

Smooth Generalization for Continuous Zooming

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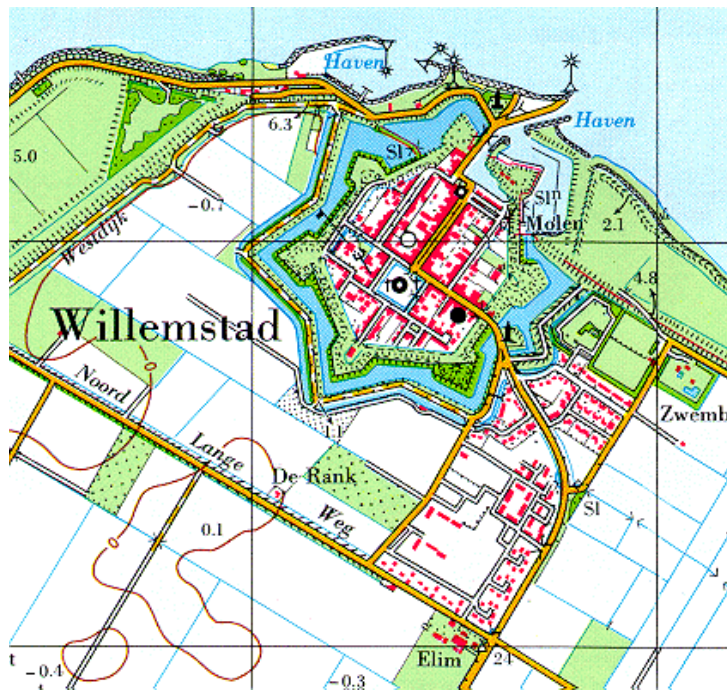
Institute of Information and

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Utrecht University

Cartographic generalization

- Making changes that are necessary when changing the map scale



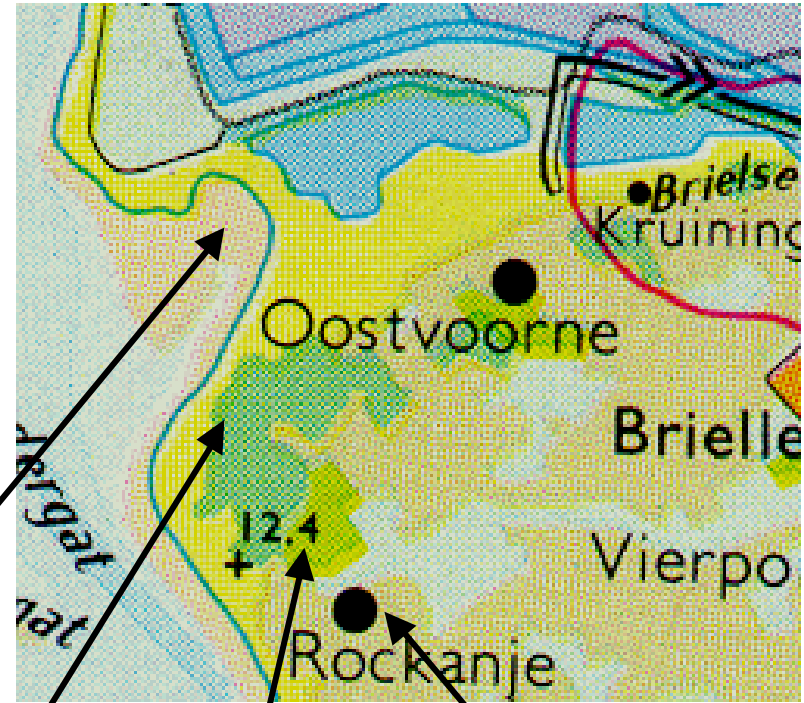
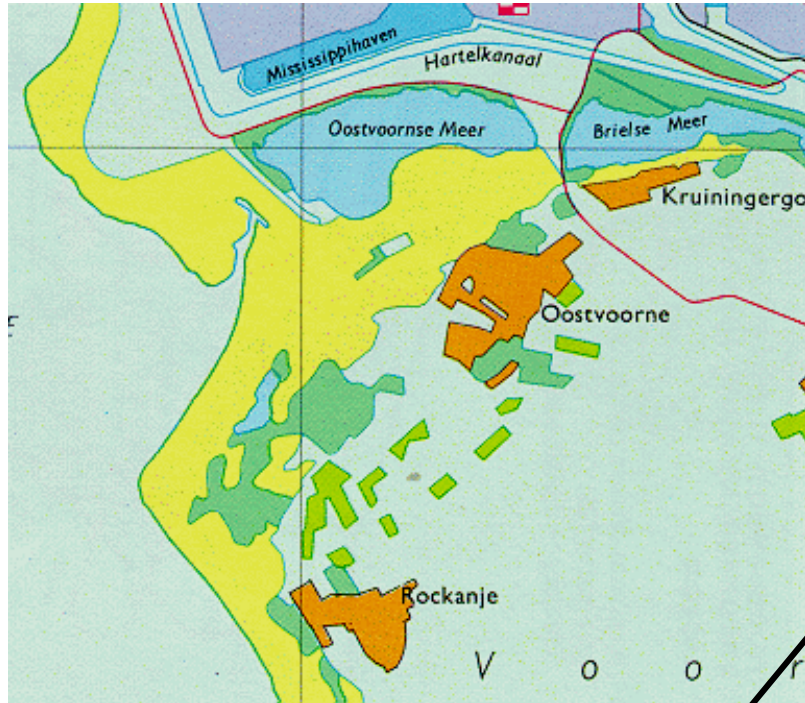
1 : 25.000



1 : 50.000



1 : 50.000 enlarged

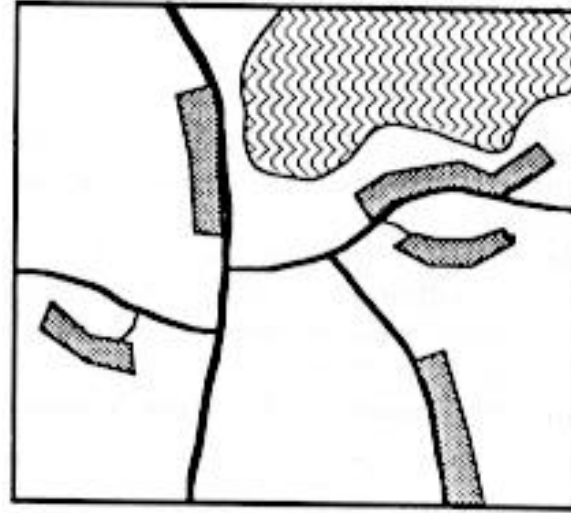
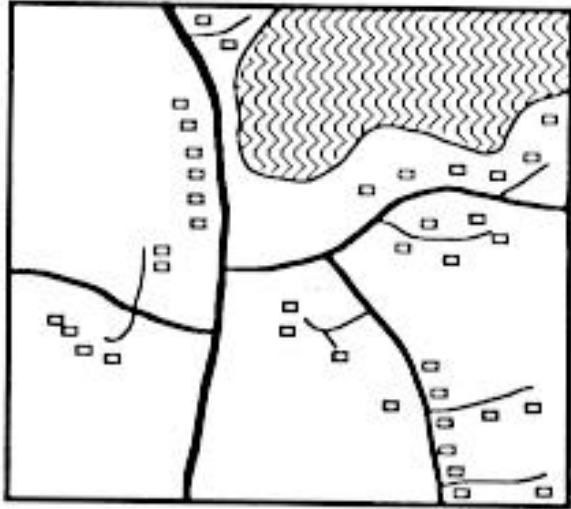


simplification

elimination

aggregation (of polygons)

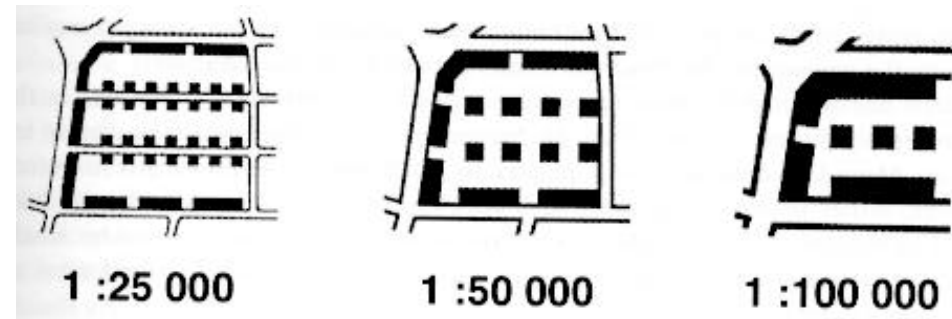
point conversion
(symbolization)



The means: operators

- Selection/elimination
- Displacement
- Shape change
- Aggregation
- Dissolution
- Reclassification

- Typification

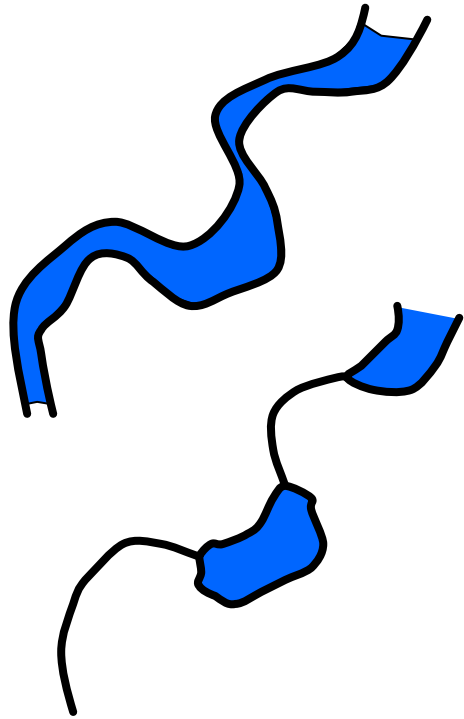


- Exaggeration
- Point, line, area conversion

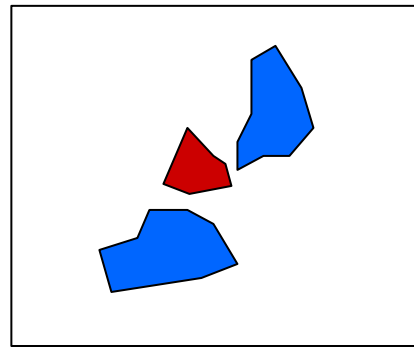
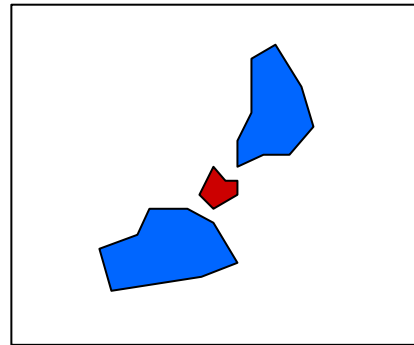
Deciduous, coniferous → *forest*

County borders → *state borders*

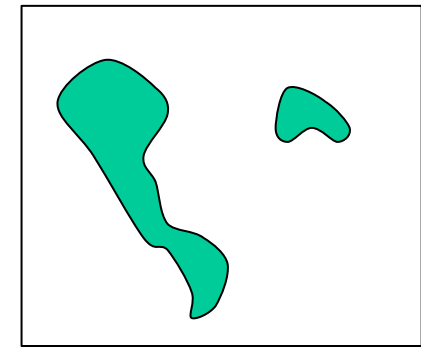
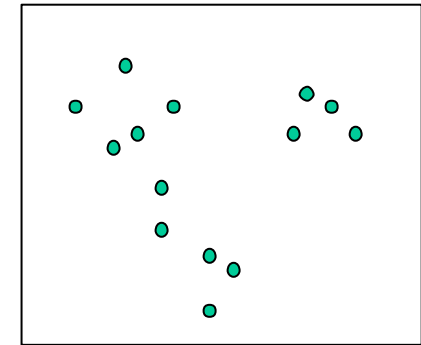
Operators: more examples



Partial line
conversion



Exaggeration
(enlargement)

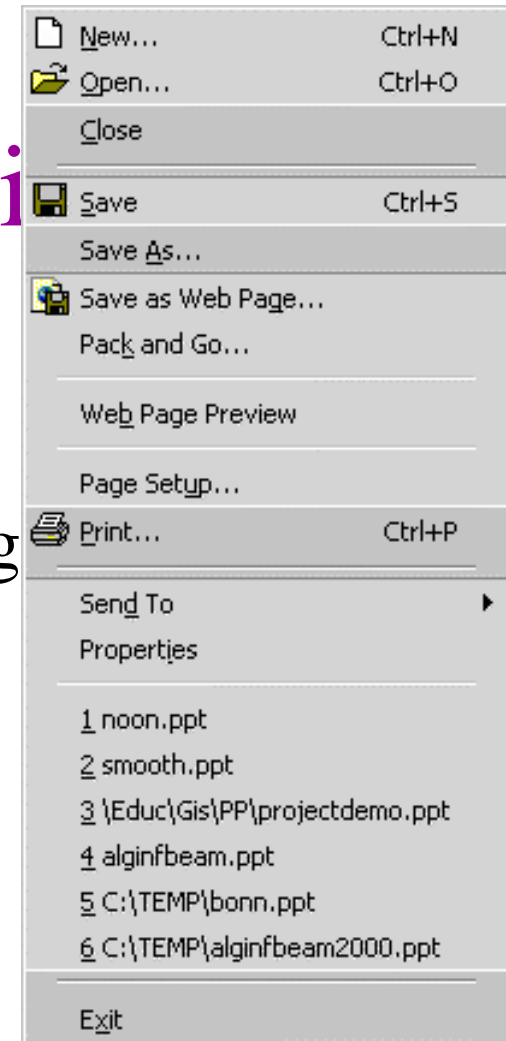


Point-to-area
conversion

Smooth changes during scale change

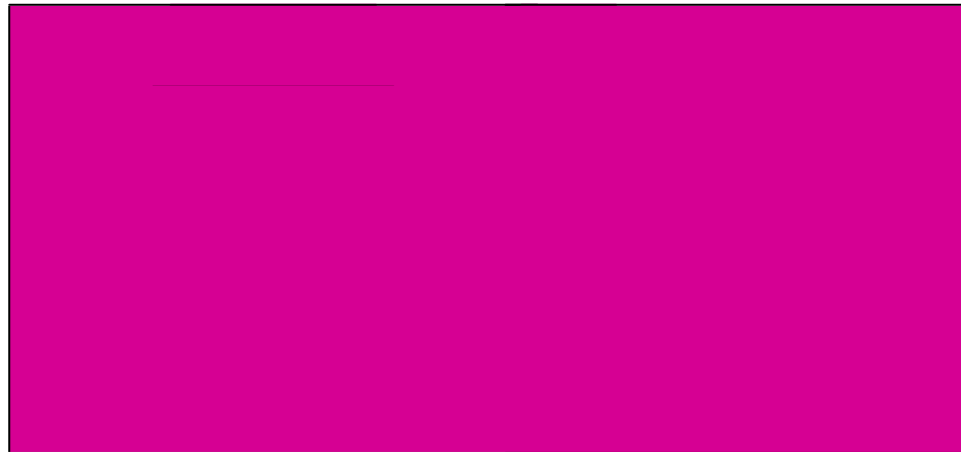
When zooming out, generalization changes
be done ‘visually smooth’

