Cache-friendly progressive data streaming with variable-scale data structures

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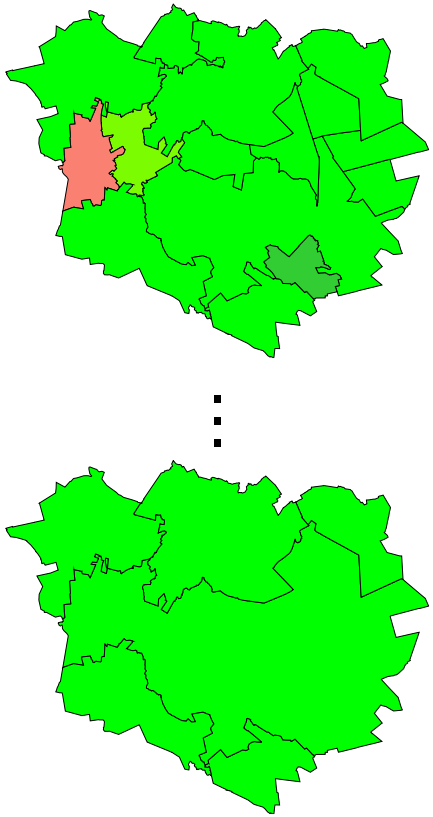
Introduction

- Part of PhD project
- Hierarchical model for 2D vector data: SSC / tGAP (not smooth!)
- 2D vector data and level of detail in one model
- Haunert et al. (2009) proposed theory for progressive transmission
- Does it work in practice?

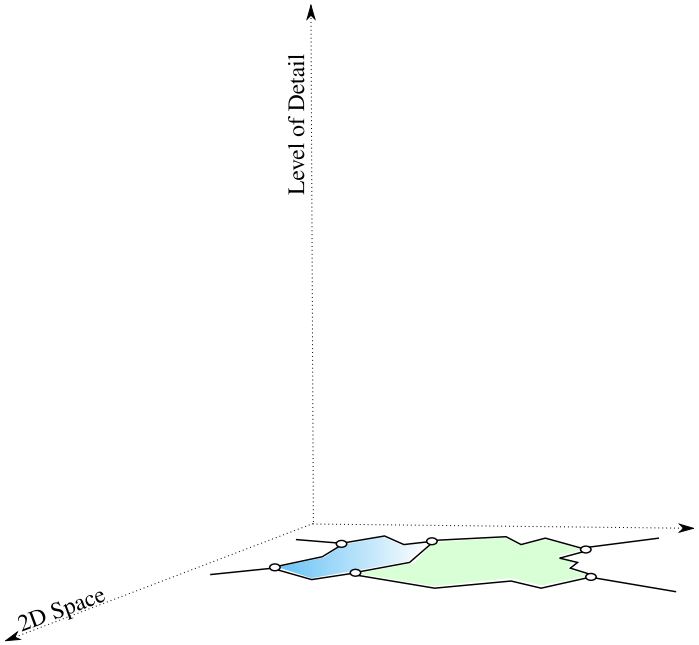
Context – Hierarchical model

- Start: area partition
- Process of merging/splitting objects, until only one object is left
- This process generates hierarchy (DAG)
- 2 questions:
  1. Which object as candidate for merge/split?
  2. Which neighbour(s) to merge (parts of) candidate object to?



Context – Hierarchical model

- Lifespan for each primitive (edges *and* faces), in the scale dimension
- Map varies with scale, going up in cube: *vario-scale*



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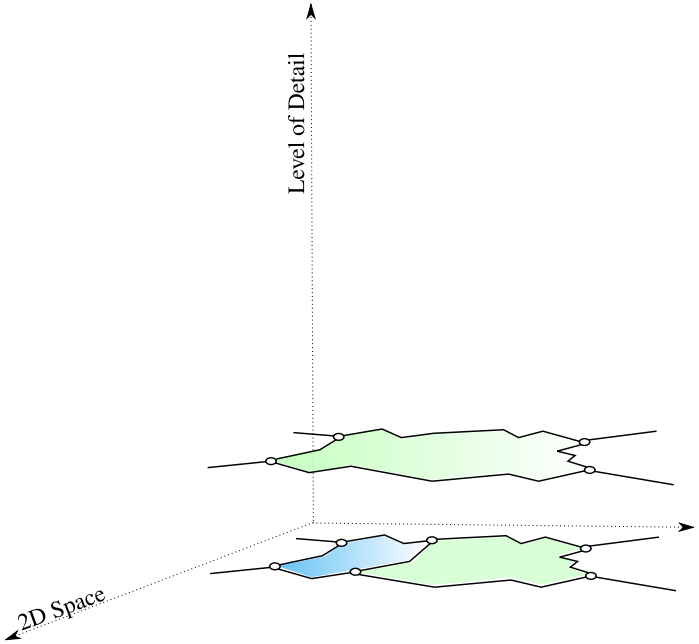

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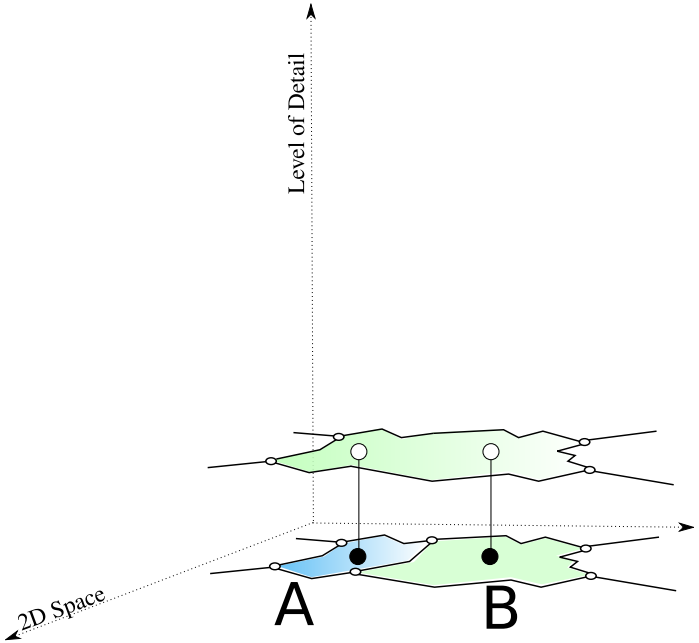

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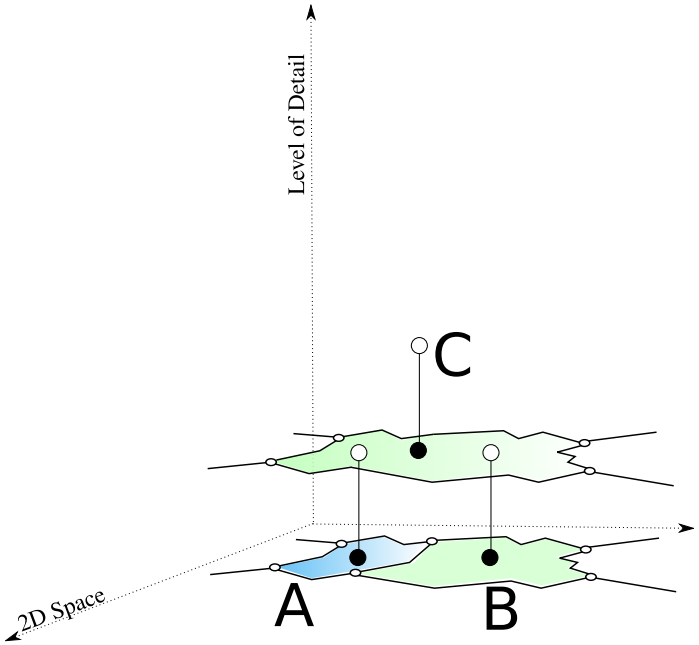
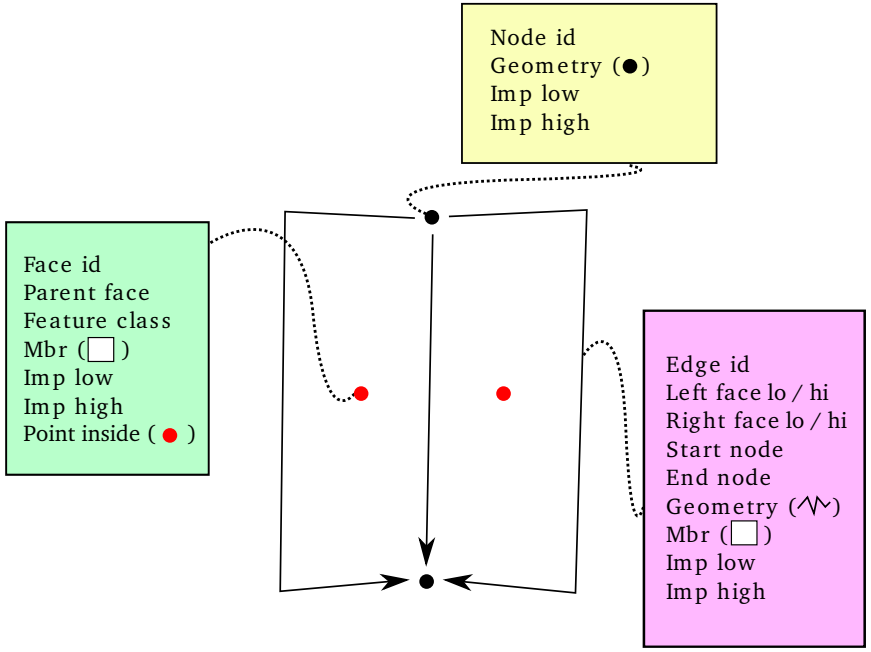
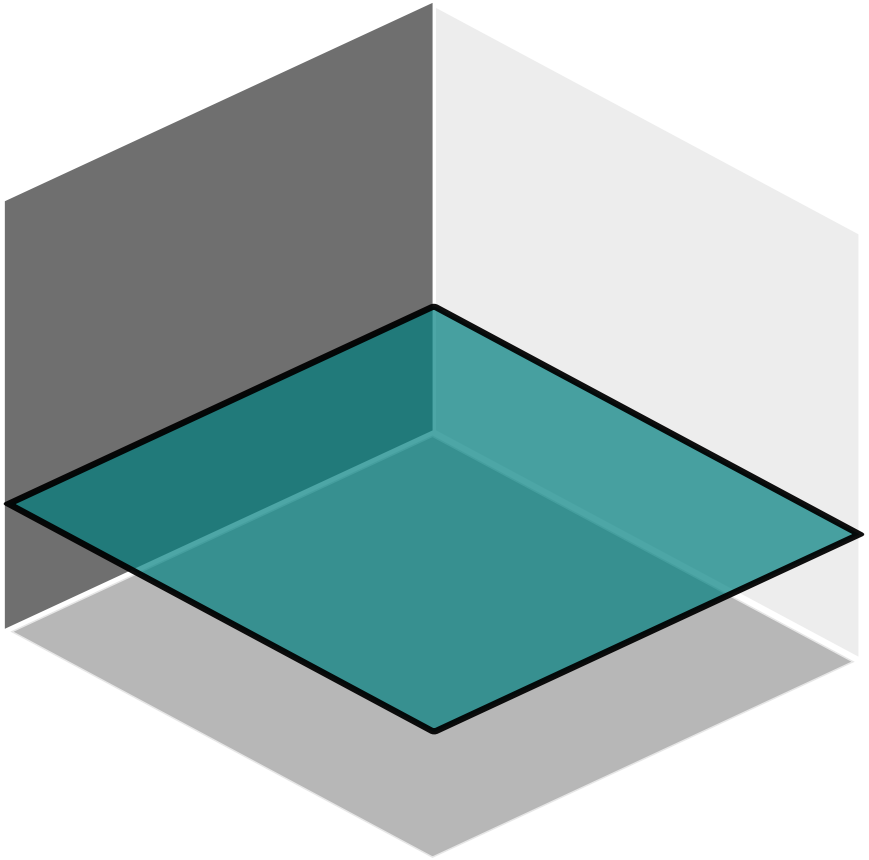


Structures for storing SSC

- Possible encoding of cube: tGAP - topological Generalized Area Partitioning
- Store information on area objects
- Use topology, no explicit geometry for area objects, but:
  1. Edge: polyline with pointers to neighbours, plus bbox
  2. Face: Area extent — bbox, plus point (convenient)



