AGILE Association of Geographic Information Laboratories in Europe

ICA Commission on Generalisation and Multiple Representation

19th ICA Workshop on Generalisation and Multiple Representation

Geometric Simplification of Administrative Borders With Mixture of Irregular and Orthogonal Segments

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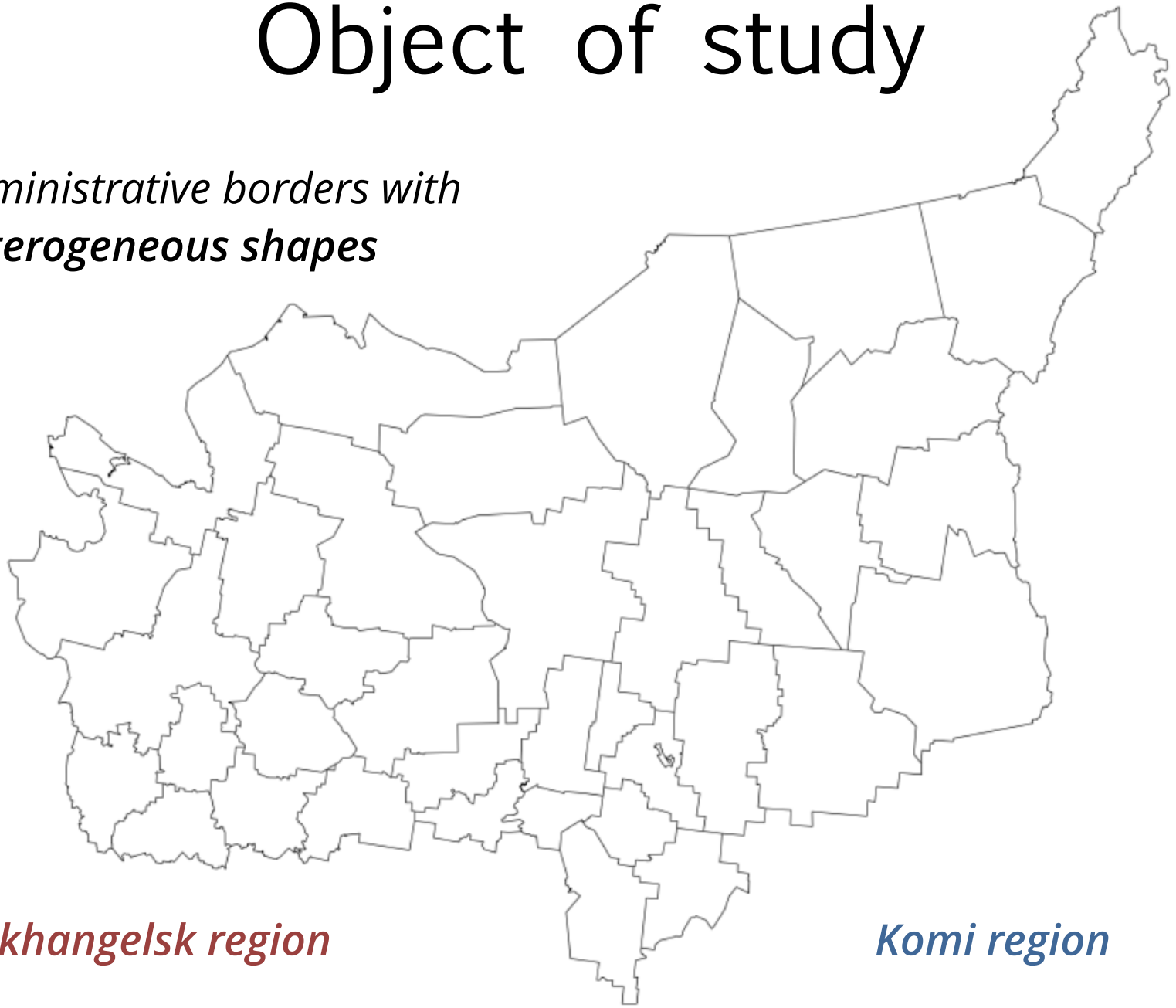
Object of study

