# Tiled top-down pyramids and segmentation of large histological images

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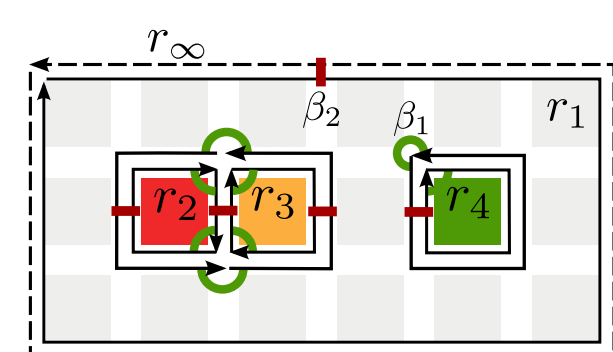CNRS, UMR5205, F-69622, Villeurbanne, France
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Context

Histological images
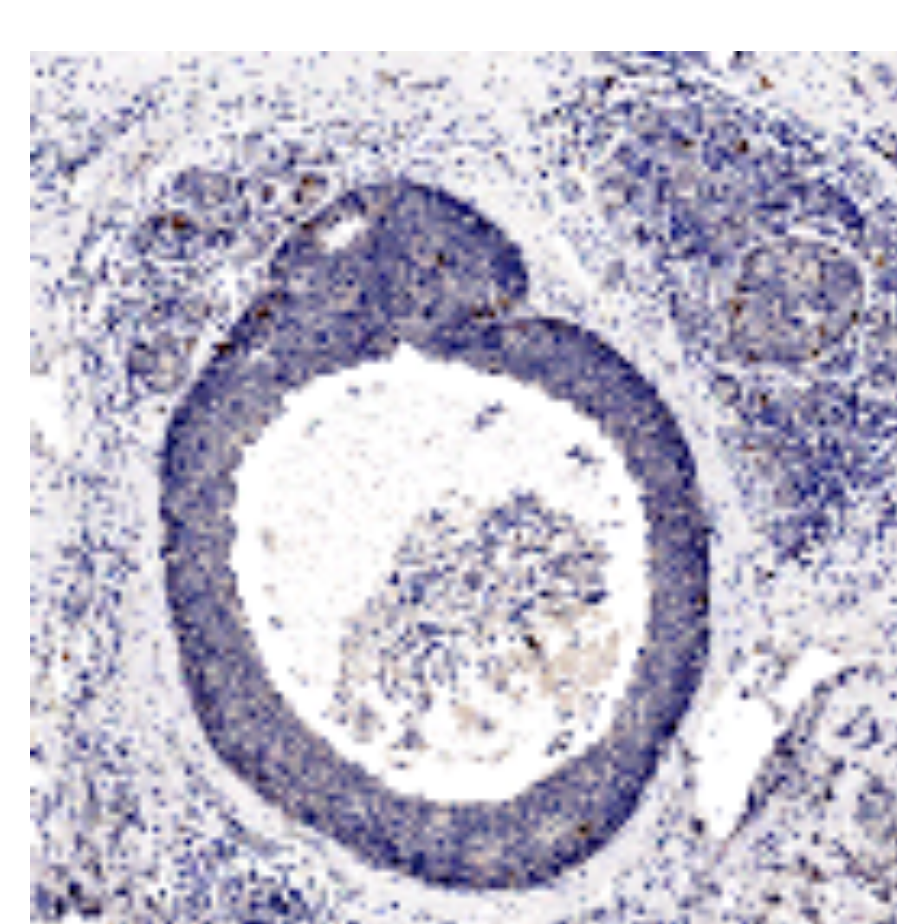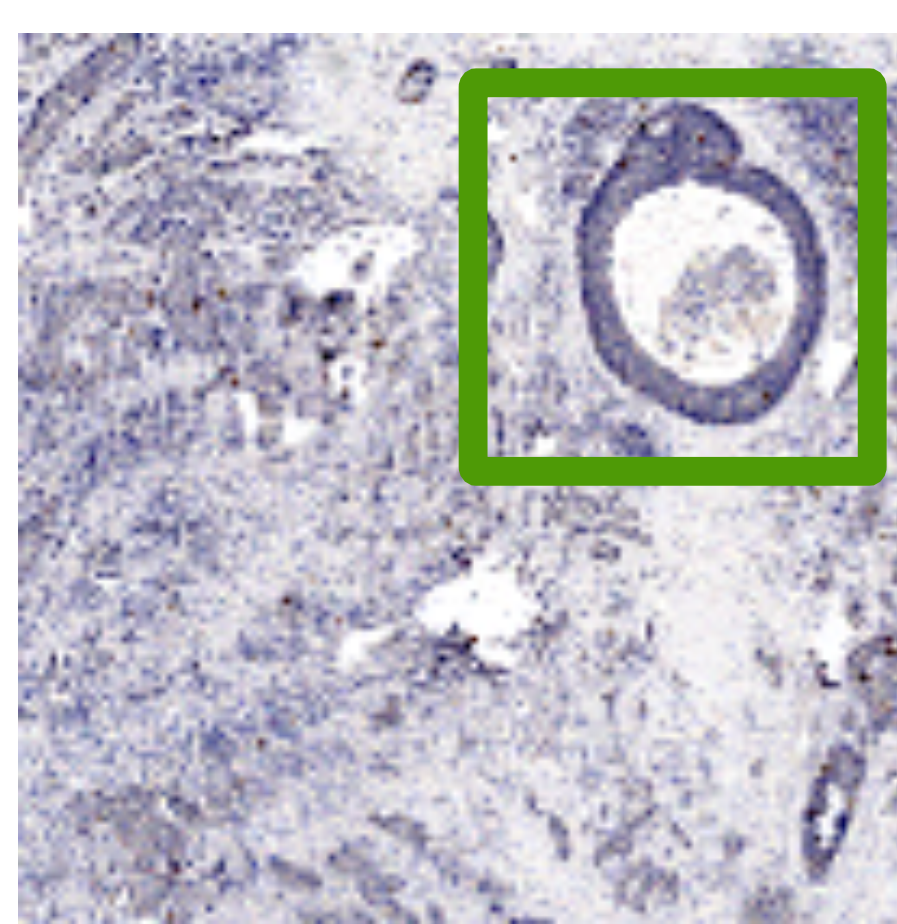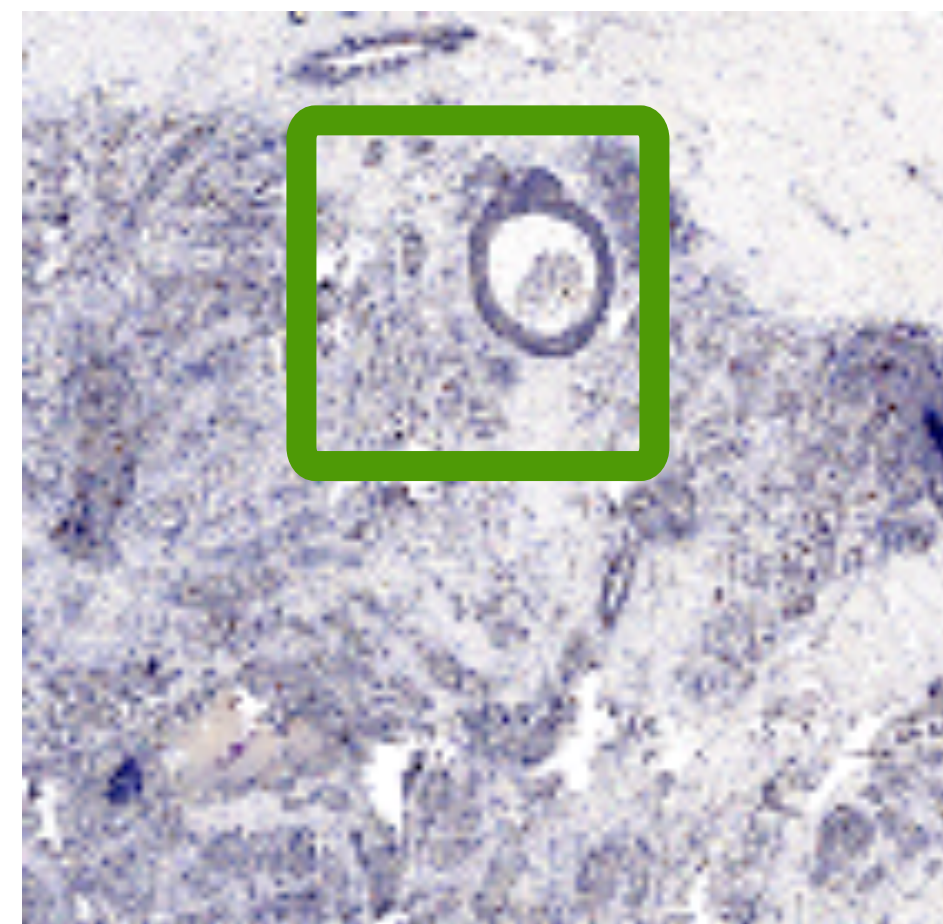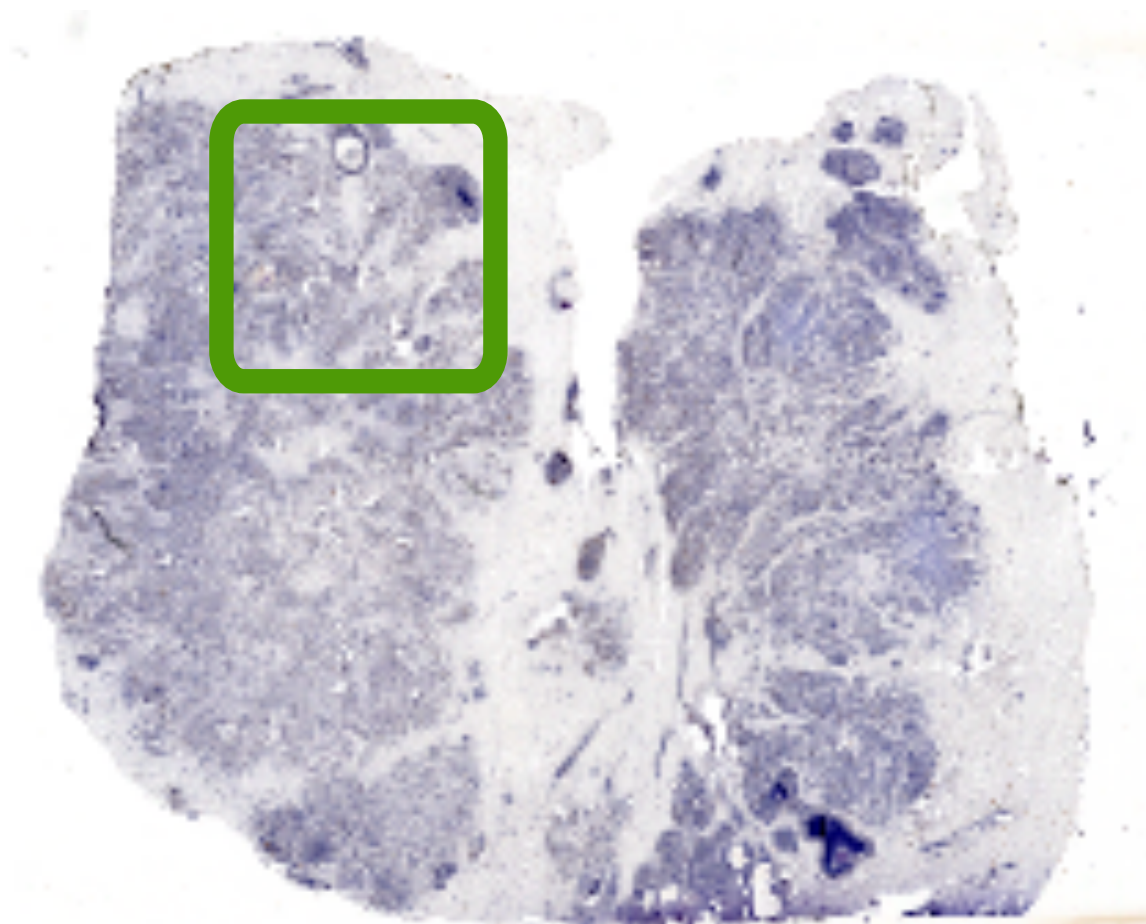
- Whole slide imaging
- Large images of 20GB
- Multi-scale and multi-resolution analysis
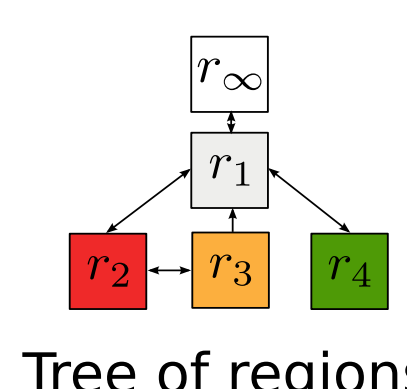
Model definition

