Validation of planar partitions using constrained triangulations

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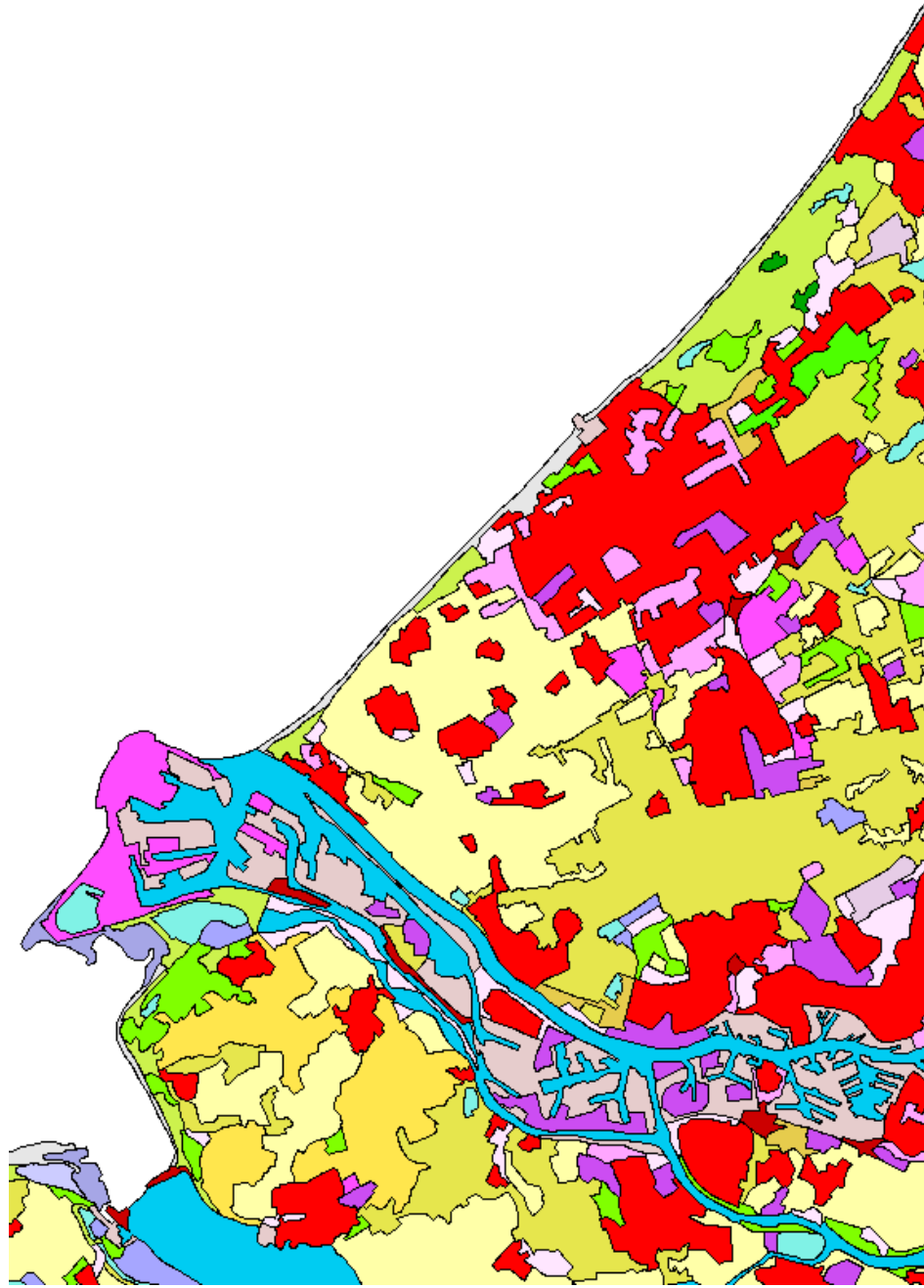
Introduction

Planar partitions frequently used in GIS:

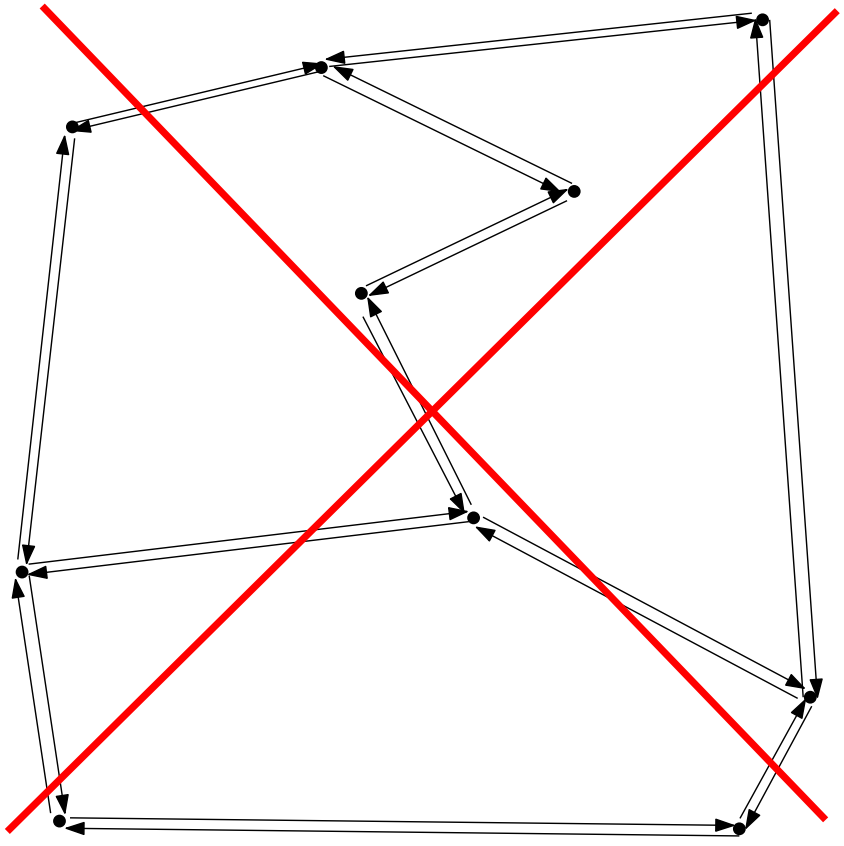
1. land cover
2. cadastral parcels
3. administrative boundaries



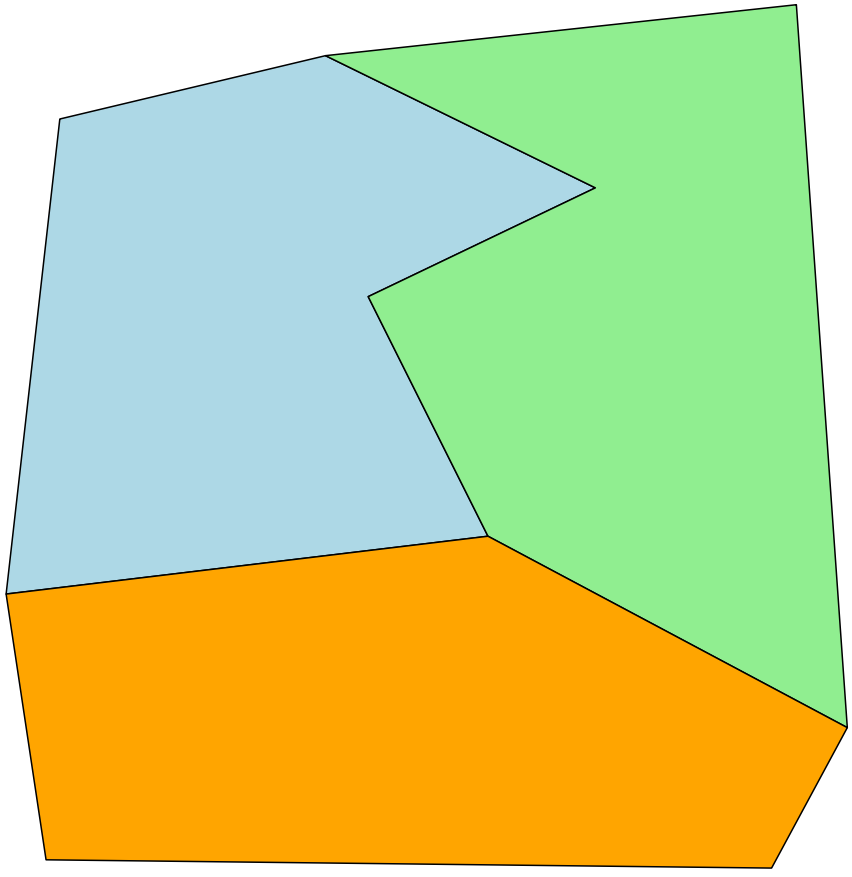
The problem:

Given a planar partition, we want to *validate* it. And if it's broken *repair* it automatically.