Making a map



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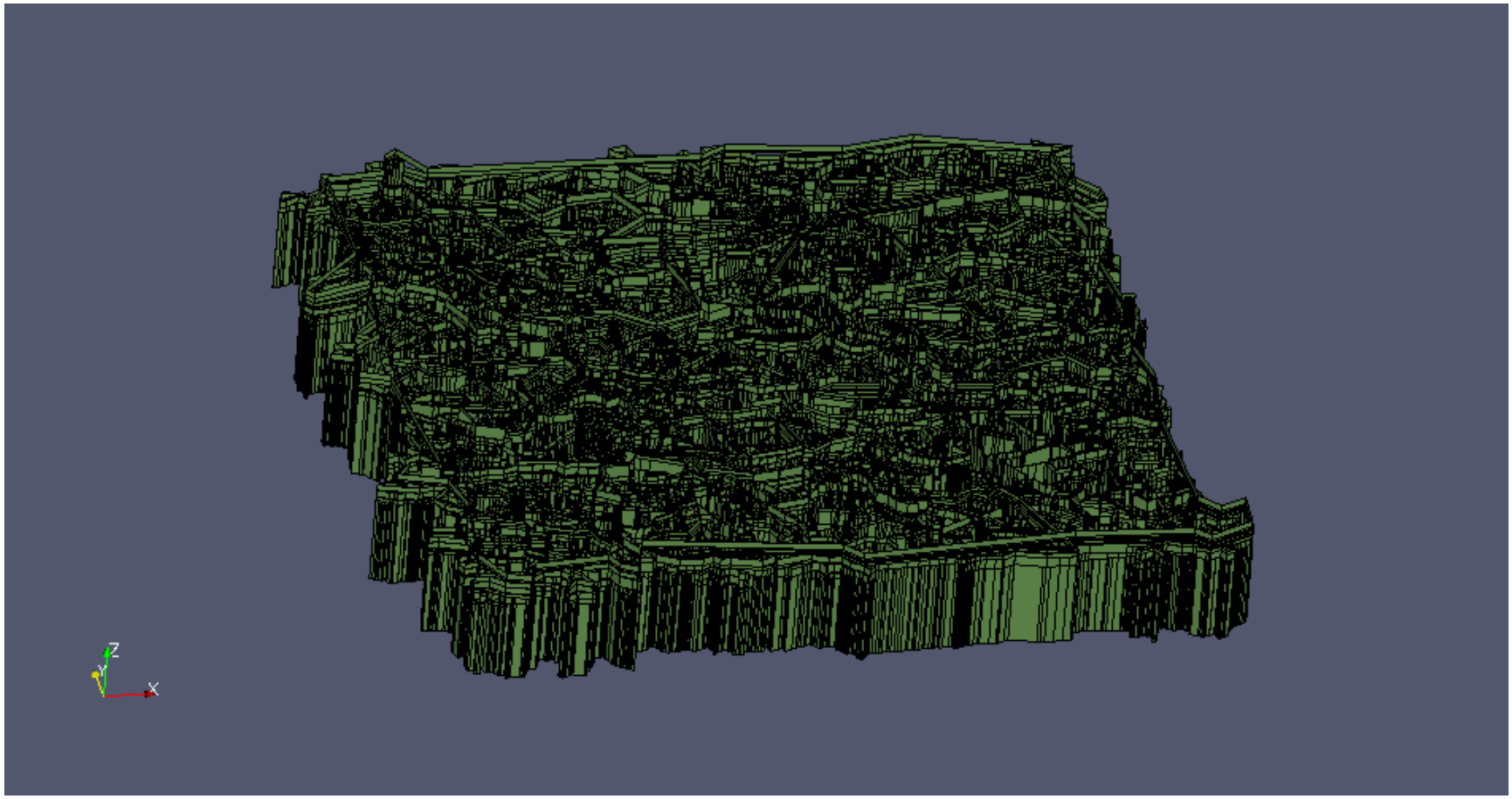
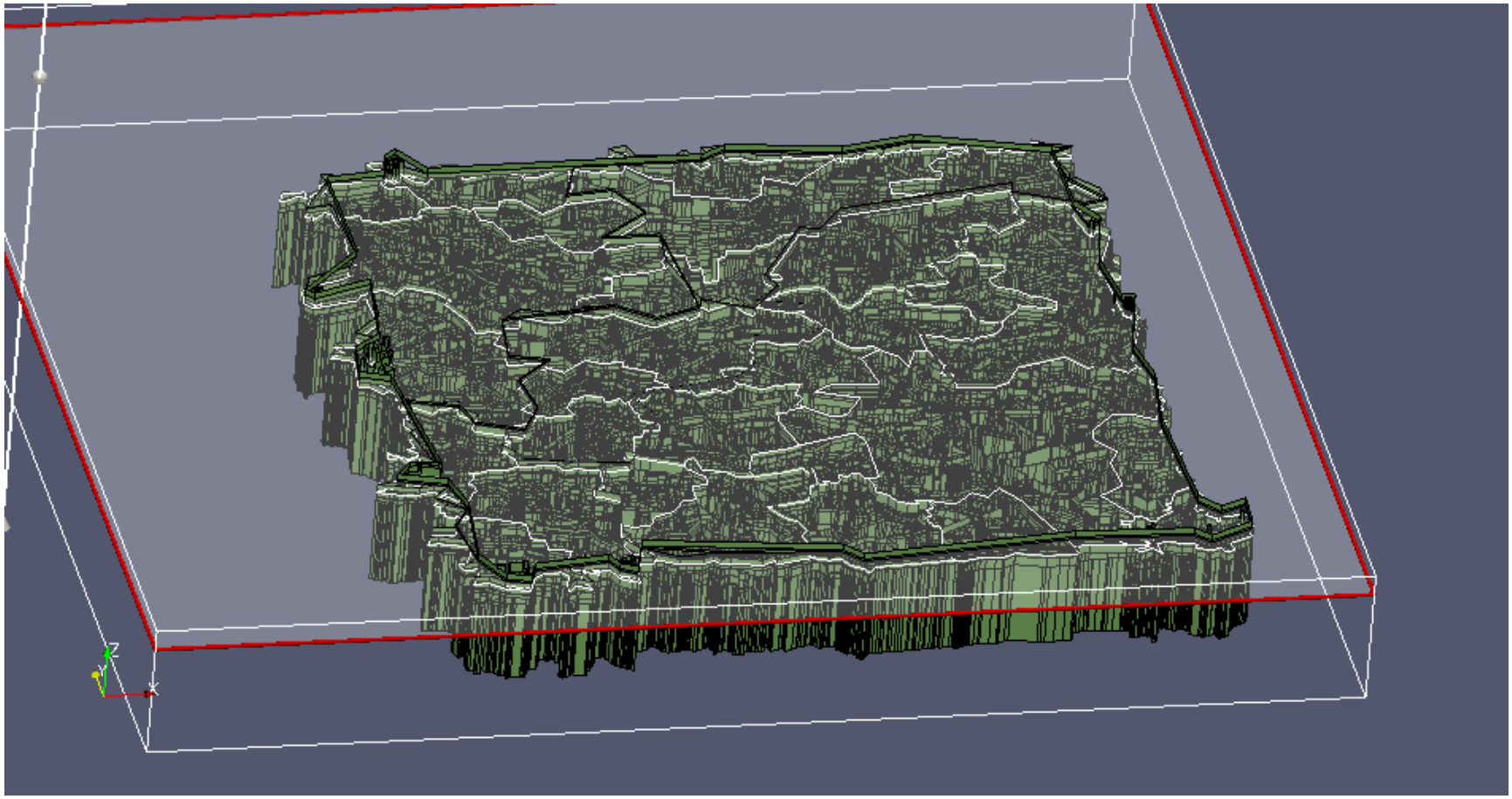


- with real data

Making a map



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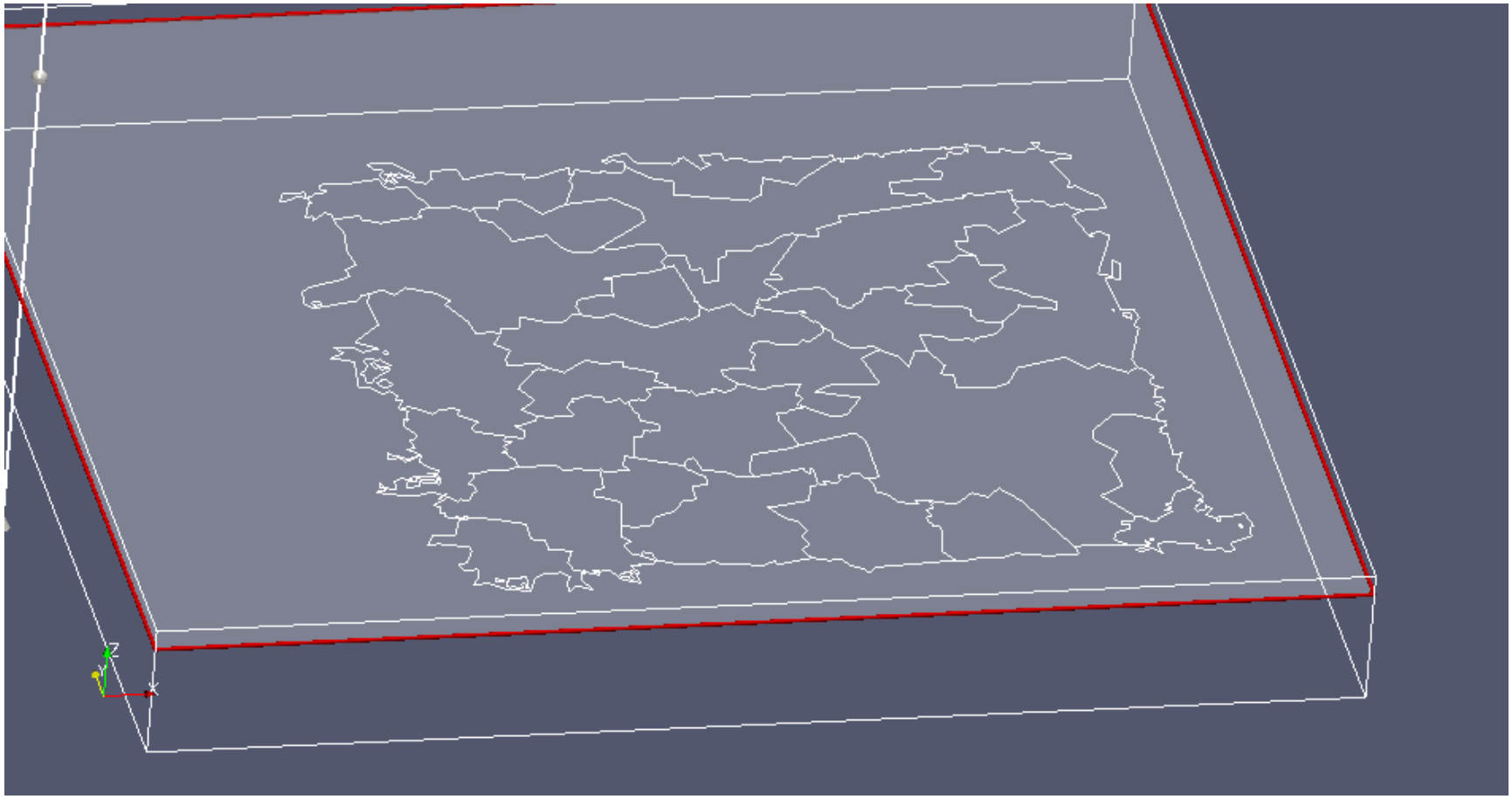

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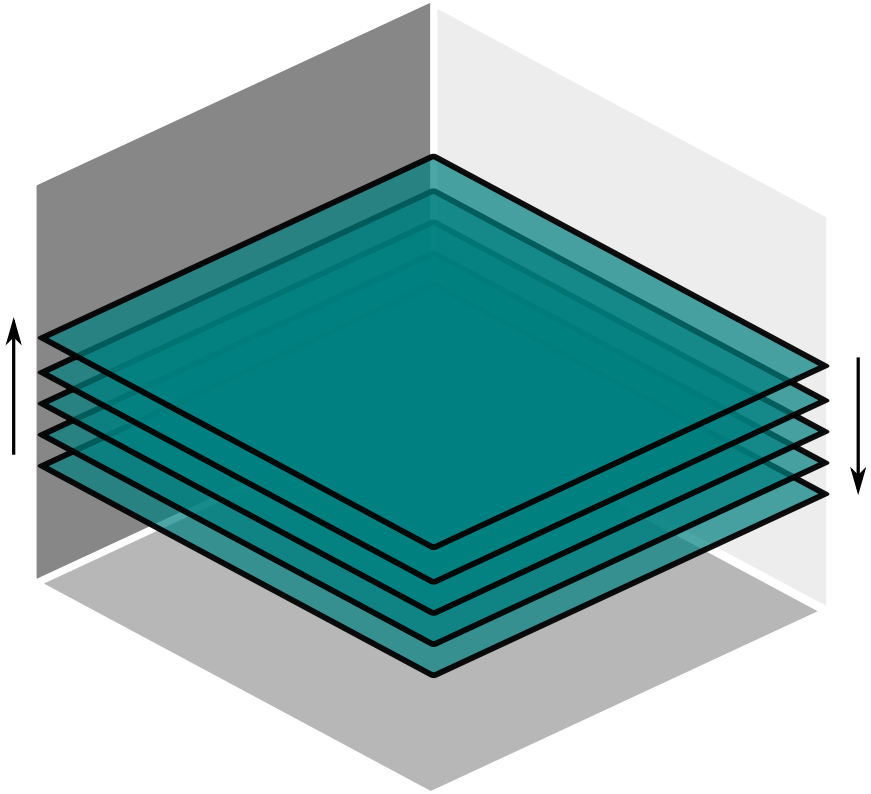
‘Progressive slices’