Topological maps

Model

Combinatorial map
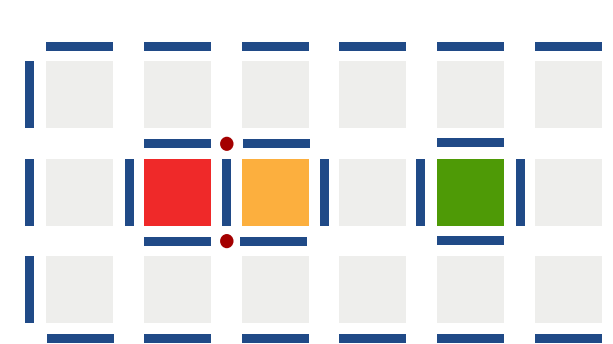
Interpixel elements

Tree of regions

Features

Multi-adjacency relationships
- set of darts (half-edges)
- β_1 and β_2 operators
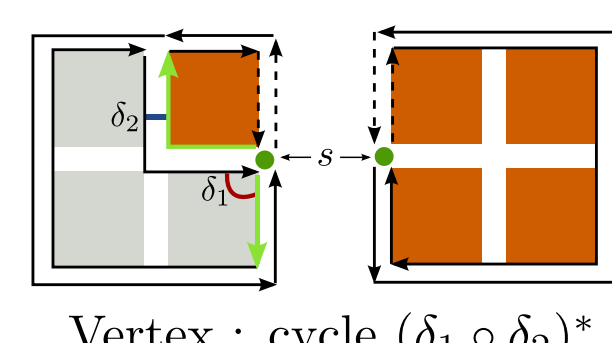
Borders' geometry
- pointels, linels, pixels
- embedding of darts