Planar partitions are often stored with Simple Features

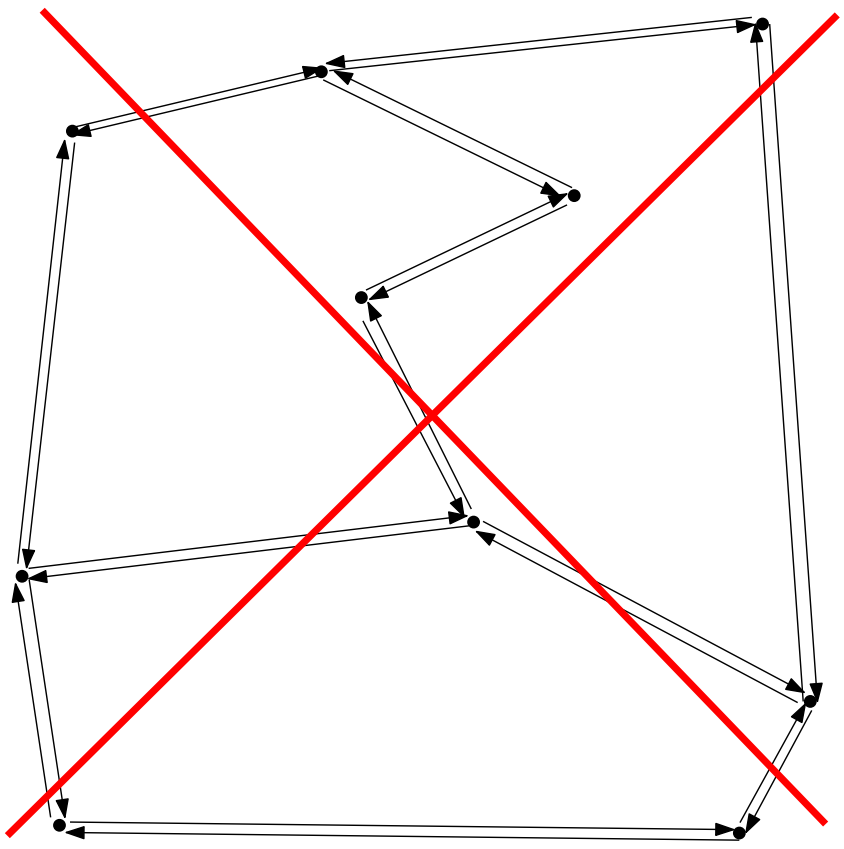


Topological structure

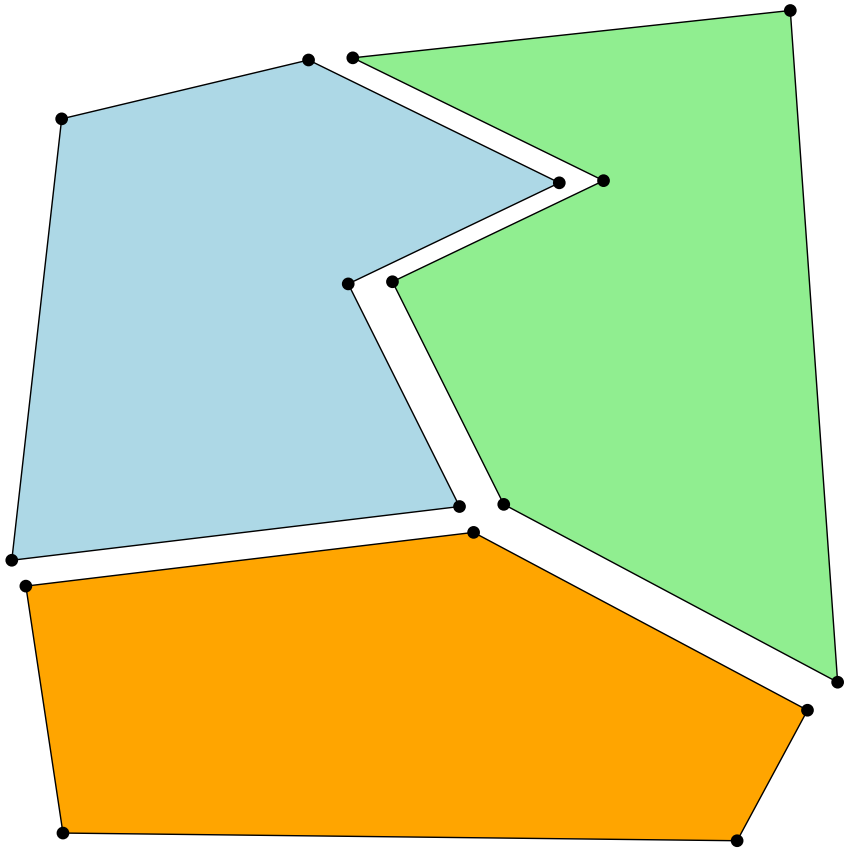


Simple Features (shapefiles)

Planar partitions are often stored with Simple Features



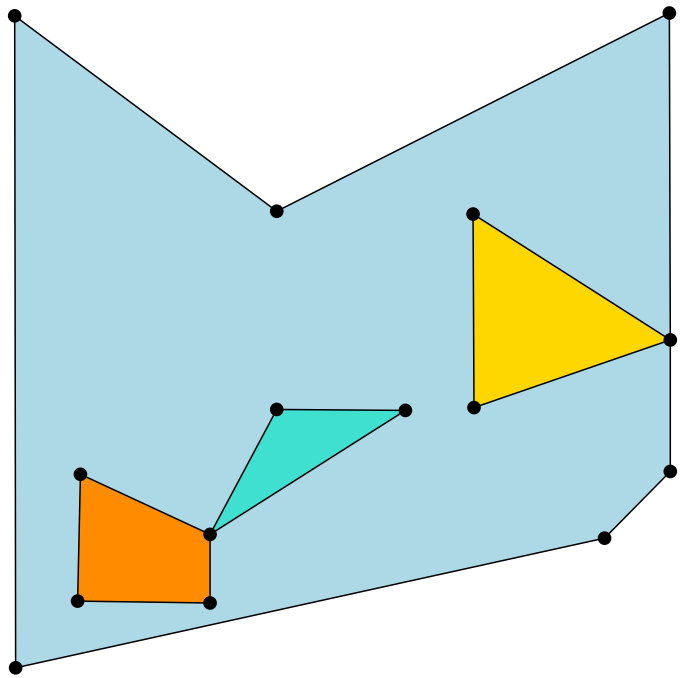
Topological structure



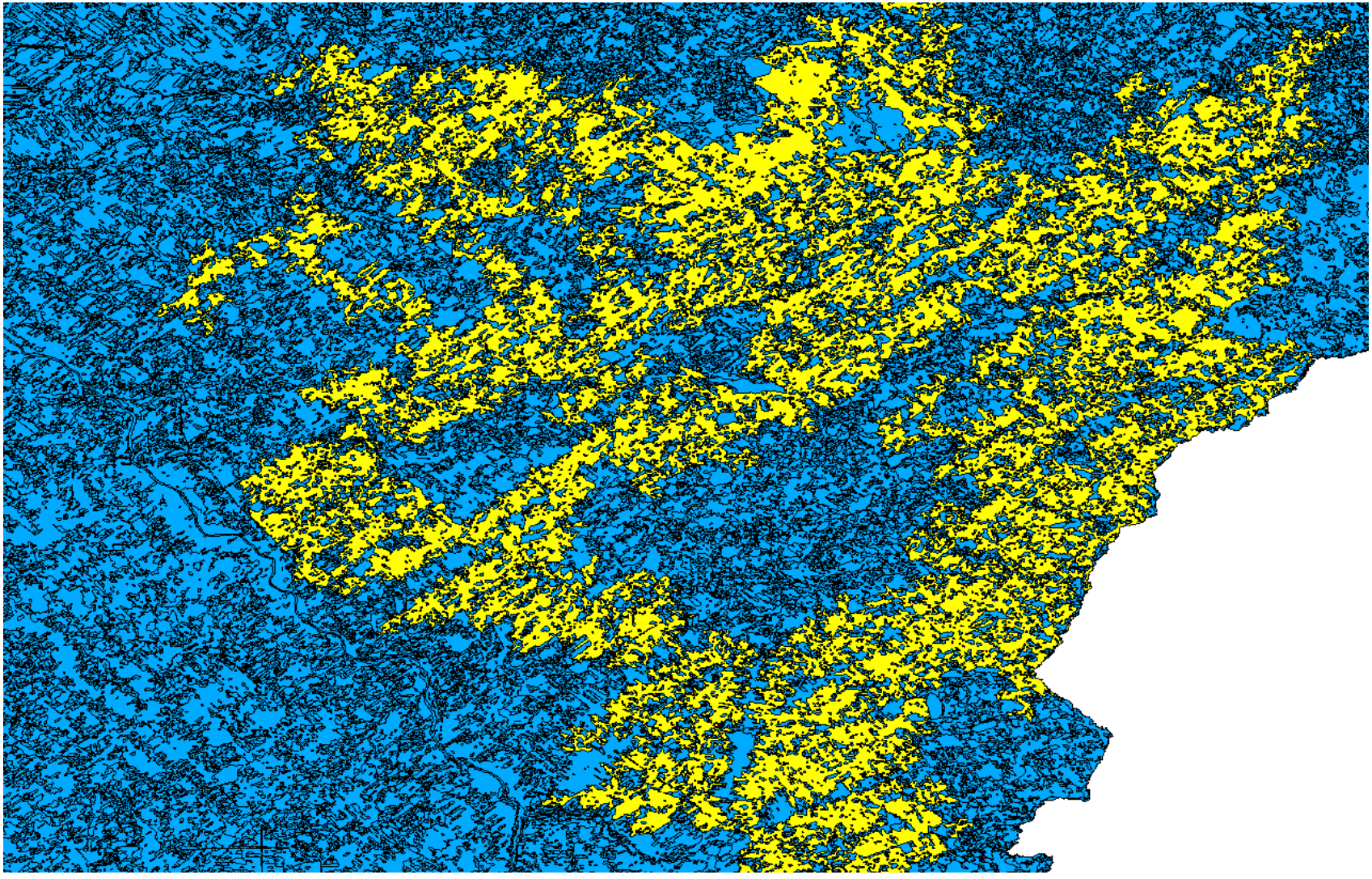
Simple Features (shapefiles)

Simple Features paradigm

- Points, lines and polygons are stored independently
- Recognised and *used* international standards (by ISO/OGC)
- Geo-DBMS and *shapefile* use it