- Looks more pleasing
- Helps to keep reference

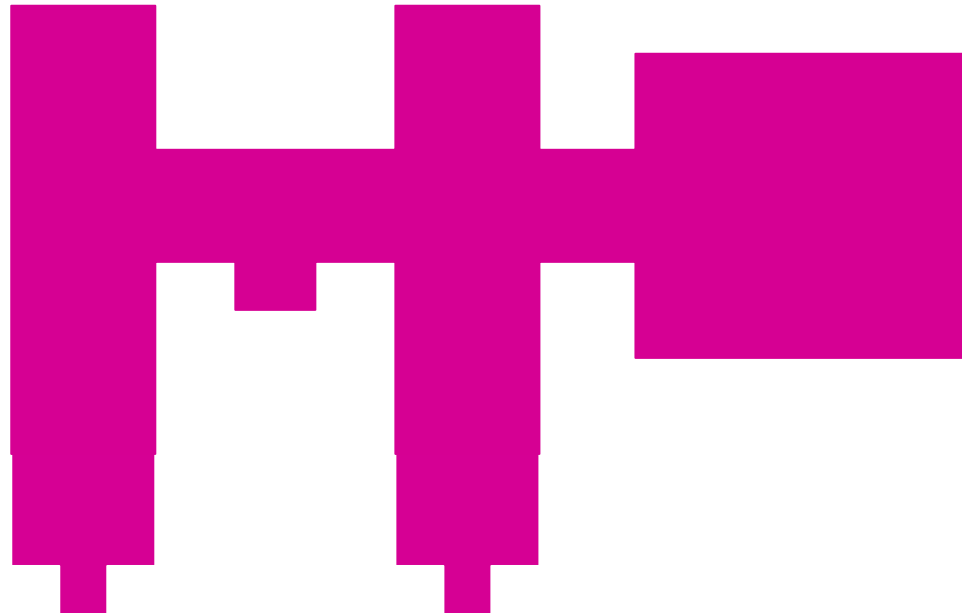


*Windows 98 and Office 2000 have it too, in
smoothly appearing pull-down menus*

Building example



Building example



Building example



Building example



Building example



Building example



Building example



Building example



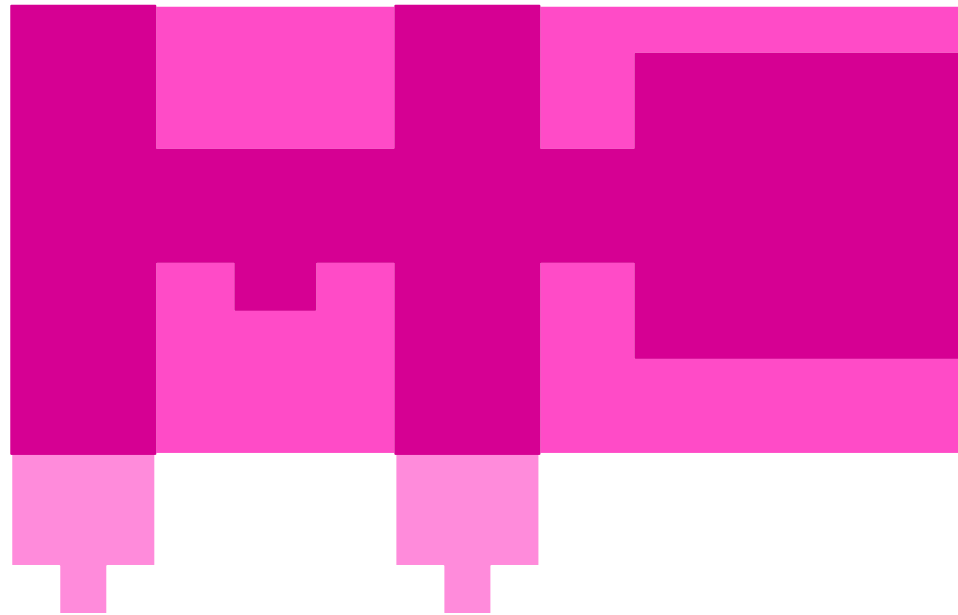
Building example



Building example



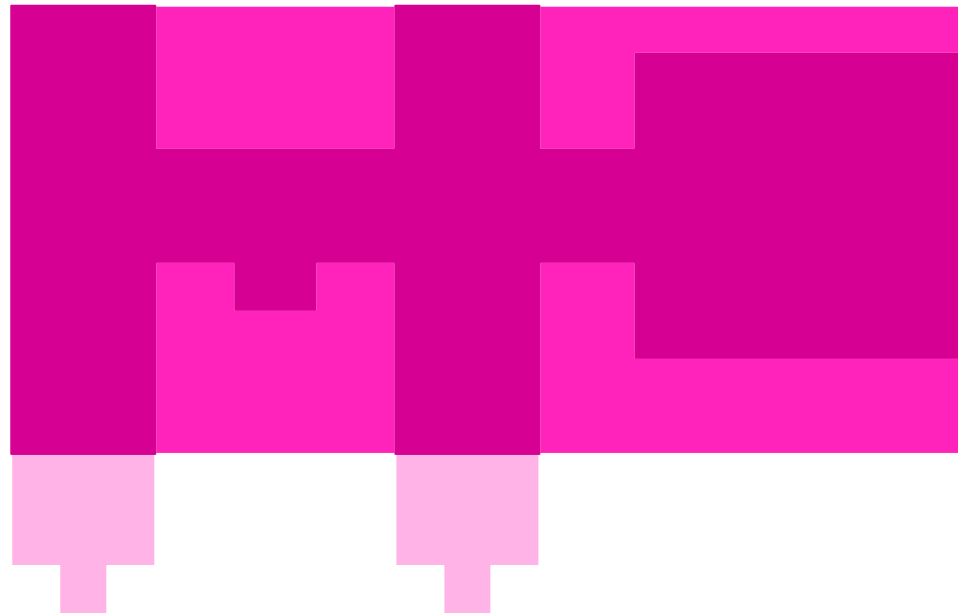
Building example



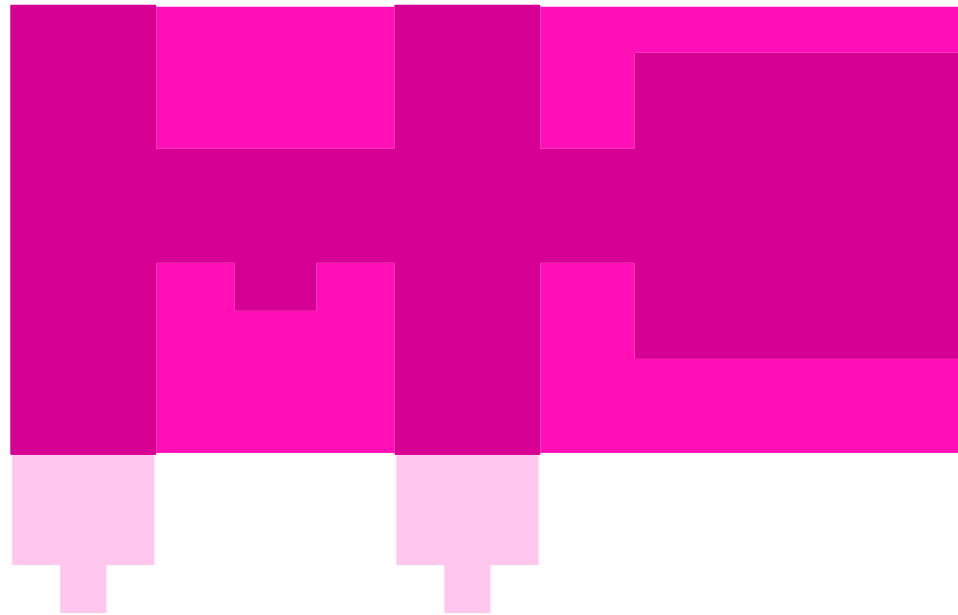
Building example



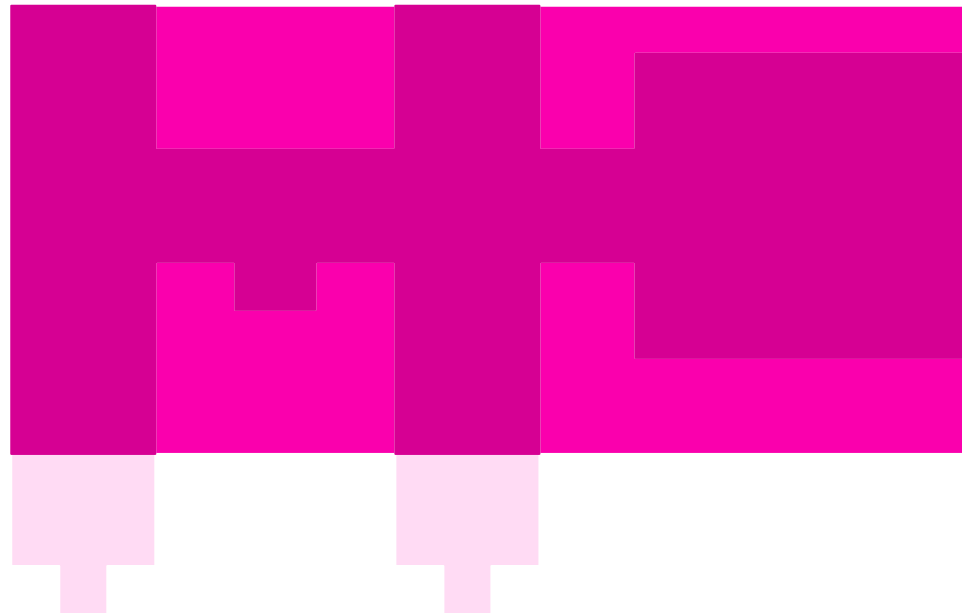
Building example



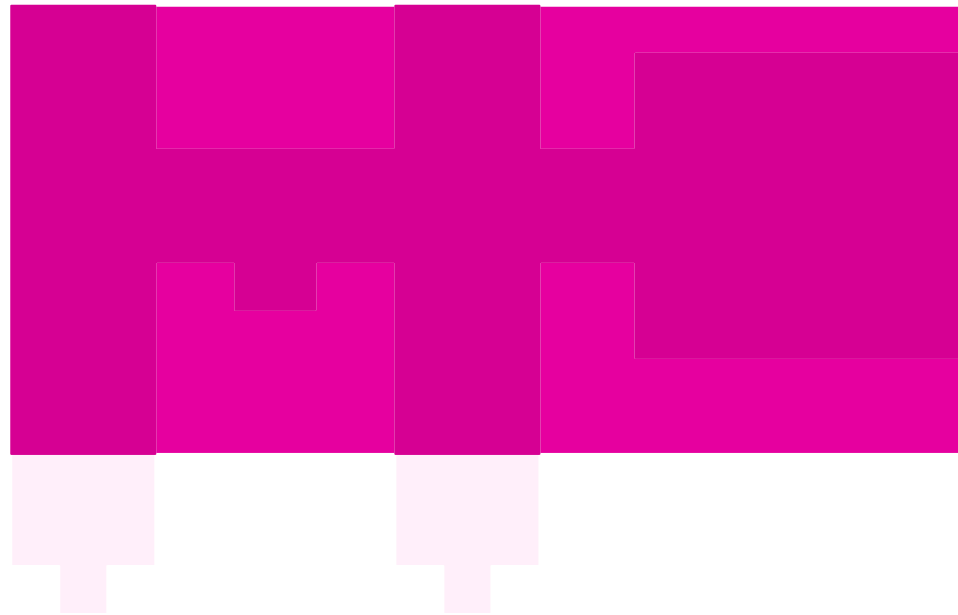
Building example



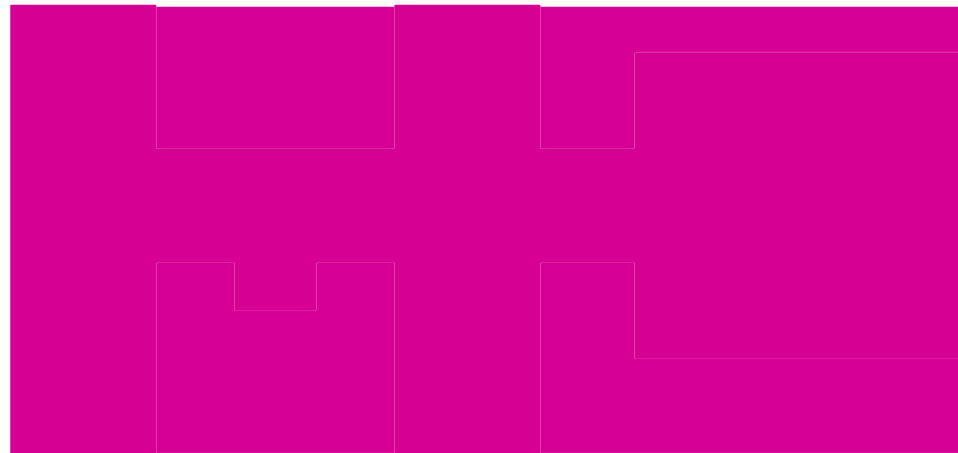
Building example



Building example



Building example

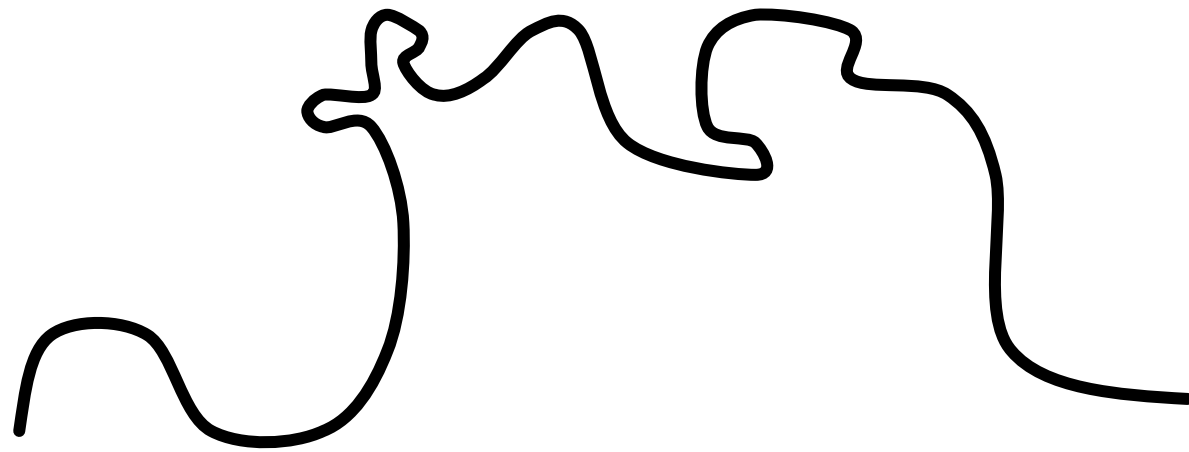


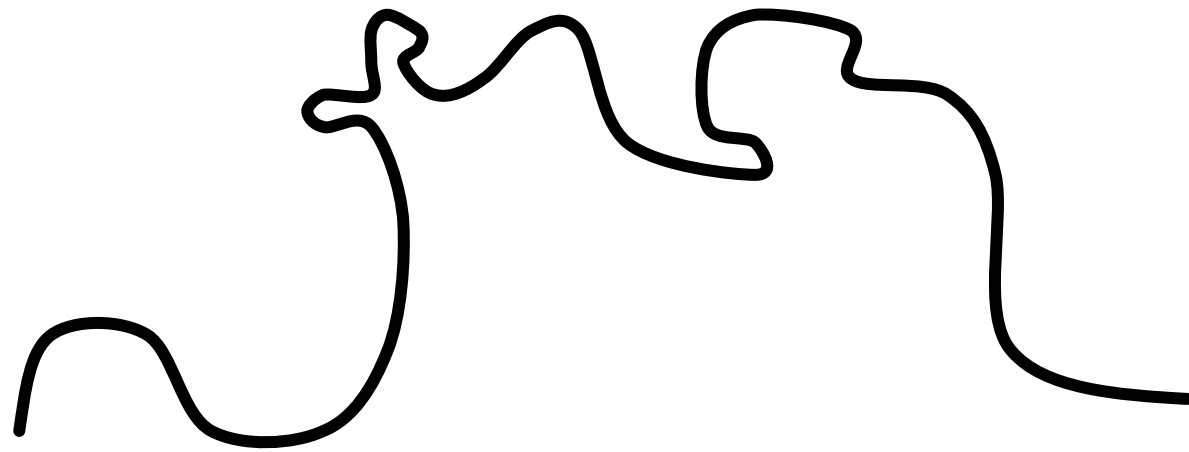
Building example

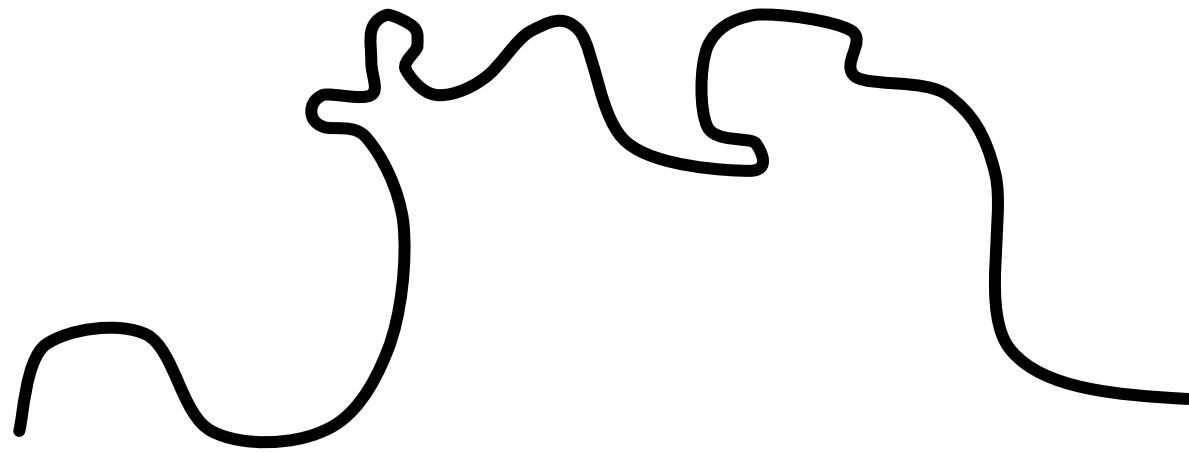


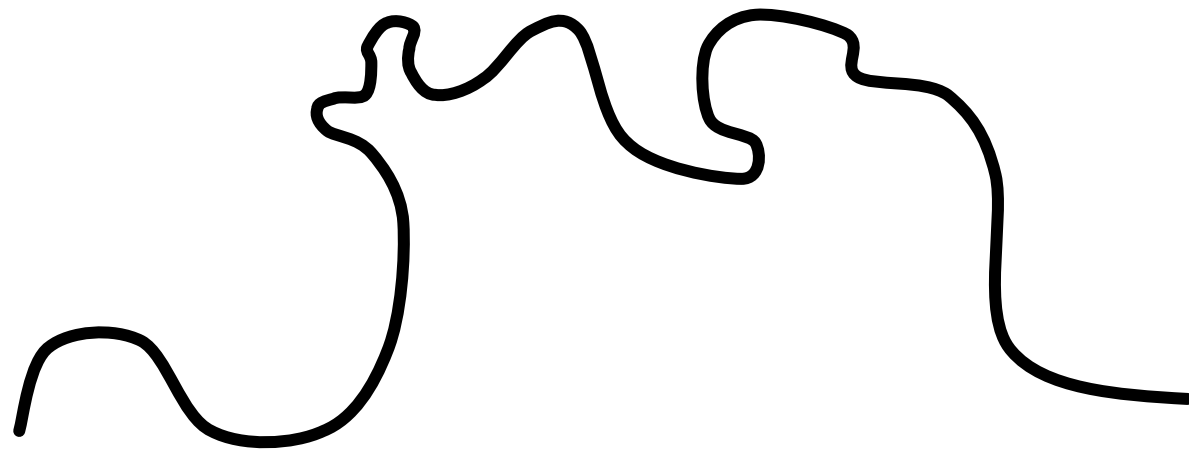
Polyline example

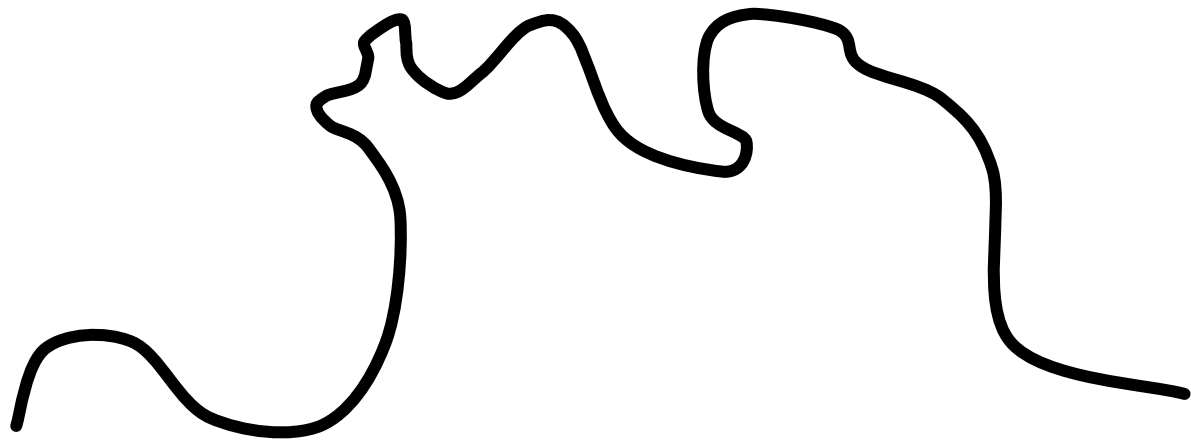
- Changing a polyline to its generalization
- Usually: simplification
Sometimes: typification, exaggeration
- Smooth change: morphing