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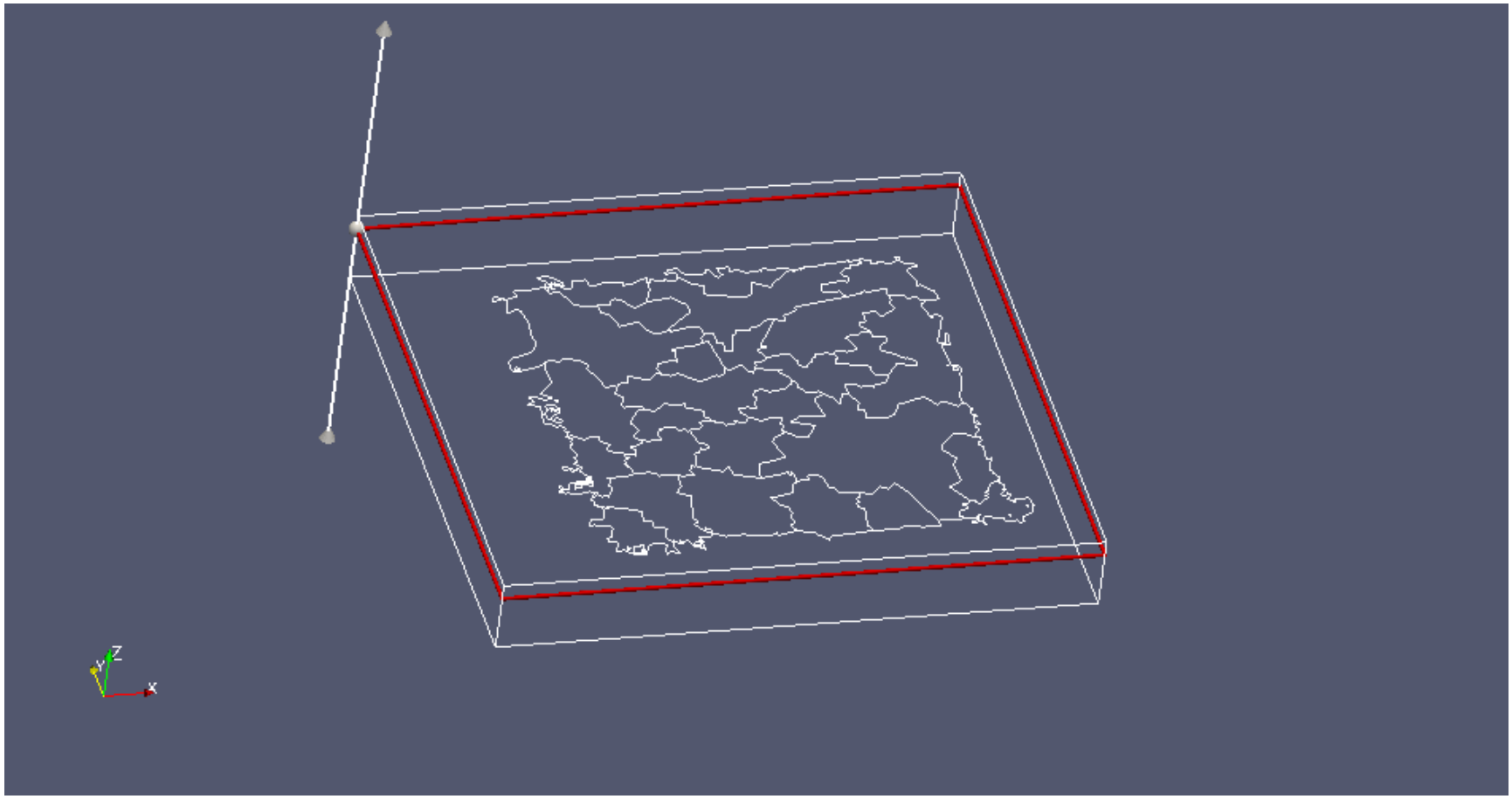

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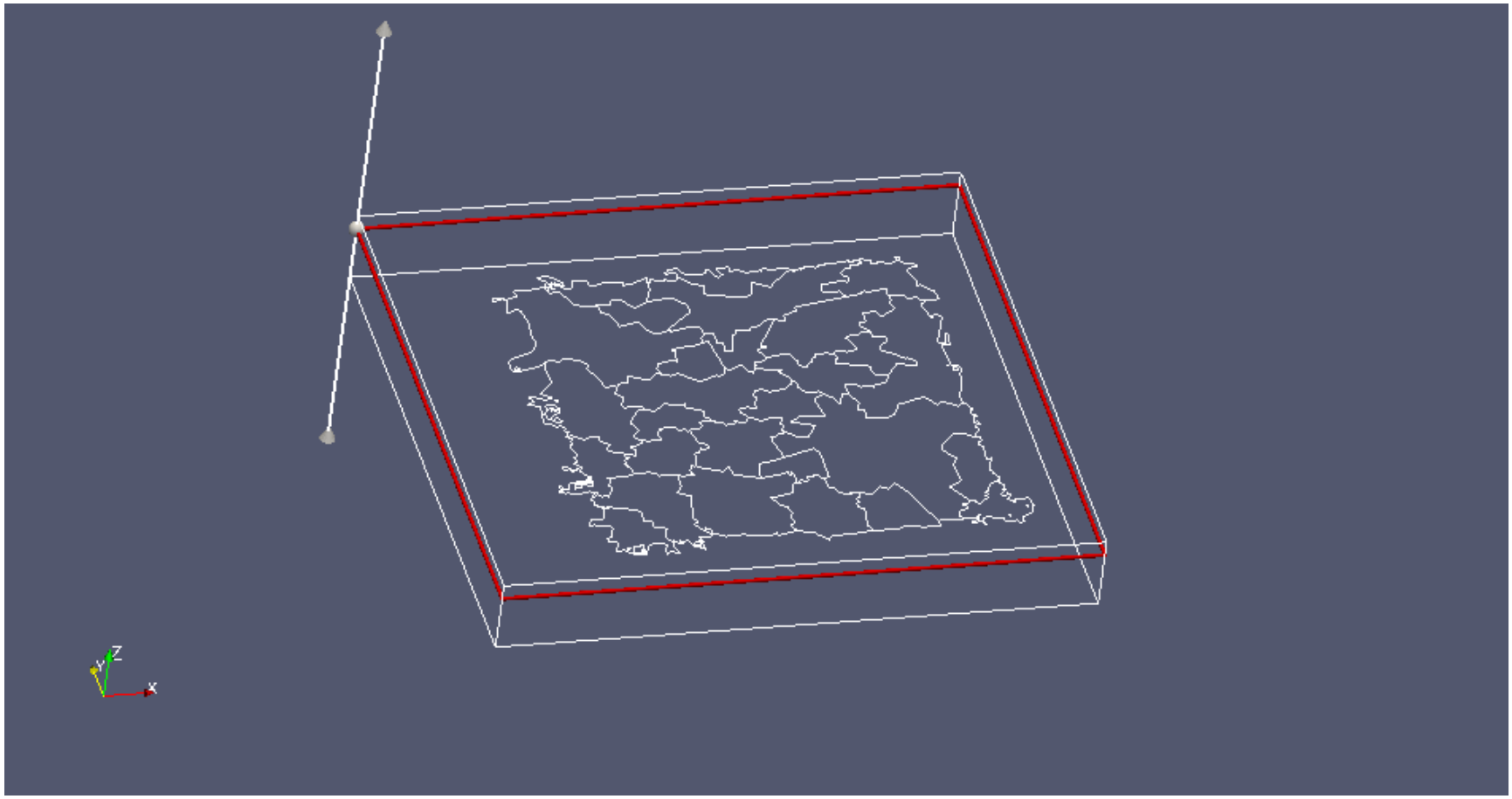

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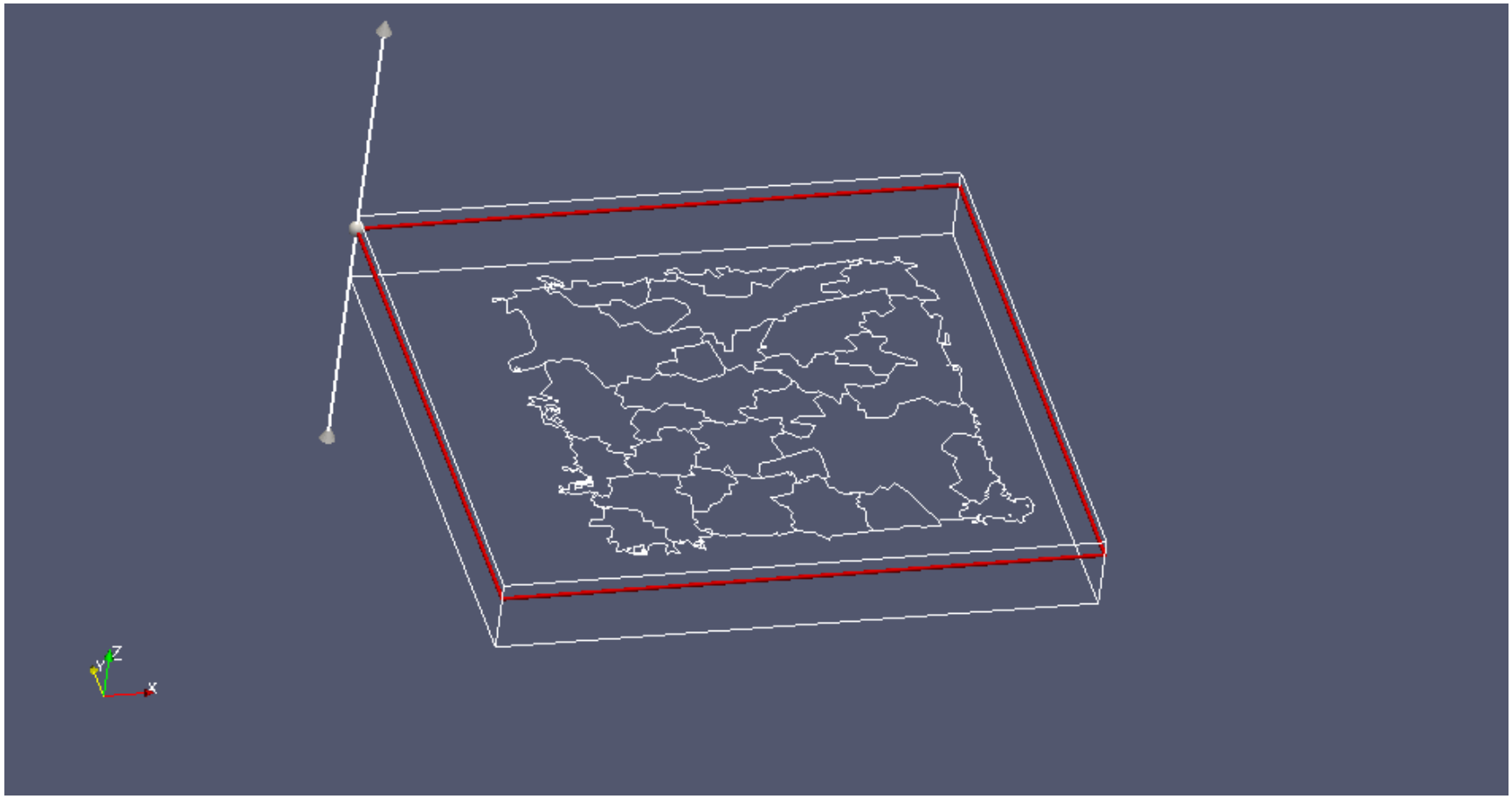