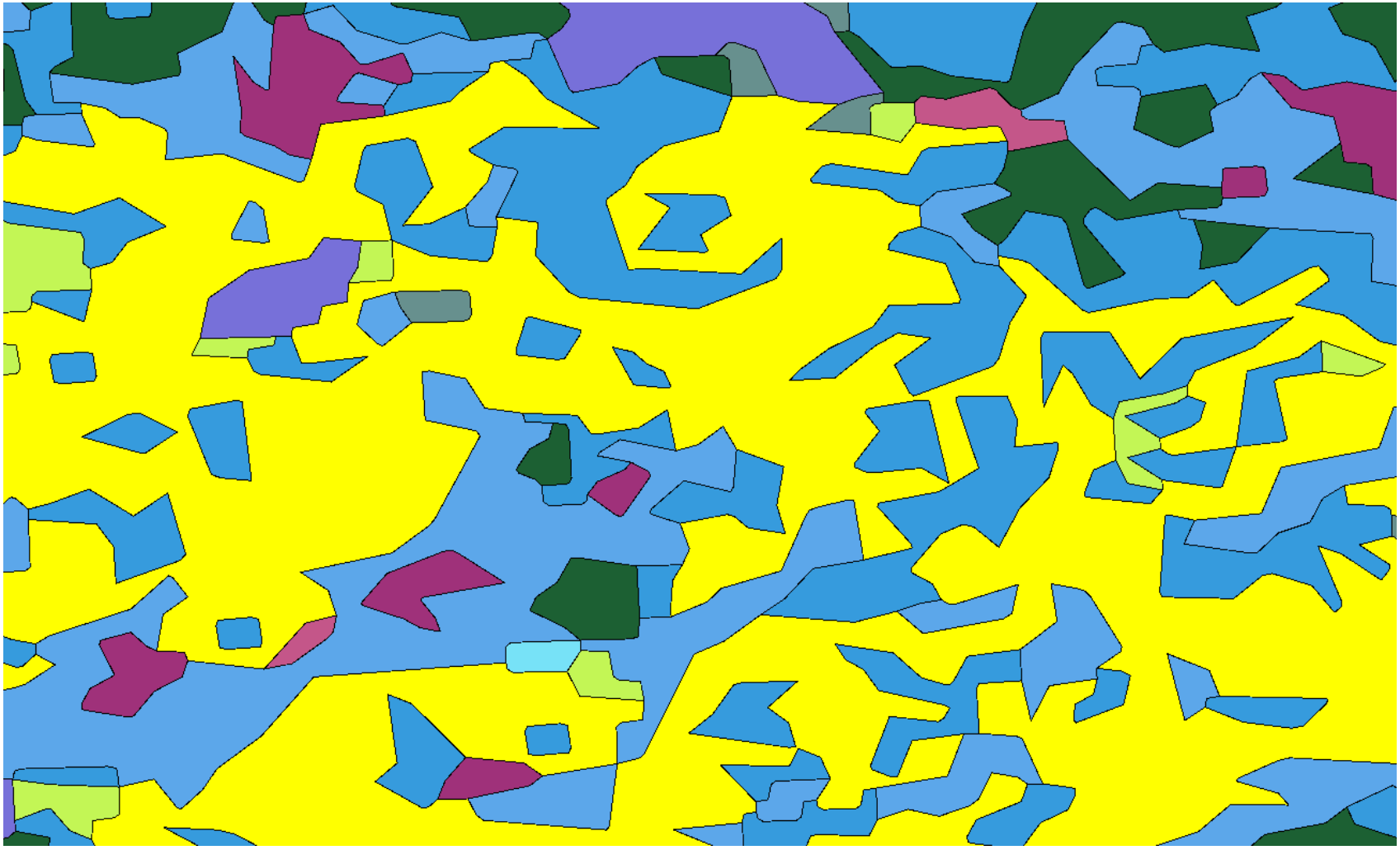


My favourite polygon!



- Outer boundary has 34 471 points
- Polygon has 3191 holes (inner rings)

Zoom in on my favourite polygon



Where could it go wrong?

In practice, errors/mistakes/inconsistencies are often introduced during the construction, manipulation or exchange:

- Overlapping polygons
- Gaps between polygons
- Unconnected polygons
- Tiles of a big datasets do not match

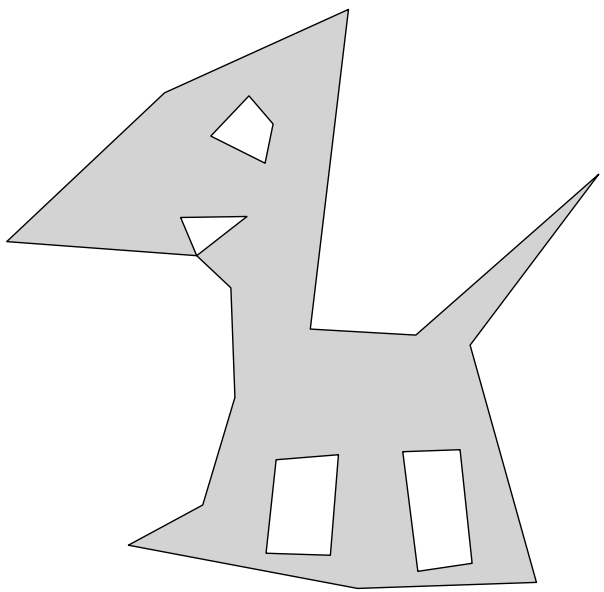
Potential solutions

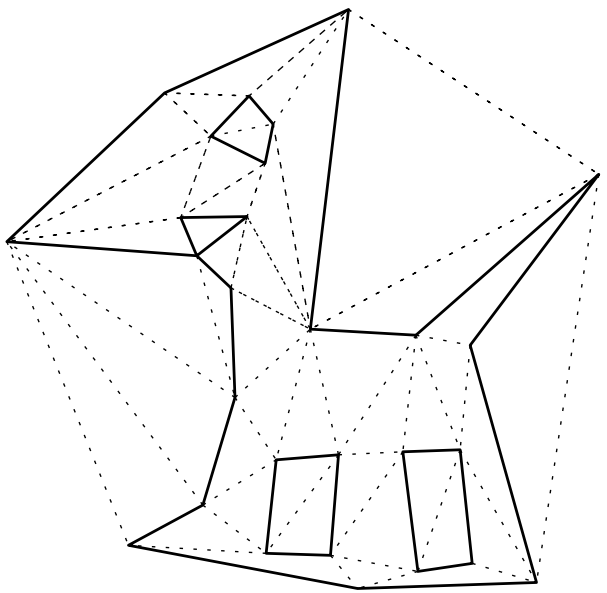
- Construct a planar graph (requires cleaning of slivers)
- Define a set of geometric and topologic validation rules on top of graph
- Some commercial solutions:
  - Oracle Spatial Topology
  - ArcGIS
  - 1Spatial Radius Topology

Problem is theoretically easy, but implementation is complicated.

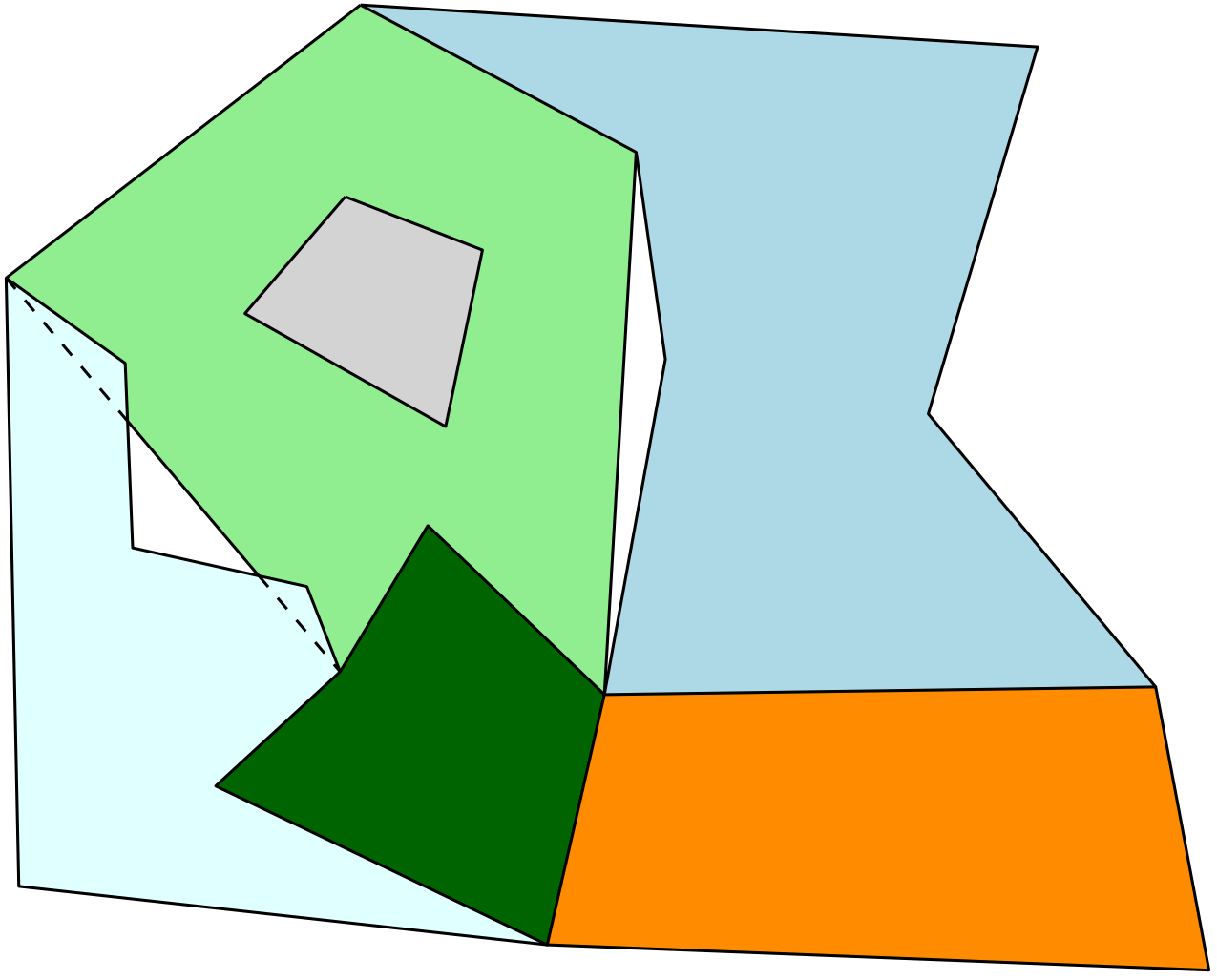
Our solution = constrained triangulation (CT)

1. Construct CT of input polygons (which is a valid planar partition)
2. Flag each triangle with ID of its polygon
3. Validation made with simple graph-based algos