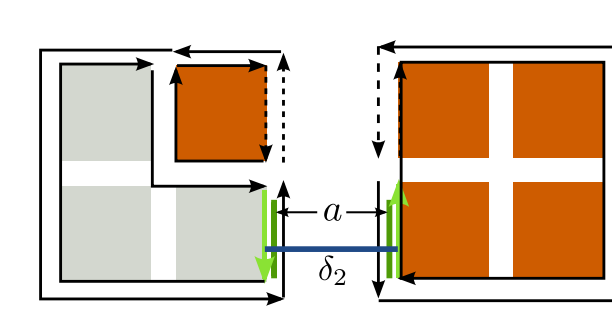**Imbrication relationships**
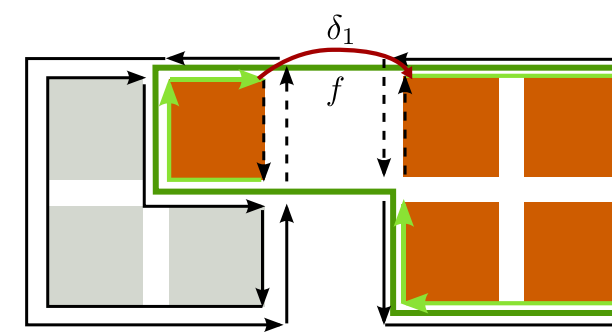- parent/child relationships
- union-find structure

Tiled maps

Vertex : cycle $(\delta_1 \circ \delta_2)^*$

Edge : cycle δ_2^*

Face : cycle δ_1^*

Model
- each tile is a topological map
- detect fictive/real borders
- δ_1 and δ_2 operators

Features
- swap/load operations
- represent large partitions with bounded memory
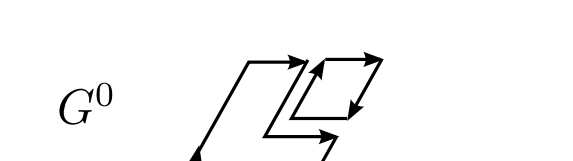- abstract the decomposition in tile

Tiled top-down pyramids

Pyramid of images

Pyramid of tiles

Pyramid of tiled maps

Hierarchical information

$\mathcal{I} = (I^0, \ldots, I^n)$
- sequence of images I^k at different resolutions
- integer ratios

⇒ reduction windows between pixels encode the hierarchy

$(\mathcal{I}, \mathcal{T} = (T^0, \ldots, T^n))$
- sequence of tilings T^k
- constant tile size