Administrative borders with
heterogeneous shapes

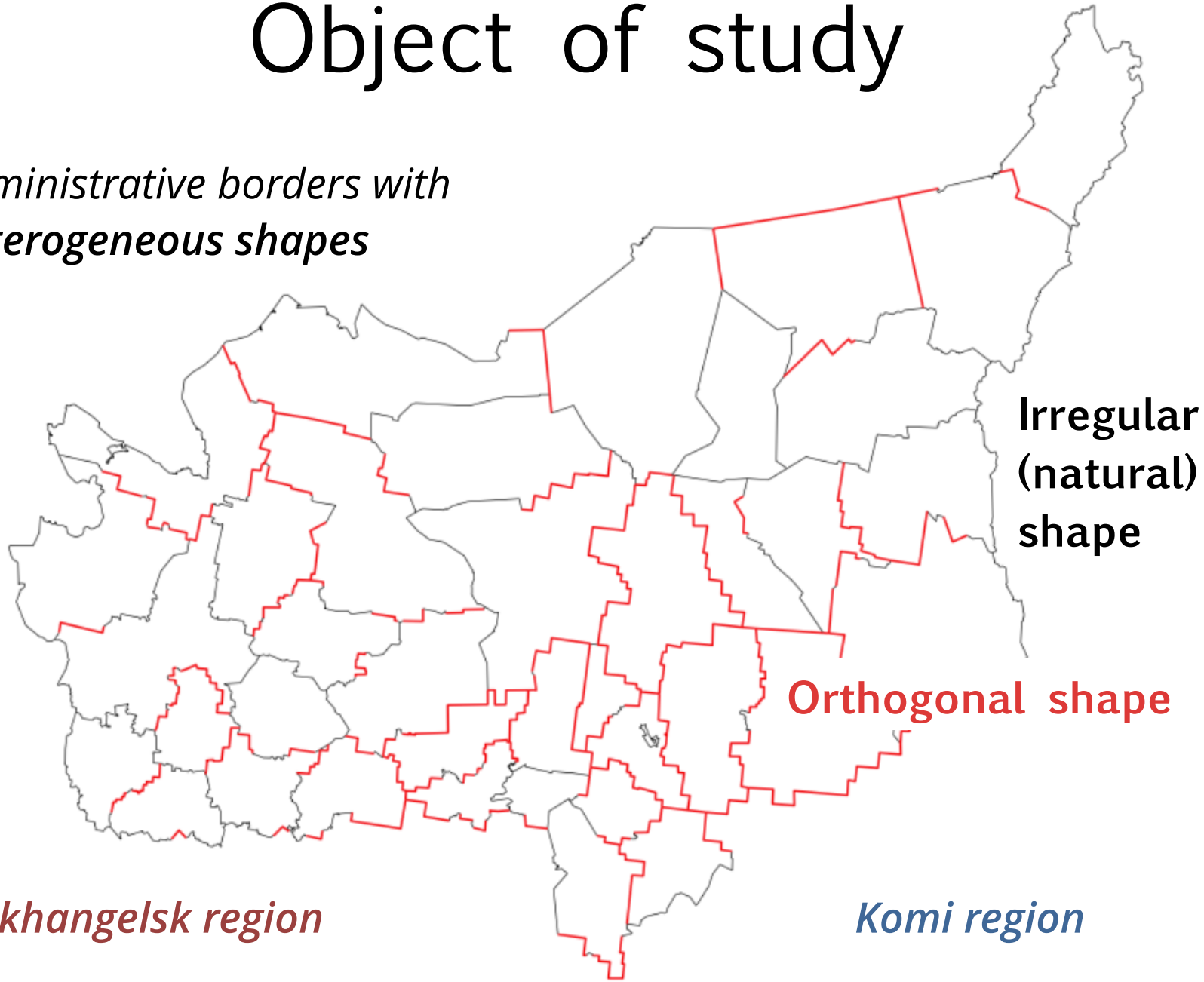


Arkhangelsk region

Komi region

Object of study

Administrative borders with ***heterogeneous shapes***



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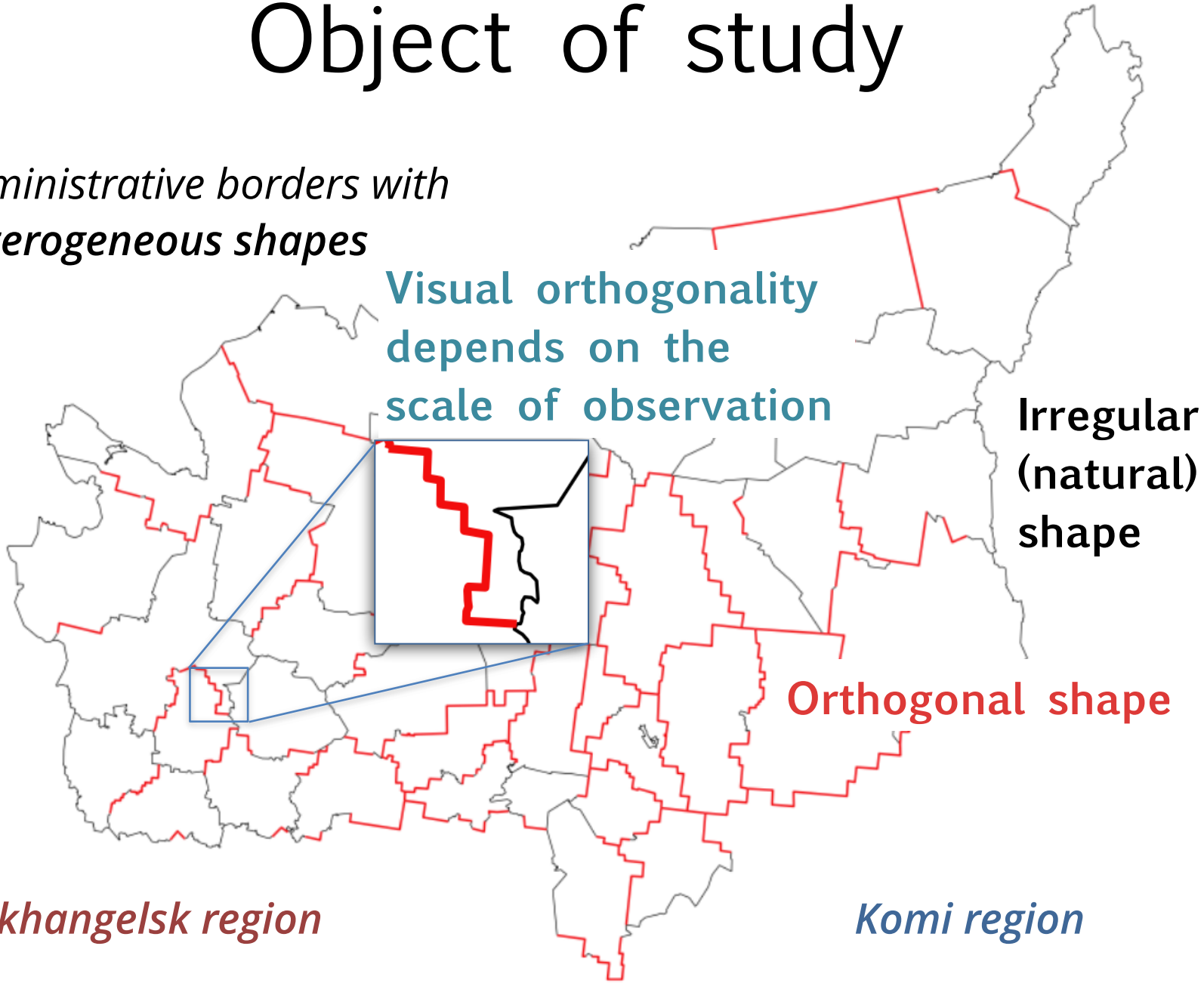
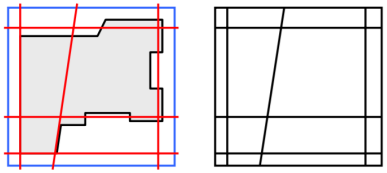
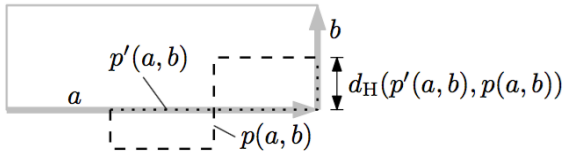
Administrative borders with ***heterogeneous shapes***





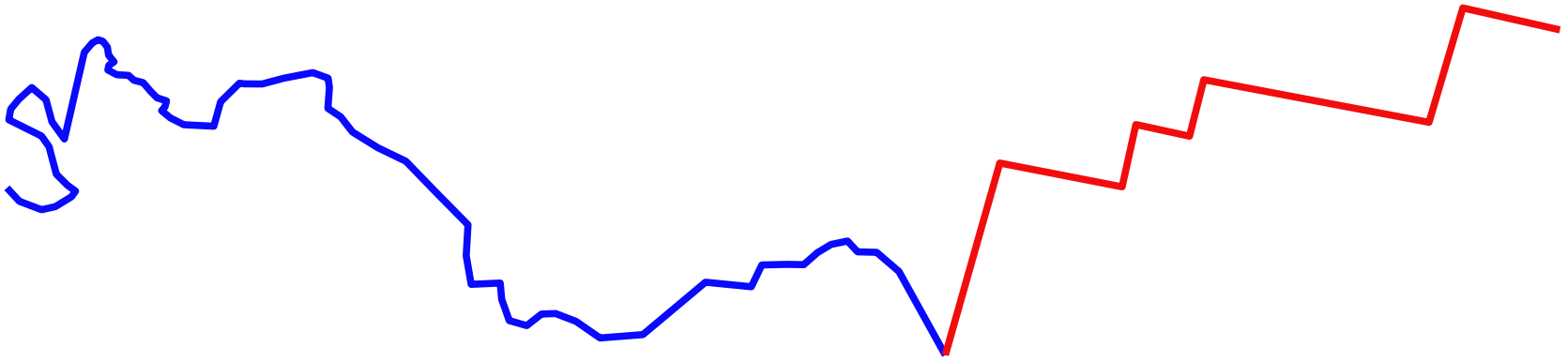
Background



- Numerous approaches have been developed for generalization of orthogonally shaped lines and polygons, mainly for generalization of buildings (Mayer 1998, Sester 2005, Kada and Luo 2006, Dutter 2007, Damen et al. 2008, Bayer 2009, Haunert & Wolff 2010, Steininger et al., 2010, Buchin et al., 2011, Cheng et al, 2013)
- The algorithms operate globally, i.e. the building is considered to be a priori orthogonally shaped, with an exception for arcs detection (Buchin et al., 2011).
- **Existing approaches are not applicable** in case of mixed orthogonal/natural geometries, because simplification and *preprocessing* approaches for orthogonal shapes are very specific (including squaring) and will distort other parts, and vice versa.

The Goal

Develop an approach to cartographic generalization of lines consisting of both irregular and orthogonal segments



Methodology

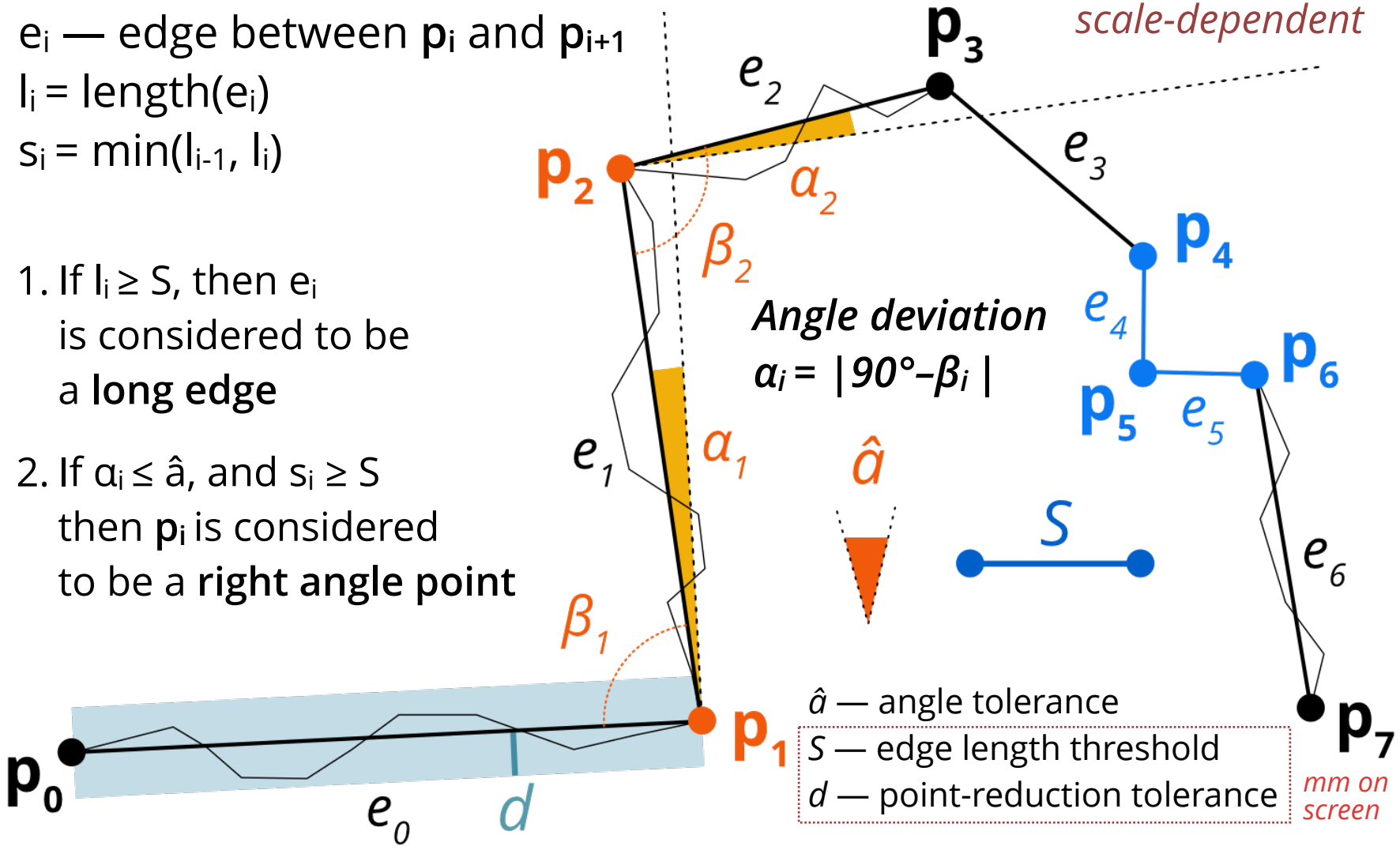
1. **Preprocessing**
   - 1.1. Extract long (visible!) edges
   - 1.2. Detect right angles and right angle sequences
   - 1.3. Square right angle sequences — derive orthogonal segments
2. **Processing**
   - 2.1. Simplify orthogonal segments
   - 2.2. Simplify other segments

Detection of right angles

β_i — angle at $\mathbf{p_i}$
e_i — edge between $\mathbf{p_i}$ and $\mathbf{p_{i+1}}$
$l_i = \text{length}(e_i)$
$s_i = \min(l_{i-1}, l_i)$