Steps of our approach



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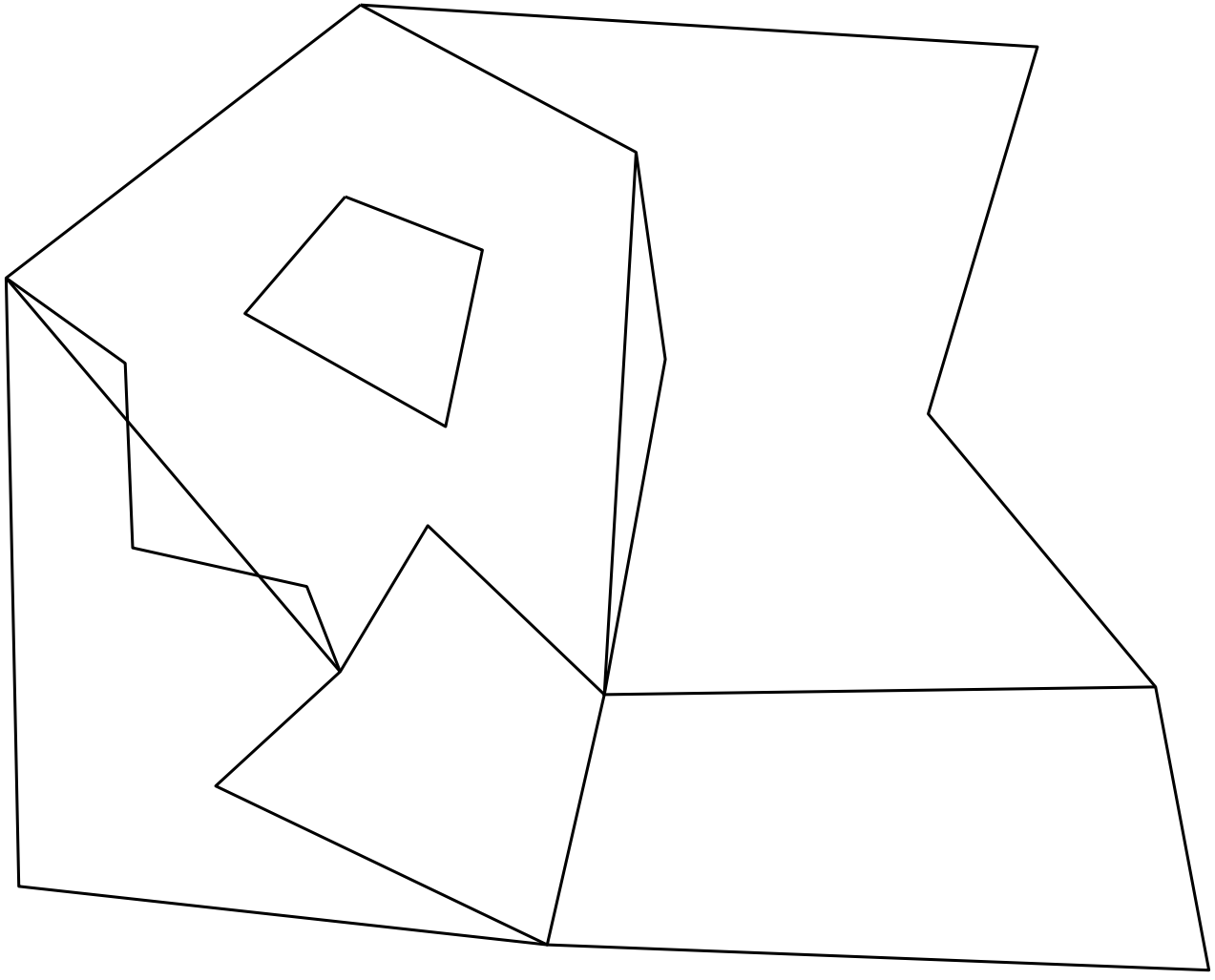

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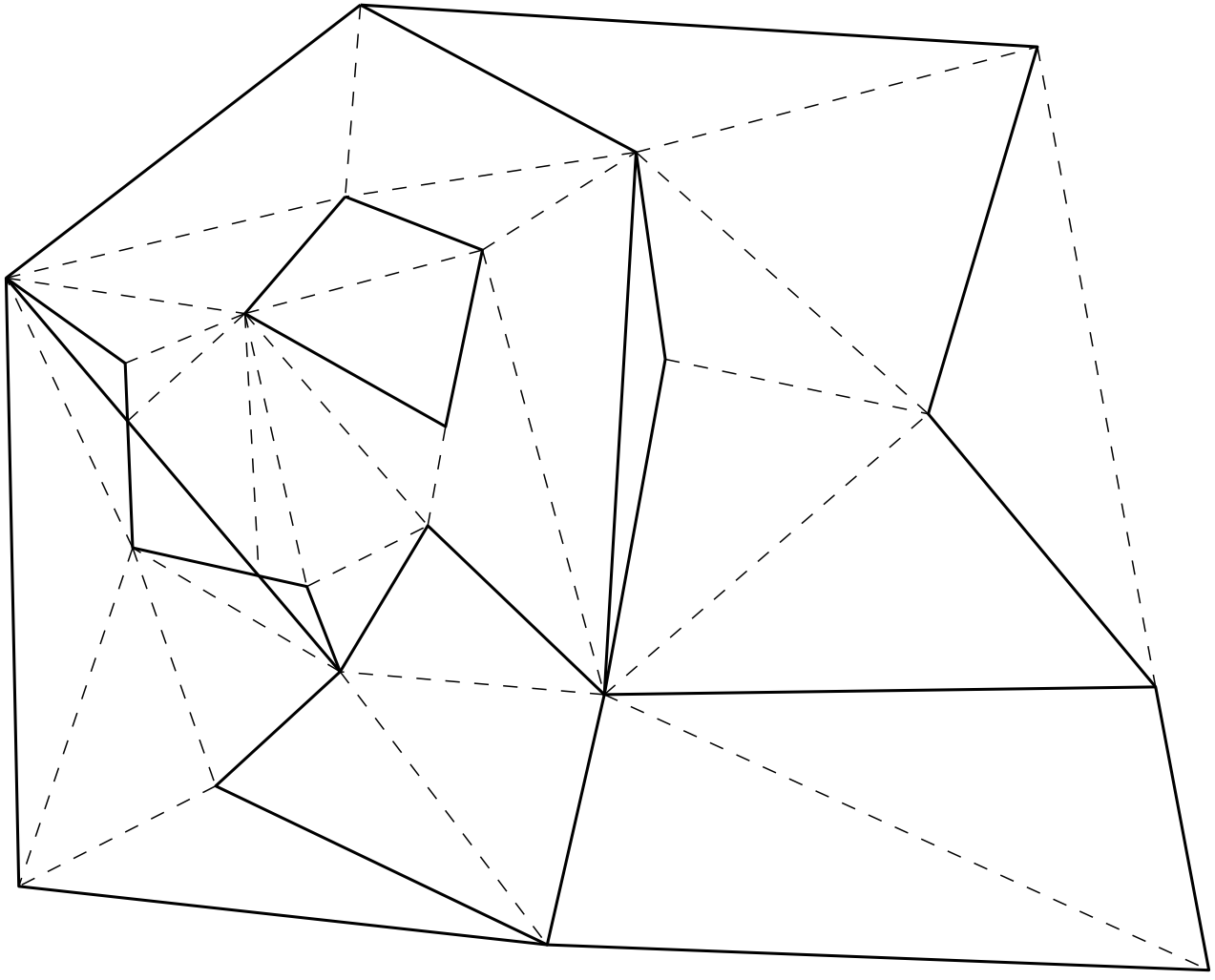

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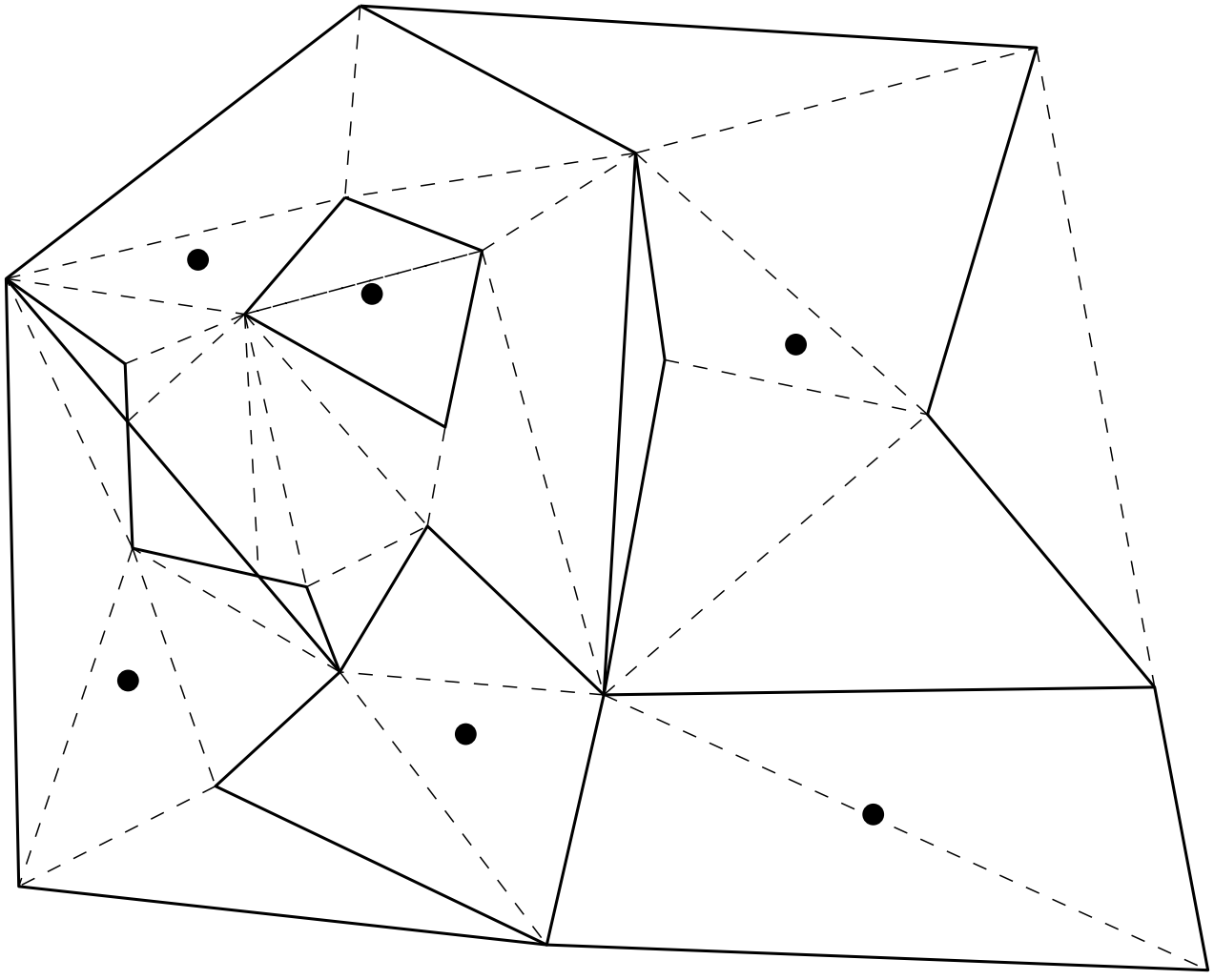