⇒ recursive subdivisions similar to quadtrees

$(\mathcal{I}, \mathcal{T}, \mathcal{G} = (G^0, \ldots, G^n))$
- sequence of tiled maps G^k
- each map is a refinement of the previous one
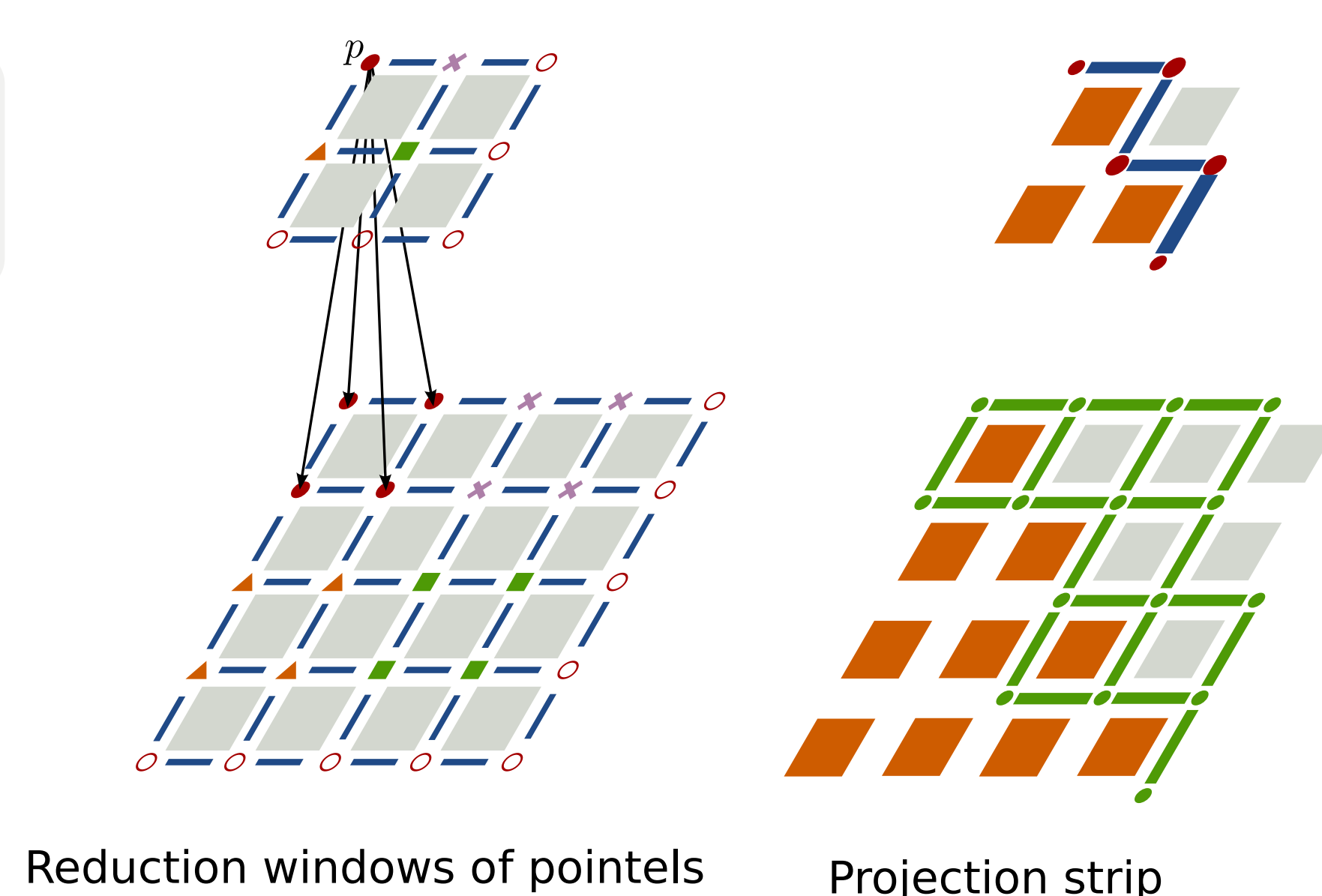
⇒ up/down relationships between darts and regions

Construction scheme

Projection

Objective

projection of a partition's borders at level k to fit on image at level k+1

Projection framework
- non-overlapping without holes pyramid of pointels
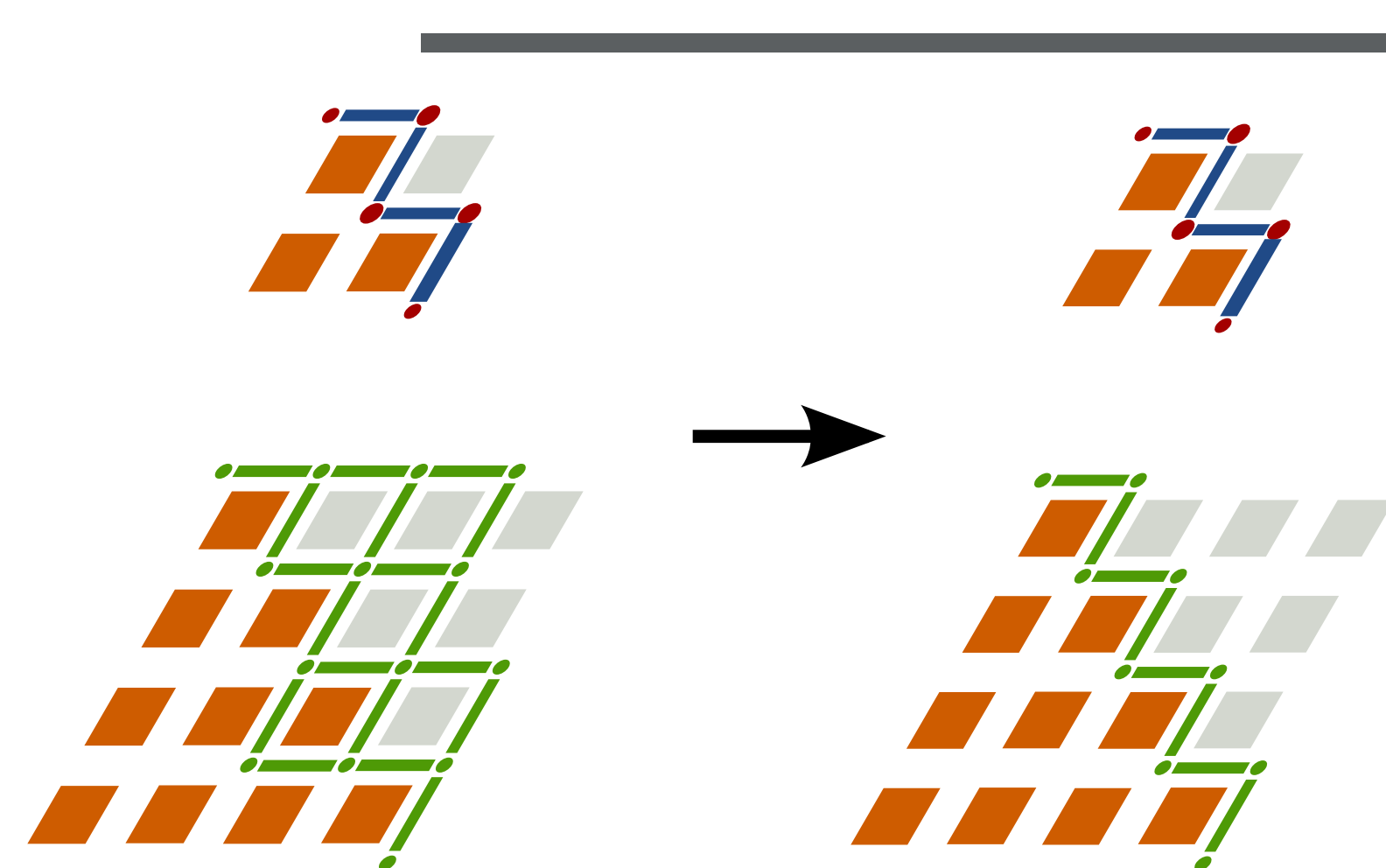- projection strips cannot intersect except on borders' extremities