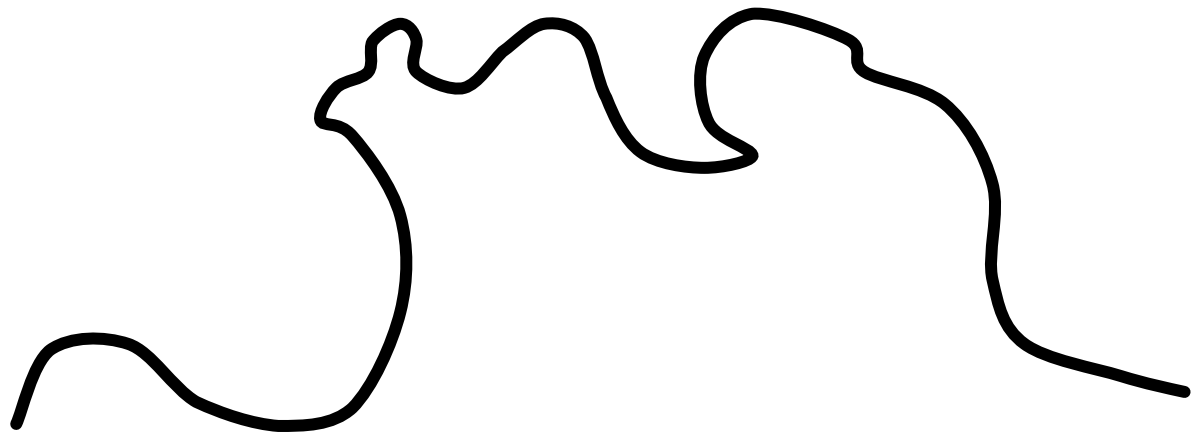




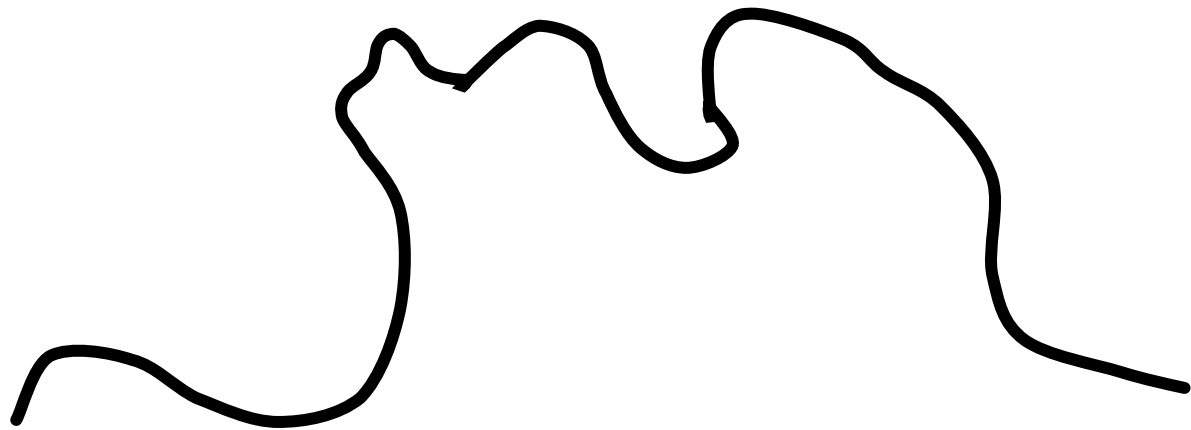


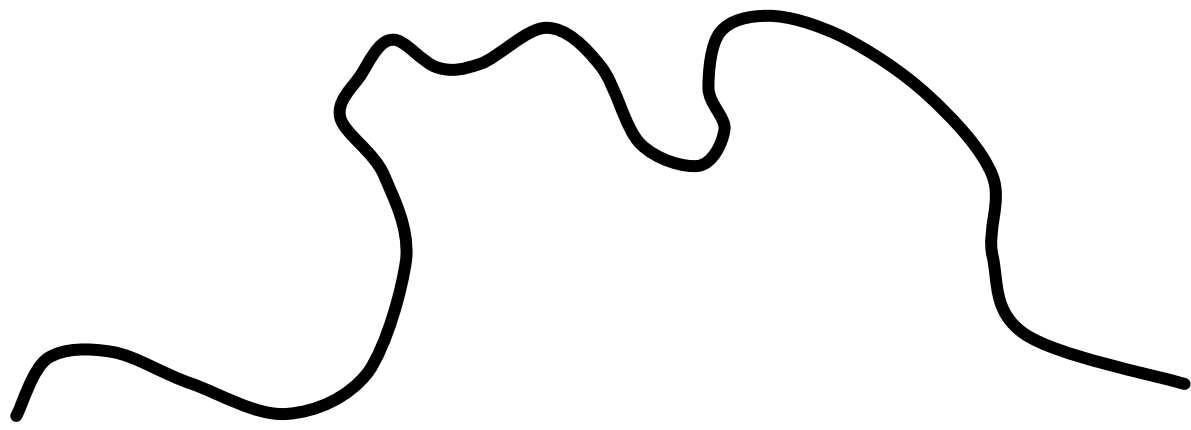


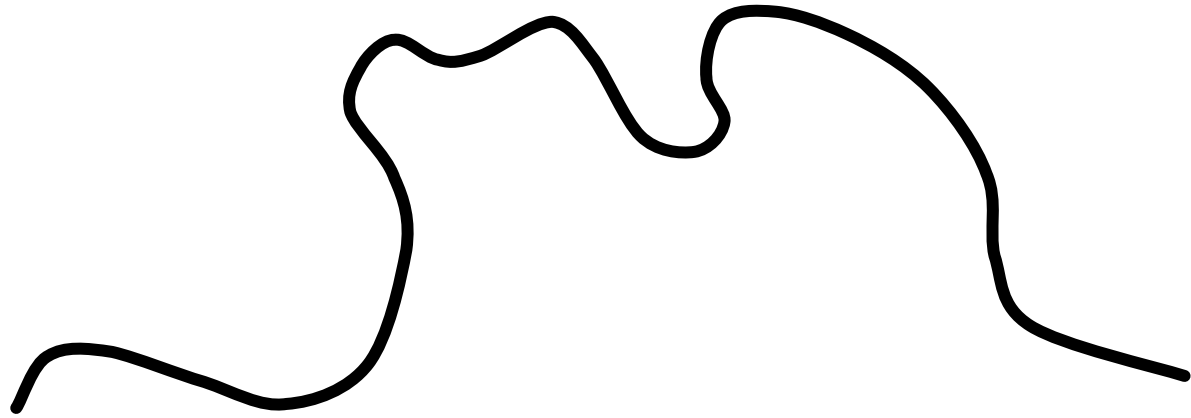


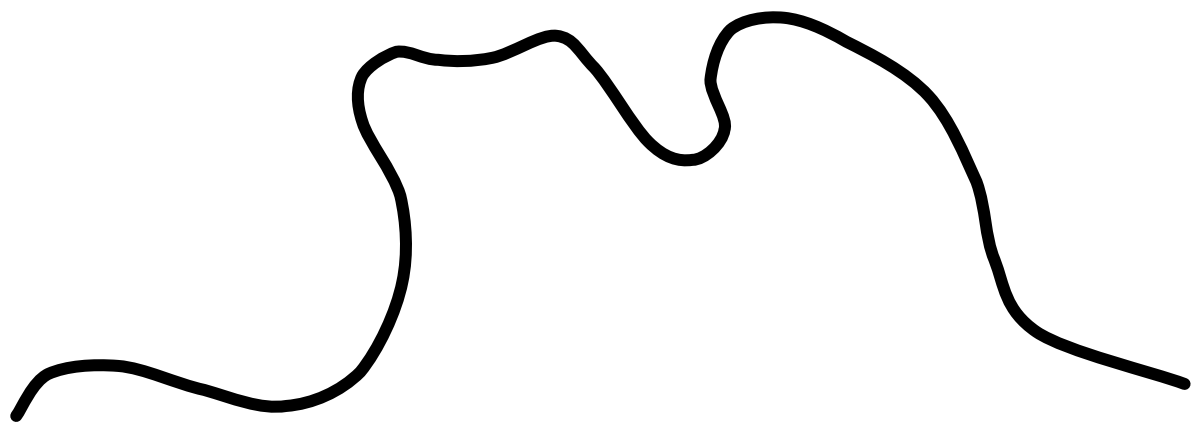


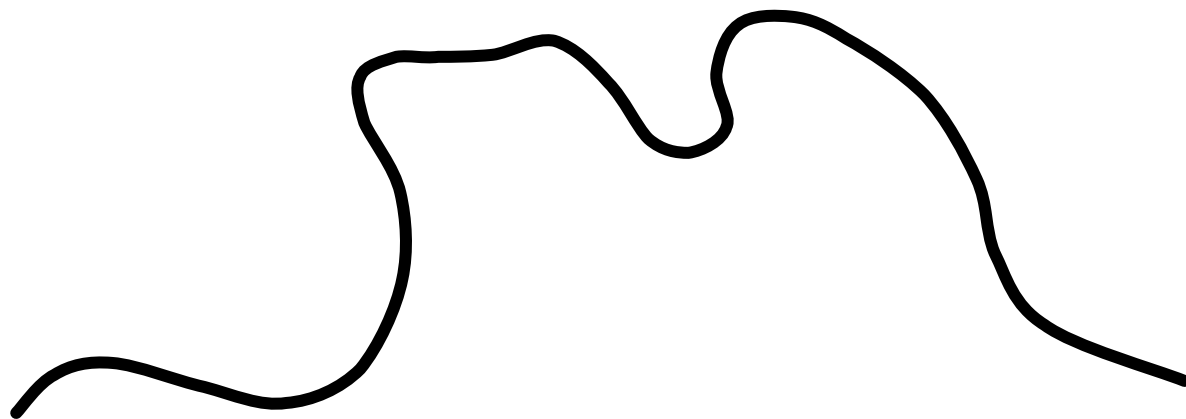


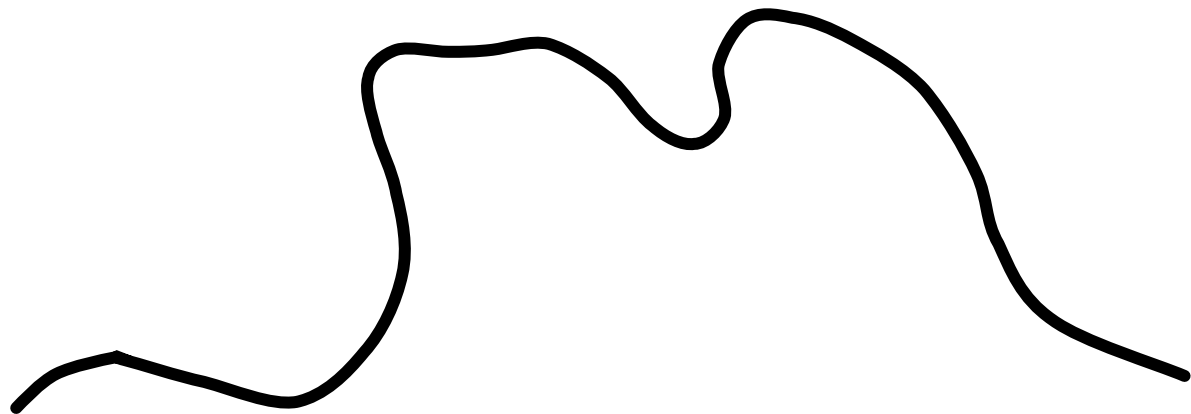


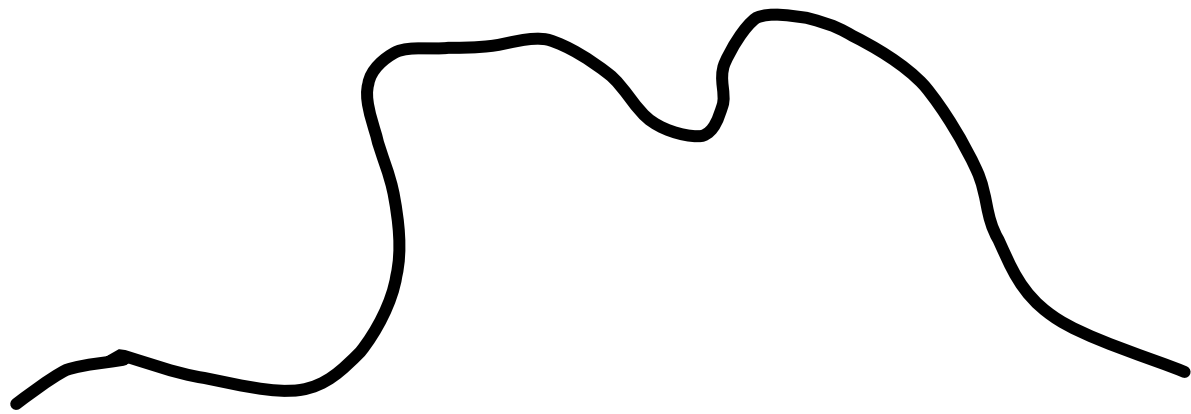


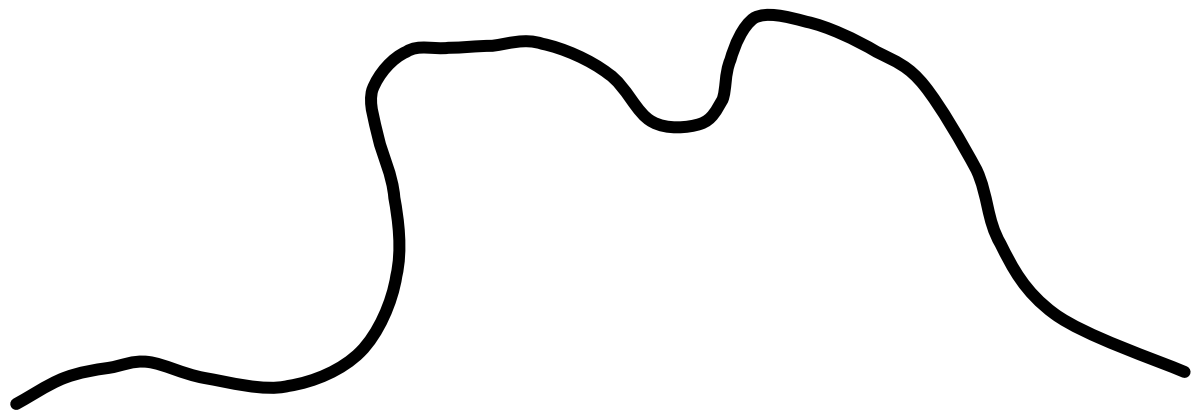


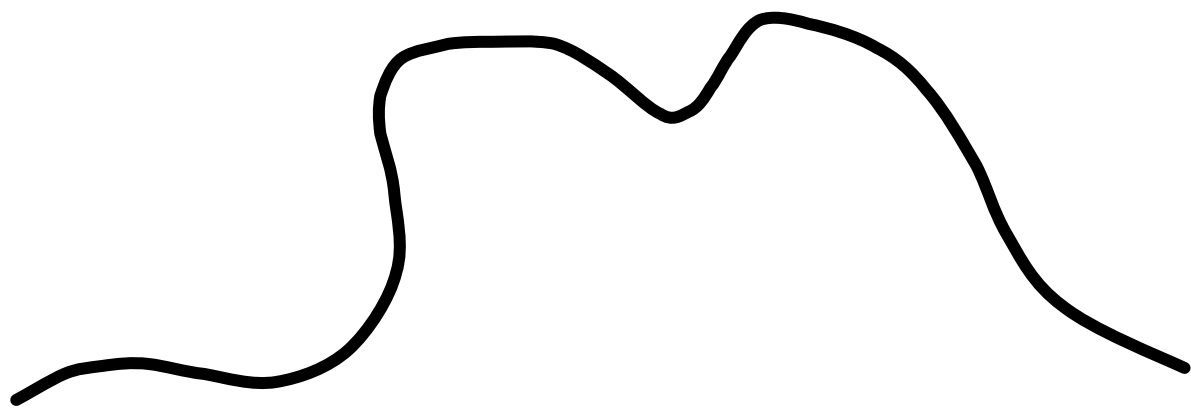


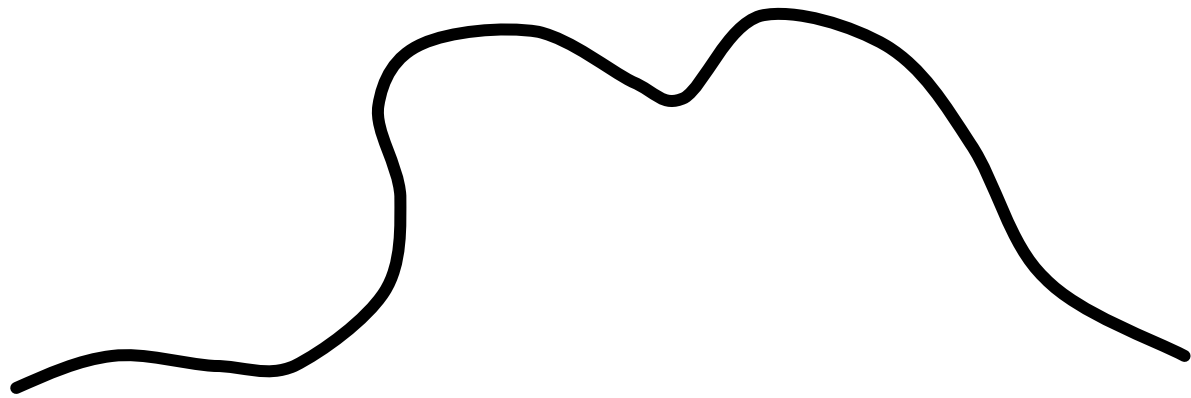


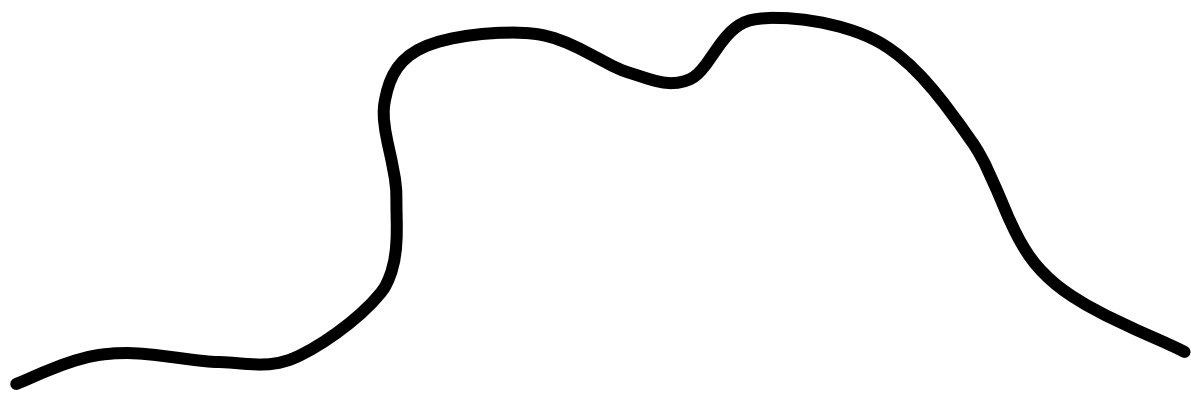