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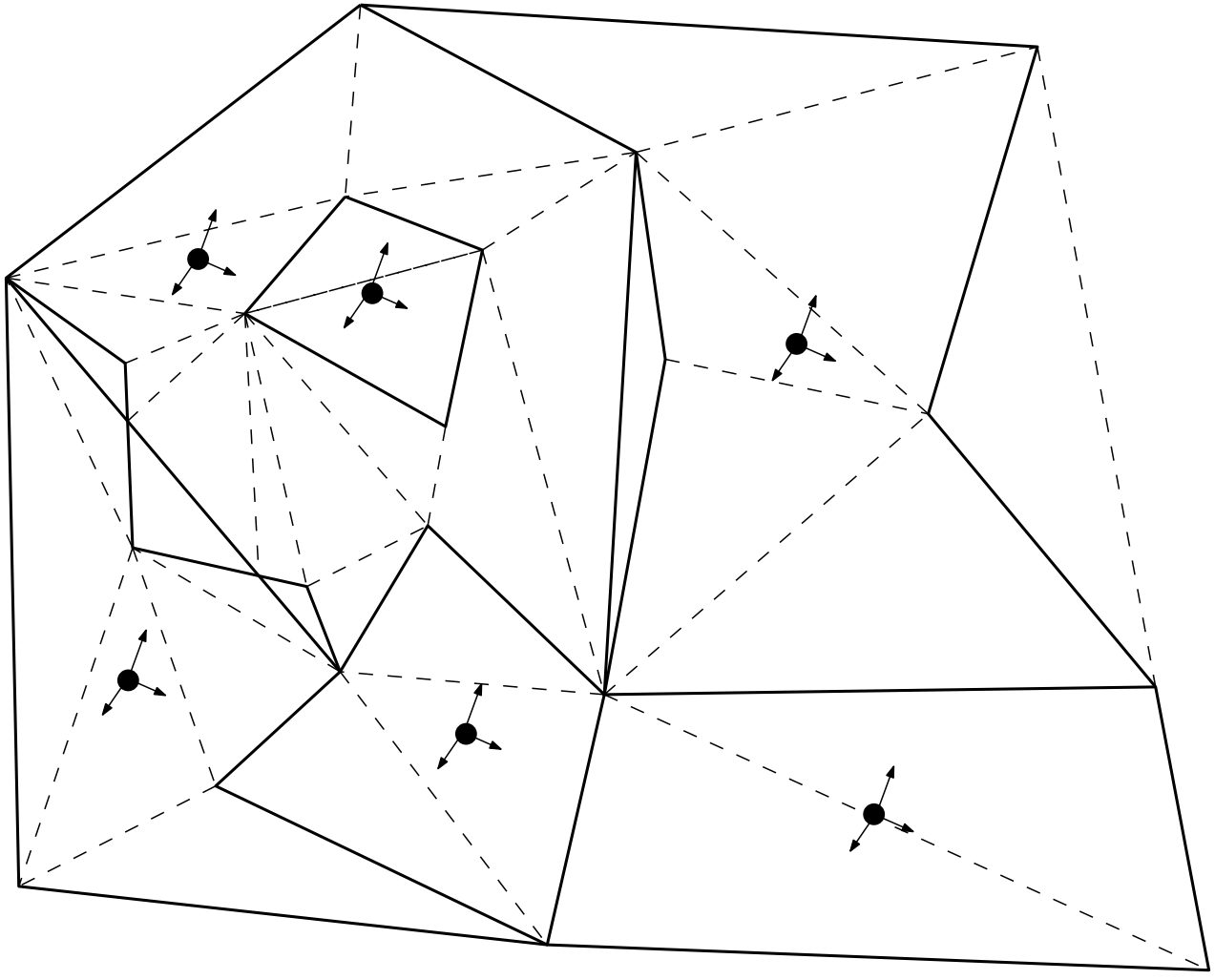

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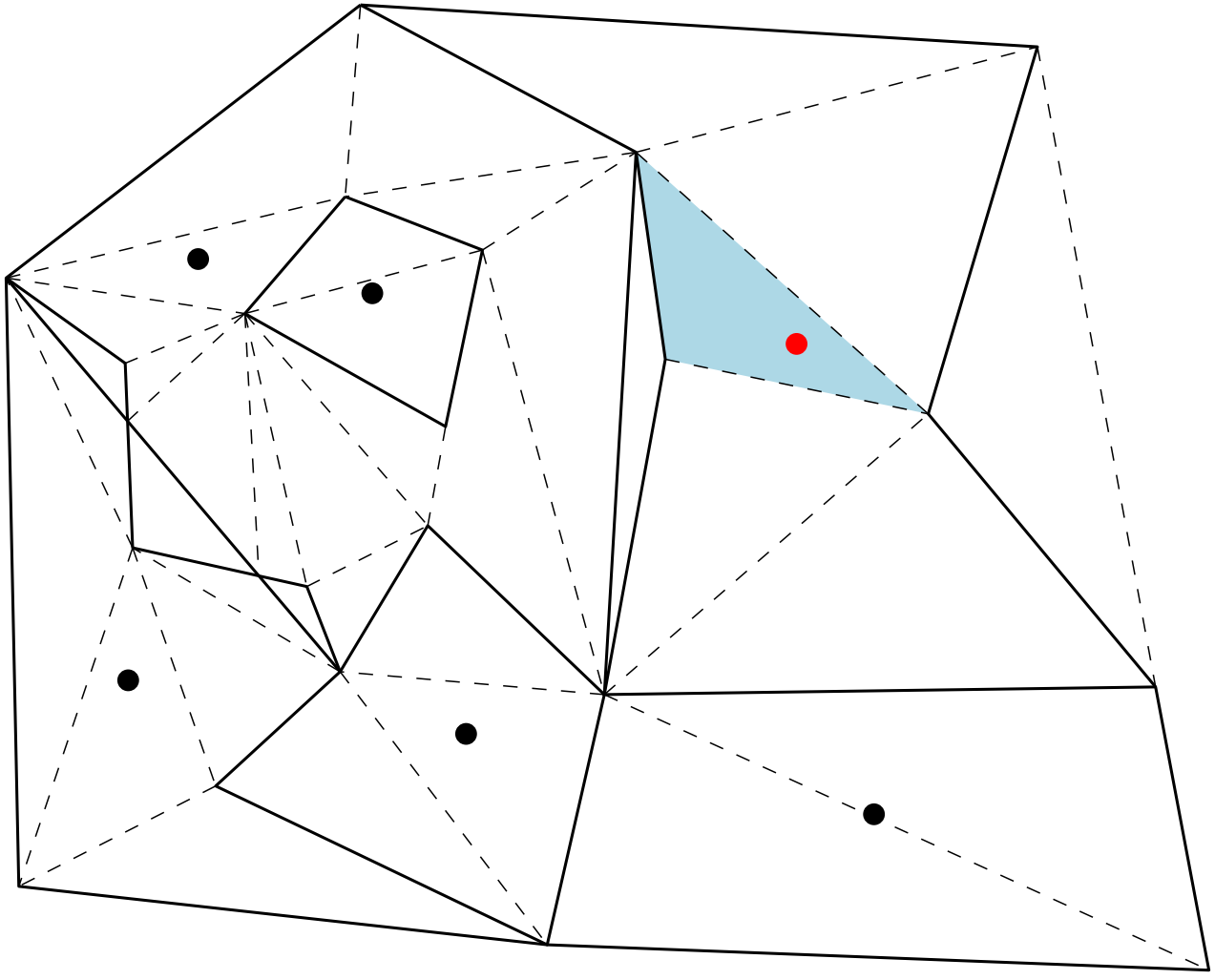