Reduction windows of pointels

Projection strip

Projection of borders
- preserve the topology of previous level
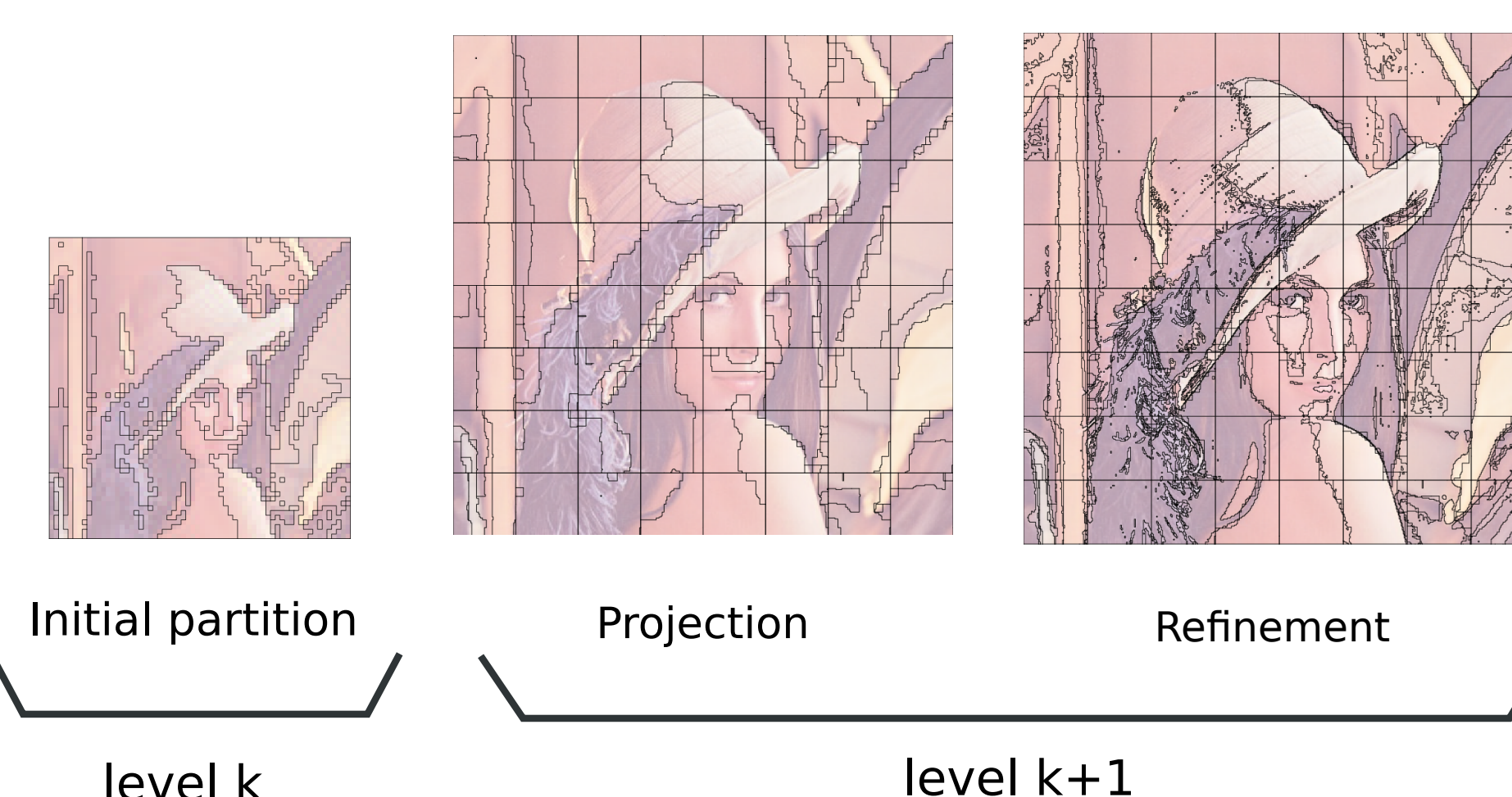- reduce projection strips on borders' extremities
- path of minimal cost (Dijkstra)