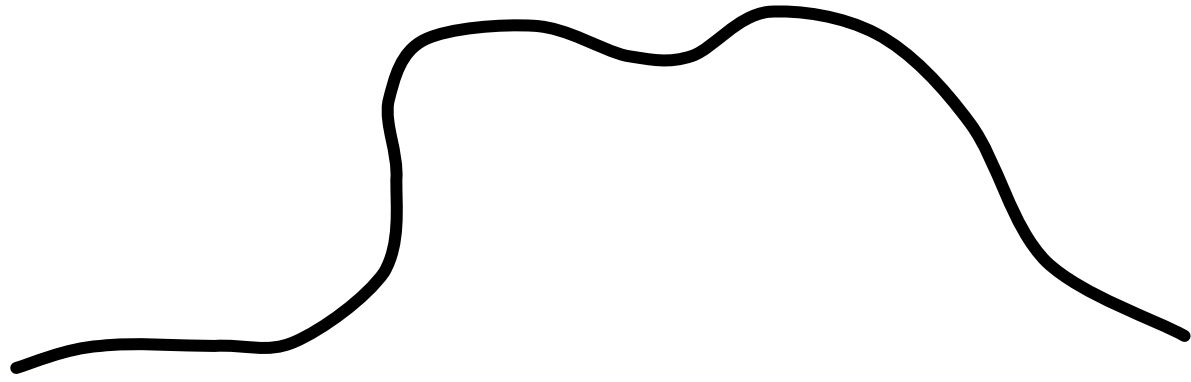


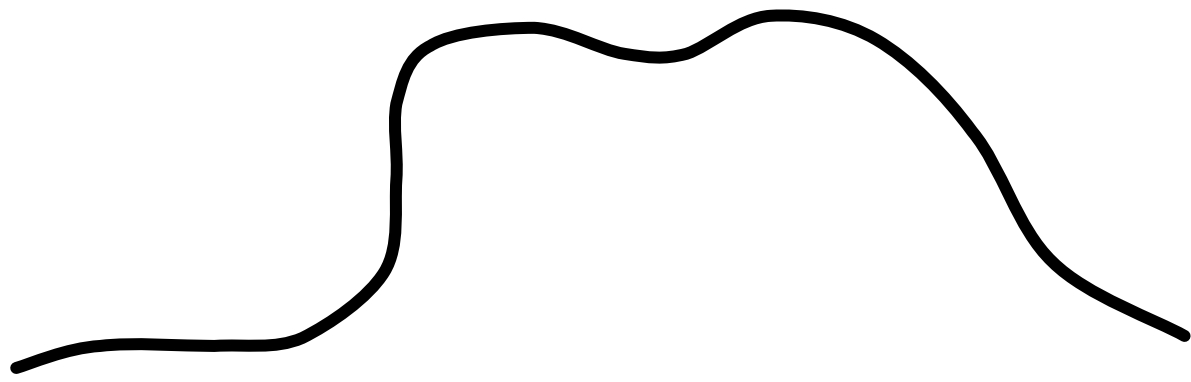


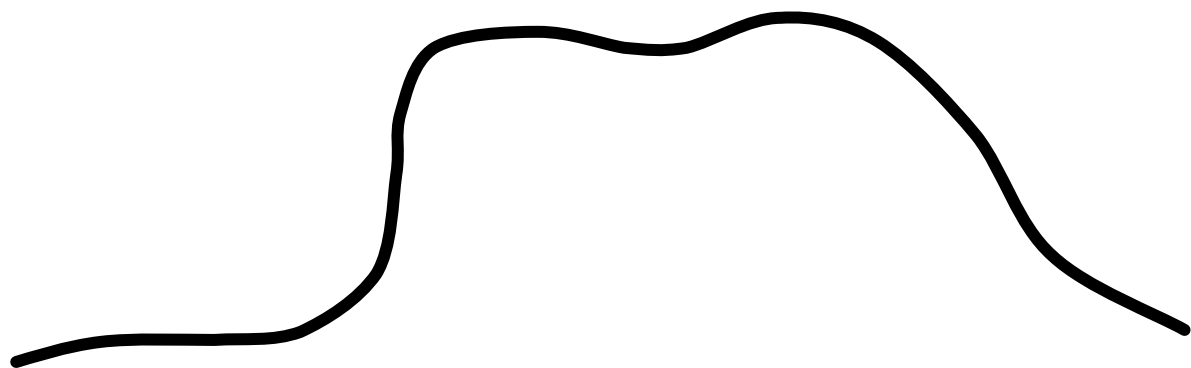


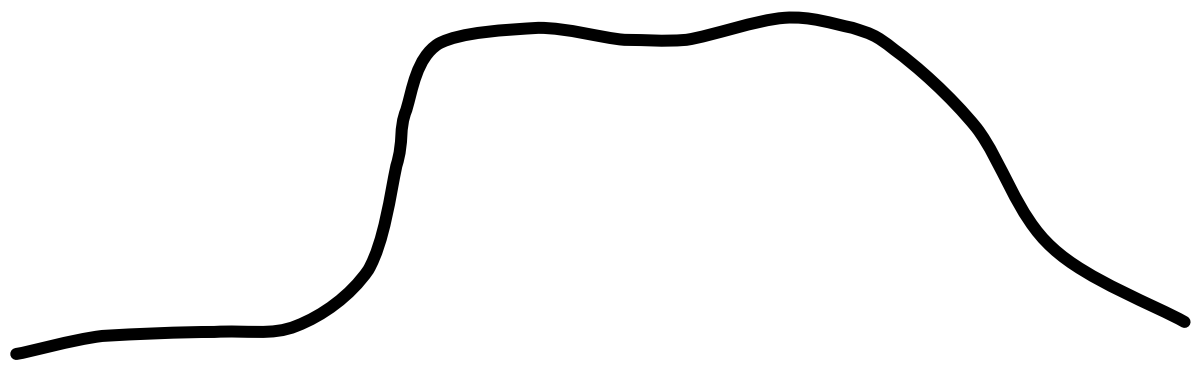


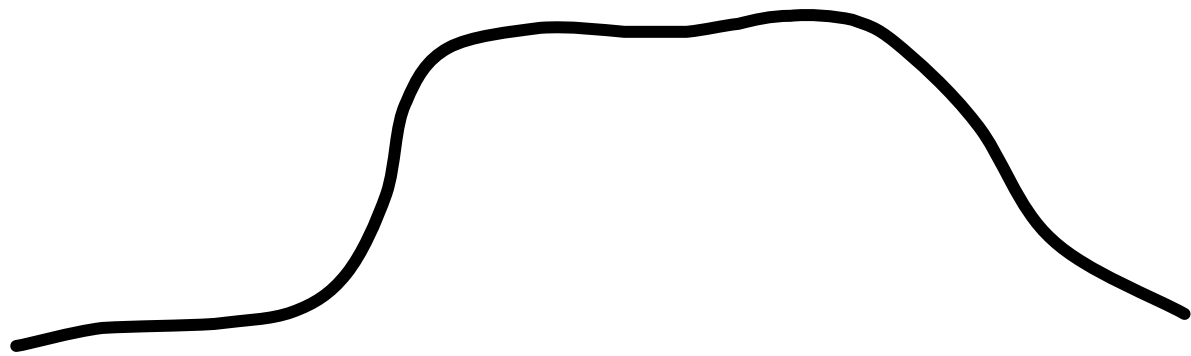


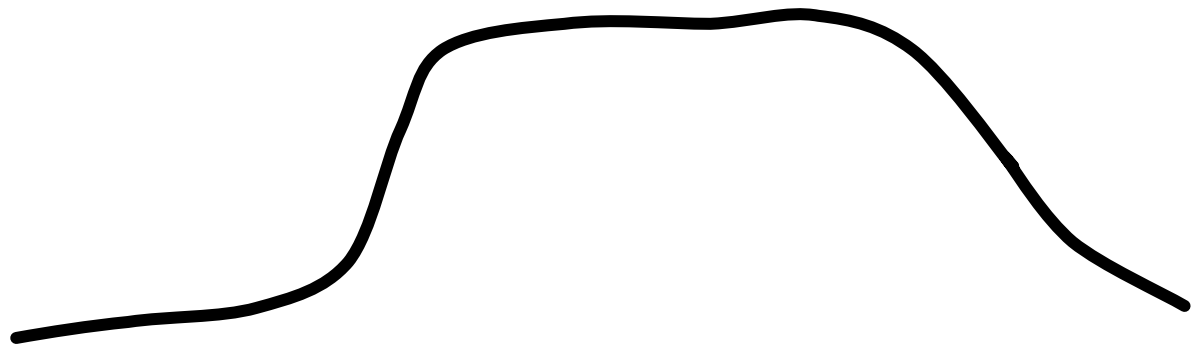


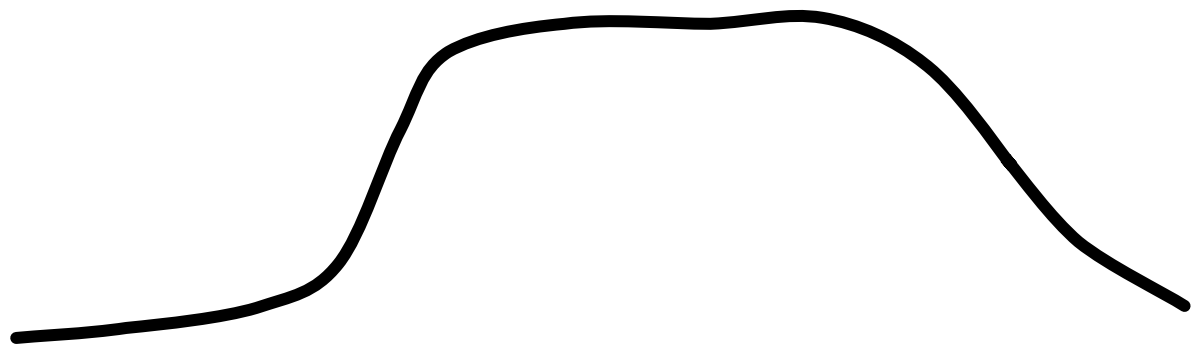


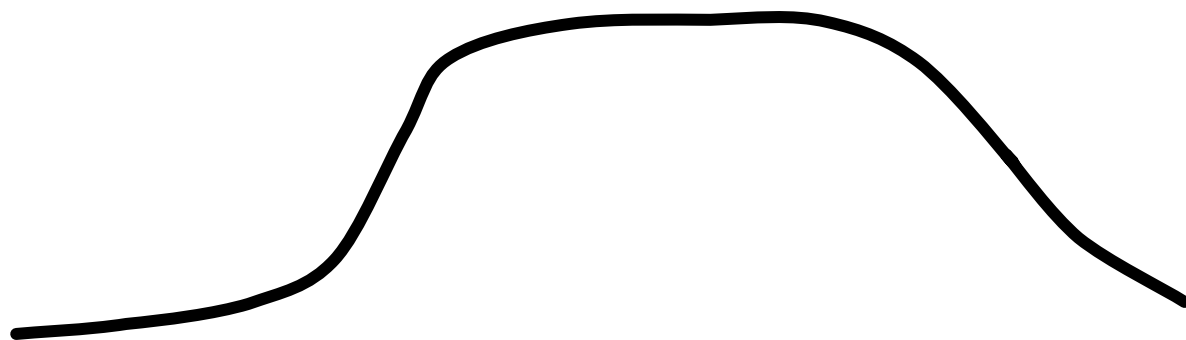


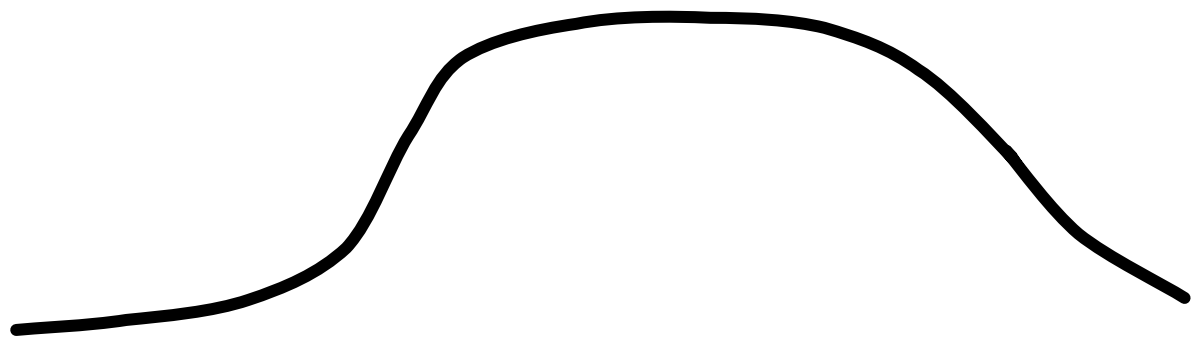


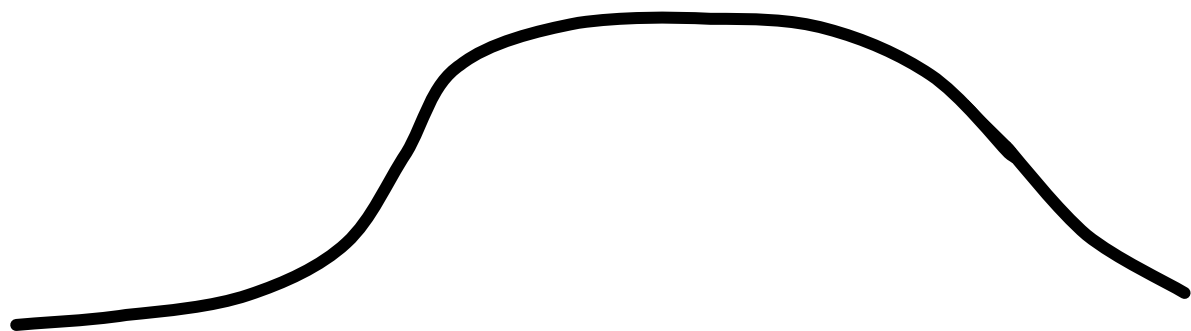


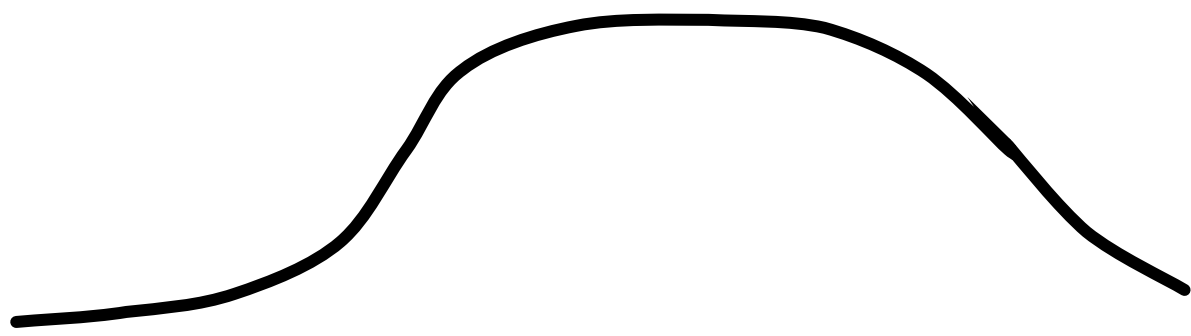


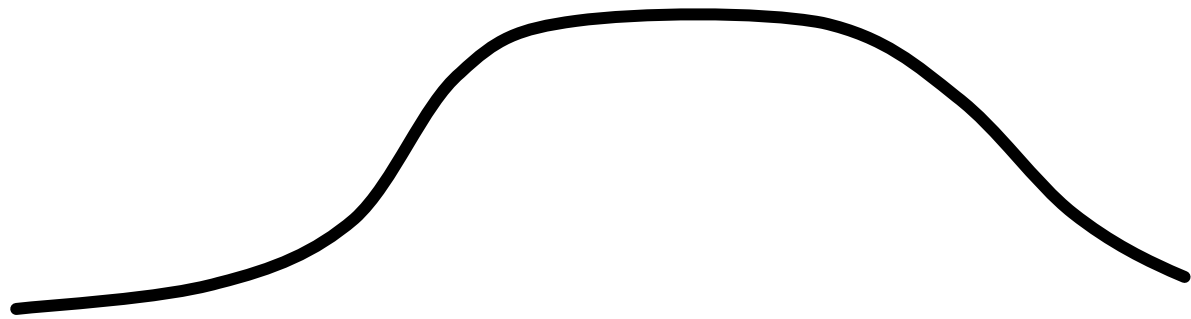