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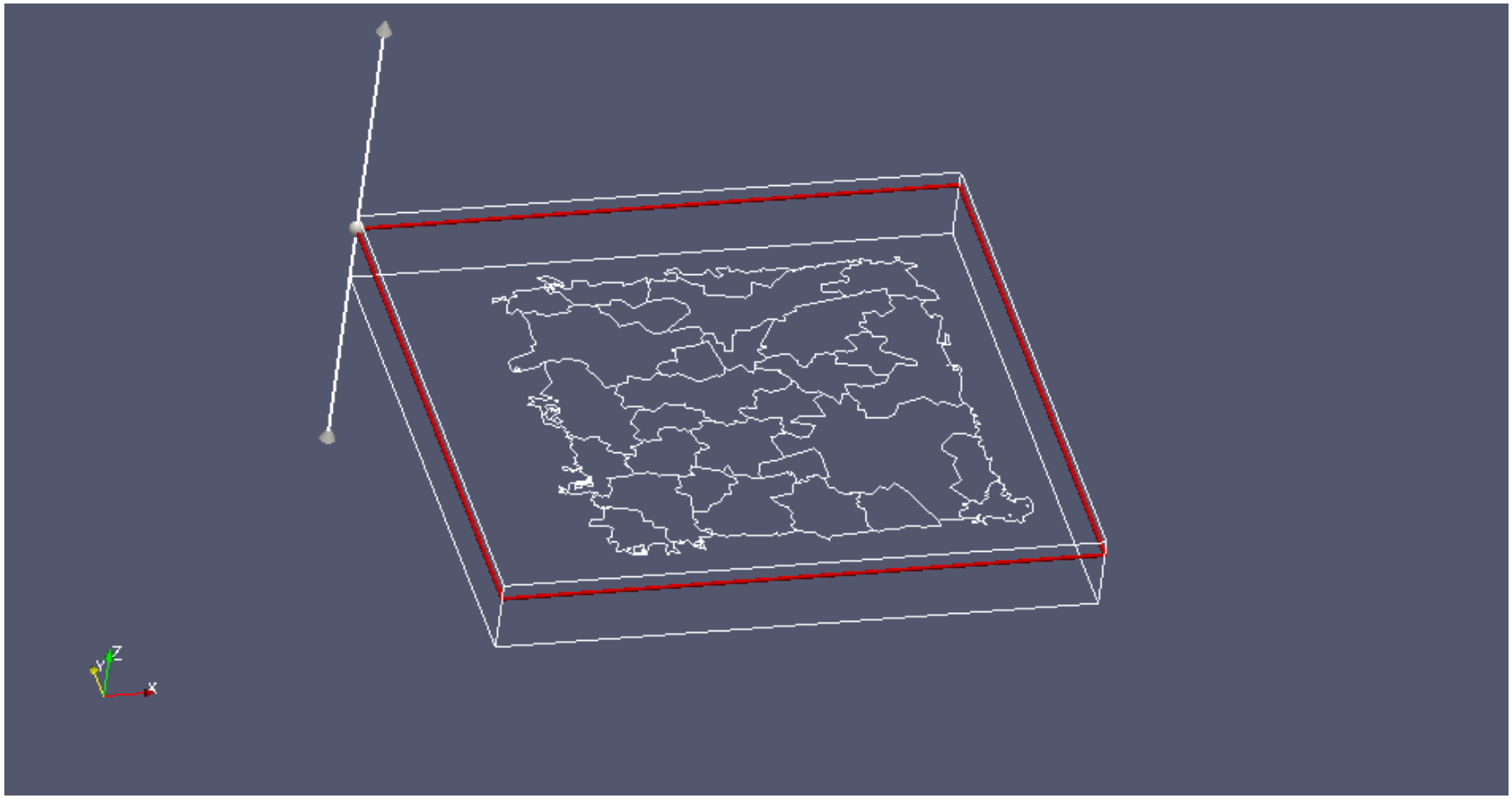
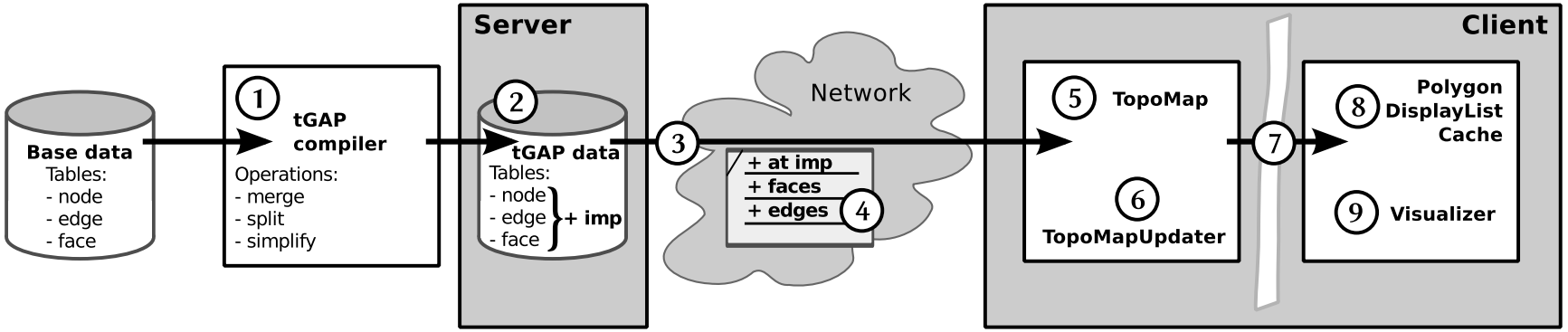
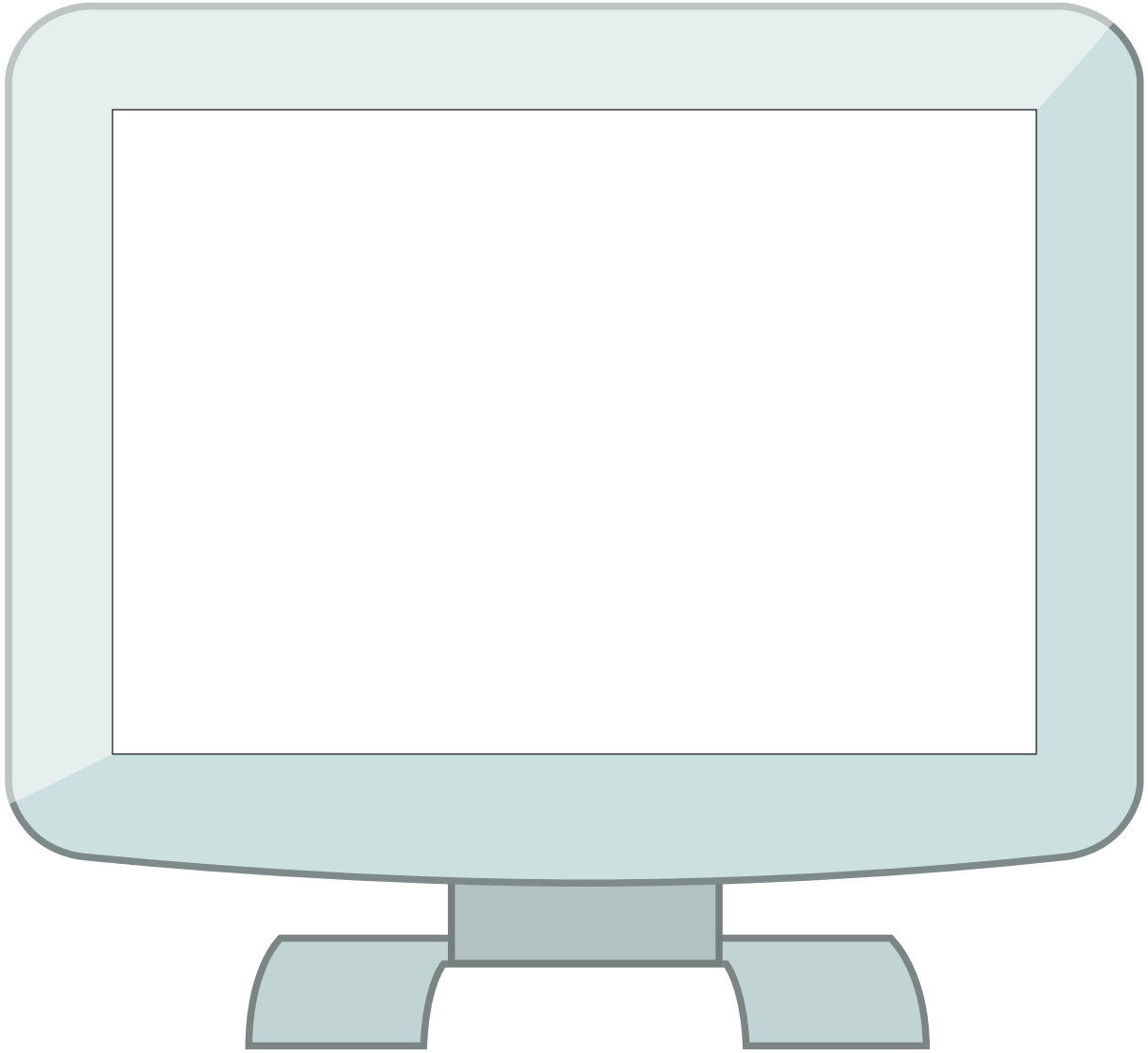


- with real data

Pipeline


Base data
Tables:
- node
- edge
- face
1
tGAP compiler
Operations:
- merge
- split
- simplify
Server
2
tGAP data
Tables:
- node
- edge
- face
+ imp
3
Network
+ at imp
+ faces
+ edges
4
Client
5
TopoMap
6
TopoMapUpdater
7
8
Polygon DisplayList Cache
9
Visualizer

Incremental updates (over the network)



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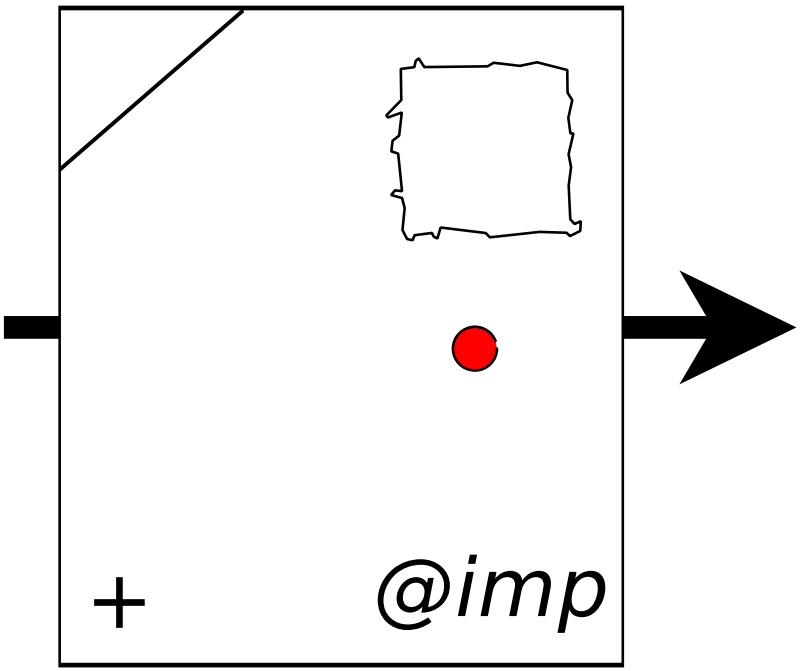

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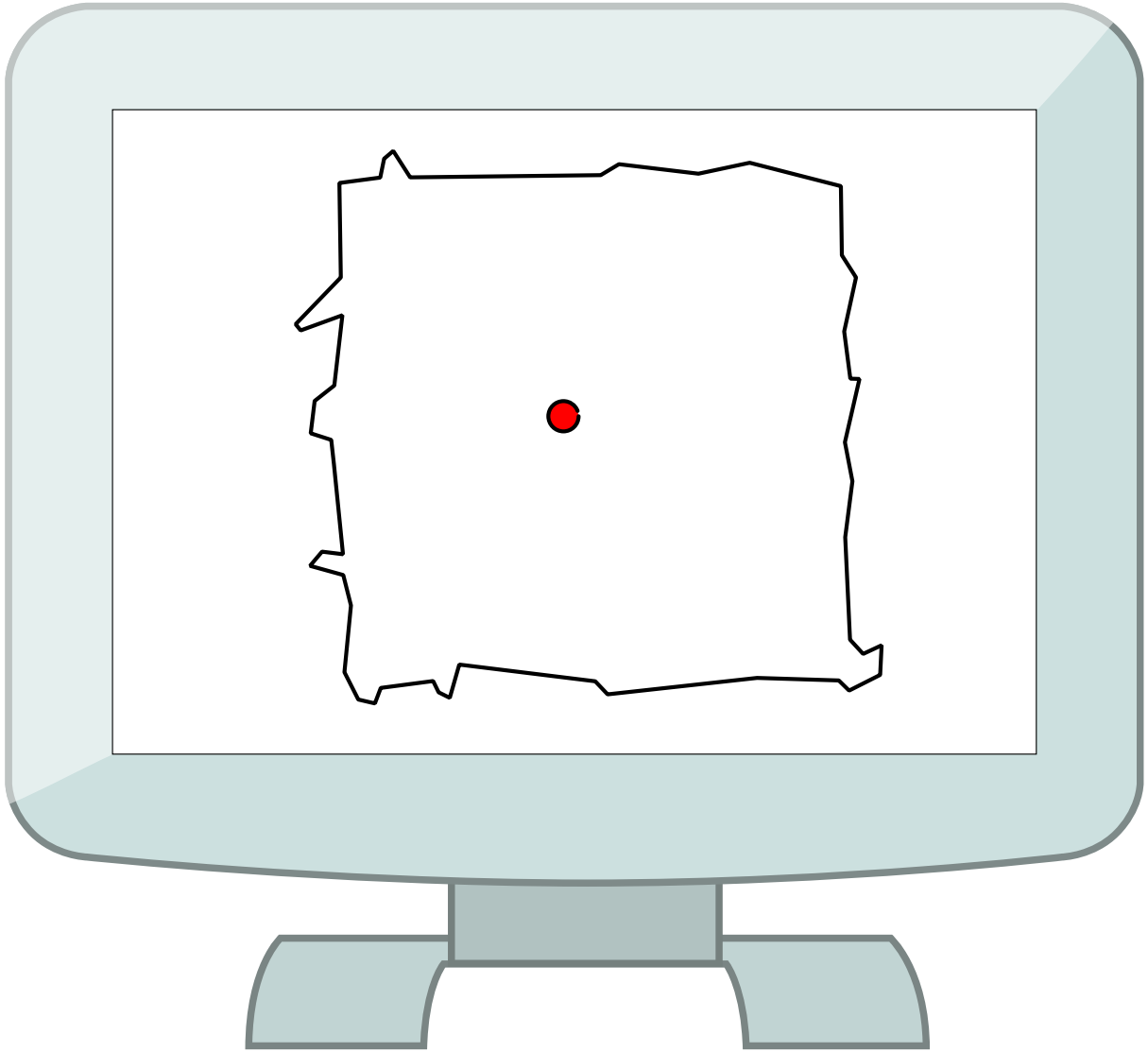

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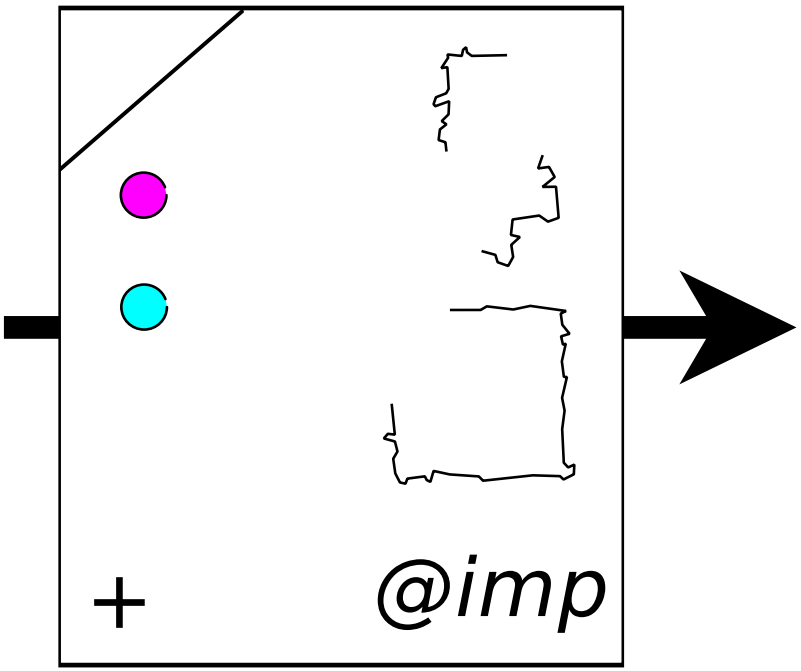