Refinement

Global scheme
- project borders
- select regions of interest
- refine children of selected regions
- iterate

Features
- causality
- focus of attention
- segmentation

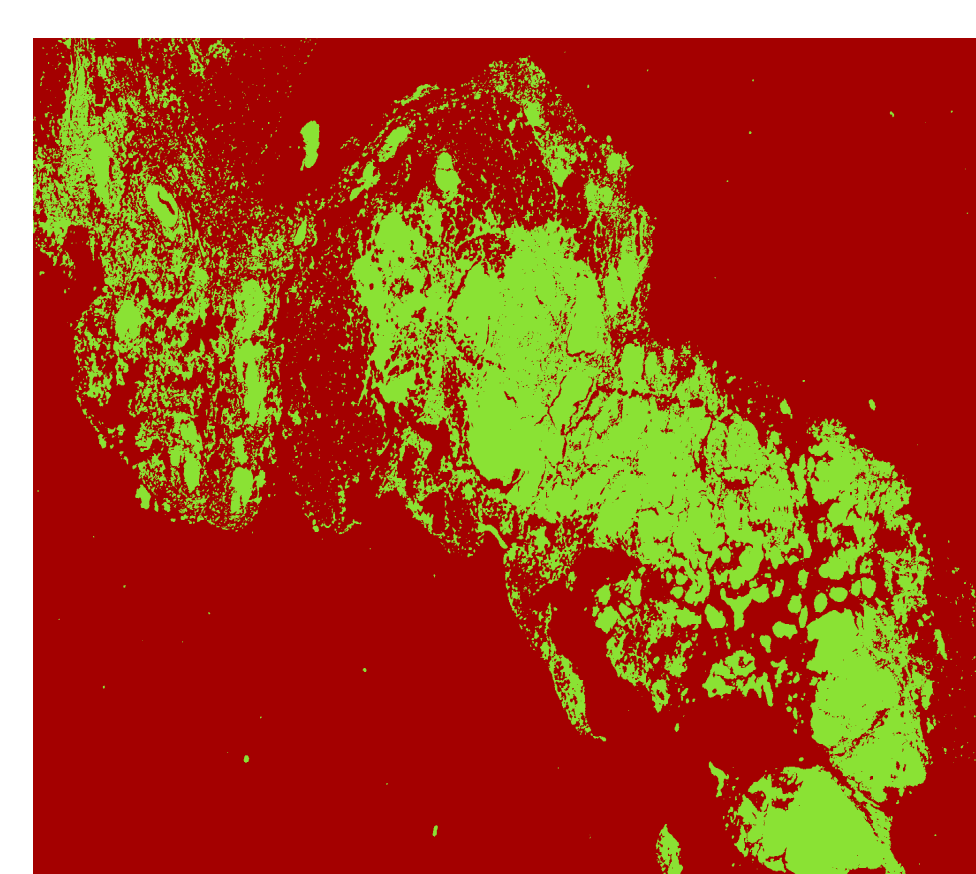
Initial partition | Projection | Refinement

