduction in size of solution sets
- Different inputs to Evidence Accumulation:
  - Best performance for clustering input from MOCK
  - To some extend, Evidence Accumulation appears to "implicitly optimize" MOCK's objectives
- Solution selection:
  - Inconsistent performance (potential for hybridization?)



Future work

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Research focus

Experiments

Conclusion