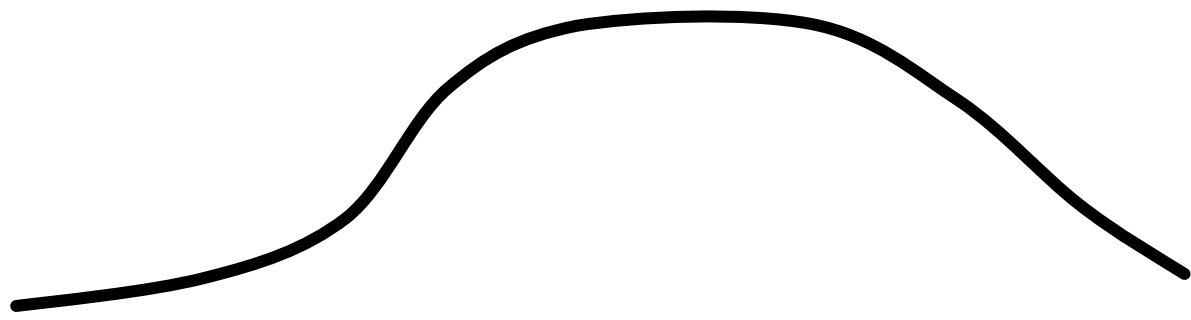




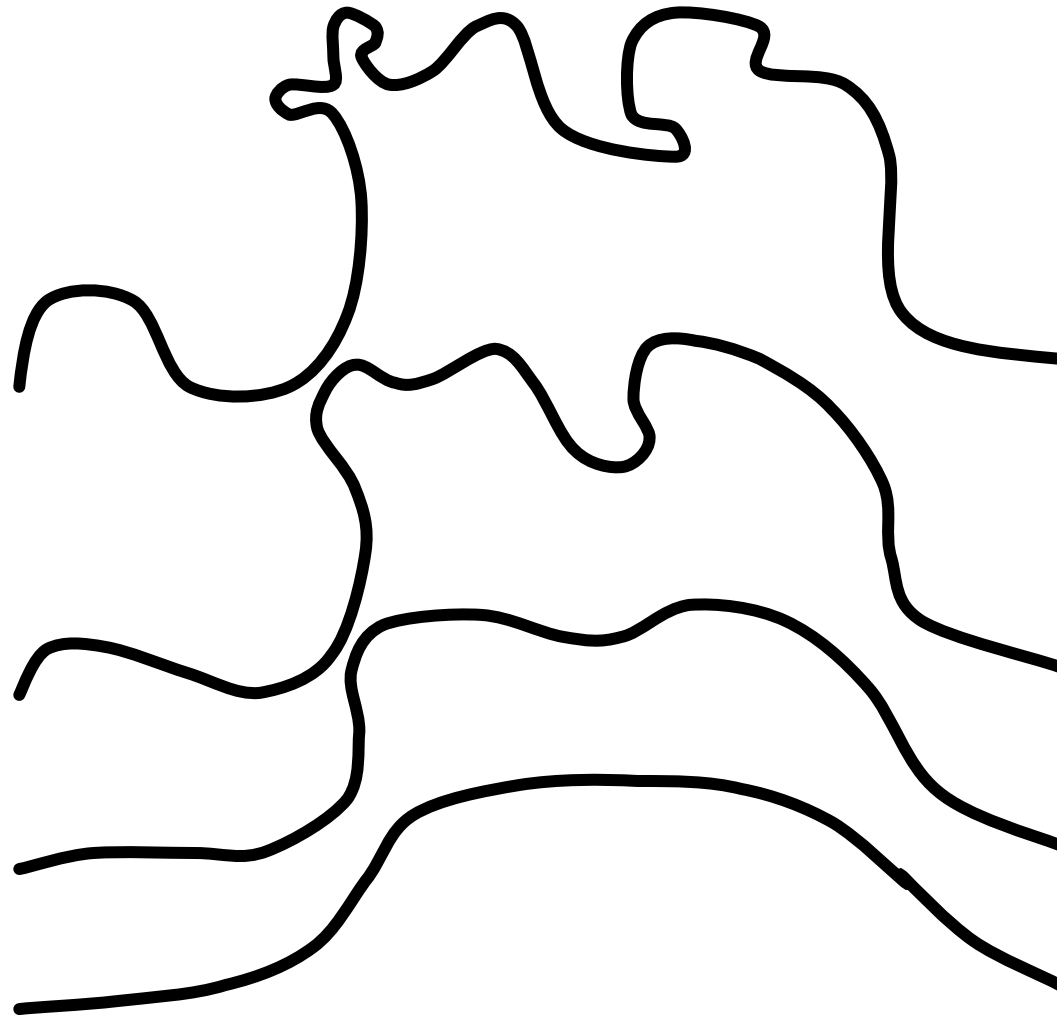








Some intermediate stages



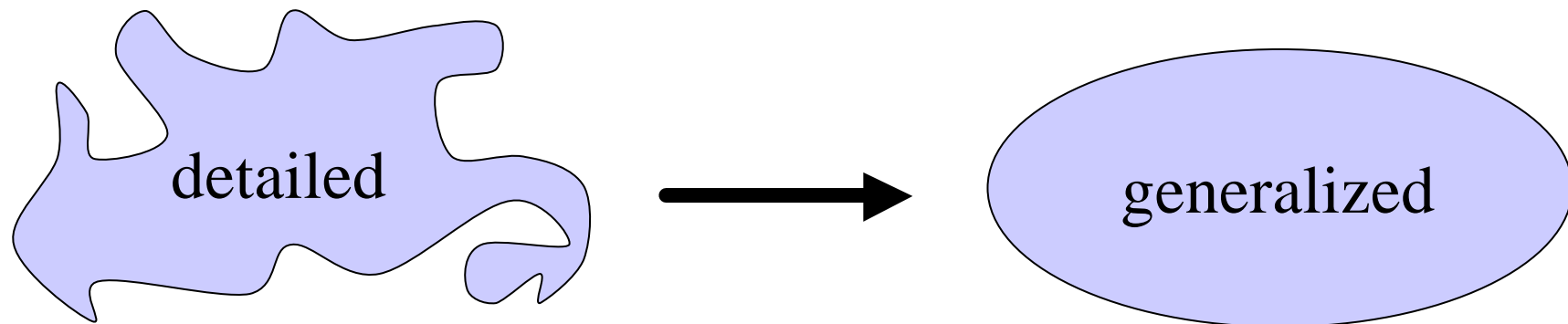
Generalization

Standard generalization:

- From a detailed feature and a desired map scale, compute a less detailed visualization

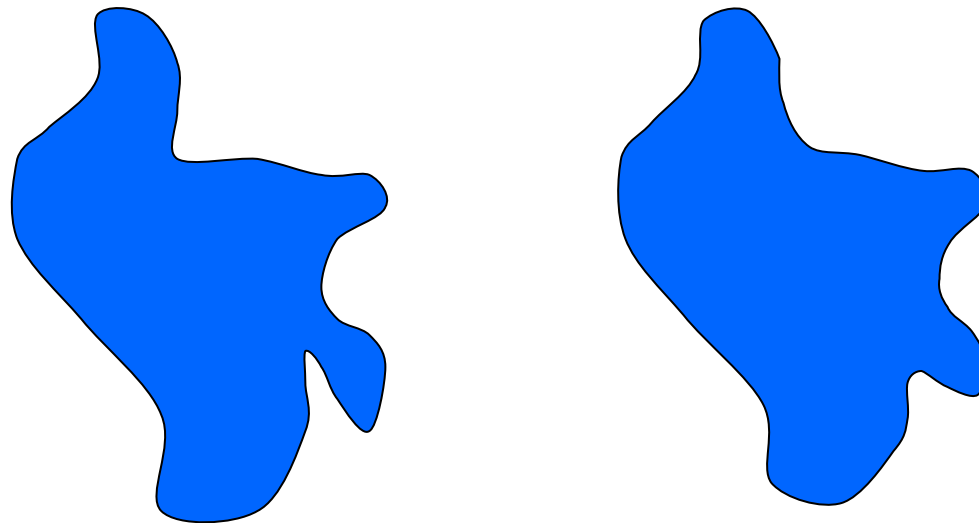
Smooth generalization:

- From a detailed feature and its generalization, compute a smooth transition to visualize it for any intermediate map scale



