Constraint-based Approach in Geological Map Generalization

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Content

1. Motivation
2. Geological map structures
3. Related Research
4. Methods
5. Experiments and results
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Motivation

Practical:
Demand for more flexible, reliable and more objective methods of geological map generalization

Theoretical:
Necessity for improvement of existing approaches for geological map generalization
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Geological map

- Uniquely suited to solving problems involving Earth resources, hazards, and environments
- A graphical presentation of geological observations and interpretations on a horizontal plane
- A complex map consisting of different structures and shapes on the map
Geological structures on the map
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Galanda, 2003

- Defined constraints for polygonal map generalization
  - Can be reused for the research
- Based on agent-based approach
  - Makes reasoning process complex
  - Less flexible in adding more generalization operators
- Generic solution for categorical map generalization
  - Exclusively on geological map generalization
  - Pragmatic definition of constraints and generalization algorithms
Peter, 1999, 2001

- Early conceptual steps of an integrated raster/vector approach
  - Can be used for the research
- Defines constraints for categorical data
  - Related to patches
  - Related to categories
  - Related to group of patches
- Highlights some advantages of raster generalization
  - Local data conversion
- Inspires the continuation of research on raster-based generalization.
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Methods

• **General approach:** Using constraints to control the overall process, and combing the advantages of the vector- as well as raster-based generalization.
Methods

Vector operators

Constraints

Raster operators
Methods

Constraints

conflict detection

value Severity

Method Evaluation

Method Measure(s)

value Goal value

conflict resolution

value List of plans

value Importance

value Priority

Galanda (2003), Ruas (1998)
## Methods

### Modelling constraints

<table>
<thead>
<tr>
<th>Constraints</th>
<th>The distance between two polygons should not be less than minimum distance (i.e. minimum visual separability).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal Value</strong></td>
<td>1 mm</td>
</tr>
<tr>
<td><strong>Measure</strong></td>
<td>Shortest distance between polygons</td>
</tr>
</tbody>
</table>
| **Plans**                                                                  | 1. Displace  
2. Exaggerate  
3. Aggregate  
4. Typify                                                                 |

*Galanda (2003)*
## Vector environment

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Goal value</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum distance between consecutive vertices</td>
<td>Distance between consecutive vertices must not be less than the readability unit.</td>
<td>0.1 mm</td>
<td></td>
</tr>
<tr>
<td>Minimum shape width</td>
<td>Width and height of polygon less than goal value must be eliminated</td>
<td>0.6 mm</td>
<td></td>
</tr>
<tr>
<td>Minimum shape height</td>
<td>Width and height of polygon less than goal value must be eliminated</td>
<td>0.4 mm</td>
<td></td>
</tr>
</tbody>
</table>

*Galanda (2003)*
## Vector environment

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Goal value</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior width</td>
<td>The interior width of polygons must not be less than minimum separability unit</td>
<td>0.6 mm</td>
<td><img src="image" alt="Example" /></td>
</tr>
<tr>
<td>Minimum size</td>
<td>Polygons must not be smaller than the differentiation size</td>
<td>4.0 mm²</td>
<td><img src="image" alt="Example" /></td>
</tr>
<tr>
<td>Polygon separability</td>
<td>The distance between two polygons must not be less than minimum readability unit</td>
<td>1 mm</td>
<td><img src="image" alt="Example" /></td>
</tr>
</tbody>
</table>

*Galanda (2003)*
## Raster environment

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Goal value</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polygon separability</td>
<td>Polygons should be differentiated from each other</td>
<td>At least four pixels (for 1:25 000)</td>
<td><img src="image" alt="Polygon Example" /></td>
</tr>
<tr>
<td>Line separability</td>
<td>Lines must be differentiated from each other</td>
<td>At least two pixels (for 1:25 000)</td>
<td><img src="image" alt="Line Example" /></td>
</tr>
</tbody>
</table>

*Steiniger et al. (2008)*
### Methods

## Modelling constraints

<table>
<thead>
<tr>
<th>Constraints</th>
<th>Polygons must not be smaller than the differentiation size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal Value</td>
<td>4.0 mm²</td>
</tr>
<tr>
<td>Measure</td>
<td>Area measurement methods</td>
</tr>
<tr>
<td>Plans</td>
<td>1. Enlarge</td>
</tr>
<tr>
<td></td>
<td>2. Aggregate</td>
</tr>
<tr>
<td></td>
<td>3. Eliminate</td>
</tr>
</tbody>
</table>

*Galanda (2003)*
Methods
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Experiments and results

- Eliminate
- Exaggeration (enlargement)
- Simplify
- Smooth
- Amalgamate
- Collapse
- Displacement

Constraint for:

- Operator and algorithm selection
- Appropriate prioritizing
Experiments and results

Merging polygons that are too small with a neighbouring polygon.

Before

After
Experiments and results

Identification of minimum distance between vertices and polygons.
Experiments and results

Identification of minimum distance between vertices and polygons.
Experiments and results

Before

After

Raster Generalization using Morphological Operator Dilate 3x3 kernel size
Experiments and results

Grow-and-shrink algorithm for the amalgamation operator.
Peter, Weibel 1999
Vector and Raster vs Vector or Raster

- More efficient
- More accurate
- More flexible
Summary

• Present geological knowledge
• Define constraints for geological map generalization;
• Identify operators and develop/implement algorithms that best suit vector- vs raster-based generalization;
• Compare and contrast the results for improvement of geological map generalization.
Thank you!

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