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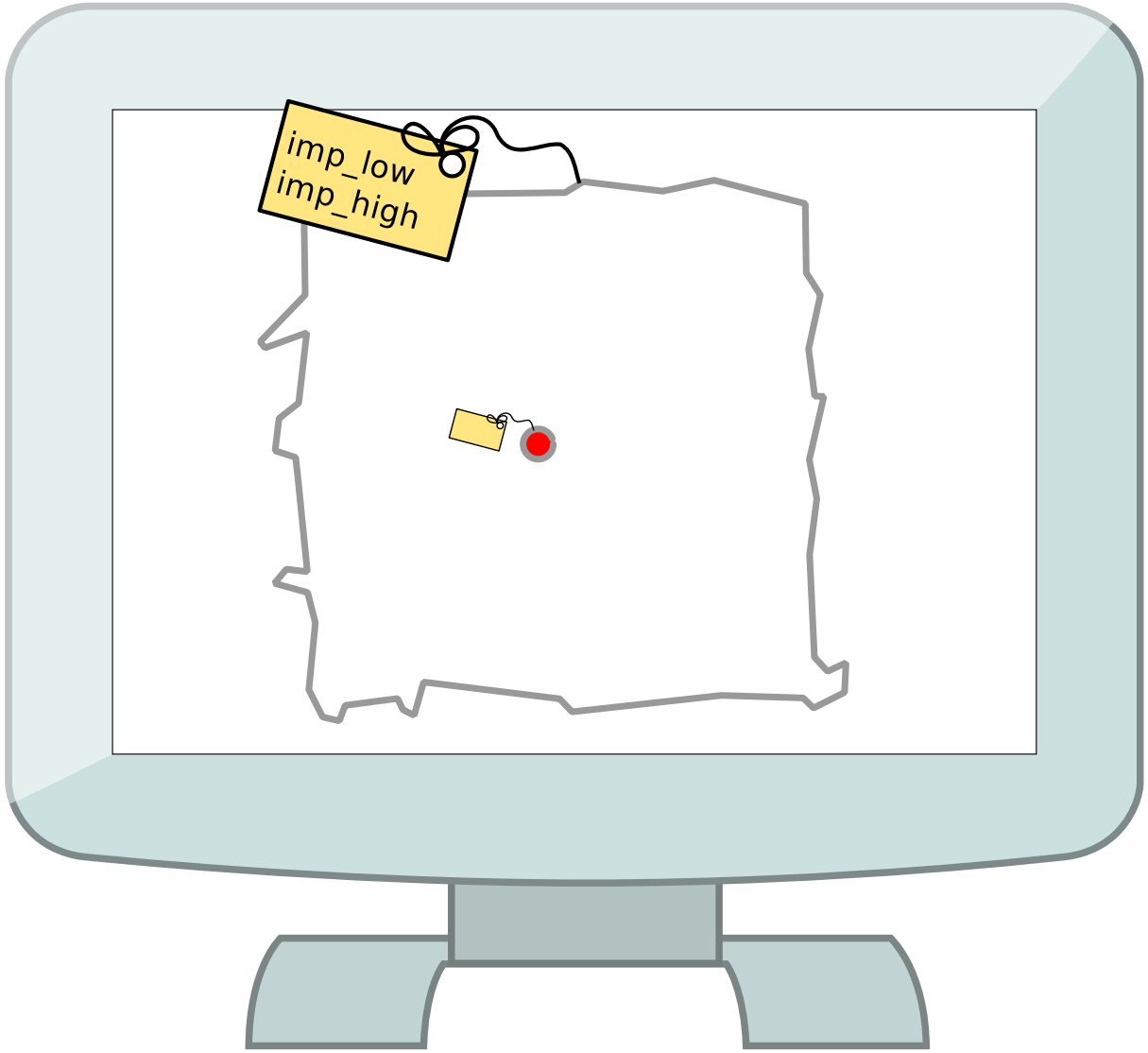

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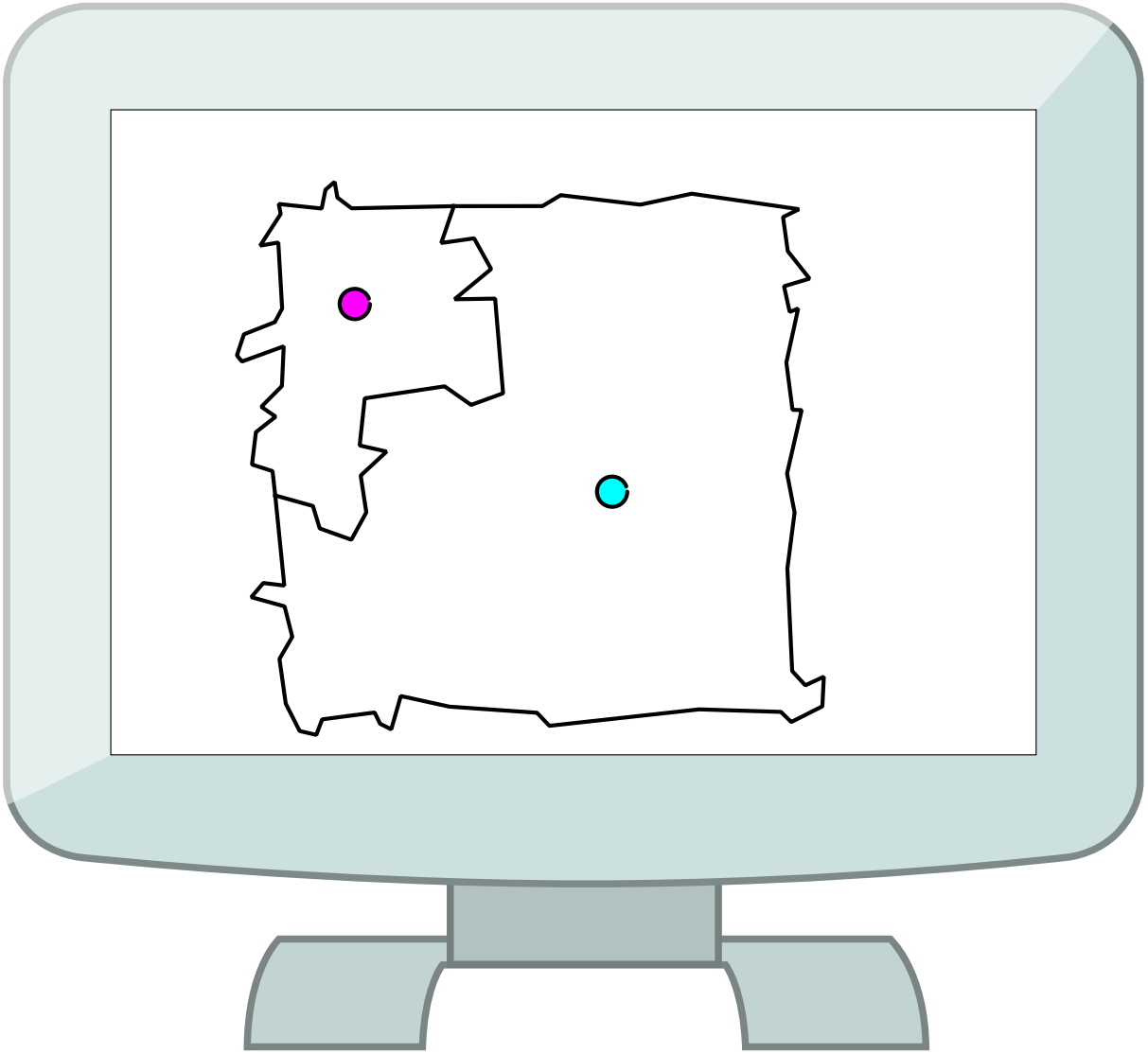

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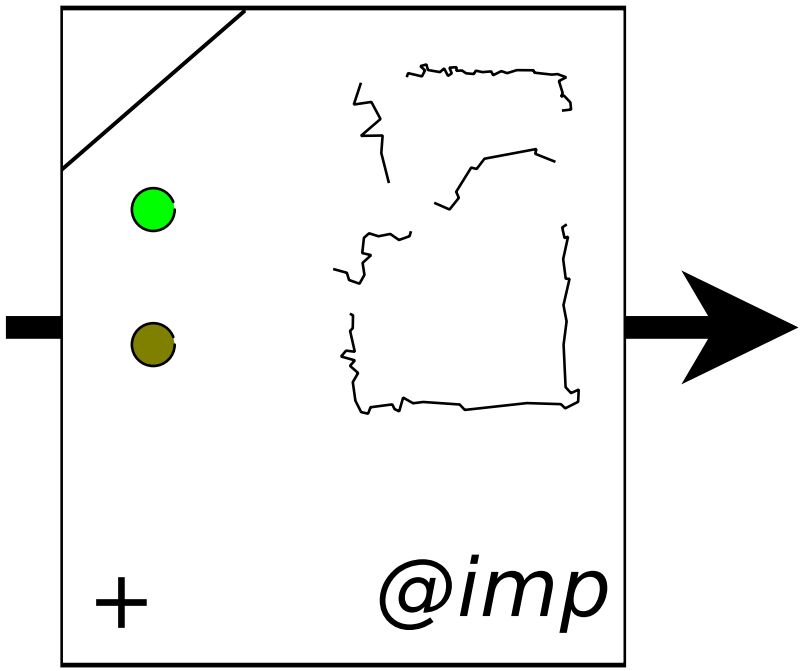

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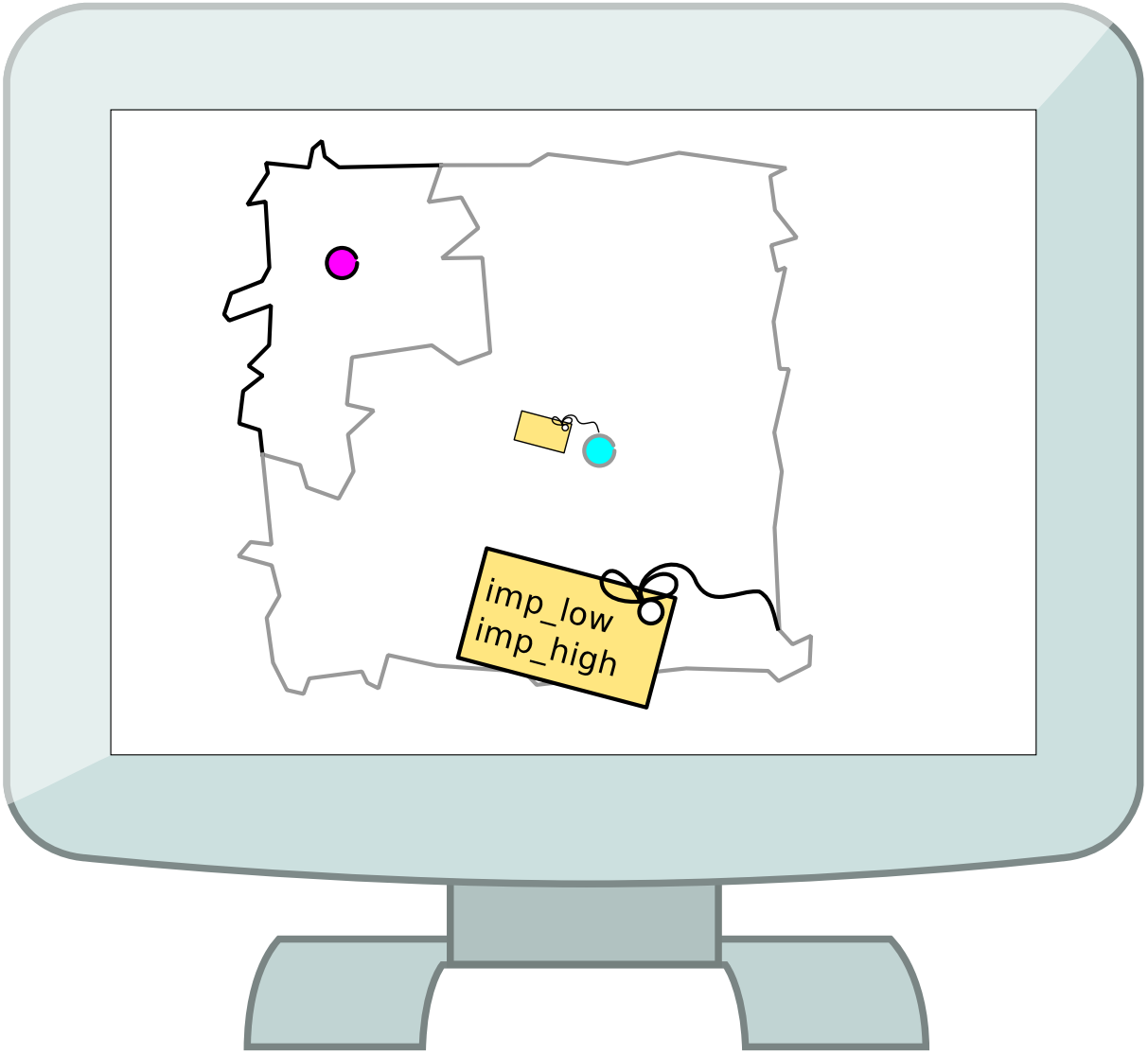