level k | level k+1
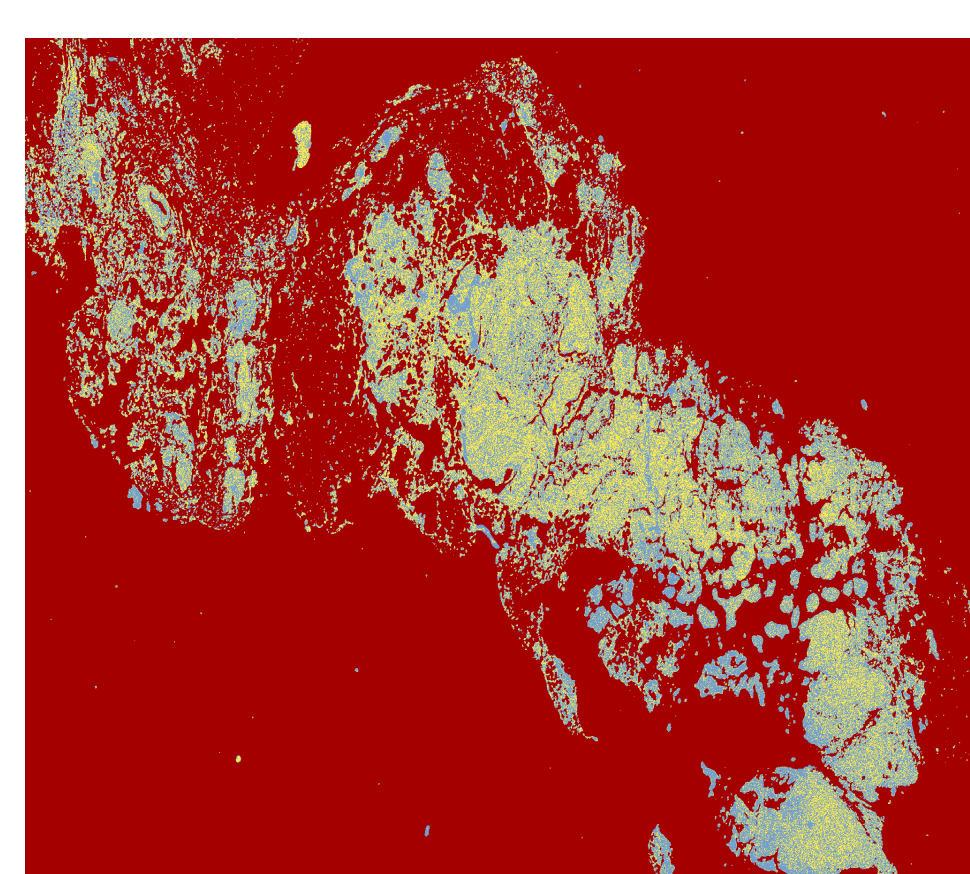
Application

Experiments and results

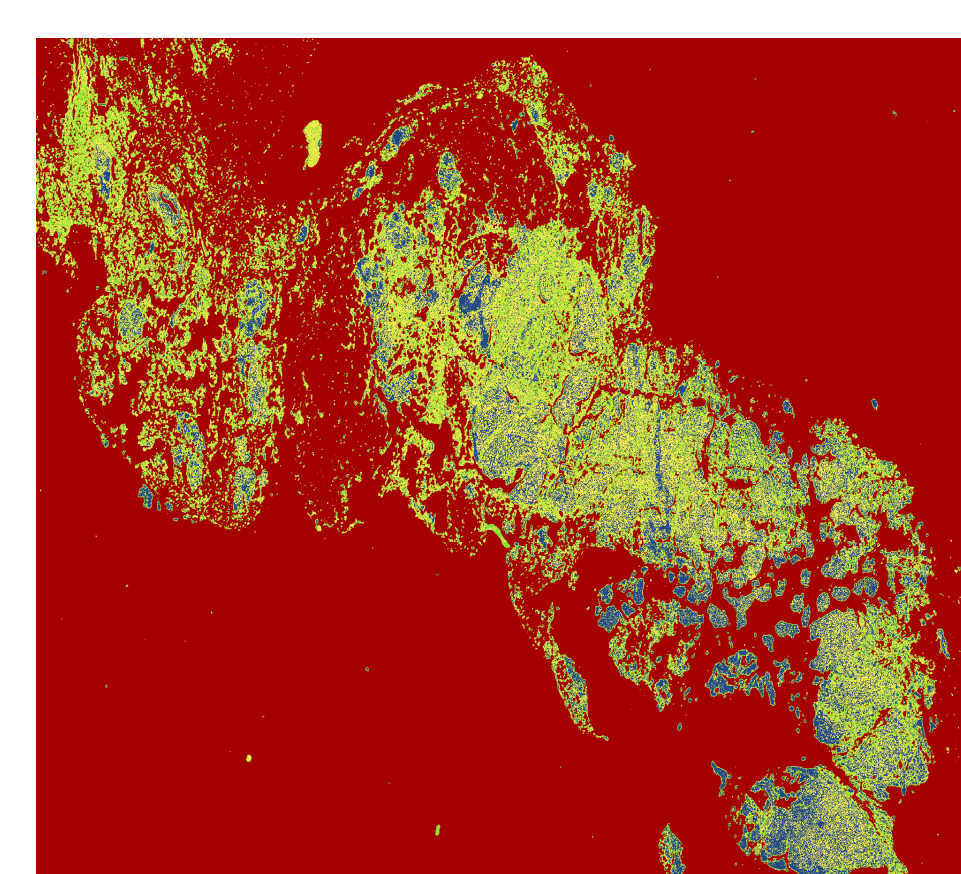Segmentation scheme for histological images

- k-means based segmentation
- successive classifications of regions of interest

Select tissue from background

Select lesions from tissue

Select cancer in situ from lesions

- Bounded memory segmentation
- Topological, geometrical and hierarchical information
- Causal data structure