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Decomposition Algorithms for the Dissection of Tissue Samples

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Introduction

Laser capture microdissection (LCM) is used to extract disease-specific regions from heterogeneous tissue samples. Tissue material collected with LCM provides more accurate molecular characterizations of diseases. The success of the dissection depends on size and shape of the regions. The selection of correct regions usually requires extensive user-interaction. For the usage of LCM in larger-scale clinical studies, procedures need to be automated.

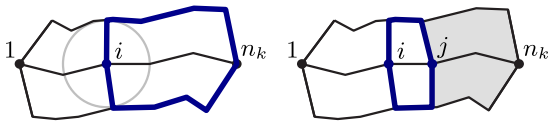
Biological problem Select regions that can be successfully dissected with LCM while requiring limited user-interaction. → **Computational problem** Use image data and compute decompositions of polygons with suitable constraints.

Method: MaxFat decomposition

1. Image processing
Process classified infrared image data to obtain regions of interest and interpret connected components as simple polygons.

2. Skeletonization
Compute a simplified skeleton of each polygon for a representation of its main morphological features.

3. Skeleton-based decomposition
Compute an optimal feasible decomposition of each polygon based on its skeleton using dynamic programming.

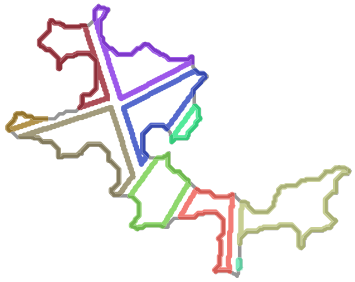


Size → feasibility criterion
A polygon is *feasible* if its area is between a given lower and upper bound.

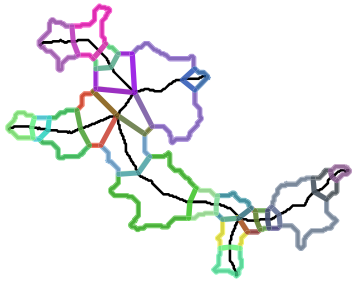
Shape → optimization goal
A decomposition is *optimal* if the fatness is maximized, i.e. the smallest aspect ratio of the subpolygons is maximized.

Comparison of approaches

BiSect (heuristic approach)
→ irregular fragments with narrow regions



MaxFat (proposed approach)
→ rounder fragments



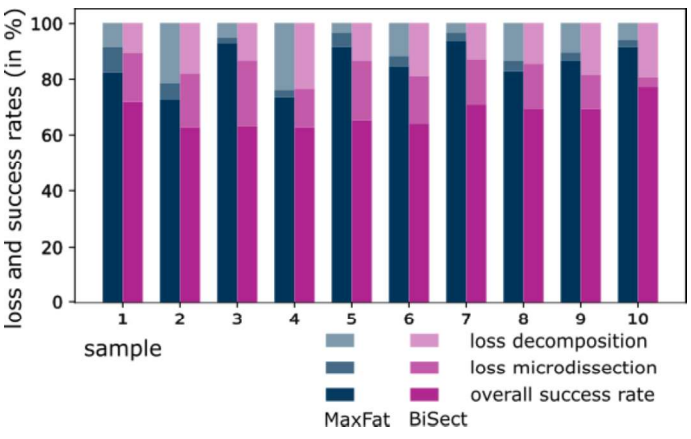
Experimental results

The experiments were conducted on tissue samples with non-small-cell carcinoma. The samples were processed with both decomposition methods: MaxFat and BiSect. Their overall success rate is determined by the amount of successfully collected material (i.e. area) in relation to the original input area.

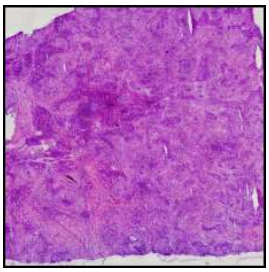
Successful dissections:
MaxFat: 95.44 %, BiSect: 80.98 %

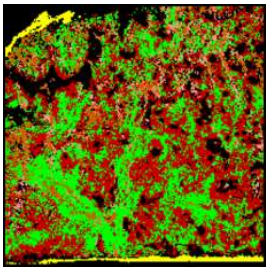
Loss and success rates:
MaxFat generally shows lower losses and higher success rates.
→ 10-30 % more tissue yield

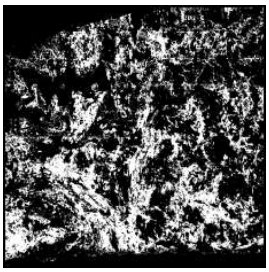
average results (in %)	MaxFat	BiSect
loss decomposition	10.77	16.35
loss microdissection	4.54	18.38
success rate	85.21	68.21

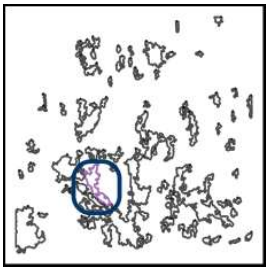


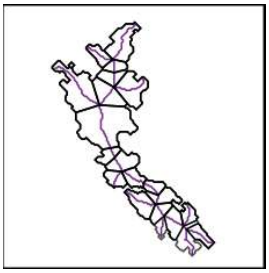
Pipeline


Tissue sample


Classified infrared image


Binary mask of one tissue class


Preprocessed image containing simple polygons


Skeleton-based decomposition of one polygon