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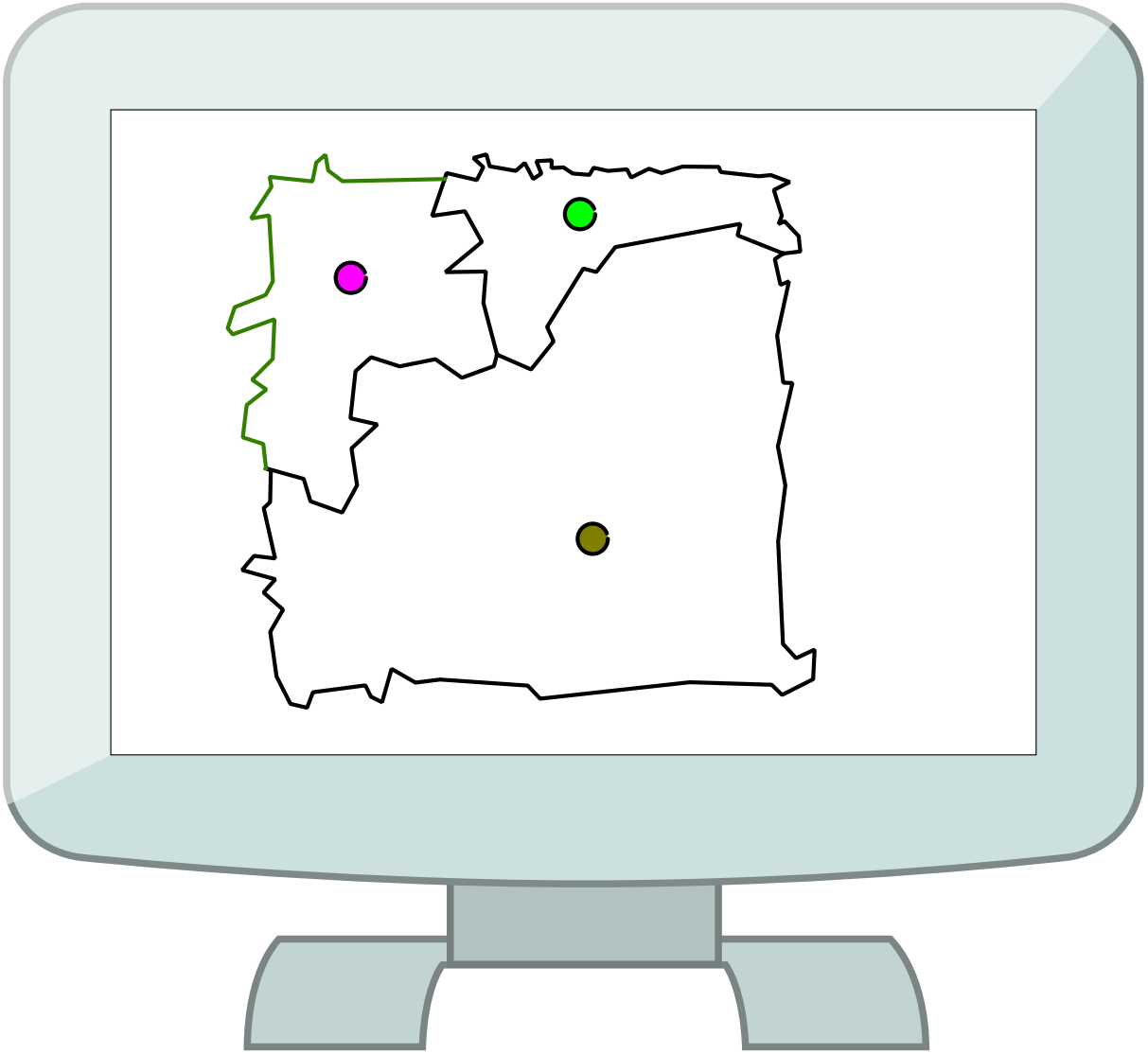
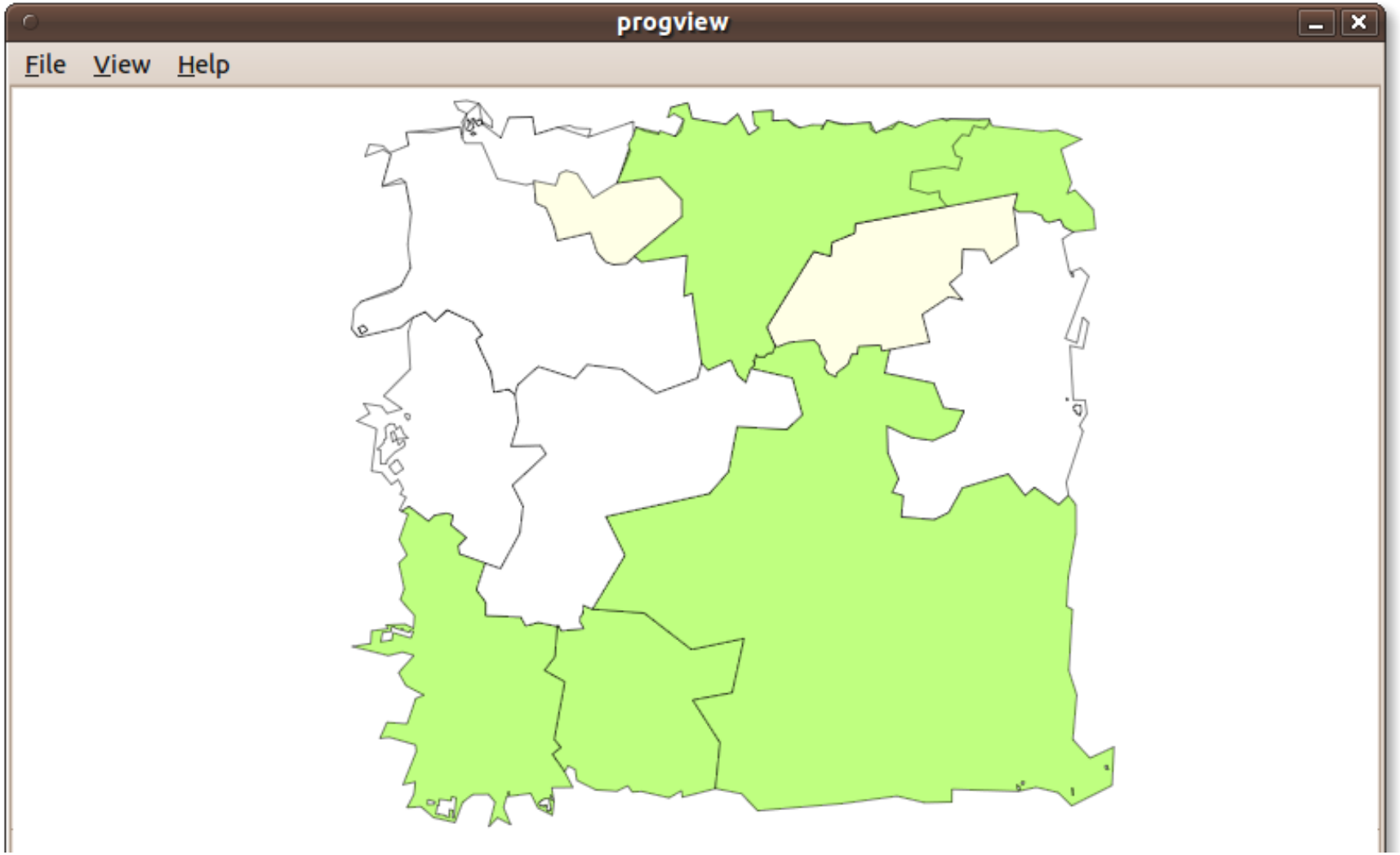


Size (compared to most detailed map)

Dataset + type of data	Size map (kB)	Size Progressive (kB)	Increase (factor)
Hamburg (rural)	477	822	1.72×
Colchester (rural)	3 377	5 366	1.59×
Buchholz (rural)	5 044	8 597	1.70×
Delft (urban)	8 369	13 802	1.65×

Note: edges simplified!

Demo



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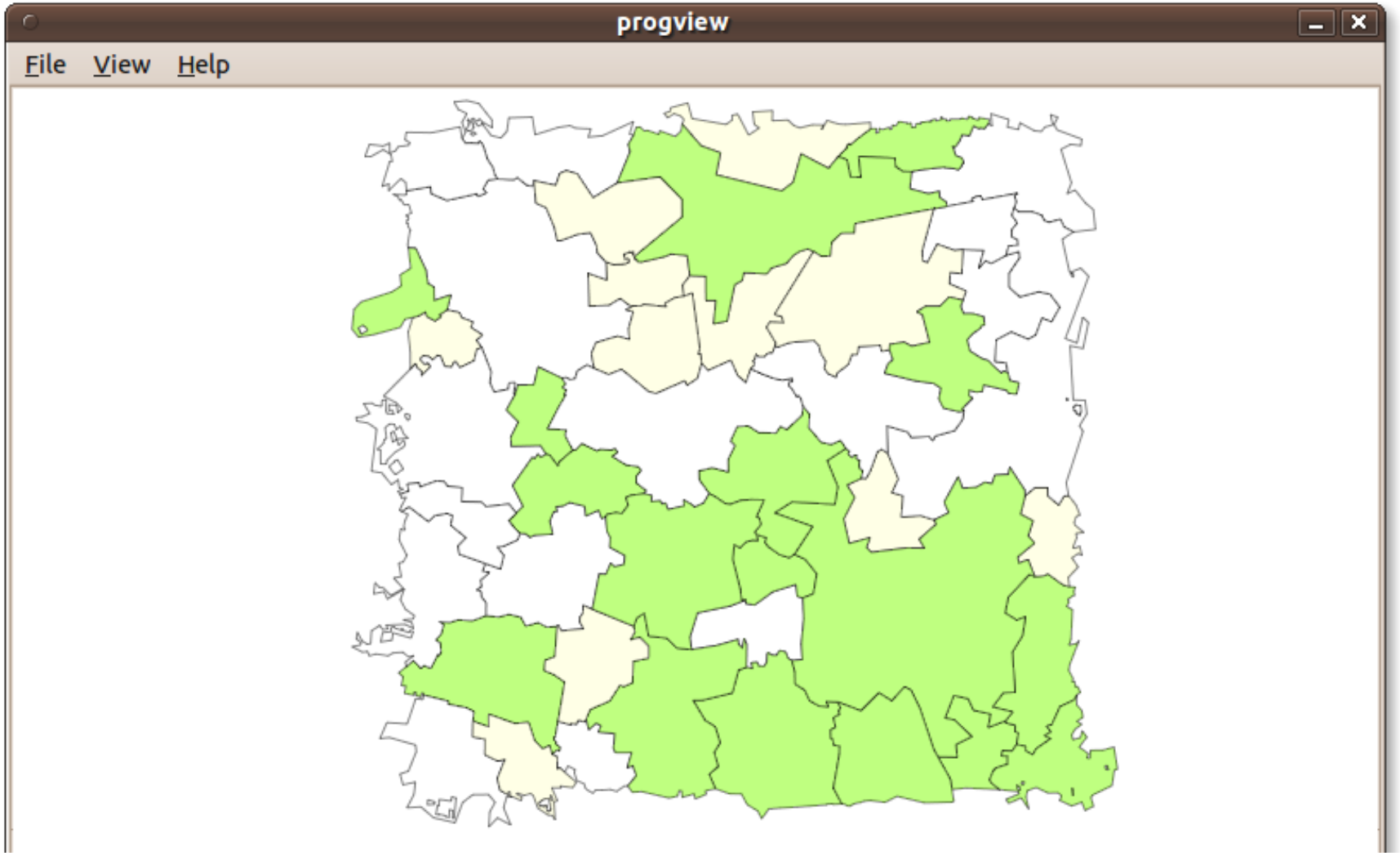