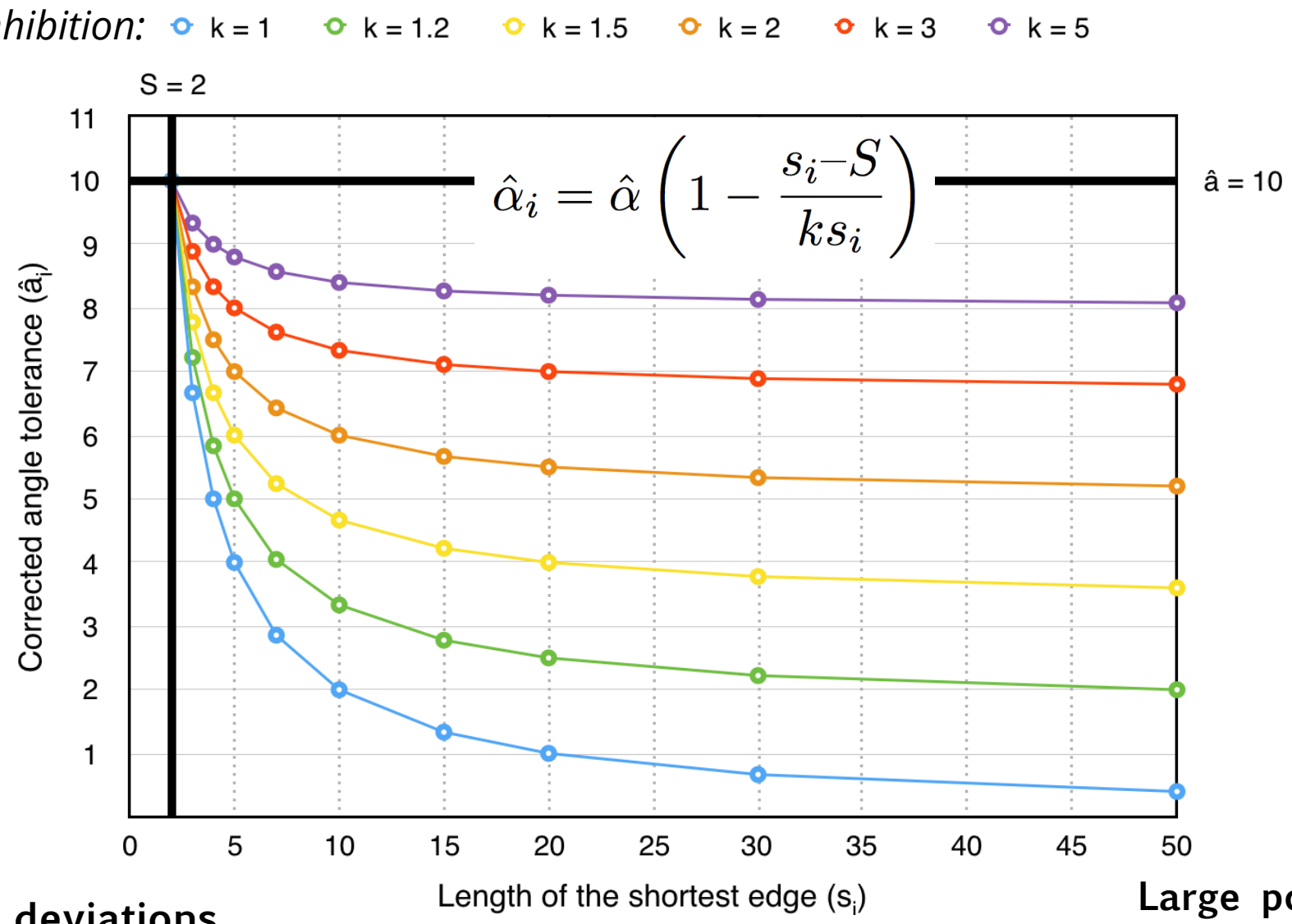
1. If $l_i \geq S$, then e_i is considered to be a **long edge**
2. If $\alpha_i \leq \hat{a}$, and $s_i \geq S$ then $\mathbf{p_i}$ is considered to be a **right angle point**

The processing is scale-dependent



Redundant points are eliminated by sequential point-reduction algorithm based on perpendicular distance

Corrected Angle Tolerance ($s_i > S$)