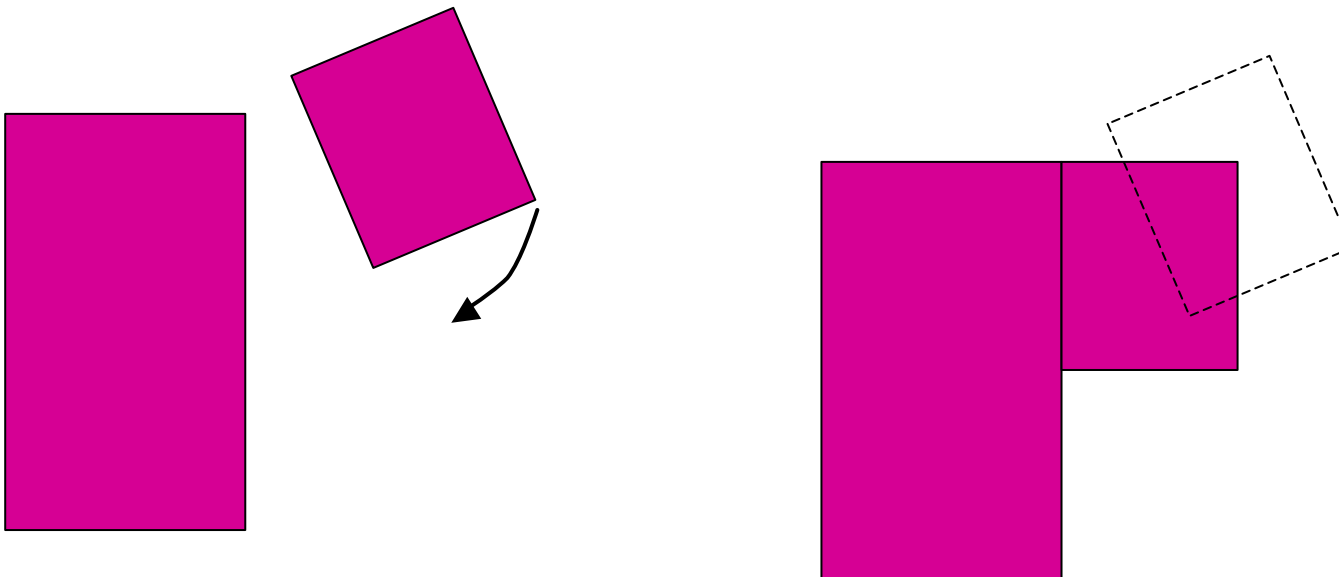
Visually smooth changes, I

- Morphing a 1-dim feature or boundary
e.g., line simplification



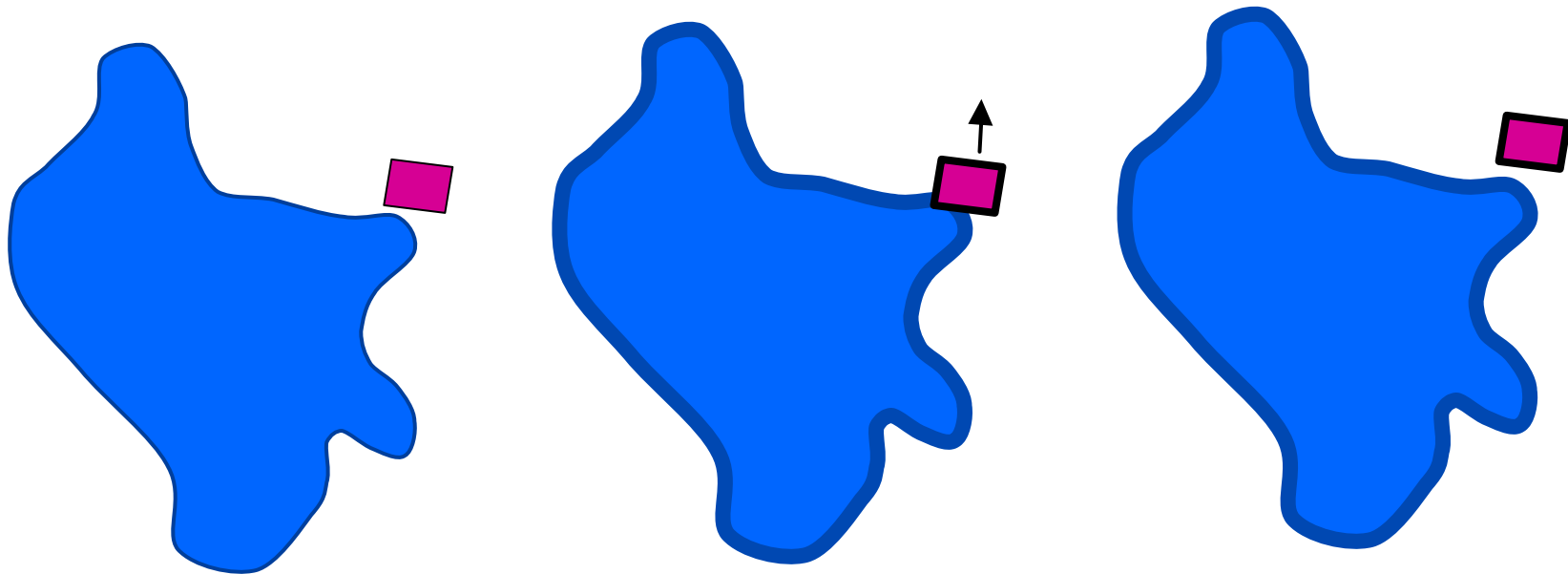
Visually smooth changes, II

- Rotating a feature
e.g., for alignment to precede building aggregation



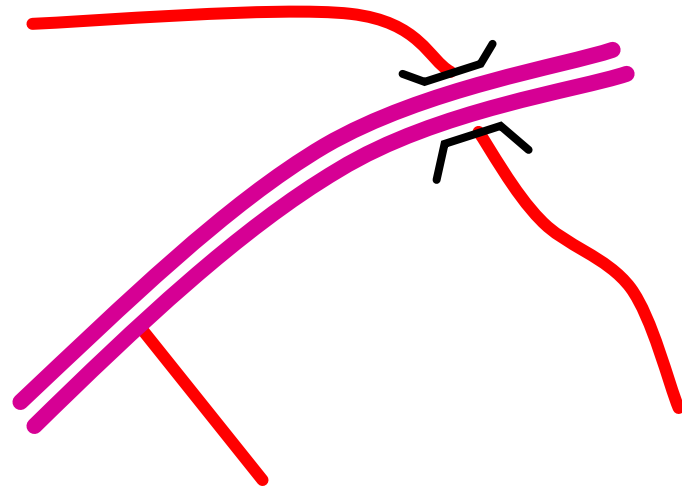
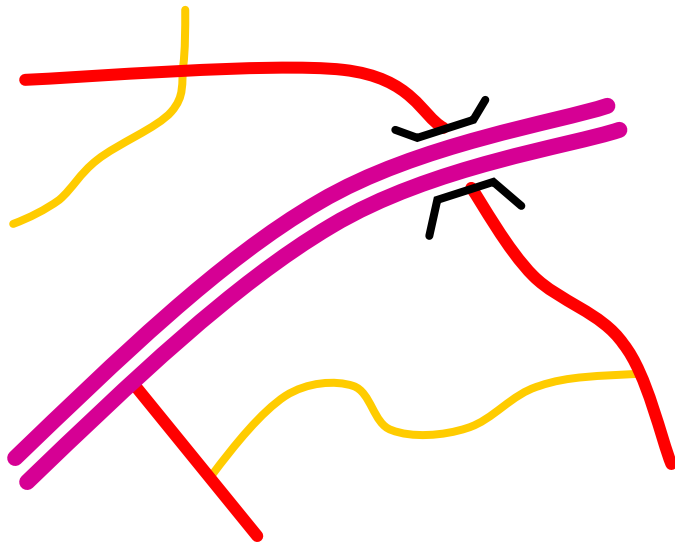
Visually smooth changes, III

- Moving a feature
displacement, to solve coalescence



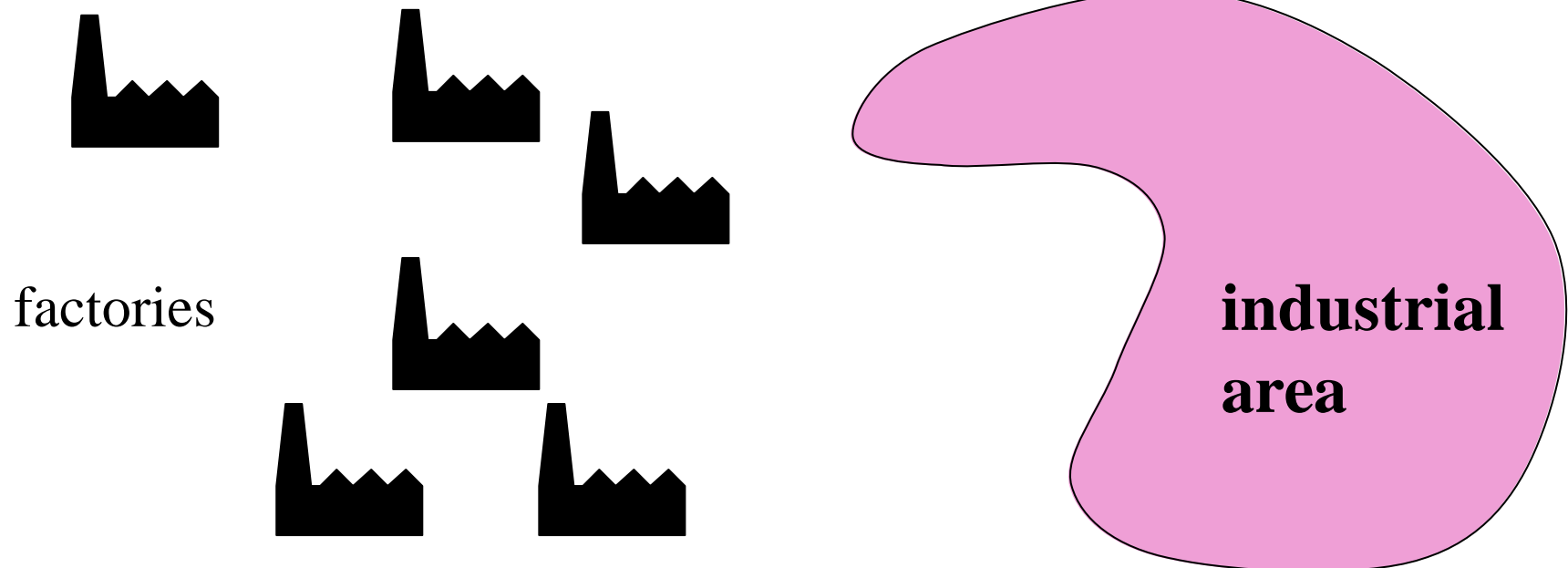
Visually smooth changes, IV

- Fading a feature into the background
elimination, or dissolution in a subdivision



Visually smooth changes, V

- Appearing of a feature
e.g., for area conversion



Visually smooth changes

- Moving
- Rotating
- Morphing
- Fading
- Appearing

Geometry change

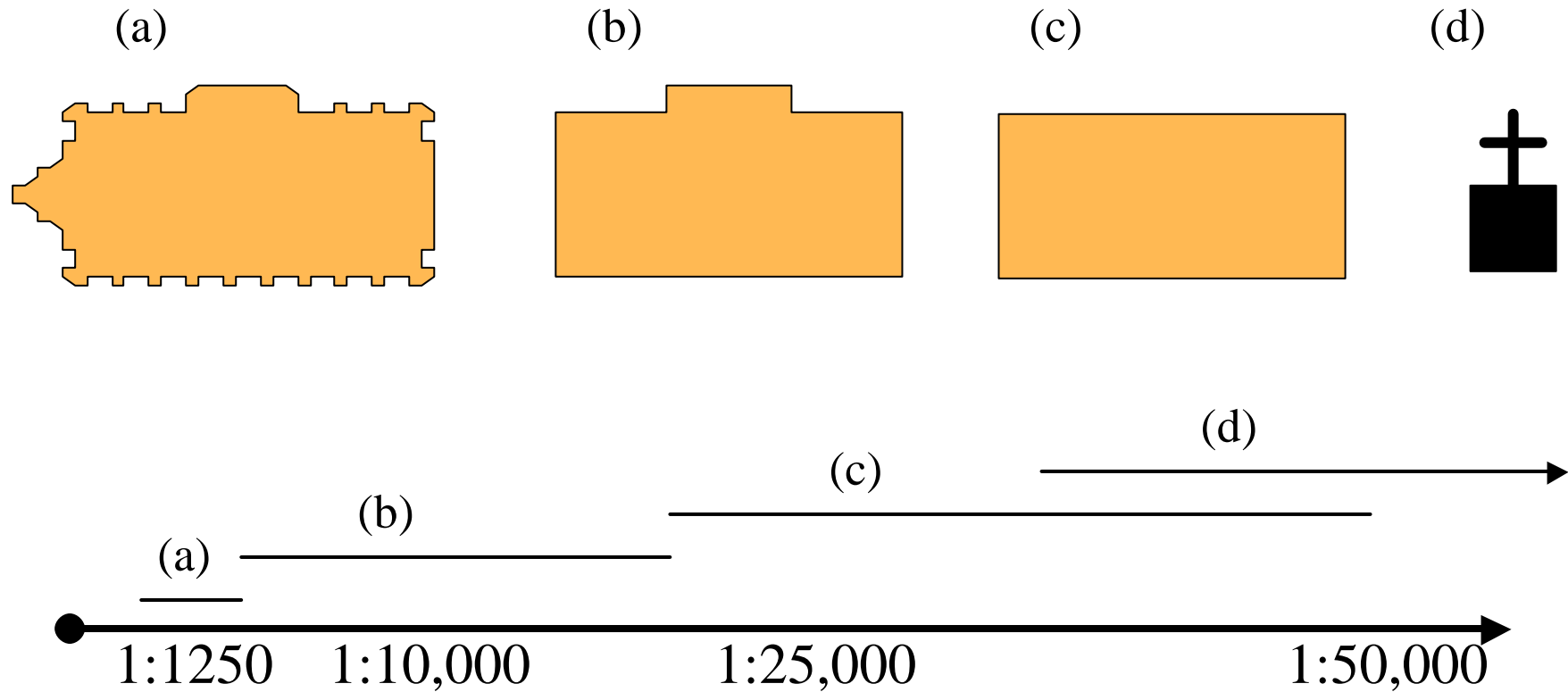
Color change

Which generalization operator can be implemented with what smooth change, and how?

Related work

- Generalization & morphing literature
- Animation in cartography (non-temporal animation)
[Kraak, MacEahren]
- Dynamic, or on-the-fly generalization