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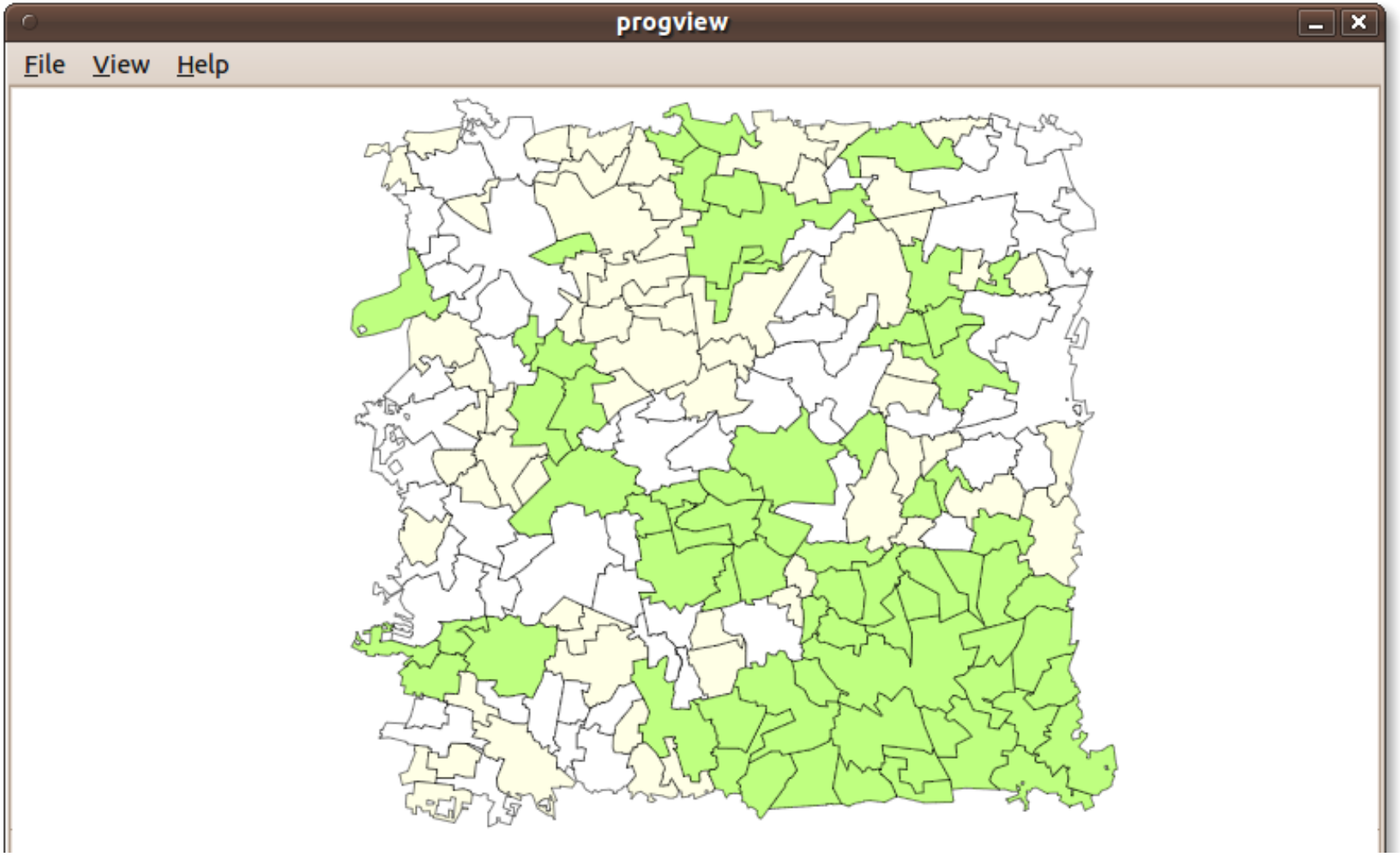

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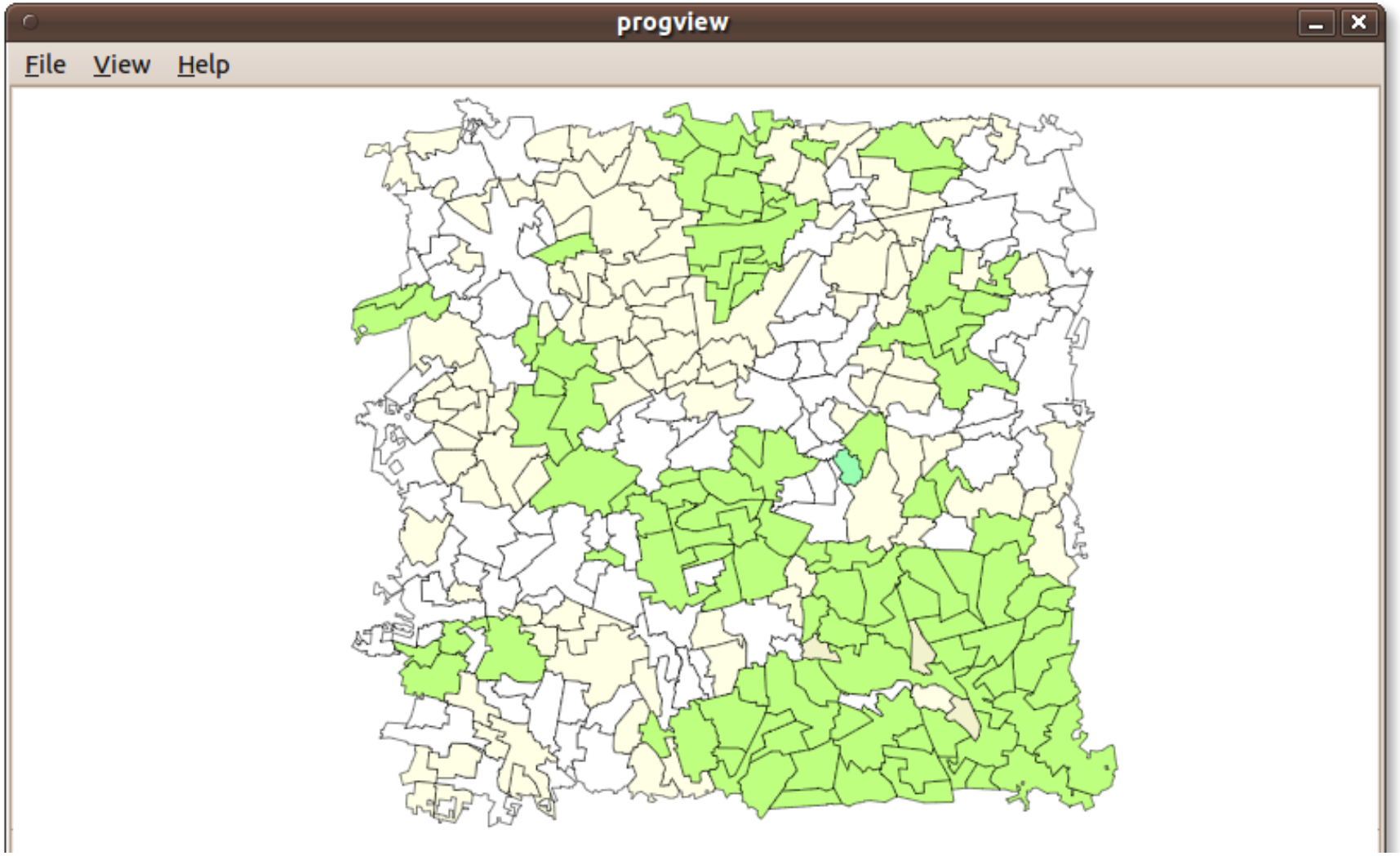

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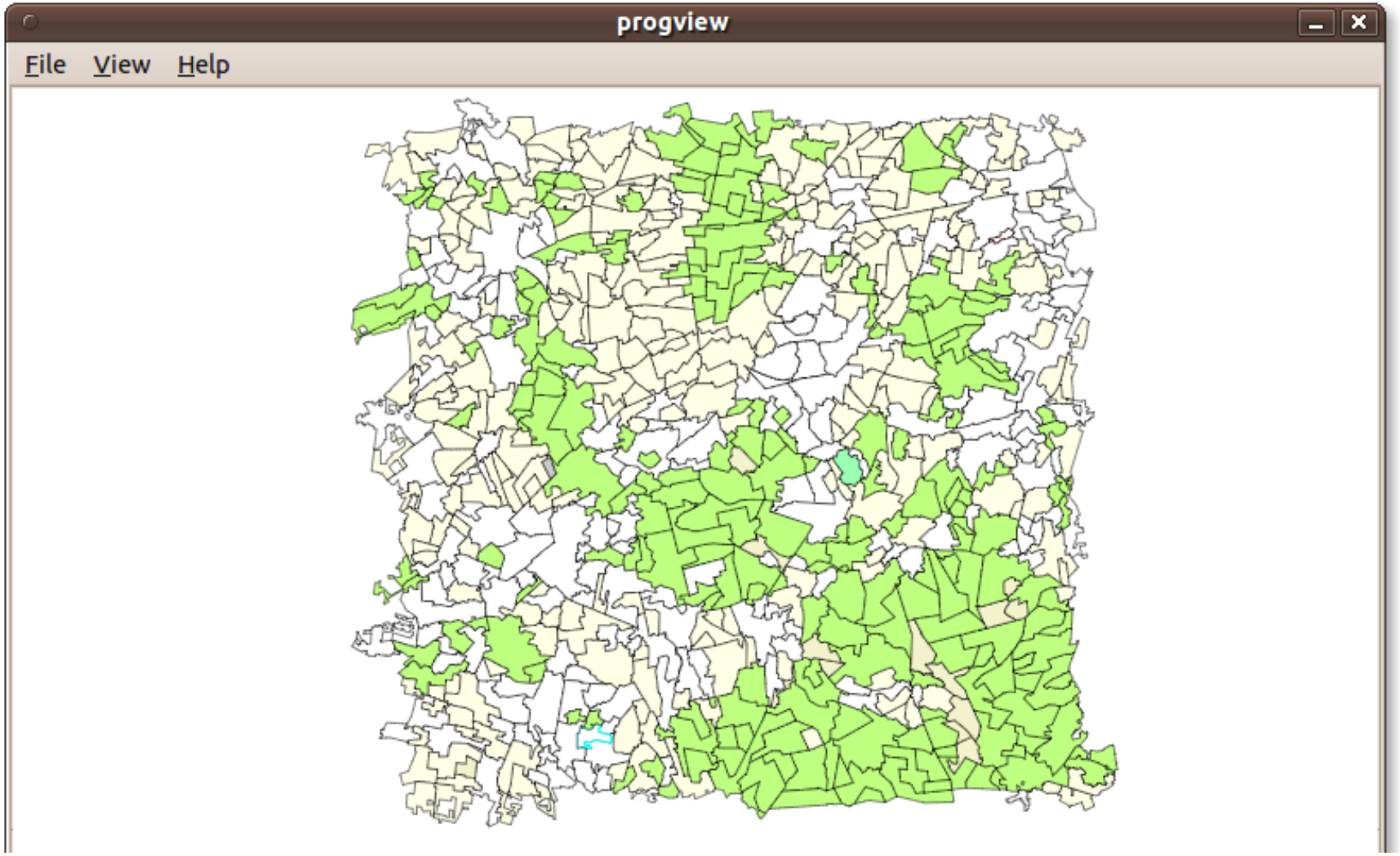
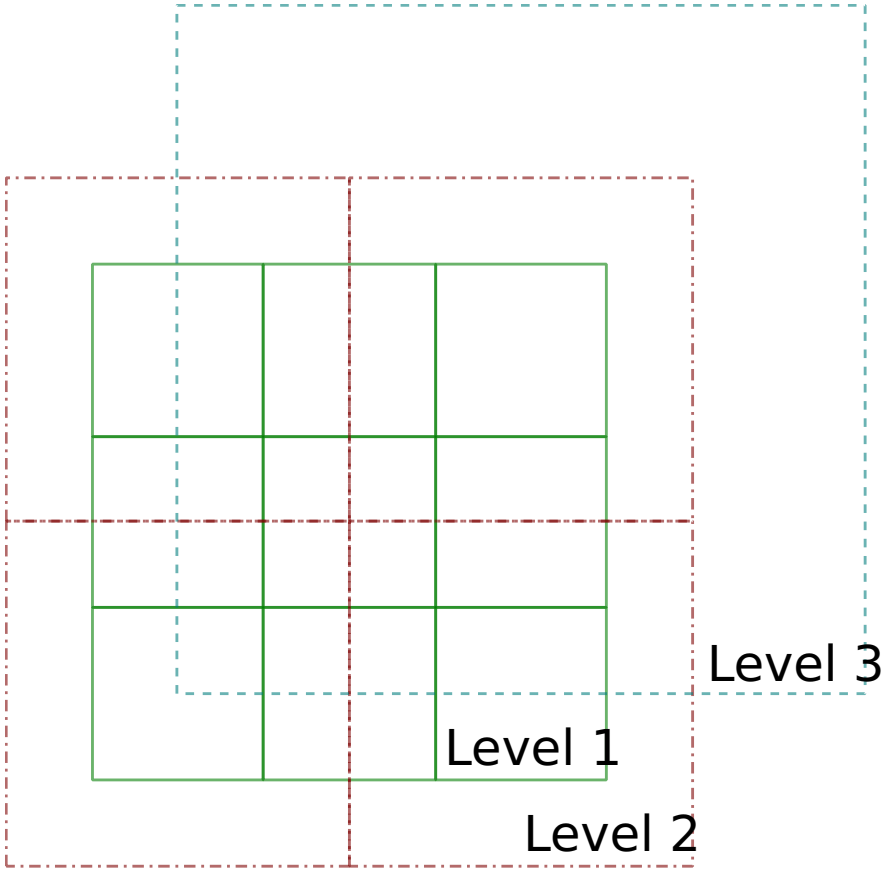
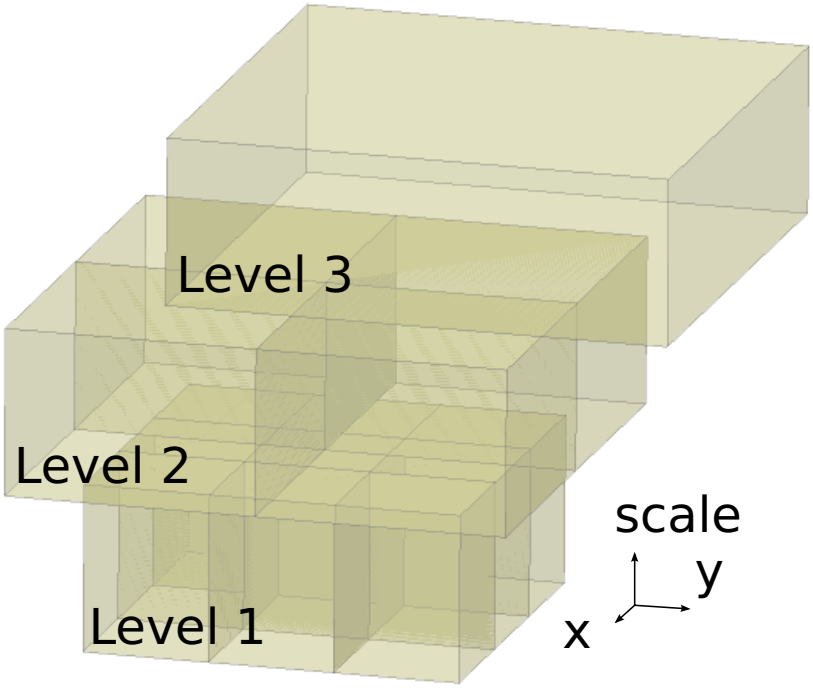