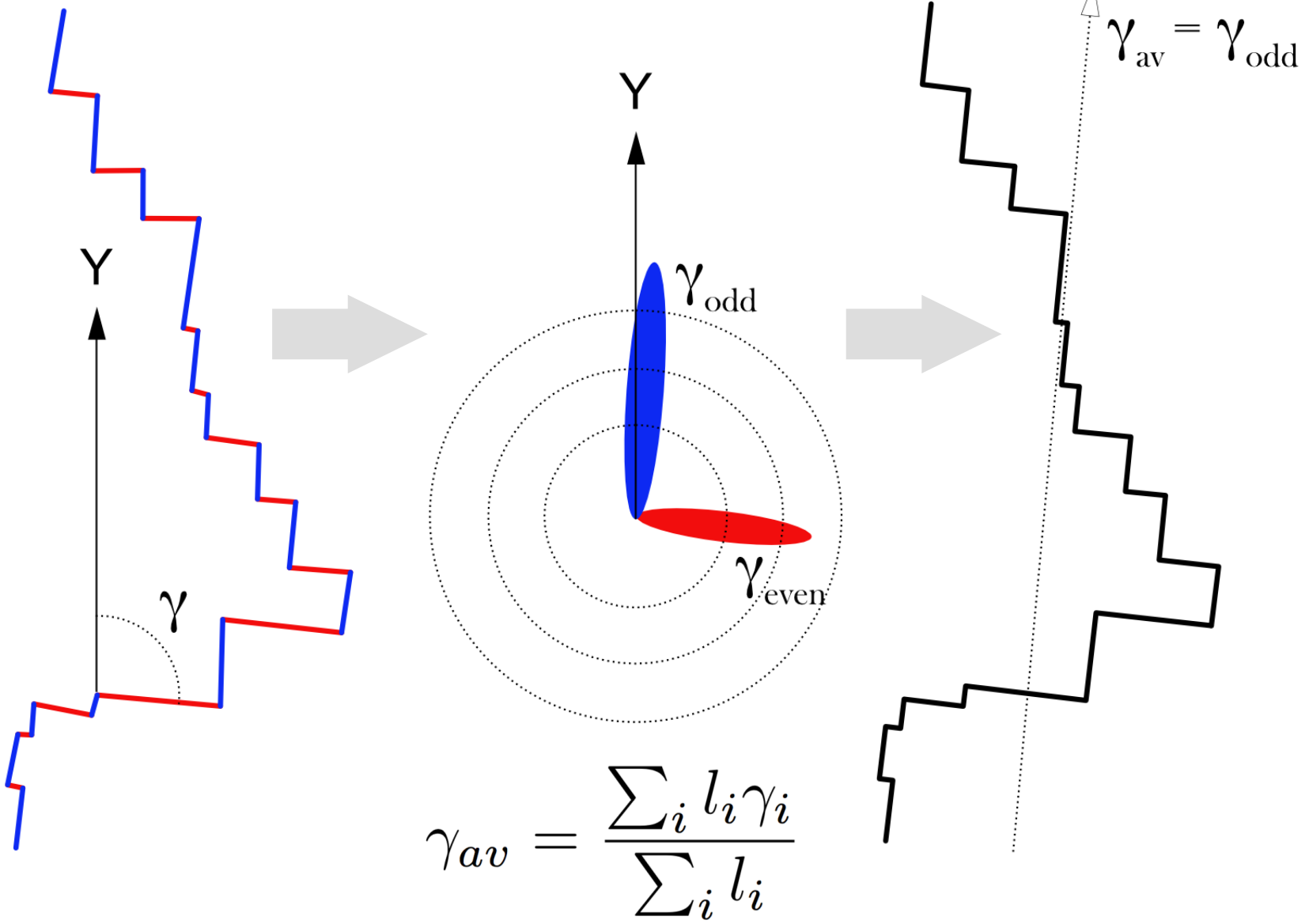


1

2

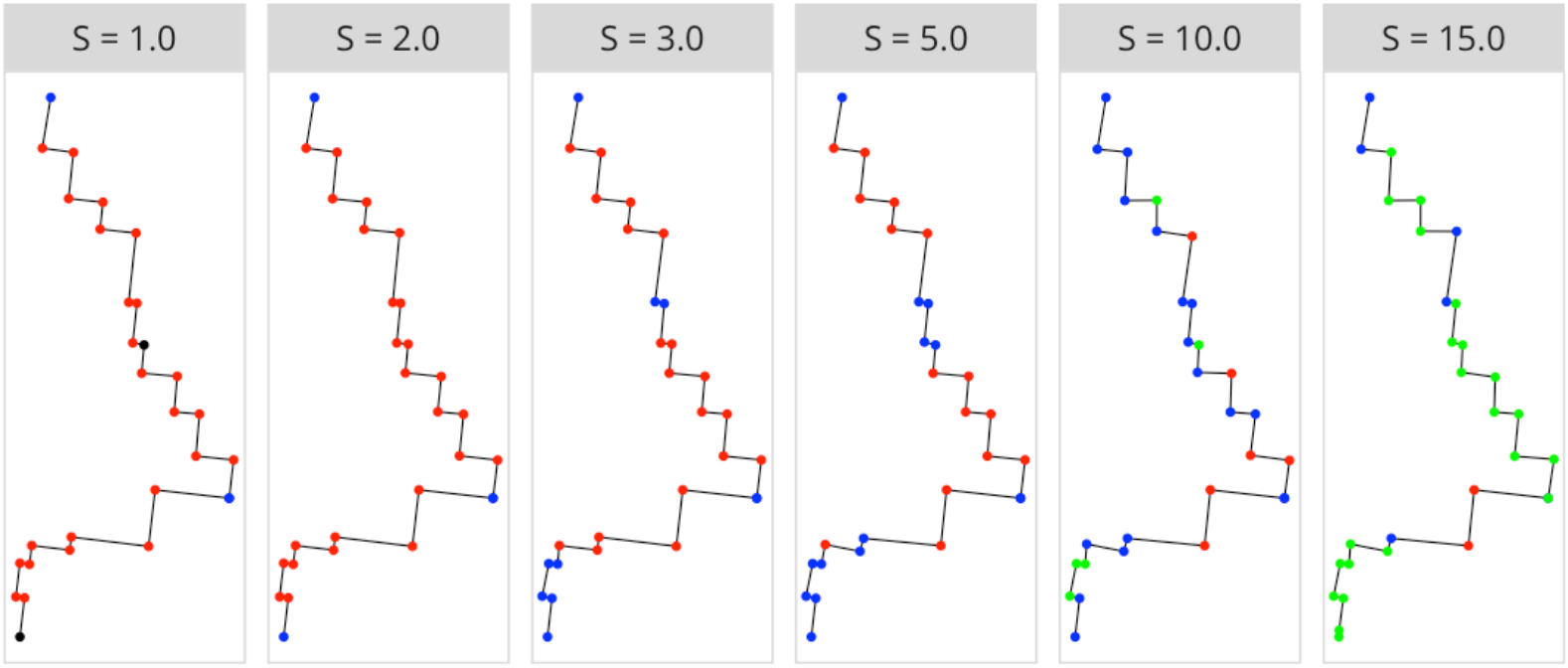
Angle deviations are more visible ⇒ *â must be corrected for the cases when $s_i > S$* ⇐ **Large point movements when squaring**

Squaring



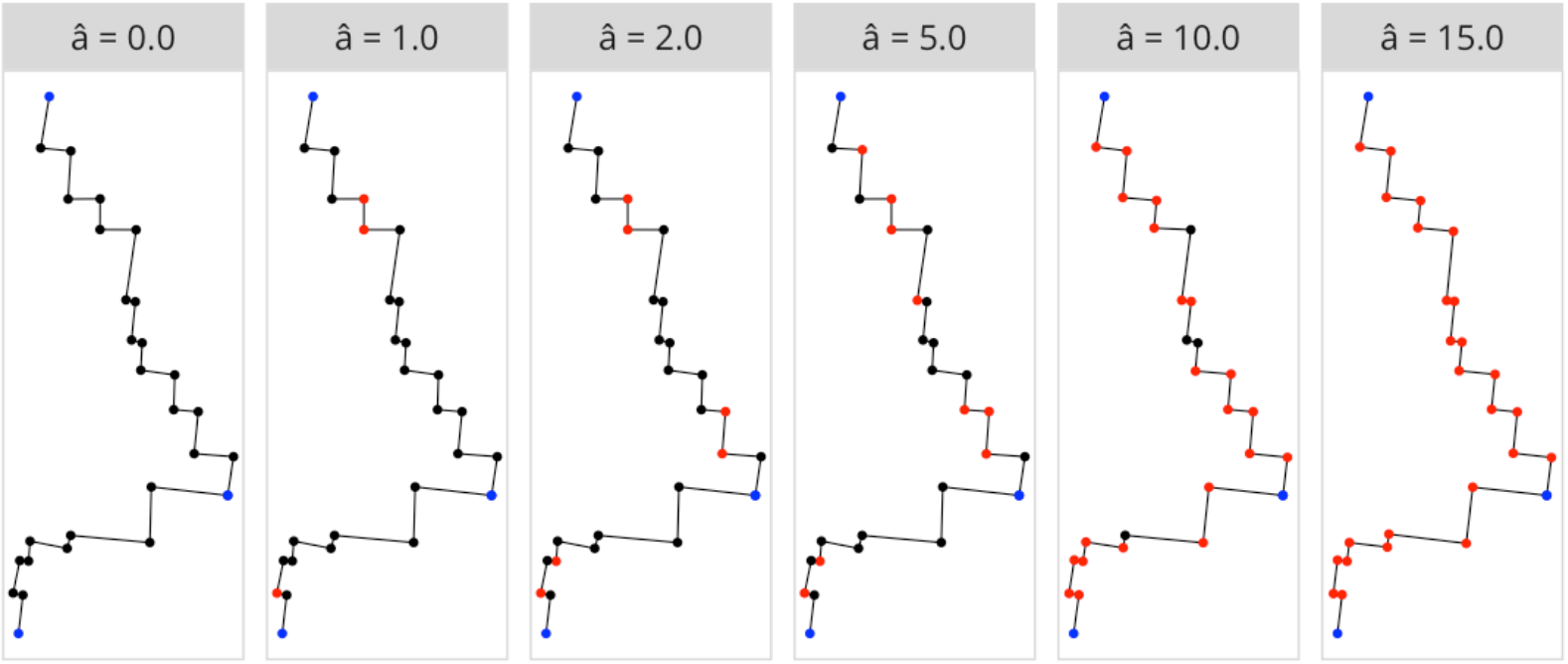
$$\gamma_{av} = \frac{\sum_i l_i \gamma_i}{\sum_i l_i}$$

Edge Length



1. **Ortho** — right angle point.
2. **Two straights** — the angle is formed by two long straight edges which do not intersect at right angle.
3. **One straight** – only one adjacent edge is long straight while the other is shorter than S.
4. **No straights** — both adjacent edges are shorter than S.

Angle Tolerance



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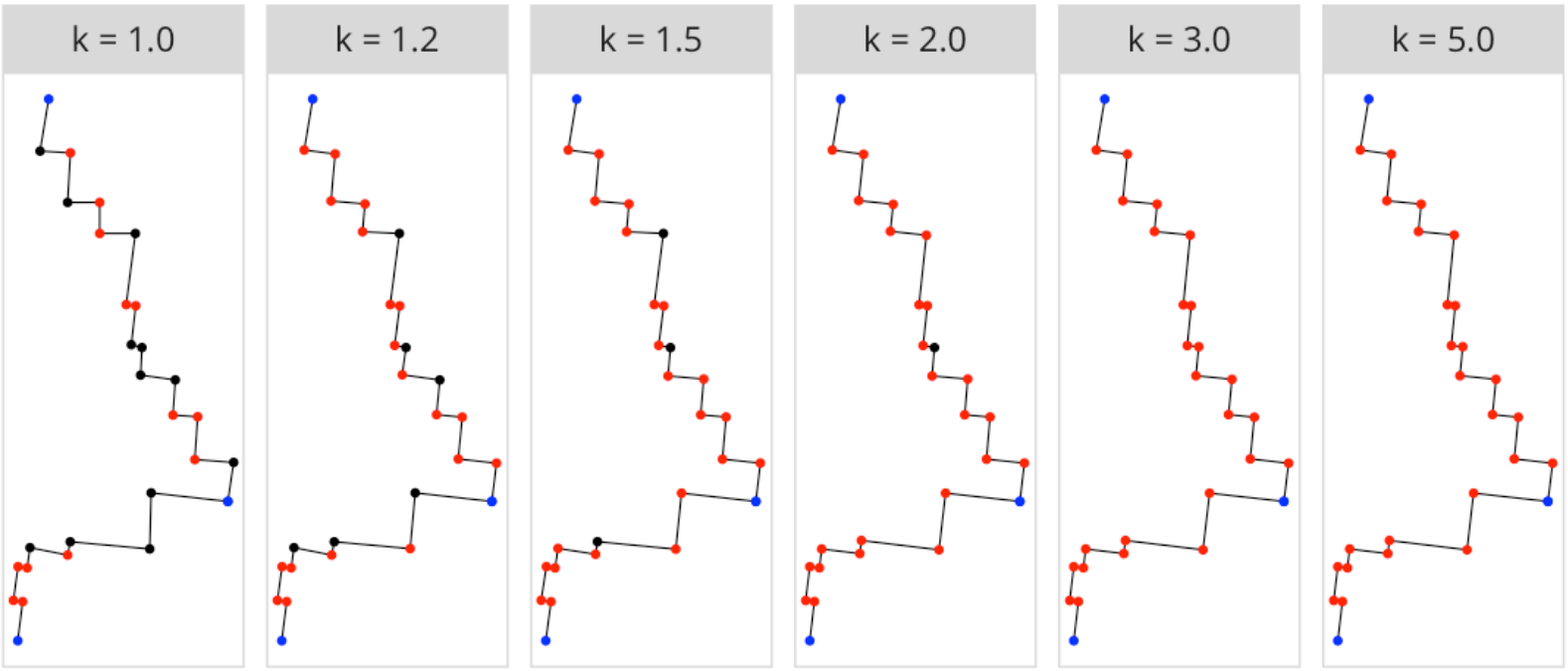
Inhibition Factor