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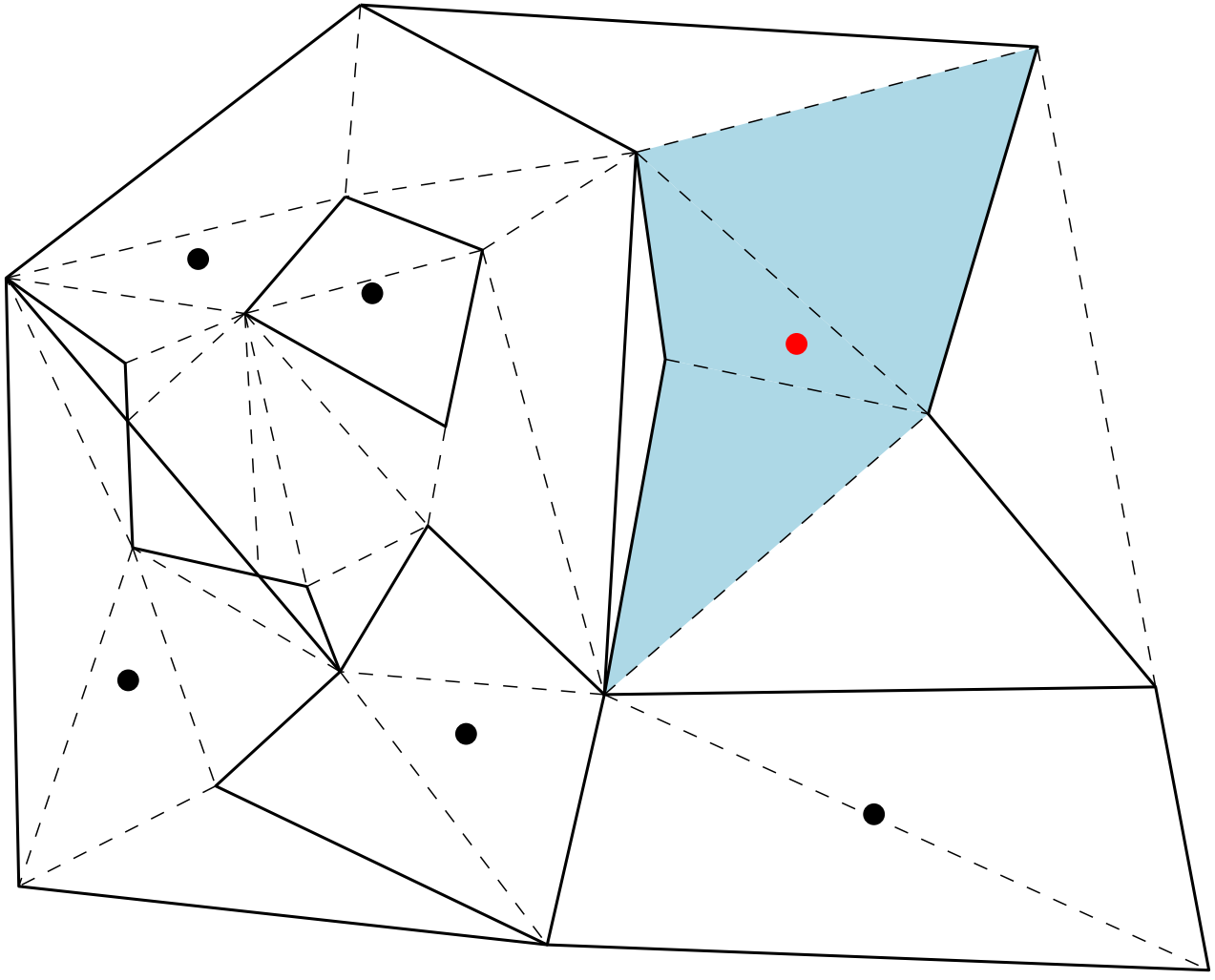

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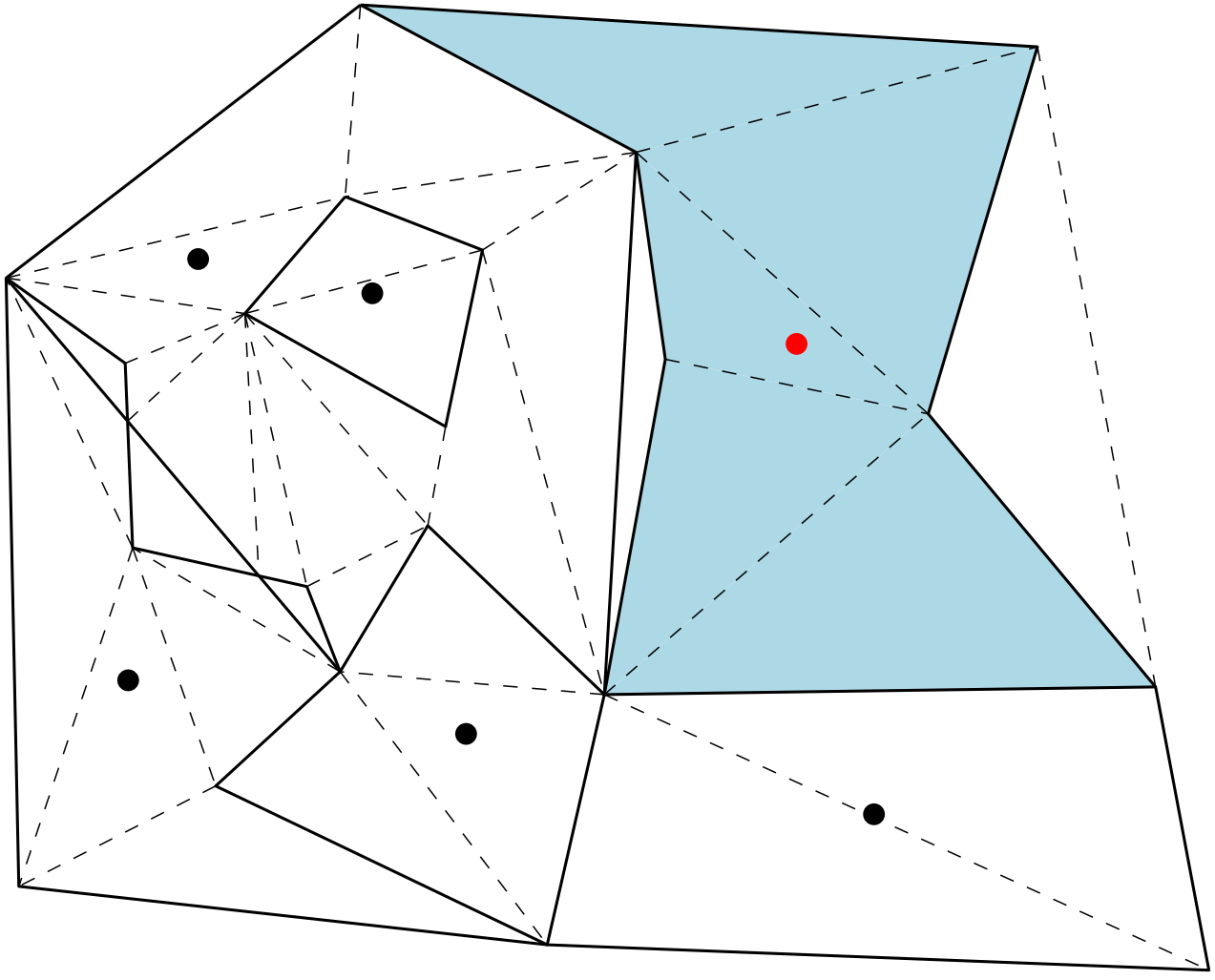

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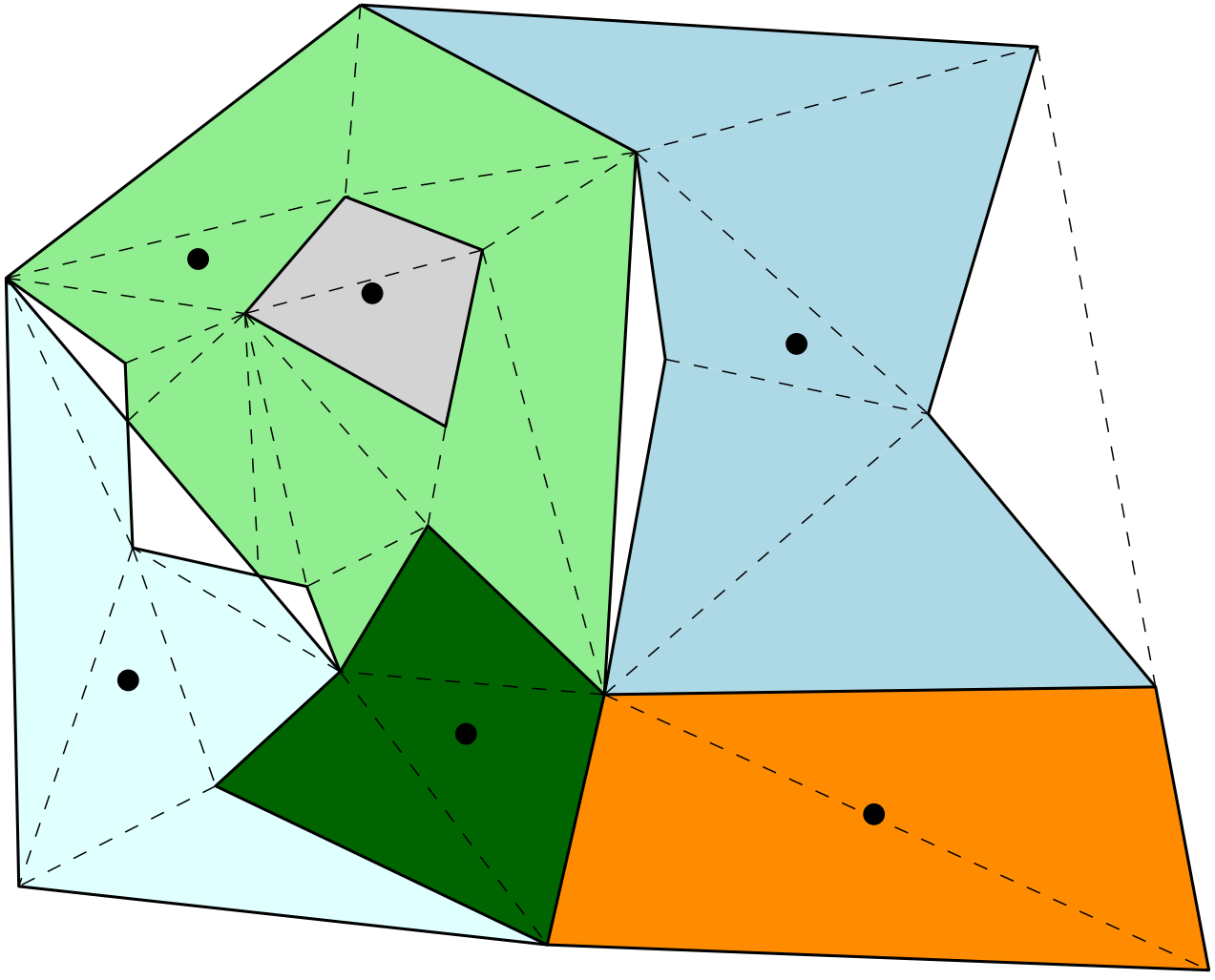

