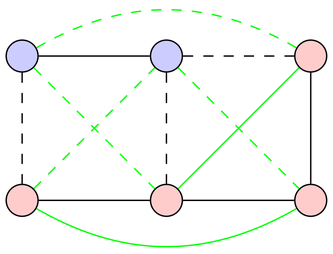

Solving Minimum Cost Lifted Multicut Problems by Node Agglomeration

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Lifted Multicut Problem

Solutions to the Minimum Cost Lifted Multicut Problems **(MCLMP)**s correspond to decomposition of a graph into an optimal number of segments.

Properties of MCLMP:

- NP-hard problem
- No need to specify the number of segments
- Generalization of MCMPs (correlation clustering)
- Consider long range connections

Related Work

GAEC [1] properties:

- Guaranteed worst case complexity
- Low quality results
- Short run-time

KLj [1] and FM-R [2] properties:

- Without guaranteed worst case complexity
- High quality results
- Long run-time

Exemplary results of KLj and GAEC with lifting radius 10

KLj

GAEC

Contributions

We propose 2 variants of a heuristic solver based on GAEC [1]:

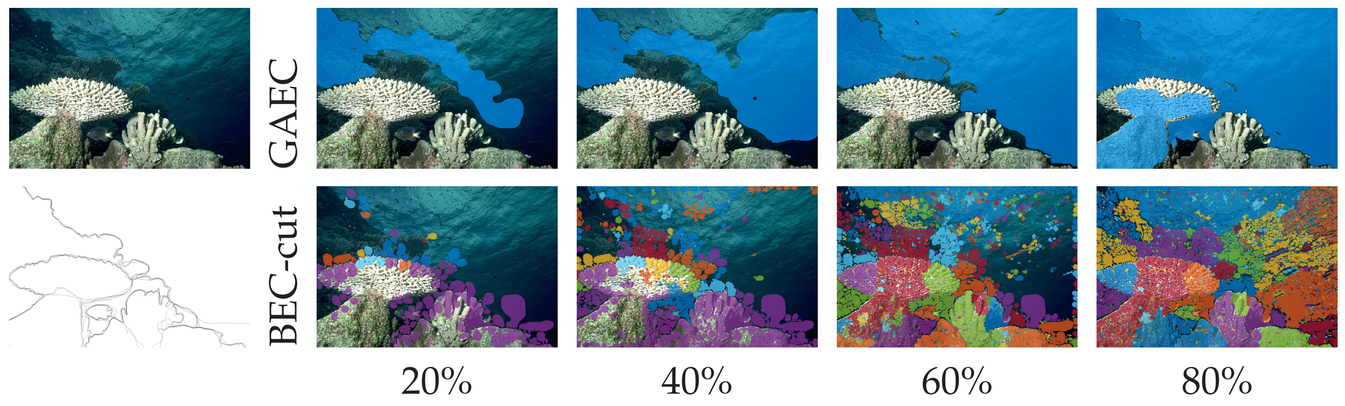
1. Balanced Edge Contraction **(BEC)**
2. **BEC-cut**

Properties of the proposed solvers:

- Generated solutions have qualities close to KLj [1]
- Computation time is similar to GAEC [1]
- Guaranteed worst case complexity

Problem Specification

Visualization of intermediate states during execution of **GAEC** [1] and the proposed **BEC-cut** solver



Technical Details

Balanced Edge Contraction (BEC)
Creates balanced clusters
Criteria:
Assuming separate clusters a' and b' and their merging cost $\chi_{a'b'}$
on graph $\mathcal{G} = (\mathcal{V}, \mathcal{E})$

$$ab := \underset{a'b' \in \mathcal{E}}{\operatorname{argmax}} \frac{\chi_{a'b'}}{|a'|+|b'|}$$

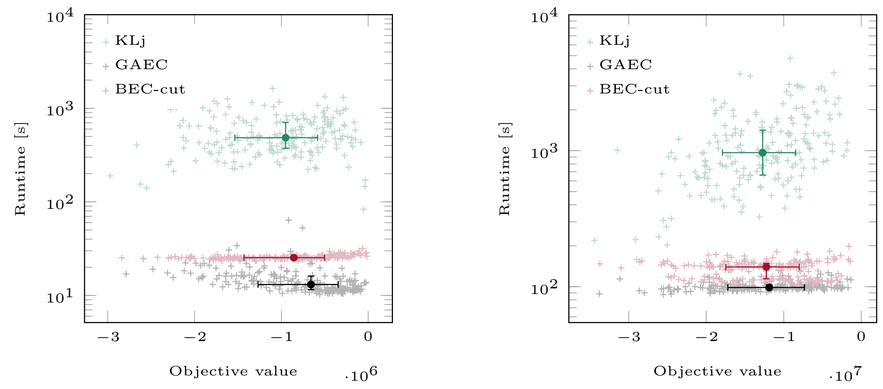
BEC-cut
Creates clusters along the object boundaries
Criteria:
Assuming separate clusters a' and b' and outgoing costs $\zeta_{a'}$ and $\zeta_{b'}$

$$\mathcal{S} := \underset{a'b' \in \mathcal{E}}{\operatorname{argmax}} \frac{\chi_{a'b'}}{|a'|+|b'|}$$
$$ab := \underset{a'b' \in \mathcal{S}}{\operatorname{argmin}} \frac{\zeta_{a'}+\zeta_{b'}-2\chi_{a'b'}}{|a'|+|b'|}$$

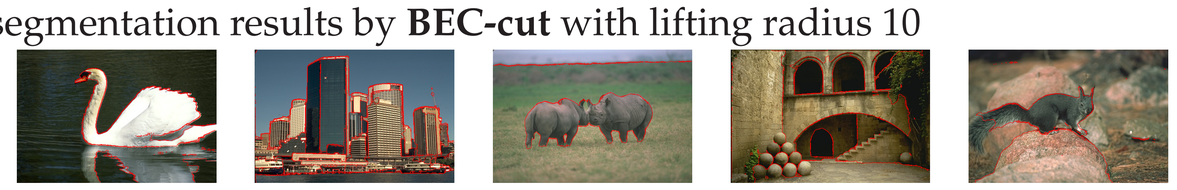
Priority queue is used for an ordered sequence of costs.

Image Decomposition

Comparison of **BEC, BEC-cut, GAEC** [1] and **KLj** [1] on BSDS500 with lifting radius 10 (**left**) and 20 (**right**)



Exemplary segmentation results by **BEC-cut** with lifting radius 10



Mesh Segmentation

Average computation time and objective value of the different solvers

	GAEC [1]	KLj-GAEC [1]	BEC	BEC-cut
Avg. Comp. time [s]	576	755	589	574
Avg. Objective Value	-17840450	-18988930	-18484140	-18057480

Exemplary segmentation results by **BEC-cut**

Future Direction

Providing good quality segmentation results in affordable amount of time motivates applying these solvers to the larger scale problems such as video segmentation.

Paper Website

The paper and code for generating lifted multicut problems are available at

`http://web.informatik.uni-mannheim.de/akardoos/`

References

[1] M. Keuper, E. Levinkov, N. Bonneel, G. Lavoué, T. Brox and B. Andres. Efficient Decomposition of Image and Mesh Graphs by Lifted Multicuts In *ICCV '15*

[2] T. Beier, B. Andres, U. Köthe and F. A. Hamprecht. An Efficient Fusion Move Algorithm for the Minimum Cost Lifted Multicut Problem. In *ECCV '16*