$\hat{a}$ = 15.0
S = 2.0

Ortho
Two straights
One straight

1. **Ortho** — right angle point.
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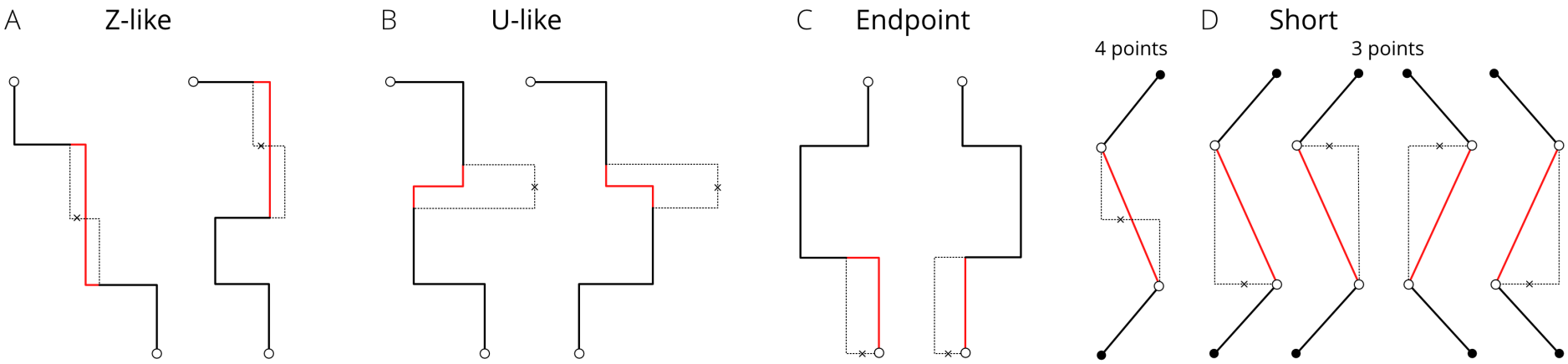
Parameters used for experiments: $\hat{a}$ = 15.0 k = 3.0 S = 2.0

Simplification — Basic Contractions

All edges shorter than **tS** are contracted,
where **t** is the reduction in scale (*times*)



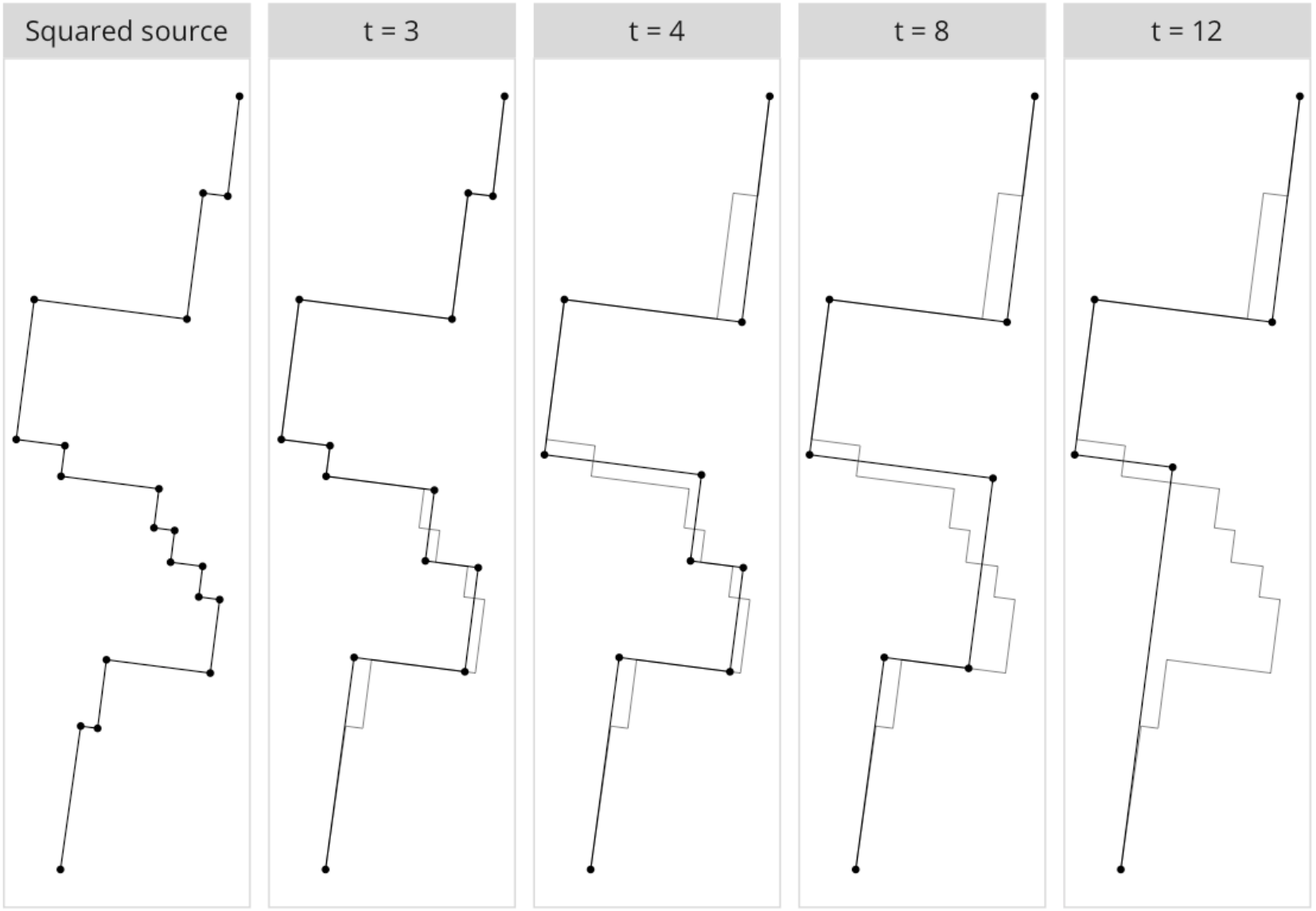
In case of Z- and U-like configurations the contracted edge e_i is replaced by the edge perpendicular to it and connected to the e_{i-2} and e_{i+2} or their extensions. Thus, e_{i-1} and e_{i+1} are removed and the line structure is reindexed.

Endpoint and short configurations are the special cases

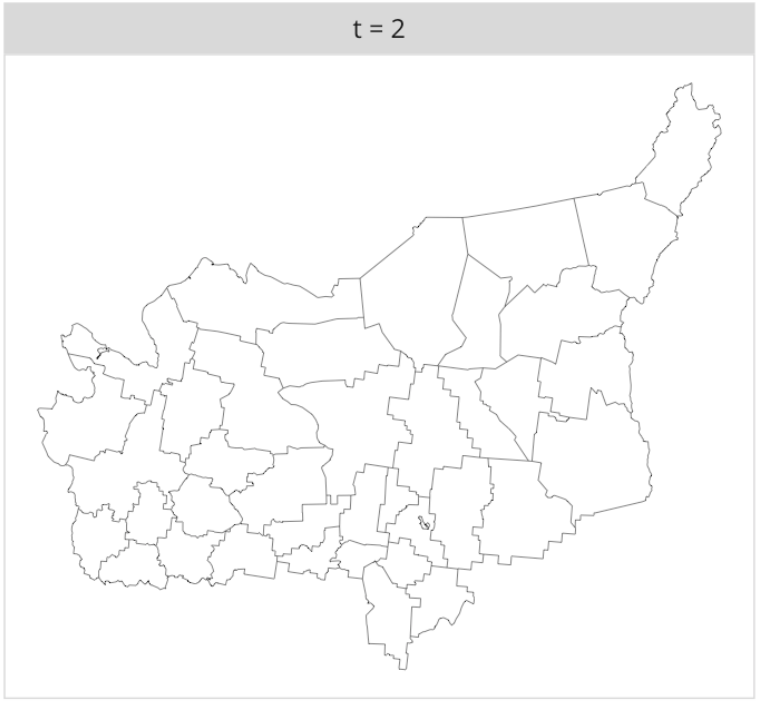
Contraction of the first edge of the orthogonal part is made by shortcut between p_0 and e_2 thus replacing e_0 and e_1 by a single edge. The similar approach is applied in case of the last point.

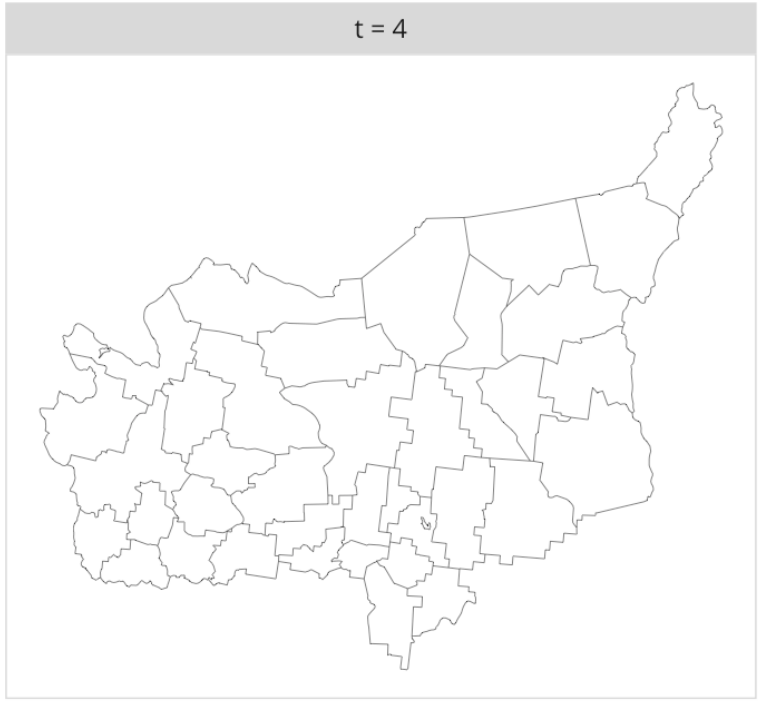
All 3-point configurations and 4-point with contracted middle edge are replaced by a straight edge connecting endpoints.