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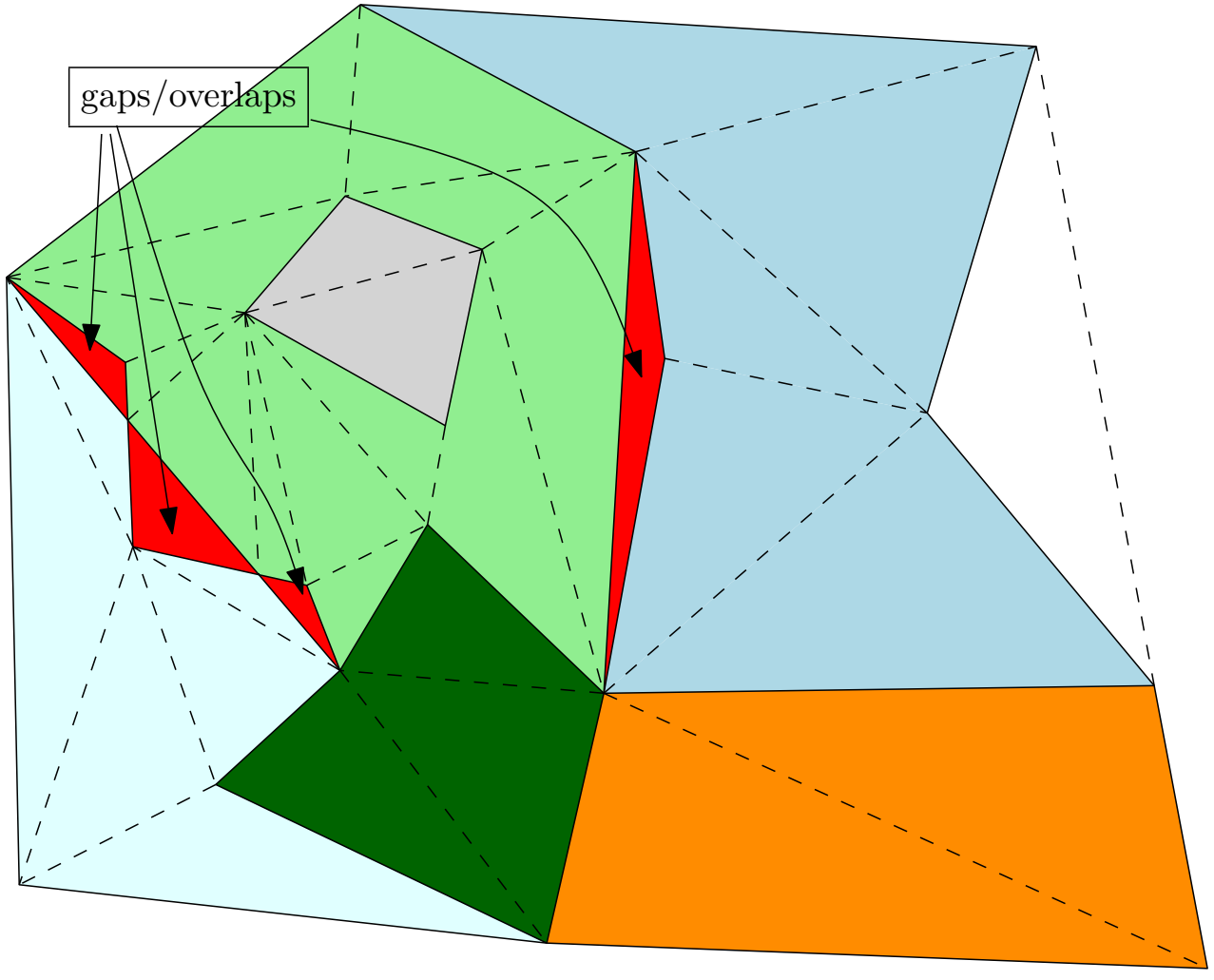
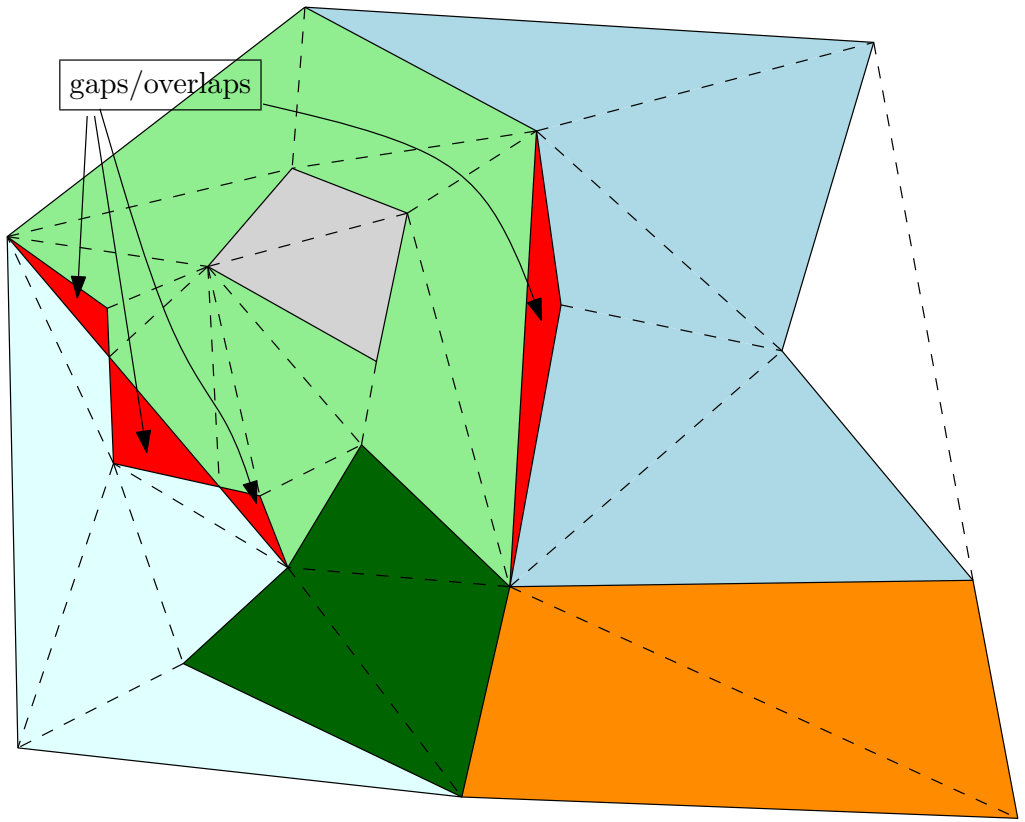


If it's broken, then fix it

1. Repair = simply re-flagging triangles
2. No need to modify and update the planar graph (slow operation)



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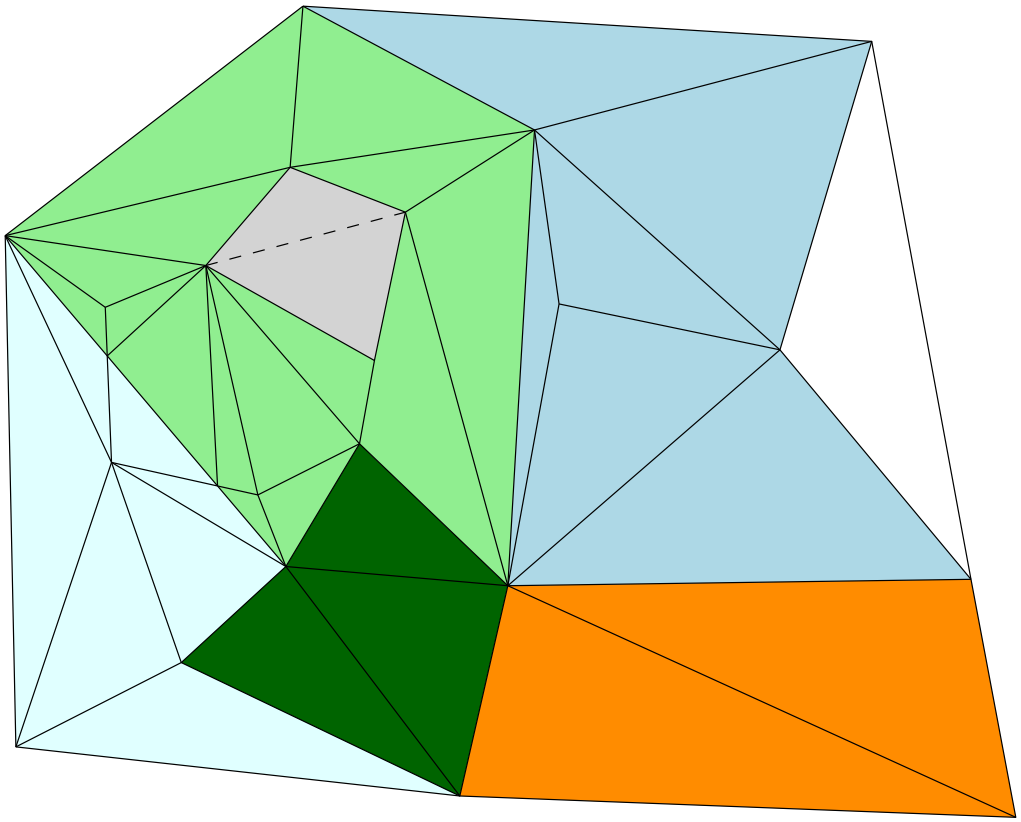
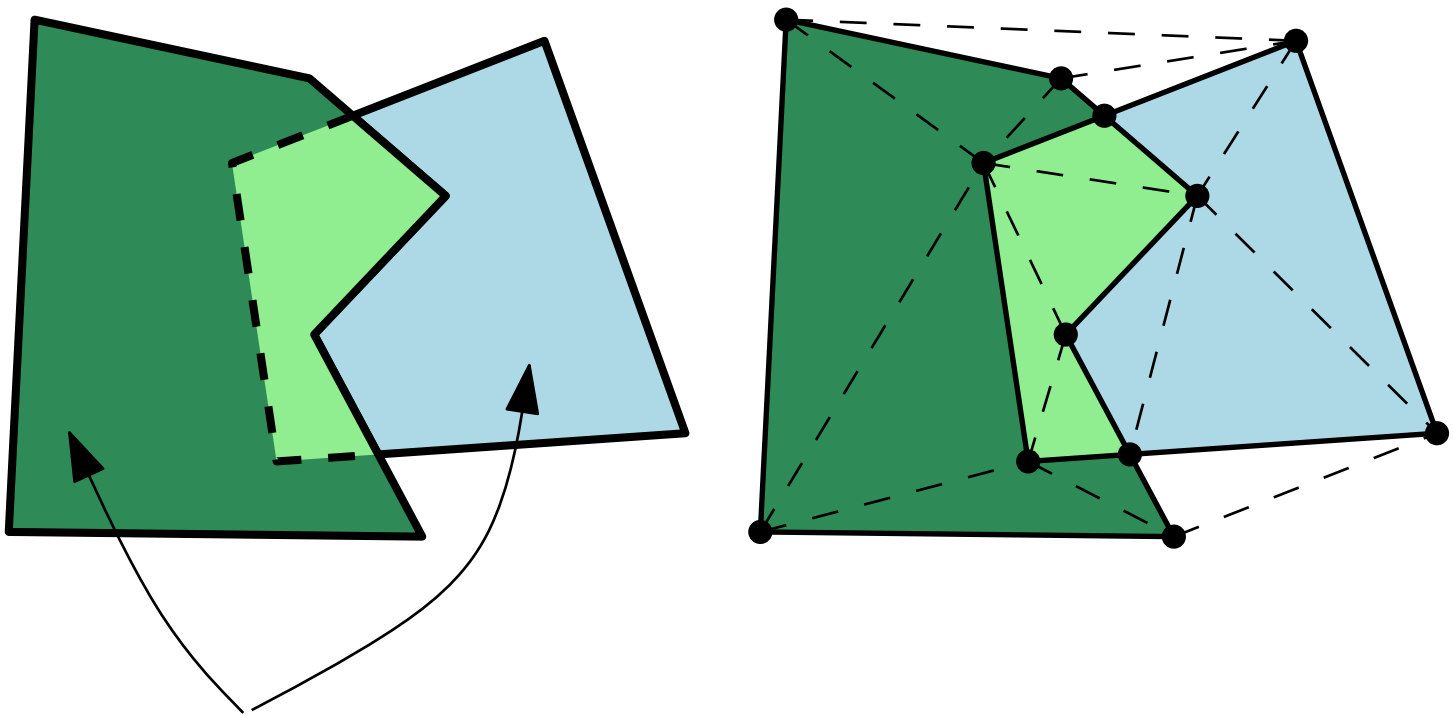


