Smooth Generalization for Continuous Zooming

Marc van Kreveld
Institute of Information and Computing Sciences
Utrecht University
Cartographic generalization

- Making changes that are necessary when changing the map scale
simplification
elimination
point conversion (symbolization)
aggregation (of polygons)
The means: operators

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

- Typification
  - Exaggeration
  - Point, line, area conversion

Deciduous, coniferous $\rightarrow$ forest

County borders $\rightarrow$ state borders
Operators: more examples

Partial line conversion

Exaggeration (enlargement)

Point-to-area conversion
Smooth changes during scale change

When zooming out, generalization changes should 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

factories

industrial area
Visually smooth changes

- Moving
- Rotating
- Morphing

Geometry change

- Fading
- Appearing

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

(a) (b) (c) (d)

(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

Degree of generalization

Scale (decreasing)

double rate of change

Valid stationary points

Valid stationary positions
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