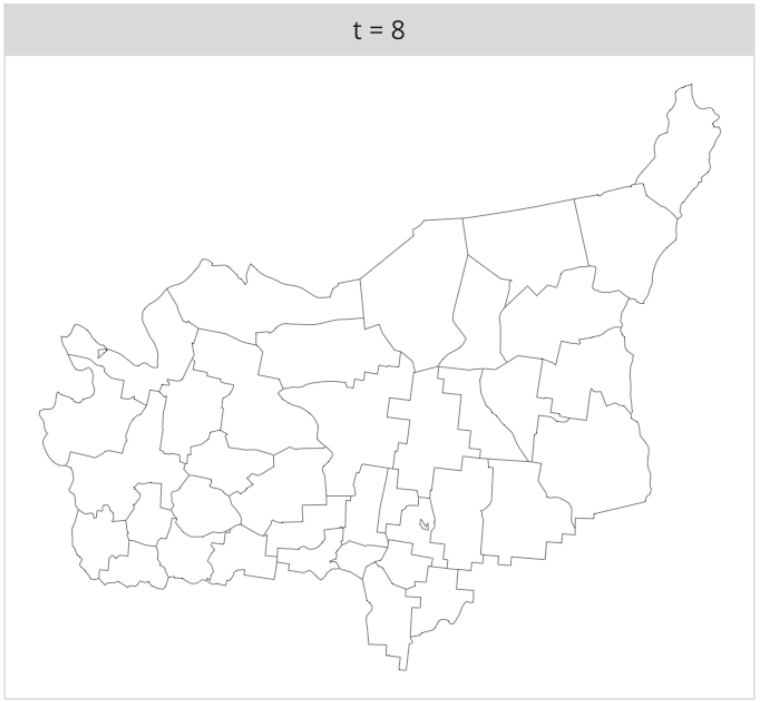
Example Generalization

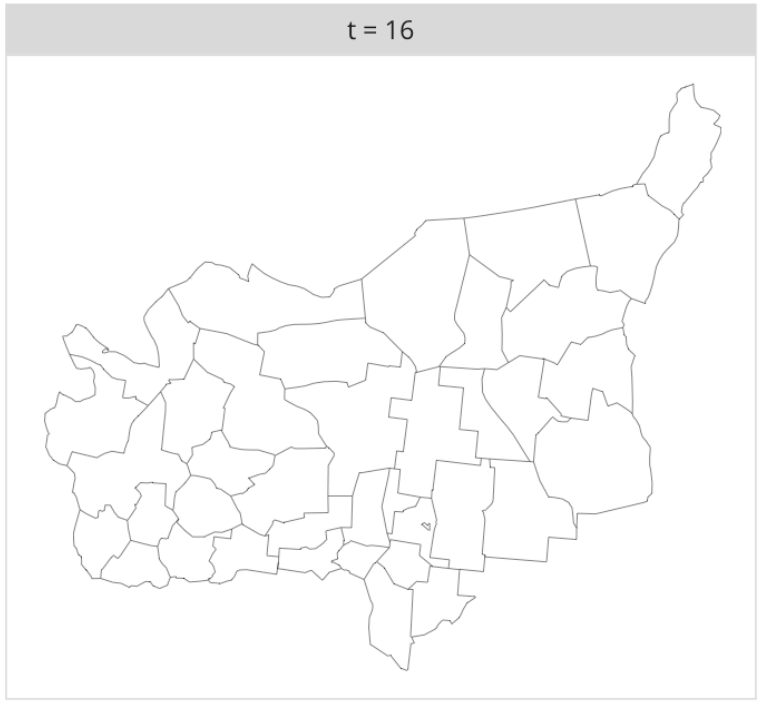


RESULTS — MIXED

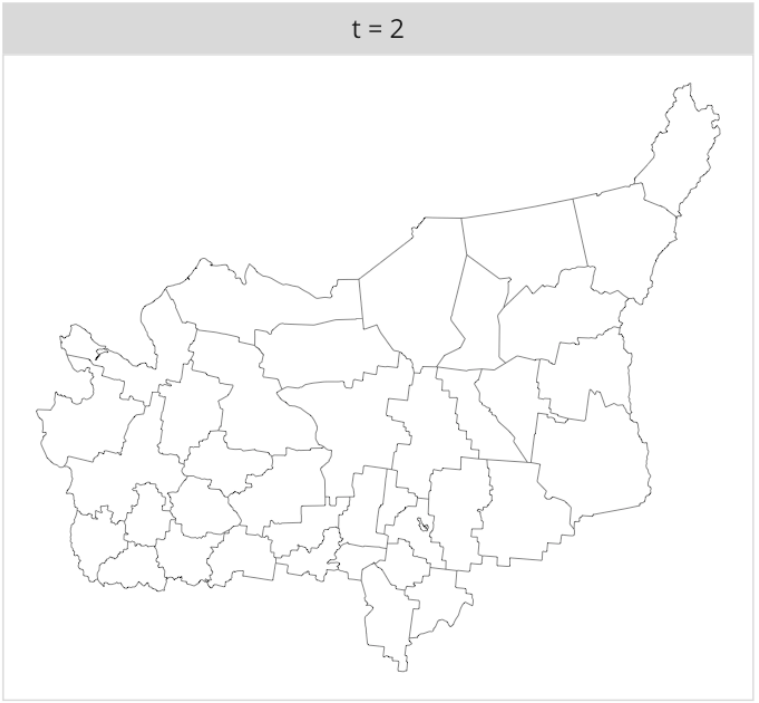


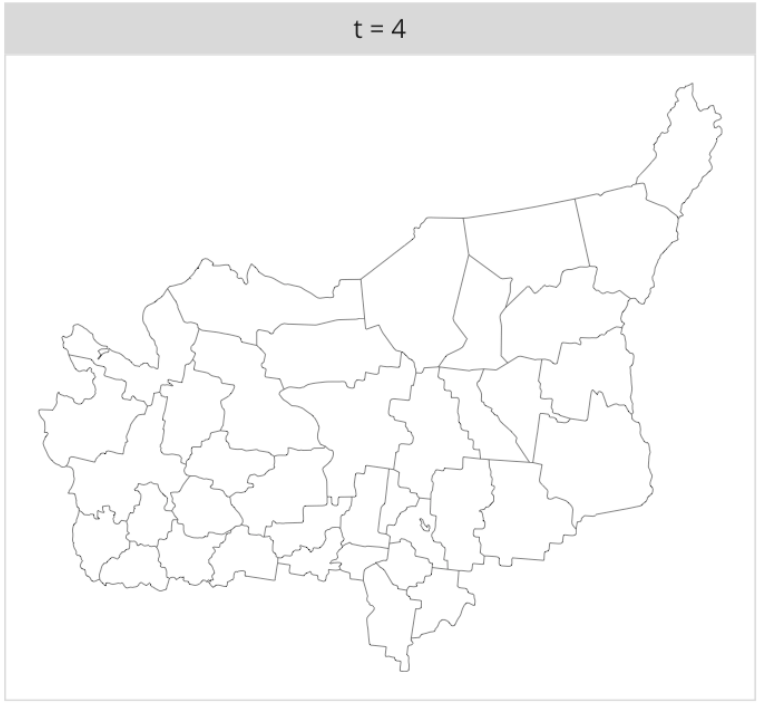


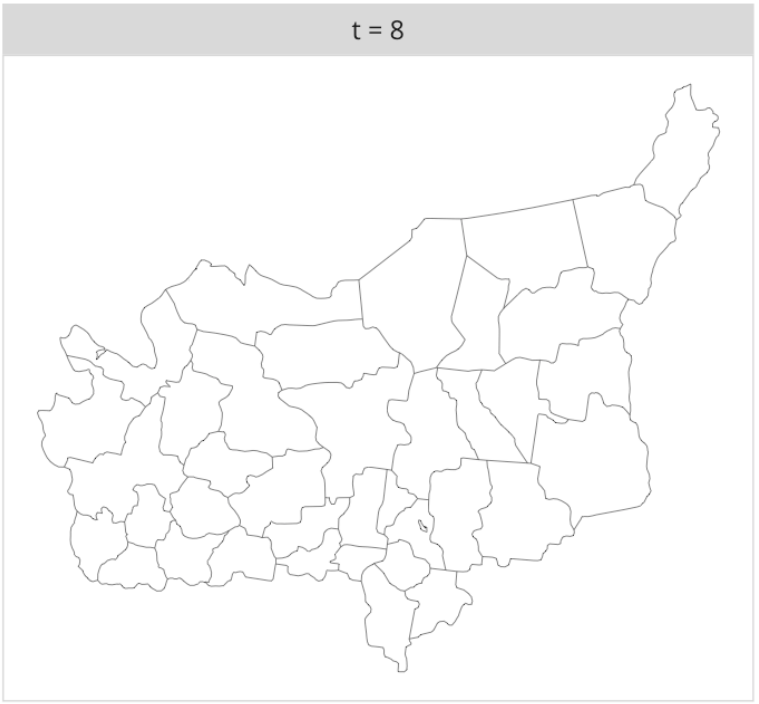


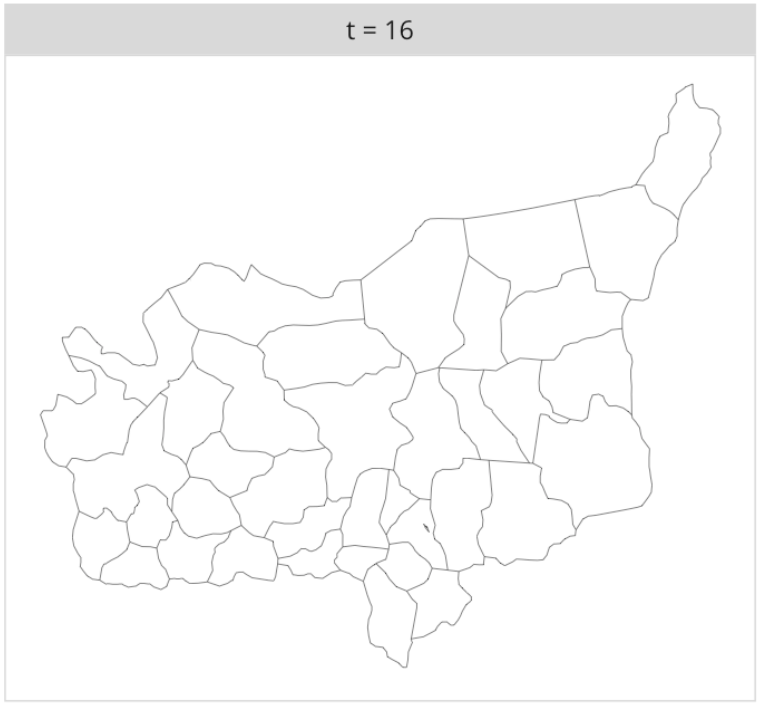


RESULTS — LiO

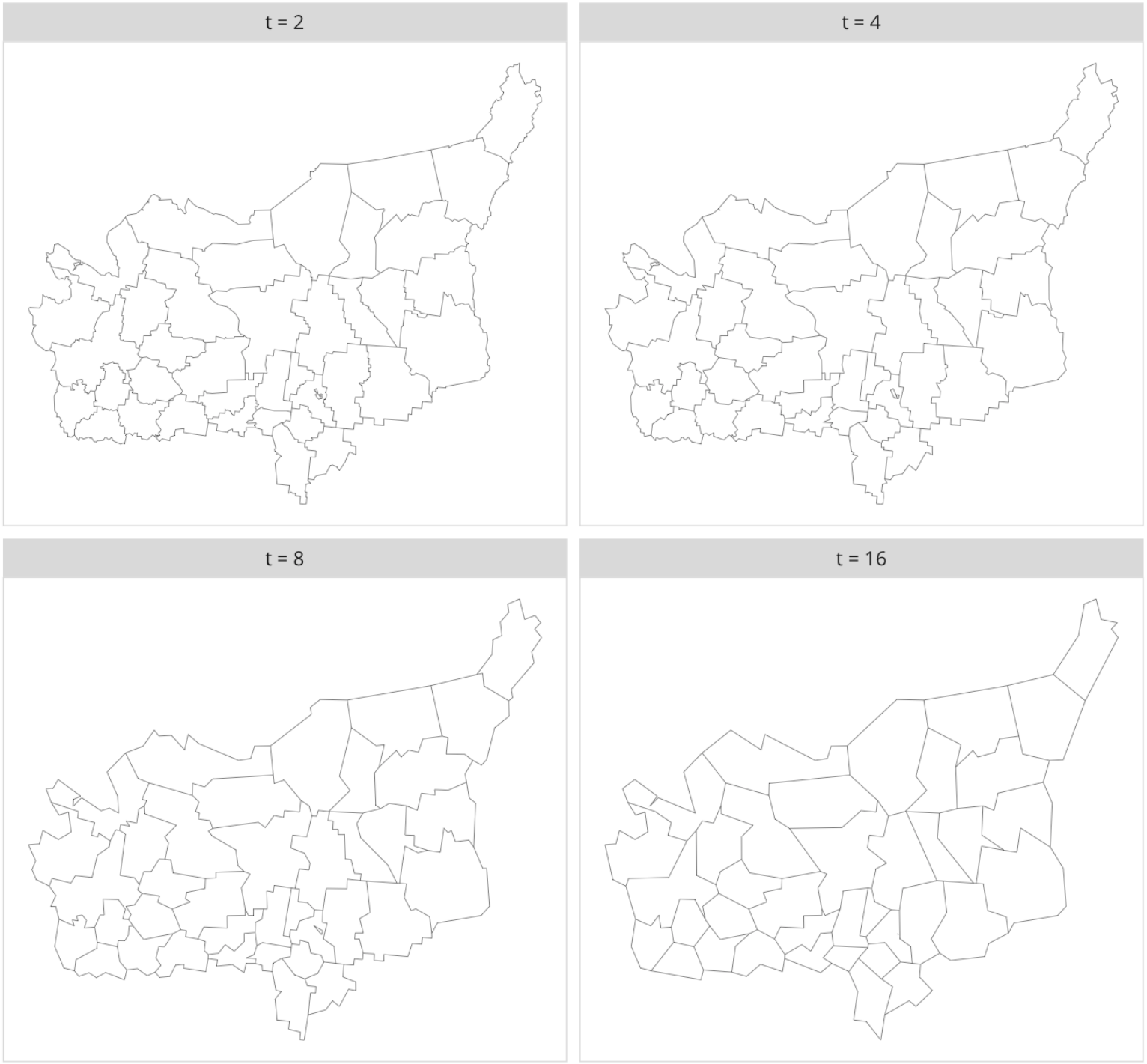




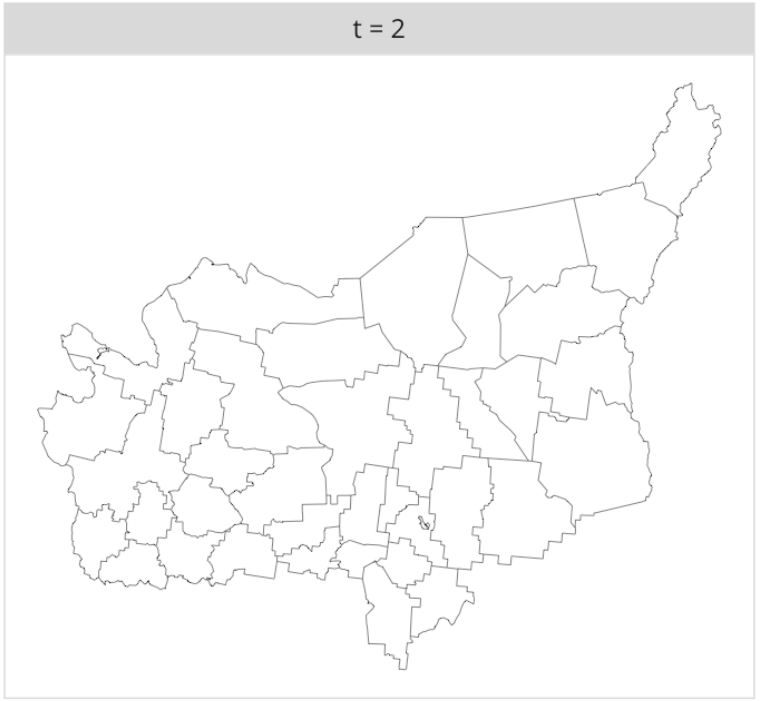


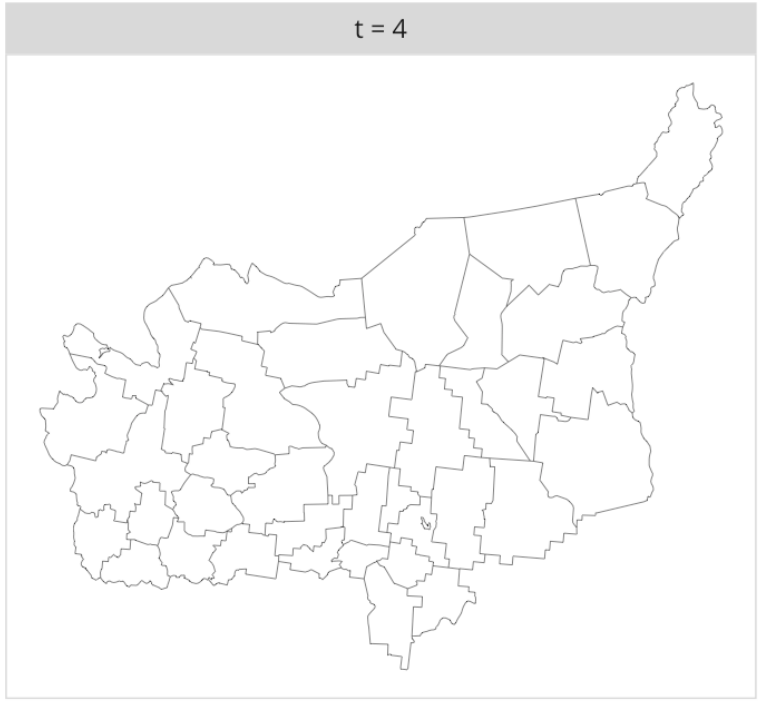