[Mackaness & Glover, van Oosterom]

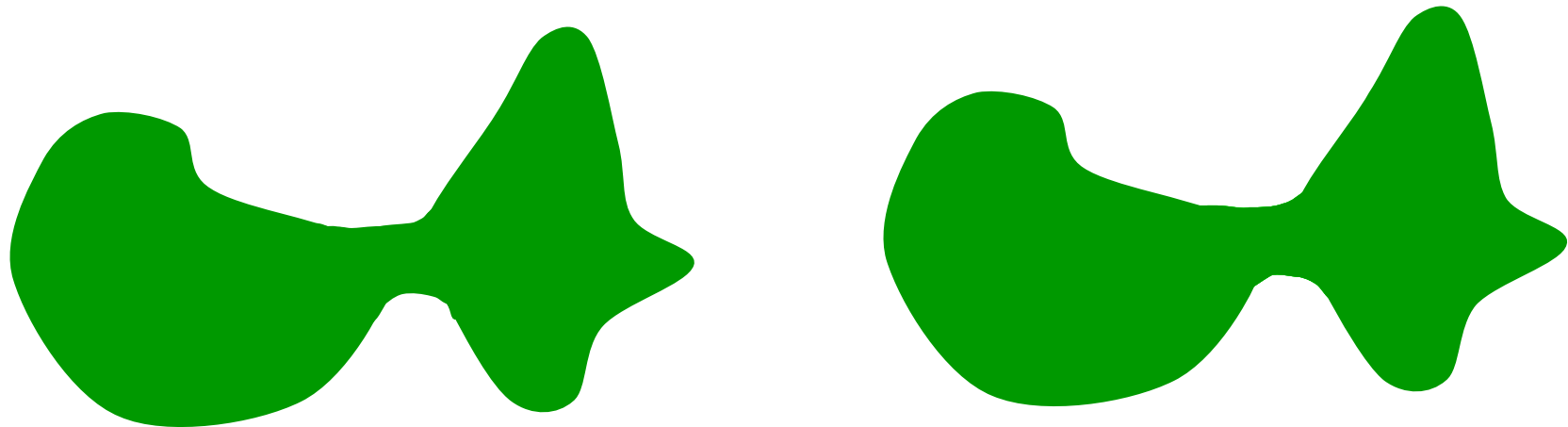
Multiple representations



(after Mackaness & Glover, 1999)

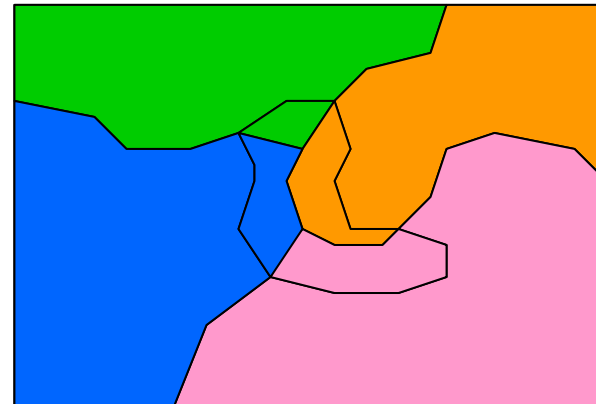
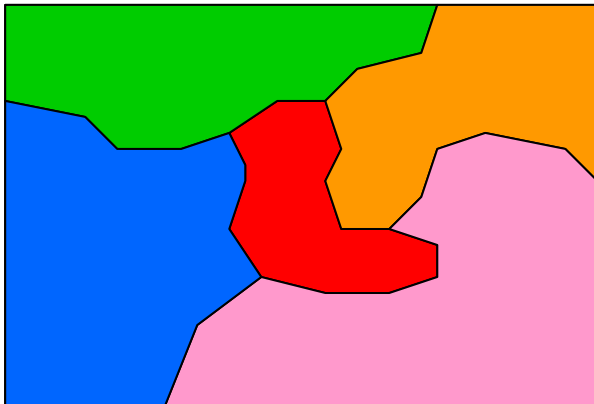
Some operators & smooth versions

- Elimination: fade or shrink (=morph)
- Displacement: move
- Aggregation: morph or appear



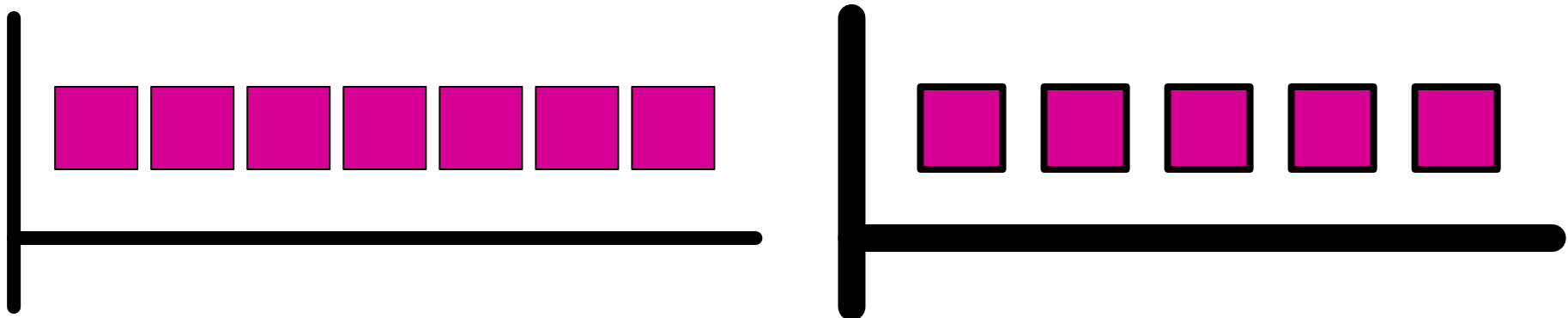
Some operators

- Dissolution: fade disappearing area, or grow (=morph) adjacent areas
- Classification: change colors to new color classes (=fade/appear); fade not needed boundaries



Many options: typification

- Fade 7 houses; let 5 appear
- Move 7 houses to the positions of 5
- Move 5 of 7 houses to new position; let 2 fade
- Same, but let 2 shrink to a point and vanish
- Shrink 7 houses; let 5 appear



Stationary and transitional maps

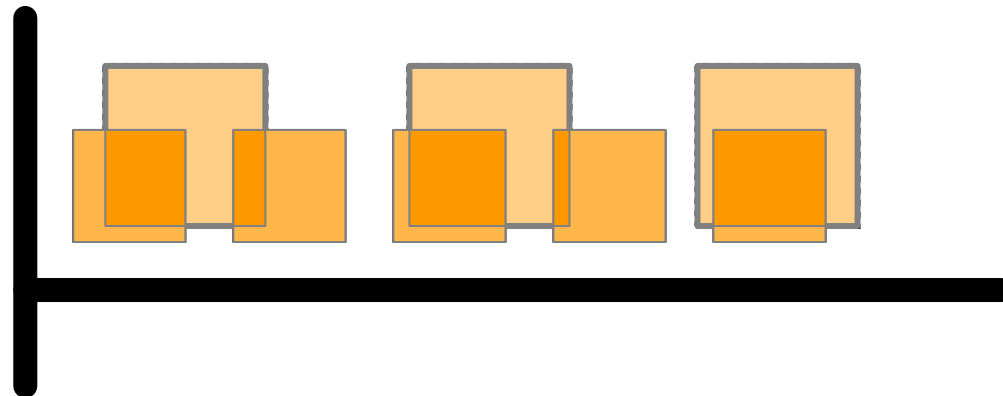
- *Stationary map:*
 - ‘normal’, not changing map
 - ‘Usual’ requirements
- *Transitional map:*
 - map that is undergoing changes (even if the user does nothing)
 - Requirements???