Implementation

1. Fast implementation in C++, with CGAL and OGR
2. Open-source code, you can test it
3. Numerical and geometric robustness. Points do not move during processing.

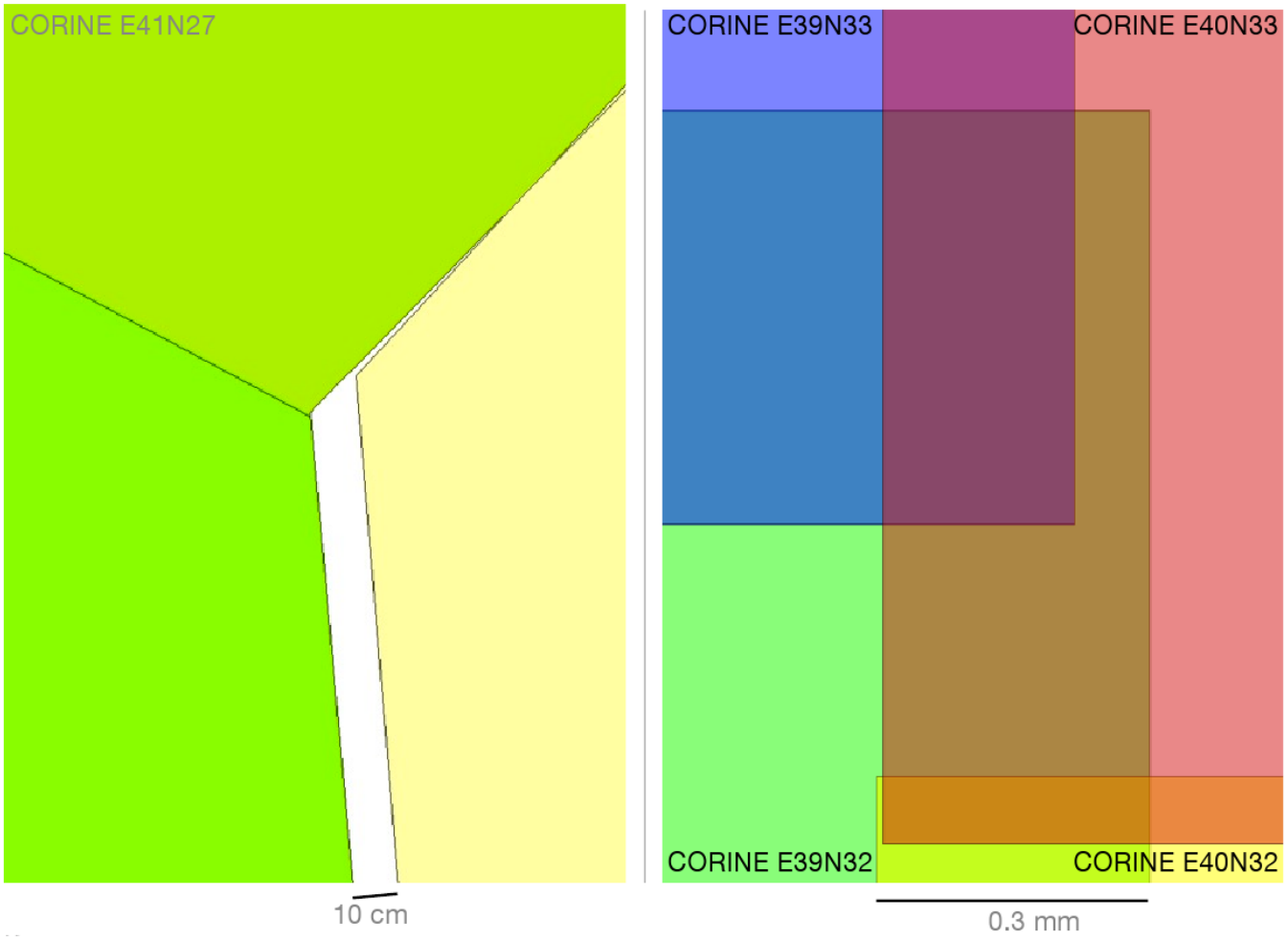


2 input polygons that overlap

Experiments with CORINE dataset

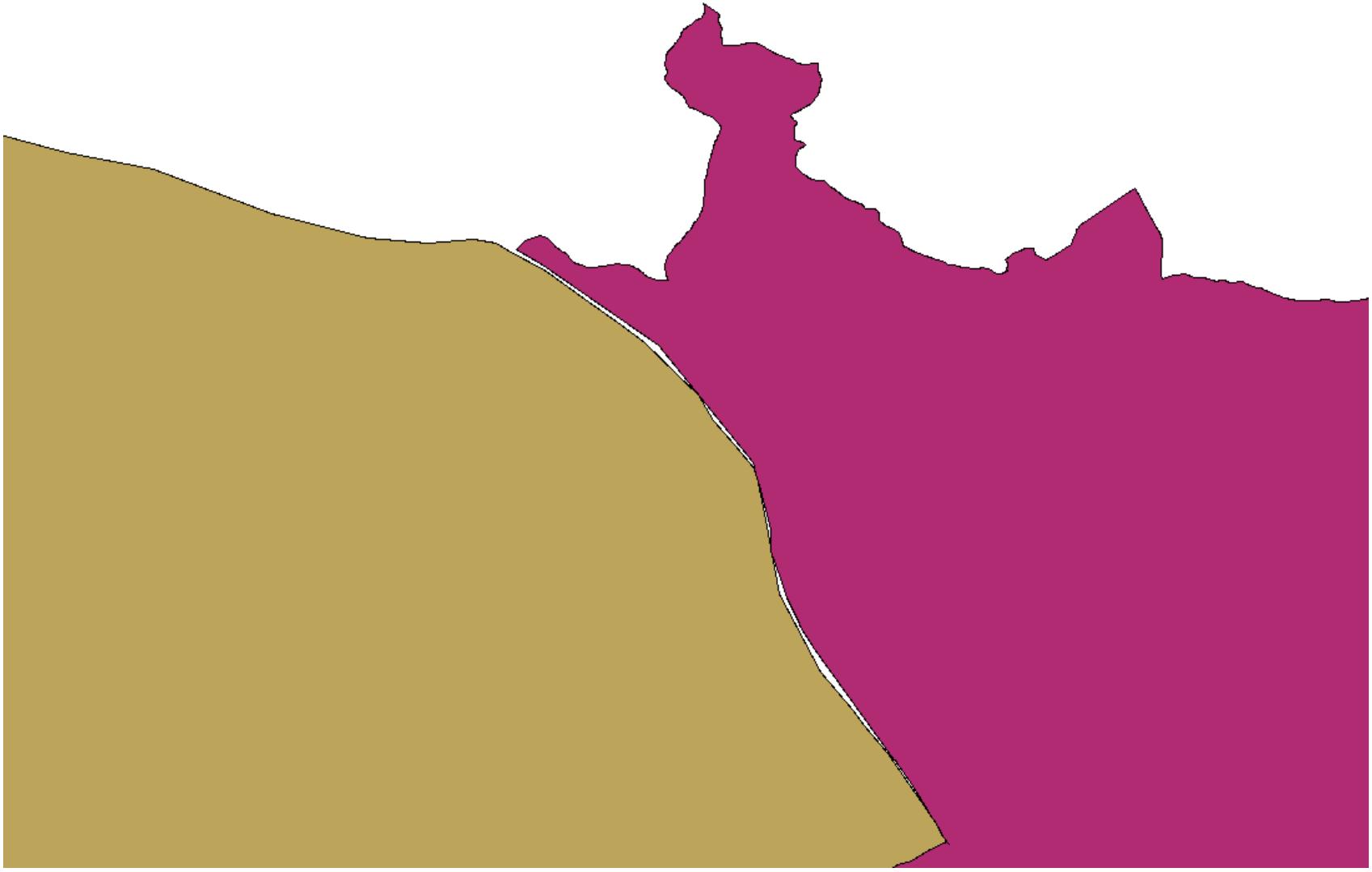
Can process around 40 tiles in < 1h
(around 120 000 polygons with 4GB main memory)

Experiments with CORINE dataset



None of the tiles fit perfectly with their neighbours.

Future work: edge matching



More Information?

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https://svn.otb.tudelft.nl/trac/OTB-GIST/KEN