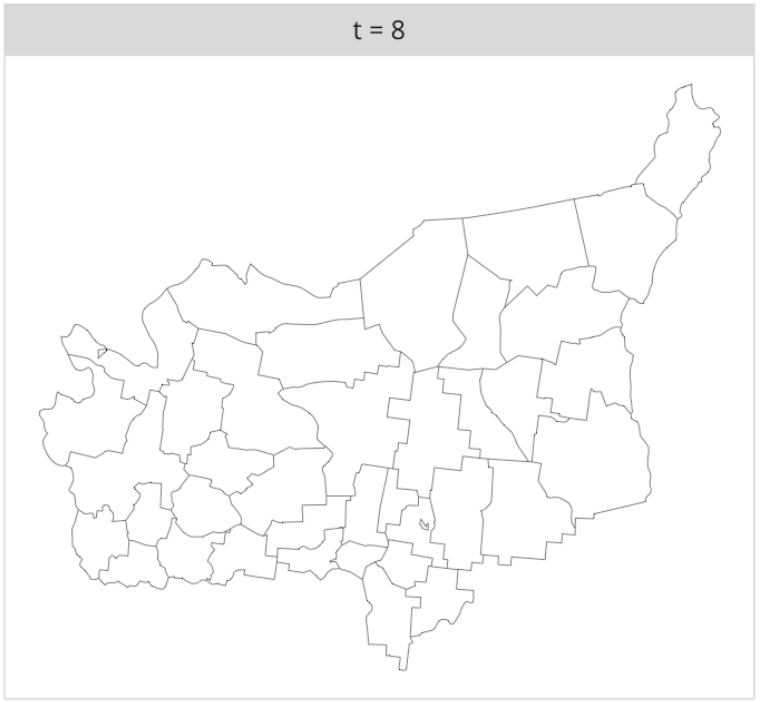
RESULTS — DP

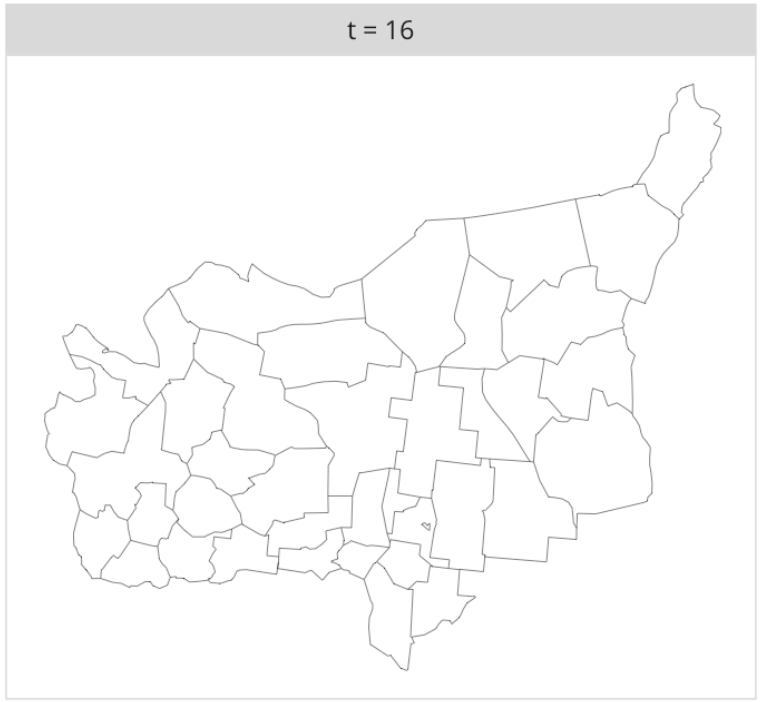


RESULTS — MIXED



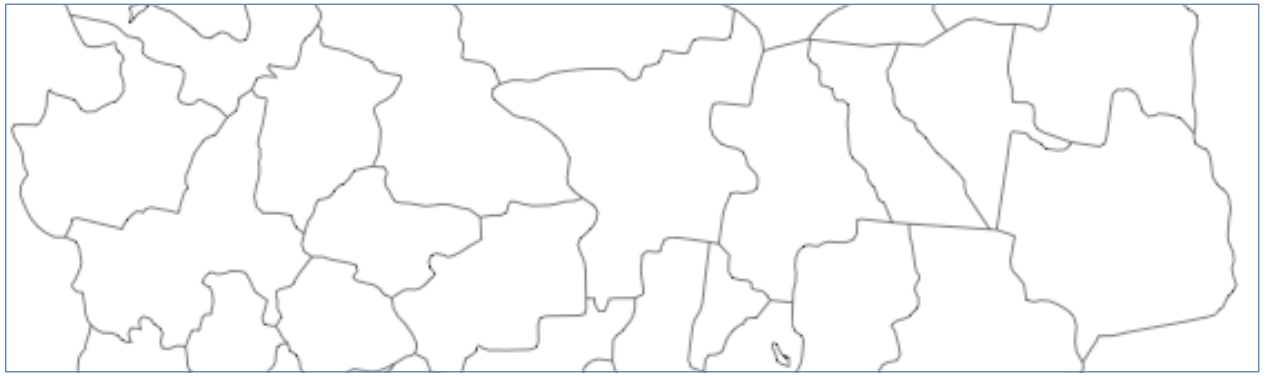






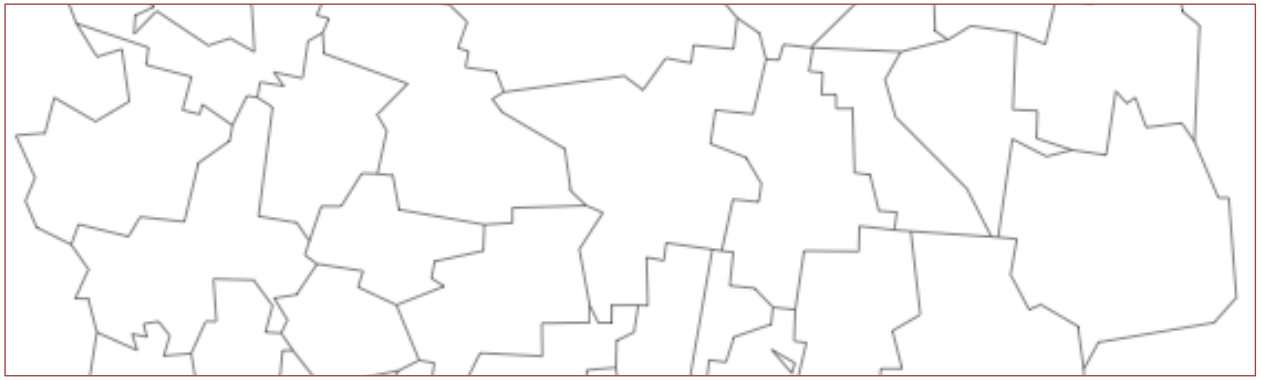
Comparison

LiO

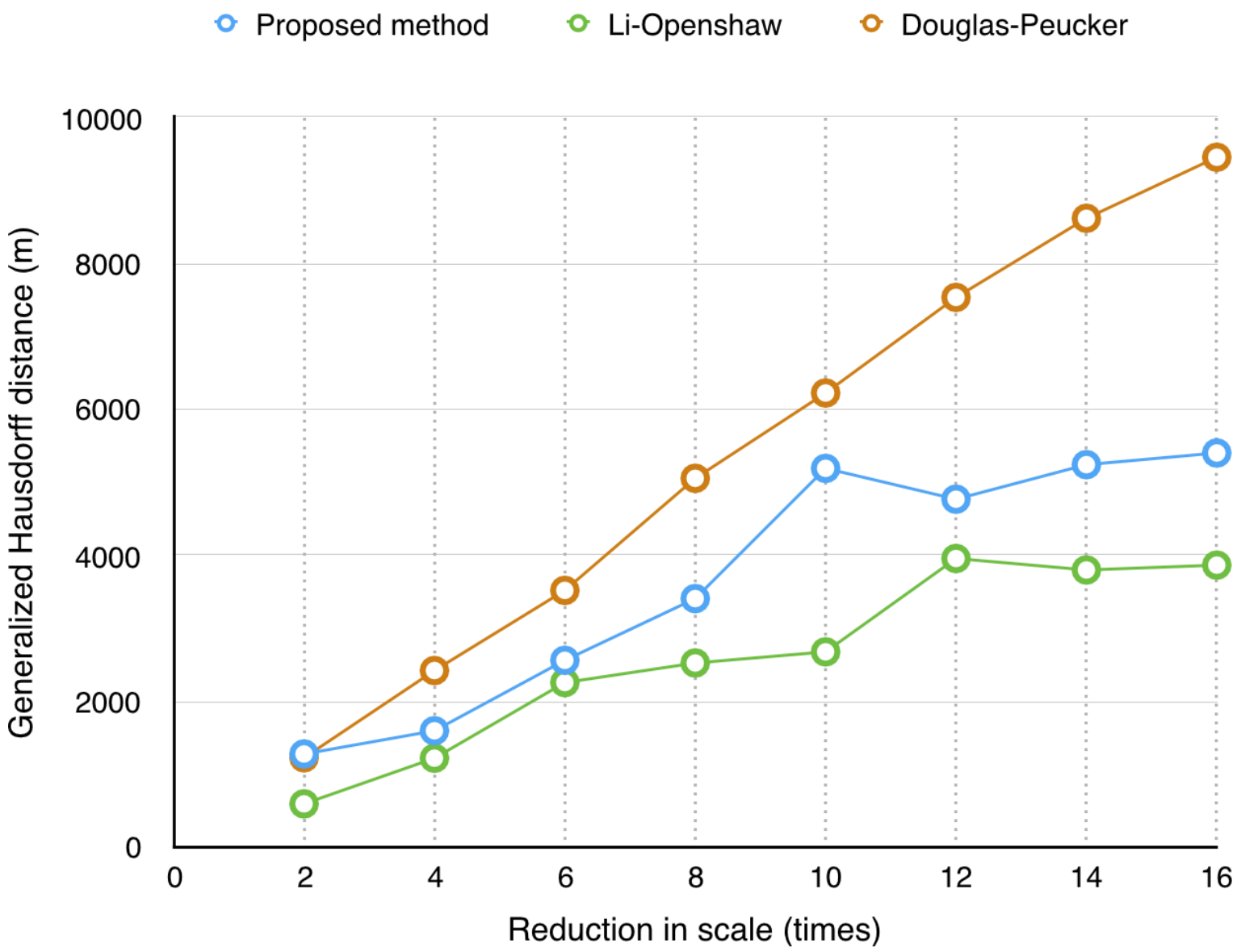


MIXED

DP



Spatial Accuracy



Conclusions

1. The developed method allows effective line segmentation into orthogonal and non-orthogonal (irregular) parts, which helps to apply different algorithms for their simplification.
2. Orthogonal parts can be simplified by numerous approaches including contractions, edge-moves, shortcuts and so on.
3. Non-orthogonal parts should better be subdivided into smooth and sharp subparts for application of the best suitable generalization algorithm (Li-O. and D.-P. correspondingly).

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Questions?