E.g., partially faded features must be allowed on transitional maps. Also some amount of congestion, coalescence?

User interaction

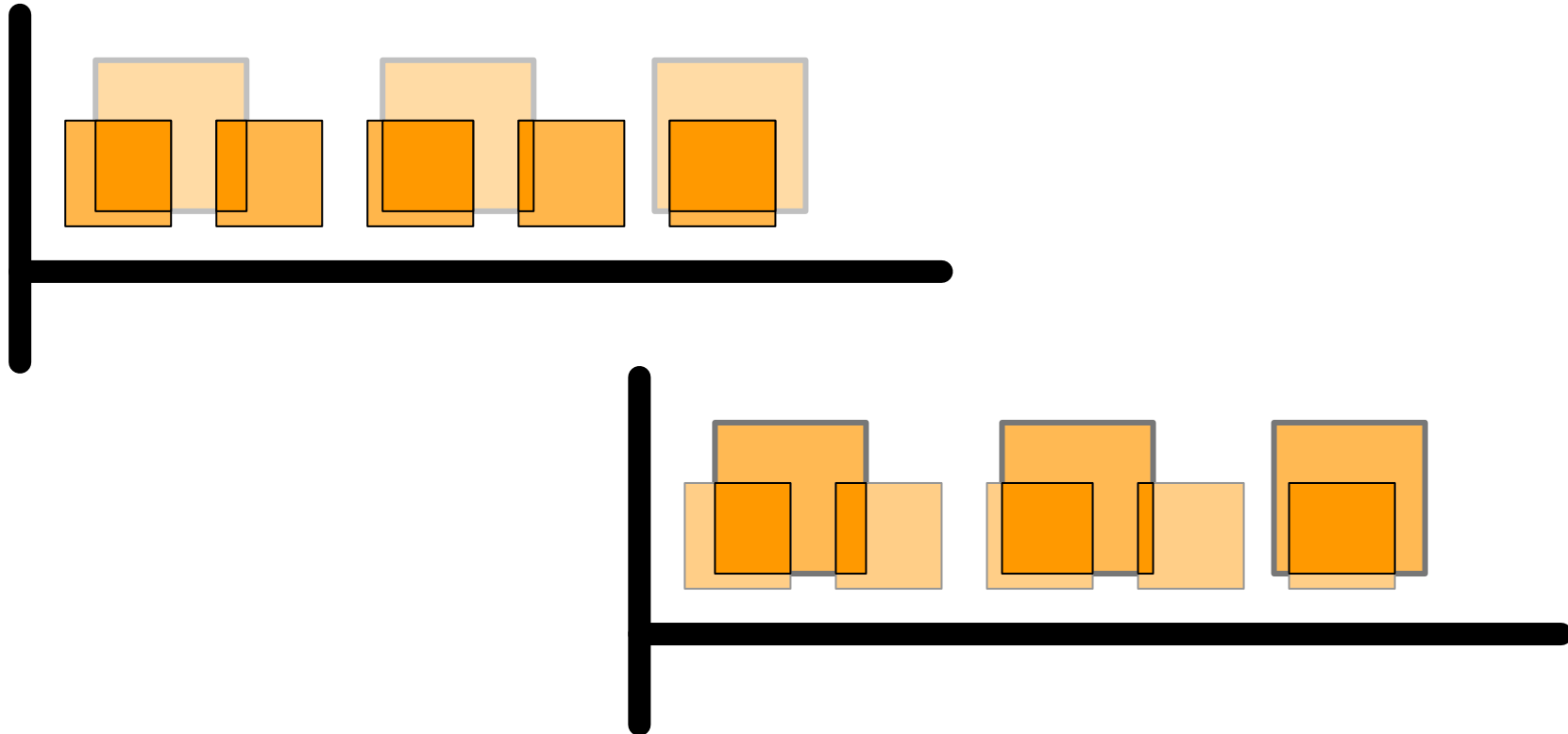
- What if the user stops zooming half-way a smooth change?

Cannot allow partially faded features when the transitional map becomes stationary....

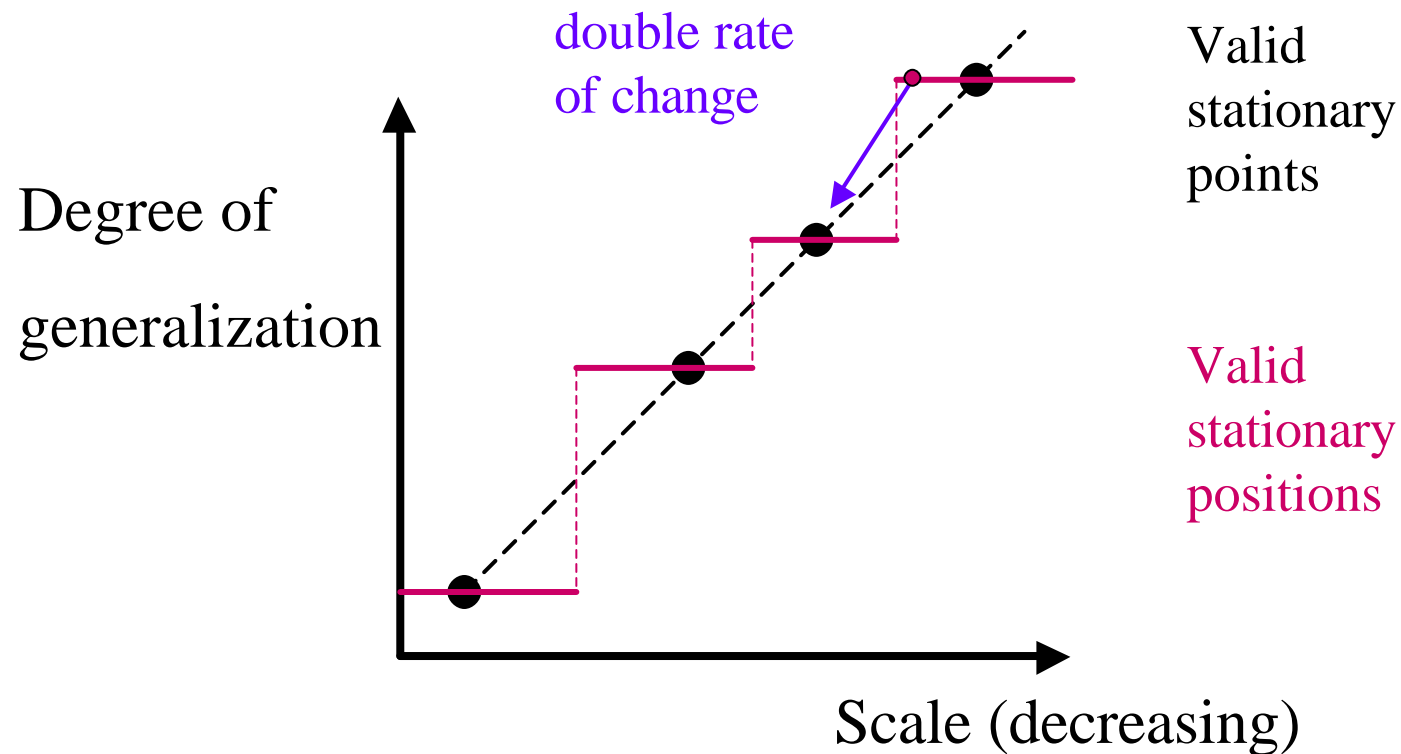


Nearest stationary representation

- Idea: keep changing to a situation that is allowed on a stationary map: continue, or undo



Scale, generalization, and rate of change

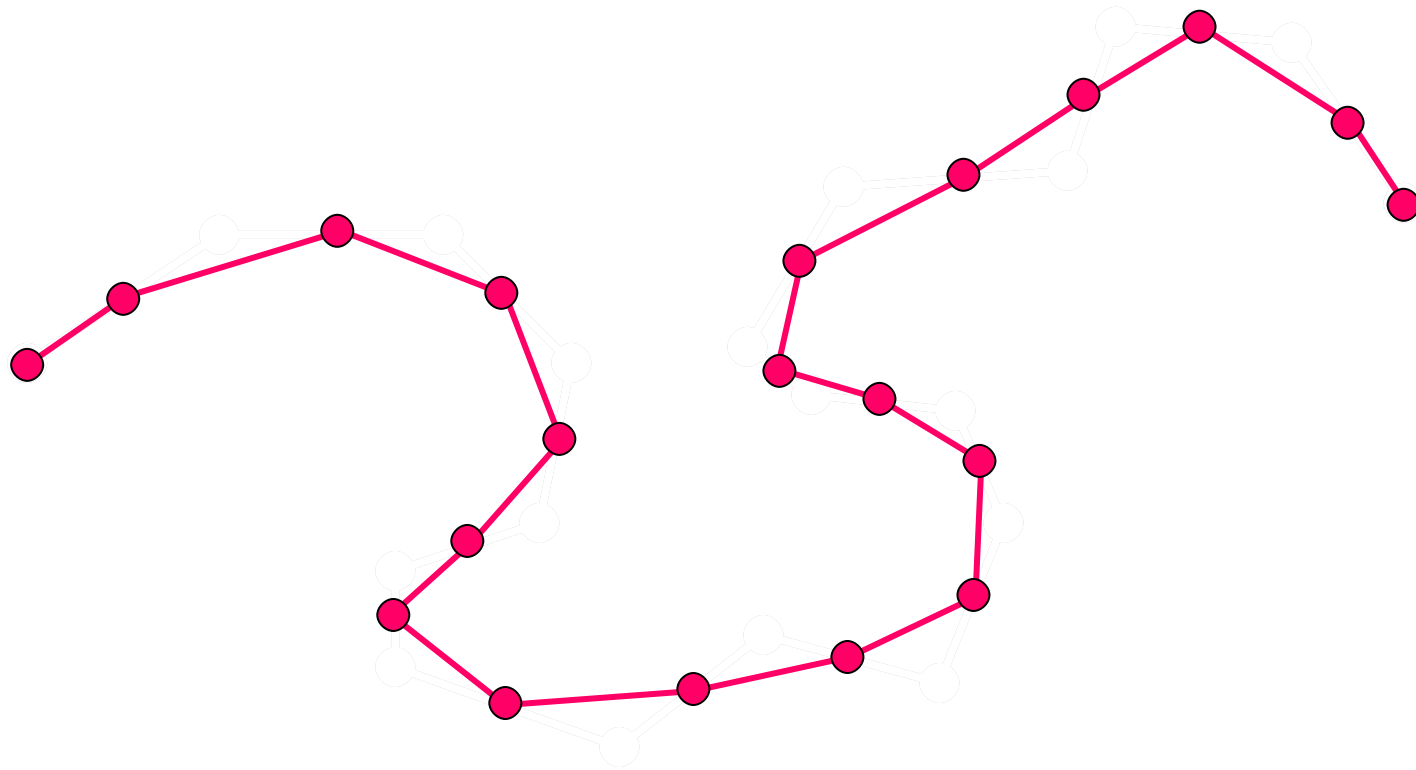


Implementing smooth changes

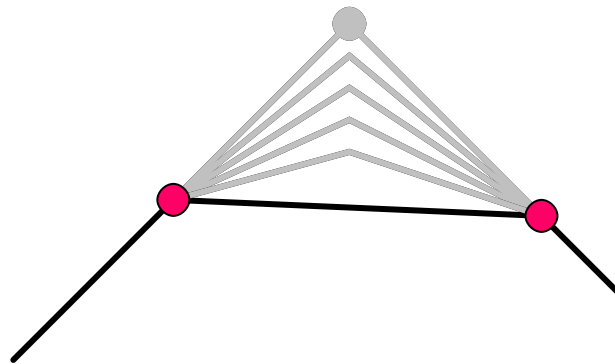
- Moving, rotating: easy (?)
- Morphing
- Fading, appearing: in raster or vector, easy (?)

*Need: simple methods that usually work well
(only for temporary, on-line maps)*

Easy morphing



Easy morphing



Summary

- Continuous zooming requires smooth generalization: computation of a sequence of representations for any map scale
- Five types of smooth change: move, morph, fade, ...
- Smooth change implies that the ideal generalization may not appear on a stationary map
- Changes must continue after zooming stops
- Smooth change should be implemented with simple means (temporary maps, quick-and-dirty)

Further work

- Implement and analyze visual appearance of smooth change
- Develop requirements for transitional maps
- Study smooth versions of the operators
- Analyze and solve the difficulties when several smooth changes take place simultaneously