Field tree

- Missing: Link between users path and data retrieval
- Super-impose ‘regular’ structure in SSC, Fieldtree (Frank and Barrera, 1990)

Field tree

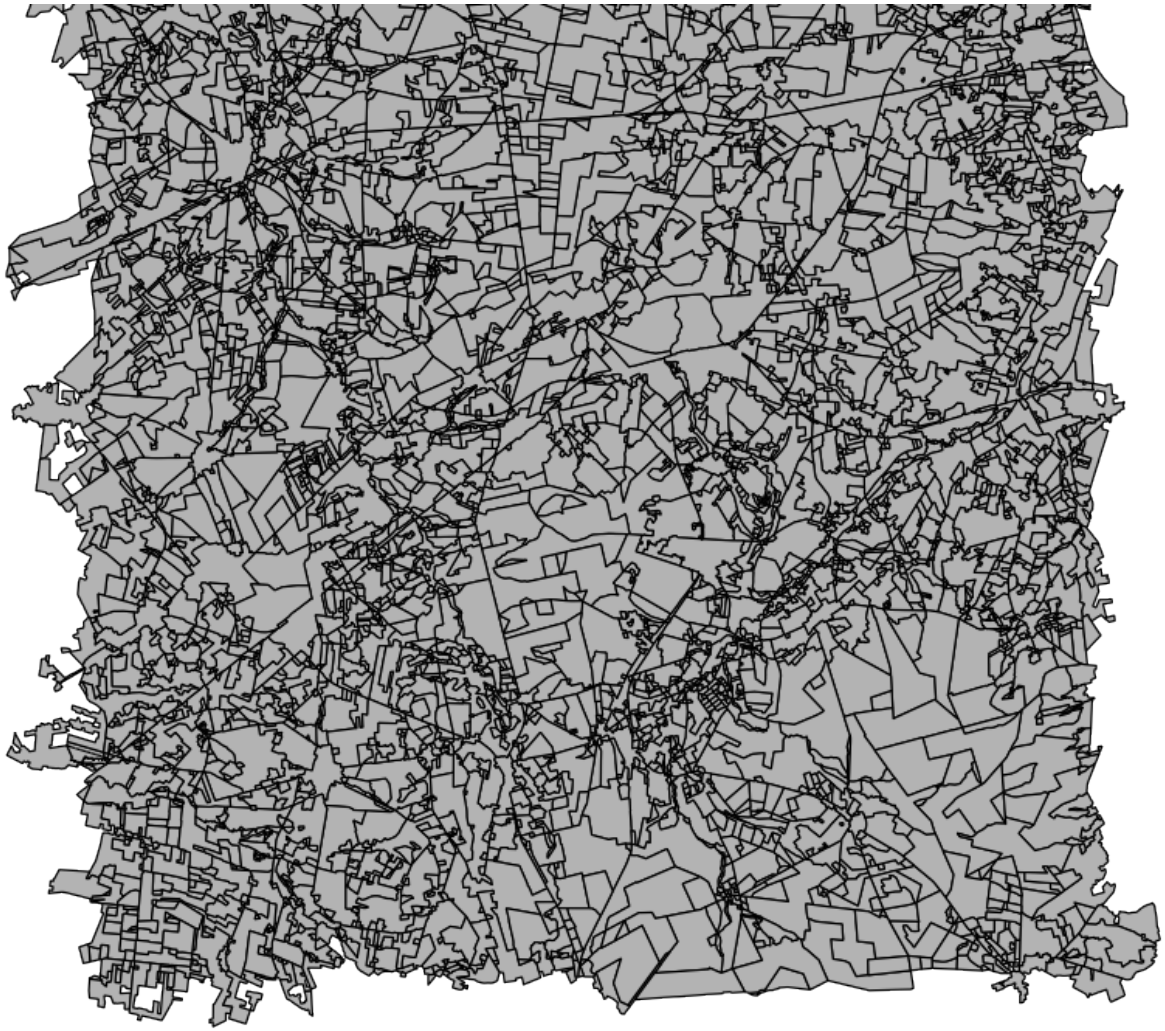




Field tree

- Use it in generalisation process
- Perform progressive transfer for Fields

Field tree



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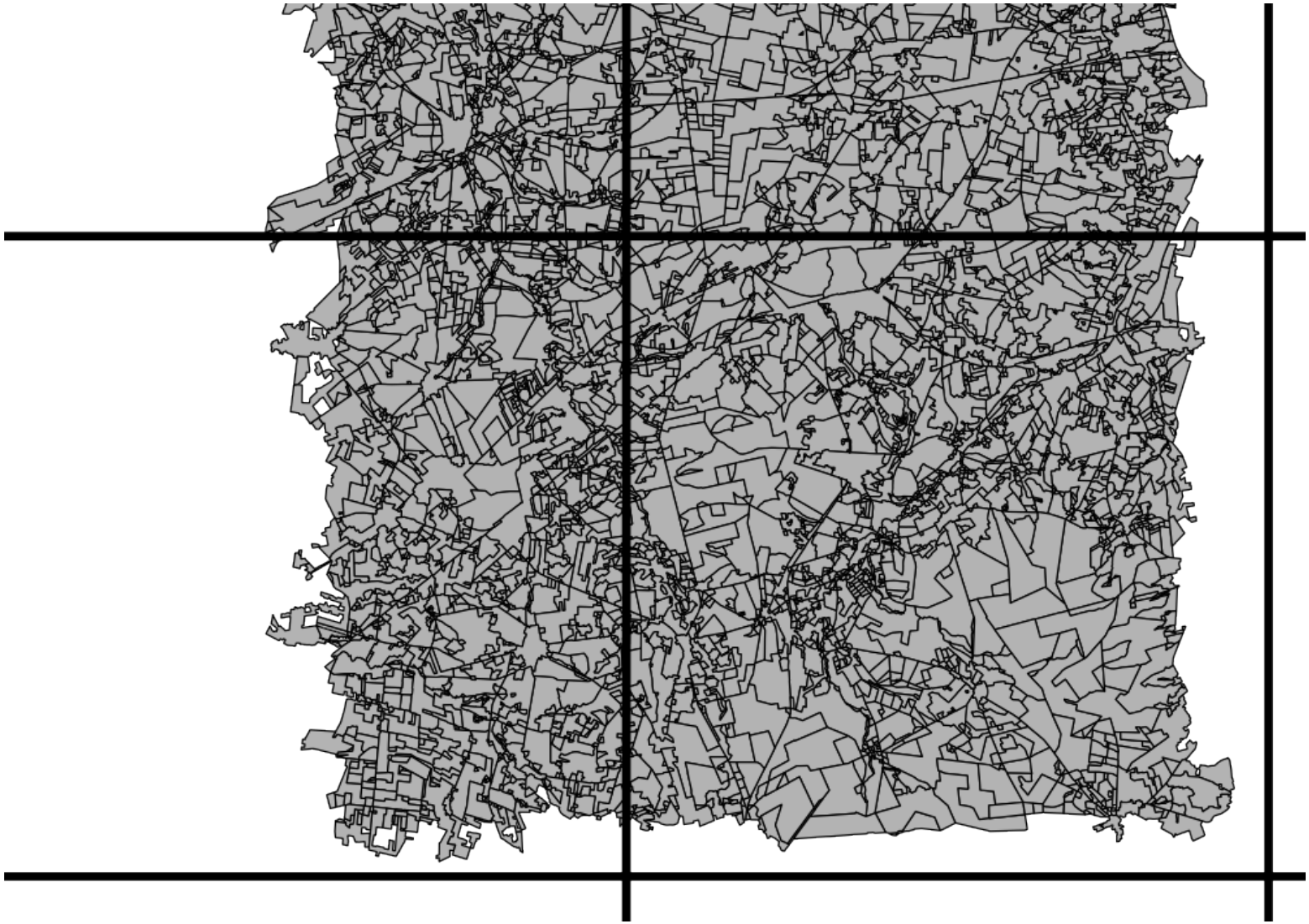

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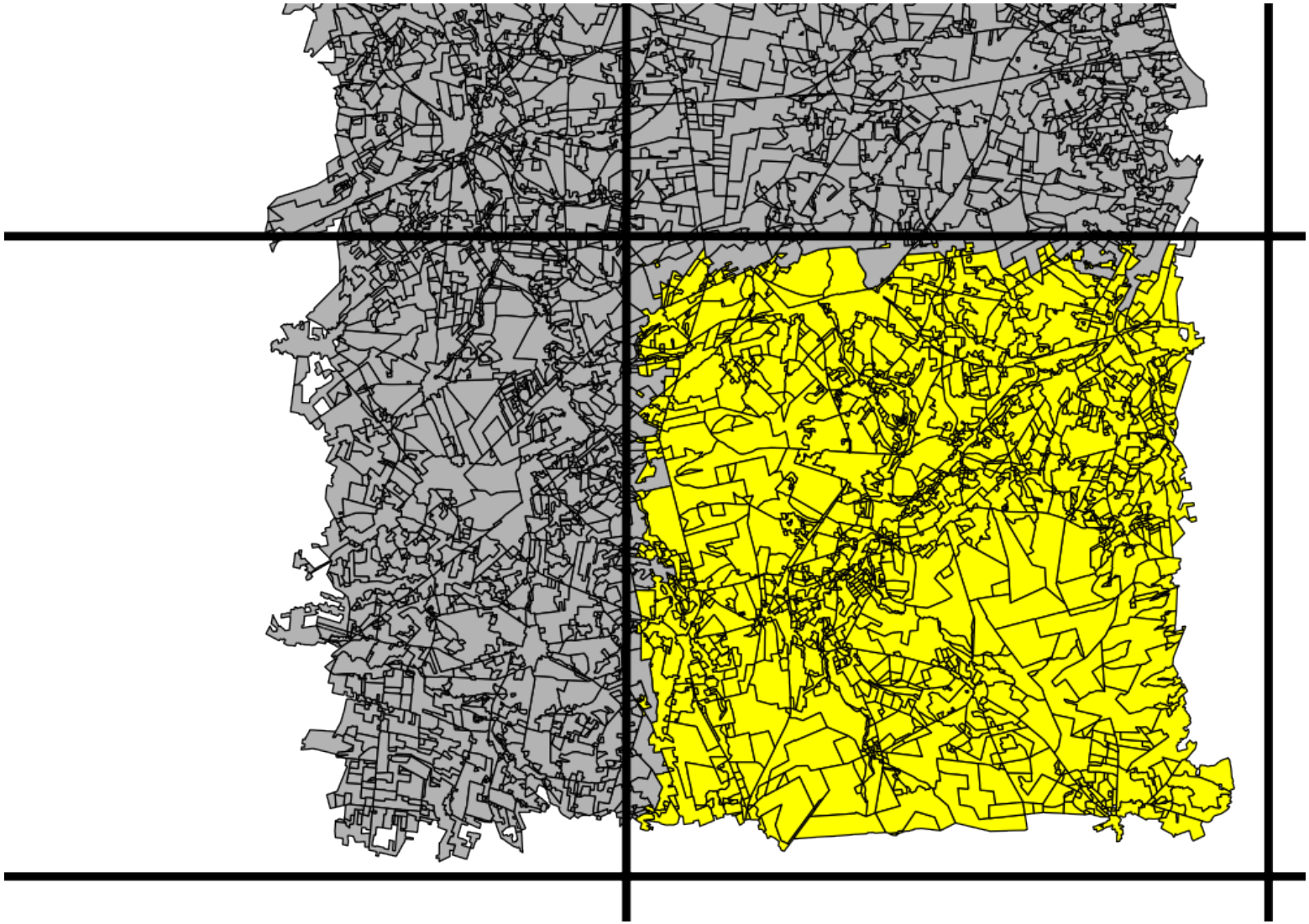

Field tree

- Fixed boundaries: trouble? Resolved at next level?
- How to deal with retrieval (shared)? Mapping Faces (point in side) 1:1 Fields?
- What's an optimal size for Fields?
- Divide-and-conquer: parallel build

Thank you for your attention

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References

Frank, A. and Barrera, R. (1990). The Fieldtree: A data structure for geographic information systems. In Buchmann, A., Günther, O., Smith, T., and Wang, Y.-F., editors, *Design and Implementation of Large Spatial Databases*, pages 29–44. Springer Berlin / Heidelberg.

Haunert, J.-H., Dilo, A., and van Oosterom, P. (2009). Constrained set-up of the tGAP structure for progressive vector data transfer. *Computers & Geosciences*, 35(11):2191–2203. Progressive Transmission of Spatial Datasets in the Web Environment.